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(54) PIPING-MEMBER MANUFACTURING METHOD

(57) An object of the present invention is to manufacture a piping member more quickly and at a lower cost. A method of manufacturing a cylindrical piping member, wherein one end becomes a welding part that is welded to another member, comprises a process group (**S1-S6**) and a process group (**S8-S10**). In the process group (**S1-S6**), a plate shaped raw material is molded by press molding into a shape that includes a cylindrical, thick walled first part (**51f**) and a thin walled second part (**52f**), which is contiguous with and intersects the first part (**51f**) and becomes a welded part. In the process group (**S8-S10**), a second part **(52f, 52g)** is molded by press molding into a cylindrical shape and a step **(56h)** is created at the boundary between a first part (**51h**) and a second part **(52h).**

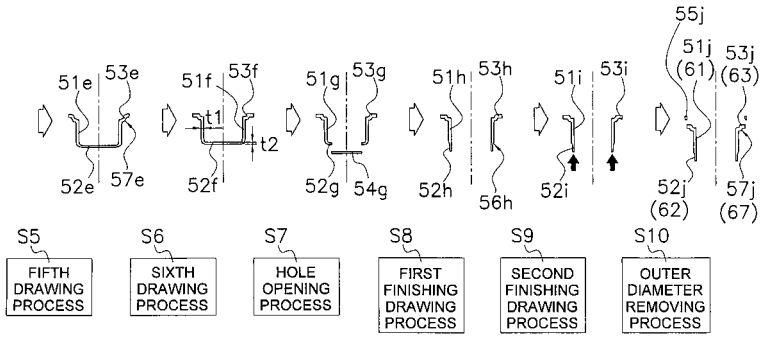


FIG. 9

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Description

TECHNICAL FIELD

[0001] The present invention relates to a method of manufacturing a cylindrical piping member, wherein one end of the cylindrical piping member is a welding part that is welded to another member.

BACKGROUND ART

[0002] In recent years, hot water supply systems have appeared (e.g., refer to Patent Document 1) wherein a heat pump collects heat from the atmosphere, hot water heated by that heat is stored in a tank, and hot water is supplied from that tank. Numerous pipings, such as a hot water supply piping, a water supply piping, and a piping connected to a heat pump, wherethrough water, hot water, and the like pass, are connected to the tank. To connect these pipings, piping members called pipe seats are connected to the tank.

[0003] As shown in **FIG 10,** a cylindrical part **31b,** which is folded toward the inner part of the tank, and a hole, which is surrounded by the cylindrical part **31b,** are formed in a welding flat part **31a** of a pipe seat of the tank. A tip thin walled cylindrical part **262** of a piping member **260** (i.e., a pipe seat) is fitted into the hole such that the tip thin walled cylindrical part **262** contacts the inner circumferential surface of the cylindrical part **31b;** furthermore, the entire circumferences of an end part of the cylindrical part **31b** of the tank and of an end part of the tip thin walled cylindrical part **262** of the piping member **260** are welded together. Moreover, a flange part **263** is formed in the piping member **260** at a portion on the side opposite the tip thin walled cylindrical part **262.** The flange part **263** is coupled to a separate flange part **181** of a piping **180,** wherethrough water, hot water, and the like passes, by a quick fastener **190** (i.e., a piping joint member that utilizes spring characteristics). A tip cylindrical part **182,** which projects from an inner circumferential part of the flange part **181** of the piping **180** in the axial directions, is inserted into an internal space of the piping member **260** and makes close contact with an inner circumferential surface **261a** of the piping member **260** via a sealing member **170.** Thereby, the water, hot water, and the like that flows from the tank via the piping member **260** to the piping **180** (or from the piping **180** to the tank) does not leak out.

Patent Document 1

[0004] Japanese Unexamined Patent Application Publication No. 2007-285655

DISCLOSURE OF THE INVENTION

<Technical Problem>

[0005] The piping member **260** discussed above is often made of a ferritic stainless steel equivalent to SUS 444, which has excellent resistance to stress, corrosion, and cracking; as a result, the thickness of the tip thin walled cylindrical part **262** must be less than that of the other portion and the outer diameter size of the tip thin walled cylindrical part **262** must be highly accurate. Consequently, the piping member **260** is conventionally manufactured by machining (e.g., cutting) a thick walled, cylindrical raw material.

[0006] However, manufacturing the piping member **260** by machining makes the manufacturing time long and the manufacturing cost high, which are problems.

[0007] An object of the present invention is to manufacture a piping member more quickly and at a lower cost.

<Solution to Problem>

[0008] A method of manufacturing a piping member according to a first aspect of the present invention is a method of manufacturing a cylindrical piping member wherein one end becomes a welding part that is welded to another member. In the manufacturing method, press molding is used to mold a plate shaped raw material into a shape that includes a first part and a second part. At that time, molding is performed such that a step is created at the boundary between the first part and the second part. The first part is a thick walled, cylindrical portion. The second part is a thin walled, cylindrical portion, which becomes the welding part, and is contiguous with the first part.

[0009] In the first aspect of the present invention, the thin walled, cylindrical second part, which is becomes a welding part, is not molded by machining as in the conventional art; instead, the piping member is manufactured by press molding such that the step is created at the boundary between the first part and the second part. Consequently, it is possible to manufacture the piping member faster and more inexpensively than the piping member manufactured by conventional machining.

[0010] A method of manufacturing a piping member according to a second aspect of the present invention is a method of manufacturing a cylindrical piping member, wherein one end becomes a welding part welded to another member, that comprises a first step and a second step. The first step uses press molding to mold a plate shaped raw material into a shape that includes the first part and the second part. The first part is a thick walled, cylindrical portion. The second part is a thin walled portion, which becomes the welding part, that is contiguous with and intersects the first part. The second step, which is performed after the first step, uses press molding to mold the second part into a cylindrical shape and creates a step at the boundary between the first part and the

second part.

[0011] In the second aspect of the present invention, the plate shaped raw material is molded, in the first step, by press molding the cylindrical, thick walled first part and the contiguous, thin walled second part such that it intersects the first part; subsequently, in the second step, the second part is also molded into a cylindrical shape and the step is created at the boundary between the first part and the second part.

[0012] Furthermore, because the first part and the second part have already been created with different thicknesses in the first step, it is possible to easily produce the step in the second step.

[0013] In addition, because the second part in the first step intersects the cylindrical first part, it is easy to reduce the thickness of the second part even using press molding by moving the mold along the axial directions of the cylindrical first part.

[0014] Thus, in the second aspect of the present invention, the shape prior to performing the second step (i.e., the shape molded by the first step) is such that the second part can easily be made thin walled; in addition, in the second step, the second part is molded into a cylindrical shape and the step is created at the boundary between the first part and the second part; thereby, the piping member is manufactured; consequently, the piping member can be manufactured by press molding in a short time and with good yield. Furthermore, because the piping member can be manufactured by press molding, the manufacturing time is shorter than that of the piping member manufactured by conventional machining.

[0015] A method of manufacturing a piping member according to a third aspect of the present invention is the manufacturing method according to the second aspect of the present invention wherein the first step comprises the first press molding process and the second press molding process. In the first press molding process, the plate shaped raw material is molded such that the second part takes on a discoidal shape that closes one end of the cylindrical first part. In the second press molding process, the thickness of the discoidal second part is reduced.

[0016] In the third aspect of the present invention, the first press molding process molds the plate shaped raw material into a drinking glass shape that comprises the cylindrical first part and the discoidal second part, which closes one end of the first part, and the subsequent second press molding process reduces the thickness of the second part. Consequently, in the second press molding process, the mold contacts both surfaces of the discoidal second part and thereby can apply force to the second part in the plate thickness directions. Consequently, the second part can be made thin walled more easily and faster than in the method wherein the second part is first molded from its initial shape into a cylindrical shape and then made thin walled.

[0017] A method of manufacturing a piping member according to a fourth aspect of the present invention is the manufacturing method according to the third aspect of the present invention wherein the second step comprises a hole-making process and a third press molding process. The hole-making process removes a center portion of the discoidal second part. The third press molding process molds the annular second part that has undergone the hole-making process into a cylindrical shape and creates the step at the boundary between the first part and the second part.

[0018] In the fourth aspect of the present invention, first, the center portion of the second part is removed and, subsequently, the second part, which is now annular, is molded into a cylindrical shape; consequently, the thin walled, cylindrical welding part can be formed more quickly and more accurately than in a method wherein the unnecessary portion is cut out after the discoidal second part is molded into a cylindrical shape.

[0019] A method of manufacturing a piping member according to a fifth aspect of the present invention is the manufacturing method according to the fourth aspect of the present invention with the addition of a third step. The third step, which is performed after the third press molding process of the second step, applies force that compresses in the axial directions the second part, which has become cylindrical, and molds the second part into the final shape of the welding part.

[0020] In the fifth aspect of the present invention, the third step is additionally performed to apply compression force in the axial directions to the cylindrical second part, thereby making it possible to finish the second part into the final shape of the welded part with good accuracy.

<Advantageous Effects of Invention>

[0021] According to the first and second aspects of the present invention, it is possible to manufacture the piping member faster and more inexpensively than a piping member manufactured by conventional machining.

[0022] According to the third aspect of the present invention, the second part can be made thin walled easily and quickly.

[0023] According to the fourth aspect of the present invention, the thin walled, cylindrical welding part can be formed quickly and with good accuracy.

[0024] According to the fifth aspect of the present invention, the second part can be finished into the final shape of the welded part with good accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is an external oblique view of a storage type water heater according to the present embodiment.

FIG. 2 is a schematic block diagram of the storage type water heater.

FIG. 3 is a circuit diagram of pipings that connect a hot water storage apparatus of the storage type wa-

ter heater with a hot water supply port and a bathtub.
FIG. 4A is a top view of a hot water storage tank.
FIG. 4B is a cross sectional view taken along the IV-IV arrows in **FIG 4A.**
FIG. 5 is a longitudinal cross sectional view of a piping member.
FIG. 6A is a front view of a quick fastener.
FIG. 6B is a cross sectional view taken along the VI-VI arrows in **FIG. 6A.**
FIG. 7 is a plan view of a plate shaped raw material before and after a first drawing process.
FIG. 8 is a cross sectional view (corresponding to a cross sectional view taken along the *VIII-VIII* arrows in **FIG 7**) of the plate shaped raw material before and after first through fourth drawing processes.
FIG. 9 is a cross sectional view of the plate shaped raw material before and after fifth and sixth drawing processes, a hole-making process, the first and second drawing processes, and an outer diameter removing process.
FIG. 10 is a longitudinal cross sectional view of a conventional piping member.

