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(54) **METHOD OF INTERNAL CHILLING, AN APPARATUS THEREFOR, AND INTERNALLY CHILLED PRODUCTS.**

(57) Internally chilling aluminium alloys, FRM, steel, Ti alloys, Ni alloys, Co alloys and the like by the use of aluminum alloys. In internally chilling highly strong materials such as ferrous ones or the like by the use of aluminum alloys, the alfin method has heretofore been employed not to leave non-plated portions by plating of aluminum. It requires, however, cumbersome operation and increased cost. This invention improves the above defects by employing vibration plating instead of said aluminum plating, and by forming a uniformly plated layer with exellent junction properties. The invention is adaptable to engine parts such as cylinder heads, pistons, etc., as well as to gears.

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SPECIFICATION

Technical field

The present invention relates to insertion, wherein an aluminum alloy, an FRM, steel, a Ti alloy, an Ni alloy, a Co alloy or the like is inserted in an aluminum alloy.

Background Art

Aluminum alloy castings have the advantages of being lightweight, being usable in die-cast casting, molten-metal forging, and low-pressure casting, and having a high productivity. However, since they have lower strength, they have lower wear resistance, and the like, than iron castings, and their application range is limited.

In view of the above situation, a high-strength material, such as an iron-based material, is inserted at a portion of an aluminum alloy casting which requires high strength. However, when simple insertion is performed, for example, when an iron-based material is inserted in an aluminum alloy, a non-welded portion remains at the iron-aluminum alloy boundary.

Since the iron-aluminum alloy boundary remains non-welded, a strength of insertion product is not sufficient.

As a method of eliminating such a non-welded portion and diffusion welding the iron-aluminum boundary, alphine treatment is known. The alphine treatment, however, requires a great deal of labor, and increases the cost and weight of the resultant material.

Disclosure of Invention

According to the present invention, an insert made of material such as an aluminum alloy, an FRM, steel, a Ti alloy, an Ni alloy, a Co alloy or the like is subjected to a pre-treatment, such as water rinsing, degreasing, pickling, drying, and the like. The insert is then dipped in a plating bath, and is plated while oscillating an oscillating plate arranged near the insert in the plating bath. Subsequently, the insert is inserted in an insertee, such as an insertee composed of an aluminum alloy.

The plating bath is oscillated to remove the surface oxide of the insert and to form a uniform plating layer. The insert is inserted in an insertee, such as an aluminum alloy, with the plating layer between them. Next, the insert and the insertee are completely welded together, and a diffusion welding region is formed between the two materials.

The insert and insertee material are securely bonded together, and an inserted article having a satisfactory strength can be manufactured. Since the plating bath need only be oscillated, the manufacturing process is easy, and the cost is low.

Brief Description of Drawings

Fig. 1 is a sectional view of a plating device used in Example 1 of the present invention; Fig. 2 shows a tapered shaft manufactured by the method of Example 1; Fig. 3 is a microphotograph (x 100) of a boundary portion between insert and insertee of an inserted article manufactured by the method in Example 1 of the present invention; Fig. 4 is a microphotograph (x 100) of a boundary portion between insert and insertee of an article of a Comparative Example obtained by inserting an insert in an insertee without plating the former [the article corresponding to the non-preheated, no treatment section for the Comparative Example in the table]; Fig. 5 is a microphotograph (x 100) of a boundary portion between piston main body 13 and anti-wear ring 12 of a piston of Example 2; Fig. 6 is a sectional view of mold 19 in Example 5; Fig. 7 is a microphotograph (x 100) of a boundary portion between steel wire 14 and aluminum alloy 20 of test piece No. 4 of Example 5; Fig. 8 is a microphotograph (x 100) of a boundary portion between steel wire 14 and aluminum alloy 20 of test piece No. 6 of Example 5; Fig. 9 is a sectional view of an engine connecting rod of Example 5; Fig. 10 is a perspective view of cam 18 of Example 6; Fig. 11 is a sectional view of a cam shaft of Example 6; Fig. 12 is a sectional view of a piston of Example 7; Fig. 13 is a sectional view of a cylinder head of Example 4; Fig. 14 is a sectional view of an engine including a cylinder head of Example 8; and Fig. 15 is a front view of a rocker arm of an internal engine according to the present invention.

Best Mode of Carrying Out the Invention

The present invention will now be described by way of its Examples.

Example 1

An insert is prepared from JISA2024S aluminum alloy.

The insert is subjected to cleaning/drying, i.e., a pre-treatment in the order of rinsing with water, degreasing, rinsing with water, pickling, rinsing with water, and drying by a pre-treatment device.

Plating is then performed in plating device 1 shown in Fig. 1.

Plating device 1 consists of solder melting furnace 2 and ultrasonic wave oscillator 3. Furnace 2 consists of solder tank 5 containing plating bath 4 at its upper portion, and heating section (heating coil) 6 arranged below tank 5 for heating it. One of oscillating plates 8 branching in a Y-shape is fixed to oscillation horn 7 of oscillator 3, and the other plate 8 is dipped in plating bath 4 in tank 5. Insert material 9 is inserted between two oscillating plates 8 and is located with a gap of 1.0 mm with respect to two plates 8 by the surface tension of the plating bath.

