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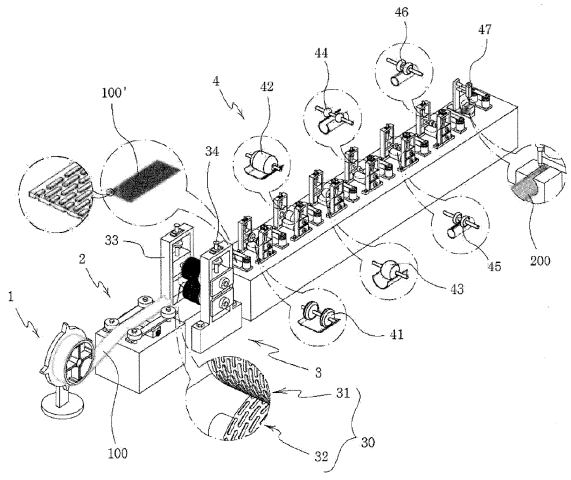
(54) EMBOSSED PIPE MANUFACTURING APPARATUS FOR EASILY WELDING BOTH SIDES OF EMBOSSED METAL SHEET AND EMBOSSED PIPE MANUFACTURING METHOD USING SAME

(57) Disclosed are an embossed pipe manufacturing apparatus including an uncoiler configured to provide a flat metal sheet, a centering guide roller configured to guide the flat metal sheet supplied from the uncoiler to an embossing machine located at the rear thereof, the embossing machine being configured to emboss the flat metal sheet supplied via the centering guide roller in order to form an embossed metal sheet, and a pipe mill configured to curve and round the embossed metal sheet supplied through the embossing machine in order to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction, the pipe mill also being configured to weld the weld seam portion of the embossed pipe manufactured as described above in order to complete the embossed pipe, and an embossed pipe manufacturing method including a first step of supplying a flat metal sheet to the embossing machine from the uncoiler via the centering guide roller, a second step of embossing the flat metal sheet using an embossing press roller of the embossing machine to form an embossed metal sheet, and a third step of supplying the embossed metal sheet to the pipe mill to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction through curving and rounding processes and welding the weld seam portion of the embossed pipe to complete the embossed pipe.

[Figure 1]



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Description

[Technical Field]

[0001] The present invention relates to an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet and an embossed pipe manufacturing method using the same, and more particularly to an embossed pipe manufacturing apparatus including an uncoiler configured to provide a flat metal sheet, a centering guide roller configured to guide the flat metal sheet supplied from the uncoiler to an embossing machine located at the rear thereof, the embossing machine being configured to emboss the flat metal sheet supplied via the centering guide roller in order to form an embossed metal sheet, and a pipe mill configured to curve and round the embossed metal sheet supplied through the embossing machine in order to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction, the pipe mill also being configured to weld the weld seam portion of the embossed pipe manufactured as described above in order to complete the embossed pipe, and an embossed pipe manufacturing method including a first step of supplying a flat metal sheet to the embossing machine from the uncoiler via the centering guide roller, a second step of embossing the flat metal sheet using an embossing press roller of the embossing machine to form an embossed metal sheet, and a third step of supplying the embossed metal sheet to the pipe mill to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction through curving and rounding processes and welding the weld seam portion of the embossed pipe to complete the embossed pipe, wherein a problem in that, in the case in which the embossed pipe is formed using the embossed metal sheet and then the seam portion is welded, welding is impossible due to mismatch of the seam portion due to a concave-convex curved surface is solved, whereby a scar of the seam portion is minimized, and at the same time the scar of the seam portion is prevented from being exposed outside, and therefore it is possible to provide an embossed pipe that is neatly finished.

[Background Art]

[0002] Metal pipes are classified into a metal pipe manufactured by extruding molten metal and a metal pipe manufactured by curving and rounding a flat metal sheet using a pipe mill to form a rounded pipe and welding opposite side surfaces of the rounded pipe in the state of being matched with each other in the longitudinal direction, in which case the metal pipe has a seam portion.

[0003] The former is a metal pipe that has a large thickness and exhibits high pressure resistance, which is used in large quantities for various purposes, such as a water supply pipe, a sewer pipe, a petroleum pipe, a high-pressure gas pipe, a liquid reactant feed pipe for chemical factories, an oil pipeline, and an electric pipe.

[0004] The latter, which is a metal pipe that has a relatively small thickness and thus has lower support force or rigidity than the metal pipe manufactured using the extrusion method, is mainly used for decorative purposes, such as an indoor handrail and a streetlamp post. In addition, the latter metal pipe does not match the former metal pipe in terms of purpose and demand.

[0005] Although the above metal pipes have been used for the purposes mentioned above, the purposes of the metal pipes have been diversified and demand for the metal pipes has increased due to improvement of metal pipe processing technology over the years.

[0006] In company with such a trend, demand for embossed pipes has increased together with improvement in processing technology in a technical field related to the embossed pipes.

[0007] As conventional embossed pipes, a metal pipe having a pattern formed on a smooth surface thereof by partially plating a colored metal, such as nickel, a pipe having a pattern formed by plasma ion deposition using titanium oxide, a pipe having a pattern formed using an etching method, and a metal pipe patterned and embossed through a mechanical cutting process have been brought to market.

[0008] Among processing technologies applied to the metal pipe, technologies well-known in the field of an embossed metal pipe related to the present invention will be described.

[0009] Korean Registered Patent No. 10-1611572 (registered on April 5, 2016) discloses an embossing technology entitled *PATTERN FORMING MACHINE FOR METAL PIPES,* wherein, when a plunger is moved rearwards, an inner die installed in a housing is pushed by the plunger and thus is moved toward the inner circumferential surface of a metal pipe, and a relief pattern formed on the outer circumferential surface of the inner die is engaged with an intaglio pattern formed on the inner circumferential surface of an outer die, whereby patterns are formed on the surfaces of the metal pipe located between the inner die and the outer die.

[0010] Korean Registered Patent No. 10-404895 (registered on October 28, 2003) discloses a method of forming embossed protrusions on a metal pipe entitled *EMBOSSED PROTRUSION FORMING APPARATUS FOR METAL PIPES,* wherein a movable fixing stand fixedly installed at the middle of a frame, left and right movable fixing stands fixedly installed at the frame, and first moving force generation members connected to the rear sides thereof are moved

inside a plurality of circular casings so as to be matched therewith in order to form a cylindrical casing having a plurality of circular casing through-holes, a metal pipe is inserted into the cylindrical casing and is fixed therein so as to be in tight contact therewith, a pipe-shaped core having punches mounted in a plurality of through-holes formed in the pipe-shaped circumferential surface thereof is inserted into the metal pipe and is fixed therein so as to be in tight contact therewith such that the casing through-holes formed in the inner surface of the cylindrical casing are matched with large-diameter core through-holes formed in the outer surface of the core, a plunger, which has a size equal to the inner diameter of the core, has a conical front end, and has a bar-shaped body, is inserted using strong pressure of a cylinder of a second moving force generation member such that lower-end bent portions of the punch large-diameter portions protruding inwards inside small-diameter through-holes pushed vertically upwards by the conical inclined surface of the front end of the plunger and thus punches of the dome-shaped large-diameter portions integrally formed with the small-diameter portions are also pushed upwards toward the casing through-holes formed in the inner surface of the casing, whereby the surface of the pipe are bent and protruded and thus a plurality of protrusions is formed on the pipe.

[0011] Korean Registered Patent No. 10-1399231 (registered on May 19, 2014) discloses an apparatus for forming circular recesses in a metal pipe entitled *PIPE EMBOSSING APPARATUS HAVING IMPROVED STRUCTURE,* wherein the apparatus includes a cylinder unit including cylinders configured to be operated by pneumatic pressure and pistons configured to be operated by the cylinders and embossing protrusions formed on the tips of the pistons, and the cylinders of the apparatus strike the embossing protrusions by pneumatic pressure at predetermined intervals based on the center line of the metal pipe in the vertical direction to form circular recesses on the metal pipe.

[0012] In the above conventional art, the pattern formed on the surface of the metal pipe is greatly deteriorated in terms of delicacy and sophistication, and a metal pipe having a smooth surface cut to a predetermined length is mounted in the manufacturing apparatus, an embossed pipe is manufactured through first to fifth steps or first to sixth steps and is then discharged from the manufacturing apparatus. Since embossed pipes are not continuously manufactured, productivity is low, and therefore mass production is impossible. Furthermore, production cost is high.

[0013] In addition, the embossed pattern of the metal pipe having circular recesses formed thereon is also neither delicate nor sophisticated, and is rather simple.

[0014] Besides, Korean Registered Patent No. 10-1017890 (registered on February 21, 2011) entitled *DIAMOND-SHAPED DIE ON OUTER CIRCUMFERENCE OF PIPE AND FORMING METHOD USING THE SAME* and Korean Registered Patent No. 10-1604011 (registered on March 10, 2016) entitled *PIPE BELLOWS FORMING APPARATUS* are disclosed as technologies related to an apparatus for embossing the outer circumferential surface of a pipe as described above.

[0015] As described above, embossed pipes that are currently used are manufactured by the above apparatus, rather than a pipe mill, and it is difficult to find examples of domestic and foreign production companies that manufacture embossed pipes using the pipe mill up to now.

[0016] When the present invention was embodied in order to manufacture an embossed pipe from a metal sheet having embossed opposite surfaces using a pipe mill that manufactures a circular metal pipe having a smooth surface from a flat metal sheet, several problems to be solved occurred.

[0017] In general, the thickness of a metal sheet, including a flat stainless steel sheet, to be embossed ranges from 0.5 mm to 5 mm. In the case in which the thickness of the metal sheet is greater than 5 mm, extraordinary power is needed, and only the shape of a pattern appears but delicate portions of the pattern do not appear when the metal sheet is embossed.

[0018] In the case in which the thickness of the metal sheet is less than 0.5 mm, a delicate pattern properly appears, but the thickness of the embossed pattern is too small, whereby the pressure resistance of the pattern is low. Although there is a difference depending on the embossing degree, the thickness of the pipe may be reduced by half in the case in which embossing is deeply performed. In this case, the thinned embossed pattern may fall down while passing through curving and rounding rollers of the pipe mill, or the embossed pattern is pushed in the direction opposite the advancing direction, whereby a defective pipe is manufactured.

[0019] Also, in the case in which a metal sheet, including a stainless steel sheet, is embossed using an intaglio-relief embossing roller capable of embossing opposite surfaces of the metal sheet, an embossed pattern is formed on the stainless steel sheet, and the ends of the embossed stainless steel sheet in the longitudinal direction or the lateral direction are curved. However, it is substantially impossible to weld the curved ends formed as described above in the state in which the curved ends are matched with each other.

[0020] Even in the case in which the opposite curved surfaces are matched with each other as the result of embossing performed using a precisely designed intaglio-relief embossing roller, the height of the embossed pattern may be changed while passing through a plurality of male-female engagement type curving rollers and symmetrical engagement type rounding rollers included in the pipe mill at the time of manufacture of the embossed pipe.

[0021] In particular, a difference in extension of the embossed stainless steel sheet in the longitudinal direction occurs due to imbalance in rolling of the engagement type rounding rollers and non-uniformity in shear force applied to the embossed stainless steel sheet in the longitudinal direction, whereby the curved surfaces are brought into contact with

each other in the state of deviating from each other in the height direction and the longitudinal direction due to the pattern. At the time of argon welding using the same material, therefore, gaps and pores are formed in the seam portion, whereby it is not possible to secure watertightness and airtightness. In addition, a weld scar is prominently formed on the surface of the pattern, whereby the product value of the embossed pipe is deteriorated.

