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(71) Applicant: **Toyo Seikan Group Holdings, Ltd.**
Shinagawa-ku,
Tokyo 141-8627 (JP)

(72) Inventors:
• **SHIROISHI, Ryozo**
Yokohama City Kanagawa 240-0062 (JP)
• **MATSUMOTO, Naoya**
Yokohama City Kanagawa 240-0062 (JP)
• **SHIMAMURA, Masahiro**
Yokohama City Kanagawa 240-0062 (JP)
• **KUMAGAI, Takuho**
Yokohama City Kanagawa 240-0062 (JP)
• **OGAWA, Tomohiro**
Yokohama City Kanagawa 240-0062 (JP)

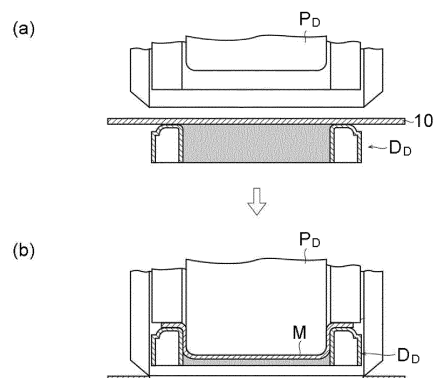
(74) Representative: **Dehns**
St. Bride's House
10 Salisbury Square
London EC4Y 8JD (GB)

(54) **METHOD FOR MANUFACTURING CLOSED-END CYLINDRICAL BODY**

(57) There is provided a method for manufacturing a bottomed cylindrical body, the method being capable of achieving both a conventional hard can manufacturing process such as drawing and ironing and reduction in the cost and the environmental load in a degreasing step. The method for manufacturing a bottomed cylindrical body includes a lubricant application step of applying liquid (lubricant) having a viscosity of lower than 200 mPa·s to a surface of a metal plate, a drawing step of drawing the metal plate to which the lubricant has been applied, with use of a forming member having a processing surface having a hardness of Hv 1000 to 12000, an ironing step of ironing, with use of another forming member having a processing surface having a hardness of Hv 1500 to 12000, a workpiece with a coolant interposed between the workpiece and the another forming member, to form a bottomed cylindrical body, and a degreasing step of degreasing oil on a surface of the bottomed cylindrical body with use of a cleaning agent. The concentration of oil contained in the coolant is lower than 4.0 percent by

volume. The cleaning agent contains any one of sulfuric acid, hydrofluoric acid, potassium carbonate, sodium hydroxide, and potassium hydroxide. The temperature of the cleaning agent in the degreasing step is lower than 75°C.

[FIG. 1]



Description

[Technical Field]

5 **[0001]** The present invention relates to a method for manufacturing a bottomed cylindrical body, and more particularly to a method for manufacturing a bottomed cylindrical body made of metal by drawing and ironing.

[Background Art]

10 **[0002]** A bottomed cylindrical body made of metal, for example, what is generally called a seamless can body, is manufactured by drawing and ironing with use of a metal die for press working.

[0003] Since a punch unit and a die unit used in the drawing and ironing described above are generally placed under a hard processing environment, for example, such metal dies as documented in PTL 2 to PTL 5 have been proposed. In particular, it has been proposed to improve durability of a metal die by coating a processing surface of the metal die with a carbon film such as a diamond film or a diamond-like carbon (DLC) film.

15 **[0004]** On the other hand, conventionally, in a case where a seamless can body is manufactured using, for example, aluminum alloy material, it is common to form a seamless can body in a wet environment using lubricant or a cooling material (coolant). In this case, after a can is manufactured, a degreasing step (washing step) of degreasing processing oil, lubricant, a coolant, and so forth that adhere to the can body with a cleaning agent or a medical agent is essentially required.

[Citation List]

[Patent Literature]

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[0005]

[PTL 1]

Japanese Patent No. 6012804

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[PTL 2]

Japanese Patent Laid-Open No. Hei 10-137861

[PTL 3]

Japanese Patent Laid-Open No. Hei 11-277160

[PTL 4]

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Japanese Patent Laid-Open No. 2013-163187

[PTL 5]

PCT Patent Publication No. WO2017/033791

[Summary]

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[Technical Problems]

[0006] However, the conventional method for manufacturing a seamless can body described above has a problem that a large amount of energy and a high cost are required in the degreasing step and another problem that the environmental load is heavy.

45 **[0007]** For example, reduction of the cost and the environmental load relating to a large amount of water used in the degreasing step, reduction of the environmental load provided by a medical agent used in the degreasing step, reduction of energy required when a cleaning agent is warmed up in the degreasing step, and so forth are demanded.

[0008] As a result of earnest investigation by the inventors, it has been found out that, in a case where a bottomed cylindrical body is manufactured using a coolant under a specific condition, it is possible to achieve both a conventional hard can manufacturing process such as drawing and ironing and reduction of the cost and the environmental load in the degreasing step, and the present invention has been made on the basis of this.

[Solution to Problems]

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[0009] In order to achieve the object described above, a method for manufacturing a bottomed cylindrical body according to an embodiment of the present invention is characterized in that (1) the method includes a lubricant application step of applying liquid lubricant having a viscosity of lower than 200 mPa·s to a surface of a metal plate, a drawing step

of drawing the metal plate to which the lubricant has been applied, with use of a forming member having a processing surface having a hardness of Hv 1000 to 12000, an ironing step of ironing, with use of another forming member having a processing surface having a hardness of Hv 1500 to 12000, a workpiece with a coolant interposed between the workpiece and the another forming member, to form a bottomed cylindrical body, and a degreasing step of degreasing oil on a surface of the bottomed cylindrical body with use of a cleaning agent, and that a concentration of oil contained in the coolant is lower than 4.0 percent by volume, the cleaning agent contains any one of sulfuric acid, hydrofluoric acid, potassium carbonate, sodium hydroxide, and potassium hydroxide, and a temperature of the cleaning agent in the degreasing step is lower than 75°C.

[0010] Further, in (1) above, (2) the bottomed cylindrical body is preferably a seamless can body.

[0011] Moreover, in (1) or (2) above, (3) the metal plate is preferably made of an aluminum alloy.

[0012] In addition, in any one of (1) to (3) above, (4) the metal plate is preferably a resin-coated metal plate having resin coated on at least one face thereof.

[0013] In any one of (1) to (4) above, (5) a weight change of the bottomed cylindrical body before and after the degreasing step is preferably smaller than 100 mg/m².

[0014] In any one of (1) to (5) above, (6) degreasing time in the degreasing step is preferably shorter than 45 seconds.

[0015] In any one of (1) to (6) above, (7) the viscosity of the lubricant is preferably lower than 100 mPa·s.

[0016] In any one of (1) to (5) above, (8) the viscosity of the lubricant is lower than 100 mPa·s and besides degreasing time in the degreasing step is preferably equal to or shorter than 30 seconds.

[0017] In any one of (1) to (8) above, (9) the cleaning agent preferably contains any one of sulfuric acid, hydrofluoric acid, potassium carbonate, sodium hydroxide, and potassium hydroxide.