Insert 9 is plated under the following conditions:

1. Plating bath composition...molten aluminum solder [eutectic Zn-5Aℓ alloy (95% Zn - 5% Aℓ); melting point ≒ 380°C]

2. Ultrasonic oscillation conditions...oscillation frequency: 18 kHz, amplitude: 20 μm, application time: 2 to 3 sec

3. Plating bath temperature...400 to 420°C

4. Plating film thickness...50 μm

5. Plating time...7 min

Insert 9 plated with Zn-5A alloy is set in a mold of a casting device (not shown). Molten AC4B aluminum alloy is gravity-cast as an insertee, thereby molding tapered shaft 10 shown in Fig. 2. Tapered shaft 10 consists of AC4B main body 11 and insert 9.

Comparative Example

Insert materials were molded from JISA2024S material and were respectively subjected to non-treated Zn plating, Sn plating, kanigen plating, and molten aluminum solder plating. Thereafter, each material was inserted in AC4B aluminum alloy to manufacture a tapered shaft (similar to Example 1).

The welding performance and presence/absence of insert loss in Example 1 and the Comparative Example were tested. The obtained results are shown in Table 1.

Table 1

	Type of Surface Treatment	Preheating Temprature(*) of Insert	Result	
			Welded State	Presence/Absence of Insert Loss
Conventional Method	No treatment	R.T. 300°C	x(Not welded) Δ(Partially welded)	o (No loss) (Partially welded)
	Zn plating	R.T. 300°C	x Δ	o x
	Sn plating	R.T. 300°C	x Δ	o x
	Kanigen plating	R.T. 300°C	x Δ	o x
	Molten Aℓ solder plating (Ultrasonic wave not applied)	R.T.	Δ	o
Method of Present Invention	Ultrasonic wave applied Molten Aℓ solder plating	R.T.	o	o

(*) The effect obtained when the insert was heated to 300°C in order to improve welding performance was tested. Insert loss occurs upon heating to 300°C. With the conventional method, welding performance is unsatisfactory even in this state.

As can be seen from this Table, Example 1 provides better results than the Comparative Example, and no insert loss is experienced.

When a comparison is made between a microphotograph of x 100 (Fig. 3) of a texture at the boundary between insert 9 and main body 11 of Example 1 and a microphotograph of x 100 (Fig. 4) of the boundary between the insert and the main body of the Comparative Example obtained with no treatment and no preheating, no nonwelded portion is observed between the insert and the main body in Example 1, wheareas a non-welded portion is present between the two materials in the Comparative Example: Therefore, the products of the Comparative Example apparently have low strength.

The insert is subjected to ultrasonic oscillation while molten aluminum soldering is performed, thereby removing the oxide layer formed on the surface of the insert and forming a uniform eutectic layer of aluminum-aluminum solder. The eutectic layer has a low melting point, easily melts in an insertee molten aluminum alloy bath, and mixes therewith.

Example 2

An anti-wear ring of a piston for a diesel engine was prepared as an insert. Following the same procedures as in Example 1, Zn-5Aℓ solder was melted and used to plate the ring, the plated ring was set in a mold, and AC8A aluminum alloy as an insertee was injected into the mold to form a piston. The casting temperature was 700°C. The anti-wear ring consisted of ADC10 aluminum alloy in which an Si_3N_4 powder was dispersed. A microphotograph (x 100; Fig. 5) of a texture at a boundary between anti-wear ring 12 and piston main body 13 cast from AC8A aluminum alloy reveals that no nonwelded portion remains between anti-wear ring 12 and piston main body 13, and that the two materials are completely welded.

Example 3

A cylinder liner of ADC10 aluminum alloy in which an Si_3N_4 powder was dispersed was prepared, and was plated with aluminum alloy solder using Zn-5Aℓ alloy as in Example 1. The obtained cylinder liner was set in a mold, and molten aluminum alloy was injected into the mold to cast a cylinder block main body, thereby obtaining a cylinder block in which the cylinder block is inserted in the cylinder block main body.

The boundary between the cylinder block main body and the cylinder liner was completely welded.

Example 4

A roof member for constituting a refractory combustion chamber wall of a cylinder head was prepared from an FRM having a great thermal fatigue strength (i.e., containing long carbon fiber and JISA6061 aluminum alloy as a matrix). Next, following the same procedures as in Example 1, the roof member was plated with aluminum alloy solder, the plated roof member was set in a mold, and an aluminum alloy as an insertee was injected into the mold to cast a cylinder main body. Thus, as shown in Fig. 13, roof member 32 was inserted in cylinder head main body 31 to complete cylinder head 33.

In this case, no non-welded portion was observed between the roof member and the cylinder head main body, and the two materials were completely welded to each other.

