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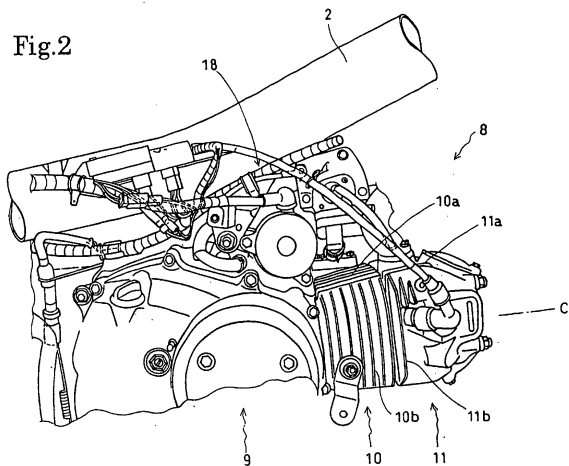
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(54) **INTERNAL COMBUSTION ENGINE FOR MOTORCYCLE**

(57) An internal combustion engine for a motorcycle provided with a leg shield (15) having right and left side walls extending on the opposite sides of a front frame (2) extending obliquely downward toward the rear from an upper part of a front fork (5). The internal combustion engine includes a cylinder (10) and a cylinder head (11). The internal combustion engine is suspended from the front frame (2) with the axis (C) of the cylinder (10) substantially horizontally extended, and the right and the left side wall of the leg shield (15) are extended on the right and the left side of the front frame (2), respectively, so as to cover the opposite sides of the cylinder (10) and the cylinder head (11). At least either the cylinder (10) or the cylinder head (11) is provided on its upper and lower side surfaces with first cooling fins (10a, 11a) parallel to the axis (C) of the cylinder (10), and at least either the cylinder (10) or the cylinder head (11) is provided on its right and left side surfaces with second cooling fins (10b, 11b) extending perpendicularly or substantially perpendicularly to the axis (C) of the cylinder (10). The substantially vertical second cooling fins (10b, 11b) enable air that has flowed into the depth of a space defined by the internal combustion engine (8), the front frame (2) and the right and the left side wall of the leg shield (15) to flow downward.



## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to an internal combustion engine provided with cooling fins for a motorcycle.

### BACKGROUND ART

**[0002]** Referring to Fig. 5, an internal combustion engine 01 for a small motorcycle is suspended from a front frame 02 extending obliquely downward toward the rear from an upper part of a front fork with the axis C of its cylinder substantially horizontally extended. The internal combustion engine 01 comprises, as principal parts, a crankcase 04, a cylinder 05 and a cylinder head 06. The opposite sides of the cylinder 05 and the cylinder head 06 are covered with a leg shield 03 of a shape shown in Fig. 6 and having right and left side walls substantially vertically extending on the opposite sides, respectively, of the front frame 02.

**[0003]** In this small motorcycle, a space defined by the internal combustion engine 01, the front frame 03, and the leg shield 03 having the right and the left side wall extending on the opposite sides of the internal combustion engine 01 and the front frame 02 is tapered forward. Various devices 07 are installed in a rear end region between the crankcase 04 and the front frame 02 of the tapered space. If a sufficient space for wind to flow through can be secured in the rear region of the tapered space, cooling fins 05f formed on the upper, lower, right and left side surfaces of the cylinder 05, and cooling fins 06 formed on the upper, lower, right and left side surfaces of the cylinder head 06 are extended parallel to the axis C of the cylinder 05, so that wind W is able to flow in a direction parallel to the axis C through spaces between the cooling fins 05f and 06f to cool the internal combustion engine 01 effectively.

**[0004]** Even if the crankcase 04 are enlarged, the devices 07 installed in the space between the crankcase 04 and the front frame 02 are enlarged and the number of devices is increased as the internal combustion engine 01 is enlarged, the width of the space between the right and the left side wall of the, leg shield 03 cannot be increased because the distance between the right and the left side wall of the leg shield 03 cannot be increased because of restrictions relating to controllability. Consequently, in some cases, a space sufficient for wind to flow through cannot be secured in the depth of the space defined by the front frame 02, and the right and the left side wall of the leg shield 03. If wind is unable to flow through the space, incoming wind is unable to flow rearward through the space, and flows downward along the right and the left side of the cylinder 05 and the cylinder head 06.

**[0005]** When the cylinder 05 and the cylinder head 06 are provided on their right and left side walls with the

cooling fins 05f and 06f parallel to the axis C of the cylinder 05 as shown in Fig. 5, and wind flows downward, the cooling fins 05f and 06f obstruct the flow of wind and, consequently, the effect of wind in cooling the internal combustion engine is reduced.

