

⑩



Europäisches Patentamt
European Patent Office
Office européen des brevets

⑪ Publication number:

0 203 198
B1

⑫

EUROPEAN PATENT SPECIFICATION

⑬ Date of publication of patent specification: **30.01.91**

⑭ Int. Cl.⁵: **B 22 D 19/00**

⑮ Application number: **85905667.3**

⑯ Date of filing: **07.11.85**

⑰ International application number:
PCT/JP85/00619

⑱ International publication number:
WO 86/02862 22.05.86 Gazette 86/11

① Method of reinforcing a metallic article.

② Priority: **07.11.84 JP 234595/84**
05.11.85 JP 247665/85

③ Date of publication of application:
03.12.86 Bulletin 86/49

④ Publication of the grant of the patent:
30.01.91 Bulletin 91/05

⑤ Designated Contracting States:
FR IT

⑥ References cited:
JP-A-5 298 621
US-A-2 895 845
US-A-3 401 026
US-A-3 969 544

⑦ Proprietor: **MITSUBISHI JIDOSHA KOGYO**
KABUSHIKI KAISHA
33-8, Shiba 5-chome Minato-ku
Tokyo 108 (JP)

⑧ Inventor: **KAKEFUDA, Masahiko**
7-18, Ichiriyama 4-chome Ohtsu-shi
Shiga-ken 520-21 (JP)
Inventor: **KONDO, Yasuo 4-6, Akebonodai**
1-chome
Higashitsutsujigaoka Kameoka-shi
Kyoto-fu 621 (JP)
Inventor: **IMAI, Minoru 7-4, Kozaumegahata**
Azashimoueno, Ohyamazakicho Otokuni-gun
Kyoto-fu 618 (JP)
Inventor: **HOUJOH, Nobuyoshi**
25-4, Kayougaoka 1-chome Nagaokakyo-shi
Kyoto-fu 617 (JP)
Inventor: **MORIMUNE, Fumio**
37-26, Nieldaira 3-chome Ohtsu-shi
Shiga-ken 520 (JP)
Inventor: **YAMASHITA, Tadao 19,**
Matsumuroyamazoecho
Nishikyo-ku Kyoto-shi
Kyoto-fu 615 (JP)

EP 0 203 198 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

EP 0 203 198 B1

**⑦ Representative: Descourtieux, Philippe et al
CABINET BEAU de LOMENIE 55 rue
d'Amsterdam
F-75008 Paris (FR)**

Description

Technical Field

The present invention relates to a method for reinforcing a metallic article, according to the preamble of claim 1, wherein an aluminum alloy, and FRM (fiber reinforced material), 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, that 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 position 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, alpine treatment is known. The alpine treatment, however, requires a great deal of labor, and increases the cost and weight of the resultant material.

In a known method for forming a bimetallic article comprised of two dissimilar metallic portions (such as steel or cast iron and aluminum or an aluminum alloy), a precleaned higher melting point portion is provided with an irregular surface by submitting said portion to high frequency sonic vibrations in a molten bath of aluminum or aluminum alloy. After the higher melting point portion has been wetted with an aluminum layer, it is removed from the bath and placed in a mold cavity into which aluminum is cast. Such a method is described in US patent 3 401 026 to WALKER ET AL, upon which the preamble of claim 1 is based.

Disclosure of Invention

According to the present invention, an inert 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 present invention is characterized in that the insert is placed with respect to the oscillation plate so that the gap therebetween is 0.5 mm or less, that the oscillation plate, the plating bath and the insert are submitted to ultrasonic oscillations until an oxide film on said insert is removed and that the plating of said insert is continued until the plating layer deposited on said insert has reached a thickness of 5 μ m.

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 ($\times 100$) 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 ($\times 100$) 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 ($\times 100$) 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 ($\times 100$) 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 ($\times 100$) 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.

EP 0 203 198 B1

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.