EXPLANATION OF THE REFERENCE NUMERALS

[0026]

31	Hot water storage tank (other member)
50	Plate shaped raw material
51a ... 51j	First parts
52a ... 52j	Second parts
56h	Step
60	Piping member
61	Cylindrical part
62	Tip thin walled cylindrical part (welding part)
S1	First drawing process (first step; first press molding process)
S2	Second drawing process (first step; second press molding process)
S3	Third drawing process (first step; second press molding process)
S4	Fourth drawing process (first step; second press molding process)
S5	Fifth drawing process (first step; second press molding process)
S6	Sixth drawing process (first step; second press molding process)
S7	Hole-making process (second step)
S8	First finishing drawing process (second step; third press molding process)
S9	Second finishing drawing process (third step)

BEST MODE FOR CARRYING OUT THE INVENTION

<Configuration of a Storage Type Water Heater>

[0027] **FIG. 1** is an external oblique view of a storage type water heater that uses piping members (i.e., pipe seats) according to the present embodiment, and **FIG 2** is a block diagram of the storage type water heater. In **FIG 1,** a storage type water heater **1** comprises a heat pump unit **2** and a hot water storage apparatus **3,** a vapor compression type refrigeration circuit is housed inside a casing of the heat pump unit **2,** and a hot water storage tank **31** is housed inside a casing of the hot water storage apparatus **3.**

[0028] In **FIG 2,** the heat pump unit **2** comprises a vapor compression type refrigeration circuit **20,** wherein a muffler **21a,** a compressor **21,** a refrigerant pipe **22a** inside a water heat exchanger **22,** an expansion valve 23 that serves as a pressure reducing means, and an air heat exchanger **24** are connected in a ring by a refrigerant piping **25.**

[0029] In addition, to exchange heat between high pressure, high temperature refrigerant that comes out of the water heat exchanger **22** and low pressure, low temperature refrigerant that comes out of the air heat exchanger **24,** a liquid-gas heat exchanger **26** is disposed in the refrigeration circuit **20.** Specifically, heat is exchanged between a refrigerant passageway that couples the water heat exchanger **22** and the expansion valve **23** and a refrigerant passageway that couples the air heat exchanger **24** and the compressor **21.**

[0030] The hot water storage apparatus **3** comprises a water circulation circuit **30** wherein the hot water storage tank **31,** a water pipe **22b** in the water heat exchanger **22,** and a water circulation pump **32** are connected in a ring by a water circulation piping **35.** A control apparatus **4** operates and controls the heat pump unit 2 and the hot water storage apparatus **3.**

<Configuration of a Hot Water Storage Apparatus that Comprises a Hot Water Storage Tank>

[0031] **FIG 3** is a circuit diagram of a piping that connects the hot water storage apparatus **3** of the storage type water heater 1 and loads. Furthermore, the loads spoken of herein refer to a hot water supply and a bath. A hot water supply pipe **71** connects a head part of the hot water storage tank **31** and a hot water supply mixing valve **73.** The hot water supply pipe **71** comprises hot water supply branch pipes **71a, 71b,** wherein the hot water supply branch pipe **71a** connects the hot water supply pipe **71** and a hot water filling mixing valve **74** and the hot water supply branch pipe **71b** connects the hot water supply pipe **71** and a relief valve **75.**

[0032] A water supply pipe **72** connects a water supply source and the hot water supply mixing valve **73.** The water supply pipe **72** comprises water supply branch pipes **72a, 72b.** The water supply branch pipe **72a** con-

nects the water supply pipe 72 and the hot water filling mixing valve **74,** and the water supply branch pipe **72b** connects the water supply pipe 72 and a bottom part of the hot water storage tank **31.** Furthermore, a pressure reducing check valve **76** is connected upstream of the water supply branch pipe **72a** and the water supply branch pipe **72b.** In addition, a water temperature sensor **41** is provided at a position spaced apart from the hot water storage tank **31** of the water supply branch pipe **72b.** The water temperature sensor **41** is adapted such that it is not affected by the temperature of the hot water storage tank **31.**

[0033] A hot water circulation piping **77** connects the head part and the bottom part of the hot water storage tank **31,** and a reheating heat exchanger **78** and a circulation pump **79** are connected midway therebetween.

[0034] A second hot water supply pipe **81** connects the hot water supply mixing valve **73** and a hot water supply port **82,** and a hot water supply amount sensor **42a** is disposed midway therebetween. A third hot water supply pipe **83** connects the hot water filling mixing valve **74** and a bath water circulation piping **91,** and a compound water valve **84** is disposed midway therebetween. The compound water valve **84** comprises a hot water filling solenoid valve **84a,** a water discharge valve **84b,** and a hot water filling amount sensor **42b.**

[0035] The bath water circulation piping **91** exits from and returns to a bathtub **92,** and a bath water circulating pump **93** is connected midway therebetween. Furthermore, in the reheating heat exchanger **78,** heat is exchanged between the bath water circulation piping **91** and the hot water circulation piping 77.

[0036] Temperature sensors **44a-44e**, which serve as means of detecting the amount of residual hot water, are provided to a sidewall of the hot water storage tank **31** at fixed spacings between the head part and the bottom part. The temperature sensors **44a-44e** detect the temperature of the hot water at each height position of the hot water storage tank **31,** and thereby the temperature of the hot water and the amount of residual hot water are calculated. Furthermore, the head part, the bottom part, and the entire circumference of the sidewall of the hot water storage tank **31** are covered with a heat insulating material.

<Configuration of Piping Members Welded and Fixed to the Hot Water Storage Tank>

[0037] As discussed above, numerous pipings, such as the hot water supply pipe **71,** the water supply pipe 72, the hot water circulation piping 77, and the water circulation piping **35,** wherethrough water, hot water, and the like pass, are connected to the hot water storage tank **31.** To connect each of these pipings (hereinafter, called pipings **180)** with the hot water storage tank **31,** piping members **60,** which are called pipe seats, are used. As shown in **FIG. 5,** each of the piping members **60** principally comprises: a cylindrical part **61;** a tip thin walled cylindrical part **62,** whose outer diameter is smaller and whose walls are thinner than those of the cylindrical part **61;** and a flange part **63,** which is disposed on the side of the cylindrical part **61** opposite the tip thin walled cylindrical part **62.** The flange part **63** is an annular portion that extends outward in the radial directions from one end of the cylindrical part **61.**

[0038] As shown in **FIG. 4A, FIG 4B**, and **FIG 5,** the piping member **60** is inserted into a hole formed by the flat part **31a** of the hot water storage tank **31** and is welded to the hot water storage tank **31.** Specifically, a hole and a cylindrical part **31b** (refer to **FIG 5),** which is folded from the circumference of the hole toward the inner part of the hot water storage tank **31,** are formed in the flat part **31a** of the hot water storage tank **31.** The tip thin walled cylindrical part **62** of the piping member **60** is inserted into the hole of the hot water storage tank **31.** Furthermore, the entire circumferences of an end part of the tip thin walled cylindrical part **62** of the piping member **60** and a tip part of the cylindrical part **31b** of the hot water storage tank **31** are welded together. Thereby, the piping member **60** is fixed to the hot water storage tank **31.**

[0039] To, for example, insert and weld around the entire circumference of the tip thin walled cylindrical part **62** of the piping member **60,** the tip thin walled cylindrical part **62** must be manufactured with particularly good accuracy with respect to its external size; furthermore, a step **66,** which is pressed to the flat part **31a** around the hole of the hot water storage tank **31,** must be formed at the boundary between an outer circumferential surface of the tip thin walled cylindrical part **62** of the piping member **60** and an outer circumferential surface of the cylindrical part **61.**

[0040] Moreover, as shown in **FIG 5,** the flange part **63** of the piping member **60** contacts a flange part **181** of the piping **180** connected to the hot water storage tank **31** and is coupled to the flange part **63** by a quick fastener **190** such that it cannot be separated therefrom. The quick fastener **190** is a piping joint member that is made of metal and has a shape as shown in **FIG 6A** and **FIG 6B;** furthermore, the quick fastener **190** utilizes its spring characteristic to grasp cylindrical trunk parts of both members to be connected by grasping parts **191, 192** positioned on the left and right of a long hole **190a.** Specifically, in a state in which they contact one another, the flange part **63** of the piping member **60** and the flange part **181** of the piping **180** are fitted into the long hole **190a** of the quick fastener **190;** furthermore, the grasping part **191,** which grasps the cylindrical part **61** of the piping member **60,** and the grasping part **192,** which grasps the cylindrical trunk part of the piping **180,** prevent the piping member **60** and the piping **180** from separating in the axial directions (refer to **FIG 5).**

[0041] Because the quick fastener **190** becomes the piping joint, it is necessary to ensure that a thickness *L3* (i.e., a length in the axial directions) of the flange part **63** of the piping member **60** is of a prescribed size; in addition, it is necessary to ensure that the surface that the

grasping part **191** of the quick fastener **190** catches on is a prescribed size in the radial directions.

[0042] To meet the requirements of the piping member **60** described above and to shorten the excessive manufacturing time required in the conventional art, wherein the piping member is manufactured from a thick walled raw material by a cutting process and the like, the piping member **60** herein is manufactured by a plurality of press molding processes, and attention is given to how to shape the piping member **60.**

[0043] The piping member **60,** which is integrally formed from a plate shaped raw material **50** (refer to **FIG. 7** and **FIG 8)** by a plurality of press molding processes, has a cross sectional shape (refer to **FIG 5)** wherein the flange part **63** of the piping member **60** includes a step **67.** Furthermore, the thickness *L3* of the flange part **63** is greater than a thickness *t1* of the plate shaped raw material **50.** Here, the thickness *t1* = 1.5 mm and the thickness *L3* = 2.8 mm. In addition, the step **67** of the flange part **63** includes a bent part, which is bent by approximately 90°; furthermore, the step **67** is formed such that a size *r4* (refer to **FIG 5),** which is a radius of curvature *R* of a surface of the bent part, is less than 0.5 mm.

