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(19) **United States**(12) **Patent Application Publication****Iida et al.**(10) **Pub. No.: US 2009/0071222 A1**(43) **Pub. Date: Mar. 19, 2009**(54) **METHOD OF BENDING PIPE MATERIAL****Publication Classification**

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(57) **ABSTRACT**

In a bending method of bending a pipe material of metal in pipe working, at first particles are fed into a flow passage of the pipe material, the particles being removable in a liquid phase. The pipe material with the particles is bent. The particles in an at least partially liquid phase are removed from the pipe material, to clean the flow passage. The particles are meltable, or soluble in dissolving liquid. Specifically, in the removing step, the dissolving liquid is supplied into the flow passage, the particles are dissolved in the dissolving liquid, and compressed air is blown in the flow passage to eject the fluid obtained by dissolving the particles in the dissolving liquid. The particles are granulated sugar, and the dissolving liquid is warmed water.

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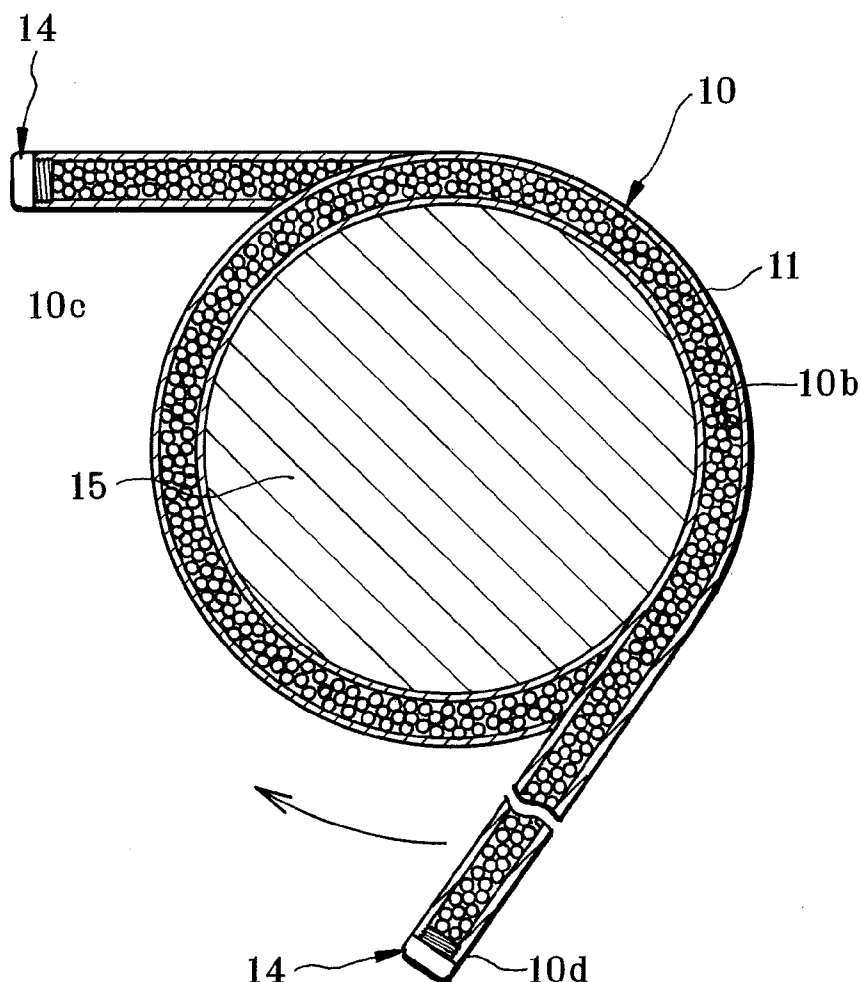


