

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a cylinder body of an engine in which a cylinder sleeve is provided by means of cast coating and a method of manufacturing the same.

BACKGROUND TO THE INVENTION

[0002] JP-A-59-74354 discloses a known cylinder body of an engine in which a cylinder sleeve of the cylinder body is formed so that a central portion thereof in an axial direction is made large in thickness as compared with both ends thereof.

[0003] This is intended for preventing a cylinder sleeve from being deformed by a large shrinkage force, which is generated with cooling of an aluminum alloy, in the casting process of a cylinder body.

[0004] Also, one end of the cylinder sleeve is exposed to an end surface of the cylinder body to constitute a part of a surface of the cylinder body, which mates with a cylinder head. In this manner, in the case where the cylinder sleeve is exposed to the mating surface, the mating surface is subjected to cutting work after casting of the cylinder body, and the mating surface is finished to be made flat.

[0005] JP-A-10-220278 also discloses a known cylinder body of an engine.

[0006] Further reduction in manufacturing cost is demanded of general cylinder bodies including the cylinder body disclosed in, for example, JP-A-59-74354 by shortening the time required for machining performed after casting.

[0007] In order to shorten the time required for working a surface of a cylinder body, which mates with a cylinder head, it is conceivable to form a cylinder sleeve so that one end thereof on a side of the mating surface of the cylinder sleeve is made thinner than the remaining portion with a view to decreasing an amount, by which the cylinder sleeve being relatively hard is cut. When one end is formed to be thin, however, there is a fear that casting of a cylinder body cannot be performed by means of die casting method. This is because of a fear that the end is deformed by pressure of a molten metal at the time of die casting. In addition, when a cylinder sleeve is manufactured by other casting methods, for example, a low-pressure casting method or the like, an increase in manufacturing cost is caused.

[0008] The invention has been thought of in order to dissolve such a problem and has its object to provide a cylinder body of an engine capable of shortening the time required for machining of a surface of the cylinder body, which mates with a cylinder head, to achieve reduction in cost while adopting a construction in which manufacture is made possible by the die casting method.

SUMMARY OF THE INVENTION

[0009] In order to attain the object, a method of manufacturing a cylinder body of an engine according to an aspect of the invention comprises a die casting step, in which a cylinder sleeve is provided in a cylinder body by means of cast coating, and a cutting step, in which a surface mating with a cylinder head is formed on one end of the cylinder body so that an end surface of the cylinder sleeve is exposed, and is carried out by forming one end of the cylinder sleeve to make the same small in outside diameter as compared with the remaining portion of the cylinder sleeve, casting the cylinder body in a state, in which a columnar portion of a casting metal mold is fitted into the cylinder sleeve, and forming an end surface of the one end of the cylinder sleeve in the cutting step to make the same flat so as to constitute a part of the mating surface.

[0010] In a cylinder body of an engine according to another aspect of the invention, a cylinder sleeve is provided by means of cast coating, one end of the cylinder sleeve constituting a part of a surface mating with a cylinder head. The cylinder body may be cast in a state, in which a columnar portion of a casting metal mold is fitted into the cylinder sleeve, by means of a die casting method. One end of the cylinder sleeve may be formed to be small in outside diameter as compared with the remaining portion of the cylinder sleeve, and an end surface of the one end is formed by cutting work after casting and comprises a flat surface, which constitutes a part of the mating surface.

[0011] The one end of the cylinder sleeve may therefore be supported from inside by the columnar portion of the casting metal mold fitted into the cylinder sleeve when the cylinder body is die cast, so that although the one end is formed to be relatively thin, it is possible to perform die casting while preventing the one end from being deformed.

[0012] Accordingly, it is possible to form the one end of the cylinder sleeve, which is exposed to a surface of the cylinder body, which mates with a cylinder head, to make the same thin, thus enabling the time required for machining of the mating surface. Consequently, it is possible to provide a cylinder body being further reduced in manufacturing cost.

[0013] The cylinder body may be molded by a casting metal mold, a gate of which is formed in a position opposed to one end of the cylinder sleeve.

[0014] The one end of the cylinder sleeve opposed to the gate may be formed to be small in thickness, so that the gates can be formed to be made appropriately wide without forming the mating surface of the cylinder body adjacent to the gate to make the same large and a molten metal can be made easy to flow into the cavity from the gate.