[0044] In addition, the piping member **60** is press molded such that the step **66** is formed at the boundary between the thick walled cylindrical part **61** (which has the thickness *t1*) and the thin walled tip thin walled cylindrical part **62** (which has a thickness *t2*), the outer diameter of the tip thin walled cylindrical part **62** and the inner diameter of the hole of the flat part **31a** of the hot water storage tank **31** coincide, and the tip of the tip thin walled cylindrical part **62** and the tip of the cylindrical part **31b** of the hot water storage tank **31** are at the same height position.

[0045] Furthermore, each of the sizes indicated in **FIG 5** is set based on the following ranges: *D1* = 20 mm or 26 mm, *D2* = 22 mm or 27 mm, *L1* = 6.5-10.0 mm, *L2* = 1.5-4.0 mm, *L3* = 2.6-3.0 mm, *L4* = 1.0-4.3 mm, *t1* = 0.5-2.0 mm, *t2* = 0.5-1.8 mm (wherein, *t2* < t1), *r1* > 1.0 mm, *r2* < 0.5 mm, *r3* < 0.5 mm, and *r4* < 0.5 mm. Here, the piping member 60 is manufactured such that *D1* = 20 mm, *D2* = 22 mm, *L1* = 9.0 mm, *L2* = 2.0 mm, *L3* = 2.8 mm, *L4* = 4.2 mm, *t1* = 1.5 mm, *t2* = 1.0 mm, *r1* > 1.0 mm, *r2* < 0.5 mm, *r3* < 0.5 mm, and *r4* < 0.5 mm.

<Piping Member Manufacturing Method>

[0046] The abovementioned piping member **60** can be regarded as one wherein the lower part in **FIG. 5** is the tip thin walled cylindrical part **62,** which is welded to the hot water storage tank **31,** and the upper part in **FIG. 5** is the flange part **63,** which constitutes the connecting part connected to the piping **181;** furthermore, the piping member **60** has a step **66** between the tip thin walled cylindrical part **62** and the cylindrical part **61** and a step **67** between the flange part **63** and the cylindrical part **61.** As shown in **FIG. 7-FIG. 9,** the piping member **60** is manufactured by 10 processes (**S1-S10**), which include numerous press molding processes. However, because each process is completed within several seconds and the processes are performed successively in a transverse flow across the figure, the worker hours needed to manufacture the piping member **60** are fewer than that required by the manufacturing method wherein conventional machining is used.

[0047] Here, as shown in the left end portions of **FIG. 7** and **FIG. 8,** press molding processes and the like are performed in order on the substantially circular plate shaped raw material **50.** The plate shaped raw material **50** is made of ferritic stainless steel wherein the chrome (Cr) content is 17-20%, the molybdenum (Mo) content is 1.7-2.5%, and the carbon (C) content is less than 0.03. Setting the thickness of the plate shaped raw material **50** to less than 2 mm makes it possible to employ press molding even when the raw material has such a composition; furthermore, press molding the plate shaped raw material **50** results in virtually no loss of material. Here, the plate shaped raw material **50** used has a plate thickness of 1.5 mm.

[0048] Each of the processes (**S1-S10**) will be discussed in detail later; first, the overall manufacturing method will be discussed.

[0049] In the method of manufacturing the piping member **60,** the plate shaped raw material **50** is press molded into a shape that includes thick walled, cylindrical first parts **(51a,** ... **51h)** and thin walled, cylindrical second parts **(52a,** ... **52h),** which are contiguous with the first parts **(51a,** ... **51h)** and become the tip thin walled cylindrical part **62;** furthermore, the plate shaped raw material **50** is press molded such that a step **(56h)** is created at the boundary between the first part **(51h)** and the second part **(52h).**

[0050] In addition, regarding the portion that becomes the step **66,** the piping member **60** manufacturing method can be broken down into three steps: the group of processes that occurs before hole-making (**S1-S6**), the hole-making process **S7** itself, and the group of processes that occurs after hole-making (**S8-S10**). In the process group (**S1-S6**), which occurs before hole-making, the plate shaped raw material **50** is press molded into a shape that includes the cylindrical thick walled first parts (**51a**, ... **51f**) and the thin walled second part (**52f**), which is contiguous with the first parts (**52a**, ... **51f**) and becomes the tip thin walled cylindrical part **62.** The first parts (**51a**, ... **51f**) and the second parts **(52a,** ... **52f**) are orthogonal to one another and respectively correspond to a cylindrical portion and a discoidal portion, which closes one end of the cylindrical portion. The thicknesses of the first part (**51f**) and the second part (**52f**) completed by the sixth drawing process **S6** are *t1* and *t2* (*t2* < t1), respectively; the second part (**52f**) further undergoes a plurality of drawing processes (i.e., press molding processes), which makes its plate thickness *t2* even smaller. In the process group (**S8-S10**), which occurs after hole-making, and particularly in the first finishing drawing process **S8,** the annular second part **(52g)** whose center portion is cut out is molded into a cylindrical shape, and a

step **(56h)** is created at the boundary between the first part (**51h**) and the second part **(52h).** Furthermore, in the second finishing drawing process **S9,** a force is applied that compresses the second part **(52h),** which has become cylindrical, in the axial directions, and thereby the second part is molded into the final shape of the tip thin walled cylindrical part **62.**

[0051] Furthermore, the process group (**S1-S6**), which occurs before hole-making, can be broken down into two steps: the first drawing process **S1**, which molds the plate shaped raw material 50 such that the second part **(52a)** becomes a disc that closes one end of the cylindrical first part (**51a**); and the wall thinning process group **(S2-S6),** which reduces the thickness of the second part (52a).

[0052] In addition, regarding the molding of the flange part **63,** the process group (**S1-S6**), which occurs before hole-making, can be broken down into two steps: the first drawing process **S1**, which occurs before the formation of the flange part **63;** and the subsequent flange part molding process group **(S2,** ...). The first drawing process **S1** molds the plate shaped raw material **50** into an initial shape, which includes the cylindrical first part (**51a**), by press molding. Furthermore, in the flange part molding process group, which occurs after the second drawing process **S2**, the portion of an intermediate molding material, which is the material that has taken the initial shape, in the vicinity of the end part of the first part (**51a**) is bent and extended outward in the radial directions, and the first part **(51a)** is molded into the first parts (**51b**, ...) and third parts **(53b,** ...) and then molded into the shapes of the cylindrical part **61** and the flange part **63.**

[0053] In addition, regarding the portion that becomes the step **67,** the process group (**S1-S6),** which occurs before hole-making, can be broken down into two steps: the preparatory process group (**S1-S3**), which occurs before the molding of the detailed shape of the flange part **63;** and the process group **(S4-S6)** that molds the detailed shape of the flange part **63.** In the preparatory process group (**S1-S3**), which occurs before the molding of the detailed shape of the flange part **63,** the plate shaped raw material **50** is molded into an intermediate molding material, which includes the first part (**51c**) that becomes the cylindrical part **61** and the third part **(53c)** that becomes the flange part **63,** by a plurality of drawing processes (i.e., press molding processes). Furthermore, in the process group **(S4-S6)** that molds the detailed shape of the flange part **63,** a step **(57e)** is formed in the third parts **(53d,** ... **53f**) of the intermediate molding material by a plurality of drawing processes. The step **(57e)** is a step that is oriented in both the axial and the radial directions.

[0054] Furthermore, regarding the portion that becomes the step **67,** the hole-making process S7 and the process group (**S8-S10**), which occurs after hole-making, can be broken down into two steps: the finishing process group **(S7-S9),** which finishes the step **67;** and the outer diameter removing process **S10**, which completes the step **67.** In the finishing process group **(S7-S9),** which finishes the step **67,** the third part (**53f**) of the intermediate molding material wherein the step **(57e)** is formed is finished by a plurality of processes into a shape that includes the shape of a final step. Furthermore, in the outer diameter removing process **S10**, a radial directions outer side portion **(55j)** of the third part **(53i)** of the intermediate molding material, which has taken a shape that includes the final step shape, is cut off to make the third part **(53j)** of the intermediate molding material. Thereby, the flange part **63,** wherein the third part **(53j)** has a prescribed external size, is completed.

[0055] Next, each of the processes (**S1-S10**) will be discussed in detail.

(S1: First Drawing Process)

[0056] As shown in **FIG. 7** and **FIG 8,** first, the first drawing process **S1**, which is the initial press molding process, is performed on the circular plate shaped raw material **50,** which has been cut out at its circumference with the exception of parts thereof. Here, a mold vertically sandwiches the plate shaped raw material **50,** which is press molded into the shape of a drinking glass that comprises the cylindrical first part **(51a)** and the discoidal second part **(52a).** Thereby, as shown in **FIG. 8**, the plate shaped raw material **50** is molded into the initial shape wherein the cross section is recessed (i.e., is shaped as a drinking glass).

(S2: Second Drawing Process)

[0057] Next, the plurality of press molding processes (i.e., processes **S2-S6**) bends and extends outward in the radial directions the portion in the vicinity of the end part of the first part **(51a)** on the side opposite the second part **(52a)** and reduces the plate thickness of the second part **(52a).**

[0058] First, in the second drawing process **S2,** the first part (**51a**) is bent such that the upper part of the first part (**51a**) is oriented diagonally upward, and the first part (**51a**) is made into the first part (**51b**) and the third part **(53b).** In addition, a compression force from the mold is applied to the second part **(52a)** in the plate thickness directions (i.e., the vertical directions), and the second part **(52a)** is made into the second part **(52b),** whose plate thickness is slightly less than that of the second part **(52a).**

(S3: Third Drawing Process)

[0059] In the third drawing process **S3,** press molding is performed such that the third part (53b) is oriented more in the horizontal directions, and the second part **(52b)** is made into the second part (52c), whose plate thickness is slightly less than that of the second part **(52b).**

(S4: Fourth Drawing Process)

[0060] In the fourth drawing process **S4,** substantially half of a tip side of the third part (53c) is bent on the side reverse that of the side bent so far such that the third part **(53c)** faces upward at a midpoint. A step is created in the third part **(53c)** that undergoes this press molding.

