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(71) Applicant: **Akashi Gohdoh inc.**
Ishikawa.ken 924 (JP)

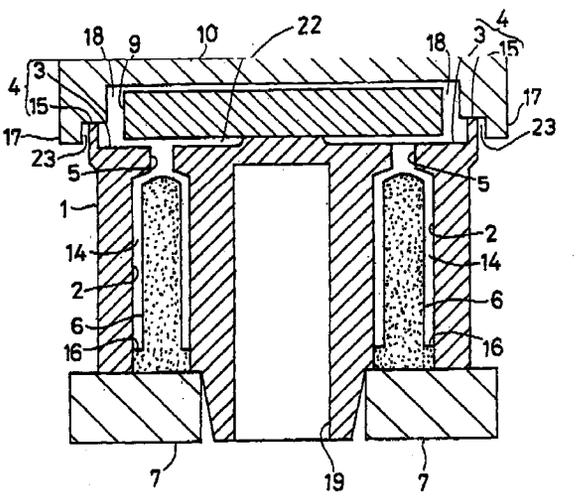
(72) Inventor: **Akashi, Kanji**
Kanazawa-shi, Ishikawa 920-1161 (JP)

(74) Representative:
Strehl Schübel-Hopf & Partner
Maximilianstrasse 54
80538 München (DE)

(54) Process and apparatus for making a composite casting

(57) A cylinder block main body (1) comprises a plurality of vertically extending cylinders (2) open at the lower end. A sliding surface (3) is formed on the upper side above the cylinders (29, a core (6) is inserted into each cylinder (2) to form a cavity (14), and the lower end of the cylinder (2) is sealed. A solid covering material (9) is placed on the sliding surface (3), a carbon lid (10) is closed and the assembly is heated at about 920 to 1050 °C. A cylinder block is thus formed by covered casting in a simple process, and a low-cost cylinder block is obtained.

FIG. 1



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Description

Background of the Invention

Field of the Invention

The present invention relates to a covered casting method of cylinder block of hydraulic axial piston pump or hydraulic axial piston motor, and a cylinder block cast by this covered casting method.

Description of the Prior Art

Fig. 3 is a diagram for explaining a conventional covered casting method of cylinder, showing a magnified view of a section of one cylinder out of plural cylinders provided in a cylinder block. In such cylinder block, on an inner wall of a cylinder 32 and a sliding surface 33 formed at the anti-piston side of the cylinder 32, thin-wall covered casting is performed by using a covering material such as copper alloy. In such covered casting, in order to fuse the covering material and cylinder block main body 31 securely, the molten metal of the covering material must be poured in after heating the cylinder block main body 31 preliminarily. However, when the cylinder block main body 31 is heated directly, the surface is oxidized to be inert, and fusion of the covering material, inner wall and sliding surface 33 becomes insufficient. Hitherto, therefore, a cavity 37 formed by the cylinder 32 and core 36 was filled with a molten flux blending borax and boric acid, and the molten metal of the covering material was poured in while preventing oxidation of the inner wall of the cylinder 32 due to heating by this flux.

Problems to be solved by the Invention

However, as shown in Fig. 3, for the purpose of thin-wall covered casting, the cavity 37 is a very narrow area. Therefore, if attempted to pour molten metal through a communicating hole 35 from the sliding surface 3 side, there is no escaping route for the existing flux, and it is hard to replace molten metal and flux. Accordingly, in the prior art, covered casting was done in the following two steps of casting process. First, the cylinder block main body 31 shown in Fig. 3 is set upside down, the molten metal is poured into the cylinder 32 to perform covered casting of the inner cylinder 32, which is a first step. Consequently, setting the cylinder block main body 31 in the vertical direction as shown in Fig. 3, the molten metal is poured onto the sliding surface 33, and covered casting of the sliding surface 33 is done, which is a second step. Therefore, the casting process was complicated, and it was hard to reduce the cost of the cylinder block. In Japanese Patent Publication No. 6-13140, for example, a method is proposed, in which the difference in specific gravity between the molten flux and molten metal is amplified by giving a centrifugal force, and the molten flux and molten metal are replaced by the amplified difference in specific gravity. In this case, too, an extra centrifugal casting machine is required, and also a step for giving a centrifugal force by the centrifugal casting machine is needed.