**[0006]** It is an object of the present invention to provide an internal combustion engine for a motorcycle, provided with cooling fins capable of effectively cooling the internal combustion engine when a space sufficient for wind to flow through easily cannot be secured in the depth of a space defined by the internal combustion engine, a front frame and side wall substantially vertically extending on the right and the left side of the front frame.

### DISCLOSURE OF THE INVENTION

**[0007]** To achieve the object, the present invention provides an internal combustion engine for a motorcycle including a leg shield having right and left side walls extending on opposite sides of a front frame extending obliquely downward toward the rear from an upper part of a front fork, a cylinder, and a cylinder head, the internal combustion engine being suspended from the front frame with an axis of the cylinder substantially horizontally extended, the right and the left side wall of the leg shield extending on the right and the left side of the front frame, respectively, so as to cover the opposite sides of the cylinder and the cylinder head, characterized in that at least one of the cylinder and the cylinder head is provided on upper and lower side surfaces thereof with first cooling fins parallel to the axis of the cylinder, and at least one of the cylinder and the cylinder head is provided on right and left side surfaces thereof with second cooling fins extending perpendicularly or substantially perpendicularly to the axis of the cylinder.

**[0008]** When the motorcycle provided with the internal combustion engine runs, wind that impinges against the top of the cylinder head of the internal combustion engine disposed between the right and the left side wall of the leg shield is divided roughly into an upper air stream and a lower air stream, and the upper and the lower air stream flow through spaces between the first cooling fins parallel to the axis of the cylinder and formed on the upper and the lower side surfaces of the cylinder head and the cylinder. When the depth of the space defined by the internal combustion engine, the front frame, and the right and the left side wall of the leg shield is blocked and there is no space sufficient for wind to flow easily through, wind that flows into the space is unable to flow rearward and is divided into right and left air streams, and the right and the left air stream flow downward through the spaces between the second cooling fins perpendicular to the axis of the cylinder and formed on the right and the left side surfaces of the cylinder head and the cylinder.

**[0009]** Since the internal combustion engine of the present invention for a motorcycle is provided with cooling fins extending in the flowing directions of air streams

depending on the arrangement of the devices of the internal combustion engine, the internal combustion engine can be effectively cooled, the temperature of the lubricating oil can be lowered and the durability of the internal combustion engine can be enhanced.

**[0010]** Desirably, the first cooling fins are straight, continuous and parallel to the longitudinal axis of the motorcycle. Desirably, the second cooling fins are straight, continuous and substantially vertical.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### **[0011]**

Fig. 1 is a side elevation of a small motorcycle provided with an internal combustion engine in a preferred embodiment according to the present invention;

Fig. 2 is a perspective view of the internal combustion engine in the preferred embodiment;

Fig. 3 is a perspective view of a cylinder included in the internal combustion engine;

Fig. 4a is a side elevation of the internal combustion engine shown in Fig. 2 of assistance in explaining the function of the embodiment;

Fig. 4b is a sectional view taken on line B-B in Fig. 4a;

Fig. 5 is a perspective view of a conventional internal combustion engine for a small motorcycle; and  
Fig. 6 is a perspective view of a leg shield employed in the motorcycle of Fig. 5.

#### BEST MODE FOR CARRYING OUT THE INVENTION

**[0012]** Referring to Fig. 1 showing a small motorcycle 1 provided with an internal combustion engine in a preferred embodiment according to the present invention in a side elevation, a principal part of a body frame is formed by connecting a curved rear frame 3 extending obliquely upward toward the rear to the rear end of a front frame 2 extending obliquely downward toward the rear from an upper part of a front fork 5. A head pipe 4 connected to the front part of the front frame 2 supports an upper part of the front fork 5 for turning. A front wheel is supported for rotation on the lower end of the front fork 5. A handlebar 7 is attached to the upper end of the front fork 5.

**[0013]** An internal combustion engine 8 includes a crankcase 9, a cylinder 10 and a cylinder head 11. The internal combustion engine 8 is suspended from the front frame 2 with the axis C of the cylinder 10 substantially horizontally extended. A chain case 12 is extended rearward from the crankcase 9, and a rear wheel 13 is supported for rotation on a rear end part of the chain case 12. A cushioning device 14 has an upper end connected to a rear part of the rear frame 3 and a lower end connected to a rear part of the chain case 12. A leg shield 15 straddling the front frame 2 has right and left

side walls covering the cylinder 10 and the cylinder head 11 of the internal combustion engine 8. The rear frame 3 is covered with a rear cover 16, and a seat 17 is disposed on top of the rear cover 16.