[0061] In addition, in the fourth drawing process **S4,** too, the second part **(52c)** is made into the second part **(52d),** whose plate thickness is slightly less than that of the second part **(52c).**

(S5: Fifth Drawing Process)

[0062] In the fifth drawing process **S5,** a tip portion of substantially half of the tip side of the third part (53d), which faces upward, is further press molded such that the tip is bent outward and approaches the horizontal directions. Thereby, the step **(57e),** which is in both the axial directions (i.e., the vertical directions) and the radial directions (i.e., the horizontal directions), is created in the third part **(53e)** that undergoes the fifth drawing process **S5.**

[0063] In addition, in the fifth drawing process **S5,** too, the second part **(52d)** is made into the second part **(52e),** whose plate thickness is slightly less than that of the second part **(52d).**

(S6: Sixth Drawing Process)

[0064] In the sixth drawing process **S6,** the third part **(53e)** is press molded such that the angle of the bent part of the step **(57e)** is further reduced. Thereby, the third part **(53e)** becomes the third part (**53f**), which more closely approximates the final shape.

[0065] In addition, in the sixth drawing process **S6,** too, the second part **(52e)** is made into the second part (**52f**), whose plate thickness is slightly less than that of the second part **(52e).** The plate thickness of the second part (**52f**) of the intermediate molding material that undergoes the sixth drawing process **S6** is *t2*. Moreover, the plate thickness of the first part (**51f**) of the intermediate molding material is *t1.*

(S7: Hole-making Process)

[0066] In the hole-making process **S7**, which is performed after the sixth drawing process **S6,** the center portion of the second part (**52f**), which is the bottom part of the intermediate molding material shaped as a drinking glass, is cut off. Specifically, a round hole whose diameter is slightly smaller than the inner diameter of the first part (**51f**) is opened in the second part (**52f**). Thereby, the second part (**52f**) becomes the annular second part **(52g)** wherein a circular center portion **(54g)** is cut away.

[0067] In addition, the third part (**53f**) becomes the third part **(53g),** which more closely approximates the final shape.

(S8: First Finishing Drawing Process)

[0068] In the first finishing drawing process **S8,** press molding is performed such that the annular second part (52g) is made to face downward. Thereby, the tip of the annular second part **(52g)** is extended in the vertical directions from the portion in the vicinity of its boundary with the first part (**51g**). Thereby, the annular second part **(52g)** becomes the cylindrical second part **(52h).** In addition, attendant therewith, the step **(56h)** is created in the portion of the boundary between the second part **(52h)** and the first part (**51h**).

[0069] In addition, the third part **(53g)** becomes the third part **(53h),** which more closely approximates the final shape.

(S9: Second Finishing Drawing Process)

[0070] The second finishing drawing process **S9** is performed to make the outer diameter of the tip thin walled cylindrical part **62** and the inner diameter of the hole of the flat part **31a** of the hot water storage tank **31** coincide and to give the tip of the tip thin walled cylindrical part **62** and the tip of the hot water storage tank **31** the same height position.

[0071] In the second finishing drawing process **S9,** a force that compresses the second part **(52h),** which has become cylindrical, in the axial directions is applied and the second part **(52h)** is molded into the second part **(52i),** whose shape is identical to the final shape of the tip thin walled cylindrical part **62.**

[0072] In addition, the third part **(53h)** becomes the third part **(53i),** whose shape is identical to the final shape with the exception of its outer diameter. In the third part **(53i),** the bent part transitions to a state wherein it is bent by approximately 90°, and the size *r4* (refer to **FIG 5),** which is the radius of curvature R of the surface of the bent part, becomes less than 0.5 mm.

(S10: Outer Diameter Removing Process)

[0073] In the outer diameter removing process **S10**, the radial directions outer side portion **(55j)** of the third part **(53i)** of the intermediate molding material is cut off and the third part **(53i)** is made into the third part **(53j),** whose external size is the same as that of the flange part **63.** The cutting performed in the process **S10** targets the outer side of the step **(57j),** which has the final step shape of the step **67** of the flange part **63,** in the radial directions.

<Characteristics of the Piping Member Manufacturing Method>

(1)

[0074] Usually, when a member that comprises a cylindrical part and a flange part is manufactured by press molding, a raw material is press molded such that it takes

on either a final shape that includes the flange part or a shape that approximates that final shape; however, in such a manufacturing method, if the raw material becomes hard or bulky, press molding is difficult to perform well. For example, even if the size of the press molding equipment is increased, the rate of loss of the raw material subject to press molding will increase. Consequently, in the conventional art, as shown in **FIG. 10**, a piping member **260** is manufactured with a manufacturing method that uses machining, wherein a thick walled, cylindrical raw material with a plate thickness of 3.5 mm is cut and the plate thickness of a tip thin walled cylindrical part **260e** is reduced to less than 1.0 mm; however, that manufacturing (process) takes a long time and is costly.

[0075] In contrast, in the method of manufacturing the piping member **60** discussed above, first, in the first drawing process **S1**, press molding is performed to create an initial shape that includes the cylindrical first part (**51a**); from there, in the flange part molding process group **(S2-),** the portion in the vicinity of the end part of the cylindrical first part (**51a**) is bent via press molding, and the first part (**51a**) is molded into the first parts (**51a**, ... **51j**) and the third parts **(53b,** ... **53j),** which correspond to the cylindrical part **61** and the flange part **63,** respectively. Consequently, although a plurality of press molding processes is needed, less of the plate shaped raw material **50,** the intermediate molding material, and the like is lost owing to press molding in both the first drawing process **S1** and the flange part forming process group **(S2-),** and therefore the piping member **60** can be manufactured with good yield. In addition, adopting such a manufacturing method makes it possible to manufacture the piping member **60** by press molding, which reduces the manufacturing time compared with that of the piping member manufacturing method based on conventional machining.

[0076] Thus, the manufacturing method discussed above makes it possible to manufacture the piping member **60** at a lower cost and more quickly.

(2)

[0077] In addition, in the manufacturing method discussed above, the numerous press molding processes **(S2-)** mold the cylindrical first part (**51a**) into the first parts (**51b**, ... **51j**) and the third parts **(53b,** ... **53j)** and, in turn, mold the first parts (**51b**, ... **51j)** and the third parts **(53b,** ... **53j)** into the cylindrical part **61** and the flange part **63;** consequently, even if the flange part **63** includes a complex step shape, the flange part **63** can be molded with good accuracy while avoiding loss of material.

(3)

[0078] In the method of manufacturing the piping member **60** discussed above, in the first drawing process **S1**, the plate shaped raw material **50** is press molded such that its cross section is recessed, namely, such that it turns into the initial shape, which is that of a drinking glass; afterwards, in the flange part molding process group **(S2-),** the third part **(53b)** is extended outward in the radial directions and, in the hole-making process **S7,** the center portion **(54g)** of the second part (**52f**) is cut away; thereby, the piping member **60** is manufactured. Thus, because the initial shape molded in the first drawing process **S1** is that of a drinking glass and includes the discoidal second part **(52a),** the press molding that starts with the plate shaped raw material **50** formed in the first drawing process **S1** is performed smoothly and satisfactorily, there is virtually no loss of the plate shaped raw material **50,** and a high yield rate is obtained.

(4)

[0079] In the piping member **60** discussed above, adopting the flange part **63** whose cross sectional shape includes a step ensures that the thickness *(L3)* of the flange part **63** is larger than the thickness (*t1*) of the plate shaped raw material **50.** Consequently, press molding the plate shaped raw material **50** makes it possible to obtain the flange part **63** of the desired thickness *(L3).*

[0080] If the cross sectional shape of a flange part **263** is a simple oblong (refer to **FIG. 10**) as in the conventional art, then, to ensure that thickness, the plate thickness of the plate shaped raw material must be of equal thickness, which makes press molding impossible; furthermore, even if press molding were possible, it would be impossible to avoid the increased cost of the press equipment and the increased time required to perform the pressing. However, in the case of the piping member **60,** which includes the step **67** as discussed above, the comparatively thin plate shaped raw material **50** can be press molded, making it possible to obtain the flange part **63** of the desired thickness *(L3).*

[0081] Thus, in the case of the piping member **60,** press molding makes it possible to integrally mold the cylindrical part **61** and the flange part **63,** which has the desired thickness *(L3).* Consequently, manufacturing time can be made shorter than that required to manufacture the piping member by conventional machining.

(5)

[0082] In the method of manufacturing the piping member **60** discussed above, in the preparatory process group (**S1-S3**), which is performed before the molding of the detailed shape of the flange part **63,** the third parts **(53b, 53c)** are created; in the process group **(S4-S6),** which molds the detailed shape of the flange part **63,** the step is formed in the third part **(53c);** and in the hole-making process **S7** and the process group (**S8-S10**), which is performed after the hole-making, the third parts **(53d,** ... **53f**), wherein the steps are formed, are finished into the shape that includes the final step. Thereby, it is possible to ensure the desired thickness (*L3*) of the flange part **63** while reducing the plate thickness (*t1*) of the plate

shaped raw material **50** to less than 2 mm (herein, 1.5 mm) and to reduce the cost of the press molding equipment.

(6)

[0083] In the method of manufacturing the piping member **60** discussed above, numerous press moldings are performed such that the radius of curvature *r4* of the surface of the bent part, which is bent at approximately 90°, is less than 0.5 mm. Consequently, it becomes possible to ensure that the length in the radial directions of a surface **63a,** namely, the portion of the flange part **63** that extends by a length *L2* from the upper end of the cylindrical part **61** outward in the radial directions, is large. Here, a length of the surface **63a** in the radial directions of 1 mm or greater, which is the thickness of the quick fastener **190,** is ensured. Accordingly, once the quick fastener **190** is fastened to the flange part **63** for the purpose of connecting with the piping **180,** the quick fastener **190** will not unfasten on its own.

(7)

[0084] In the method of manufacturing the piping member **60** discussed above, in the outer diameter removing process **S10,** the radial directions outer side portion **(55j),** which is the portion in the vicinity of the outer circumferential edge of the third part **(53j),** is cut off, and consequently the accuracy of the shape of the outer circumferential edge of the flange part **63** is increased.