5 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 10 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 $\approx$ 380°C]

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

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

4. Plating film thickness . . . 50 μ m

5. Plating time . . . 7 min

20 Insert 9 plated with Zn-5Al 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

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

30

35

40

45

50

55

60

65

EP 0 203 198 B1

TABLE 1

	Type of Surface Treatment	Preheat- ing Temp- erature(*) of Insert	Result	
			Welded State	Presence/Ab- sence of Insert Loss
Con- ven- tion- al	No treat- ment	R.T. 300°C	x(Not welded) Δ(Partially welded)	o (No loss) (Partially welded)
Meth- od	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
	Ultrasonic wave ap- plied	R.T.	o	o
Meth- od of Pre- sent In- ven- tion	Molten Al solder plating			

(*) 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 $\times 100$ (Fig. 3) of a texture at the boundary between insert 9 and main body 11 of Example 1 and a microphotograph of $\times 100$ (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, whereas 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 plating 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.

EP 0 203 198 B1

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 ($\times 100$; 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 IAlmit AM350I 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 has a size of 7 (diameter) $\times$ 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.	Insert Material	Casting Preparation Conditions				Tensile Test Results	
		Plating Condition				Tensile Strength kg/mm ²	Fractured State
		Material	Treatment Temperature x Time	Ultrasonic Wave Application Conditions	Solder Layer Thickness		
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 AM350": Product of Nihon Almit K.K., Al solder: 95% Zn, 5% Al

*2 "MASIC steel": Product of DAIDO STEEL CO., LTD., high-strength steel (tensile strength 199 kg/mm² 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

EP 0 203 198 B1

The test results reveal that a uniform plating layer can be obtained by plating an iron-based insert 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 $\times 100$ 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 ($\times 100$) 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 frequency 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.

5 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 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
10 oscillation plate.

In the above-described Examples, the distance between the oscillation plate and the plating surface of the insert 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
15 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.

20 In the above-described Examples, the insert material was an aluminum alloy, stainless steel, high strength 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 connecting rod were
25 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
30 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
35 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.

40 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
45 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 oscillation plate is set to be 0.1 mm. However, the gap can be
50 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
55 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.

60 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.

65

Claims

1. A method of reinforcing a metallic article by inserting a high-strength material according to which a pre-treated insert (9) is dipped in a plating bath (4) containing an oscillation plate (8) arranged near the insert (9), said plating bath (4) is oscillated by said oscillation plate (8), and the plated insert is inserted in an aluminium alloy (11) by casting said alloy around said plated insert in a mold, characterized in that the insert (9) is placed with respect to the oscillation plate (8) so that the gap therebetween is 0.5 mm or less, that the oscillation plate (8), the plating bath (4) and the insert (9) are submitted to ultrasonic oscillations until the oxide film on said insert (9) is removed and that the plating of said insert (9) is continued until the plating layer deposited on said insert (9) has reached a thickness of at least 5 μm .
2. A method according to claim 1, characterized in that the insert (9) is itself oscillated by oscillation of the plating bath (4).
3. A method according to claim 1, characterized in that the oscillation plate (8) is submitted to ultrasonic oscillations having an amplitude in the range of 5 to 35 μm .
4. A method according to claim 1, characterized in that the plating bath (4) consists of aluminium solder.
5. A method according to claim 1, characterized in that the plating bath (4) consists of pure zinc.
6. A method according to claim 1, characterized in that the plating bath (4) consists of a cadmium-silver alloy.
7. A method according to claim 1, characterized in that the plating bath (4) consists of a tin-zinc alloy.
8. A method according to claim 1, characterized in that after the insert (9) is plated, the insert (9) is preheated to a temperature of 400°C or lower, and is inserted in an aluminum alloy (11).
9. A method according to claim 1, characterized in that the plating layer formed on a surface of the insert (9) has a thickness of 5 to 300 μm .
10. A method according to claim 1, characterized in that the oscillation frequency is 1 to 1,000 KHz.
11. A 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 aluminium alloy, an FRM having an aluminium alloy as a matrix, and an FRM having a zinc alloy as a matrix.
12. A method according to claim 8, characterized in that the insert is made of an iron-based material.