The invention is therefore devised to solve the problems of the prior arts, and it is an object thereof to present a covered casting method capable of performing covered casting of cylinder block in a simple process, and to present a cylinder block capable of reducing the cost by this covered casting method.

Summary of the Invention

A covered casting method of cylinder block as set forth in claim 1 is a covered casting method of cylinder block for covering a cylinder block main body 1 comprising plural cylinders 2 extending vertically opened at the lower end side, a sliding surface 3 opened toward the upper side above the cylinders 2, and plural communicating holes 5 for communicating between the upper part of the sliding surface 3 and inner parts of the cylinders 2, with a covering material 9 on the sliding surface 3 and the inner wall of the cylinders 2, wherein a core 6 is inserted into the cylinder 2 from beneath the cylinder 2 to form a cavity 14 between the cylinder 2 and the core 6, the lower end of the cylinder 2 is sealed, and by heating in a non-oxidizing gas atmosphere such as inert gas and reducing gas, a molten metal 8 of covering material 9 is poured into the cavity 14 from the sliding surface 3 side through the communicating holes 5.

According to the covered casting method of cylinder block of claim 1, since heating of the cylinder block main body 1 and pouring of molten metal 8 are done in non-oxidizing gas atmosphere, the conventionally used flux is not necessary. Therefore, by pouring the molten metal 8 from the sliding surface 3 side, the molten metal 8 can be poured into the cavity 14 easily through the communication holes 5. As a result, covering of the inner wall of the cylinder 2 and sliding surface 3 can be done in a simple casting process of one step.

In a covered casting method of cylinder block as set forth in claim 2, the heating is done together with the solid covering material 9, and the pouring is done by passing the molten metal 8 of the covering material 9 gradually melted by this heating into the cavity 14.

According to the covered casting method of cylinder block of claim 2, since the covering material 9 gradually flows into the cavity 14 from the portion melted by heating, it is possible to pour the molten metal 8 into the cavity 14 while discharging the non-oxidizing gas in the cavity 14 smoothly. Hence, particular pouring step is not needed, so that the casting process may be further simplified.

At this time, as in claim 3, when the solid covering material 9 is placed on the sliding surface 3, by its melting, since both covering of the sliding surface 3 and cov-

ering of the cylinder 2 can be done securely, the casting process may be further simplified.

In a covered casting method of cylinder block as set forth in claim 4, the cylinder block main body 1 is formed of ferriferous material, and the covering material 9 is a copper alloy.

According to the covered casting method of cylinder block of claim 4, it is executed easily. At this time, as in claim 5, when the heating temperature is about 920 to 1050°C, it is ideal for pouring smoothly by passing the molten steel 8 gradually Into the cavity 14. If the heating temperature is less than the specified temperature range, melting of the covering material 9 is very slow, but when the heating temperature exceeds the specified temperature range, flow of the molten metal 8 into the cavity 14 is very rapid, and a turbulent flow occurs in the non-oxidizing gas, and bubbles may be mixed into the molten metal 8.

In a covered casting method of cylinder block as set forth in claim 6, the heating is done together with a carbon material 10, and the non-oxidizing gas atmosphere is formed by combustion of the heated carbon material 10.

According to the covered casting method of cylinder block of claim 6, since the non-oxidizing gas atmosphere is formed by heating of the cylinder block main body 1, the manufacturing process may be further simplified.

A cylinder block as set forth in claim 7 is cast by a covered casting method of cylinder block in any one of claims 1 to 6.

According to the cylinder block of claim 7, the cost can be reduced by is simplified casting process.

