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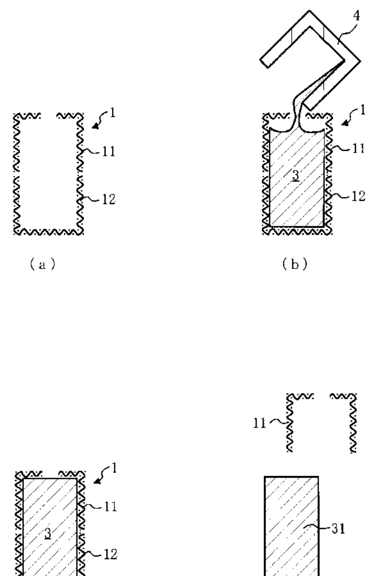
(54) CASTING MOLD FOR MAGNESIUM ALLOY AND METHOD OF CASTING MAGNESIUM ALLOY

(57) The mold assembly for magnesium alloys comprises a mold and/or a core, each formed of an air permeable material. The air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth. The network, the sheet or the cloth is any one or any combination of a metal, a chemical fiber, and a ceramic material. The invention also provides a casting method for magnesium alloys, which uses that mold assembly.

FIG. 1



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Description

TECHNICAL ART FIELD

[0001] The present invention relates generally to a mold assembly for magnesium alloys and a casting method for magnesium alloys, and more particularly to a mold assembly for magnesium alloys and a casting method for magnesium alloys, which make sure of the fluidity of a molten magnesium alloy.

BACKGROUND ART

[0002] Magnesium is practically the lightest metal, and has increasing applications, partly because it is better in specific strength and specific rigidity than steels and aluminum, and partly because it is improved in terms of electromagnetic shield capability, machinability, vibration absorption capability, denting resistance, and recyclability.

[0003] Magnesium alloys in particular are now increasingly used, and in mounting demand, as materials for parts in the car and personal digital assistant fields.

[0004] So far, such parts have been produced by molding magnesium alloys by casting. However, a problem with casting of magnesium alloys by means of a metallic mold is that there is much difficulty in a molten magnesium alloy gaining access to the whole cavity of the mold. This is because the magnesium alloy has a low latent heat of fusion per unit volume and there is a large thermal conductivity between the molten alloy and the metallic mold; so the molten magnesium alloy solidifies and loses fluidity the very moment it contacts the metallic mold.

[0005] Referring especially to casting of small or thin parts, the solidified magnesium alloy clogs up a molten alloy flow space, rendering it difficult to allow the molten alloy to gain access to the whole cavity of the mold.

[0006] For this reason, casting has thus far been carried out by a process wherein the metallic mold is heated thereby taking hold of the fluidity of the molten magnesium alloy. Such casting involving heating of the metallic mold is set forth in JP(A) 2002-129272.

[0007] JP(A) 2002-129272 shows that the metallic mold is heated at 200°C to implement casting while the fluidity of the molten alloy is ensured.

Patent Publication 1: JP(A) 2002-129272

SUMMARY OF THE INVENTION

OBJECT OF THE INVENTION

[0008] However, a problem with casting using a heated metallic mold is that casting equipment production costs much and heating adds up energy costs because of the needs of heat generators for heating the metallic mold and thermometers.

[0009] Therefore, the object of the present invention is to provide a mold assembly for magnesium alloys which makes sure of the fluidity of a molten magnesium alloy while the production cost of casting equipment and the energy cost added up by heating are kept low and casting method for magnesium alloys using the mold assembly.

MEANS FOR ACCOMPLISHING THE OBJECT

[0010] To accomplish that object, the present invention is embodied as follows.

[0011] According to one aspect (Claim 1) of the invention, the mold assembly for magnesium alloys comprises a mold and/or a core formed of an air permeable material.

[0012] According to another aspect (Claim 2) of the invention, the air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth.

[0013] According to the third aspect (Claim 3) of the invention, the network, the sheet or the cloth is any one or any combination of a metal, a chemical fiber, and a ceramic material.

[0014] According to the fourth aspect (Claim 4) of the invention, the network, the sheet, and the cloth has flexibility.

[0015] According to the fifth aspect (Claim 5) of the invention, there is a casting method for magnesium alloys provided, in which a mold assembly comprising a mold and/or a core formed of an air permeable material is used.

[0016] According to the sixth aspect (Claim 6) of the invention, the air permeable blank mold and/or core are formed of any one or any combination of a network, a sheet having multiple holes, and cloth.