[0015] Accordingly, since a molten metal can be caused to flow into the cavity at high speed, it is possible to cast even the cylinder body having a multiplicity of

radiating fins so as to make the same high in quality.

[0016] The cylinder body may be cast in a state, in which both axial ends of the cylinder sleeve are interposed by the casting metal mold.

[0017] With this arrangement, it is possible to perform die casting in a state, in which the cylinder sleeve is supported by the casting metal mold so as not to move. Therefore, the cylinder sleeve is not changed in position every casting and an amount required for working the cylinder sleeve is made constant every casting, so that it is possible to make the time required for working the mating surface shortest always.

[0018] A plurality of circumferentially extending ridges may be formed on an outer periphery of the cylinder sleeve to be spaced in an axial direction of the cylinder sleeve.

[0019] With this arrangement the ridges of the cylinder sleeve engage with a central portion of the cylinder body, which is cast so as to surround the cylinder sleeve, so that it is possible to prevent the cylinder sleeve from coming off from inside the cylinder body after the cylinder body is cast. Accordingly, it is possible to provide a cylinder body, on which a cylinder sleeve is provided firmly.

[0020] Also, according to the invention, a region, in which the cylinder sleeve and the central portion of the cylinder body contact with each other, is increased in area making it easy for heat of the cylinder sleeve to be transferred to the central portion, so that it is possible to provide a cylinder body being high in coolability.

[0021] According to a further aspect of the present invention there is provided a method of manufacturing a cylinder body of an engine, the method comprising the steps of:

providing a cylinder sleeve having a first end formed to be smaller in outside diameter relative to the remaining portion of the cylinder sleeve,
inserting a columnar portion of a casting mold into the cylinder sleeve;
casting a cylinder body around the cylinder sleeve;
and
machining a mating surface of the cast cylinder body to be mated with a cylinder head, wherein an end face of the first end of the cylinder sleeve is formed in the machining step to be made flat so as to constitute a part of the mating surface.

[0022] The casting mold may comprise a gate which is formed in a position opposed to the first end of the cylinder sleeve.

[0023] The cylinder sleeve may have a second end axially opposite the first end, and during the step of casting the first and second ends of the cylinder sleeve may be interposed by the casting mold.

[0024] A plurality of circumferentially extending ridges may be formed on an outer periphery of the cylinder sleeve to be spaced in an axial direction of the cylinder sleeve.

[0025] A cylinder body of an engine may comprise a cylinder sleeve having a first end which defines an outer diameter which is smaller than the outer diameter of the remaining portion of the cylinder sleeve, wherein the cylinder sleeve is provided within the cylinder body by casting said body around said sleeve while a columnar portion of a casting mold is inserted into said sleeve. A machined mating surface adapted to mate with a cylinder head may be formed on the cylinder body, wherein an end face of the first end of the cylinder sleeve is formed by machining to define a flat surface which constitutes a part of the mating surface.

[0026] A gate of the casting mold may be formed in a position opposed to the first end of the cylinder sleeve.

[0027] The cylinder sleeve may define a second end axially opposite the first end, and wherein the cylinder body may be cast in a state, in which the first and second ends of the cylinder sleeve are interposed by the casting mold.

[0028] A plurality of circumferentially extending ridges may be formed on an outer periphery of the cylinder sleeve to be spaced in an axial direction of the cylinder sleeve.

[0029] Further aspects of the invention may relate to an engine comprising a cylinder block manufactured by the method of any other aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a cross sectional view showing a part of an engine using a cylinder body according to the invention;

Fig. 2 is a cross sectional view showing a casting metal mold for casting of a cylinder body according to the invention; and

Fig. 3 is a perspective view showing a cylinder body after casting.

DETAILED DESCRIPTION OF THE DRAWINGS

[0031] An embodiment of a cylinder body manufactured by a method of manufacturing in accordance with and embodiment of the present invention will be described in detail below with reference to Figs. 1 to 3.

[0032] Fig. 1 is a cross sectional view showing a part of an engine using a cylinder body according to the invention, Fig. 2 is a cross sectional view showing a casting metal mold for casting of a cylinder body according to the invention, and Fig. 3 is a perspective view showing a cylinder body after casting.