[0022] Also, for metal pipes having embossed outer circumferential surfaces, the embossed pattern is simple and thus it is not possible to obtain a delicate and sophisticated embossed pattern, and metal pipes cut to a predetermined length are mounted in the apparatus one by one such that the outer circumferential surface of each of the metal pipes is embossed, which is very inefficient.

[0023] The present invention solves the above problems of the embossed metal pipe manufacturing apparatus and thus is capable of efficiently manufacturing an embossed pipe having a sophisticated and fine embossed pattern using the pipe mill.

[0024] A long time was required to successfully manufacture an embossed pipe from an embossed metal sheet using the pipe mill in connection with the present invention, and unexpected problems have occurred. The problems were solved one by one, and therefore a final embossed metal pipe was completed.

[0025] One of the problems is that, in the case in which a flat metal sheet passes through the pipe mill, high pressure from male-female engagement type curving rollers, which are installed horizontally and vertically, is applied to the metal sheet while the metal sheet passes between the male-female engagement type curving rollers, whereby the metal sheet is curved while being plastically deformed.

[0026] In contrast, an embossed metal sheet has an apparent volume equivalent to twice the thickness of a metal sheet before embossing due to formation of a concave-convex embossed pattern thereon.

[0027] As a concrete example, in the case in which metal sheets having thicknesses of 0.5 mm and 1 mm before embossing are used, the heights from the protruding portions of the embossed patterns to the bottom surfaces of the metal sheets after embossing become 1 mm and 2 mm, respectively, while defining a space therein. In the case in which an embossed metal pipe is manufactured using the embossed metal sheet, the embossed pattern has difficulty maintaining the original shape thereof and thus is distorted while the embossed metal sheet passes through the male-female engagement type curving rollers of the pipe mill. In order to solve this, it is necessary to accurately adjust the distance between the male-female engagement type curving rollers depending on the embossed degree.

[0028] Also, in the case in which the distance between the male-female engagement type curving rollers is small and thus pressure increases, the embossed pattern is excessively deformed, and at the same time the width of the embossed metal pipe is increased, whereby the sides of the embossed metal pipe may overlap each other in the symmetrical engagement type rounding rollers. In the case in which the distance between the male-female engagement type curving rollers is large, it is not possible to sufficiently curve the metal sheet.

[0029] Another problem is related to the seam portion formed at the embossed metal pipe in the longitudinal direction. That is, in the case in which the embossed pipe is manufactured from the embossed metal sheet using the pipe mill, it is substantially impossible to weld the seam portion formed at the embossed pipe in the longitudinal direction.

[0030] The above description may be summarized as follows.

[0031] When manufacturing the embossed pipe using the pipe mill, in the case in which the embossed metal sheet or the embossed metal band, embossed by the intaglio-relief engagement embossing roller having high dimensional stability, passes through the pipe mill, the embossed pattern of the embossed metal sheet, which is further thinned by embossing, is deformed and thus the height of the embossed pattern is changed while passing between the horizontal male-female engagement type curving rollers, each of which is made of a high-strength metal material, and between the horizontal and vertical symmetrical engagement type rounding rollers. In addition, there is a difference in length of the embossed pattern in the longitudinal direction due to the difference in pressing force and rotational shear force caused by engagement between the rollers in the longitudinal direction, whereby corresponding portions of the embossed pattern at the weld portion deviate from each other in the height direction and the longitudinal direction, and therefore welding is not possible.

[0032] Even in the case in which welding is performed, large numbers of gaps and micro-scale holes are formed in the weld seam portion, whereby it is not possible to secure watertightness and airtightness. In the case in which welding time is increased in order to remove the gaps and the holes, the weld material contaminates the surface of the embossed pattern, whereby the product value of the embossed pipe is lost.

[0033] The above problems are solved by an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet presented by the present invention and an embossed pipe manufacturing method using the same.

[Disclosure]

[Technical Problem]

[0034] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet, wherein the embossed pipe manufacturing apparatus is capable of preventing deformation of an embossed pattern due to distortion and shove of the embossed pattern that occur at the time of manufacture of an embossed pipe from an embossed metal sheet using an ordinary pipe mill, solving dimensional instability of the embossed metal sheet due to an increase in width thereof, solving a problem in that, in the case in which an embossed pipe is formed using an embossed metal sheet having a concave-convex curved surface formed as the result of an embossing process and then a seam portion is welded, welding is impossible due to mismatch of the seam portion due to the concave-convex curved surface, minimizing a scar of the seam portion and at the same time preventing the scar of the seam portion from being exposed outside, whereby it is possible to provide an embossed pipe that is neatly finished, and an embossed pipe manufacturing method using the same.

[0035] It is another object of the present invention to provide an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet, wherein the embossed pipe manufacturing apparatus is capable of preventing thinning of a seam portion and directly forming inclined surfaces using an embossing press roller, whereby it is possible to provide an embossed pipe having a delicate and sophisticated embossed pattern, and of maximizing productivity by coupling an intaglio-relief engagement type embossing press roller having a continuous repetition property to an ordinary pipe mill, and an embossed pipe manufacturing method using the same.

[Technical Solution]

[0036] In accordance with an aspect of the present invention, the above objects can be accomplished by the provision of an embossed pipe manufacturing apparatus using an embossed metal sheet, the embossed pipe manufacturing apparatus including an uncoiler configured to provide a flat metal sheet, a centering guide roller configured to guide the flat metal sheet supplied from the uncoiler to an embossing machine located at the rear thereof, the embossing machine being configured to emboss the flat metal sheet supplied via the centering guide roller in order to form an embossed metal sheet, and a pipe mill configured to curve and round the embossed metal sheet supplied through the embossing machine in order to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction, the pipe mill also being configured to weld the weld seam portion of the embossed pipe manufactured as described above in order to complete the embossed pipe, wherein the embossing machine includes an embossing press roller including an upper roller having a relief embossing pattern formed thereon and a lower roller having an intaglio embossing pattern formed thereon, the upper roller and the lower roller being configured to be rotated in the state of being engaged with each other, a frame unit defining the outer framework of the embossing machine, the frame unit being configured to support the embossing press roller, and a hydraulic cylinder installed at the upper end of the frame unit, wherein the upper roller includes a roller body, rotary shafts installed at the centers of opposite side surfaces of the roller body, a relief embossing pattern unit formed on the surface of the roller body, and first left and right ends formed along opposite side edges of the roller body so as to be lower than the relief embossing pattern unit, and wherein the lower roller includes a roller body, rotary shafts formed at the centers of opposite side surfaces of the roller body, an intaglio embossing pattern unit formed on the surface of the roller body, and second left and right ends formed along opposite side edges of the roller body so as to be higher than the intaglio embossing pattern unit.

[0037] In accordance with another aspect of the present invention, there is provided an embossed pipe manufacturing method using the manufacturing apparatus, the embossed pipe manufacturing method including a first step of supplying a flat metal sheet to the embossing machine from the uncoiler via the centering guide roller, a second step of embossing the flat metal sheet using the embossing press roller of the embossing machine to form an embossed metal sheet, and a third step of supplying the embossed metal sheet to the pipe mill to manufacture an embossed pipe having a weld seam portion formed in the longitudinal direction through curving and rounding processes and welding the weld seam portion of the embossed pipe to complete the embossed pipe, wherein the embossed metal sheet has an embossed structure formed on the outer surface thereof, small-width planes are formed at opposite side edges of the embossed metal sheet, opposite side surfaces of the embossed metal sheet are brought into contact with each other through the curving and rounding processes of the pipe mill, whereby the weld seam portion is formed so as to have a V-shaped groove, and the V-shaped groove is melted and fused by welding, whereby the embossed pipe is completed.

[Advantageous Effects]

[0038] An embossed pipe manufacturing apparatus using an embossed metal sheet according to the present invention

and an embossed pipe manufacturing method using the same have the following effects.

[0039] First, it is possible to prevent deformation of an embossed pattern due to distortion and shove of the embossed pattern that occur at the time of manufacture of an embossed pipe from an embossed metal sheet using an ordinary pipe mill.

[0040] Second, it is possible to solve dimensional instability of the embossed metal sheet due to an increase in width thereof and to solve a problem in that, in the case in which an embossed pipe is formed using an embossed metal sheet having a concave-convex curved surface formed as the result of an embossing process and then a seam portion is welded, welding is impossible due to mismatch of the seam portion due to the concave-convex curved surface, whereby it is possible to minimize a scar of the seam portion and at the same time to prevent the scar of the seam portion from being exposed outside, and therefore it is possible to provide an embossed pipe that is neatly finished.

[0041] Third, it is possible to directly form inclined surfaces using an embossing press roller, whereby it is possible to very neatly perform welding through a V-shaped groove formed in the weld seam portion as the result of opposite side surfaces of the embossed metal sheet being brought into contact with each other, and therefore it is possible to provide an embossed pipe having a delicate and sophisticated embossed pattern entirely formed thereon.

[0042] Fourth, it is possible to realize productivity five times or more as high as that of a conventional embossed pipe production apparatus by coupling an embossing machine including an intaglio-relief engagement type embossing press roller having a continuous repetition property to an ordinary pipe mill, whereby it is possible to maximize productivity.

[0043] Fifth, the present invention has advantages in that compression load of the embossed pipe is 40 to 50% higher than that of a conventional mechanical structural pipe and tensile load of the embossed pipe is 10 to 20% higher than that of the conventional mechanical structural pipe, whereby the mechanical properties of the embossed pipe are improved, and therefore it is possible to easily reduce the weight of the embossed pipe due to improvement of the mechanical properties of thereof.

[0044] Sixth, the present invention has advantages in that the embossed pipe exhibits improved durability, provides an aesthetically pleasing appearance, and has a hand slip prevention effect.

[0045] Seventh, it is possible to change the external appearance of the embossed pipe so as to have various patterns depending on market demand.

[0046] Eighth, it is possible to achieve temperature change (cooling and heat conservation) effects in a coolant and hot water piping system based on flow resistance of a fluid generated by a concave-convex structure formed in the pipe.

[Description of Drawings]

[0047]

FIG. 1 is an overall perspective view of an embossed pipe manufacturing apparatus according to the present invention.

FIG. 2 is a perspective view of a first embodiment of an embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 3 is a front view of the first embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 4 is a front view of a second embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 5 is a front view of a third embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 6 is a front view of a fourth embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 7 is a front view of a fifth embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 8 is a front view of a sixth embodiment of the embossing press roller constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 9 is a front view of an embossed metal sheet manufactured using the embossing press roller according to the first embodiment constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 10 is a front view of an embossed metal sheet manufactured using the embossing press roller according to the third embodiment constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 11 is a front view of an embossed metal sheet manufactured using the embossing press roller according to the fifth embodiment constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 12 is a front view of an embossed metal sheet manufactured using the embossing press roller according to the sixth embodiment constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 13 is a side sectional view of the embossed metal sheet manufactured using the embossing press roller

according to the sixth embodiment constituting the embossed pipe manufacturing apparatus according to the present invention.

FIG. 14 is a side sectional view schematically showing an embodiment of an embossed metal pipe manufactured using the embossed metal sheet according to the present invention before welding.

FIG. 15 is a side sectional view schematically showing the embodiment of the embossed metal pipe manufactured using the embossed metal sheet according to the present invention after welding.

FIG. 16 is a side sectional view showing another form of the embossed metal sheet according to the present invention.

FIG. 17 is a perspective view of an embossed metal pipe manufactured using the embossed metal sheet shown in FIG. 16.

FIG. 18 is a side sectional view showing various forms of a weld seam portion formed in the embossed metal pipe of FIG. 14.

FIG. 19 is a photograph showing actual products of the embossed metal pipe according to the present invention.

FIG. 20 is a view showing the shapes of samples before SUS304 PIPE (φ50.8 X 1.5T) tensile test.