ADVANTAGES OF THE INVENTION

[0017] According to the mold assembly for magnesium alloys recited in Claim 1, the mold and/or the core of the mold assembly for magnesium alloys are formed of an air permeable material so that there can be a decrease in the apparent thermal conductance between a molten alloy and the mold assembly for magnesium alloys.

[0018] The decrease in the apparent thermal conductance prevents the molten alloy from solidification momentarily upon contact with the mold assembly for magnesium alloys, making sure of the fluidity of the molten alloy and letting the molten alloy gain access to the whole mold assembly for magnesium alloys.

[0019] Therefore, there is no need of providing a heat generator for heating the mold assembly for magnesium alloys and a thermometer, resulting in a decrease in the production cost of casting equipment.

[0020] Further, no need of heating the mold assembly for magnesium alloys during casting contributes to a lowering of the energy cost added up by heating.

[0021] According to the mold assembly for magnesium alloys as recited in Claim 2, the air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth. Under the influences of a low latent heat of fusion per unit volume and surface tension of the molten magnesium alloy, the molten alloy solidifies upon contact with the mold assembly for magnesium alloys without going out of the network, the holes and the interstices, and between fibers, etc.

[0022] As described above, the air permeable material is formed of any one or any combination of a network, a sheet having multiple holes, and cloth. Therefore, there is no need of providing another air vents in the mold assembly for magnesium alloys.

[0023] Further, the influences of linear expansion due to the heat of the molten alloy are eased off by and absorbed in the whole mold assembly for magnesium alloys, leaving the mold and/or the core less distorted.

[0024] According to the mold assembly for magnesium alloys as recited in Claim 3, the network, sheet or cloth material best-suited for casting may be chosen in consideration of the composition of magnesium alloys, the size and shape of castings, etc.

[0025] According to the mold assembly for magnesium alloys as recited in Claim 4, the network, the sheet, and the cloth is flexible so that the mold assembly for magnesium alloys can easily be produced.

[0026] Further, the shape of the mold assembly for magnesium alloys can be so varied easily that the shape of a magnesium alloy casting can be varied easily too.

[0027] According to the casting method for magnesium alloys as recited in Claim 5, the mold and/or the core of the mold assembly for magnesium alloys are formed of an air permeable material so that there can be a decrease in the apparent thermal conductance between a molten alloy and the mold assembly for magnesium alloys.

[0028] The decrease in the apparent thermal conductance prevents the molten alloy from solidification momentarily upon contact with the mold assembly for magnesium alloys, making sure of the fluidity of the molten alloy and letting the molten alloy gain access to the whole mold assembly for magnesium alloys.

[0029] Therefore, there is no need of providing a heat generator for heating the mold assembly for magnesium alloys and a thermometer, resulting in a decrease in the production cost of casting equipment.

[0030] Further, no need of heating the mold assembly for magnesium alloys during casting contributes to a lowering of the energy cost added up by heating.

[0031] According to the casting method for magnesium alloys as recited in Claim 6, the air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth. Under the influences of a low latent heat of fusion per unit volume and surface tension of the molten magnesium alloy, the molten alloy solidifies upon contact with the mold assembly for magnesium alloys without going out of the network, the holes and the interstices, and between fibers, etc.

[0032] As described above, the air permeable material is formed of any one or any combination of a network, a sheet having multiple holes, and cloth. Therefore, there is no need of providing another air vents in the mold assembly for magnesium alloys.

[0033] Further, the influences of linear expansion due to the heat of the molten alloy are eased off by and absorbed in the whole mold assembly for magnesium alloys, leaving the mold and/or the core less distorted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034]

Fig. 1 is a sectional view showing the process of casting a columnar magnesium alloy casting.

Fig. 2 is a sectional view showing the process of casting a hollow, spherical magnesium alloy casting.

EXPLANATION OF REFERENCE NUMERALS

[0035]

1: Mold assembly,
2: Core,
3: Molten alloy,
4: Crucible,
11: Top mold,
12: Bottom mold, and
31: Magnesium alloy casting.

BEST MODE FOR CARRYING OUT THE INVENTION

[0036] The object of the present invention - the fluidity of a molten magnesium alloy is ensured while the production cost of casting equipment and energy cost added by heating are kept low - is accomplished by the mold assembly for magnesium alloys wherein the mold and/or the core are formed of an air permeable material, and the casting method for magnesium alloys using that mold assembly.

[0037] Examples of the present invention are now explained with reference to the accompanying drawings.