FIG. 1

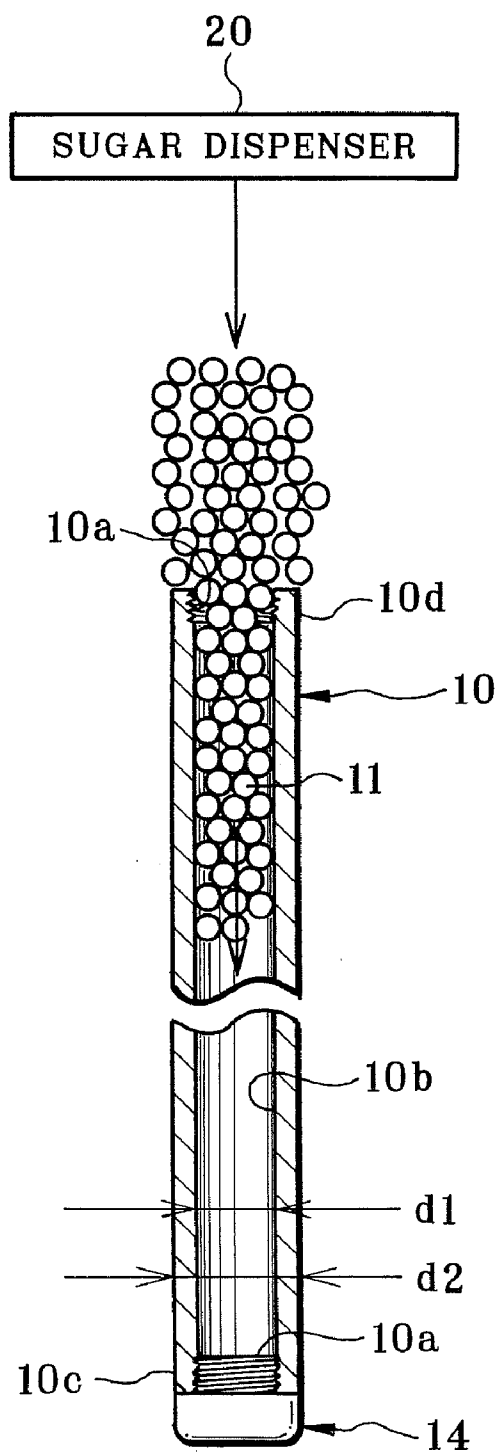


FIG. 2