**[0014]** Referring to Fig. 2 showing the internal combustion engine 8 in a perspective view, the internal combustion engine 8 is disposed under the front frame 2 with the axis C of the cylinder 10 substantially horizontally extended. The motorcycle 1 is supposed to run forward to the right as viewed in Fig. 2. The internal combustion engine 8 includes as principal components, in addition to the crankcase 9, the cylinder 10 and the cylinder head 11, various devices 18 disposed above the crankcase 9. The cylinder 10 and the cylinder head 11, which are heated at high temperatures, are provided on their outer surfaces with cooling fins,

**[0015]** First cooling fins 10a parallel to the axis C of the cylinder 10, namely, longitudinal cooling fins, are formed on the upper and the lower side surface of the cylinder 10, and second cooling fins 10b perpendicular or substantially perpendicular to the axis C of the cylinder 10, namely, vertical cooling fins, are formed on the right and the left side surface of the cylinder 10. Similarly, first cooling fins 11a parallel to the axis C of the cylinder 10 are formed on the upper and the lower side surface of the cylinder head 11, and second cooling fins 11b perpendicular or substantially perpendicular to the axis C of the cylinder 10 are formed on the right and the left side surface of the cylinder head 11. The first and the second cooling fins are continuous and straight.

**[0016]** Fig. 3 is a perspective view of the cylinder 10. The axis C of the cylinder 10 is indicated by a chain line. The arrows U, D, R and L indicate an upward direction, a downward direction, a rightward direction and a leftward direction, respectively, when the internal combustion engine 8 including the cylinder 10 is mounted on the motorcycle. The upper, the lower, the right and the left side surface of the cylinder 10 correspond to the directions indicated by the arrows U, D, R and L, respectively. The axis C of the cylinder 10 coincides with the center axis of a cylinder bore 10c formed in the cylinder 10. A chain chamber 10d for a timing chain is formed beside the cylinder bore 10c. The cylinder 10 is provided with a tensioner lifter mounting hole 10e so as to extend between the upper side surface of the cylinder 10 and the chain chamber 10d. A tensioner lifter takes up a slack in the timing chain. Bolt holes 10f are formed in peripheral parts of the cylinder 10. Connecting bolts are passed through the bolt holes 10f to fasten together the crankcase 9, the cylinder 10 and the cylinder head 11.

**[0017]** As mentioned above, the first cooling fins 10a parallel to the axis C are formed on the upper and the lower side surface of the cylinder 10, and the second cooling fins 10b perpendicular or substantially perpendicular to the axis C are formed on the right and the left side surface of the cylinder 10. The cooling fins 10a and 10b are formed integrally with the cylinder 10 when the cylinder 10 is formed by casting an aluminum material.

The cooling fins 11a and 11b of the cylinder head 11 are formed integrally with the cylinder head 11 when the cylinder head 11 is formed by casting an aluminum material.

[0018] Figs. 4a and 4b are views of assistance in explaining the function of the present invention. Fig. 4a is a side elevation of the internal combustion engine 8, and Fig. 4b is a sectional view taken on line B-B in Fig. 4a. The internal combustion engine 8 is suspended from the front frame 2. Principal components of the internal combustion engine 8 shown in Figs. 4a and 4b are the crankcase 9, the cylinder 10, the cylinder head 11, and the devices 18 disposed between the front frame 2 and the crankcase 9. The leg shield 15 extends downward on the right and the left side of the internal combustion engine 8 to protect the rider's legs from high-temperature heat. In Fig. 4a, the left side wall of the leg shield 15 is removed. A space defined by the front frame 2, the leg shield 15 and the crankcase 9 is occupied by the devices 18, and gaps for air to flow are scarcely available in the space.

[0019] Wind flows rearward into the space between the front frame 2 and the leg shield 15. Wind Wa that impinges against the top of the cylinder head 11 is divided roughly into an upper air stream and a lower air stream, and the upper and the lower air stream flow through spaces between the first cooling fins 11a and 10a parallel to the axis C and formed on the upper and the lower side surfaces of the cylinder 10 and the cylinder head 11. Wind Wb that flows into the space between the front frame 2 and the cylinder head 11 is unable to flow rearward because the depth of the space is substantially blocked. Therefore, the wind Wb is divided into right and left air streams, and the right and the left air stream flow downward through spaces between the second cooling fins 11a and 10b perpendicular to the axis C and formed on the right and the left side surface of the cylinder head 11 and the cylinder 10. Eventually, the air streams flowed through the spaces between the first cooling fins 11a and 10a parallel to the axis C of the cylinder flow downward along the right and the left side surface of the cylinder 10.