FIG. 21 is a view showing the shapes of samples before SUS304 PIPE (φ38.1 X 1.1T) tensile test.

FIG. 22 is a view showing the shapes of samples before SUS304 PIPE (φ50.8 X 1.5T) compression test.

FIG. 23 is a view showing the shapes of samples before SUS304 PIPE (φ38.1 X 1.1T) compression test.

FIG. 24 is a view showing a tensile load test process.

FIG. 25 is a view showing a compressive load test process.

[Best Mode]

[0048] An embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet, the embossed pipe manufacturing apparatus including an uncoiler (1) configured to provide a flat metal sheet (100), a centering guide roller (2) configured to guide the flat metal sheet (100) supplied from the uncoiler (1) to an embossing machine (3) located at the rear thereof, the embossing machine (3) being configured to emboss the flat metal sheet (100) supplied via the centering guide roller (2) in order to form an embossed metal sheet (100'), and a pipe mill (4) configured to curve and round the embossed metal sheet (100') supplied through the embossing machine (3) in order to manufacture an embossed pipe (200) having a weld seam portion (201) formed in a longitudinal direction, the pipe mill also being configured to weld the weld seam portion (201) of the embossed pipe (200) in order to complete the embossed pipe (200), wherein the embossing machine (3) includes an embossing press roller (30) including an upper roller (31) having a relief embossing pattern formed thereon and a lower roller (32) having an intaglio embossing pattern formed thereon, the upper roller and the lower roller being configured to be rotated in the state of being engaged with each other, a frame unit (33) defining the outer framework of the embossing machine, the frame unit being configured to support the embossing press roller (30), and a hydraulic cylinder (34) installed at the upper end of the frame unit (33), wherein the upper roller (31) includes a roller body (311), rotary shafts (312) formed at the centers of opposite side surfaces of the roller body (311), a relief embossing pattern unit (313) formed on the surface of the roller body (311), and first left and right ends (315, 316) formed along opposite side edges of the roller body (311) so as to be lower than the relief embossing pattern unit (313), and wherein the lower roller (32) includes a roller body (321), rotary shafts (322) formed at the centers of opposite side surfaces of the roller body (321), an intaglio embossing pattern unit (323) formed on the surface of the roller body (321), and second left and right ends (325, 326) formed along opposite side edges of the roller body (321) so as to be higher than the intaglio embossing pattern unit (323).

[Mode for Invention]

[0049] Hereinafter, the technical construction of the present invention will be described in detail with reference to the drawings.

[0050] As shown in FIG. 1, an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet according to the present invention includes an uncoiler 1 configured to provide a flat metal sheet 100, a centering guide roller 2 configured to guide the flat metal sheet 100 supplied from the uncoiler 1 to an embossing machine 3 located at the rear thereof, the embossing machine 3 being configured to emboss the flat metal sheet 100 supplied via the centering guide roller 2 in order to form an embossed metal sheet 100', and a pipe mill 4 configured to curve and round the embossed metal sheet 100' supplied through the embossing machine 3 in order to manufacture an embossed pipe 200 having a weld seam portion 201 formed in the longitudinal direction, the pipe mill also being configured to weld the weld seam portion 201 of the embossed pipe 200 manufactured as described above in order to complete the embossed pipe 200. The embossing machine 3 includes an embossing press roller 30 including an upper roller 31 having a relief embossing pattern formed thereon and a lower roller 32 having an intaglio embossing pattern formed thereon, the upper roller and the lower roller being configured to be rotated in the state of being engaged with each other, a frame unit 33 defining the outer framework of the embossing machine, the frame unit being configured

to support the embossing press roller 30, and a hydraulic cylinder 34 installed at the upper end of the frame unit 33. The upper roller 31 includes a roller body 311, rotary shafts 312 formed at the centers of opposite side surfaces of the roller body 311, a relief embossing pattern unit 313 formed on the surface of the roller body 311, and first left and right ends 315 and 316 formed along opposite side edges of the roller body 311 so as to be lower than the relief embossing pattern unit 313. The lower roller 32 includes a roller body 321, rotary shafts 322 formed at the centers of opposite side surfaces of the roller body 321, an intaglio embossing pattern unit 323 formed on the surface of the roller body 321, and second left and right ends 325 and 326 formed along opposite side edges of the roller body 321 so as to be higher than the intaglio embossing pattern unit 323.

[0051] Any one selected from among a stainless steel sheet, an aluminum sheet, a brass sheet, a copper sheet, and a soft iron sheet is used as the flat metal sheet 100 wound around the uncoiler 1.

[0052] The stainless steel sheet has an advantage in that this sheet is superior to the other kinds of flat metal sheets 100 in terms of deterioration and rigidity.

[0053] Each of the aluminum sheet, the brass sheet, the copper sheet, and the soft iron sheet has advantages in that this sheet exhibits high malleability and ductility, is delicate, and is sophisticated, whereby this sheet has a higher embossing effect than the stainless steel sheet, and in that this sheet is easily worked and power consumption is low.

[0054] In the state of being wound around the uncoiler 1, the flat metal sheet 100 has a thickness ranging from 0.5 mm to 5 mm and a hardness ranging from 100 Hv to 550 Hv.

[0055] In the case in which the thickness of the flat metal sheet is less than 0.5 mm, the thickness of a relief embossed pattern formed through an embossing process is reduced to a range of 0.2 mm to 0.3 mm or less. As a result, the pressure resistance of the relief embossed pattern is reduced during a process in which the flat metal sheet passes through male and female curving rollers of the pipe mill, which are engaged with each other, whereby the embossed pattern is deformed flat. In the case in which the thickness of the flat metal sheet is greater than 5 mm, power consumption is abruptly increased in order to manufacture the embossed metal pipe through the embossing process and the curving and rounding process using the pipe mill, and furthermore the embossed pattern may not be properly formed. For these reasons, the thickness of the flat metal sheet 100 is preferably maintained within a range of 0.5 mm to 5 mm.

[0056] The hardness defined above is a numerical range within which the flat metal sheet is capable of withstanding the pressure of the rollers while passing through the pipe mill 4. Only in the case in which the hardness range suggested above is maintained, it is possible to curve the flat metal sheet without deformation of the embossed pattern and to prevent the embossed pattern from being cracked or ruptured by mechanical impact from the pipe mill 4 based on proper hardness thereof.

[0057] In particularly, among several kinds of flat metal sheets 100 described above, the stainless steel sheet is a soft sheet having a hardness ranging from 100 Hv to 250 Hv, and therefore it is possible to improve the embossing effect at the time of performing the embossing process using the embossing machine 3, whereby it is possible to form a delicate and sophisticated embossed pattern.

[0058] There is no difference between the width of the stainless steel sheet before being introduced into the embossing machine 3 and the width of the stainless steel sheet after being embossed by the embossing machine 3 and being discharged from the embossing machine.

[0059] After passing through the pipe mill 4, however, the width of the embossed stainless steel sheet is increased by 0.1 to 0.5% compared to the width of the embossed stainless steel sheet before passing through the pipe mill. The greater the unevenness due to embossing, the higher a width increase rate. In the case in which the unevenness is not great, therefore, the width increase rate of the embossed stainless steel sheet is reduced.

[0060] The embossed degree of the embossed stainless steel sheet is the length acquired by subtracting the thickness of the stainless steel sheet used in order to obtain the embossed stainless steel sheet from the height from the embossed bottom surface of the embossed stainless steel sheet to the upper end of the embossed pattern (hereinafter referred to as an "embossed degree").

[0061] In order to maximally emboss the stainless steel sheet, the stainless steel sheet may be embossed at an embossed degree equivalent to the thickness of the stainless steel sheet. As the embossed degree is increased, increment in width of the embossed stainless steel sheet in the pipe mill increases. As the embossed degree is decreased, increment in width of the embossed stainless steel sheet in the pipe mill decreases.

[0062] Since the width of the embossed stainless steel sheet corresponding to the inner diameter of the embossed metal pipe is set, it is preferable to use a stainless steel sheet having a width reduced within a range of 0.1 to 0.5% as the stainless steel sheet that is introduced into the embossing machine 3.

[0063] The embossing machine 3 embosses opposite surfaces of the flat metal sheet 100 supplied from the uncoiler 1 to manufacture the embossed metal sheet 100'.

[0064] The embossing press roller 30 constituting the embossing machine 3 may be classified into six embodiments depending on the shape and structure thereof, as shown in FIGS. 2 to 8.

[0065] The embossing press roller 30 shown in FIGS. 2 and 3 is the first embodiment.

[0066] The embossing press roller 30 includes an upper roller 31 including a roller body 311, rotary shafts 312 formed

at the centers of opposite side surfaces of the roller body 311, a relief embossing pattern unit 313 formed on the surface of the roller body 311, and first left and right ends 315 and 316 formed along opposite side edges of the roller body 311 so as to be lower than the relief embossing pattern unit 313, and a lower roller 32 including a roller body 321, rotary shafts 322 formed at the centers of opposite side surfaces of the roller body 321, an intaglio embossing pattern unit 323 formed on the surface of the roller body 321, and second left and right ends 325 and 326 formed along opposite side edges of the roller body 321 so as to be higher than the intaglio embossing pattern unit 323.

[0067] The upper roller 31 and the lower roller 32 according to the first embodiment are not provided with a band-shaped groove 314 configured to partition the relief embossing pattern unit 313 and a band-shaped protrusion 324 configured to partition the intaglio embossing pattern unit 323, respectively.

[0068] The upper roller 31 and the lower roller 32 according to the second embodiment shown in FIG. 4 are provided with a band-shaped groove 314 configured to partition the relief embossing pattern unit 313 and a band-shaped protrusion 324 configured to partition the intaglio embossing pattern unit 323, respectively.

[0069] The embossing press roller 30 according to the second embodiment includes an upper roller 31 including a roller body 311, rotary shafts 312 formed at the centers of opposite side surfaces of the roller body 311, a relief embossing pattern unit 313 formed on the surface of the roller body 311, a band-shaped groove 314 formed on the surface of the roller body 311 in the rotational direction of the roller so as to be lower than the relief embossing pattern unit 313 in order to partition the relief embossing pattern unit 313 at predetermined intervals, and first left and right ends 315 and 316 formed along opposite side edges of the roller body 311 so as to be lower than the relief embossing pattern unit 313, and a lower roller 32 including a roller body 321, rotary shafts 322 formed at the centers of opposite side surfaces of the roller body 321, an intaglio embossing pattern unit 323 formed on the surface of the roller body 321, a band-shaped protrusion 324 formed on the surface of the roller body 321 in the rotational direction of the roller so as to be higher than the intaglio embossing pattern unit 323 in order to partition the intaglio embossing pattern unit 323 at predetermined intervals, and second left and right ends 325 and 326 formed along opposite side edges of the roller body 321 so as to be higher than the intaglio embossing pattern unit 323. The protrusion 324 of the lower roller 32 is configured to be inserted into the groove 314 of the upper roller 31.

[0070] The embossing press roller 30 according to the third embodiment is different from the embossing press roller 30 according to each of the first and second embodiments in terms of the structure of opposite side ends of the roller body 311 of the upper roller 31. That is, left and right inclined surface formation portions 317 and 318 are formed at opposite side ends of the roller body 311 of the upper roller 31 constituting the embossing press roller 30 according to the third embodiment. FIG. 5 shows the embossing press roller 30 according to the third embodiment.