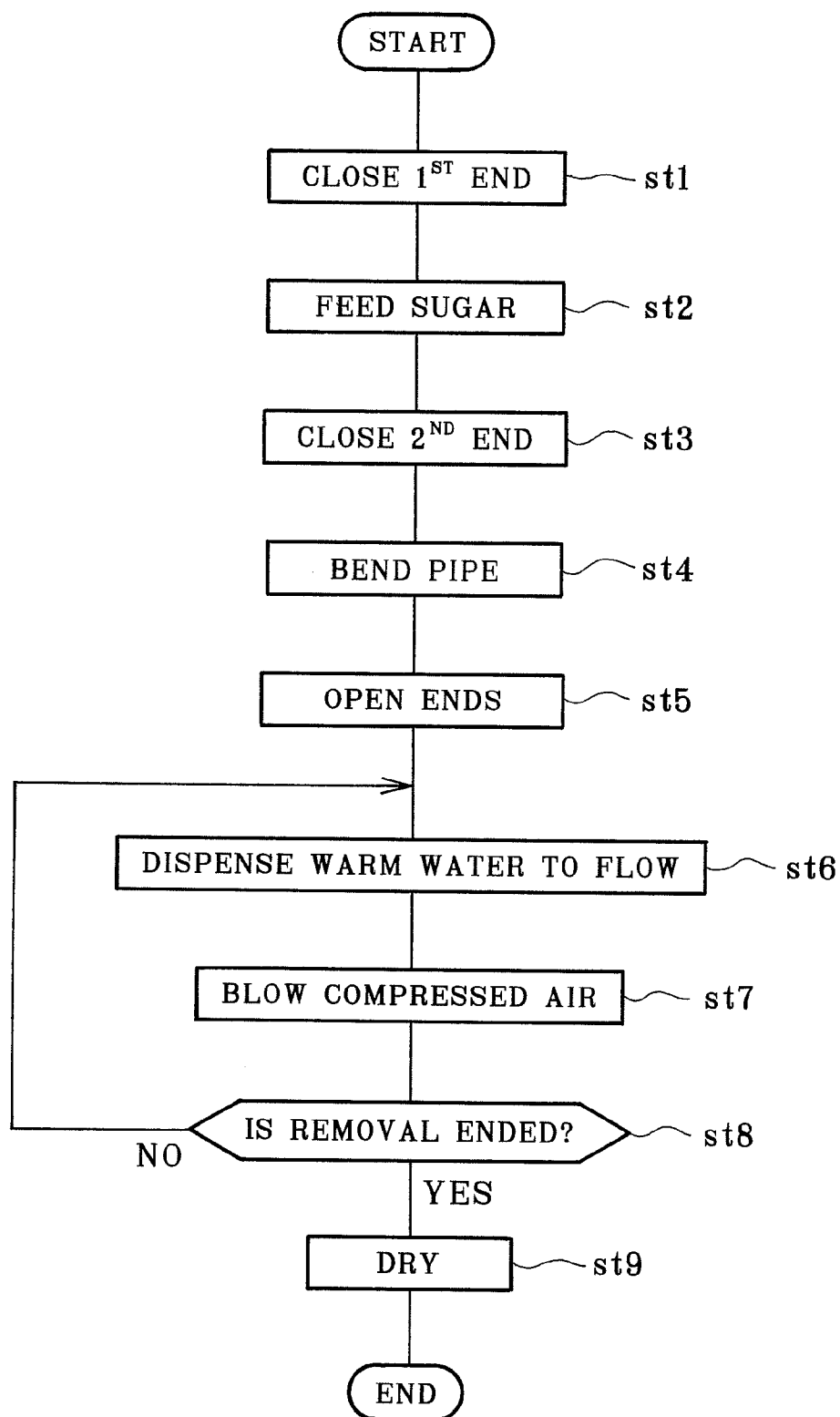


FIG. 3

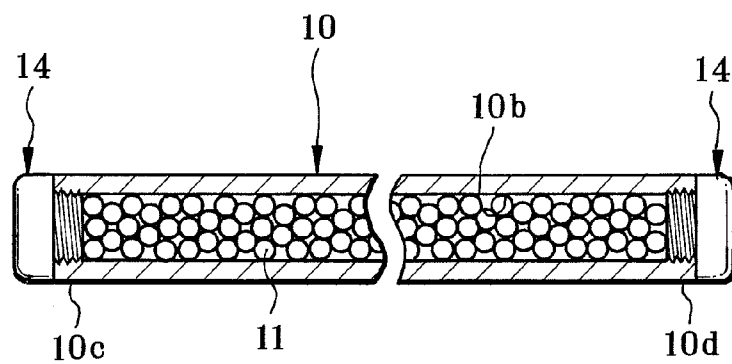