[0020] Since the second cooling fins 11b and 10b perpendicular to the axis C are formed on the right and the left side surfaces of the cylinder head 11 and the cylinder 10, respectively, air that is unable to flow rearward in the space above the cylinder 10 flows downward through spaces between the second cooling fins 11b and 10b of the cylinder head 11 and the cylinder 1. Consequently, the wind cools the internal combustion engine 8 effectively and lowers the temperature of the lubricating oil, and the durability of the internal combustion engine 8 can be improved.

[0021] In the above described embodiment, the second cooling fins 11b and 10b are formed straight, but they may be formed partly in a curved shape to ensure smooth flow of the air therealong.

## Claims

1. An internal combustion engine for a motorcycle including a leg shield (15) having right and left side walls extending on opposite sides of a front frame (2) that extends obliquely downward toward the rear from an upper part of a front fork (5), a cylinder (10), and a cylinder head, said internal combustion engine being suspended from the front frame (2) with an axis (C) of the cylinder (10) substantially horizontally extended, the right and left side walls of the leg shield (15) extending on the right and the left side of the front frame (2), respectively, so as to cover the opposite sides of the cylinder (10) and the cylinder head (11):

**characterized in that** at least one of the cylinder (10) and the cylinder head (11) is provided on upper and lower side surfaces thereof with first cooling fins (10a, 11a) parallel to the axis (C) of the cylinder (10), and at least one of the cylinder (10) and the cylinder head (11) is provided on right and left side surfaces thereof with second cooling fins (10b, 11b) extending perpendicularly or substantially perpendicularly to the axis (C) of the cylinder (10).

2. The internal combustion engine for a motorcycle according to claim 1, **characterized in that** the first cooling fins (10a, 11a) are straight, continuous and parallel to the longitudinal axis of the motorcycle.
3. The internal combustion engine for a motorcycle according to claim 1 or 2, **characterized in that** the second cooling fins (10b, 11b) are straight, continuous and substantially vertical.

## Amended claims under Art. 19.1 PCT

1. (Amended) An internal combustion engine for a motorcycle including a leg shield (15) having right and left side walls extending on opposite sides of a front frame (2) that extends obliquely downward toward the rear from an upper part of a front fork (5), a cylinder, a cylinder head, said internal combustion engine (8) being suspended from the front frame (2) with an axis (C) of the cylinder (10) substantially horizontally extended, the right and left side walls of the leg shield (15) extending on the right and the left side of the front frame (2), respectively, so as to cover the opposite sides of the cylinder (10), and devices disposed between an upper part of a crankcase (9) of the engine (8) and said front frame (2):  
**characterized in that** at least one of the cylinder (10) and the cylinder head (11) is provided on upper and lower side surfaces thereof with first cooling fins (10a, 11a) which are continuous, straight and parallel to the axis (C) of the cylinder (10), and at least one of the cylinder (10) and the cylinder

head (11) is provided on right and left side surfaces thereof with second cooling fins (10b, 11b) which extend continuously, straight and perpendicularly or substantially perpendicularly to the axis (C) of the cylinder (10).

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**2.** (Amended) The internal combustion engine for a motorcycle according to claim 1, **characterized in that** the first cooling fins (10a, 11a) extend parallel to the longitudinal axis of the motorcycle.

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**3.** (Amended) The internal combustion engine for a motorcycle according to claim 1 or 2, **characterized in that** the second cooling fins (10b, 11b) extend substantially vertical.