[0071] The embossing press roller 30 according to the third embodiment includes an upper roller 31 including a roller body 311, rotary shafts 312 formed at the centers of opposite side surfaces of the roller body 311, a relief embossing pattern unit 313 formed on the surface of the roller body 311, first left and right ends 315 and 316 formed along opposite side edges of the roller body 311 so as to be lower than the relief embossing pattern unit 313, and left and right inclined surface formation portions 317 and 318 extending outwards from the first left and right ends 315 and 316 in the lateral direction so as to be integrally formed therewith, the left and right inclined surface formation portions protruding outwards from points extending from the first left and right ends 315 and 316 in the oblique direction, the left and right inclined surface formation portions being rotated in the state of being engaged with second left and right ends 325 and 326 of a lower roller 32 to shape opposite side surfaces of the flat metal sheet 100 in the oblique direction, and a lower roller 32 including a roller body 321, rotary shafts 322 formed at the centers of opposite side surfaces of the roller body 321, an intaglio embossing pattern unit 323 formed on the surface of the roller body 321, and second left and right ends 325 and 326 formed along opposite side edges of the roller body 321 so as to be higher than the intaglio embossing pattern unit 323.

[0072] The upper roller 31 and the lower roller 32 according to the third embodiment are not provided with a band-shaped groove 314 configured to partition the relief embossing pattern unit 313 and a band-shaped protrusion 324 configured to partition the intaglio embossing pattern unit 323, respectively.

[0073] The upper roller 31 and the lower roller 32 according to the fourth embodiment shown in FIG. 6 are provided with a band-shaped groove 314 configured to partition the relief embossing pattern unit 313 and a band-shaped protrusion 324 configured to partition the intaglio embossing pattern unit 323, respectively.

[0074] The embossing press roller 30 according to the fourth embodiment includes an upper roller 31 including a roller body 311, rotary shafts 312 formed at the centers of opposite side surfaces of the roller body 311, a relief embossing pattern unit 313 formed on the surface of the roller body 311, a band-shaped groove 314 formed on the surface of the roller body 311 in the rotational direction of the roller so as to be lower than the relief embossing pattern unit 313 in order to partition the relief embossing pattern unit 313 at predetermined intervals, first left and right ends 315 and 316 formed along opposite side edges of the roller body 311 so as to be lower than the relief embossing pattern unit 313, and left and right inclined surface formation portions 317 and 318 extending outwards from the first left and right ends 315 and 316 in the lateral direction so as to be integrally formed therewith, the left and right inclined surface formation portions protruding outwards from points extending from the first left and right ends 315 and 316 in the oblique direction, the left

and right inclined surface formation portions being rotated in the state of being engaged with second left and right ends 325 and 326 of a lower roller 32 to shape opposite side surfaces of the flat metal sheet 100 in the oblique direction, and a lower roller 32 including a roller body 321, rotary shafts 322 formed at the centers of opposite side surfaces of the roller body 321, an intaglio embossing pattern unit 323 formed on the surface of the roller body 321, a band-shaped protrusion 324 formed on the surface of the roller body 321 in the rotational direction of the roller so as to be higher than the intaglio embossing pattern unit 323 in order to partition the intaglio embossing pattern unit 323 at predetermined intervals, and second left and right ends 325 and 326 formed along opposite side edges of the roller body 321 so as to be higher than the intaglio embossing pattern unit 323.

[0075] The embossing press roller 30 according to each of the fifth and sixth embodiments has an embossing pattern different from the embossing pattern of the embossing press roller 30 according to each of the first to fourth embodiments.

[0076] As shown in FIG. 7, the embossing press roller 30 according to the fifth embodiment has substantially the same structure as the embossing press roller 30 according to the second embodiment except for the embossing pattern.

[0077] As shown in FIG. 8, the embossing press roller 30 according to the sixth embodiment has substantially the same structure as the embossing press roller 30 according to the fourth embodiment except for the embossing pattern.

[0078] Hereinafter, the construction of the respective components of the embossing press roller 30 according to each of the first to sixth embodiments will be described in more detail.

[0079] The embossing press roller 30 is configured such that the upper roller 31 and the lower roller 32, each of which is made of a high-rigidity metal material, are rotated in the state of being engaged with each other.

[0080] A pattern constituting the relief embossing pattern unit 313 and a pattern constituting the intaglio embossing pattern unit 323 are formed on the surface of the upper roller 31 and the surface of the lower roller 32, respectively, and the relief embossing pattern unit 313 and the intaglio embossing pattern unit 323 are formed so as to be engaged with each other.

[0081] The pattern harmonizes with relief and intaglio volumes and thus has a direct influence on the aesthetics of the embossed metal sheet. The pattern may be selected depending on taste.

[0082] As concrete examples, each of the embossing pattern units 313 and 323 shown in FIGS. 2 to 6 has a long rectangular pattern with round ends, and each of the embossing pattern units 313 and 323 shown in FIGS. 7 and 8 has a pattern with a quadrangular pyramidal protrusion.

[0083] The embossing press roller 30 according to each of the first and third embodiments shown in FIGS. 2, 3, and 5 and the embossing press roller 30 according to each of the fifth and sixth embodiments shown in FIGS. 4 and 6 to 8 are different from each other in terms of whether the small-width band-shaped groove 314 and the small-width band-shaped protrusion 324 are formed on the upper roller 31 and the lower roller 32, respectively.

[0084] The band-shaped groove 314 and the band-shaped protrusion 324 are configured to be rotated in the state of being engaged with each other when the upper roller 31 and the lower roller 32 are rotated in the state in which the flat metal sheet 100 is interposed therebetween. That the band-shaped groove 314 and the band-shaped protrusion 324 are rotated in the state of being engaged with each other means that the band-shaped protrusion 324 pushes the metal sheet into the groove 314 during rotation thereof.

[0085] An embossing pattern is partitioned along the circumferential surface of each of the upper roller and the lower roller at predetermined intervals by a corresponding one of the small-width band-shaped groove 314 and the small-width band-shaped protrusion 324 formed as described above, and a decorative effect may be provided together with the embossing pattern by the small-width groove 314 partitioned as described above.

[0086] The embossing press roller 30 according to the present invention is characterized by the first left and right ends 315 and 316 and the second left and right ends 325 and 326 formed respectively at the opposite side ends of the upper roller 31 and the lower roller 32, as shown in FIGs. 2 to 10.

[0087] The first left and right ends 315 and 316 and the second left and right ends 325 and 326 are important in solving a welding problem that occurs at the time of manufacture of the embossed pipe 200 using the embossed metal sheet 100'.

[0088] That is, the first left and right ends 315 and 316 and the second left and right ends 325 and 326 formed at the opposite side ends of the embossing press roller 30 provide small-width planes to opposite side surfaces of the embossed metal sheet, whereby it is possible to solve a problem in that, at the time of manufacture of the embossed pipe using a conventional pipe mill configured to manufacture a smooth metal pipe, a concave-convex embossed pattern formed on the embossed metal sheet is deformed or welding is impossible due to mismatch of the concave-convex embossed pattern formed at the seam portion in the longitudinal direction.

[0089] In addition, the present invention is technically characterized by the inclined surfaces formed at the opposite side surfaces of the flat metal sheet 100 that is introduced into the embossing press roller 30 of the embossing machine 3.

[0090] In the case in which the flat metal sheet 100 is introduced into the embossing press roller 30, the inclined surfaces are formed at the flat metal sheet simultaneously with embossing of the flat metal sheet.

[0091] Even in the case in which no inclined surfaces are formed at opposite side surfaces of the flat metal sheet 100, small-width planes are formed at opposite side surfaces of the embossed metal sheet 100' by the first left and right ends 315 and 316 and the second left and right ends 325 and 326, as shown in FIGS. 9 and 11. Subsequently, when the

embossed metal sheet 100' formed as described above is curved and rounded by the pipe mill 4, opposite side surfaces of the embossed metal sheet 100' come into contact with each other, whereby a V-shape groove is naturally formed at the point at which opposite side surfaces of the embossed metal sheet are in contact with each other due to the difference between the inner diameter and the outer diameter of the rounded metal sheet. However, the width of the V-shape groove may be very small depending on the thickness of the flat metal sheet 100. In the case in which the inclined surfaces are formed, therefore, molten fusion is easily performed by welding, whereby it is possible to perform neat and strong welding.

[0092] As shown in FIGS. 10 and 12, the flat metal sheet 100 is introduced into the embossing press roller 30 in order to manufacture an embossed metal sheet 100' having inclined surfaces formed at opposite ends thereof.

[0093] The embossed metal sheet having the inclined surfaces formed at the opposite ends thereof manufactured through the above processes is shown in FIG. 13.

[0094] At this time, the flat metal sheet is embossed using the embossing press roller 30, and at the same time the inclined surfaces are formed at the opposite ends of the flat metal sheet by the provision of the left and right inclined surface formation portions 317 and 318 formed at the opposite side surfaces of the upper roller 31, as shown in FIGS. 10 and 12.

[0095] The angle $\theta 1$ between each of the left and right inclined surface formation portions 317 and 318 and a corresponding one of the first left and right ends 315 and 316 ranges from 110 to 135 degrees. The inclined surfaces formed at the opposite ends of the metal sheet by the left and right inclined surface formation portions 317 and 318 are brought into contact with each other to form a weld seam portion 201 having a V-shaped groove 201a. The interior angle $\theta 2$ of the V-shaped groove 201a ranges from 20 to 90 degrees.

[0096] After the inclined surfaces are formed at the opposite ends of the embossed metal sheet at the time of manufacture of the embossed metal sheet, as described above, the embossed metal sheet passes through a curving roller and a rounding roller of the pipe mill so as to be formed as a round pipe. At this time, the small-width inclined surfaces of the pipe are brought into contact with each other to form a small-width V-shaped groove 201a. The V-shaped groove 201a is melted and fused by welding using the same material, whereby a weld seam portion 201 identical to the groove 314 is formed. As a result, the weld seam portion 201 and the groove 314 form a kind of pattern, whereby aesthetics are improved in addition to the provision of the pattern.

[0097] Each of the groove 314 and the weld seam portion 201 has a small width, more specifically a width of 2.0 mm or less.

[0098] In order to maintain the widths of the groove 314 and the weld seam portion 201 equal to each other, the width L1 of each of the first left and right ends 315 and 316 formed at the opposite side ends of the upper roller 31 according to the present invention is set to 1/2 the width L2 of the groove 314.

[0099] That is, the sum of the width of the first left end 315 and the width of the first right end 316 is equal to the width of the groove 314.

[0100] FIGS. 14 and 15 are side sectional views schematically showing an embossed pipe 200 manufactured using the embossed metal sheet 100' according to the present invention before welding, wherein the weld seam portion 201 and the V-shaped groove 201a are mainly shown.

[0101] FIG. 14 is a side sectional view schematically showing the embossed pipe 200 before welding, and FIG. 15 shows the state in which the V-shaped groove 201a shown in FIG. 14 is melted and fused by welding.

[0102] In the case in which the embossed metal sheet 100' manufactured using the embossing press roller 30 of the embossing machine 3 according to the present invention is introduced into the pipe mill 4 to manufacture the embossed pipe 200, as shown in FIGS. 14 and 15, a weld seam portion 201 is formed at the embossed pipe 200 in the longitudinal direction, and a small-width V-shaped groove 201a is formed in the weld seam portion 201. The V-shaped groove 201a is melted and fused by welding using the same material, whereby a groove identical to a partition groove 200a formed in the circumferential surface of the embossed pipe 200 at predetermined intervals is formed.

[0103] As a result, the weld seam portion 201 formed at the embossed pipe 200 in the longitudinal direction is integrally connected to the embossed pipe through neat and sophisticated welding, and at the same time forms a seam groove identical to another partition groove 200a configured to partition the embossed pattern, whereby an aesthetically pleasing design is exhibited and thus a decorative effect is provided.

[0104] FIG. 16 is a side sectional view showing another form of the embossed metal sheet 100' according to the present invention, and FIG. 17 is a perspective view of an embossed pipe 200 manufactured using the embossed metal sheet 100' shown in FIG. 16.