(8)

[0085] In the method of manufacturing the piping member **60** discussed above, in the outer diameter removing process **S10**, when the material is cut at the step **(57j)** portion, consideration is given to ensuring that the thickness of the cut is large, and therefore the cut is made on the outer side of the step **(57j)** in the radial directions. Thereby, only the amount of the plate thickness (*t1*) of the plate shaped raw material **50** should be cut in the outer diameter removing process **S10**; furthermore, the size of the cutting apparatus and the cost of the equipment are prevented from increasing.

(9)

[0086] In the method of manufacturing the piping member **60** discussed above, a tip thin walled cylindrical part **262** (refer to **FIG. 10**), which becomes a welding part, is not molded by machining as in the conventional art; instead, in the first finishing drawing process **S8,** the piping member **60** is manufactured by press molding such that the step **(56h)** is created at the boundary between the first part (**51h**) and the second part **(52h).** Consequently, it becomes possible to manufacture the piping member **60** more inexpensively and faster than the piping member manufactured by conventional machining.

(10)

[0087] In the method of manufacturing the piping member **60** discussed above, in the process group (**S1-S6**), which is performed before the hole-making, the plate shaped raw material **50** is molded by press molding the cylindrical thick walled first part (**51f**) and the thin walled second part (**52f**), which is contiguous with and intersects the first part (**51f**); subsequently, in the hole-making process **S7** and in the process group (**S8-S10**), which is performed after the hole-making, the second part **(52g)** is molded into a cylindrical shape and the step **(56h)** is created at the boundary between the first part (**51h**) and the second part

(52h).

[0088] Furthermore, because a difference between the thickness (*t1*) of the first part (**51f**) and the thickness (*t2*) of the second part (**52f**) has already been created in the process group (**S1-S6**), which is performed before the hole-making, it is possible to easily produce the step **(56h)** in the process group (**S8-S10**), which is performed after the hole-making.

[0089] In addition, because the second parts **(52a,** ... **52e)** in the process group (**S1-S6**), which is performed before the hole-making, are orthogonal to the cylindrical first parts (**51a**, ... **51e**), reducing the thickness of the second parts **(52a,** ... **52e)** is easy when press molding is performed by moving the mold along the axial directions of the cylindrical first parts (**51a**, ... **51e**).

[0090] Thus, herein, in the process group (**S1-S6**), which is performed before the hole-making, the shape (i.e., the drinking glass shape) of the intermediate molding material is such that the second parts **(52a,** ... 52e) can easily be made thin walled; in addition, in the process group (**S8-S10**), which is performed after the hole-making, the second part **(52g)** is molded into a cylindrical shape and the step **(56h)** is created at the boundary between the first part (**51h**) and the second part **(52h);** thereby, the piping member is manufactured. Consequently, the piping member **60** can be manufactured by press molding with good yield and in a short time. Furthermore, because the piping member **60** can be manufactured by press molding, the manufacturing time is shorter than that of the piping member manufactured by conventional machining.

(11)

[0091] In the method of manufacturing the piping member **60** discussed above, the first drawing process **S1** molds the plate shaped raw material **50** into a drinking glass shape that comprises the cylindrical first part (**51a**) and the discoidal second part **(52a),** which closes one end of the first part (**51a**), and the subsequent wall thin-

ning process group (**S2-S6**) reduces the thickness of the second part **(52a).** Consequently, in the wall thinning process group **(S2-S6),** the mold contacts the surfaces both above and below the discoidal second parts **(52a,** ... **52e)** and thereby can apply force to the second part **(52a,** ... **52e)** in the plate thickness directions. Consequently, the second parts **(52a,** ... **52e)** can be made thin walled more easily and faster than in the method wherein the second part is first molded from its initial shape into a cylindrical shape and then made thin walled.

(12)

[0092] In the method of manufacturing the piping member **60** discussed above, in the hole-making process **S7,** the center portion of the second part (**52f**) is removed and, subsequently, the second part **(52g),** which is now annular, is molded into a cylindrical shape; consequently, the thin walled, cylindrical tip thin walled cylindrical part **62** can be formed more quickly and more accurately than in a method wherein the unnecessary portion is cut out after the discoidal second part is molded into a cylindrical shape.
In addition, after the first finishing drawing process **S8,** wherein the second part **(52g)** that is now annular is molded into a cylindrical shape, the second finishing drawing process **S9** is performed in order to apply compression force in the axial directions to the second part **(52h),** which is now cylindrical, thereby making it possible to finish the second part **(52h)** into the final shape of the tip thin walled cylindrical part **62** with good accuracy.

Claims

1. A method of manufacturing a cylindrical piping member **(60),** wherein one end becomes a welding part **(62)** that is welded to another member **(31),** comprising a step of:

using press molding to mold a plate shaped raw material **(50)** into a shape that includes a thick walled, cylindrical first part (**51h**) and a thin walled, cylindrical second part **(52h),** which is contiguous with the first part and becomes the welding part such that a step **(56h)** is created at the boundary between the first part and the second part.

2. A method of manufacturing a cylindrical piping member **(60),** wherein one end becomes a welding part **(62)** that is welded to another member **(31),** comprising:

a first step (**S1-S6**), which uses press molding to mold a plate shaped raw material **(50)** into a shape that includes a cylindrical thick walled first part (**51f**) and a thin walled second part (**52f**), which is contiguous and intersects with the first part and becomes the welding part; and
a second step **(S8),** which is performed after the first step, that uses press molding to mold the second part into a cylindrical shape and creates a step **(56h)** at the boundary between the first part and the second part.

3. A method of manufacturing a piping member according to claim 2, wherein
the first step comprises:

the first press molding process (**S1**), wherein the plate shaped raw material is molded such that the second part takes on a discoidal shape that closes one end of the cylindrical first part; and
the second press molding process (**S2-S6**), which reduces the thickness of the discoidal second part.

4. A method of manufacturing a piping member according to claim 3, wherein
the second step comprises:

the hole-making process **(S7),** which removes a center portion **(54g)** of the discoidal second part (**52f**); and
the third press molding process **(S8),** which molds the annular second part **(52g)** that has undergone the hole-making process into a cylindrical shape and
creates the step **(56h)** at the boundary between the first part and the second part.

5. A method of manufacturing a piping member according to claim 4, further comprising:

a third step **(S9),** which is performed after the third press molding process of the second step, that applies force that compresses the second part **(52h),** which has become cylindrical, in the axial directions and molds the second part into the final shape of the welding part.