[0033] In these drawings, the reference numeral 1 denotes an engine, which uses a cylinder body 2 according to the embodiment. The engine 1 is an air-cooled type four-stroke single-cylinder engine. The engine 1 includes

a crank case 4, which rotatably supports a crank shaft 3, the cylinder body 2 mounted to the crank case 4, and a cylinder head 5 mounted to a tip or top end of the cylinder body 2. Also, the engine 1 is mounted on a body frame (not shown) of a motorcycle in a state, in which an axis C of a cylinder is directed substantially to the front of a vehicle body.

[0034] The cylinder body 2 is molded into a predetermined shape by a die casting method, in which an aluminum alloy is used as a material and a casting metal mold 6 (see Fig. 2) described later is used. As shown in Fig. 1, a cylinder sleeve 11, into which a piston 7 is inserted and fitted, is provided on the cylinder body 2 by means of cast coating.

[0035] Also, the cylinder body 2 is formed integrally with a multiplicity of radiating fins 12 as shown in Fig. 1 and with a chain chamber 13 as shown in Fig. 3. The chain chamber 13 is formed in a manner to extend through a side of the cylinder body 2 in an axial direction of the cylinder.

[0036] Further, a mount seat 14 for mounting of the cylinder body 2 is provided at one end of the cylinder body 2 as shown in Figs. 1 and 3. The mount seat 14 is formed to project toward the cylinder head 5 with a step from the radiating fin 12 in a position closest to the cylinder head 5 and formed with a mating surface 15, which mates with the cylinder head 5. An end of the cylinder sleeve 11 is exposed to the mating surface 15.

[0037] The cylinder sleeve 11 is formed from cast iron to be cylindrically shaped and positioned in the cylinder body 2 in a state, in which one end 11a thereof is exposed to the mating surface 15 of the cylinder body 2.

[0038] A plurality of circumferentially extending ridges 16 are formed on an outer periphery of the cylinder sleeve 11 to be spaced in an axial direction (axial direction of the cylinder) of the cylinder sleeve 11. These ridges 16 are formed so as not to be made discrete in a circumferential direction of the cylinder sleeve 11 and embedded in a central portion 2a of the cylinder body 2.

[0039] An outside diameter D1 (see Fig. 2) of the one end 11a of the cylinder sleeve 11 is formed to be small as compared with an outside diameter D2 of other portions (main, outer peripheral surfaces positioned between the ridges 16) of the cylinder sleeve 11. That is, end 11a is formed to be small in thickness as compared with other portions of the cylinder sleeve 11.

[0040] An end surface of the end 11a is made flat by machining after casting of the cylinder body 2 so as to constitute a continuous and flush mating surface 15 for mating with the cylinder head 5. The machining is performed by using, for example, a milling cutter to cut the end surface of the cylinder sleeve 11 and an end surface of the cylinder body 2 simultaneously. By subjecting the both end surfaces to the machining, the mating surface 15 may be formed on the cylinder body 2.

[0041] As shown in Fig. 1, a recess 21, which defines a combustion chamber S with the piston 7 in formed on the cylinder head 5. An intake port 22 and an exhaust

port 23 with respective ends being opened to the recess 21 are also formed on the cylinder head 5. Also, provided on the cylinder head 5 are an intake valve 24, an exhaust valve 25, a rocker arm type valve operating device 26 for driving of the both valves 24, 25 or the like. A cam shaft 27 of the valve operating device 26 is connected to the crank shaft 3 by a timing chain (not shown). The timing chain is extended through the chain chamber 13 of the cylinder body 2 to connect between the cam shaft 27 and the crank shaft 3.

[0042] As shown in Fig. 2, the cylinder body 2 is cast by a die casting method with the use of the casting metal mold 6. The casting metal mold 6 comprises a stationary metal mold 31 formed in a manner to cover the cylinder body 2 from the cylinder head 5 side, a moving metal mold 32 capable of moving in a direction (vertical direction in Fig. 2) toward and away from the stationary metal mold 31, a bore pin 33 formed to be made columnar to fit into the cylinder sleeve 11 and mounted to the moving metal mold 32, and four slide metal molds 34 positioned between the stationary metal mold 31 and the moving metal mold 32 in a manner to surround a periphery of the bore pin 33. The bore pin 33 constitutes a columnar portion of a casting metal mold referred to in the invention.

[0043] A tip end (upper end in Fig. 2) of the bore pin 33 is formed to be fusiform-shaped to become gradually thinner toward a tip end and faces an interior of a runner 35 of the stationary metal mold 31 in a state of closing shown in Fig. 2. An upstream end of the runner 35 is connected to a sprue (not shown). Also, a step 33a, against which an end surface of the cylinder sleeve 11 toward a crank chamber abuts, is formed at a base end of the bore pin 33.