[0018] In any one of (1) to (9) above, (10) the processing surface of the forming members is preferably formed from carbon or ceramics.

[0019] In (10) above, (11) the carbon is preferably a diamond.

[0020] In any one of (1) to (1) above, (12) the method for manufacturing a bottomed cylindrical body preferably further includes a purification step of purifying waste water discharged in the ironing step and/or the degreasing step.

[Advantageous Effect of Invention]

[0021] According to the method for manufacturing a bottomed cylindrical body of the present invention, it includes the steps of performing drawing and ironing with use of the forming members (for example, a punch and a die) having processing surfaces having hardnesses equal to or higher than the predetermined values.

[0022] Therefore, even in a case where the viscosity of processing oil or the lubricant to be applied to the surface of the metal plate (flat plate) that has not yet been subjected to drawing is made lower, it is possible to achieve processability similar to or higher than that of the conventional method.

[0023] Further, even if the oil to be contained in the coolant to be used in the ironing step is made equal to or lower than the predetermined value, it is possible to obtain a bottomed cylindrical body of an ironing ratio similar to or higher than that of the conventional method.

[0024] Further, according to the present embodiment, it is possible to reduce the amount of oil adhering to the inner side surface and the outer side surface of the bottomed cylindrical body after going through the drawing step and the ironing step. Therefore, even in a case where the concentration of the cleaning agent in the degreasing step is made lower or heating of the cleaning agent is suppressed, it is possible to achieve sufficient degreasing, and it is possible to achieve reduction of the environmental load and reduction of the cost in the degreasing step.

[Brief Description of Drawings]

[0025]

[FIG. 1]

FIG. 1 is a schematic view depicting a drawing step in a method for manufacturing a bottomed cylindrical body according to an embodiment of the present invention.

[FIG. 2]

FIG. 2 is a schematic view depicting an ironing step in the method for manufacturing a bottomed cylindrical body according to the embodiment of the present invention.

[FIG. 3]

FIG. 3 is a schematic view depicting a flow of the method for manufacturing a bottomed cylindrical body according to the present embodiment.

[Description of Embodiment]

[Method for Manufacturing Bottomed Cylindrical Body]

[0026] The applicants of the present invention have found out such a method for manufacturing a seamless can body as disclosed in the specification of Japanese Patent Application No. 2018-204896 and the specification of Japanese Patent Application No. 2018-204823. In particular, it has been found out that, in a case where press working is performed with oil in a coolant set to a predetermined amount or lower while a metal die having a processing surface on which a diamond film or the like having a high slip property is formed, even if a hard process such as ironing is performed, a degree of processing (for example, a limit ironing ratio) equal to or higher than that of a press-worked product manufactured using a conventional amount of lubricant is obtained.

[0027] Further, the inventors have this time found out a method for manufacturing a bottomed cylindrical body related to the method for manufacturing a seamless can body described above.

[0028] In the following, the method for manufacturing a bottomed cylindrical body of the present invention is described in detail suitably with reference to the drawings. It is to be noted that an embodiment described below illustrates an example of the present invention and is described in regard to the contents of this example, but does not intentionally restrict the present invention. Further, although the embodiment described below is described taking a seamless can body as an example of a bottomed cylindrical body, this does not intentionally restrict the present invention.

<Metal Plate>

[0029] The metal plate as a workpiece in the present embodiment is not specifically limited to any kind if it is used in common metal pressing. For example, various known metal plates of aluminum, copper, iron, steel, and titanium including not only pure metals but also alloys of them are applicable. In a case where a seamless can body is to be formed, an aluminum alloy plate among them is especially preferable.

[0030] It is to be noted that, in the present embodiment, the metal plate described above may be a metal plate of the type in which one face or both faces are subjected to known surface treatment or are coated, for example, with resin or the like.

[0031] In this case, as the resin for coating the surface of the metal plate, a polyester resin or the like is favorably applicable.

[0032] The thickness of the metal plate in the present embodiment is not specifically limited to any thickness, and an ordinary thickness in seamless can body manufacture is applicable. For example, as an example of the thickness of the metal plate in a case where can manufacturing is performed using an aluminum alloy plate, the original plate thickness (thickness of an original plate) is 0.1 to 0.5 mm.

<Lubricant Application Step>

[0033] The method for manufacturing a bottomed cylindrical body of the present embodiment includes a lubricant application step of applying lubricant to the surface of a metal plate. As commonly known, application of lubricant makes it possible to process a metal plate into a desired shape such as a bottomed cylindrical body shape without causing damage to or fracture of the metal plate even if hard drawing or ironing is performed for the metal plate in a later drawing step or ironing step.

[0034] Here, the type of the lubricant is not specifically limited to any type, and lubricant that is commonly used when metal working is performed can be used suitably as long as it satisfies a condition hereinafter described. For example, mineral oil composed of fatty acid ester, higher alcohol, fatty acid, or the like can be used.

[0035] Also to the application amount and the application method of the lubricant, a known amount and a known method can be applied as long as they satisfy a condition hereinafter described.

[0036] In the present embodiment, the lubricant whose the viscosity is lower than 200 mPa·s is necessary from the point of view of reduction of the environmental load and the cost in the degreasing step aimed by the present invention. In a case where the viscosity of the lubricant is equal to or higher than 200 mPa·s, there is a possibility that sufficient degreasing cannot be achieved in the later degreasing step, and this is not desirable. It is to be noted that it is more preferable that the viscosity of the lubricant be lower than 100 mPa·s.

<Drawing Step>

[0037] Now, the drawing step in the present embodiment is described.

[0038] The drawing step in the present embodiment is characterized in that the processing surface of forming members (for example, a drawing die and a drawing punch) in the drawing step has equal to or higher than a predetermined

hardness. In particular, it is necessary for the hardness of the processing surface to be Hv 1000 to 12000 in Vickers hardness. The reason is as follows.

[0039] In particular, describing an example of the drawing step of a metal plate with reference to FIG. 1, drawing is performed by a drawing punch P_D in a state in which a metal plate 10 is interposed between a drawing die D_D and the drawing punch P_D , to manufacture a shallow draw cup M. Since, at this time, a strong impact load or high surface pressure acts upon the drawing die D_D and the drawing punch P_D , high durability and high wear resistance of such a degree that they can withstand mass production are required.

[0040] Further, in the present embodiment, in order to achieve reduction of the environmental load and the cost in the degreasing step, a viscosity of lubricant to be applied in the lubricant application step as described above is prescribed. At this time, in order to avoid damage to or fracture of the metal plate, the damage or fracture being caused by the forming members, it is necessary to provide a higher hardness or slippage to the metal die.

[0041] As a result of trial and error by the inventors from the point of view described above, it has been found out that, in the present embodiment, in a case where the hardness of the processing surface of the forming members is set to Hv 1000 to 12000 in Vickers hardness, even in a case where hard drawing is performed, there is no problem from the point of view of the durability, wear resistance, damage to the metal plate, and so forth.