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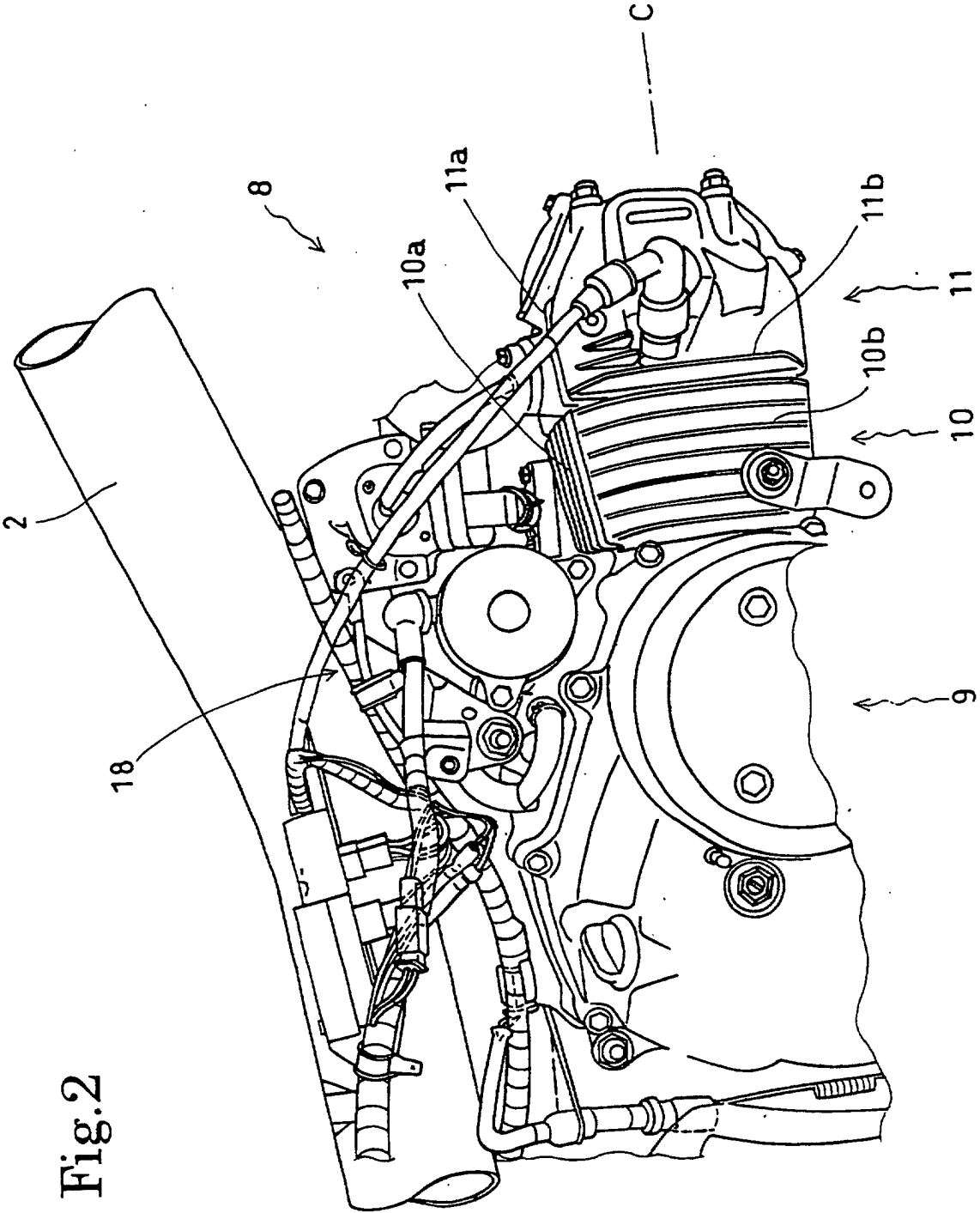