FIG. 4

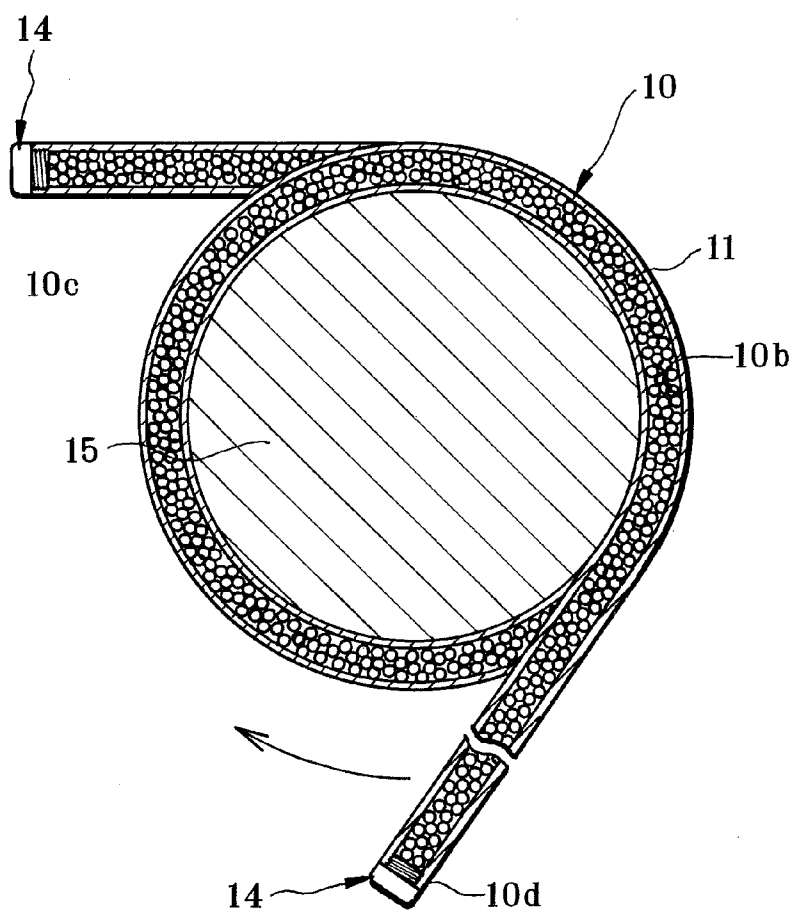


FIG. 5