[0044] The cylinder sleeve 11 is charged into a cavity 36 (see Fig. 2) of the metal mold 6 in a state of having the bore pin 33 fitted thereinto and being born by the step 33a of the bore pin 33. A core (not shown) for molding of the chain chamber 13 is provided in a position adjacent to the cylinder sleeve 11 within the cavity 36.

[0045] Projections 37, which interpose the cylinder sleeve 11 between them and the step 33a, are provided in four locations on that end of the stationary metal mold 31, at which a downstream end of the runner 35 is formed. The projections 37 are provided to be spaced at equal intervals in four locations in the circumferential direction of the cylinder sleeve 11. The projections 37 abut against the end surface of the one end 11a of the cylinder sleeve 11 to push the same toward the other end in a state of closing shown in Fig. 2.

[0046] The downstream end of the runner 35 is connected to gates 38 formed in positions opposed to the one end 11a of the cylinder sleeve 11. The gates 38 are formed between the stationary metal mold 31 and the bore pin 33 and between two adjacent projections 37. That is, as shown in Fig. 3, the gates 38 are formed so as to cause a molten metal in the runner 35 to be led into the cavity 36 from four locations around the cylinder sleeve 11.

[0047] Fig. 3 shows a molding 41 formed by a molten metal, which solidifies in a whole region, which ranges from the runner 35 to the cavity 36, in a state of being not cut midway and being taken out of the casting metal mold 6. Since the runner 35 and the cavity 36 formed in the casting metal mold 6 corresponds in shape to the molding 41, the reference numerals 35, 38, 36 for the runner, the gates, and the cavity are denoted for the molding 41 in Fig. 3.

[0048] The four slide metal molds 34 serve to mold a peripheral wall of the cylinder body 2 and are formed with recesses 42, which serve to mold the radiating fins 12 as shown in Fig. 2. The slide metal molds 34 are supported on the moving metal mold 32 so as to be able to move in the radial direction of the cylinder sleeve 11.

[0049] An explanation will now be given to a method of manufacturing the cylinder body 2 with the use of the casting metal mold 6.

[0050] First, prior to closing of the casting metal mold 6, the cylinder sleeve 11 is fitted into the bore pin 33 and born by the step 33a of the bore pin 33. Then, the casting metal mold 6 is closed as shown in Fig. 2. Owing to the closing, the cylinder sleeve 11 is interposed between the step 33a and the projections 37 of the stationary metal mold 31.

[0051] After closing is performed in this manner, pressure in the cavity 36 is reduced as needed and a molten metal is supplied into the cavity 36 through the gates 38 from the runner 35. When the molten metal flows into the cavity 36 from the gates 38, end 11a of the cylinder sleeve 11 is pushed radially inward by pressure of the molten metal.

[0052] Since the bore pin 33 is fitted inside the end 11a, however, said end 11a is borne by the bore pin 33 from inside when being pushed by pressure of the molten metal as described above, and so is not deformed by the pressure.

[0053] After the molten metal solidifies, an end of the runner 35 toward the sprue is cut from the sprue and the moving metal mold 32, the bore pin 33, and the four slide metal molds 34 are separated from the stationary metal mold 31. Then, the slide metal molds 34 are moved away from the bore pin 33 and the molding 41 is removed from the moving metal mold 32 and the bore pin 33.

[0054] As shown in Fig. 3, an in-runner molding 41a, which the molten metal solidified in the runner 35 forms, and an in-gate molding 41b, which the molten metal solidified in the gates 38 form, are molded integrally with a product portion 41c to form the molding 41.

[0055] In order to obtain the cylinder body 2 (product portion 41c) from the molding 41, boundary portions of the mount seat 14 and the gates 38 are cut and the mating surface 15 mating with the cylinder head 5 is formed on a cut end surface of the mount seat 14 by means of cutting work.

[0056] Since the end 11a of the cylinder sleeve 11 is exposed to the cut end surface, said end 11a of the cylinder sleeve 11 is cut simultaneously when the cut end

surface is worked. End 11a of the cylinder sleeve 11 according to the embodiment is formed to be smaller in outside diameter than the remaining portions and formed to be small in thickness. Therefore, the cutting work of the cut end surface can be performed in a relatively short time although the cylinder sleeve 11 is formed from cast iron, which is relatively high in hardness.