[0042] In the present embodiment, the forming members (metal dies) in the drawing step may be manufactured from a base material composed of a known raw material or may be a base material that is composed of a known raw material and that has a surface treatment film on the processing surface thereof, as long as the processing surface has the hardness described above.

[0043] As the raw material of the base material in the metal dies, specifically, a hard metal alloy obtained by sintering mixture of tungsten carbide (WC) and a metal binder such as cobalt; cermet obtained by sintering mixture of metal carbide such as titanium carbide (TiC) or titanium compound such as titanium carbonitride (TiNC) and a metal binder such as nickel or cobalt; and ceramics such as silicon nitride, alumina or zirconia are applicable, for example.

[0044] Further, as the surface treatment film that is to be formed on the base material, for example, a carbon film, a ceramics film, and so forth can favorably be used.

[0045] As the carbon film, a diamond film, a DLC film, and so forth are applicable. The formation method of such carbon films is not specifically limited to any method, and, for example, a chemical vapor deposition (CVD) method, a physical vapor deposition (PVD), and so forth are applicable.

[0046] Further, as the ceramics film, hard ceramics films of, for example, silicon carbide (SiC), silicon nitride (Si_3N_4), alumina (Al_2O_3), zirconia (ZrO_2), titanium nitride (TiN), TiC, chromium nitride (CrN), and so forth are applicable.

[0047] In the present embodiment, as a combination of types of forming members that are to be used in the drawing step, a same raw material or a same surface treatment film may be used or different raw materials or different surface treatment films may be used for both the drawing die and the drawing punch. For example, both the drawing die and the drawing punch may be made of a hard metal alloy, or one of the drawing die and the drawing punch may be made of a hard metal alloy. Alternatively, a carbon film may be formed on the processing surface of both the drawing die and the drawing punch, or a carbon film may be formed on the processing surface of one of the drawing die and the drawing punch.

[0048] It is to be noted that, in a case where the surface treatment film of one of the drawing die and the drawing punch is a diamond film, it is preferable that the surface treatment film of the other one of the drawing die and the drawing punch be a surface treatment film other than a diamond film from the point of view of dimension management between the metal dies and suppression of rapture damage between the metal dies.

<Ironing Step>

[0049] Now, the ironing step in the present embodiment is described.

[0050] The ironing step in the present embodiment is characterized in that the processing surface of the forming members (for example, an ironing die and an ironing punch) in the ironing step has a hardness equal to or higher than a predetermined hardness. In particular, the ironing step is characterized in that the hardness of the processing surface is Hv 1500 to 12000. In the following, a detailed description is given.

[0051] Describing the ironing step in the present embodiment more particularly with reference to the drawings, the ironing step includes a step of performing, for example, with use of an ironing die D_I having a diamond film 20 formed on its processing surface and an ironing punch P_I having a surface treatment film 30 different from a diamond film on its processing surface as depicted in (a) and (b) of FIG. 2, ironing of a shallow draw cup M with the processing surfaces of the die D_I and the punch P_I in a state in which a coolant C is interposed between the die D_I and the shallow draw cup M and between the punch P_I and the shallow draw cup M.

[0052] At this time, high durability and high wear resistance of such a degree that the ironing die D_I and the ironing die D_I described above can withstand mass production are required for them. Further, in the present embodiment, it is required that the concentration of oil contained in the coolant C be lower than 4.0 percent by volume. Therefore, in order

to avoid damage to or fracture of a workpiece (the metal plate 10 and the shallow draw cup M), for example, it is necessary to set the hardness of the processing surface of the ironing die D_1 and the ironing punch P_1 to Hv 1500 to 12000.

[0053] It is to be noted that, in the present embodiment, specifically, a diamond film of approximately Hv 8000 to 12000 in Vickers hardness is preferably formed on the processing surface of any one of the male die and the female die of the metal die.

[0054] In particular, the diamond film 20 having a high hardness may be formed on the processing surface of the ironing die D_1 while the surface treatment film 30 different from a diamond film is formed on the processing surface of the ironing punch P_1 , as depicted in FIG. 2, or though not depicted, the diamond film 20 having a high hardness may be formed on the processing surface of the ironing punch P_1 while the surface treatment film 30 different from a diamond film is formed on the processing surface of the ironing die D_1 .

[0055] It is to be noted that, since it is common that the ironing die is frequently subjected to harder processing load than the case of the drawing punch, the diamond film 20 is preferably formed on the processing surface of, specifically, the drawing die.

[0056] Preferably, the thickness of the diamond film 20 is 5 to 30 μm . In a case where the thickness is smaller than 5 μm , the diamond film obtained is liable to suffer from cracking and exfoliation, which is not preferable. On the other hand, in a case where the thickness exceeds 30 μm , the internal stress of the diamond film increases and the diamond film becomes liable to be exfoliated, which is not preferable.

[0057] Further, in the present embodiment, a surface roughness R_a (JIS B-0601-1994) of the diamond film 20 is preferably 0.12 or lower from the point of view that a high sliding property can be provided to the metal die. Moreover, in a case where the R_a is set equal to or lower than 0.08 μm , the appearance of a workpiece (for example, a can body) can be made a mirror surface or a smooth surface similar to a mirror surface, and this is more preferable.

[0058] In this case, it is preferable that the coefficient μ of friction between the diamond film 20 and a workpiece upon press working be lower than 0.1.

[0059] Now, the coolant that is used in the ironing step in the present embodiment is described.

[0060] As the coolant to be used in the present embodiment, a coolant that contains oil in its components is preferably applicable.

[0061] In the coolant in the present embodiment, as the oil described above, oil that is contained in a common water-soluble metal working oil agent composition is applicable. The oil may be natural oil or may be synthetic oil.

[0062] As the natural oil, paraffinic mineral oil, naphthenic mineral oil, aromatic mineral oil, and so forth are applicable. Also fatty acid glyceride is applicable as the natural oil.

[0063] As the synthetic oil, for example, hydrocarbon-based oil such as polyolefin, ester-based oil such as fatty acid ester, ether-based oil such as polyalkylene glycol, fluorine-containing oil such as perfluorocarbon, phosphorous-containing oil such as phosphate ester, silicon-containing oil such as silicic acid ester, and so forth are applicable.

[0064] Each of the oils listed above may be used alone or two or more kinds of the oil may be used in mixture.

[0065] It is to be noted that, as the water-soluble metal working oil agent described above, for example, water-soluble metal working oil agents of the A1 type (emulsion type), A2 type (soluble type), and A3 type (solution type) prescribed in JIS K 2241 are applicable.

[0066] Further, though not prescribed in the JIS standard, also a water-soluble metal working oil agent of what is generally called a synthetic type (metal working oil that does not contain mineral oil but contains chemically synthesized oil) is applicable.