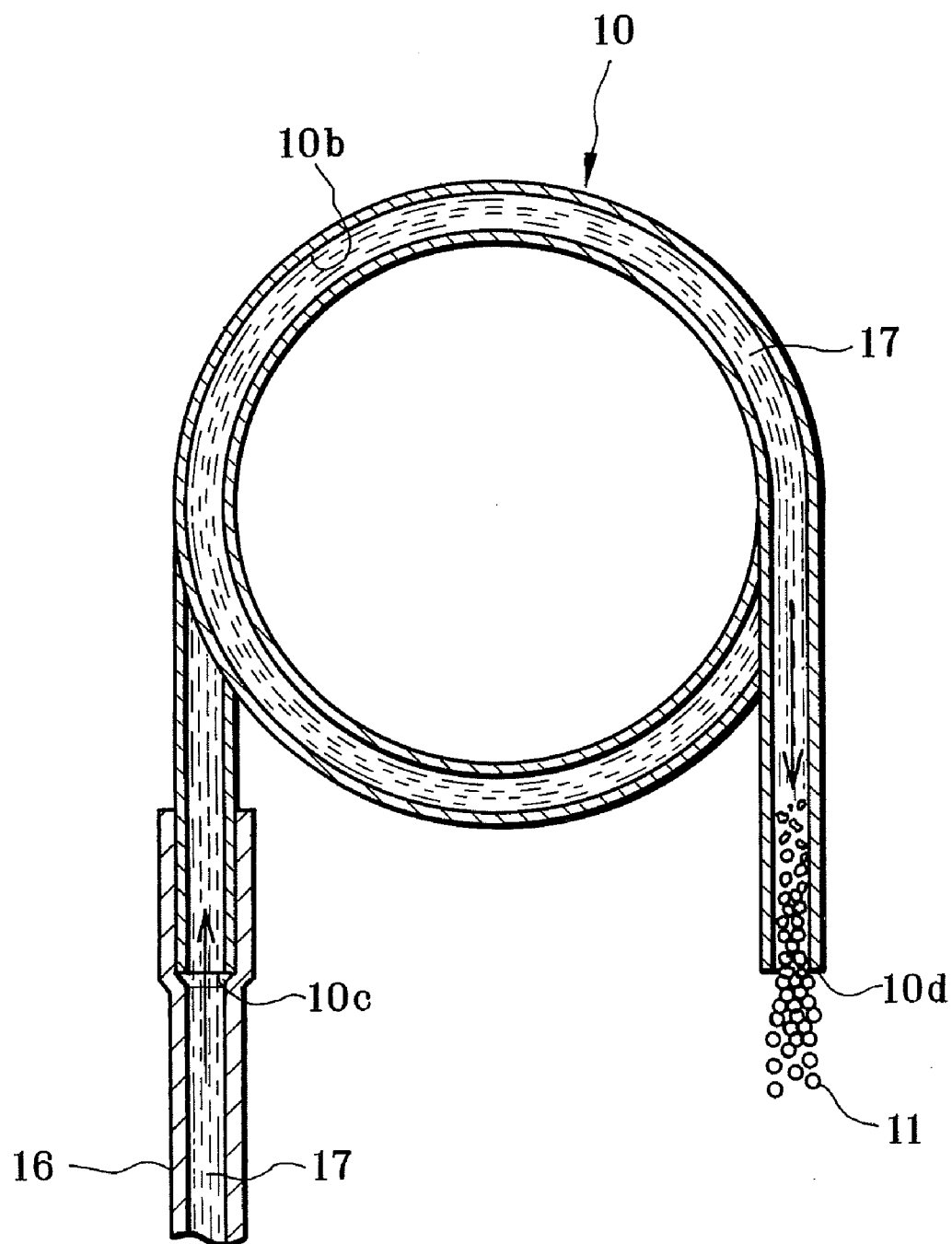
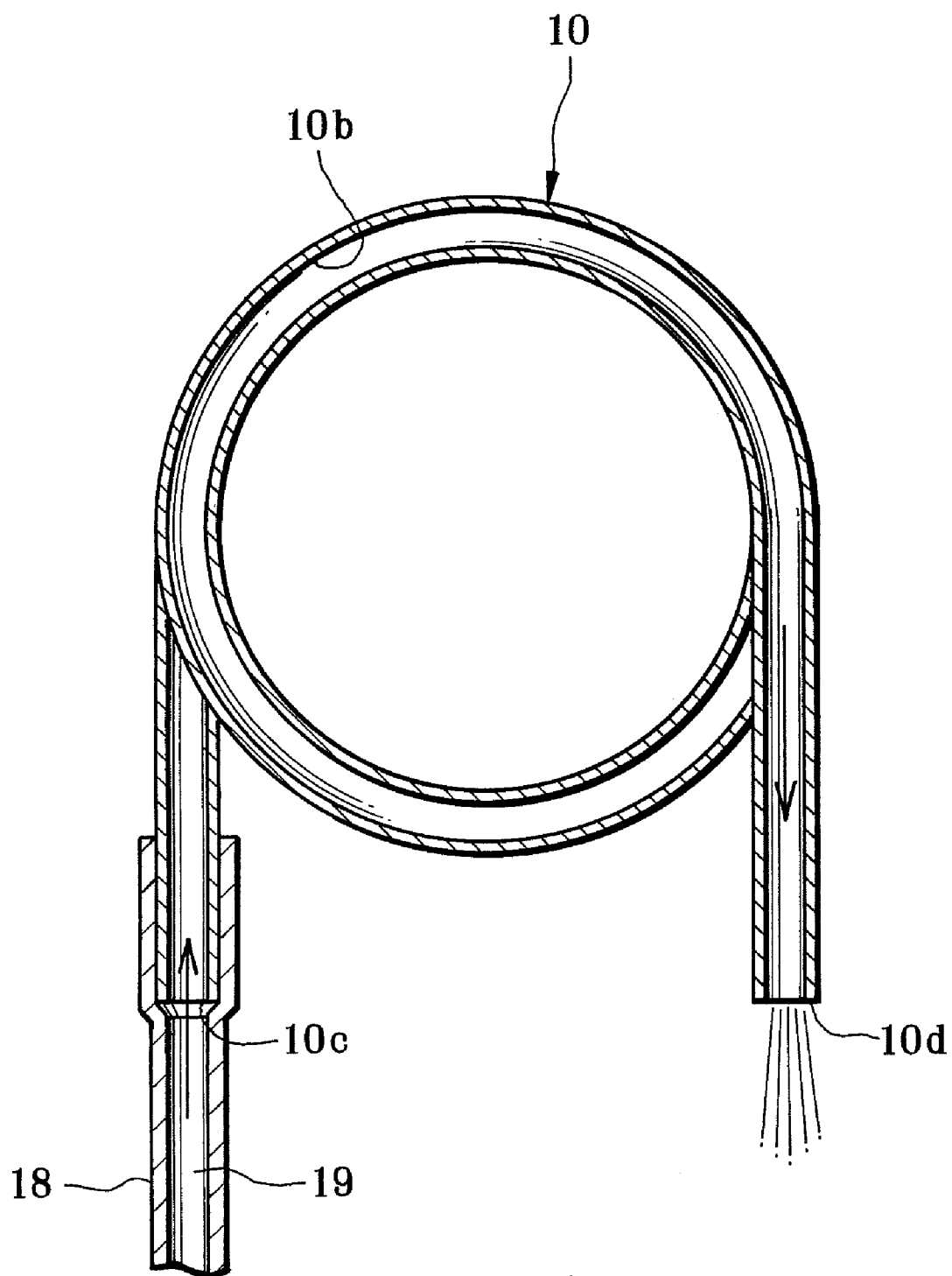