Brief Description of the Drawings

Fig. 1 is a sectional view for explaining a covered casting method of cylinder block in embodiment 1 of the invention and a cylinder block.

Fig. 2 is a sectional view for explaining a covered casting method of cylinder block in embodiment 2 of the invention and a cylinder block.

Fig. 3 is a partial sectional view for explaining a conventional covered casting method of cylinder block.

Reference Numerals

1	Cylinder block main body
2	Cylinder
3	Sliding surface
4	Sliding part
5	Communicating hole
6	Core
8	Molten metal
9	Covering material
10	Carbon lid
14	Cavity

Preferred Embodiment of the Invention

Some of specific embodiments of the covered casting method of cylinder block and cylinder block of the invention are described in detail below while referring to the accompanying drawings.

Embodiment 1

Fig. 1 is a sectional view for explaining a covered casting method of cylinder block in embodiment 1 of the invention and a cylinder block. A cylinder block main body 1 is formed of a ferriferous material such as SCM440 chrome-molybdenum steel. In this cylinder block main body 1, a coupling hole 19 for fitting in an input shaft (not shown) is formed around its axial center, and plural cylinders 2 extending vertically, opened at the lower end side, are provided around the coupling hole 19. A sliding part 4 is provided above the cylinders 2, and this sliding part 4 is composed of a sliding surface 3 formed toward the upper side, and a rising edge 15 formed around this sliding surface 3. A recess 22 is formed on the outer circumference of the sliding surface 3, and the inside of each cylinder 2 communicates with the sliding part 4 side, that is, the upper side of the sliding surface 3, through the communicating hole 5 opened in the recess 22.

In such cylinder block main body 1, the core 6 is inserted from beneath the cylinder 2. This core 6 is a refractory material using ethyl silicate or the like as binder. By inserting the core 6, the cavity 14 is formed between the cylinder 2 and the core 6, and the lower end opening of the cylinder 2 is sealed by a bulge 16 formed at the lower end side of the core 6. At the lower side of the core 6, a doughnut-shaped tray 7 is disposed, and the core 6 is fixed in the cylinder 2. On the other hand, on the sliding surface 3, the solid covering material 9 is placed. This covering material 9 is a copper alloy such as LBC-3. So as to cover the covering material 9 from above, a carbon-made lid 10 is put on the cylinder block main body 1. A step 23 is formed at a side edge 17 of the carbon lid 10, and the rising edge 15 of the sliding part 4 abuts against the step 23, so that the both members may contact with each other tightly. Therefore, by mounting the carbon lid 10 on the cylinder block main body 1, the cavity 14 and a space 18 above the sliding surface 3 are isolated from the external air.

Consequently, thus assembled casting assembly is heated to a temperature of about 920 to 1050°C. In this process, part of the carbon lid 10 burns, and the space 18 and cavity 14 are filled with reducing gas such as CO. When the casting assembly reaches a temperature of about 920 to 1050°C, the solid covering material 9 begins to melt gradually. Part of the melted covering material 9 flows down into the recess 22 formed in the sliding surface 3, and further flows gradually into the cavity 14 through the communicating hole 5. Other part spreads over the sliding surface 3. When this heating is

continued for several minutes to more than ten minutes, the cavity 14 and upper part of the sliding surface 3 are filled with the molten metal of covering material 9. In this way, after being filled with the molten metal of the covering material 9, it is cooled by force. After being cooled, partly burned carbon lid 10, tray 7, and core 6 are taken out, so that a cylinder block by covered casting is obtained.