[0105] As shown in FIGS. 16 and 17, the embossed metal sheet 100' according to the present invention and the embossed pipe 200 manufactured using the same may be manufactured in various forms within a range of the embossed pipe manufacturing apparatus and the embossed pipe manufacturing method presented by the present invention.

[0106] FIG. 18 shows that the weld seam portion 201 according to the embodiment shown in FIG. 14 may be modified in various forms. It is obvious that the weld seam portion 201 including the V-shaped groove 201a may have various other forms in addition to the forms shown in FIG. 18.

[0107] The pipe mill 4 is a device configured to complete the embossed pipe 200 through curving, rounding, and welding processes of the embossed metal sheet 100'.

[0108] Any pipe mill 4 that is well-known and commonly used may be used as the pipe mill 4. The present invention is characterized in that the embossing machine 3 presented by the present invention and the pipe mill 4 are sequentially installed to constitute an embossed pipe manufacturing apparatus, by which the embossed pipe 200 is manufactured from the embossed metal sheet 100', wherein deformation of the embossed pattern due to distortion and shove thereof, dimensional instability of the embossed metal sheet due to an increase in width thereof is solved, a problem in that, in the case in which an embossed pipe is formed using the embossed metal sheet having a concave-convex curved surface formed as the result of the embossing process and then a seam portion is welded, welding is impossible due to mismatch of the seam portion due to the concave-convex curved surface is solved, whereby a scar of the seam portion is minimized, and at the same time the scar of the seam portion is prevented from being exposed outside, and therefore it is possible to provide an embossed pipe 200 that is neatly finished.

[0109] As shown in FIG. 1, the pipe mill 4 manufactures an embossed pipe through a curving process using a first curving roller 41, a second curving roller 42, and a third curving roller 43, and a rounding process using a first rounding roller 44, a second rounding roller 45, and a third rounding roller 46. At this time, a seam portion 201 is formed at the completed embossed pipe in the longitudinal direction, and a V-shaped groove 201a' is formed in the middle of the inside of the seam portion 201.

[0110] Next, the V-shaped groove 201a' is melted and fused using a welding device 47, whereby the embossed pipe 200 according to the present invention is completed.

[0111] Hereinafter, an embossed pipe manufacturing method using the embossed pipe manufacturing apparatus according to the present invention will be described.

[0112] The embossed pipe manufacturing method according to the present invention includes a first step of supplying a flat metal sheet 100 to the embossing machine 3 from the uncoiler 1 via the centering guide roller 2, a second step of embossing the flat metal sheet 100 using the embossing press roller 30 of the embossing machine 3 to form an embossed metal sheet 100', and a third step of supplying the embossed metal sheet 100' to the pipe mill 4 to manufacture an embossed pipe 200 having a weld seam portion 201 formed in the longitudinal direction through curving and rounding processes and welding the weld seam portion 201 of the embossed pipe 200 to complete the embossed pipe 200, wherein the embossed metal sheet 100' has an embossed structure formed on the outer surface thereof, small-width planes are formed at opposite side edges of the embossed metal sheet, opposite side surfaces of the embossed metal sheet 100' are brought into contact with each other through the curving and rounding processes of the pipe mill 4, whereby the weld seam portion 201 is formed so as to have a V-shaped groove 201a, and the V-shaped groove 201a is melted and fused by welding, whereby the embossed pipe 200 is completed.

[0113] At this time, any one that is selected from among a stainless steel sheet, an aluminum sheet, a brass sheet, a copper sheet, and a soft iron sheet and that has a thickness ranging from 0.5 mm to 5 mm and a hardness ranging from 100 Hv to 550 Hv is used as the flat metal sheet 100. The reason that the thickness and the hardness are defined so as to be within the above ranges has been previously described.

[0114] The flat metal sheet 100 is embossed by the embossing press roller 30 of the embossing machine 3, whereby an embossed metal sheet 100' is formed. At this time, a plane having a predetermined width is formed at each of the opposite side ends of the embossed metal sheet 100'. As a result, a V-shaped groove 201a is formed in a weld seam portion 201 formed at the time of manufacture of an embossed pipe, whereby welding is easily and neatly performed.

[0115] The embossed metal sheet 100' is introduced into the pipe mill 4, and sequentially passes through the first curving roller 41, the second curving roller 42, and the third curving roller 43 constituting the pipe mill 4, whereby the embossed metal sheet is curved. Subsequently, the curved metal sheet sequentially passes through the first rounding roller 44, the second rounding roller 45, and the third rounding roller 46, whereby the curved metal sheet is rounded and thus an embossed pipe is formed.

[0116] At this time, a seam portion 201 is formed at the embossed pipe completed through the rounding process in the longitudinal direction, and a V-shaped groove 201a' is formed in the middle of the inside of the seam portion 201.

[0117] Next, the V-shaped groove 201a' is melted and fused using the welding device 47, whereby the embossed pipe 200 according to the present invention is completed.

[0118] In addition, inwardly inclined surfaces are formed at opposite side surfaces of the embossed metal sheet 100'. In the case in which no inclined surfaces are formed, the width of the V-shaped groove 201a formed as the result of opposite side surfaces of the embossed metal sheet 100' being brought into contact with each other is reduced in the case in which the thickness of the embossed metal sheet 100' is too small, whereby welding may not be easily performed. In the case in which the inclined surfaces are formed, the V-shaped groove 201a is widely formed so as to have a predetermined width or more as the result of opposite side surfaces of the embossed metal sheet 100' being brought into contact with each other, whereby welding is easily performed and thus neat and strong welding is possible.

[0119] FIG. 19 is a photograph showing actual products of the embossed pipe according to the present invention. Hereinafter, tensile load and compressive load of the embossed pipe according to the present invention will be described.

[0120] Tensile and compression load tests of the embossed pipe 200 (SUS304 PIPE) manufactured according to the present invention were performed by Korea Testing & Research Institute (Test No. TBP-000041, Sample Description: Metal test pieces (SUS304 PIPE)), and the results thereof are as follows.

[Test Example 1]

1. Samples

[0121] Samples of the embossed pipe 200 (SUS304 PIPE) are shown in FIGS. 20 to 23. Test Examples 1 to 3 according to the present invention and Comparative Examples 1 to 3 were used as the samples. The samples were classified based on the outer diameter and shape thereof, as shown in Table 1 below.

[Table 1]

Classification of samples		
Classification of Samples	Sample description	Test items
SUS304 PIPE (φ50.8 X 1.5T)	Test Example 1	Tensile Load and Compression Load
	Test Example 2	Tensile Load and Compression Load
	Test Example 3	Tensile Load and Compression Load
	Comparative Example 1 (B Company)	Tensile Load and Compression Load
	Comparative Example 2 (J Company)	Tensile Load and Compression Load
	Comparative Example 3 (K Company)	Tensile Load and Compression Load
SUS304 PIPE (φ38.1 X 1.1T)	Test Example 1	Tensile Load and Compression Load
	Test Example 2	Tensile Load and Compression Load
	Test Example 3	Tensile Load and Compression Load
	Comparative Example 1 (B Company)	Tensile Load and Compression Load
	Comparative Example 2 (J Company)	Tensile Load and Compression Load
	Comparative Example 3 (K Company)	Tensile Load and Compression Load

2. Test conditions and methods

[0122] Tensile and compression load tests of the samples of the embossed pipe 200 (SUS304 PIPE) were performed, as shown in Table 2 below.

[Table 2]

Test methods		
Test Items	Test methods	Test standards
Tensile Load	- Test speed: 10 mm/min	KS B 5541: 1985
Compression Load	- Test speed: 10 mm/min - SUS304 PIPE (φ50.8 X 1.5T): Measurement of compression load at time of displacement of 20 mm - SUS304 PIPE (φ38.1 X 1.1T): Measurement of compression load at time of displacement of 15 mm	KS B 5541: 1985

3. Test results

1) Test processes

[0123] FIG. 24 shows a tensile load test process, and FIG. 25 shows a compressive load test process.

2) Test results

[0124] Tensile and compressive load test results are shown in Table 3 below.

[Table 3]

Tensile and compressive loads			
Classification of Samples	Sample description	Tensile load (kN)	Compressive load (N)
SUS304 PIPE (φ50.8 X 1.5T)	Test Example 1	174.8	6307
	Test Example 2	177.7	6587
	Test Example 3	179.6	6419
	Comparative Example 1 (B Company)	157.6	5439
	Comparative Example 2 (J Company)	167.1	4873
	Comparative Example 3 (K Company)	157.6	4617
SUS304 PIPE (φ38.1 X 1.1T)	Test Example 1	98.5	4292
	Test Example 2	100.3	4310
	Test Example 3	103.7	5208
	Comparative Example 1 (B Company)	89.0	3266
	Comparative Example 2 (J Company)	90.0	3668
	Comparative Example 3 (K Company)	88.3	3237

[0125] It can be seen from the compressive load (N) test results that the embossed pipe according to the present invention is 40 to 50% stronger than conventional structural pipes (Comparative Examples 1 to 3). Also, it can be seen from the tensile load (kN) test results that the embossed pipe according to the present invention is 10 to 20% stronger than the conventional structural pipes (Comparative Examples 1 to 3) .

[Industrial Applicability]

[0126] In an embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet according to the present invention and an embossed pipe manufacturing method using the same, dimensional instability of the embossed metal sheet due to an increase in width thereof is solved, a problem in that, in the case in which an embossed pipe is formed using the embossed metal sheet having a concave-convex curved surface formed as the result of an embossing process and then a seam portion is welded, welding is impossible due to mismatch of the seam portion due to the concave-convex curved surface is solved, whereby a scar of the seam portion is minimized, and at the same time the scar of the seam portion is prevented from being exposed outside, and therefore it is possible to provide an embossed pipe that is neatly finished.

[0127] An embossing machine presented by the present invention and an ordinary pipe mill are coupled to constitute the embossed pipe manufacturing apparatus, whereby it is possible to realize productivity five times as high as that of a conventional embossed pipe production apparatus.

[0128] In addition, the embossed pipe manufacturing apparatus is lightweight and has an aesthetically pleasing appearance while exhibiting high durability, whereby it is possible to reduce the weight of parts for multiple purposes in a conventional market of mechanical structural pipes, embossed pipe products, which are not uniform products but design products having aesthetically pleasing appearances, are brought to a conventional market of mechanical structural pipes and decorative materials for building, whereby it is possible to satisfy market demand and to create new demand, and the flow of water used in a coolant and hot water piping system is forcibly interfered with by a concave-convex structure formed in the pipe, whereby it is possible to improve a cooling or heat conservation effect.

[0129] Furthermore, the embossed pipe according to the present invention having the above function is applicable to various fields, such as a handrail or a guardrail for railways, including Korea Train Express (KTX), subways, and light rail transits, a handrail or a guardrail for buses, decorative products, including a handrail and a guardrail for ships, a handrail or a guardrail for yachts, a high-quality structural pipe, such as a building material, a handrail, a bollard, a bellows, a hanger, and electronic product handle, a piping material related to a coolant and hot water, and a general structural pipe. Consequently, the present invention has high industrial applicability.