FIG. 6



METHOD OF BENDING PIPE MATERIAL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method of bending pipe material. More particularly, the present invention relates to a method of bending pipe material in which an inner surface of a flow passage of the pipe material can be free from wrinkles.

[0003] 2. Description Related to the Prior Art

[0004] A pipe material of metal is bent in a coil shape, arch shape or the like by bending operation in a working method, and is used for various purposes. An outer surface of the pipe material becomes deformed in an eccentric shape. On an inner surface of a flow passage of the pipe material, wrinkles are likely to occur. To prevent deformation of the pipe material as viewed in the cross section due to the bending operation, various methods are known. In one method, sand is filled in the flow passage of the pipe material, which is heated before bending. JP-A 58-009723 discloses a method in which gaseous nitrogen is filled in the pipe material, which is heated before bending.

[0005] In the method of filling sand before bending, there is a problem in difficulty in removal of sand from the pipe material. Even removal of sand is carried out after the bending operation, part of the sand is likely to remain in the pipe material. This is a problem particularly serious for the pipe material with as small a diameter as 1-10 mm.

[0006] In JP-A 58-009723, the inner pressure of the pipe material may change remarkably in the heating or bending operation owing to the use of the gaseous nitrogen or the like. However, nothing in the document suggests observation of changes in the inner pressure. Control of the inner pressure is too difficult and cannot be used, because of danger of breakage of the pipe material and possible problems inconsistent to the safety in the bending.

SUMMARY OF THE INVENTION

[0007] In view of the foregoing problems, an object of the present invention is to provide a method of bending pipe material in which an inner surface of a flow passage of the pipe material can be free from wrinkles.

[0008] In order to achieve the above and other objects and advantages of this invention, a bending method of bending a pipe material of metal includes a step of loading particles into a flow passage of the pipe material, the particles being processable in a liquid phase. The pipe material with the particles is bent. The particles in an at least partially liquid phase are removed from the pipe material.

[0009] The particles are meltable with heat, or soluble in dissolving liquid.

[0010] The pipe material has first and second end openings. Furthermore, there is a step of closing the first end opening of the pipe material before the loading step.

[0011] Furthermore, the second end opening is closed after the loading step.

[0012] Preferably, the pipe material has first and second end openings. Furthermore, the first and second end openings are closed before the bending step.

[0013] Furthermore, the first and second end openings are opened after the bending step.

[0014] In the removing step, the dissolving liquid is supplied into the flow passage to dissolve the particles.

[0015] In the removing step, the dissolving liquid is supplied into the flow passage, the particles are dissolved in the dissolving liquid, and compressed air is blown in the flow passage to eject fluid obtained by dissolving the particles in the dissolving liquid.

[0016] Supply of the dissolving liquid and blow of the compressed air are carried out alternately and repeatedly.

[0017] In the blow of the compressed air at a final time, the flow passage is dried.

[0018] The particles are granulated sugar or salt, and the dissolving liquid is water or warmed water.

[0019] In the removing step, the particles are melted with heat.

[0020] In the removing step, the pipe material is heated, and compressed air is blown in the flow passage to eject the fluid obtained by melting the particles.

[0021] Also, a bending system for bending a pipe material of metal is provided. A material dispenser loads particles into a flow passage of the pipe material, the particles being removable in a liquid phase. A shaping mold bends the pipe material with the particles. An ejector removes the particles in an at least partially liquid phase from the pipe material, to clean the flow passage.

[0022] The particles are meltable, or soluble in dissolving liquid.

[0023] Consequently, an inner surface of a flow passage of the pipe material can be free from wrinkles, because the pipe material is filled with particles at least partially for the purpose of safety in bending.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The above objects and advantages of the present invention will become more apparent from the following detailed description when read in connection with the accompanying drawings, in which:

[0025] FIG. 1 is an explanatory view in section illustrating a step of filling a pipe material with granulated sugar;

[0026] FIG. 2 is a flow chart illustrating a bending method;

[0027] FIG. 3 is an explanatory view in section illustrating the pipe material and caps for closing its ends;

[0028] FIG. 4 is an explanatory view in section illustrating bending of the pipe material;

[0029] FIG. 5 is a horizontal section illustrating ejection of granulated sugar from the pipe material;

[0030] FIG. 6 is a horizontal section illustrating blow of compressed air into the pipe material.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S) OF THE PRESENT INVENTION

[0031] In FIG. 1, a pipe material 10 to bend according to a working method of the invention is illustrated. A material of the pipe material 10 is copper. The pipe material 10 has an inner diameter d1 of 2-3 mm, and an outer diameter d2 of 3-5 mm. A female thread 10a is formed in an inner surface of each of the ends of the pipe material 10, and used for securing a cap which will be described later. Steps of the process of bending the pipe material 10 are illustrated in the flow of FIG. 2.

[0032] If the pipe material 10 is bent simply with a shaping mold, a flow passage 10b or inner space in the pipe material 10 will be made narrower by local collapse of the pipe material 10. In view of this, granulated sugar 11 is fed and filled in the flow passage 10b of the pipe material 10 as particles.