Example 5

3.0 mm diameter wires of SUS630 steel and MASIC steel were pre-treated. Thereafter, each wire was plated with aluminum solder using ℓAlmit AM350ℓ as JISZ3281 aluminum solder. After preheating each wire 14 to 300°C, it was set in mold 19 shown in Fig. 6, and AC4B aluminum alloy 20 kept at 700°C as an insertee was injected into the mold to prepare a casting. Reference numeral 21 denotes a support jig for holding steel wire 14 in mold 19. JIS tensile strength test piece (No. 4) 15 (indicated by the alternate two long and one short dashed line in Fig. 6) was cut from each casting with wire 14 as the center, and each test piece was subjected to a tensile strength test. Each tensile strength test piece 15 had a size of 7 (diameter) x 32 mm at a parallel portion thereof (marked distance: 25 mm). A chuck portion thereof had threads of M12 and P1.5 so as to eliminate the influence of chucking on the insertee in the tensile strength test.

The plating conditions and the results of the tensile strength test are shown in Table 2 below.

Table 2 Insertion Test Piece Preparation Conditions and Tensile Test Results

No.		Casting Preparation Conditions				Tensile Test Results	
		Plating Condition					
	Insert Material	Material	Treatment Temperature x Time	Ultrasonic Wave Application Conditions	Solder Layer Thickness	Tensile Strength kg/mm^2	Fractured State
1	SUS304	Almit AM350	500°C x 5 min	18 kHz, 20 μm amplitude, 5 sec	100 μm	38.0	Both steel and Aℓ fractured
2	↑	↑	500°C x 10 min	↑	↑	37.2	↑
3	↑	No plating (Comparative Example)				20.5	Only Aℓ fractured
4	MASIC steel	Almit AM350	500°C x 5 min	18kHz, 20 μm amplitude, 5 sec	100 μm	53.2	Both steel and Aℓ fractured
5	↑	↑	500°C x 10 min	↑	↑	52.5	↑
6	↑	No plating (Comparative Example)				20.3	Only Aℓ fractured

*1 "Almit AM350ℓ: Product of Nihon Almit K.K., Aℓ solder: 95% Zn, 5% Aℓ

*2 "MASIC steelℓ: Product of DAIDO STEEL CO., LTD., high-strength steel (tensile strength 199 kg/mm^2 or more) C: 0.03% or less, Si: 0.1% or less, Mn: 0.1% or less, Ni: 18.5%, Mo: 4.8%, Co: 9.0%, Ti: 0.6%, Aℓ: 0.1%, Fe: balance

The test results reveal that a uniform plating layer can be obtained by plating an iron-based insertee with aluminum solder under ultrasonic oscillation, and with such a uniform plating layer, the insert and the insertee (AC4B) are completely welded together at their boundary, as can be seen from the x 100 microphotograph of the texture in Fig. 7. Note that Fig. 7 corresponds to test piece No. 4 in Table 2.

In the Comparative Example test piece (test piece No. 6) which was not subjected to ultrasonic oscillation, many non-welded portions remained in the boundary between the insert and insertee, as can be seen from the microphotograph (x 100) in Fig. 8.

Example 5

MASIC steel wire 16 having a diameter of 4.0 mm was subjected to plating with aluminum solder under the same conditions as test piece No. 4 in Example 4. After the wire was preheated to 300°C, it was set in a mold and ADC10 aluminum alloy was cast by the non-porous die cast method, thereby molding connecting rod 17 for an automobile engine as shown in Fig. 9.

The resultant connecting rod 17 exhibited about 50% improvement in strength as compared to that when a similar wire was not inserted in MASIC steel. The MASIC steel and ADC10 material were completely welded together through the aluminum solder.

Example 6

Internal engine cams 18 shown in Fig. 10 were made by an iron-based sintered alloy. The side and inner circumferential surfaces of cams 18 were pre-treated and plated after the same procedures as in Example 1. After aluminum solder-plated cams 18 were preheated to 300°C, they were set in a mold for casting an internal engine cam shaft, and ADC10 aluminum alloy was injected into the mold and cast by the die cast method, thereby mounting cams 18 on shaft 19, as shown in Fig. 11.

Cams 18 and shaft 19 were completely welded together through the aluminum solder.

Example 7

Diesel engine anti-wear ring 21 of Ni-resist cast iron was plated with aluminum solder in the same manner as test piece No. 4 in Example 5. After the anti-wear ring was preheated to 300°C, it was set in a mold, and ADC10 aluminum alloy was injected by gravity casting to mold diesel engine piston 22 as shown in Fig. 12.

The anti-wear ring and ADC10 aluminum alloy were completely welded together through the aluminum solder.