[0057] In this manner, the mating surface 15 comprising a flat surface is formed on the mount seat 14 whereby the manufacturing process of the cylinder body 2 terminates.

[0058] Accordingly, with the cylinder body 2 and a method of manufacturing the same according to the embodiment, end 11a of the cylinder sleeve 11 is supported from inside by the bore pin 33 fitted into the cylinder sleeve 11 at the time of die casting, so that although the end 11a is formed relatively thin, it is possible to perform die casting while preventing the one end from being deformed.

[0059] Therefore, time required for machining of the mating surface 15 can be shortened by forming the one end 11a of the cylinder sleeve 11, which is exposed to the mating surface 15 between the cylinder body 2 and the cylinder head 5, to make the same thin.

[0060] According to the embodiment, since the end 11a of the cylinder sleeve 11 opposed to the gates 38 of the casting metal mold 6 is formed to be thin, the gates 38 can be formed to be made appropriately wide without forming the mount seat 14 large and molten metal can more readily to flow into the cavity 36 from the gates 38.

[0061] Accordingly, since a molten metal can be caused to flow into the cavity 36 at a relatively large flow-rate, it is possible to cast even the cylinder body 2 having the multiplicity of radiating fins 12 so as to make the same high in quality.

[0062] According to the embodiment, it is possible to perform die casting in a state, in which the cylinder sleeve 11 is supported by the stationary metal mold 31 and the bore pin 33 so as not to move. Therefore, the cylinder sleeve 11 is not changed in position every casting and an amount required for working the cylinder sleeve 11 is made constant every casting, so that it is possible to make the time required for working of the mating surface 15 shortest always.

[0063] According to the embodiment, the ridges 16 of the cylinder sleeve 11 engage with the central portion 2a of the cylinder body 2, which is cast so as to surround the cylinder sleeve 11, so that it is possible to prevent the cylinder sleeve 11 from detaching from inside the cylinder body 2 after the cylinder body 2 is cast.

[0064] Also, according to the embodiment, a region, in which the cylinder sleeve 11 and the central portion 2a of the cylinder body 2 contact with each other, is increased in area making it easy for heat of the cylinder sleeve 11 to be transferred to the central portion 2a. Therefore, it is possible to improve the engine 1 in coolability.

[0065] In addition, while the embodiment has been de-

scribed with respect to an example, in which the invention is applied to a cylinder body of an air-cooled engine, the invention is applicable to a cylinder body of a water-cooled engine and to a cylinder body of a multi-cylinder engine.

Description of Reference Numerals and Signs

[0066] 2: cylinder body, 5: cylinder head, 6: casting metal mold, 11: cylinder sleeve, 11a: one end, 14: mount seat, 15: mating surface, 31: stationary metal mold, 32: moving metal mold, 33: bore pin, 34: slide metal mold, 35: runner, 38: gate

Claims

1. A method of manufacturing a cylinder body (2) of an engine (1), the method comprising the steps of:

providing a cylinder sleeve (11) having a first end (11a) formed to be smaller in outside diameter relative to the remaining portion of the cylinder sleeve (11),
inserting a columnar portion (33) of a casting mold into the cylinder sleeve (11);
casting a cylinder body (2) around the cylinder sleeve (11); and
machining a mating surface (15) of the cast cylinder body (2) to be mated with a cylinder head (5), wherein an end face of the first end of the cylinder sleeve (11) is formed in the machining step to be made flat so as to constitute a part of the mating surface (15).

2. The method of claim 1, wherein the casting mold comprises a gate (38) which is formed in a position opposed to the first end (11a) of the cylinder sleeve (11).

3. The method of claim 1 or 2, wherein the cylinder sleeve (11) has a second end axially opposite the first end (11a), and during the step of casting the first and second ends of the cylinder sleeve (11) are interposed by the casting mold.

4. The method of claim 1, 2 or 3, wherein a plurality of circumferentially extending ridges (16) are formed on an outer periphery of the cylinder sleeve (11) to be spaced in an axial direction of the cylinder sleeve (11).