Patentansprüche

1. Verfahren zur Verstärkung eines Metallgegenstandes durch Einsetzen eines hochfesten Materials, gemäß dem ein vorbehandelter Einsatz (9) in ein Beschichtungsbad (4) eingetaucht wird, das eine nahe dem Einsatz (9) angeordnete Schwingungsplatte (8) enthält, das Beschichtungsbad (4) durch die Schwingungsplatte (8) in Schwingungen versetzt wird und der beschichtete Einsatz in eine Aluminiumlegierung (11) durch Gießen der Legierung um den beschichteten Einsatz in einer Form eingebracht wird, dadurch gekennzeichnet, daß der Einsatz (9) bezüglich der Schwingungsplatte (8) so angeordnet wird, daß der Spalt dazwischen 0,5 mm oder weniger ist, daß die Schwingungsplatte (8), das Beschichtungsbad (4) und der Einsatz (9) Ultraschallschwingungen ausgesetzt werden, bis der Oxidfilm auf dem Einsatz (9) beseitigt ist, und daß die Beschichtung des Einsatzes (9) fortgesetzt wird, bis die auf dem Einsatz (9) abgeschiedene Beschichtungsschicht eine Dicke von wenigstens 5 μm erreicht hat.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Einsatz (9) selbst durch Schwingung des Beschichtungsbades (4) in Schwingungen versetzt wird.
3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Schwingungsplatte (8) Ultraschallschwingungen mit einer Amplitude im Bereich von 5 bis 35 μm unterworfen wird.
4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Beschichtungsbad (4) aus Aluminiumlot besteht.
5. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Beschichtungsbad (4) aus reinem Zink besteht.
6. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Beschichtungsbad (4) aus einer Cadmium-Silber-Legierung besteht.
7. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Beschichtungsbad (4) aus einer Zinn-Zink-Legierung besteht.
8. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß nachdem der Einsatz (9) beschichtet ist, der Einsatz (9) auf eine Temperatur von 400°C oder darunter vorerhitzt und in eine Aluminiumlegierung (11) eingebracht wird.
9. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die auf einer Oberfläche des Einsatzes (9) gebildete Beschichtungsschicht eine Dicke von 5 bis 300 μm hat.
10. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Schwingungsfrequenz 1 bis 1000 kHz ist.
11. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Einsatz aus dem aus der Gruppe gewählten Material hergestellt wird, die aus einem Eisenbasismaterial, einer Titanlegierung, einer Nickellegierung, einer Kobaltlegierung, einer Aluminiumlegierung, einem FRM mit einer Aluminiumlegierung als Matrix und einem FRM mit einer Zinklegierung als Matrix besteht.

EP 0 203 198 B1

12. Verfahren nach Anspruch 8, dadurch gekennzeichnet, daß der Einsatz aus einem Eisenbasismaterial hergestellt wird.

Revendications

5

1. Procédé pour renforcer un article métallique par insertion d'un matériau à haute résistance selon lequel un insert (9) prétraité est plongé dans un bain de placage (4) contenant une plaque oscillante (8) disposée à proximité de l'insert (9), ledit bain de placage (4) est amené à osciller par ladite plaque oscillante (8), et l'insert plaqué est inséré dans un alliage d'aluminium (11) par coulée dans un moule dudit alliage
10 autour dudit insert plaqué, caractérisé en ce que l'insert (9) est placé par rapport à la plaque oscillante (8) de telle façon que l'interstice entre eux soit de 0,5 mm ou moins, que la plaque oscillante (8), le bain de placage (4) et l'insert (9) soient soumis à des oscillations ultrasonores jusqu'à ce que la pellicule d'oxyde sur ledit insert (9) soit retirée et en ce que le placage déposée sur ledit insert (9) ait atteint une épaisseur d'au moins 5 µm.

15

2. Procédé selon la revendication 1, caractérisé en ce que l'insert (9) est lui-même amené à osciller par l'oscillation du bain de placage (4).

3. Procédé selon la revendication 1, caractérisé en ce que la plaque oscillante (8) est soumise à des oscillations ultrasonores ayant une amplitude comprise dans la gamme de 5 à 35 µm.

20

4. Procédé selon la revendication 1, caractérisé en ce que le bain de placage (4) consiste en soudure d'aluminium.

5. Procédé selon la revendication 1, caractérisé en ce que le bain de placage (4) consiste en zinc pur.

6. Procédé selon la revendication 1, caractérisé en ce que le bain de placage (4) consiste en un alliage cadmium-argent.

25

7. Procédé selon la revendication 1, caractérisé en ce que le bain de placage (4) consiste en un alliage étain-zinc.

8. Procédé selon la revendication 1, caractérisé en ce qu'après avoir été plaqué, l'insert (9) est préchauffé à une température de 400°C ou inférieure, et est inséré dans un alliage d'aluminium (11).