Fig.2

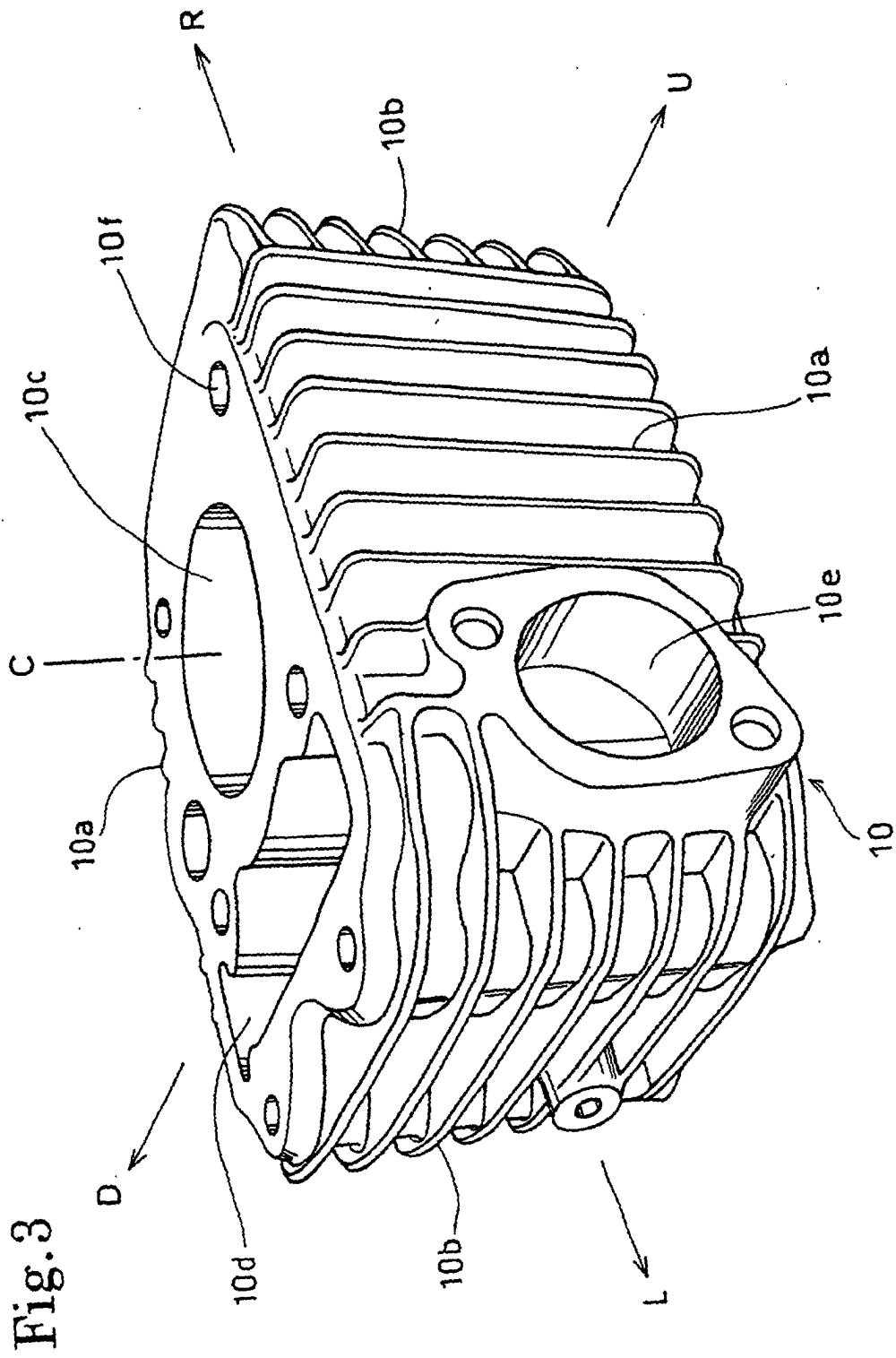


Fig.4a

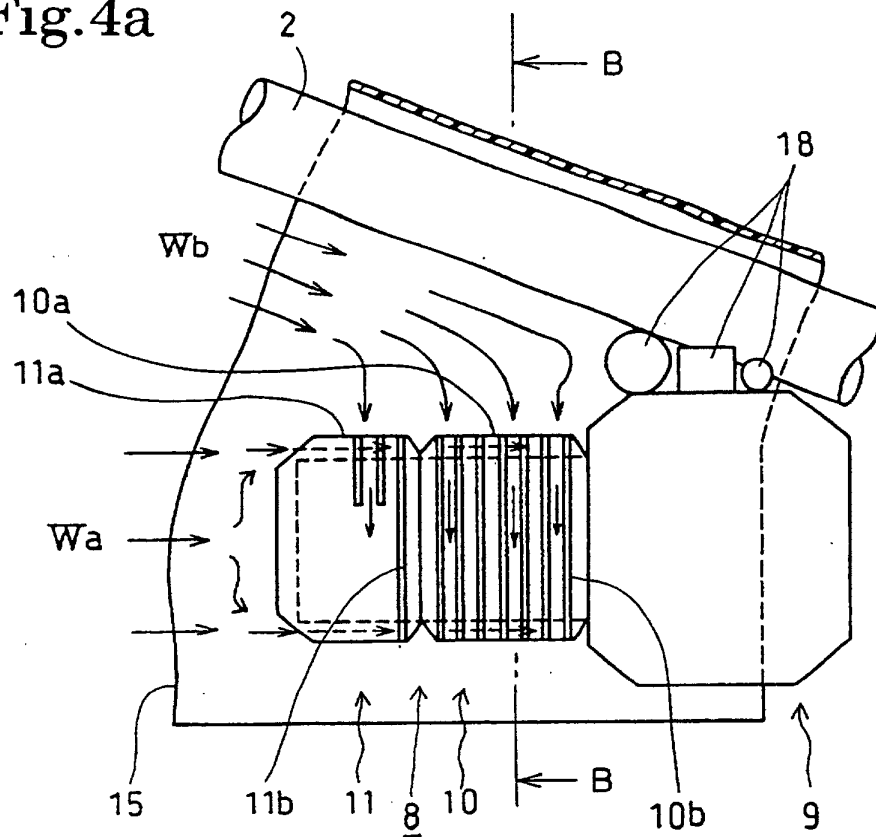


Fig.4b