Claims

1. An embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet, the embossed pipe manufacturing apparatus comprising: an uncoiler (1) configured to provide a flat metal sheet (100); a centering guide roller (2) configured to guide the flat metal sheet (100) supplied from the uncoiler (1) to an embossing machine (3) located at a rear thereof; the embossing machine (3) being configured to emboss the flat metal sheet (100) supplied via the centering guide roller (2) in order to form an embossed metal sheet (100'); and a pipe mill (4) configured to curve and round the embossed metal sheet (100') supplied through the embossing machine (3) in order to manufacture an embossed pipe (200) having a weld seam portion (201) formed in a longitudinal direction, the pipe mill also being configured to weld the weld seam portion (201) of the embossed pipe (200) in order to complete the embossed pipe (200), wherein
the embossing machine (3) comprises: an embossing press roller (30) comprising an upper roller (31) having a relief embossing pattern formed thereon and a lower roller (32) having an intaglio embossing pattern formed thereon, the upper roller and the lower roller being configured to be rotated in a state of being engaged with each other; a frame unit (33) defining an outer framework of the embossing machine, the frame unit being configured to support the embossing press roller (30); and a hydraulic cylinder (34) installed at an upper end of the frame unit (33), wherein
the upper roller (31) comprises: a roller body (311); rotary shafts (312) formed at centers of opposite side surfaces of the roller body (311); a relief embossing pattern unit (313) formed on a surface of the roller body (311); and a band-shaped groove (314) formed on the surface of the roller body (311) in a rotational direction of the roller so as to be lower than the relief embossing pattern unit (313) in order to partition the relief embossing pattern unit (313) at predetermined intervals, wherein
the lower roller (32) comprises: a roller body (321); rotary shafts (322) formed at centers of opposite side surfaces of the roller body (321); an intaglio embossing pattern unit (323) formed on the surface of the roller body (321); and a band-shaped protrusion (324) formed on the surface of the roller body (321) in the rotational direction of the roller so as to be higher than the intaglio embossing pattern unit (323) in order to partition the intaglio embossing pattern unit (323) at predetermined intervals, the protrusion (324) being configured to be inserted into the groove (314), wherein
the upper roller (31) further comprises first left and right ends (315, 316) formed along opposite side edges of the roller body (311) so as to be lower than the relief embossing pattern unit (313), a width (L1) of each of the first left and right ends (315, 316) being 1/2 a width (L2) of the groove (314), and wherein
the lower roller (32) further comprises second left and right ends (325, 326) formed along opposite side edges of the roller body (321) so as to be higher than the intaglio embossing pattern unit (323).

2. The embossed pipe manufacturing apparatus according to claim 1, wherein
the upper roller (31) further comprises left and right inclined surface formation portions (317, 318) extending outwards from the first left and right ends (315, 316) in a lateral direction so as to be integrally formed therewith, the left and right inclined surface formation portions protruding outwards from points extending from the first left and right ends (315, 316) in an oblique direction, the left and right inclined surface formation portions being rotated in a state of being engaged with the second left and right ends (325, 326) of the lower roller (32) to shape opposite side surfaces of the flat metal sheet (100) in the oblique direction, and wherein
an angle ($\theta 1$) between each of the left and right inclined surface formation portions (317, 318) and a corresponding one of the first left and right ends (315, 316) ranges from 110 to 135 degrees, inclined surfaces formed at opposite ends of the metal sheet by the left and right inclined surface formation portions (317, 318) are brought into contact with each other to form a weld seam portion (201) having a V-shaped groove (201a), and an interior angle ($\theta 2$) of the V-shaped groove (201a) ranges from 20 to 90 degrees.

3. An embossed pipe manufacturing apparatus capable of easily welding opposite side surfaces of an embossed metal sheet, the embossed pipe manufacturing apparatus comprising: an uncoiler (1) configured to provide a flat metal sheet (100); a centering guide roller (2) configured to guide the flat metal sheet (100) supplied from the uncoiler (1) to an embossing machine (3) located at a rear thereof; the embossing machine (3) being configured to emboss the flat metal sheet (100) supplied via the centering guide roller (2) in order to form an embossed metal sheet (100'); and a pipe mill (4) configured to curve and round the embossed metal sheet (100') supplied through the embossing machine (3) in order to manufacture an embossed pipe (200) having a weld seam portion (201) formed in a longitudinal direction, the pipe mill also being configured to weld the weld seam portion (201) of the embossed pipe (200) in order to complete the embossed pipe (200), wherein
the embossing machine (3) comprises: an embossing press roller (30) comprising an upper roller (31) having a relief embossing pattern formed thereon and a lower roller (32) having an intaglio embossing pattern formed thereon, the upper roller and the lower roller being configured to be rotated in a state of being engaged with each other; a frame

unit (33) defining an outer framework of the embossing machine, the frame unit being configured to support the embossing press roller (30); and a hydraulic cylinder (34) installed at an upper end of the frame unit (33), wherein the upper roller (31) comprises: a roller body (311); rotary shafts (312) formed at centers of opposite side surfaces of the roller body (311); a relief embossing pattern unit (313) formed on a surface of the roller body (311); and a band-shaped groove (314) formed on the surface of the roller body (311) in a rotational direction of the roller so as to be lower than the relief embossing pattern unit (313) in order to partition the relief embossing pattern unit (313) at predetermined intervals, wherein

the lower roller (32) comprises: a roller body (321); rotary shafts (322) formed at centers of opposite side surfaces of the roller body (321); an intaglio embossing pattern unit (323) formed on the surface of the roller body (321); and a band-shaped protrusion (324) formed on the surface of the roller body (321) in the rotational direction of the roller so as to be higher than the intaglio embossing pattern unit (323) in order to partition the intaglio embossing pattern unit (323) at predetermined intervals, the protrusion (324) being configured to be inserted into the groove (314), wherein

the upper roller (31) further comprises first left and right ends (315, 316) formed along opposite side edges of the roller body (311) so as to be lower than the relief embossing pattern unit (313), a width (L1) of each of the first left and right ends (315, 316) being 1/2 a width (L2) of the groove (314), wherein

the lower roller (32) further comprises second left and right ends (325, 326) formed along opposite side edges of the roller body (321) so as to be higher than the intaglio embossing pattern unit (323), wherein

the upper roller (31) further comprises left and right inclined surface formation portions (317, 318) extending outwards from the first left and right ends (315, 316) in a lateral direction so as to be integrally formed therewith, the left and right inclined surface formation portions protruding outwards from points extending from the first left and right ends (315, 316) in an oblique direction, the left and right inclined surface formation portions being rotated in a state of being engaged with the second left and right ends (325, 326) of the lower roller (32) to shape opposite side surfaces of the flat metal sheet (100) in the oblique direction, and wherein

an angle (θ1) between each of the left and right inclined surface formation portions (317, 318) and a corresponding one of the first left and right ends (315, 316) ranges from 110 to 135 degrees, inclined surfaces formed at opposite ends of the metal sheet by the left and right inclined surface formation portions (317, 318) are brought into contact with each other to form a weld seam portion (201) having a V-shaped groove (201a), and an interior angle (θ2) of the V-shaped groove (201a) ranges from 20 to 90 degrees.

4. An embossed pipe manufacturing method capable of easily welding opposite side surfaces of an embossed metal sheet, the embossed pipe manufacturing method comprising:

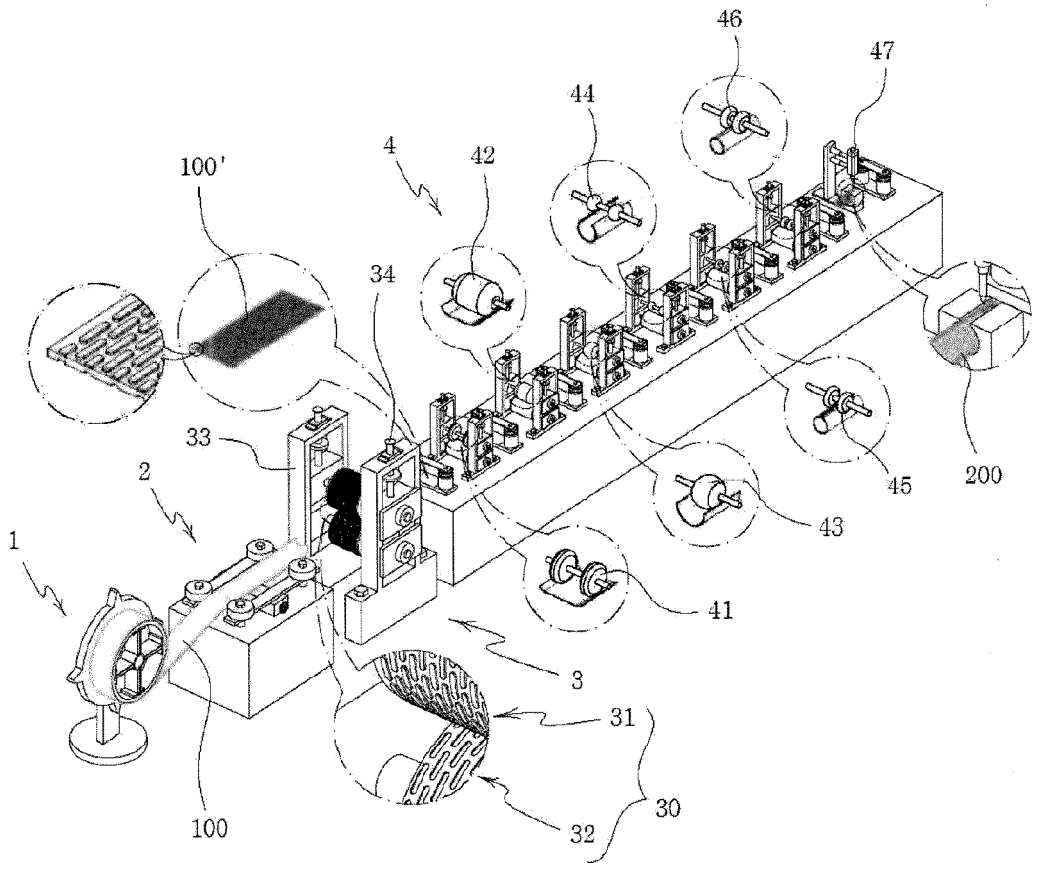
a first step of supplying a flat metal sheet (100) to an embossing machine (3) from an uncoiler (1) via a centering guide roller (2);

a second step of embossing the flat metal sheet (100) using an embossing press roller (30) of the embossing machine (3) to form an embossed metal sheet (100'); and