9. Procédé selon la revendication 1, caractérisé en ce que la couche de placage formée sur une surface de l'insert (9) a une épaisseur de 5 à 300 µm.

30

10. Procédé selon la revendication 1, caractérisé en ce que la fréquence d'oscillation est de 1 à 1 000 KHz.

35

11. Procédé selon la revendication 1, caractérisé en ce que l'insert est en un matériau choisi dans le groupe formé par un matériau à base de fer, un alliage de titane, un alliage de nickel, un alliage de cobalt, un alliage d'aluminium, un MRF ayant comme matrice un alliage d'aluminium, et un MRF ayant comme matrice un alliage de zinc.

12. Procédé selon la revendication 8, caractérisé en ce que l'insert est en un matériau à base de fer.

40

45

50

55

60

65

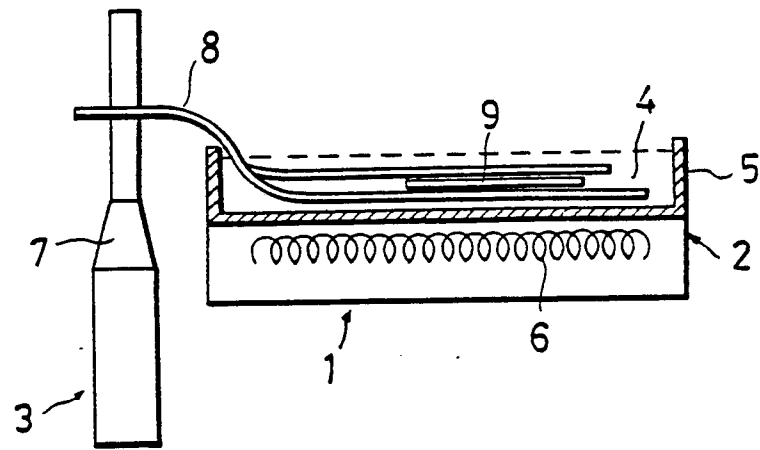


Fig. 1

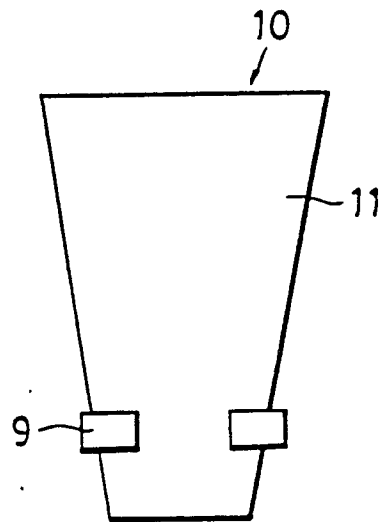


Fig. 2



Fig.3

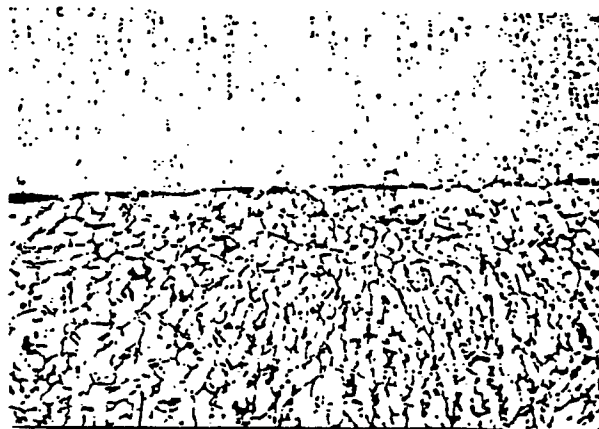


Fig.4