[0067] In the present embodiment, the concentration of the oil in the coolant is preferably lower than 4.0% by volume. In this case, in a case where a coolant that contains oil is used in the present embodiment, a coolant in which the concentration of the oil is lower than 4.0% by volume may be prepared by preparing undiluted solution containing oil of a content of 4.0% by volume or more, storing the prepared undiluted solution until use, and then diluting, at the time of use, the undiluted solution with solvent such as water. In particular, it is sufficient if the concentration of the oil in the coolant is lower than 4.0% by volume in a use state.

[0068] Further, the oil concentration in the coolant is more preferably equal to or lower than 3.5% by volume and is further preferably equal to or lower than 2.0% by volume.

[0069] Meanwhile, the components, in the coolant, other than the oil may suitably include components that are contained in common water-soluble metal working oil agent compositions, for example, water, a surface active agent, a rust-preventive agent, an extreme pressure additive, a coupling agent, a non-ferrous metal corrosion inhibitor, an antiseptic agent, a defoaming agent, a chelating agent, a coloring matter, an aroma chemical, a modifier, a stabilizing agent, and so forth.

[0070] In this manner, in the manufacturing method of the present embodiment, even if the oil in the coolant is comparatively low in concentration, forming failure and so forth upon can manufacturing can be suppressed, and as a result, the forming stability can be improved.

[0071] Further, in the present embodiment, since the oil in the coolant is low in concentration in comparison with that of the conventional method as described above, in the degreasing step hereinafter described, cleaning with a medical

agent or water whose environmental load is low is possible, and the environmental load can be reduced. Further, since the waste water treatment after cleaning is facilitated, in a case where the waste water is recycled and recirculated, it is possible to improve the recycle rate and reduce the cost and the environmental load.

[0072] It is to be noted that it is preferable that the ironing step in the present embodiment include a step of ironing processing for ironing the metal material such that the ironing ratio (plate thickness reduction rate) becomes equal to or higher than 10% to form a can body portion. It is to be noted that the step of ironing processing may be repeated multiple times in the ironing step, and the ironing ratio may be changed for each cycle of the step of ironing processing. For example, the ironing ratio in an initial ironing step may be set to 10% or more, and the ironing ratio in the last ironing step may be set to 30% or more.

[0073] It is to be noted that the ironing ratio in the present embodiment is represented by the following expression in a case where the plate thickness before ironing is represented by t_0 and the plate thickness after ironing (at a portion of 60 mm from the can bottom) is represented by t_1 .

$$\text{ironing ratio (\%)} = 100 \times (t_0 - t_1) / t_0$$

[0074] It is to be noted that, in the present embodiment, it is more preferable that the ironing ratio be equal to or higher than 40%.

<Degreasing Step>

[0075] Now, the degreasing step in the present embodiment is described.

[0076] The degreasing step in the present embodiment is a step of bringing a cleaning agent into contact with a bottomed cylindrical body obtained by the drawing step and the ironing step described above, to remove the oil adhering to the inner side surface and the outer side surface of the bottomed cylindrical body.

[0077] It is to be noted that the oil adhering to the inner side surface and the outer side surface of the bottomed cylindrical body described above includes both the lubricant used in the drawing step and the oil included in the coolant used in the ironing step.

[0078] As the method for bringing the cleaning agent into contact with the bottomed cylindrical body, a known method can be used suitably. For example, the bottomed cylindrical body may be immersed into the cleaning agent, or the cleaning agent may be sprayed to the bottomed cylindrical body by a spray or a shower.

[0079] As the cleaning agent to be used in the present embodiment, a known alkaline cleaning agent or acid cleaning agent can be used.

[0080] In a case where an alkaline cleaning agent is used as the cleaning agent to be used in the present embodiment, aqueous solution of inorganic compounds such as, for example, potassium carbonate, sodium hydrogen carbonate, sodium hydroxide, and potassium hydroxide is applicable.

[0081] On the other hand, in a case where an acid cleaning agent is used as the cleaning agent to be used in the present embodiment, aqueous solution of inorganic acid, for example, such as sulfuric acid, nitric acid, hydrochloric acid, and hydrofluoric acid can preferably be used.

[0082] It is to be noted that, after the degreasing process is performed, in order to remove a degreasing agent remaining on the metal plate surface, it is preferable to remove, after a process of washing with water is performed, water on the metal plate surface by an air blow method, a hot air drying method, or the like, as known in the art.

[0083] It is to be noted that, in a case where an alkaline cleaning agent, an acid cleaning agent, or the like is used as the cleaning agent to be used in the present embodiment, from the point of view of suppression of the cost and the environmental load while the cleanability is maintained, it is preferable that the concentration of the cleaning component of the cleaning agent be 2.0% to 5.0% by volume.

[0084] The degreasing step in the present embodiment is characterized in that the temperature of the cleaning agent used (degreasing temperature) is lower than 75°C. In particular, in the present embodiment, since the amount of the lubricant used in the drawing step and the contained amount of oil contained in the coolant used in the ironing step are small, even if the temperature of the cleaning agent is lower than 75°C, it is possible to sufficiently remove the oil on the inner side surface and the outer side surface of the bottomed cylindrical body. It is to be noted that, in the present embodiment, the degreasing temperature is more preferably equal to or lower than 55°C and is further preferably equal to or lower than 40°C.

[0085] On the other hand, the lower limit of the temperature of the cleaning agent is preferably a room temperature (for example, higher than 20°C). Commonly, when processing oil or the like is to be cleaned in metal pressing, a cleaning agent is used in a heated condition in order to enhance the cleanability. However, in order to heat the cleaning agent, an appropriate energy resource is consumed. Therefore, in the present embodiment, from the point of view of cost suppression or environmental load reduction, when a cleaning agent is used, it is possible to use the cleaning agent at

a room temperature as long as the cleanability does not degrade.

[0086] Further, in the present embodiment, from the point of view of cost suppression or environmental load reduction, the degreasing time in the degreasing step is preferably shorter than 45 seconds and is more preferably equal to or shorter than 30 seconds. In particular, in the present embodiment, since the amount of the lubricant used in the drawing step and the content of oil contained in the coolant used in the ironing step are small, even if the degreasing time is shorter than 45 seconds, it is possible to sufficiently remove the oil on the inner side surface and the outer side surface of the bottomed cylindrical body. On the other hand, in a case where the degreasing time is equal to or longer than 45 seconds, there is a possibility that elution of the bottomed cylindrical body itself may progress more than necessary as hereinafter described, and therefore, this is not preferable.

[0087] It is to be noted that, although there is no particular lower limit of the degreasing time, it is preferable that the lower limit of the degreasing time with which degreasing can be achieved without any problem in practical use and besides there is no problem in the waste water processability be, for example, longer than 10 seconds.

[0088] Further, in a case where the degreasing method is spraying of a cleaning agent by a spray or a shower, the cleaning agent spray amount per one can is preferably 60 to 70 ml/second.

[0089] In the degreasing step in the present embodiment, the cleaning agent not only removes the oil adhering to the inner side surface and the outer side surface of the bottomed cylindrical body but also elutes the bottomed cylindrical body itself. Therefore, although a change occurs in the weight of the bottomed cylindrical body before and after the degreasing, the weight change is preferably smaller than 100 mg/m².