5. A method of manufacturing a cylinder body (2) of an engine (1), the method comprising

a die casting step, in which a cylinder sleeve (11) is provided in a cylinder body (2) by means of cast coating, and

a cutting step, in which a surface (15) mating with a cylinder head (5) is formed on one end of the cylinder body so that an end surface of the cylinder sleeve (11) is exposed, and
wherein one end (11a) of the cylinder sleeve (11) is formed to be small in outside diameter as compared with the remaining portion of the cylinder sleeve (11),
the cylinder body (2) is cast in a state, in which a columnar portion (33) of a casting metal mold is fitted into the cylinder sleeve (11), and
an end surface of the one end (11a) of the cylinder sleeve (11) is formed in the cutting step to be made flat so as to constitute a part of the mating surface (15).

6. An engine comprising a cylinder body (2) manufactured by the method of any preceding claim.

7. A cylinder body (2) of an engine (1), wherein a cylinder sleeve (11) is provided by means of cast coating, one end of the cylinder sleeve (11) constituting a part of a surface (15) mating with a cylinder head (5),
one end (11a) of the cylinder sleeve (11) is formed to be small in outside diameter as compared with the remaining portion of the cylinder sleeve (11), and
an end surface of the one end (11a) is formed by cutting work after casting and comprises a flat surface which constitutes a part of the mating surface (15).

8. The cylinder body (2) of an engine (1) according to claim 6, wherein a plurality of circumferentially extending ridges (16) are formed on an outer periphery of the cylinder sleeve (11) to be spaced in an axial direction of the cylinder sleeve (11).