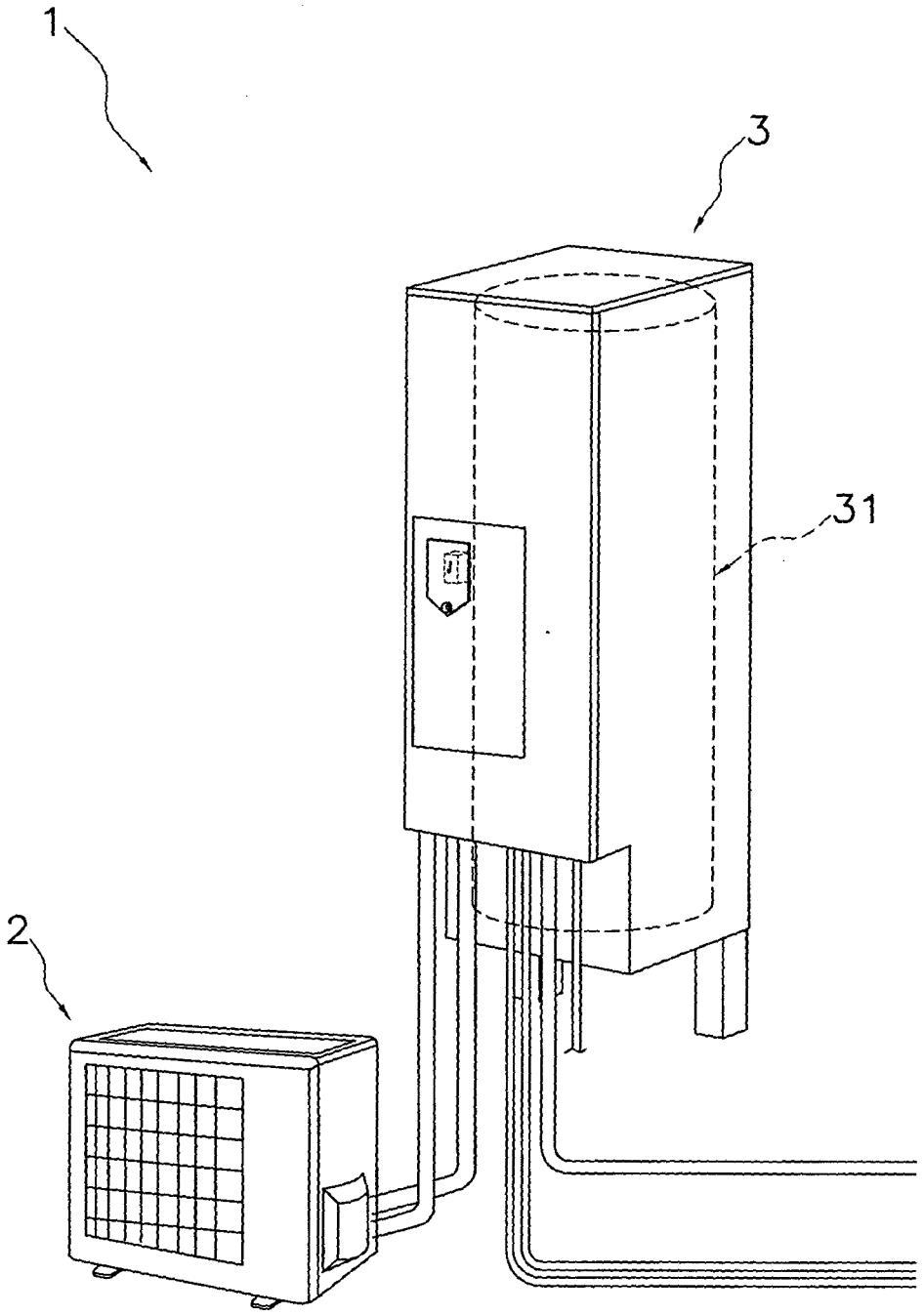


FIG. 1

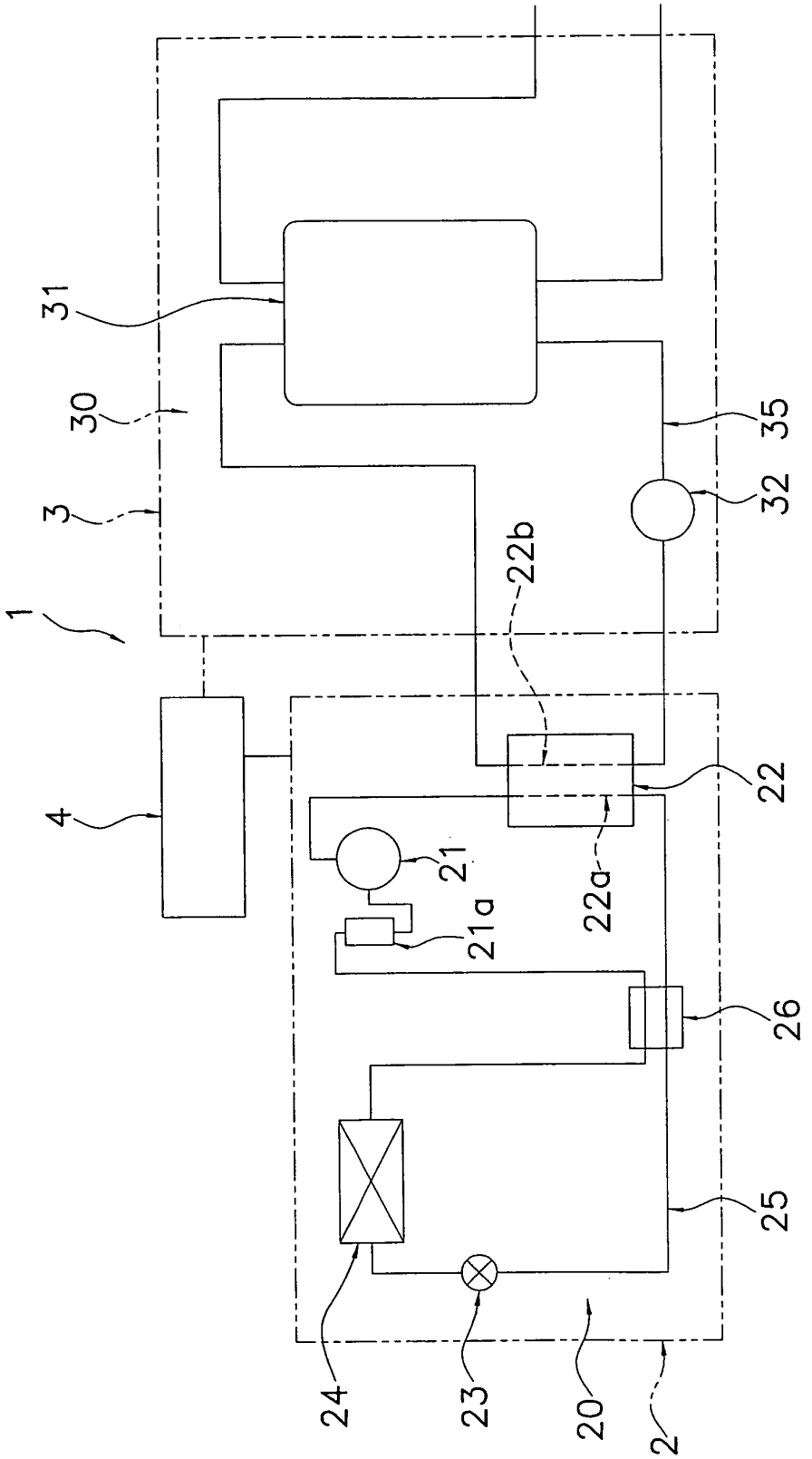


FIG. 2

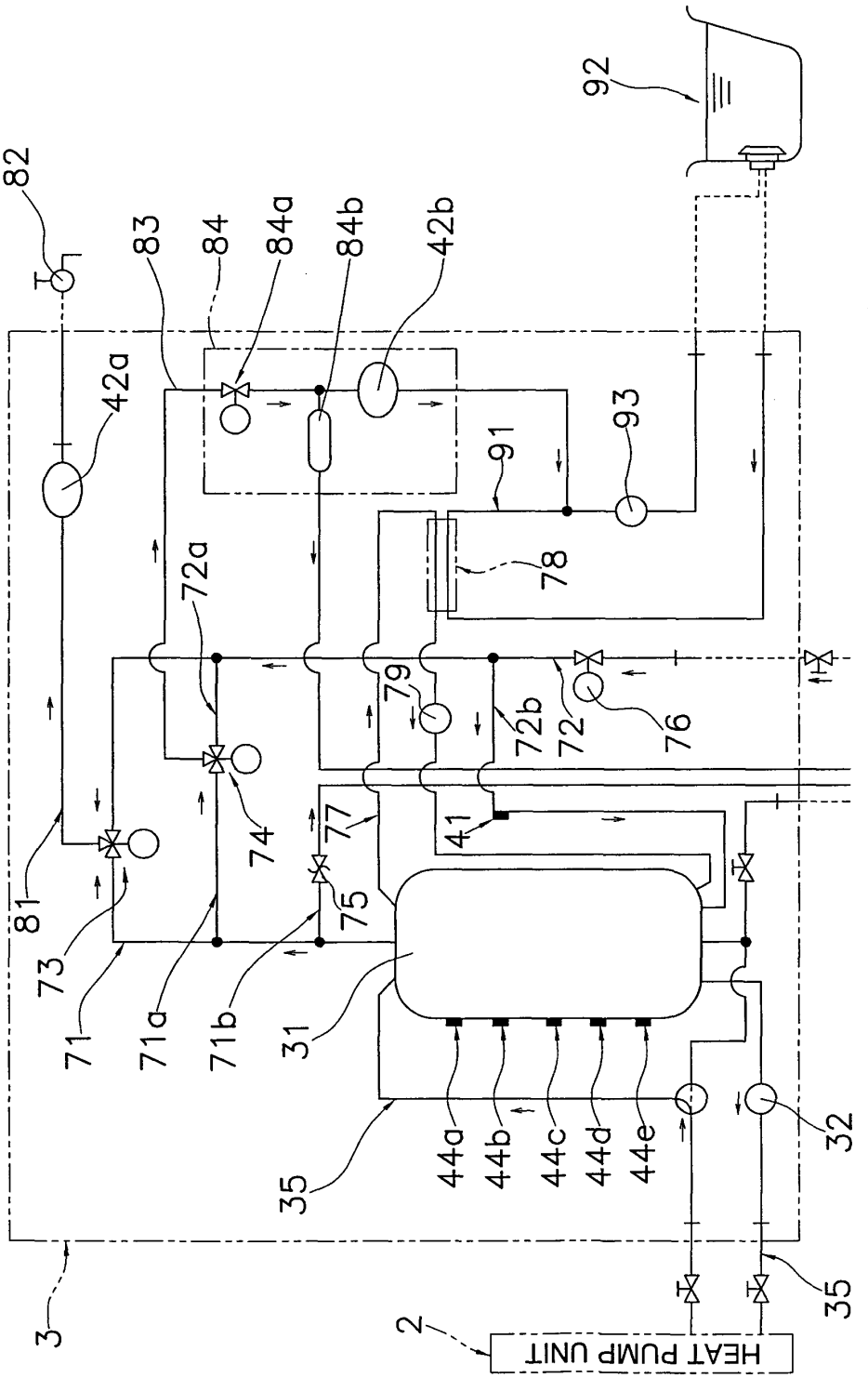

92
82
83
84
84a
84b
42b
42a
91
93
78
72a
79
72b
72
76
74
77
41
81
75
73
71
71a
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44a
44b
44c
44d
44e
32
35
35
3
2
HEAT PUMP UNIT