Example 1

[0038] Fig. 1 is a sectional view showing the process of casting a columnar magnesium alloy casting.

[0039] The magnesium alloy used here is AZ91D.

[0040] As shown in Fig. 1(a), a mold assembly 1 for magnesium alloys is built up of a network formed of an air permeable material.

[0041] Formed of stainless steel, the network has a line diameter of 0.30 mm and a mesh of 20.

[0042] The mold assembly 1 is constructed of a top mold 11 and a bottom mold 12.

[0043] As shown in Fig. 1(b), a molten magnesium alloy 3 melted in a crucible 4 is cast into a space defined between the top mold 11 and the bottom mold 12.

[0044] The molten alloy is at a temperature of 560°C to 800°C.

[0045] The upper mold 11, and the bottom mold 12 is constructed of an air permeable network so that there is a decrease in the apparent thermal conductance between a molten magnesium alloy 3 and the upper mold 11 and the bottom mold 12.

[0046] The decrease in the apparent thermal conductance makes sure of the fluidity of the molten alloy 3 without solidification momentarily upon contact with the top mold 11 and the bottom mold 12; so the molten alloy 3 gains access to all over the space defined between the top mold 11 and the bottom mold 12 (see Fig. 1(c)).

[0047] After cooling, the top mold 11 and the bottom mold 12 are released off to obtain a columnar magnesium alloy casting 31 (see Fig. 1(d)).

Example 2

[0048] Fig. 2 is a sectional view showing the process of casting a hollow, spherical magnesium alloy casting.

[0049] The magnesium alloy used here is again AZ91D, as used in Fig. 1.

[0050] As shown in Fig. 2(a), a mold assembly 1 for magnesium alloys, and a core 2 is built up of a network formed of an air permeable material.

[0051] Formed of stainless steel, the network has a line diameter of 0.30 mm and a mesh of 20.

[0052] The mold assembly 1 is constructed of a top mold 11 and a bottom mold 12.

[0053] As shown in Fig. 2(b), a molten magnesium alloy 3 melted in a crucible 4 is cast into a space defined between the top mold 11, the bottom mold 12 and the core 2.

[0054] The molten alloy 3 is at a temperature of 560°C to 800°C.

[0055] The upper mold 11, the bottom mold 12, and the core 2 is made up of an air permeable network so that there is a decrease in the apparent thermal conductance between the upper mold 11, the bottom mold 12 and the core 2.

[0056] The decrease in the apparent thermal conductance makes sure of the fluidity of the molten alloy 3 without solidification momentarily upon contact with the top mold 11, the bottom mold 12 and the core 2; so the molten alloy 3 gains access to all over the space defined between the top mold 11, the bottom mold 12 and the core 2 (see Fig. 2(c)).

[0057] After cooling, the top mold 11 and the bottom mold 12 are released off to obtain a hollow, spherical magnesium alloy casting 31 (see Fig. 2(d)).

[0058] The core 2 is within the magnesium alloy casting 31; so the ensuing casting is a magnesium alloy/stainless composite one.

[0059] If another material is used for the core 2, it is then possible to obtain another composite casting comprising a magnesium alloy and that core material.

[0060] As mentioned above, the mold assembly 1, and the core 2 is made up of a network; so the molten alloy 3 takes hold of fluidity without application of heat to the mold assembly 1, and the core 2.

[0061] Therefore, there is no need of using a heat generator for heating the mold assembly 1 for magnesium alloys and a thermometer, ending up with a lowering of the production cost of casting equipment.

[0062] Further, there is no need of heating the mold assembly 1 for magnesium alloys during casting; so it is possible to bring down the energy cost added up by heating.

[0063] Even with the mold assembly 1 and the core 2 each made up of a network, the molten magnesium alloy 3 in contact with the mold assembly 1 and/or the core 2 solidifies without going out of the network under the influences of the low latent heat per unit volume of the molten magnesium alloy 3 and surface tension.

[0064] The mold assembly 1 for magnesium alloys, and the core 2 is constructed of a network; so there is no need of providing another air vents in the mold assembly 1 and the core 2.

[0065] Further, the influences of linear expansion by heat of the molten alloy 3 are eased off by and absorbed in the whole mold assembly for magnesium alloys, leaving the mold assembly 1 for magnesium alloys and the core 2 less distorted.

[0066] While the aforesaid examples have been explained with referent to the columnar, and hollow spherical magnesium alloy castings 31, it is to be understood that the present invention is in no sense limited to them. If the mold assembly for magnesium alloys is configured into another shape, it is then possible to vary the shape of the inventive castings as desired.