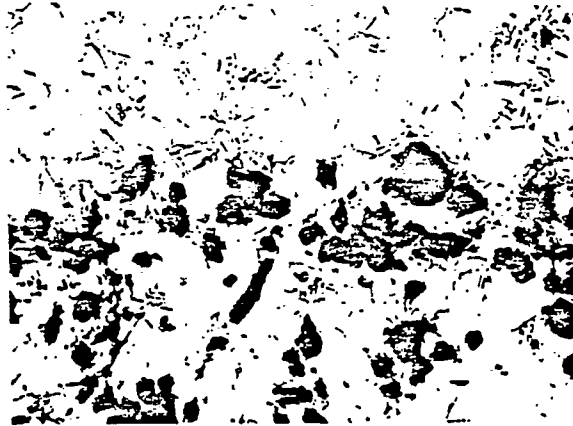


Fig.5



Fig.7

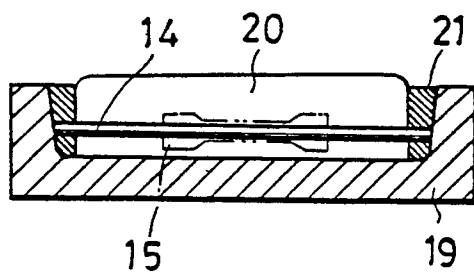


Fig. 6

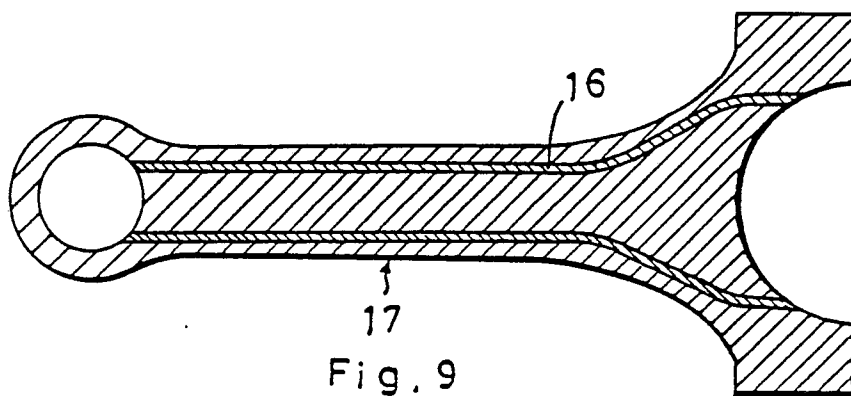


Fig. 9



Fig.8

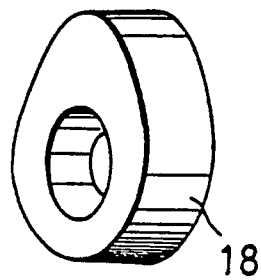


Fig.10

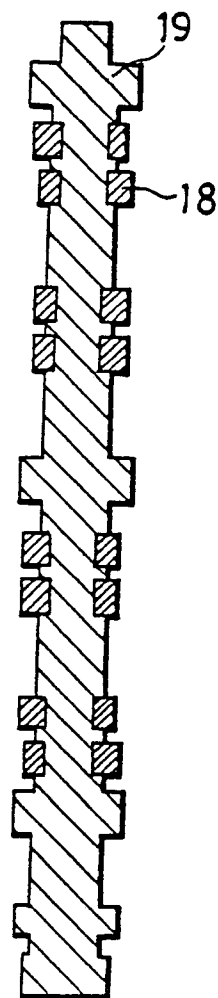


Fig.11

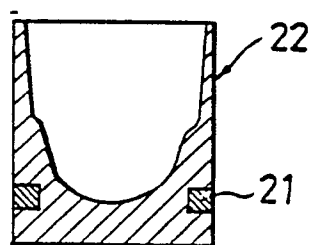


Fig.12

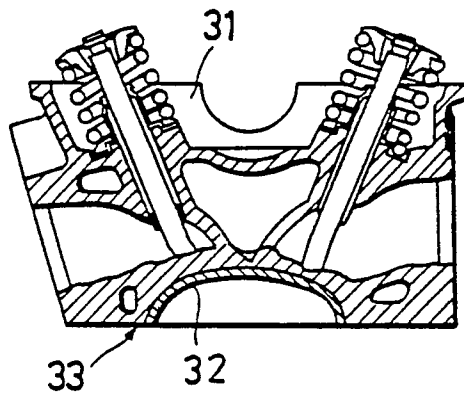


Fig.13

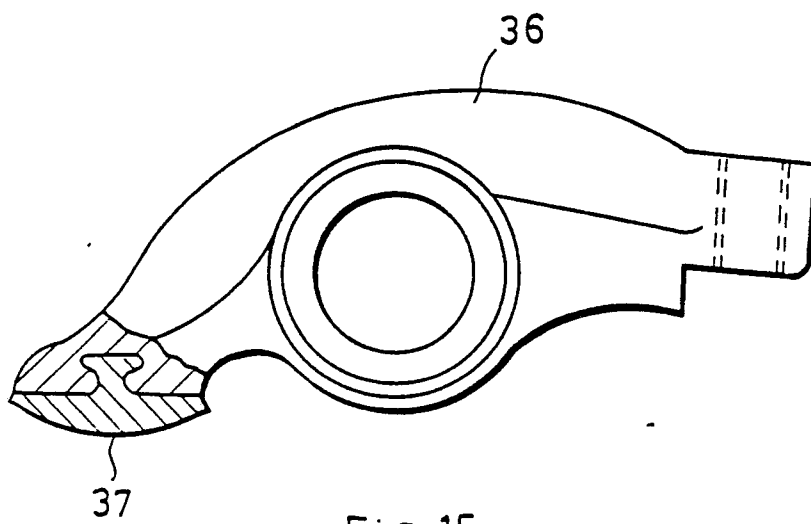


Fig.15

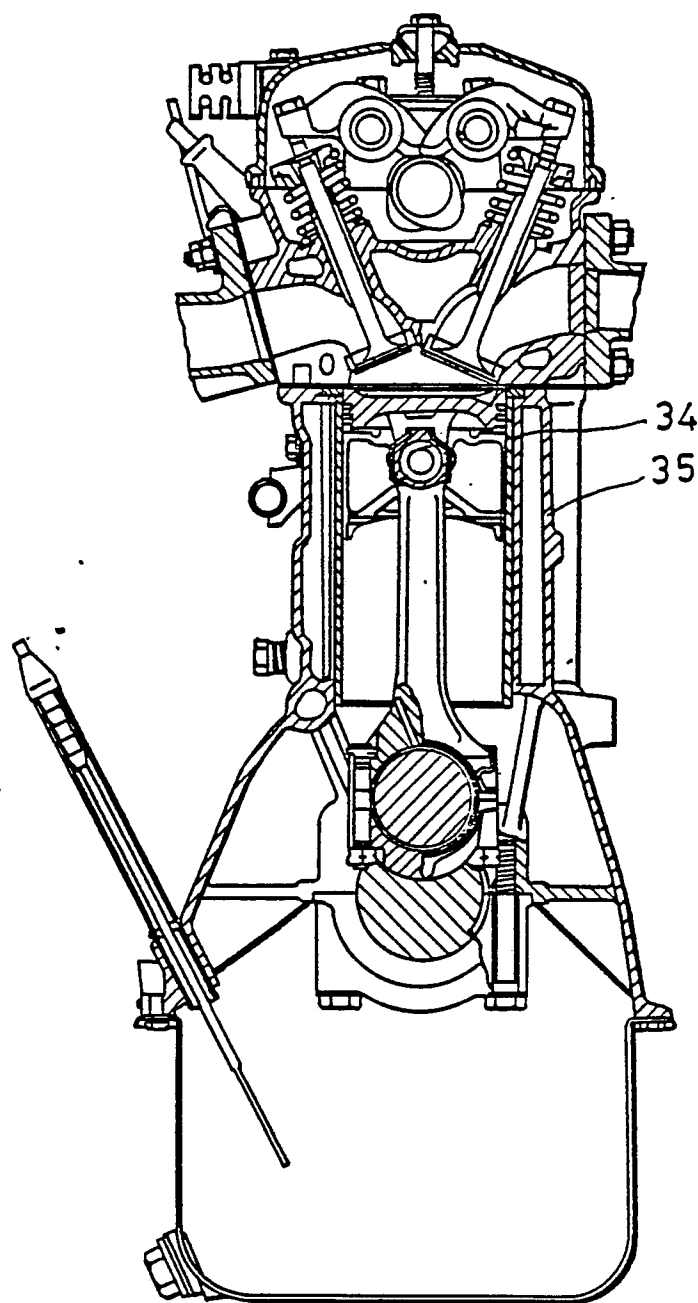


Fig.14