FIG. 3

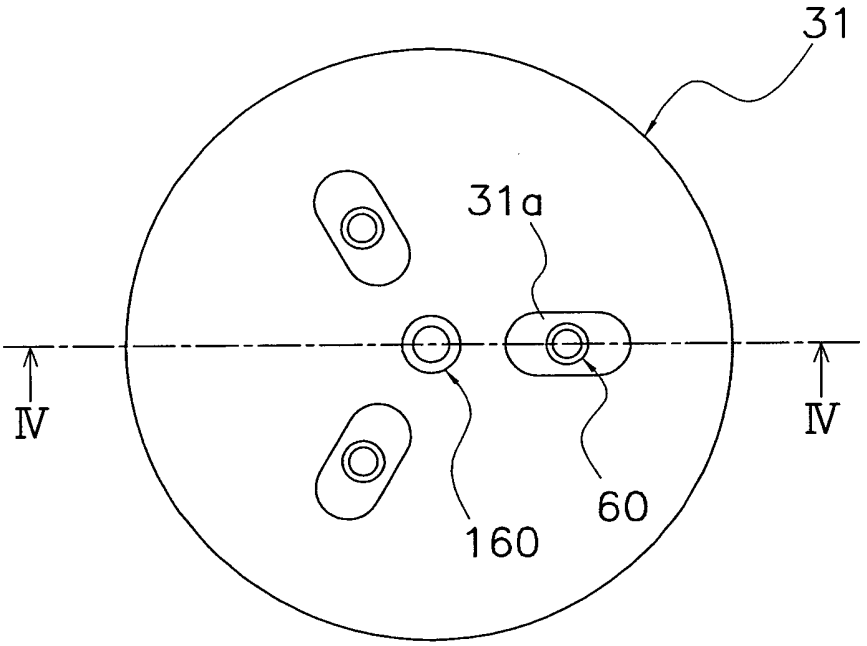


FIG. 4A

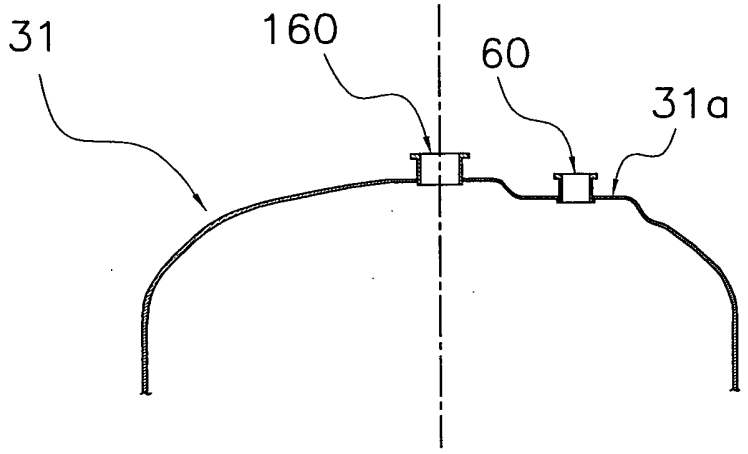


FIG. 4B

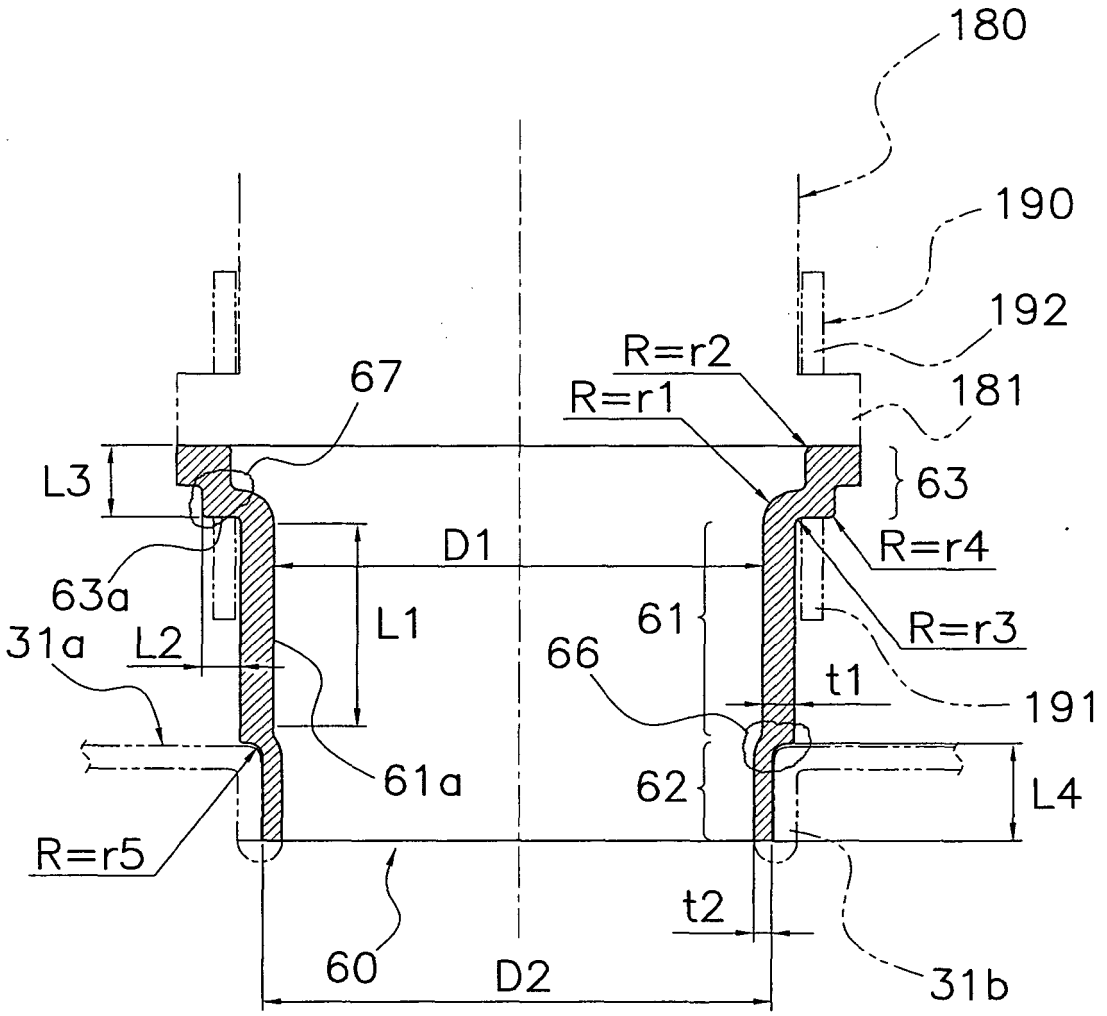

180
190
192
R=r2
R=r1
67
181
L3
63
D1
R=r4
63a
L1
61
R=r3
31a
L2
66
t1
191
61a
62
L4
R=r5
t2
60
D2
31b

FIG. 5

FIG. 6A

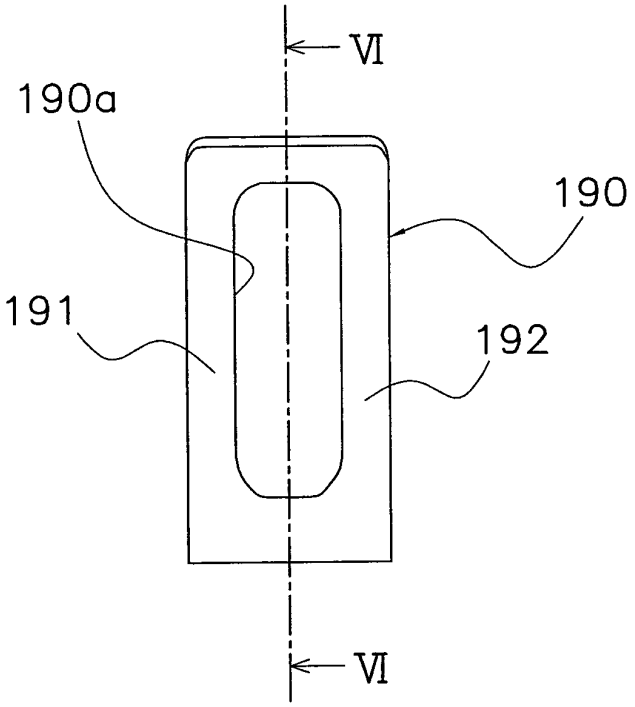
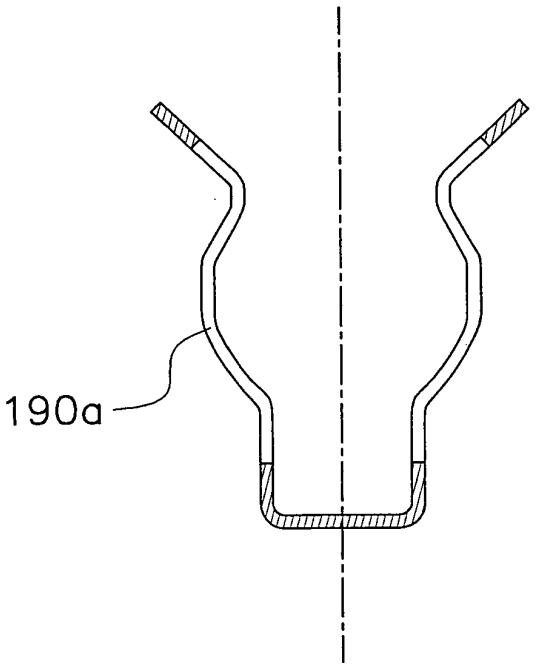


FIG. 6B



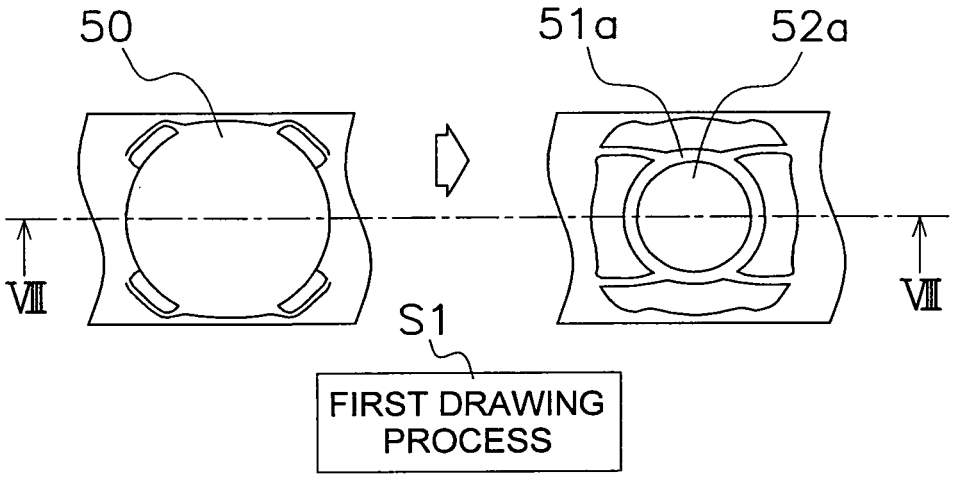


FIG. 7

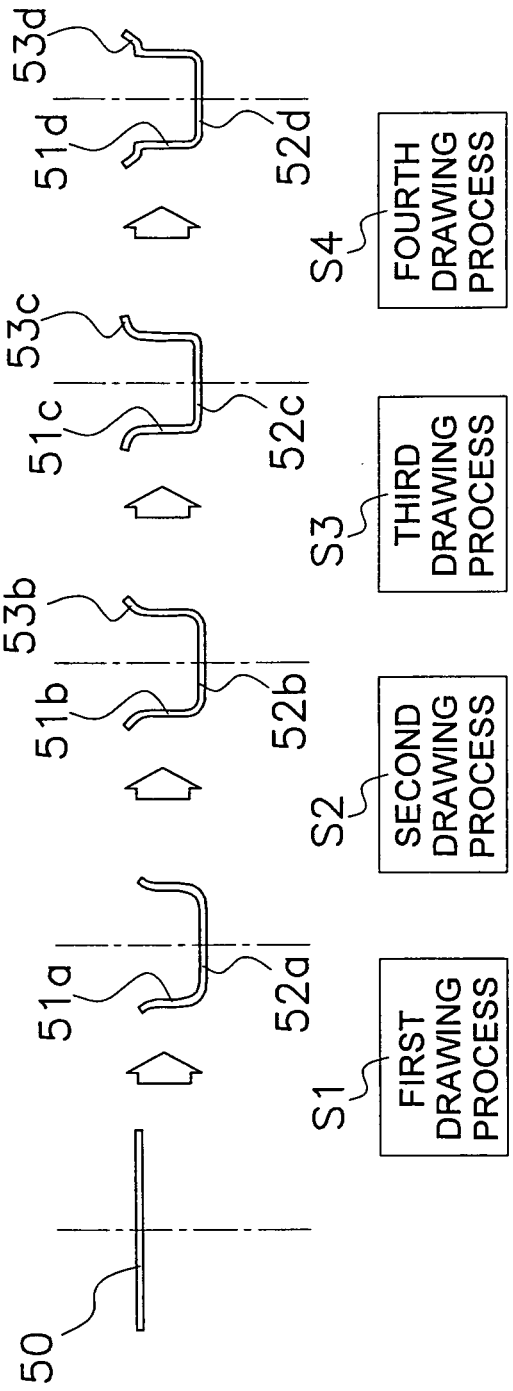

50
51a
52a
53b
51b
52b
53c
51c
52c
53d
51d
52d
S1
FIRST DRAWING PROCESS
S2
SECOND DRAWING PROCESS
S3
THIRD DRAWING PROCESS
S4
FOURTH DRAWING PROCESS