Example 8

A cylinder liner was molded with ADC10 aluminum alloy in which an Si_3Ni_4 powder was dispersed. In the same procedures as in Example 1, the cylinder liner was pre-treated and plated with pure zinc under ultrasonic oscillation. The plating conditions were as follows:

1. Plating bath composition...pure zinc
2. Plating bath temperature...440 - 450°C
3. Plating film thickness...50 µm
4. Ultrasonic oscillation conditions...oscillation frequency 18 kHz, amplitude 20 µm, application time: 2 - sec

The zinc-plated cylinder liner was inserted into a mold, and molten aluminum alloy (ADC10 alloy) was injected into the mold to mold cylinder block 35, in which cylinder liner 34 was inserted as shown in Fig. 14.

The boundary between the cylinder liner and the cylinder block was completely welded.

Example 9

Internal engine cams were prepared from an iron-based sintered alloy as in Example 6. The cams were pre-treated and then plated with pure zinc following the same procedures as in Example 8. After the cams were preheated to 300°C, they were set in a mold and ADC10 aluminum alloy was injected to cast a cam shaft in which the cams were inserted, by the die cast method.

When the boundary between the cams and cam shaft was examined, the two materials were completely welded.

The zinc plating bath temperature was 500°C, the plating time was 5 minutes, and the ultrasonic oscillation application time was 5 seconds.

In the above-described Examples, the ultrasonic oscillation frequencty is 18 kHz. However, according to the present invention, the ultrasonic oscillation frequency can be within a range of 1 to 1,000 kHz, and preferably 1 to 100 kHz. When the ultrasonic oscillation frequency is below 1 kHz, the repeating number within a unit time is small, the oxide film formed on the surface of the material to be plated cannot be removed, complete plating cannot be performed, the plating layer is easily peeled off, and a uniform plating layer cannot be formed. When the ultrasonic oscillation frequency exceeds 1,000 kHz, the plating bath cannot follow oscillation of the oscillation plate, and the plating bath is peeled from the surface of the oscillation plate to cause cavitation, which damages the oscillation plate.

In the above-described Examples, the plating film thickness is set to be 50 µm or 100 µm. According to the present invention, the plating film thickness is preferably within a range of 5 to 300 µm, and in particular, 30 to 100 µm. When the plating film thickness is below 5 µm, welding with the aluminum alloy during the insertion process is incomplete. Since a complete welding between the insert and insertee can be achieved with plating film thicknesses of 300 µm or less, plating exceeding a thickness of 300 µm is superfluous.

In the above-described Examples, the amplitude of the oscillation plate was 20 µm. The amplitude is preferably within a range of 5 to 35 µm. When the amplitude is less than 5 µm, sufficient energy cannot be applied to the plating bath, the oxide formed on the surface of the insert material cannot be removed, and a uniform plating layer cannot be formed. However, when the amplitude exceeds 35 µm, the plating bath cannot follow movement of the oscillation plate, and cavitation may cause damage to the oscillation plate.

In the above-described Examples, the distance between the oscillation plate and the plating surface of the insertee was 0.1 mm. However, the distance can be 0.5 mm or less to allow the presence of the plating bath between the oscillation plate and the insert. When the distance exceeds 0.5 mm, wave force of the plating bath applied by oscillation of the oscillation plate is not sufficiently transmitted to the insert, and a uniform, strong plating layer cannot be formed.

In the above-described Examples, the plating bath composition was Zn-Aℓ alloy or pure zinc. However, any aluminum solder according to JISZ3281, SAL-BQZ, or SAL-CRZ can be used. In addition, a cadmium-silver alloy [Cd: 95%, Ag: 5% (by weight)], a tin-zinc alloy [Sn: 85%, Zn: 15% (% by weight)], or the like can also be used.

In the above-described Examples, the insert material was an aluminum alloy, stainless steel, hightrength steel, cast iron, an FRM (an aluminum alloy containing carbon fiber), or an iron-based sintered alloy. However, iron steel (including stainless steel or heat-resistant steel), a titanium alloy, a nickel alloy, a cobalt alloy, an FRM using an aluminum or zinc alloy as a matrix, or the like can be used.

In the above-described Examples, internal engine constituent parts such as a cylinder head, a cylinder block, a cam shaft, a piston, or a connecting rod were prepared. However, constituent parts such as a crank shaft, a rocker arm, an automobile suspension part (e.g., a suspension arm), a differential gear carrier, a disk brake caliper, and various gears can also be prepared.

More specifically, a rocker arm consists of chip 37 of an iron-based sintered alloy and rocker arm main body 36 of an aluminum alloy, and chip 37 is in slidable contact with a cam, as shown in Fig. 15. A Zu-Aℓ alloy or the like is plated on the outer surface of chip 37 under ultrasonic oscillation, and is inserted in rocker arm main body 36.

In the case of a suspension arm, steel is inserted in the longitudinal direction thereof, a bush, as a mount portion of the arm to the vehicle body, and a joint member to a wheel are inserted, the outer surface of the wire is plated by the method of the present invention, the joint surface between the steel outer cylinder of the bush and the joint member is plated by the method of the present invention, and the three members are inserted in an aluminum alloy to prepare a suspension arm.

In the case of a differential gear, the method of the present invention is used in the same manner as for a mount bush to the vehicle body and a suspension arm. A wire, an FRM or the like is inserted by the method of the present invention.