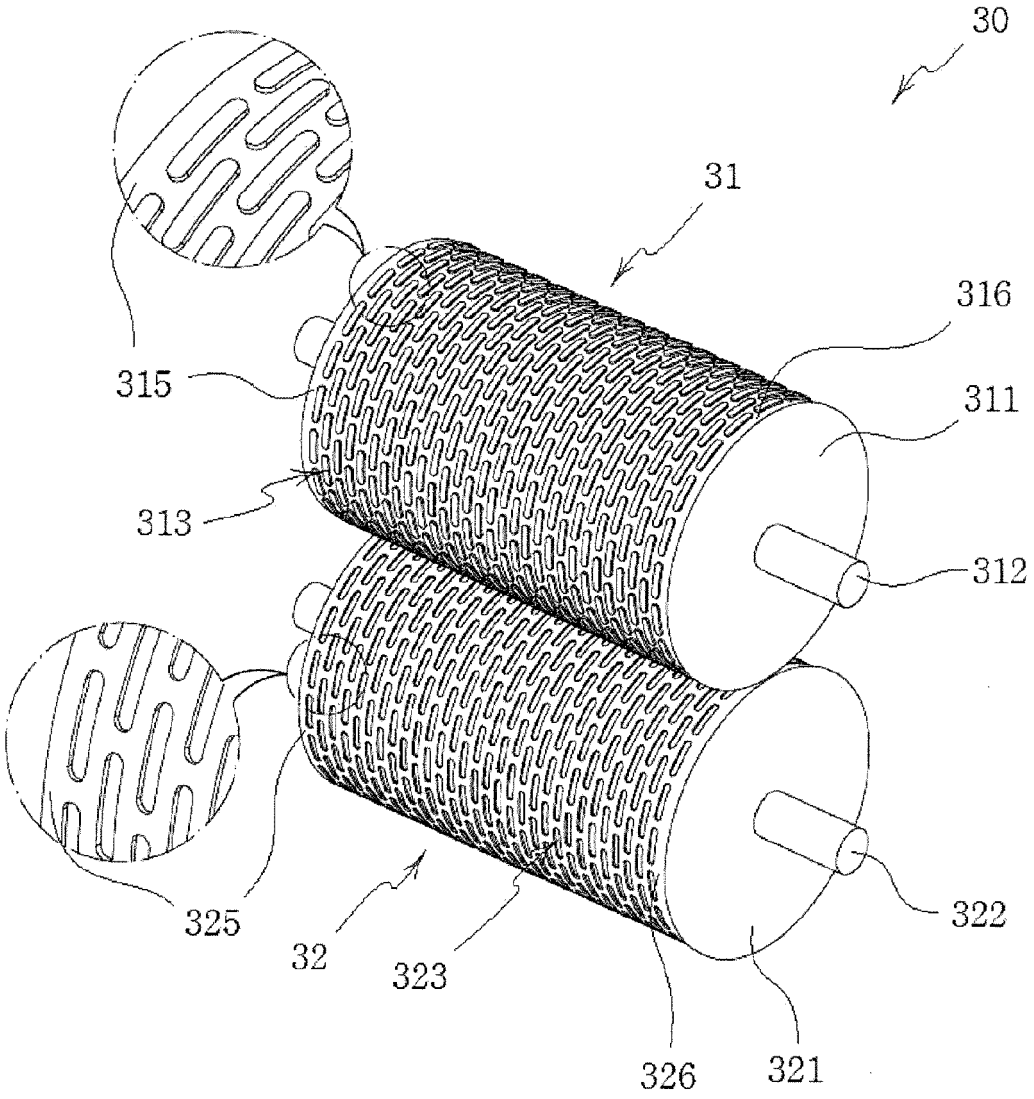
a third step of supplying the embossed metal sheet (100') to a pipe mill (4) to manufacture an embossed pipe (200) having a weld seam portion (201) formed in a longitudinal direction through curving and rounding processes and welding the weld seam portion (201) of the embossed pipe (200) to complete the embossed pipe (200), wherein

the embossed metal sheet (100') is one selected from among a stainless steel sheet, an aluminum sheet, a brass sheet, a copper sheet, and a soft iron sheet, the embossed metal sheet has a thickness ranging from 0.5 mm to 5 mm and a hardness ranging from 100 Hv to 550 Hv, the embossed metal sheet has an embossed structure formed on an outer surface thereof, small-width planes are formed at opposite side edges of the embossed metal sheet, inwardly inclined surfaces are formed at opposite side surfaces of the embossed metal sheet, the opposite side surfaces of the embossed metal sheet (100') are brought into contact with each other through the curving and rounding processes of the pipe mill (4) to form a weld seam portion (201) having a V-shaped groove (201a), an interior angle (θ2) of which ranges from 20 to 90 degrees, and the V-shaped groove (201a) is melted and fused by welding, whereby the embossed pipe (200) is completed.

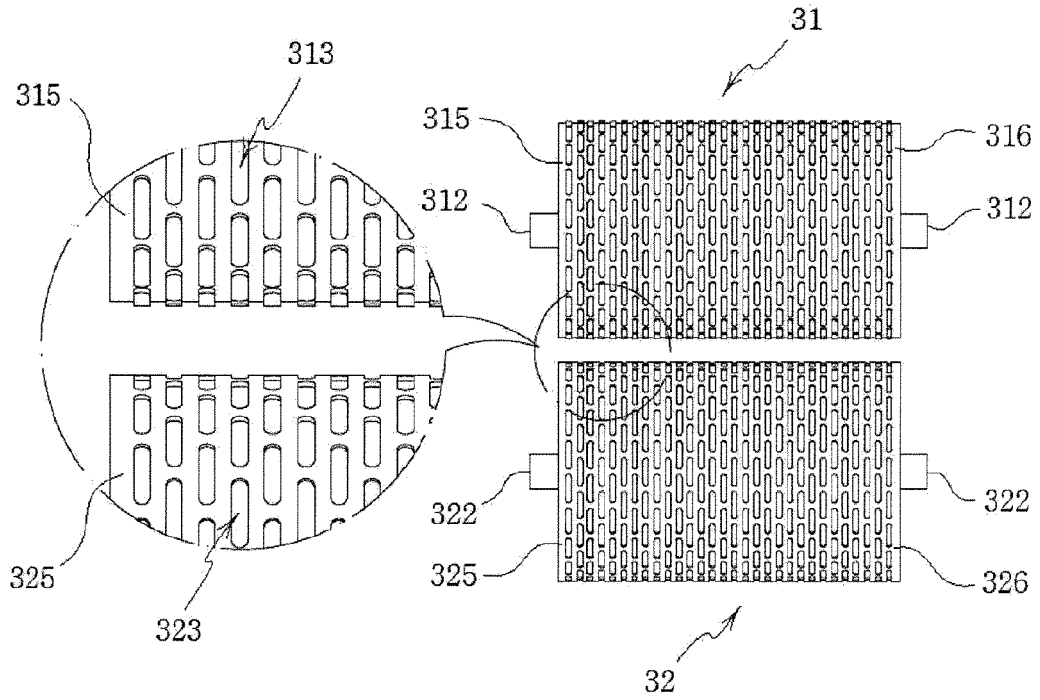
[Figure 1]



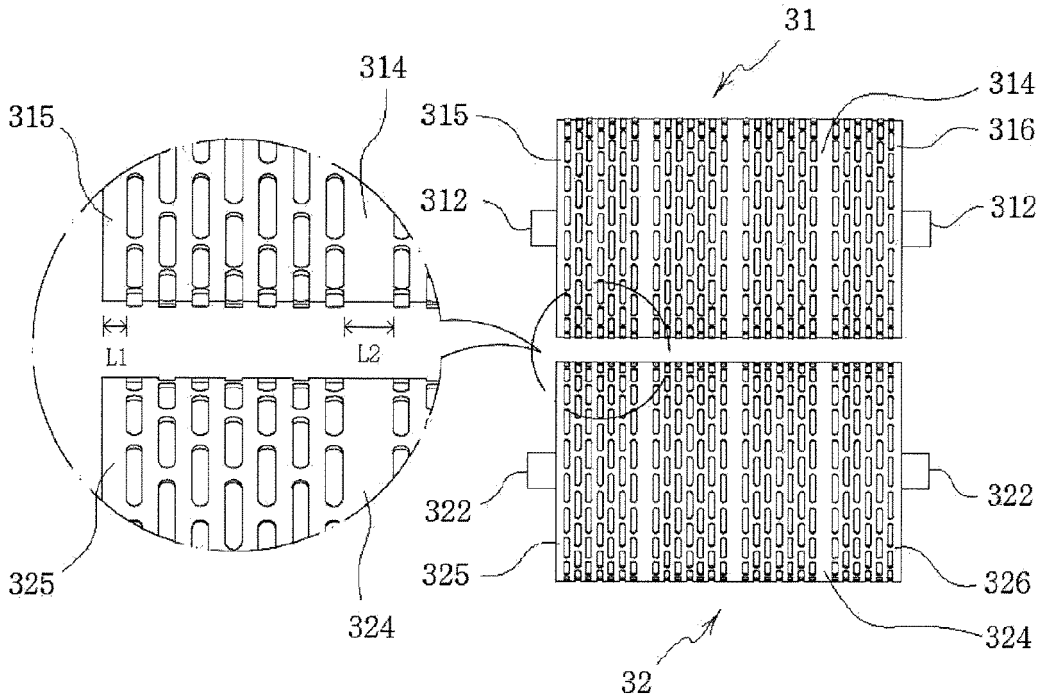
[Figure 2]



[Figure 3]



[Figure 4]



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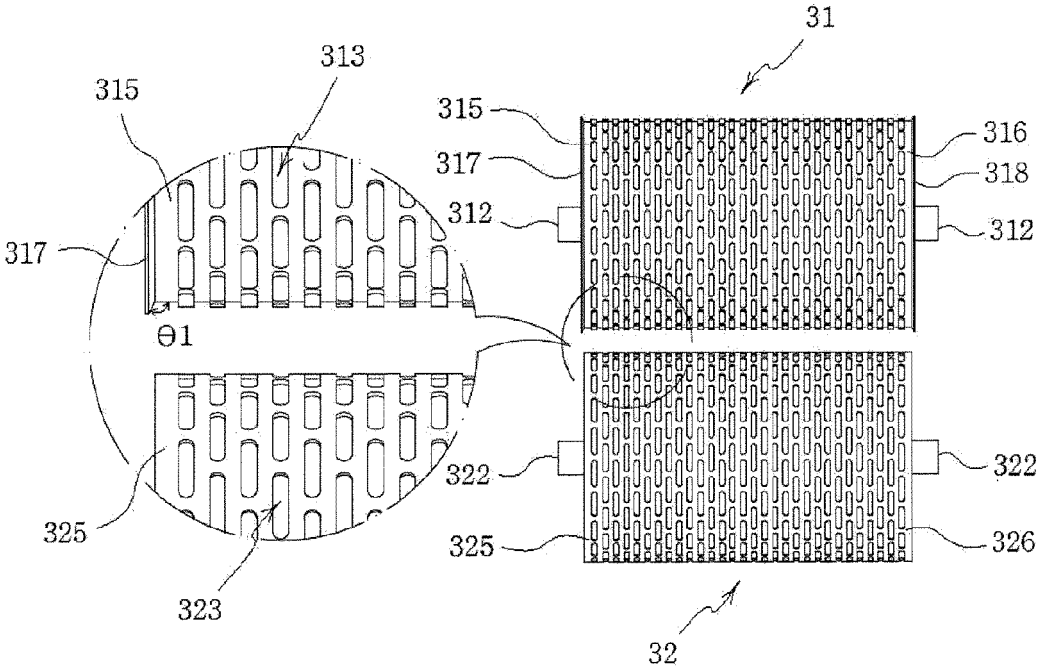

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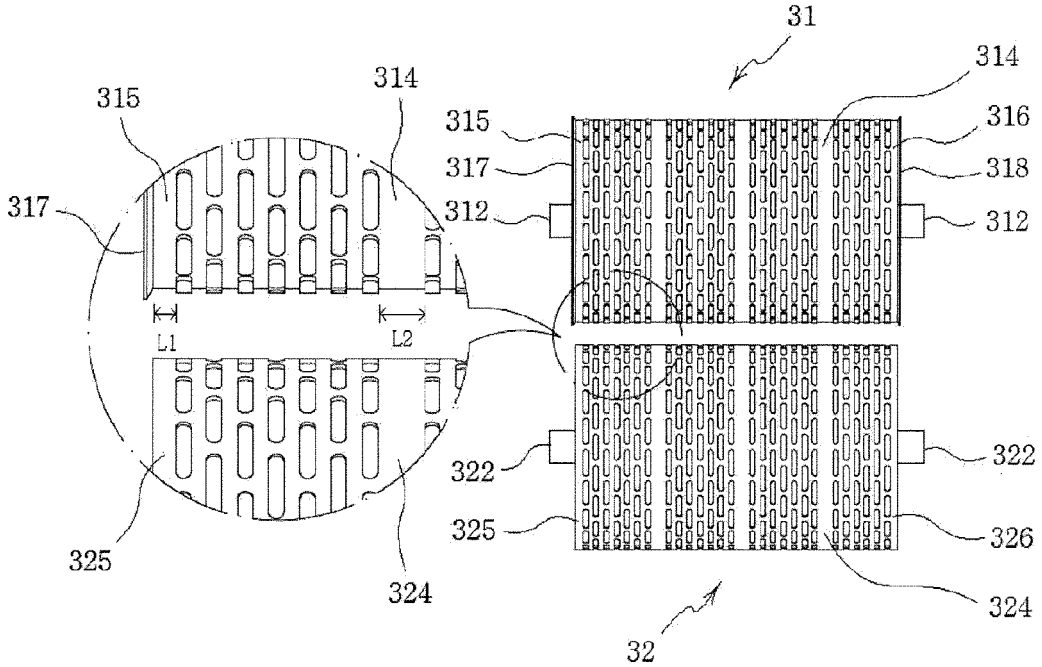