In this covered citing method, after filling the cavity 14 and the space 18 above the sliding surface 3 with reducing gas, heating and pouring of the covering material 9 are done, the hitherto used flux is not needed. Accordingly, the molten metal of the covering material 9 can be poured easily into the cavity 14 through the communicating hole 5 from above the sliding surface 3. Therefore, without requiring complicated process such as the two-step casting process or the processing using centrifugal casting machine, the casting process can be simplified. Herein, the solid covering material 9 is put on the sliding surface 3, and it is heated together with the cylinder block main body 1, and the gradually melted molten metal of the covering material 9 is poured into the cavity 14 gradually. Therefore, without disturbing the reducing gas for filling the cavity 14, smooth pouring is realized, and residue of bubbles of reducing gas in the poured molten metal can be avoided. Moreover, any particular pouring process is not needed only by mounting and heating the covering material 9, and the casting process is further simplified. Still more, since the recess 22 is formed in the sliding surface 3, the pouring is more smooth. The cylinder block main body 1 is made of ferriferous material such as SCM440 chrome-molyodenum steel, and the covering material 9 is a copper alloy such as LBC-3. Therefore, the covering material 9 can be poured in while avoiding heat damage of the cylinder block main body 1 due to heating. In particular, by defining the heating temperature to about 920 to 1050°C, the fusion speed of the covering material 9 is optimum, and the molten metal flows securely and smoothly into the cavity 14. The reducing gas is generated by combustion of the carbon lid 10, and the spaces 18, 14 isolated by this carbon lid 10 from the fresh air is filled with the reducing gas. Therefore, particular chamber or process is not needed for forming such non-oxidizing gas atmosphere, and the casting process is much simplified. By casting the cylinder block in such covered casting method, the cylinder block reduced in cost can be presented.

Embodiment 2

Fig. 2 is a sectional view for explaining a covered casting method of cylinder block in embodiment 2 of the invention and a cylinder block. What the covered casting method of this embodiment 2 differs from the covered casting method in the above embodiment 1 is that the molten metal 8 is poured in from outside of the carbon lid 10, after being heated, instead of heating by putting the solid covering material 9 on the sliding surface 3. Accordingly, in the carbon lid 10 in this embodiment, a casting hole 21 is pierced nearly in its center, and an auxiliary lid 11 for closing the casting hole 21 is provided. The auxiliary lid 11 may be made of either carbon or other material. This is because a sufficient amount of reducing gas is obtained by the combustion of the carbon lid 10. In the covered casting method of embodiment 2, same as in embodiment 1, after assembling the core 6 and tray 7 into the cylinder block main body 1, the carbon lid 10 is put on the sliding surface 3 without mounting the solid covering material 9, and the casting hole 21 is closed with the auxiliary lid 11. Thus assembled casting assembly is heated to about 900°C. The heating temperature is lower than in embodiment 1 because it is not necessary to melt the covering material 9 at this step, and it is enough to activate the inner wall of the cylinder 2 and the sliding surface 3 only so that the covering material 9 may be fused securely to the cylinder block main body 1. When the casting assembly is heated to about 900°C, the auxiliary lid 11 is removed, and the molten metal 8 is poured in from the casting hole 21. When pouring is over, cooling in the same method as in embodiment 1, a cylinder block by covered casting is obtained.

In this covered casting method, since heating is done by filling with reducing gas generated by combustion of the carbon lid 10, flux is not needed, and the casting process is simplified, same as in embodiment 1. In the covered casting method of the embodiment, however, since the molten metal 8 is poured in from outside of the carbon lid 10 after heating, pouring is completed in a shorter time than in embodiment 1. In addition, since it is not necessary to melt the covering material 9 by heating, the heating temperature can be set lower. On the other hand, by casting the cylinder block by using such covered casting method, the cylinder block lowered in the cost can be presented, same as in embodiment 1.