In the case of a gear, after an FRM formed in a ring form is plated by the method of the present invention, the FRM is inserted in an aluminum alloy to provide a gear element. The FRM is then cut to form gear teeth.

As the casting method for inserting an insert plated by the method of the present invention with an insertee, any one of sand mold casting, mold gravity casting, low-pressure casting, die-casting, molten metal forging and the like can be used.

In the above-described Examples, when the insert is an iron-based material, it is preheated before insertion. However, preheating is not always necessary, and can be performed at 400°C or lower. Whether or not to perform preheating can be determined in accordance with the material of the insert used.

In the above-described Examples, plating is performed while ultrasonic oscillation is applied to the plating bath. The gap between the insert and insertee is set to be 0.1 mm. However, the gap can be 0.5 mm or less: the plating bath need only be present between the two materials. However, if the gap is 0.5 mm or less, oscillation applied to the plating bath by the oscillation plate is reflected by the insert. The reflected wave is amplified with the oscillation energy by the oscillation plate, and the amplified energy reaches the surface of the insert to remove the oxide on the surface of the insert and to form a uniform plating layer. However, if the gap exceeds 0.5 mm, the wave reflected by the insert is attenuated. Then, even if the attenuated reflected wave is amplified by the oscillation plate, the oscillation wave cannot have sufficient oscillation energy. Therefore, oxide on the surface of the insert material cannot be completely removed, a uniform plating layer cannot be formed, and a non-welded portion is formed between the insert and insertee.

Industrial Applicability

The present invention can be applied to the manufacture of cylinder heads, pistons, connecting rods, cam shafts pistons, and cylinder blocks, of engines, crank shafts, rocker arms, suspension arms, differential gear carriers, disk brake calipers, and various gears.

Claims

1. An insertion method characterized in that an insert is dipped in a plating bath after the insert is pre-treated, the insert is plated while an oscillation plate arranged in the plating bath and near the insert is oscillated, and the plated insert is inserted in an aluminum alloy.

2. An insertion method according to claim 1, characterized in that the insert is oscillated by oscillation of the plating bath.

3. An insertion method according to claim 1, characterized in that the pre-treatment comprises the steps of rinsing the insert with water, degreasing it, rinsing it with water, pickling it, rinsing it with water, and drying it.

4. An insertion method according to claim 1, characterized in that the plating bath consists of aluminum solder.

5. An insertion method according to claim 1, characterized in that the plating bath consists of pure zinc.

6. An insertion method according to claim 1, characterized in that the plating bath consists of a cadmium-silver alloy.

7. An insertion method according to claim 1, characterized in that the plating bath consists of a tin-zinc alloy.

8. An insertion method according to claim 1, characterized in that after the insert is plated, the insert is preheated to a temperature of 400°C or lower, and is inserted in an aluminum alloy.

9. An insertion method according to claim 1, characterized in that the plating layer formed on a surface of the insert has a thickness of 5 to 300 μm.

10. An insertion method according to claim 1, characterized in that the oscillation frequency is 1 to 1,000 kHz.

11. An insertion method according to claim 1, characterized in that a gap between the oscillation plate and the insert is 0.5 mm or less.

12. An insertion method according to claim 1, characterized in that the insert is made of the material selected from the group consisting of an iron-based material, a titanium alloy, a nickel alloy, a cobalt alloy, an aluminum alloy, an FRM having an aluminum alloy as a matrix, and an FRM having a zinc alloy as a matrix.

13. An insertion method according to claim 8, characterized in that the insert is made of an iron-based material.

14. An insertion method characterized in that an insert is plated while a plating bath is subjected to ultrasonic oscillation, the plated insert is inserted into an aluminum alloy, and the insert and the aluminum alloy are diffusion-welded.

15. An insertion method characterized in that an insert is dipped in a plating bath after the insert is pretreated, the insert is plated while an oscillation plate arranged in the plating bath and near the insert is oscillated, and the plated insert is inserted in an insertee essentially consisting of an aluminum alloy.

16. An insertion apparatus characterized by comprising a pre-treatment device for pre-treating an insert material, a plating device for plating the insert while oscillating a plating bath with an oscillation plate, and a casting device for holding the plated insert in a mold and injecting an aluminum alloy into the mold to obtain a casting in which the insert is inserted.

17. An insertion apparatus according to claim 12, characterized in that a gap between the oscillation plate and the insert is 0.5 mm or less.

18. An insertion article characterized by comprising an insert, a plating layer formed on a surface of the insert while oscillating a plating bath, and an insertee consisting of an aluminum alloy which is diffusion-welded

to the insert through the plating layer.