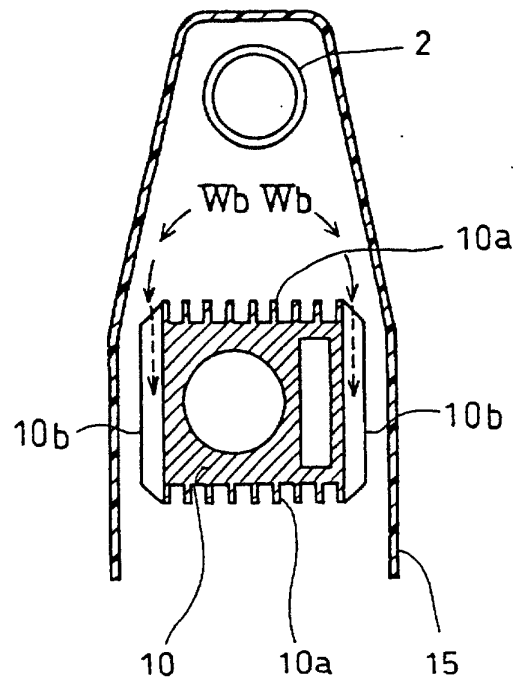


Fig.5

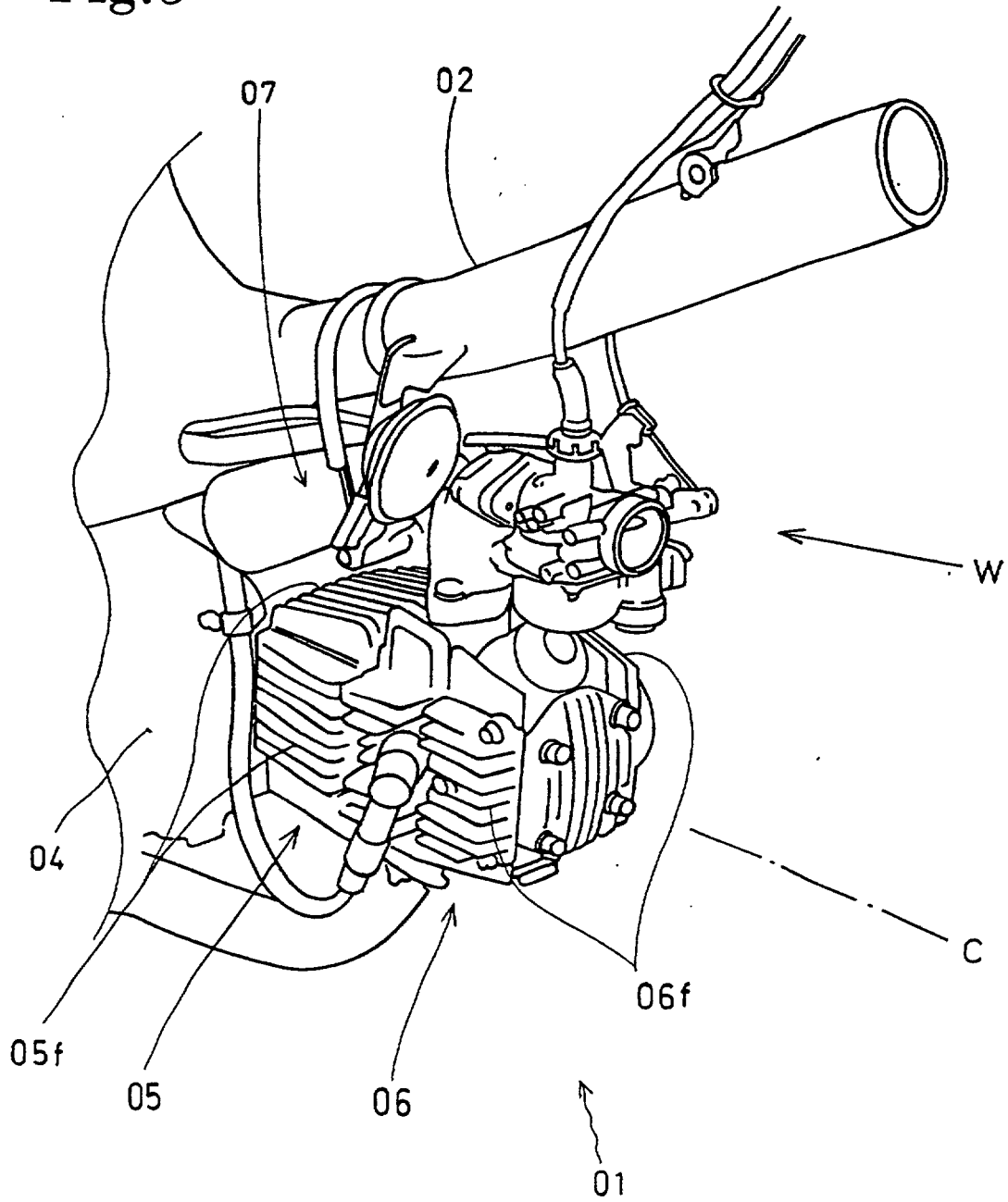
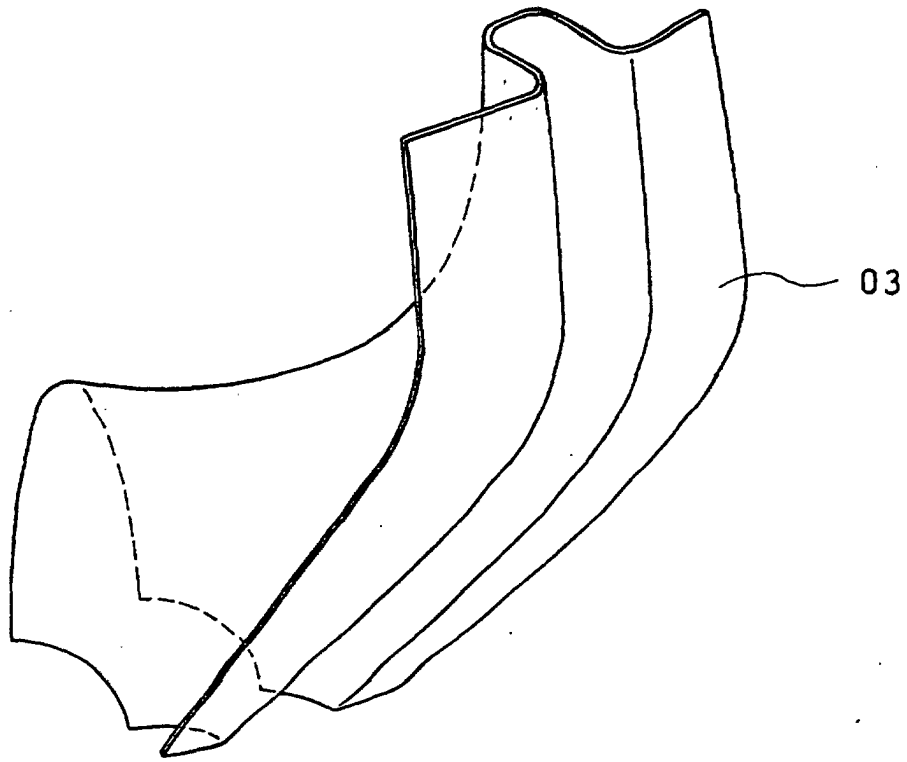