[0033] Before filling the pipe material 10 with the granulated sugar 11, a first end opening 10c of the pipe material 10 is closed by a cap 14 in helical engagement at the step st1. Then the granulated sugar 11 is fed by a sugar dispenser 20 or sugar charger through a second end opening 10d into the flow passage 10b of the pipe material 10. At the first end opening 10c, there is no clearance where air can escape because of the firm closing. However, the granulated sugar 11 can be filled in the flow passage 10b without difficulty at the step st2, because particles of the granulated sugar 11 are very fine with the grain property, and are low absorbent in relation to moisture. Note that the granulated sugar 11 is contained in the flow passage 10b nearly fully, but not packed therein with high tightness. Each particle of the granulated sugar 11 should be movable with degree of freedom so as to allow the bend of the pipe material 10 to be described later.

[0034] When the flow passage 10b of the pipe material 10 is filled with the granulated sugar 11, the cap 14 in FIG. 3 is engaged with the second end opening 10d helically for closing at the step st3. Thus, the granulated sugar 11 is kept enclosed between the end openings 10c and 10d in the course of bending the pipe material 10 to be described later.

[0035] In FIG. 4, a cylindrical shaping mold 15 as pipe bender for use in the bending step of the pipe material 10 is illustrated. The shaping mold 15 is formed from metal, ceramics or other materials, and has high rigidity. The pipe material 10 is pushed in contact with the surface of the shaping mold 15, and bent in a coil shape at the step st4 by winding operation. The granulated sugar 11 is contained in the flow passage 10b of the pipe material 10 with suitable tightness, so that the pipe material 10 can be bent without narrowing the flow passage 10b. No deformation occurs in the shape of a cross section of the pipe material 10. Note that the pipe material 10 can be warmed at a temperature slightly short of melting the granulated sugar 11 in the bending step. This is effective in facilitating the bend of the pipe material 10.

[0036] After completion of the bending step for the pipe material 10, the caps 14 are removed to open the end openings 10c and 10d at the step st5. Then in FIG. 5, a hose or conduit 16 as ejector is connected with the first end opening 10c of the pipe material 10. Warm water 17 as dissolving liquid is poured into the flow passage 10b of the pipe material 10 with temperature of 40 deg. C. or so at the step st6.

[0037] Although soluble in the warm water 17, the granulated sugar 11 does not dissolve abruptly inside the pipe material 10. When the warm water 17 starts being poured into the flow passage 10b of the pipe material 10 through the first end opening 10c, part of the granulated sugar 11 starts dissolving in the warm water 17 in the vicinity of the first end opening 10c. The warm water 17 penetrates between the inner surface of the flow passage 10b and peripheral part of the granulated sugar 11. The peripheral part of the granulated sugar 11 starts dissolving. The remaining part of the granulated sugar 11 comes to have smaller friction with the inner surface of the flow passage 10b. Thus pressure of the warm water 17 ejects the granulated sugar 11 through the second end opening 10d.

[0038] After the pipe material 10 is supplied with the warm water 17 for five (5) minutes as predetermined time, the supply of the warm water 17 is stopped. The hose 16 is detached from the first end opening 10c of the pipe material 10. In FIG. 6, a second hose or conduit 18 as ejector is connected with the first end opening 10c of the pipe material 10. Compressed air 19 is blown into the flow passage 10b of

the pipe material 10 at the step st7. The remainder of the granulated sugar 11 and sugar solution in the warm water 17 are ejected from the flow passage 10b.

[0039] After the compressed air 19 flows continuously for three (3) minutes, the second hose or conduit 18 is removed from the first end opening 10c of the pipe material 10. Then the hose or conduit 16 is connected with the first end opening 10c to pour the warm water 17 into the flow passage 10b at the step st6. At the lapse of predetermined time, supply of the warm water 17 is stopped. The second hose 18 is connected in place of the hose 16, to blow the compressed air 19 into the flow passage 10b of the pipe material 10 at the step st7. The remainder of the granulated sugar 11 in the flow passage 10b and aqueous sugar solution in the warm water 17 are removed completely from the flow passage 10b at the step st8.

[0040] Final flow of the compressed air 19 dries the flow passage 10b at the step st9. Thus, the sequence of bending the pipe material 10 is completed.