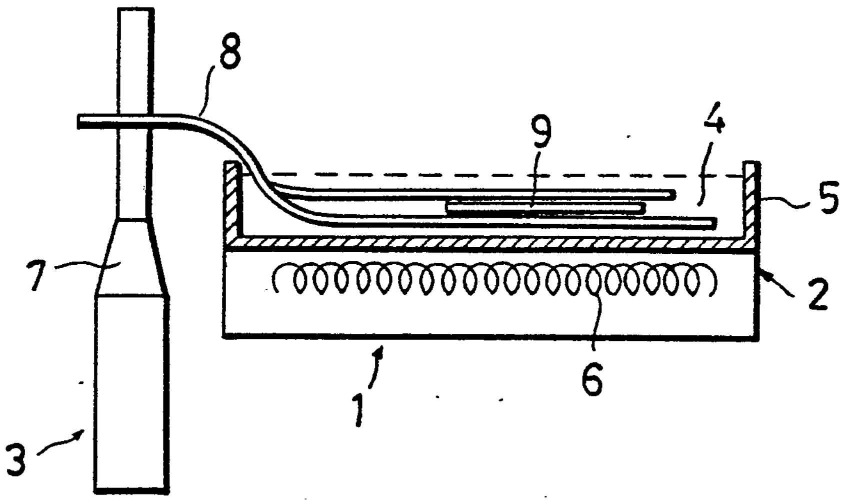

Fig.1

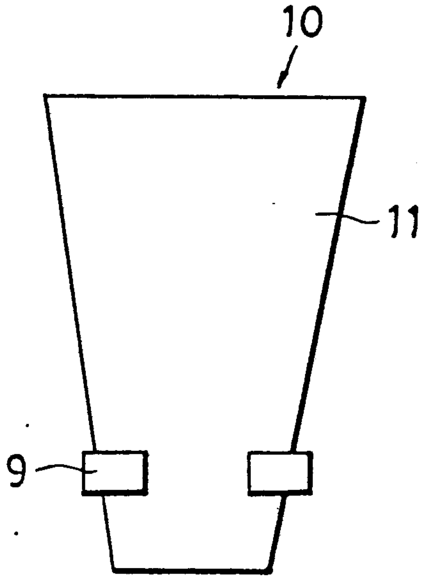

Fig.2

Fig.3

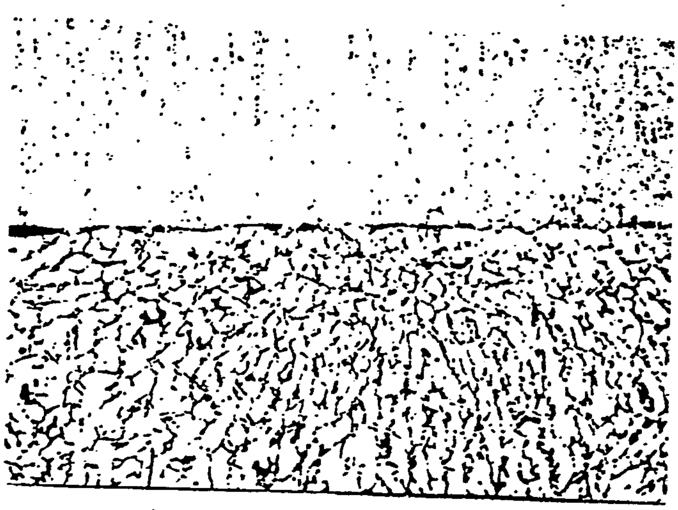

Fig.4

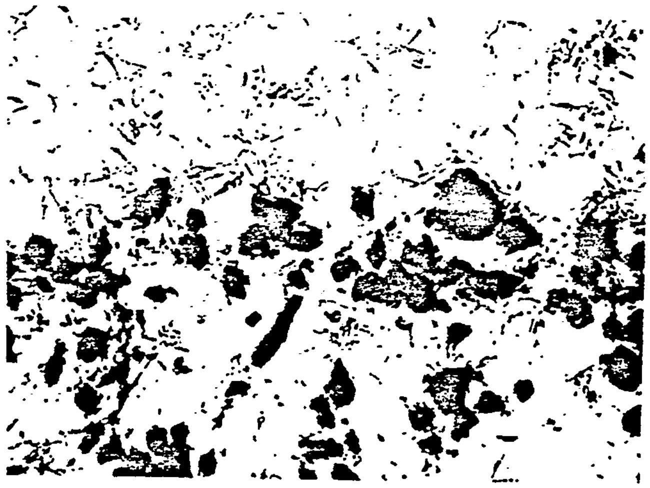

Fig.5

Fig.7

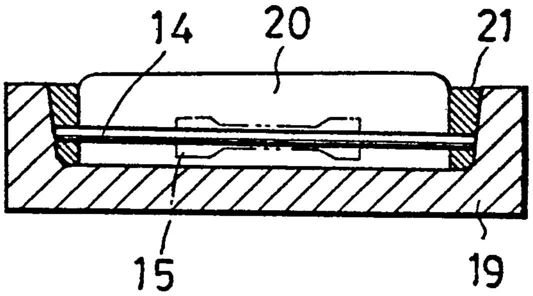

Fig. 6

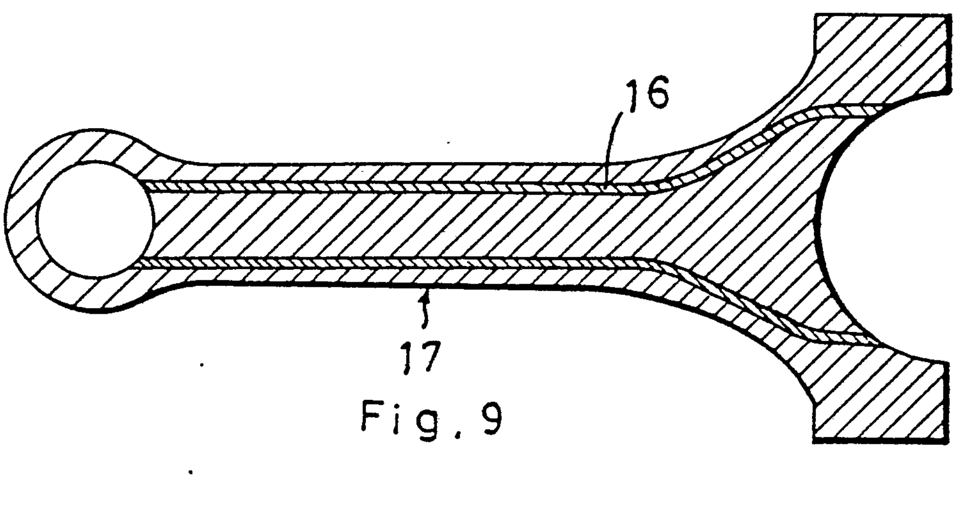

Fig. 9

Fig.8

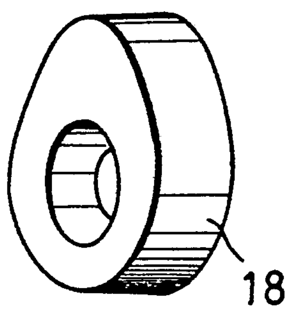

Fig.10

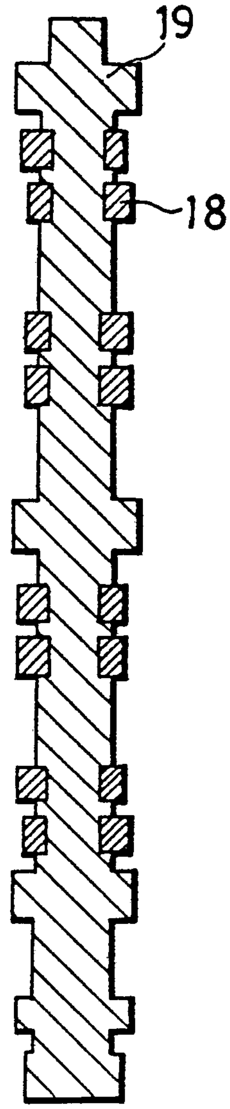

Fig.11

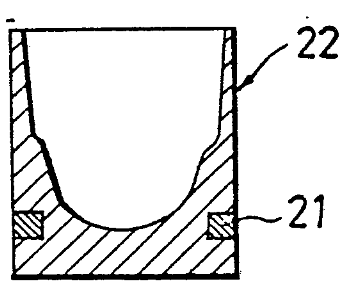

Fig.12

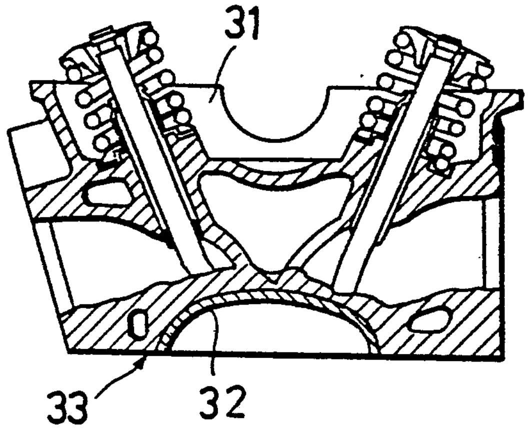