[0067] While the aforesaid examples have been explained with reference to the use of the network as the air permeable material and the mold assembly formed of the air permeable material on the whole, it is to be understood that the present invention is in no sense limited to them. For instance, a part of the mold assembly may be formed of the air permeable material.

[0068] If a part of the mold assembly is formed of the air permeable material, the molten alloy could then gain access even to details or thin sites where the molten alloy is apt to lose fluidity.

[0069] While the network is used as the air permeable material in the foresaid examples, it is to be noted that the present invention is by no means limited to them. For instance, use may be made of a sheet having multiple holes (punching metal), cloth or a network, or any combination of a sheet having multiple holes (punching metal) and cloth or a network.

[0070] Although such air permeable materials are used, the decrease in the apparent thermal conductance makes sure of the fluidity of the molten alloy 3; so the molten alloy 3 gains access to all over the mold assembly 1 and the core 2 without solidification momentarily upon contact with the mold assembly 1 and the core 2.

[0071] While AZ91D is used as the magnesium alloy in the aforesaid examples, it is to be noted that the present invention is by no means limited to them. For instance, use may be made of magnesium alloys having added to them a suitable element or elements selected from the group consisting of aluminum, zinc, manganese, rare earths, heavy rare earths, yttrium, calcium, strontium, silver, silicon, zirconium, beryllium, nickel, iron, copper, cobalt, sodium, potassium, and barium.

[0072] The network may have been woven in the form of plain weaving, diagonal weaving, stranded weaving, herringbone weaving, satin weaving, plain tatami weaving, diagonal tatami weaving, reversed tatami weaving, extension weaving, chain-like longitudinal tri-weaving, cord weaving (cord fabric), etc.

[0073] While the network having a mesh of 20 is used in the aforesaid examples, it is to be noted that the mesh used may be chosen from the range of 1.5 to 3,600.

[0074] While the network having a line diameter of 0.30 mm is used in the aforesaid examples, it is to be noted that the line diameter may be chosen from the range of 0.02 mm to 6 mm.

[0075] Thus, the network best-suited for casting may be sorted out in consideration of the composition of magnesium alloys, the size and shape of castings, etc.

[0076] When the sheet having multiple holes is used, sheet thickness, the shape of holes having influences on air permeability, and aperture may be set at any desired values.

[0077] This enables the sheet having multiple holes best-suited for casting to be sorted out in consideration of the composition of magnesium alloys, the size and shape of castings, etc.

[0078] For the cloth, air permeable woven and unwoven fabrics may be used. The woven fabrics may have been woven by any desired weaving processes, and the unwoven fabrics may have been made by any desired processes, with any desired fiber diameter.

[0079] For the air permeable woven fabrics, for instance, prepregs made of air permeable carbon fibers may be used.

[0080] This enables the cloth best-suited for casting to be picked up in consideration of the composition of magnesium alloys, the size and shape of castings, etc.

[0081] In the foregoing examples, the network is formed of stainless steel; however, the present invention is in no way limited to it. For instance, the network may be formed of metals such as an aluminum alloy, nickel, monel metal, brass, red brass, phosphor bronze, copper, silver, gold, iron, titanium, nichrome, hastelloy, and inconel; heat-resistant chemical fibers such as PBO, carbon fibers, and metal meta-aramides; and ceramic materials such as carbon, mullite, alumina, and zirconia, which may be used alone or in combination of two or more.

[0082] Likewise, the sheet having multiple holes, and the cloth, too, may be formed of the above described metals, chemical fibers and ceramic materials as mentioned above, which may be used alone or in combination of two or more.

[0083] Thus, the network, sheet or cloth material best-suited for casting may be picked up in consideration of the composition of magnesium alloys, the size and shape of castings, etc.

[0084] The network, the sheet, and the cloth may have flexibility.

[0085] Thus, by use of the network, the sheet, and the cloth, each having flexibility, it is possible to make the production of mold assemblies for magnesium alloys much easier.

[0086] Further, by changing the shape of the mold assembly, it is also easy to change the shape of magnesium alloy castings.

[0087] It is here to be noted that the present invention may also be applied to continuous casting. When the present invention is applied to continuous casting, for instance, the mold assembly, and continuous casting rolls and belts of continuous casting equipment are each made of an air permeable material.