[0090] In particular, in the present embodiment, it has become possible to, compared to a predetermined amount of lubricant, reduce the amount of the lubricant used in the drawing step and the amount of oil contained in the coolant used in the ironing step, as described hereinabove. Accordingly, it has become possible to reduce the amount of the oil that adheres to the inner side surface and the outer side surface of the bottomed cylindrical body, after going through the can manufacturing step (the drawing step and the ironing step).

[0091] Therefore, it has become possible to reduce also the amount of the oil to be included in waste water generated in the degreasing step, and it has become possible to reduce the environmental load. Further, also it has become possible to suppress the bottomed cylindrical body from being eluted more than necessary in the degreasing step.

<Purification Step>

[0092] Now, the purification step of purifying waste water discharged in the ironing step and/or the degreasing step in the above-described method for manufacturing a bottomed cylindrical body in the present embodiment is described.

[0093] In particular, as described hereinabove, in the ironing step in the method for manufacturing a bottomed cylindrical body in the present embodiment, ironing is performed with the coolant interposed. Further, in the degreasing step, prior to main washing by which the oil and so forth adhering to the surface of the bottomed cylindrical body are removed using a cleaning agent, precleaning with water is performed, or after such main washing, rinsing for removing the cleaning agent with water or the like is performed. Therefore, in the degreasing step, a large amount of waste water is generated.

[0094] According, the method for manufacturing a bottomed cylindrical body in the present embodiment may further include a purification step of purifying the waste water as depicted in FIG. 3. At this time, for a reason hereinafter described, it is preferable that the waste water purified in such a manner as described above is re-used (recycled) again as purified water in the ironing step or the degreasing step.

[0095] In particular, in the method for manufacturing a bottomed cylindrical body in the present embodiment, the viscosity of oil to be applied in the lubricant application step is equal to or lower than a predetermined value as described hereinabove. Also the concentration of oil contained in the coolant used in the ironing step is lower than a predetermined value as described hereinabove. Accordingly, also the viscosity and the concentration of oil contained in waste water discharged in the ironing step and the degreasing step are lower than the respective predetermined values.

[0096] Therefore, it is possible to purify waste water generated in the ironing step and/or the degreasing step, by a comparatively simple and easy method. Then, by the purification step, further reduction of the environmental load and the cost can be achieved.

[0097] As the purification method for waste water in the purification step, a known method can be used suitably. In particular, such methods as filtration, neutralization, boiling, precipitation, levitation, biological treatment, and ultraviolet (UV) sterilization can be combined suitably to perform purification. Further, a coagulant, a disinfectant, a bactericide, or the like may be mixed suitably.

[0098] According to the method for manufacturing a bottomed cylindrical body in the present embodiment described above, the following advantageous effects can be achieved.

(A) Since the hardness of the processing surface of the forming members in the drawing step and/or the ironing step is made equal to or higher than a predetermined value, the viscosity of the lubricant in the lubricant application step can be made equal to or lower than a predetermined value.

(B) The amount of oil contained in the coolant used in the ironing step can be made smaller than a predetermined value.

(C) As a result of the foregoing, it is possible to suppress heating of the cleaning agent in the degreasing step and/or reduce the degreasing time.

(D) As a result, reduction of the environmental load and cost reduction can be achieved.

[0099] Further, if the purification step is executed further in the present embodiment, the following advantageous effects can further be achieved.

[0100] (E) It is possible to make the purification process for waste water discharged in the ironing step and/or the degreasing step easy.

[0101] (F) It is possible to purify and re-use (recycle) waste water, and it is possible to reduce the cost and the environmental load.

Examples

[0102] Although the present invention is described in more detail below in connection with examples, the present invention is not limited to the following examples.

(Example 1)

[0103] A drawn ironed can (DI can) having an inner volume of 350 mL was manufactured by a method described below.

[0104] First, an aluminum alloy plate (JIS H 4000 3104 material, 0.28 mm) was prepared. Then, as lubricant for drawing, known cupping oil was applied by 1.0 to 1.3 g/m² to the opposite faces of the aluminum alloy plate. It is to be noted that the viscosity of the cupping oil was 200 mPa·s.

[0105] Next, the aluminum alloy plate was punched into a disk shape of a diameter of 160 mm, and drawing was then performed immediately to form a cup body of a diameter of 90 mm by a drawing machine. It is to be noted that the processing surface hardness of the forming members upon drawing was Hv 1500.

[0106] The resulting cup body was transported to a body maker (can body manufacturing machine), by which redrawing was performed such that the cup body has a shape of a diameter of 66 mm, and thereafter, ironing was performed using a coolant such that the cup body has a shape of a diameter of 66 mm and a height of 130 mm.

[0107] As the ironing die at this time, an ironing die that has a diamond film of an average thickness of approximately 10 μm formed on the surface thereof was used. The surface hardness of the diamond film was Hv 10000.

[0108] Further, as the ironing punch used, an ironing punch that has a DLC film of a thickness of 0.5 μm formed on the surface thereof was used. The surface hardness of the DLC film was Hv 3000.

[0109] The ironing ratio at the time of the ironing was such as indicated in Table 1. The content of the oil in the coolant was such as indicated in Table 1. In the coolant, a known surface active agent, rust-preventive agent, extreme pressure additive, and antiseptic agent were added.

[0110] For the obtained DI can, degreasing for removing the oil on the inner side surface and the outer side surface of the DI can was performed. As the cleaning agent used upon degreasing, sulfuric acid (concentration: 3.0% by volume) was used. Further, the temperature of the cleaning agent used upon degreasing was 50°C, the degreasing time was 30 seconds, and the spray amount of the cleaning agent per one can was 60 ml/second.

[0111] Further, the weight change of the DI can before and after the degreasing step was measured and indicated in Table 1.

(Example 2)

[0112] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the viscosity of the cupping oil was changed to 90 mPa·s. A result is indicated in Table 1.

(Example 3)

[0113] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the processing surface hardness of the forming members used upon drawing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 4)

[0114] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the processing

surface hardness of the forming members used upon ironing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 5)

[0115] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the content of oil in the coolant was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 6)

[0116] Sodium hydroxide (NaOH) (concentration: 3.0% by volume) was used as the cleaning agent used upon degreasing. Except this, manufacturing of a DI can was performed in a manner similar to that in Example 1. A result is indicated in Table 1.

(Example 7)

[0117] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the degreasing temperature set upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 8)

[0118] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the degreasing time set upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 9)

[0119] Manufacturing of a DI can was performed in a manner similar to that in Example 2 except that the processing surface hardness of the forming members used upon ironing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 10)

[0120] NaOH (concentration: 3.0% by volume) was used as the cleaning agent used upon degreasing. Except this, manufacturing of a DI can was performed in a manner similar to that in Example 2. A result is indicated in Table 1.