Fig.13

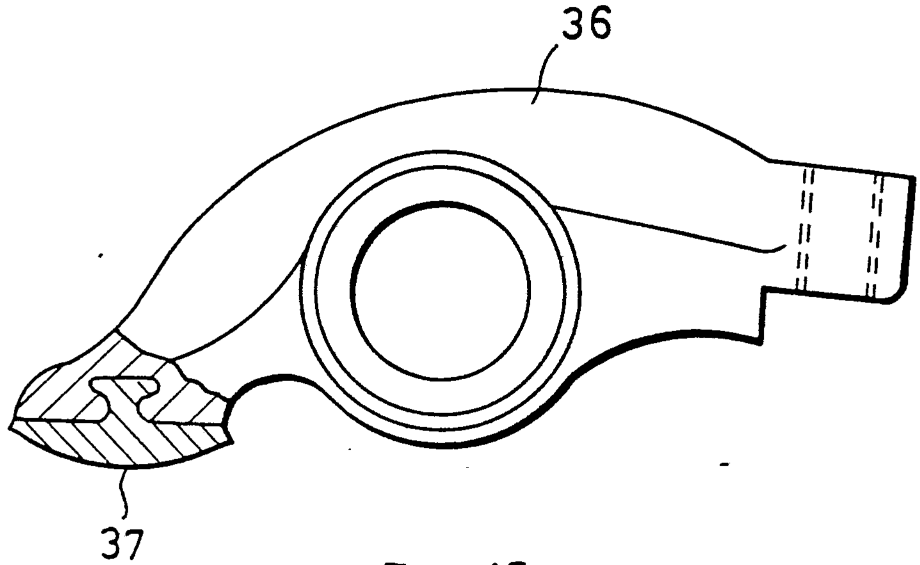

Fig.15

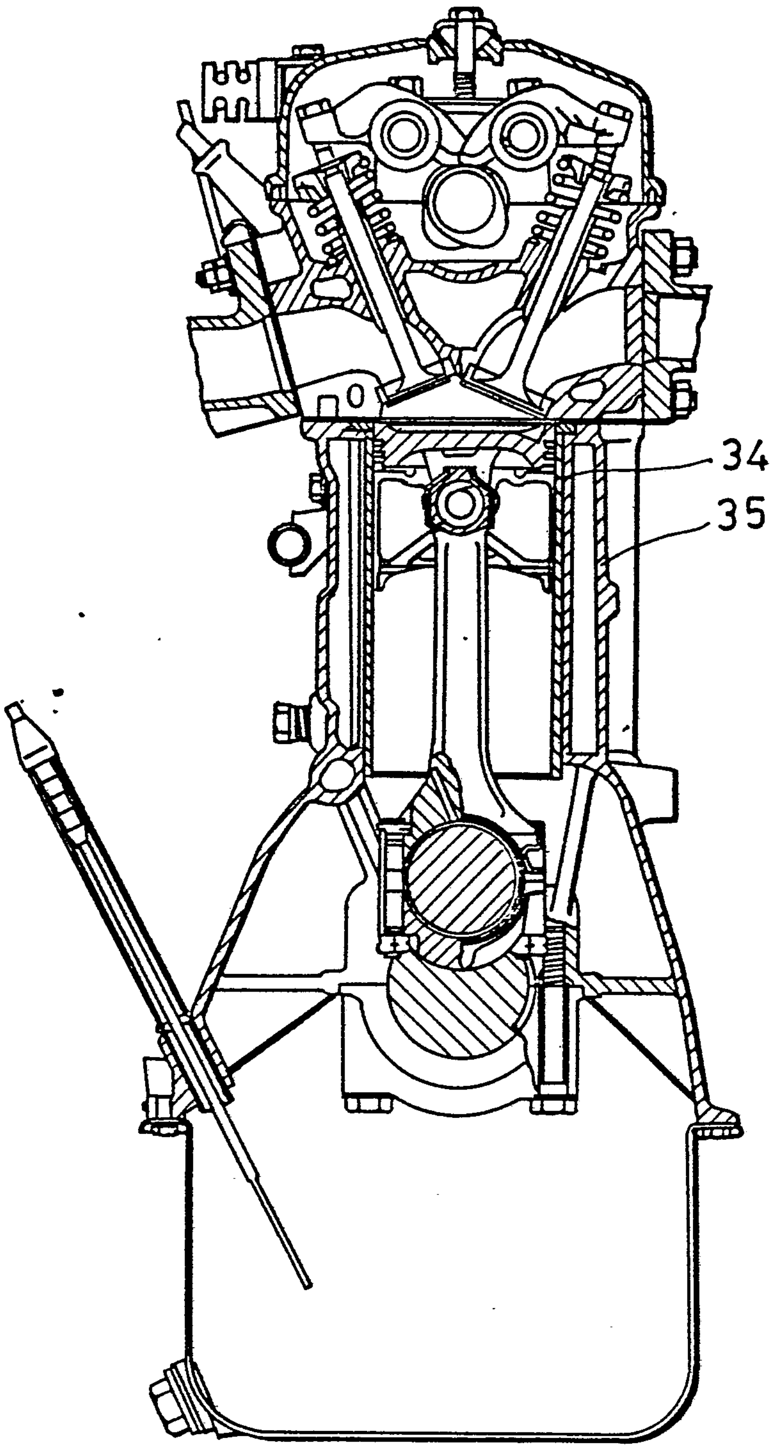

Fig.14

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP85/00619

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] B22D 19/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B22D 19/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
X	JP, A, 52-98621 (Teikoku Piston Ring Kabushiki Kaisha), 18 August 1977, Page 104, left column, upper part, line 16 to right column, upper part, line 7 (Family: none)	1 - 18

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" 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)

"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

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"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

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
January 27, 1986 (27. 01. 86)	February 3, 1986 (03. 02. 86)
International Searching Authority [1]	**Signature of Authorized Officer** [20]
Japanese Patent Office	