INDUSTRIAL APPLICABILITY

[0088] With the present invention, it is possible to provide a mold assembly for magnesium alloys which makes sure of the fluidity of a molten magnesium alloy while the production cost of casting equipment and energy costs added up by heating are kept low, and a magnesium alloy casting method using that mold assembly.

Claims

1. A mold assembly for magnesium alloys, **characterized by** comprising a mold and/or a core formed of an air permeable material.

2. The mold assembly for magnesium alloys according to claim 1, **characterized in that** the air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth.

3. The mold assembly for magnesium alloys according to claim 2, **characterized in that** the network, the sheet or the cloth is any one or any combination of a metal, a chemical fiber, and a ceramic material.

4. The mold assembly for magnesium alloys according to claim 2 or 3, **characterized in that** the network, the sheet, and the cloth has flexibility.

5. A magnesium alloy casting method, **characterized by** using a mold assembly wherein a mold and/or a core are each formed of an air permeable material.

6. The magnesium alloy casting method according to claim 5, **characterized in that** the air permeable material is any one or any combination of a network, a sheet having multiple holes, and cloth.

FIG. 1

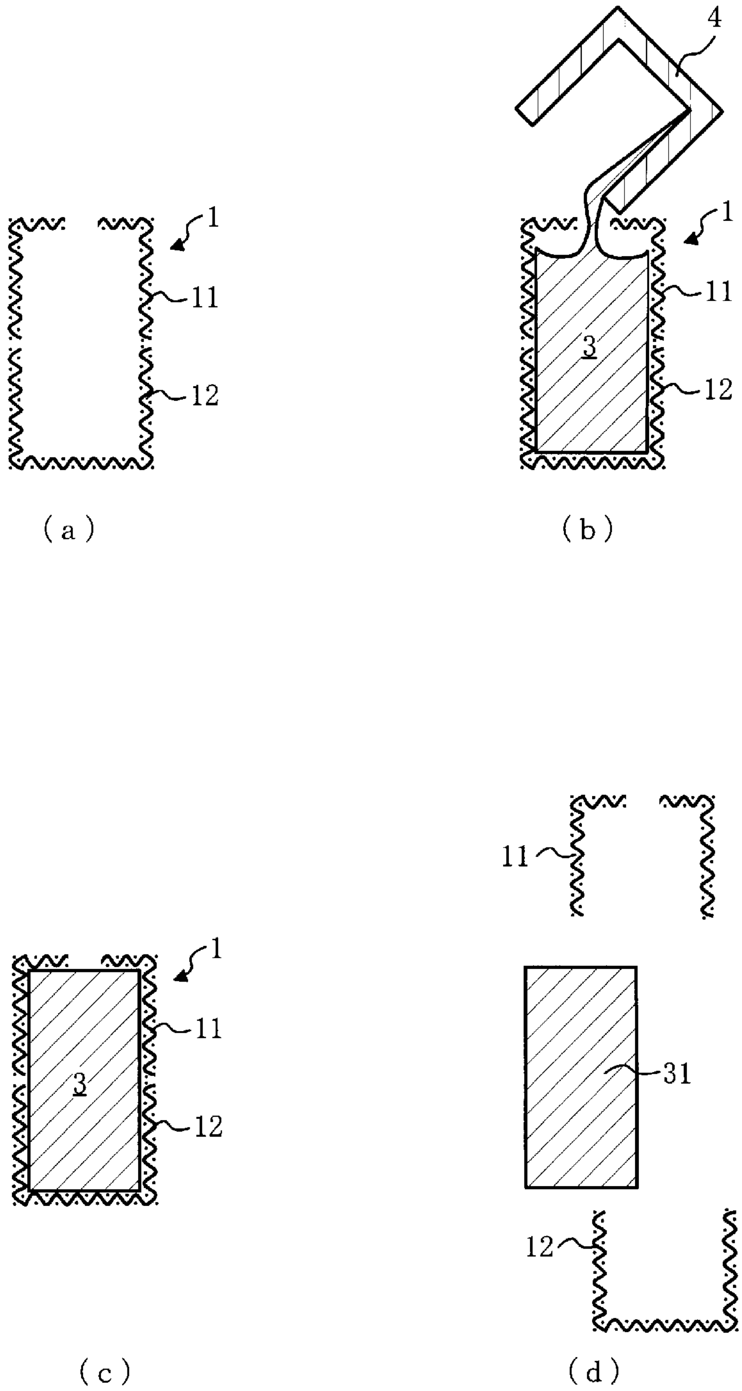
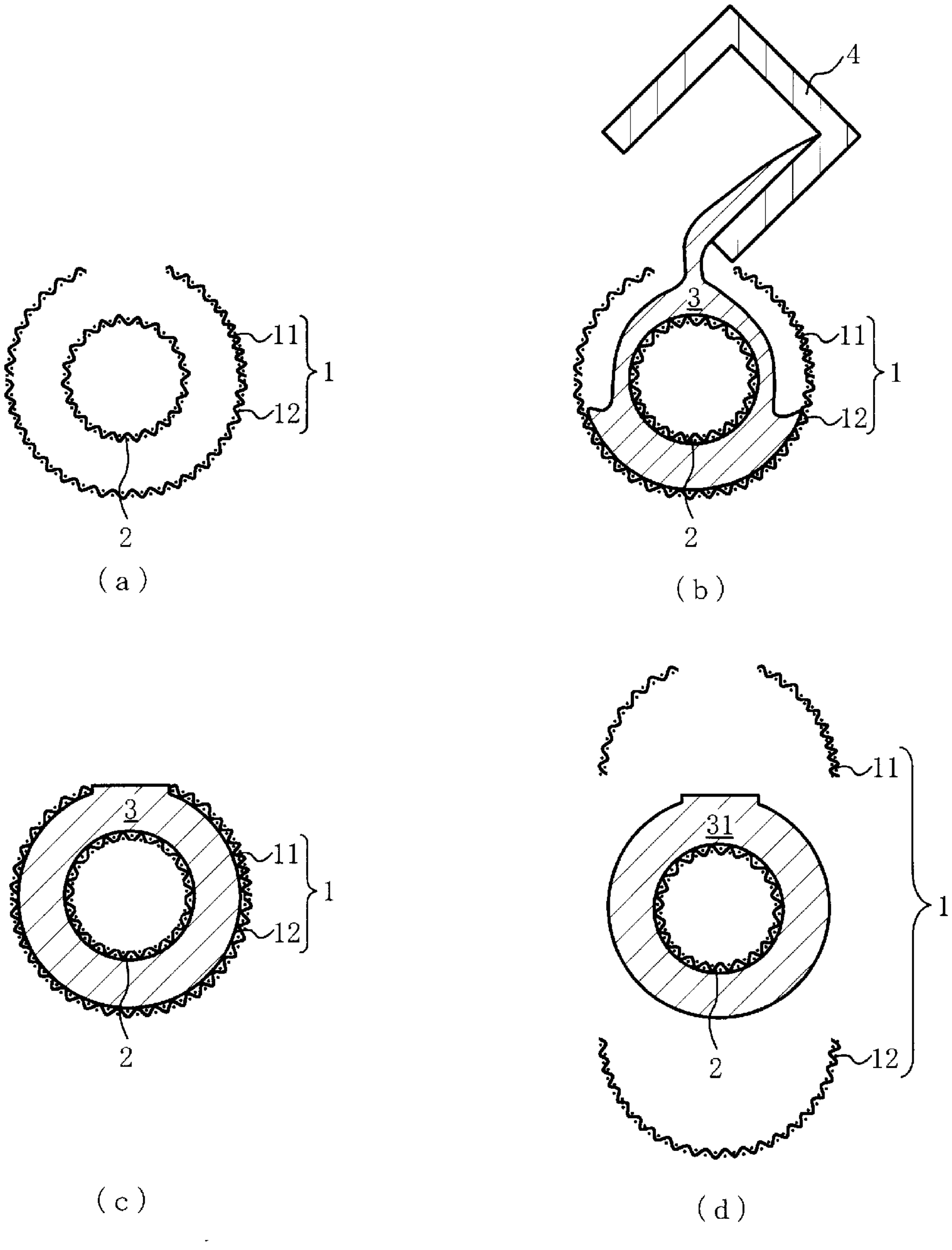


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/056034

A. CLASSIFICATION OF SUBJECT MATTER
B22D21/04(2006.01)i, *B22C1/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22D21/04, B22C1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 04-333343 A (Kobe Steel, Ltd.), 20 November, 1992 (20.11.92), Par. Nos. [0020] to [0026] (Family: none)	1,5 2-4,6
A	JP 61-115643 A (Kao Soap Co., Ltd.), 03 June, 1986 (03.06.86), Full text (Family: none)	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
03 June, 2009 (03.06.09)	16 June, 2009 (16.06.09)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2002129272 A **[0006] [0007]**