(Example 11)

[0121] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the processing surface hardness of the forming members used upon drawing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Example 12)

[0122] Manufacturing of a DI can was performed in a manner similar to that as in Example 1 except that the processing surface hardness of the forming members used upon ironing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 1)

[0123] Water was used as the cleaning agent used in degreasing. Except this, manufacturing of a DI can was performed in a manner similar to that in Example 1.

[0124] A result is indicated in Table 1.

(Comparative Example 2)

[0125] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the viscosity of cupping oil was changed to 200 mPa·s and the processing surface hardness of the forming members used upon ironing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 3)

[0126] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the degreasing temperature set upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 4)

[0127] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the degreasing time used upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 5)

[0128] Manufacturing of a DI can was performed in a manner similar to that in Example 2 except that the content of oil in the coolant was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 6)

[0129] Manufacturing of a DI can was performed in a manner similar to that in Example 2 except that the degreasing time set upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 7)

[0130] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the content of oil in the coolant was changed to that indicated in Table 1. A result is indicated in Table 1.

(Comparative Example 8)

[0131] Manufacturing of a DI can was performed in a manner similar to that in Example 1 except that the degreasing time set upon degreasing was changed to that indicated in Table 1. A result is indicated in Table 1.

[Evaluation]

[0132] Evaluation of the DI cans obtained by the methods described above was performed by the following method. A result is indicated in Table 1.

[Ironing Processability]

[0133] The DI cans were visually observed for three items of (i) presence/absence of fracture upon ironing, (ii) breed-through (black streak) at the opening of the obtained DI can and discoloration of the inner and outer faces of the can body portion, and (iii) scratch on the outer face of the can body portion. In a case where a DI can has no problem in regard to the three items and the can surface is a mirror surface, this is indicated by "Excellent," a DI can that does has any problem in the three items and is good is indicated by "Good," a DI can that has a problem in any of the items but can withstand practical use is indicated by "Fair," and a DI can that has a problem in any of the items and cannot withstand practical use is indicated by "Poor."

[Cleanability]

[0134] The state of residue (smut) remaining on the can inner face after degreasing was performed for the obtained DI cans was evaluated. The can body of the DI can after degreasing was partly cut out, residue components on the surface on the inner face side was collected with a transparent adhesive tape, and then the adhesive tape was caused to adhere to white paper, whereafter the can body was measured with a color difference meter. The evaluation was performed such that, as a L value comes closer to 90 (value originating only from the adhesive tape), the DI can is less dirty and is higher in cleanability. A DI can whose L value is equal to or higher than 85 is indicated by "Excellent," a DI can whose L value is 80 to 85 is indicated by "Good," and a DI can whose L value is lower than 80 is indicated by "Poor."

[Waste Water Processability]

[0135] Waste water after the DI cans were spray-cleaned using the cleaning agent and washed with water was ac-

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commodated into a beaker, and the chemical oxygen demand (COD) was measured by a known method. In a case where the COD was lower than 200 ppm, the DI can was determined to be "Good" (waste water processability is good), but if the COD was equal to or higher than 200 ppm, the DI can was determined to be "Poor" (waste water processability is poor). Results are indicated in Table 1.

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[Table 1]

	Lubricant application step	Drawing step		Ironing step				Degreasing step				Evaluation		
		Die surface hardness	Punch surface hardness	Die surface hardness	Punch surface hardness	Coolant oil (% by volume)	Ironing ratio (%)	Cleaning agent component	Degreasing temperature (°C)	Degreasing time (second)	Weight change before and after degreasing (mg/m ²)	Ironing processability	Cleanability	Waste water processability
Example 1	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	30	90	Excellent	Excellent	Good
Example 2	90	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	30	90	Fair	Excellent	Good
Example 3	190	10000	10000	10000	3000	3.5	40	Sulfuric acid	55	30	90	Excellent	Excellent	Good
Example 4	190	1500	1500	10000	10000	3.5	40	Sulfuric acid	55	30	90	Excellent	Excellent	Good
Example 5	190	1500	1500	10000	3000	20	40	Sulfuric acid	55	30	90	Fair	Excellent	Good
Example 6	190	1500	1500	10000	3000	3.5	40	NaOH	55	30	90	Excellent	Excellent	Good
Example 7	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	40	30	70	Excellent	Good	Good
Example 8	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	20	70	Excellent	Good	Good
Example 9	90	1500	1500	10000	10000	3.5	40	Sulfuric acid	55	30	90	Fair	Excellent	Good
Example 10	90	1500	1500	10000	3000	3.5	40	NaOH	55	30	90	Fair	Excellent	Good
Example 11	190	1000	1000	10000	3000	3.5	40	Sulfuric acid	55	30	90	Excellent	Excellent	Good

(continued)

	Lubricant application step	Drawing step		Ironing step				Degreasing step				Evaluation		
		Die surface hardness	Punch surface hardness	Die surface hardness	Punch surface hardness	Coolant oil (%) by volume	Ironing ratio (%)	Cleaning agent component	Degreasing temperature (°C)	Degreasing time (second)	Weight change before and after degreasing (mg/m ²)	Ironing processability	Cleanability	Waste water processability
Example 12	190	1500	1500	1500	1500	3.5	40	Sulfuric acid	55	30	90	Good	Excellent	Good
Comparative Example 1	190	1500	1500	10000	3000	3.5	40	Water	55	30	90	Excellent	Poor	Good
Comparative Example 2	200	1500	1500	12000	2000	3.5	40	Sulfuric acid	55	30	90	Excellent	Poor	Good
Comparative Example 3	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	20	30	50	Excellent	Poor	Poor
Comparative Example 4	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	10	50	Excellent	Poor	Good
Comparative Example 5	90	1500	1500	10000	3000	20	40	Sulfuric acid	55	30	90	Poor	Excellent	Good
Comparative Example 6	90	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	10	50	Fair	Poor	Good
Comparative Example 7	190	1500	1500	10000	3000	70	40	Sulfuric acid	55	30	90	Excellent	Excellent	Poor

(continued)

	Lubricant application step	Drawing step		Ironing step			Degreasing step				Evaluation			
		Die surface hardness	Punch surface hardness	Die surface hardness	Punch surface hardness	Coolant oil (% by volume)	Ironing ratio (%)	Cleaning agent component	Degreasing temperature (°C)	Degreasing time (second)	Weight change before and after degreasing (mg/m2)	Ironing processability	Cleanability	Waste water processability
Com parative Ex-ample 8	190	1500	1500	10000	3000	3.5	40	Sulfuric acid	55	50	120	Excellent	Excellent	Good

[0136] In the contents of the examples described above, all of the DI cans are usable in practice in regard to all of the ironing processability, the cleanability, and the waste water processability. On the other hand, in the comparative examples, all of the DI cans are unusable in practice in regard to any of the ironing processability, the cleanability, and the waste water processability. In the Comparative Example 8, although the DI can was good in regard to its results of the ironing processability, the cleanability, and the waste water processability, since the weight change of the can before and after degreasing step was equal to or higher than the 100 mg/m², it is estimated that the can itself was eluted more than necessary in the degreasing step, and the result is not preferable.