Specific embodiments of the invention are described above, but the invention is not limited to the illustrated embodiments alone, but may be changed or modified within the scope of the invention. In the foregoing embodiments, the space 18 and cavity 14 are isolated from the fresh air by the carbon lid 10, but they may be also isolated by the lid of other material such as metal or ceramics, or carbon powder may be sprinkled in the isolated space 18, or carbon material may be adhered to the back side of the lid, or part of the lid may be formed of carbon. Alternatively, instead of isolating the space 18 and cavity 14 from the fresh air by the lid, they may be also isolated from the fresh air by using chamber or the like. In such a case, the reducing gas may be generated by combustion of carbon material, but in other method, for example, by feeding under pressure from outside, the chamber may be filled with reducing gas or inert gas to form a non-oxidizing gas atmosphere. In embodiment 1, the covering material 9

was directly put on the sliding surface 3, but the covering material 9 may be put on some table or the like. Of course, the material of the cylinder block main body 1 or covering material 9 is not limited to SCM440 chrome-molybdenum steel or LBC-3 copper alloy alone. For example, the material of the cylinder block may be FCD450 cast iron or the like, and the material of the covering material may be PBC-2 bronze or the like.

In the covered casting method of cylinder block in any one of claims 1 to 6, the conventional flux is not needed, and covered casting of cylinder block is possible in a simple process. Besides, by simplifying the process, automation of covered casting may be easier.

In the cylinder block in claim 7, the cost can be reduced substantially by the simple covered casting method.

Claims

1. A covered casting method for a cylinder block, wherein

   a cylinder block main body (1), which comprises a plurality of vertically extending cylinders (2) open at the lower end, a sliding surface (3) open toward the upper side above the cylinders (2), and a plurality of communicating holes (5) between the upper part of the sliding surface (3) and inner parts of the cylinders (2), is covered with a covering material (9) on the sliding surface (3) and the inner wall of the cylinders (2),
   a core (6) is inserted into each cylinder (2) from the beneath cylinder (2) to form a cavity (14) between the cylinder (2) and the core (6),
   the lower end of the cylinder (2) is sealed,
   the thus formed assembly is heated in an atmosphere of a non-oxidising gas, such as inert gas and/or reducing gas, and
   molten covering material (8; 9) is poured into the cavity (14) from the sliding surface (3) side through the communicating holes (5).

2. The method of claim 1, wherein the heating is applied to solid covering material (9), and the pouring is done by passing the covering material (9), which is gradually melted by this heating, into the cavity (14).

3. The method of claim 2, wherein the solid covering material (9) is placed on the sliding surface (3).

4. The method of any preceding claim, wherein the cylinder block main body (1) is formed of ferriferous material and the covering material (9) is a copper alloy.

5. The method of claim 4, wherein the heating temperature is about 920 to 1050 °C.

6. The method of any preceding claim, wherein the heating is applied to a carbon material (10), and the non-oxidising gas atmosphere is formed by combusting the heated carbon material (10).