9. An engine comprising a cylinder body according to claim 7 or 8.

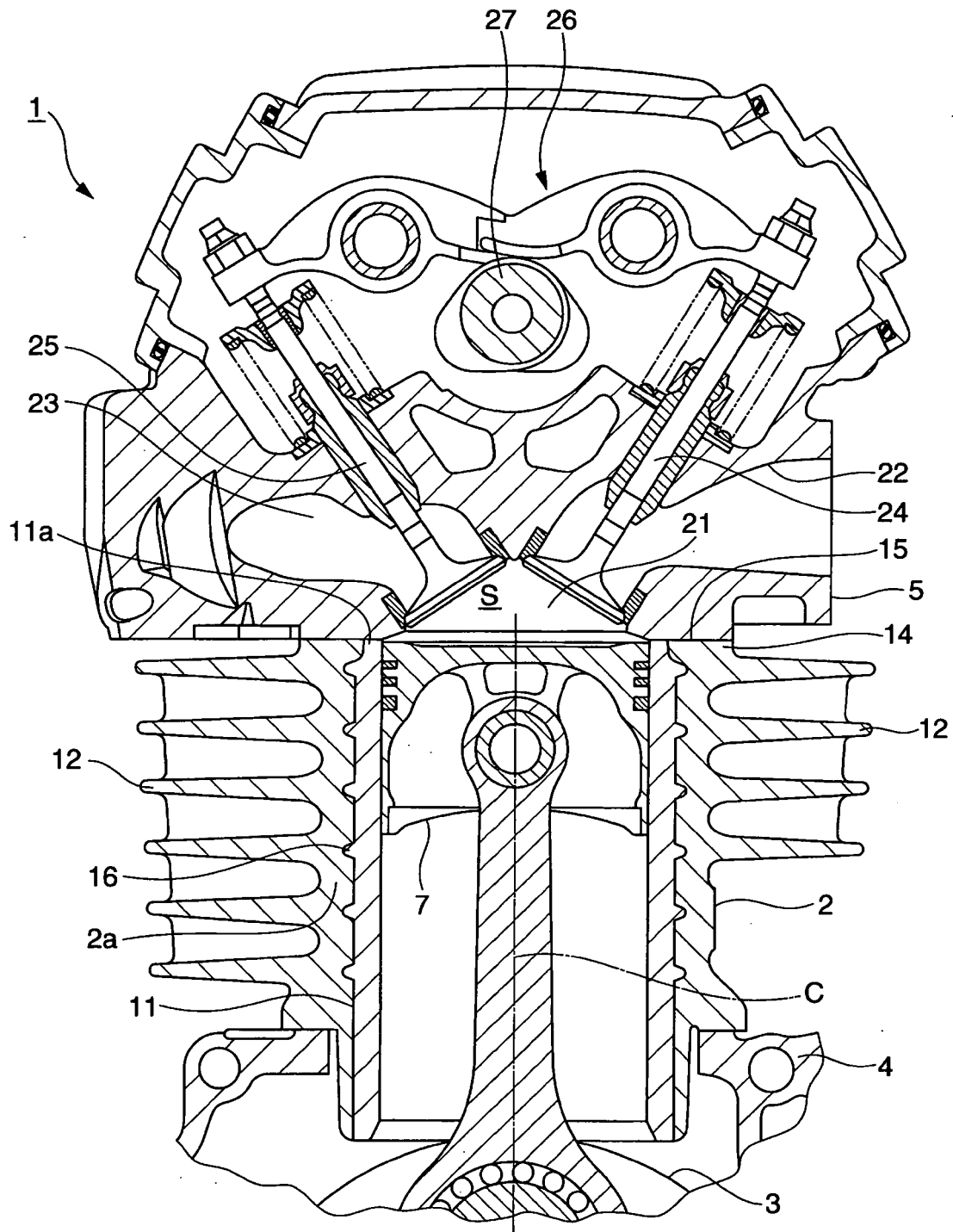


FIG. 1

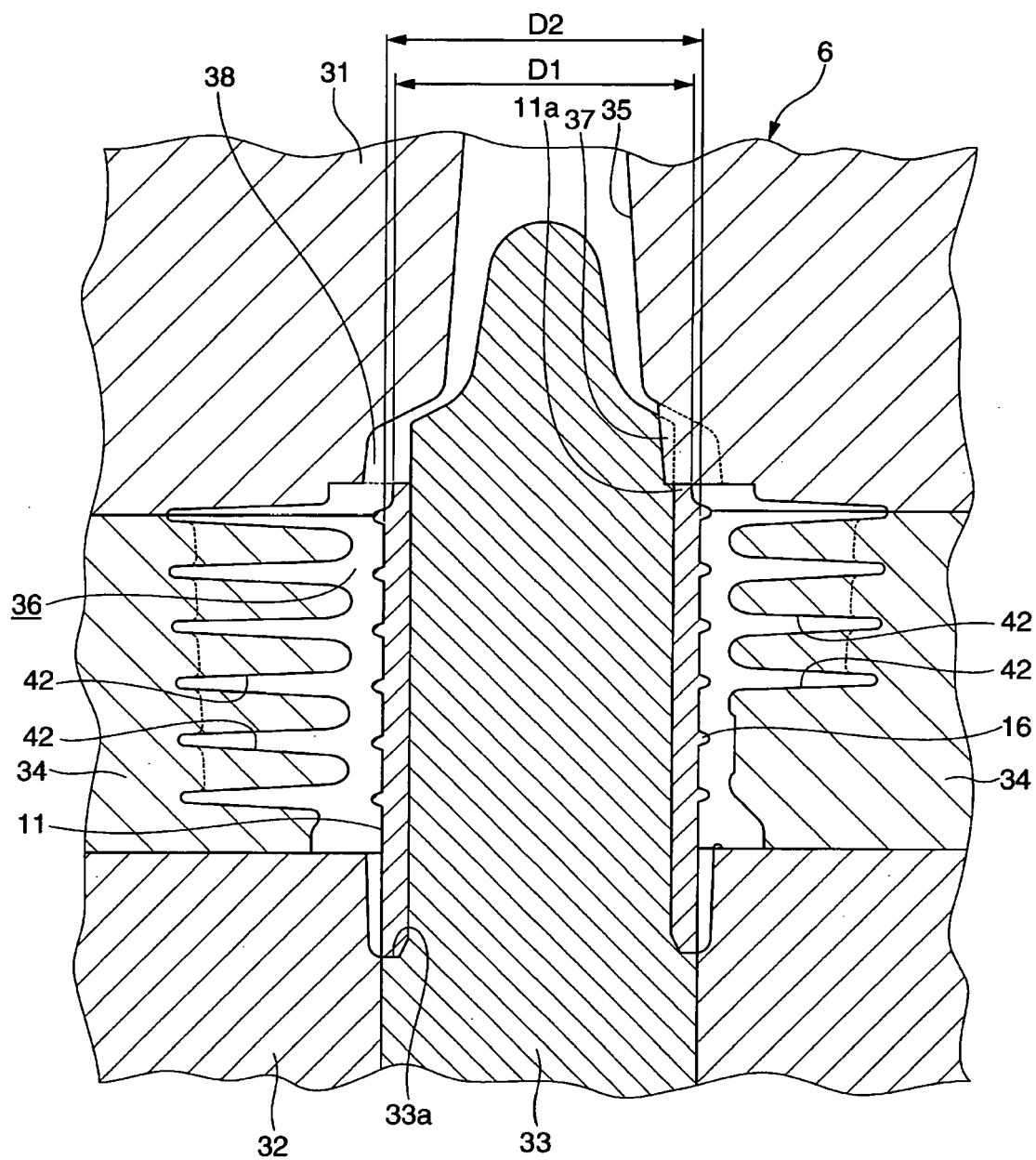


FIG. 2

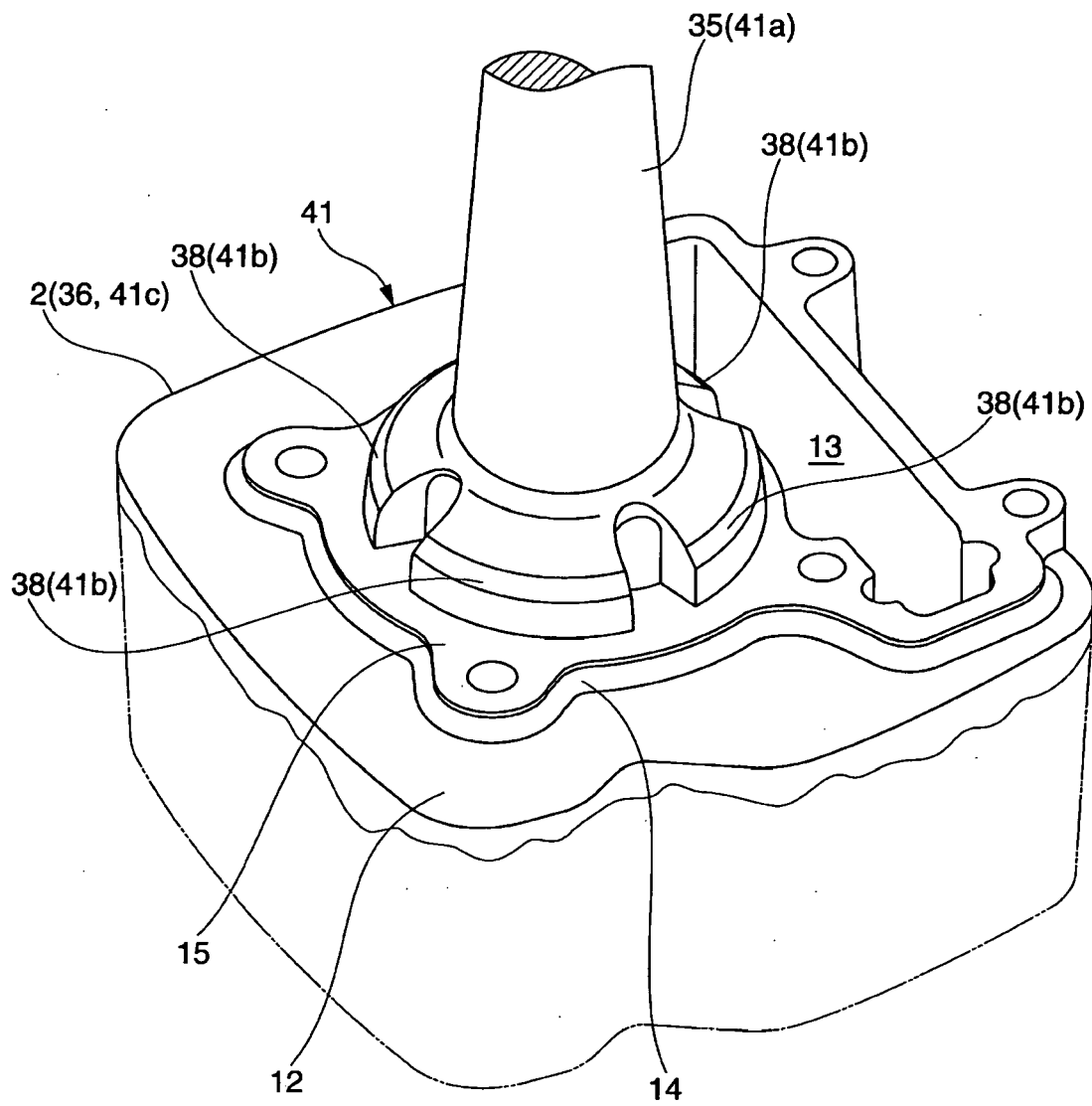


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 08 25 2467

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 November 2008	Examiner Baumgartner, Robin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 25 2467

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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