[0137] It is apparent that the method for manufacturing a bottomed cylindrical body of the present invention achieves all of the ironing processability, the cleanability, and the waste water processability. Further, it is apparent that, after the purification step of purifying waste water generated in the drawing step and the degreasing step is performed, the waste water can be re-used (recycled) again in the ironing step and the degreasing step.

[Industrial Applicability]

[0138] The present invention can favorably be used in the field of metal pressing that is environmentally friendly while it maintains processability and forming stability.

[Reference Signs List]

[0139]

D_D: Drawing die
 P_D: Drawing punch
 D_I: Ironing die
 P_I: Ironing punch
 C: Coolant
 M: Shallow draw cup
 10: Metal plate
 20: Diamond film
 30: Surface treatment film

Claims

1. A method for manufacturing a bottomed cylindrical body, comprising:

a lubricant application step of applying liquid lubricant having a viscosity of lower than 200 mPa·s to a surface of a metal plate;
 a drawing step of drawing the metal plate to which the lubricant has been applied, with use of a forming member having a processing surface having a hardness of Hv 1000 to 12000;
 an ironing step of ironing, with use of another forming member having a processing surface having a hardness of Hv 1500 to 12000, a workpiece with a coolant interposed between the workpiece and the another forming member, to form a bottomed cylindrical body; and
 a degreasing step of degreasing oil on a surface of the bottomed cylindrical body with use of a cleaning agent, wherein
 a concentration of oil contained in the coolant is lower than 4.0 percent by volume,
 the cleaning agent contains any one of sulfuric acid, hydrofluoric acid, potassium carbonate, sodium hydroxide, and potassium hydroxide, and
 a temperature of the cleaning agent in the degreasing step is lower than 75°C.

2. The method for manufacturing a bottomed cylindrical body according to claim 1, wherein the bottomed cylindrical body is a seamless can body.

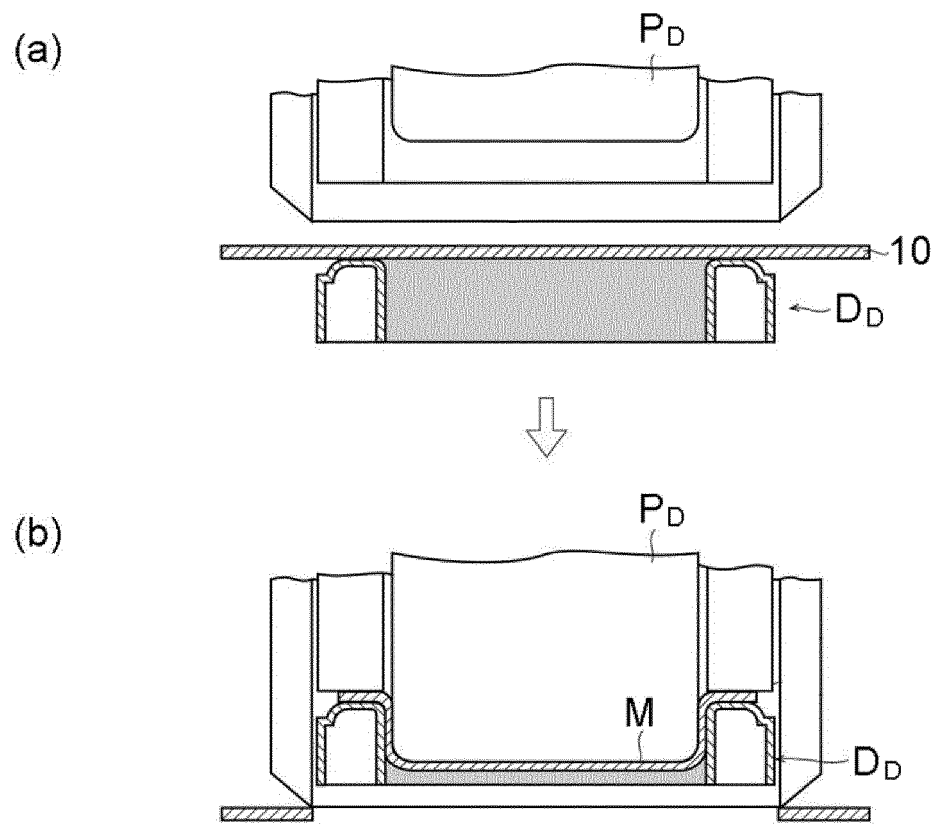
3. The method for manufacturing a bottomed cylindrical body according to claim 1 or 2, wherein the metal plate is made of an aluminum alloy.

4. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 3, wherein the metal plate is a resin-coated metal plate having resin coated on at least one face thereof.