Fig.6



International application No.  
PCT/JP02/09423

<p>A. CLASSIFICATION OF SUBJECT MATTER Int.Cl<sup>7</sup> F01P1/02</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																													
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) Int.Cl<sup>7</sup> F01P1/02, F02F1/06, F02F1/30</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>																													
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>JP 62-223444 A (Kawasaki Heavy Industries, Ltd.), 01 October, 1987 (01.10.87), Page 2, lower left column, line 13 to page 3, lower right column, line 2; Figs. 1 to 7 (Family: none)</td> <td>1-3</td> </tr> <tr> <td>A</td> <td>Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 51473/1982 (Laid-open No. 154841/1983) (Suzuki Motor Co., Ltd.), 17 October, 1983 (17.10.83), Description page 1, line 13 to page 2, line 15; description page 4, line 1 to page 4, line 15; Figs. 1 to 2 (Family: none)</td> <td>1-3</td> </tr> </tbody> </table> <p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p> <table border="1"> <tr> <td>* Special categories of cited documents:</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier document but published on or after the international filing date</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table> <table border="1"> <tr> <td>Date of the actual completion of the international search 10 October, 2002 (10.10.02)</td> <td>Date of mailing of the international search report 29 October, 2002 (29.10.02)</td> </tr> <tr> <td>Name and mailing address of the ISA/ Japanese Patent Office</td> <td>Authorized officer</td> </tr> <tr> <td>Facsimile No.</td> <td>Telephone No.</td> </tr> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	JP 62-223444 A (Kawasaki Heavy Industries, Ltd.), 01 October, 1987 (01.10.87), Page 2, lower left column, line 13 to page 3, lower right column, line 2; Figs. 1 to 7 (Family: none)	1-3	A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 51473/1982 (Laid-open No. 154841/1983) (Suzuki Motor Co., Ltd.), 17 October, 1983 (17.10.83), Description page 1, line 13 to page 2, line 15; description page 4, line 1 to page 4, line 15; Figs. 1 to 2 (Family: none)	1-3	* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier document but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means		"P" document published prior to the international filing date but later than the priority date claimed		Date of the actual completion of the international search 10 October, 2002 (10.10.02)	Date of mailing of the international search report 29 October, 2002 (29.10.02)	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	Facsimile No.	Telephone No.
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