FIG. 8

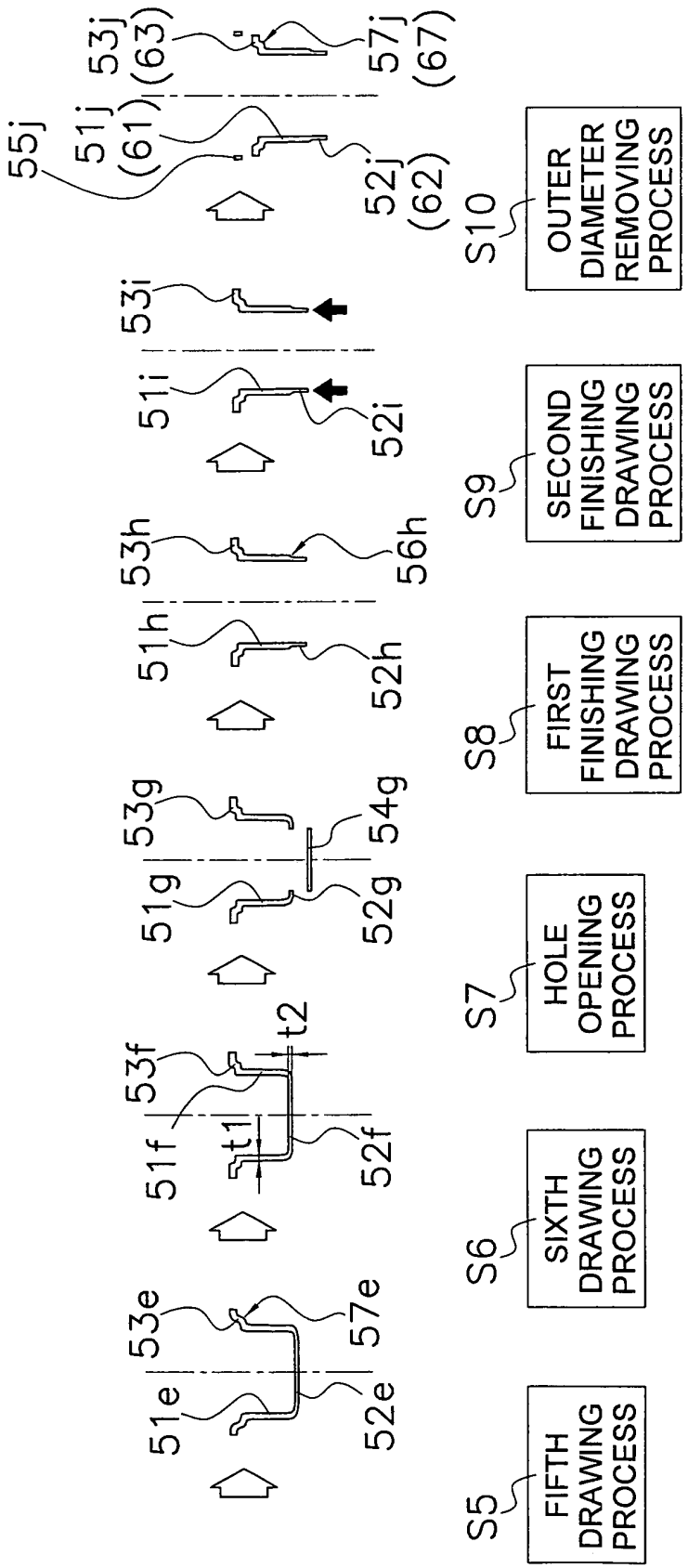

55j
51j
(61)
53j
(63)
57j
(67)
52j
(62)
S10
OUTER DIAMETER REMOVING PROCESS
53i
51i
52i
S9
SECOND FINISHING DRAWING PROCESS
53h
56h
51h
52h
S8
FIRST FINISHING DRAWING PROCESS
53g
54g
51g
52g
S7
HOLE OPENING PROCESS
t2
53f
51f
t1
52f
S6
SIXTH DRAWING PROCESS
53e
57e
51e
52e
S5
FIFTH DRAWING PROCESS

FIG. 9

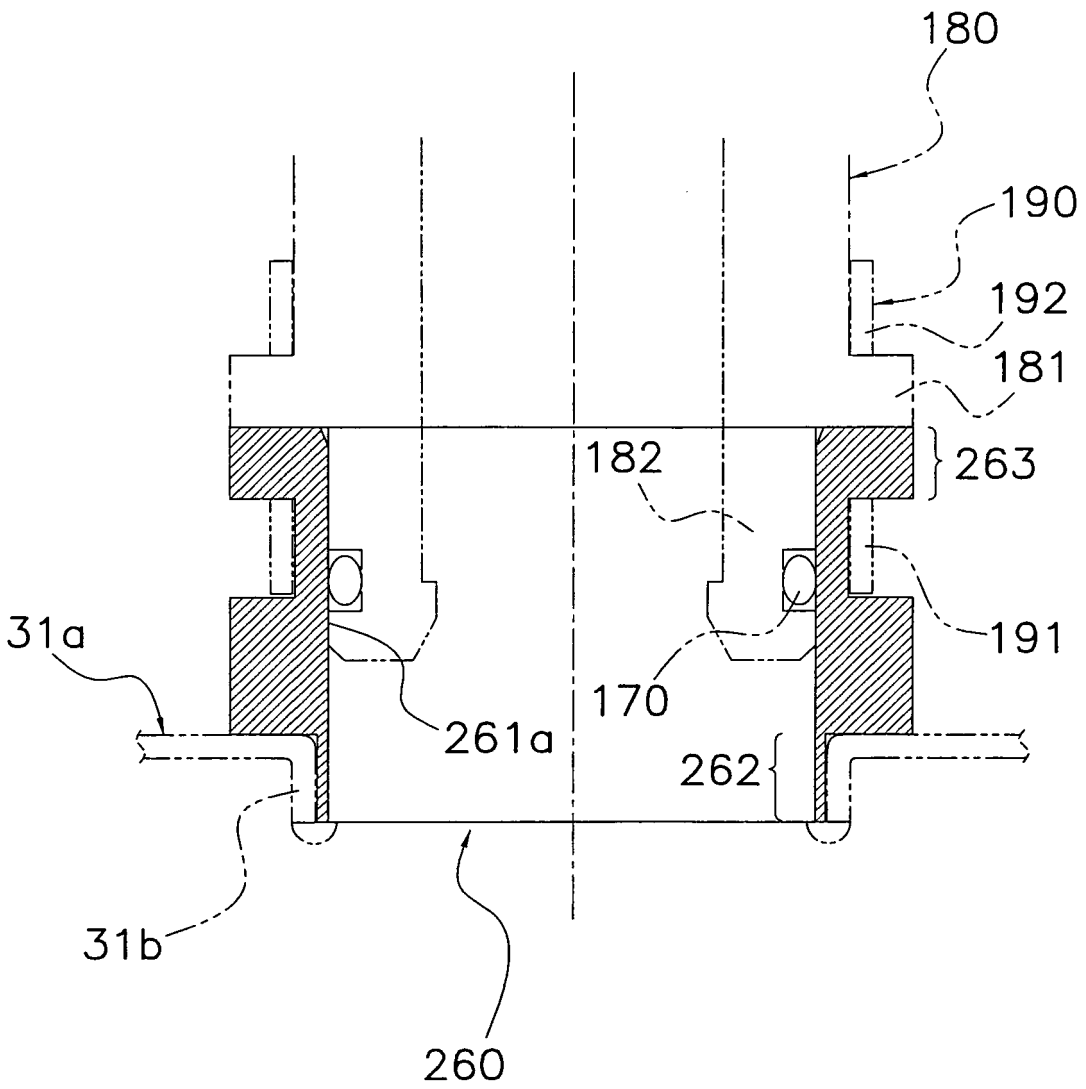


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/051684

A. CLASSIFICATION OF SUBJECT MATTER
B21D51/16(2006.01)i, ***B21D22/26***(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)
B21D51/16, B21D22/26

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.
Y	JP 2003-120466 A (Sanoh Industrial Co., Ltd.), 23 April, 2003 (23.04.03), Par. Nos. [0016] to [0018]; Figs. 4 to 8 (Family: none)	1-5
Y	JP 2003-184694 A (Usui Kokusai Sangyo Kaisha, Ltd.), 03 July, 2003 (03.07.03), Par. No. [0005] (Family: none)	1-5
Y	JP 4-46636 A (Toyota Motor Corp.), 17 February, 1992 (17.02.92), Fig. 3 (Family: none)	3-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 April, 2009 (03.04.09)	14 April, 2009 (14.04.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/051684

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 3-204123 A (Aida Engineering, Ltd.), 05 September, 1991 (05.09.91), Figs. 8, 9 (Family: none)	5 1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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