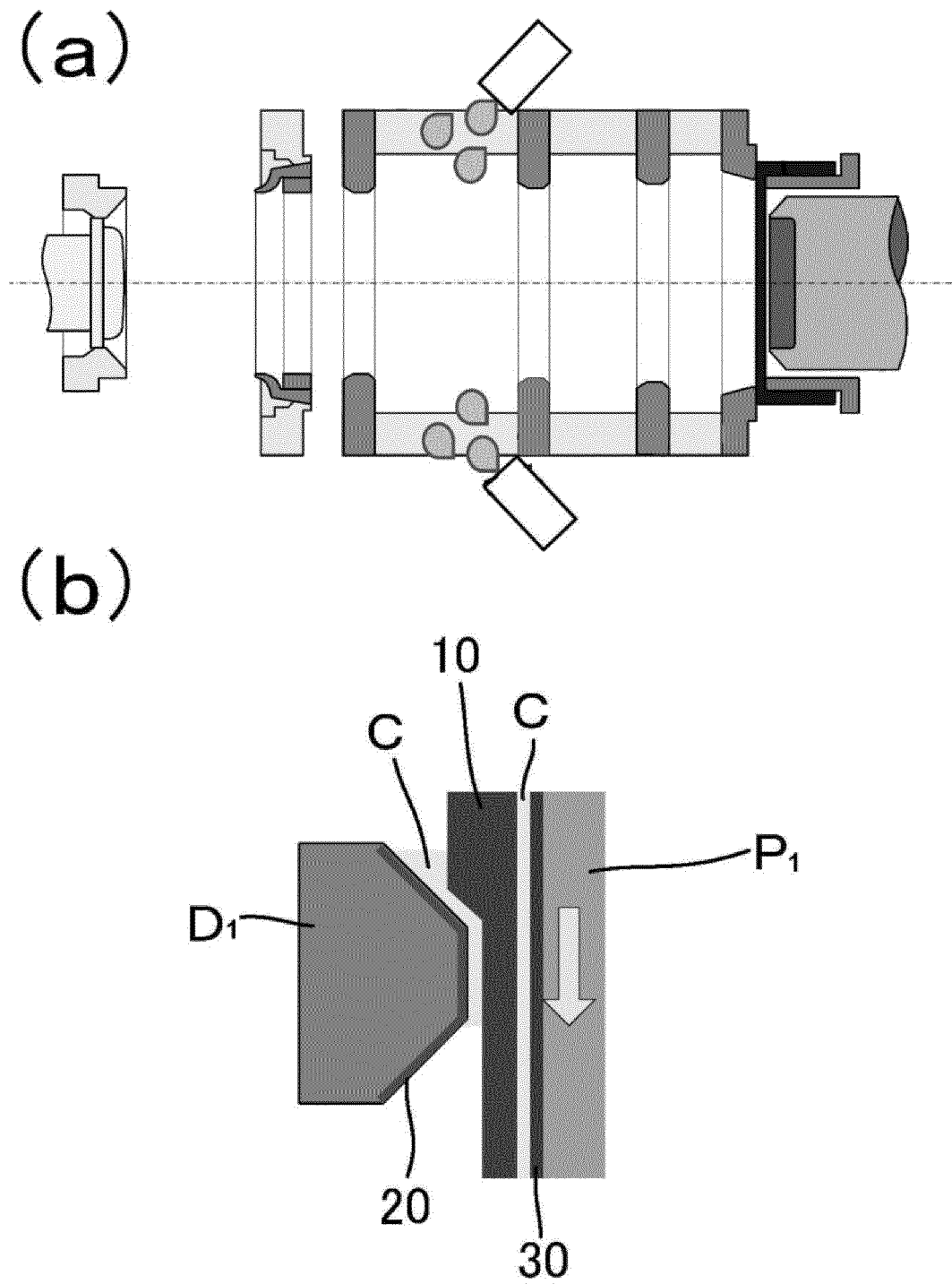
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5. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 4, wherein a weight change of the bottomed cylindrical body before and after the degreasing step is smaller than 100 mg/m^2 .
6. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 5, wherein degreasing time in the degreasing step is shorter than 45 seconds.
7. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 6, wherein the viscosity of the lubricant is lower than $100 \text{ mPa}\cdot\text{s}$.
8. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 5, wherein the viscosity of the lubricant is lower than $100 \text{ mPa}\cdot\text{s}$ and besides degreasing time in the degreasing step is equal to or shorter than 30 seconds.
9. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 8, wherein the cleaning agent contains any one of sulfuric acid, hydrofluoric acid, potassium carbonate, sodium hydroxide, and potassium hydroxide.
10. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 9, wherein the processing surface of the forming members is formed from carbon or ceramics.
11. The method for manufacturing a bottomed cylindrical body according to claim 10, wherein the carbon is a diamond.
12. The method for manufacturing a bottomed cylindrical body according to any one of claims 1 to 11, further comprising: a purification step of purifying waste water discharged in the ironing step and/or the degreasing step.

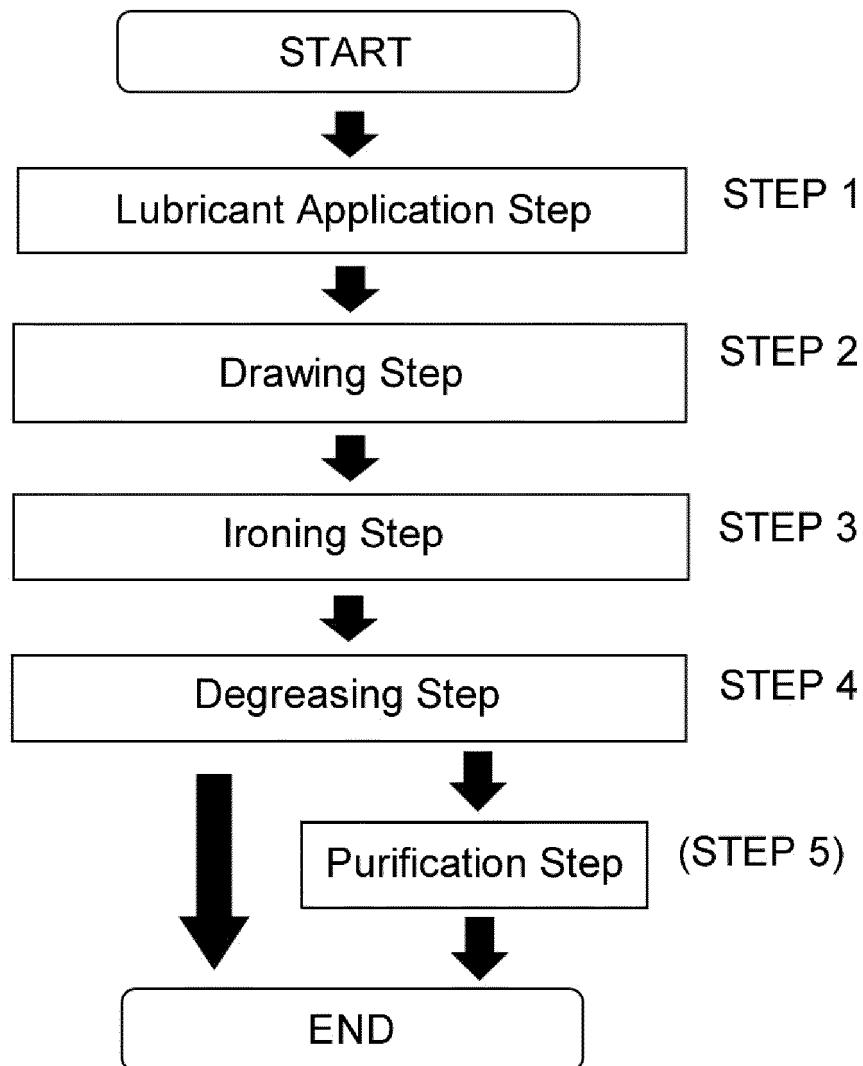
[FIG. 1]



[FIG. 2]



[FIG. 3]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/009204

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. B21D22/28(2006.01)i, B21D22/30(2006.01)i, B21D51/26(2006.01)i, C23G1/12(2006.01)i, C23G1/22(2006.01)i

FI: B21D22/28 H, B21D22/28 B, B21D22/28 L, B21D22/30 B, B21D51/26 X, C23G1/12, C23G1/22

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)

Int. Cl. B21D22/28, B21D22/30, B21D51/26, C23G1/12, C23G1/22

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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.
Y	JP 10-137861 A (SKY ALUMINIUM KK) 26 May 1998, paragraphs [0001], [0019]-[0021], [0034]-[0036], [0039]-[0042]	1-12
Y	JP 2008-36677 A (DAIWA CAN CO.) 21 February 2008, paragraphs [0054]-[0058]	1-12
Y	JP 2007-197775 A (NIPPON PAINT CO., LTD.) 09 August 2007, paragraphs [0002], [0022], [0030]-[0035]	1-12



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search
16.04.2021Date of mailing of the international search report
27.04.2021Name and mailing address of the ISA/
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Tokyo 100-8915, Japan

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/009204

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 60-28497 A (TOYO SEIKAN KAISHA, LTD.) 13 February 1985, p. 3, lower right column, line 10 to p. 4, upper left column, line 9	12
A	JP 1-306023 A (SHOWA ALUMINUM CORP.) 11 December 1989, entire text	1-12

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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