[0041] In the embodiment, the material of the pipe material 10 is copper. However, metals as material of the pipe material 10 may be aluminum, iron and other substances. The working method of the invention is advantageous particularly for pipes with a small diameter. Although the pipe material 10 has an inner diameter d1 of 2-3 mm, and an outer diameter d2 of 3-5 mm according to the embodiment, the size of the pipe material is not limited.

[0042] In the above embodiment, the pipe material is bent in a coil shape. However, the pipe material can be bent in other shape, for example, in the L shape.

[0043] In the above embodiment, the warm water 17 of 40 deg. C. is poured into the flow passage 10b of the pipe material 10. However, the temperature of the water as dissolving liquid for the granulated sugar 11 is not limited, and can be room temperature. For example, the water as dissolving liquid may be tap water, and underground water as industrial water, particularly in the season of summer.

[0044] In the embodiment, the granulated sugar is used. However, particles of other substances soluble in dissolving liquid can be used instead, for example, salt. Also, particles removable in a liquid phase may be particles soluble in oil, particles meltable with heat, and chemically soluble or chemically removable particles, in other words, particles of heat and/or solvent-liquefiable material. An example of particles meltable with heat is a thermoplastic bead. In a manner similar to the above embodiment, compressed air flows in the flow passage in the pipe material after dissolving particles, so as to eject the remainder of the particles and its solution in dissolving liquid. The use of the compressed air is the same also for the particles soluble in oil, chemically soluble or chemically removable particles, and the like.

[0045] In the above embodiment, each of the caps 14 is secured with threads by helical engagement. However, the caps 14 can have a tightly fittable structure without threads. Furthermore, each one of the end openings of the pipe material may be hammered for closing by deformation with a hammer or other tool. After closing of the end opening of the pipe material by hammering, the hammered end portion can be cut away before removing the granulated sugar 11.

[0046] In the above embodiment, compressed air is blown into the flow passage of the pipe material to remove remaining warm water and dry the flow passage. However, it is possible in the invention to dry the pipe material with heat in a drying chamber, or dry the same with natural drying after removing the granulated sugar.

[0047] In the above embodiment, the water and air are supplied in the direction reverse to that of feeding of the granulated sugar 11. However, the water can be supplied and compressed air can flow in the direction the same as that of the feeding of the granulated sugar 11 by entry through the second end opening 10d.

[0048] In the above embodiment, supply of the warm water and blow of the compressed air is repeated for two times. However, the repetition of supply and blow of those may be three, four, five or more times. Also, supply and blow of those may be one time if all the warm water and the compressed air is removed sufficiently. In the above embodiment, the time of supply of the warm water is 5 minutes. The time of blow of the compressed air is 3 minutes. However, the invention is not limited to those values.

[0049] Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A bending method of bending a pipe material of metal, comprising steps of:

loading particles into a flow passage of said pipe material, said particles being processable in a liquid phase; bending said pipe material with said particles; and removing said particles in an at least partially liquid phase from said pipe material.

2. A bending method as defined in claim 1, wherein said particles are meltable with heat, or soluble in dissolving liquid.

3. A bending method as defined in claim 2, wherein said pipe material has first and second end openings;

further comprising a step of closing said first end opening of said pipe material before said loading step.

4. A bending method as defined in claim 3, further comprising a step of closing said second end opening after said loading step.

5. A bending method as defined in claim 2, wherein said pipe material has first and second end openings;

further comprising a step of closing said first and second end openings after said loading step.

6. A bending method as defined in claim 5, further comprising a step of opening said first and second end openings after said bending step.

7. A bending method as defined in claim 2, wherein in said removing step, said dissolving liquid is supplied into said flow passage to dissolve said particles.

8. A bending method as defined in claim 7, wherein in said removing step, said dissolving liquid is supplied into said flow passage, and compressed air is blown in said flow passage to eject fluid obtained by dissolving said particles in said dissolving liquid.

9. A bending method as defined in claim 8, wherein supply of said dissolving liquid and blow of said compressed air are carried out alternately and repeatedly.

10. A bending method as defined in claim 9, wherein said flow passage is dried with said compressed air after said fluid is ejected.

11. A bending method as defined in claim 2, wherein said particles are granulated sugar or salt, and said dissolving liquid is water or warmed water.

12. A bending method as defined in claim 2, wherein in said removing step, said particles are melted with heat by heating said pipe.

13. A bending method as defined in claim 12, wherein in said removing step, said pipe material is heated, and compressed air is blown in said flow passage to eject said fluid obtained by melting said particles.

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