7. A cylinder block of an axial piston pump or axial piston motor, produced by the method of any preceding claim.

FIG. 1

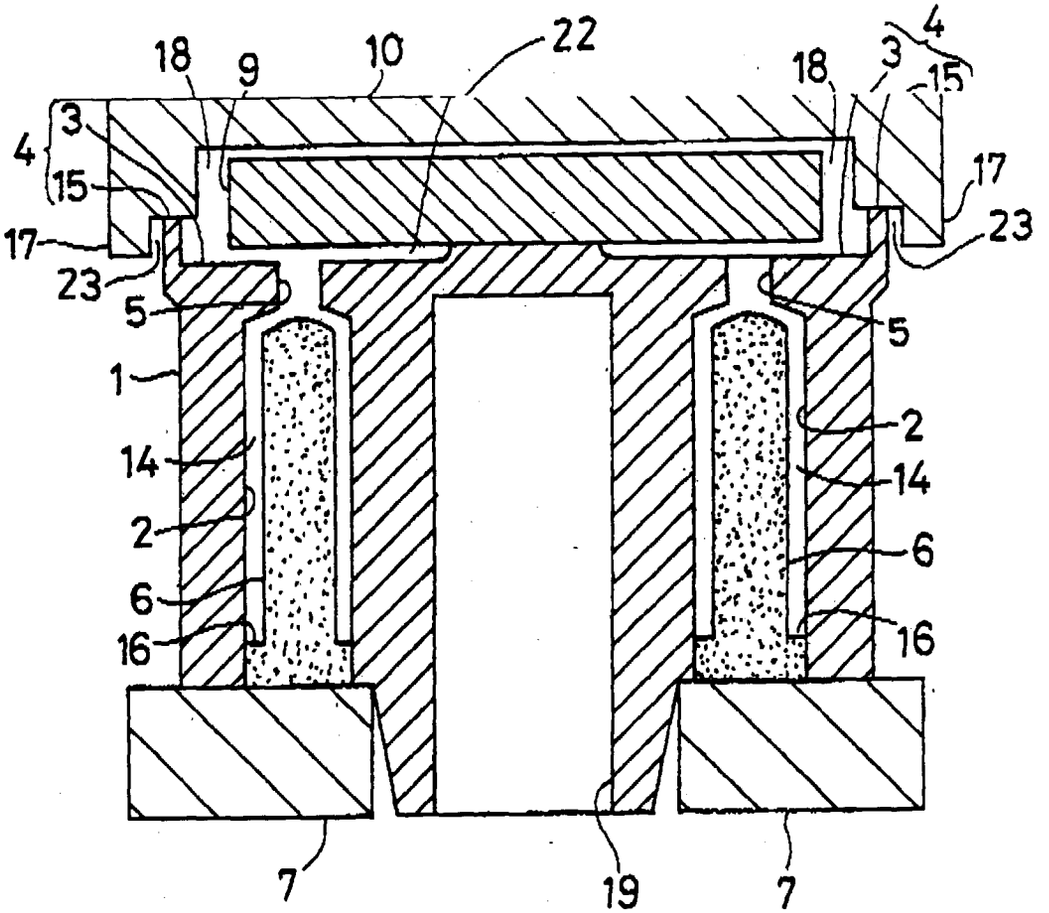


FIG. 2

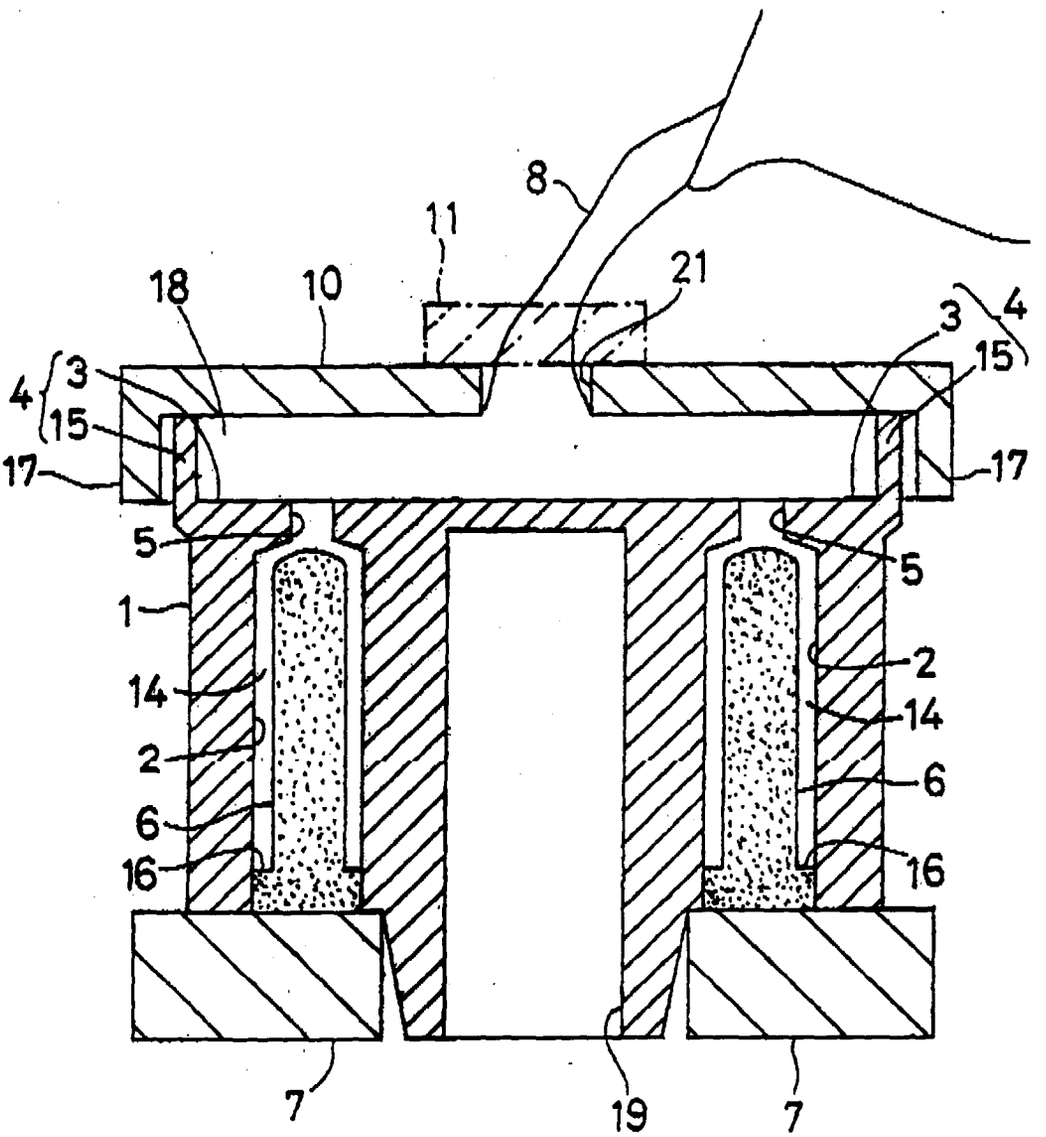
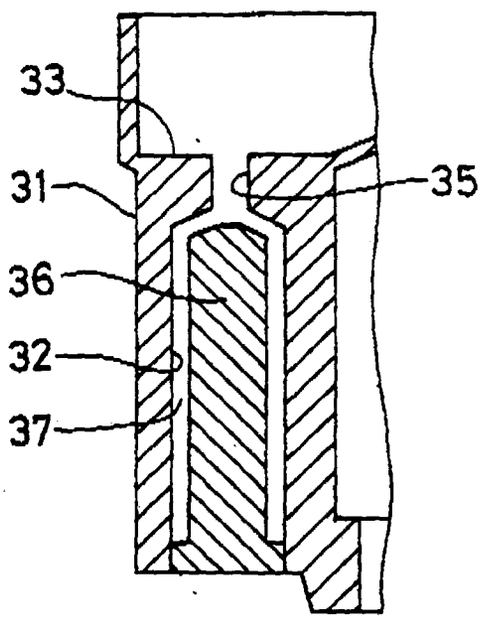


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 98 10 6623

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y,D	JP 02 155 554 A (AKASHI GODO K.K.) 14 June 1990 * figures 2,3 * -& PATENT ABSTRACTS OF JAPAN vol. 014, no. 407 (M-1019), 4 September 1990 & JP 02 155554 A (AKASHI GODO:KK), 14 June 1990, * abstract *	1	B22D19/08
Y	DE 804 227 C (VEREINIGTE DEUTSCHE METALLWERKE AKT.-GES.) * claim 1; figure 1 *	1	
A	EP 0 084 864 A (GENERAL SIGNAL CORPORATION) 3 August 1983 * claim 1; figures 1,2 *	1	
A	US 3 937 268 A (R. G. LOEBS ET AL.) 10 February 1976 * claim 1; figures 1,2 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	DE 15 58 233 A (FÜRSTLICH HOHENZOLLERNSCHE HÜTTENVERWALTUNG) 19 March 1970 * claim 1; figure *	1	B22D
A	DE 17 03 403 B (JOSEPH LUCAS (INDUSTRIES) LTD.) * claim; figures 1,2 *		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	21 July 1998	Sutor, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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