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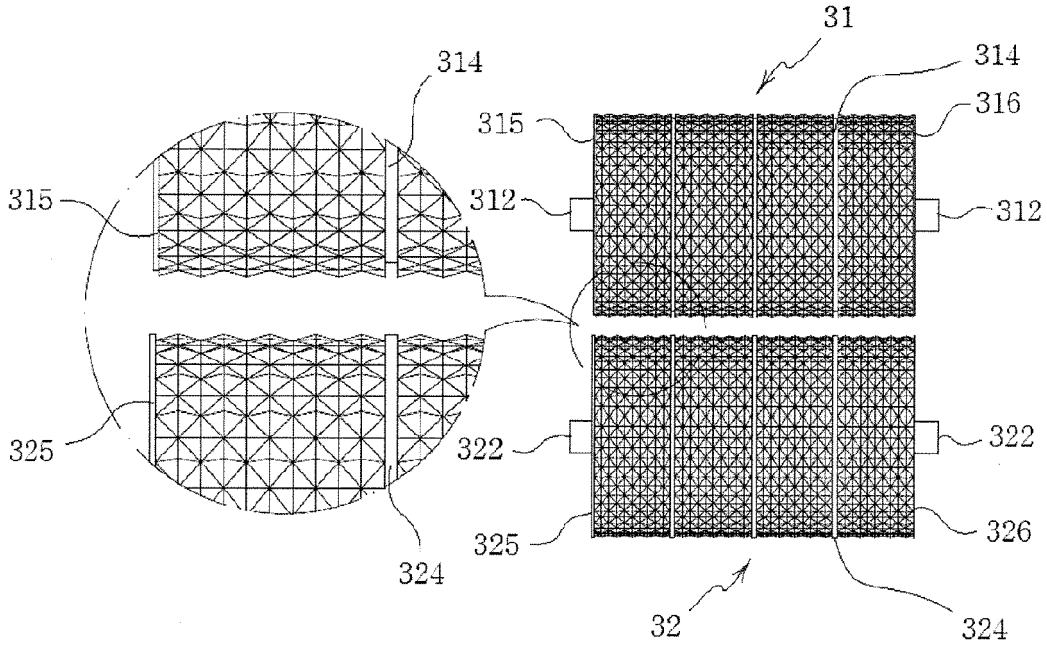

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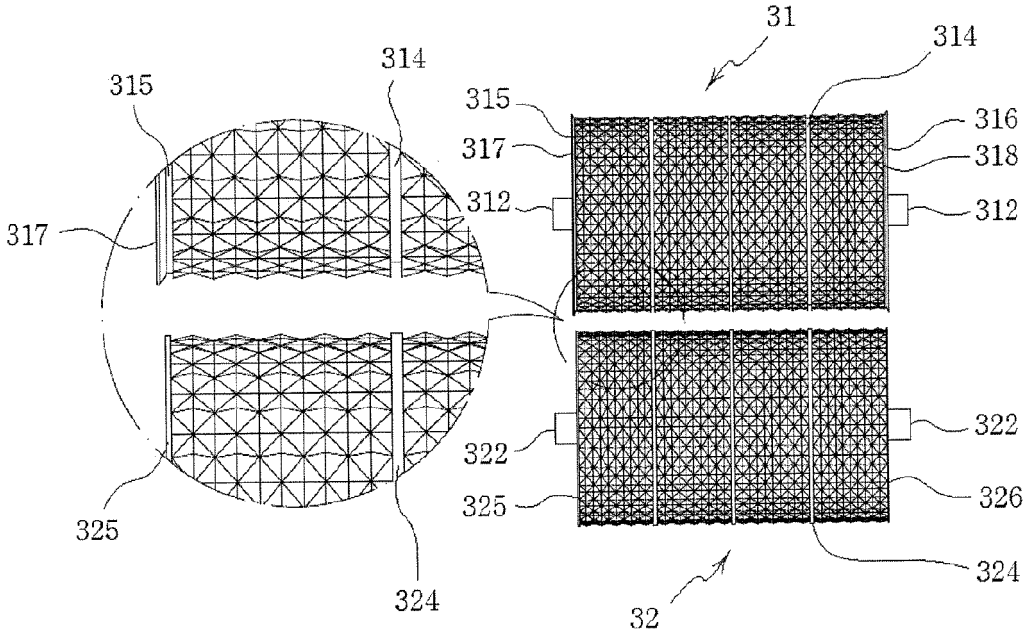

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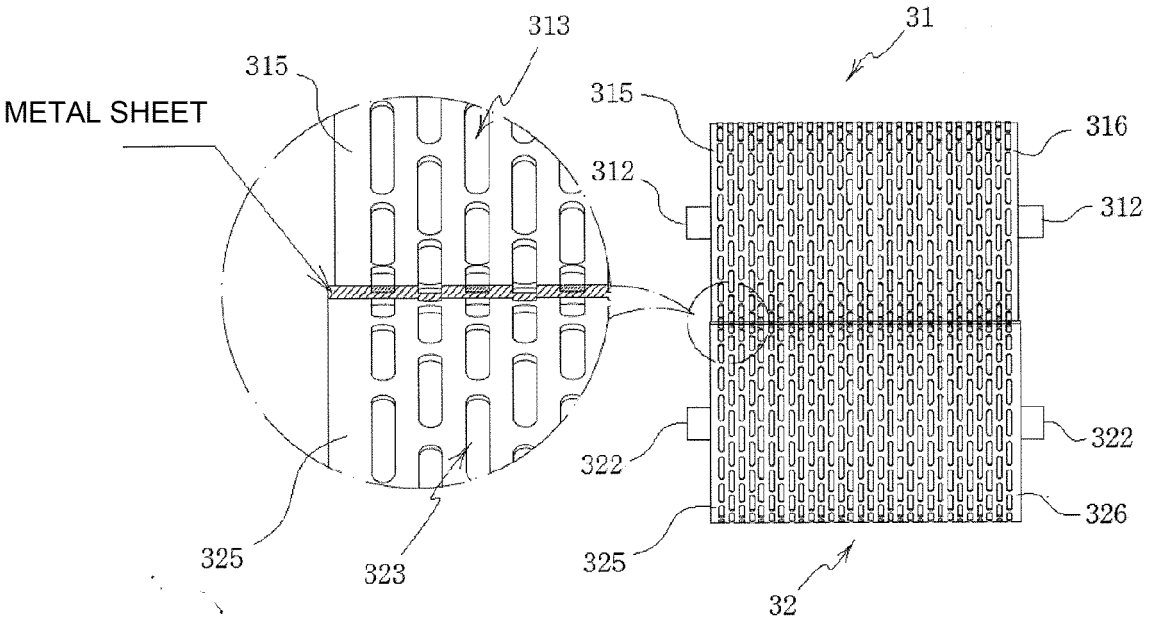

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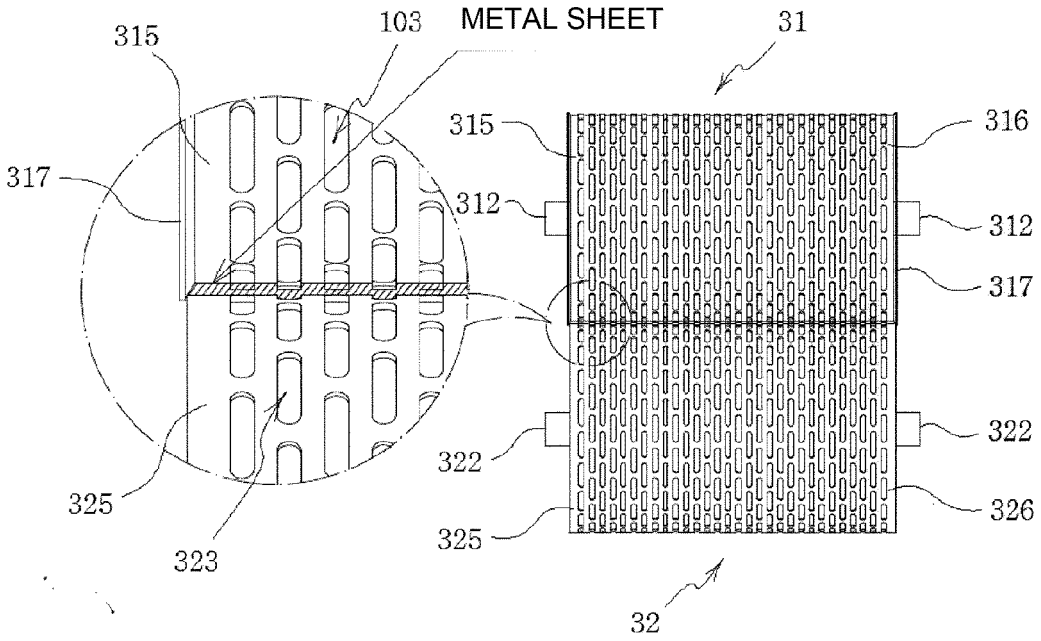

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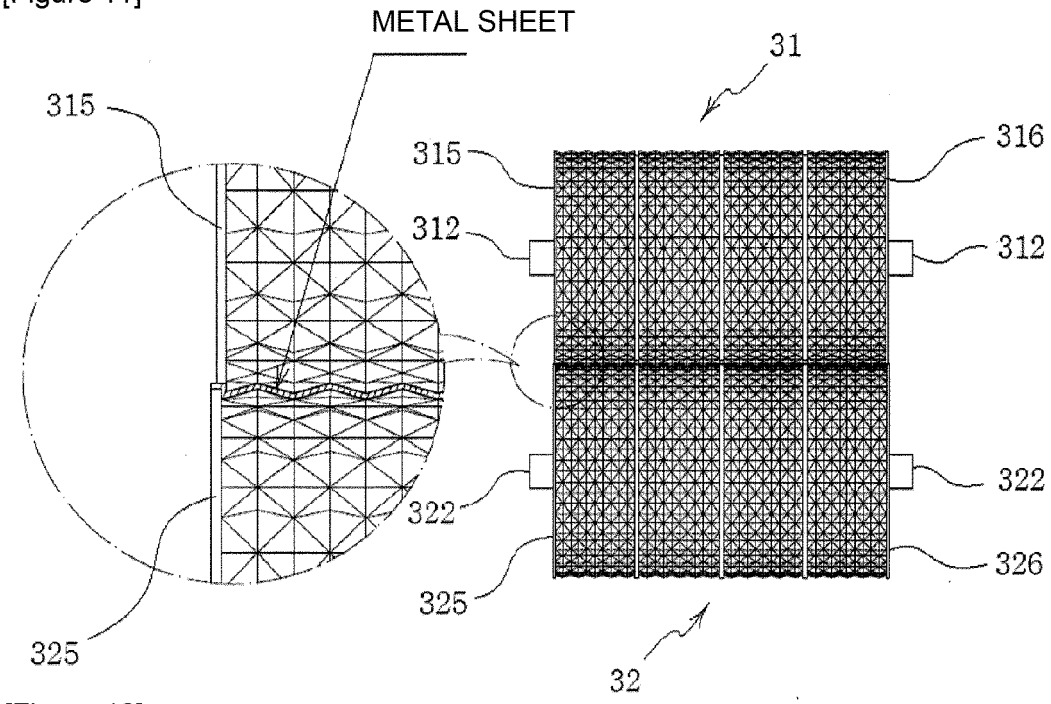

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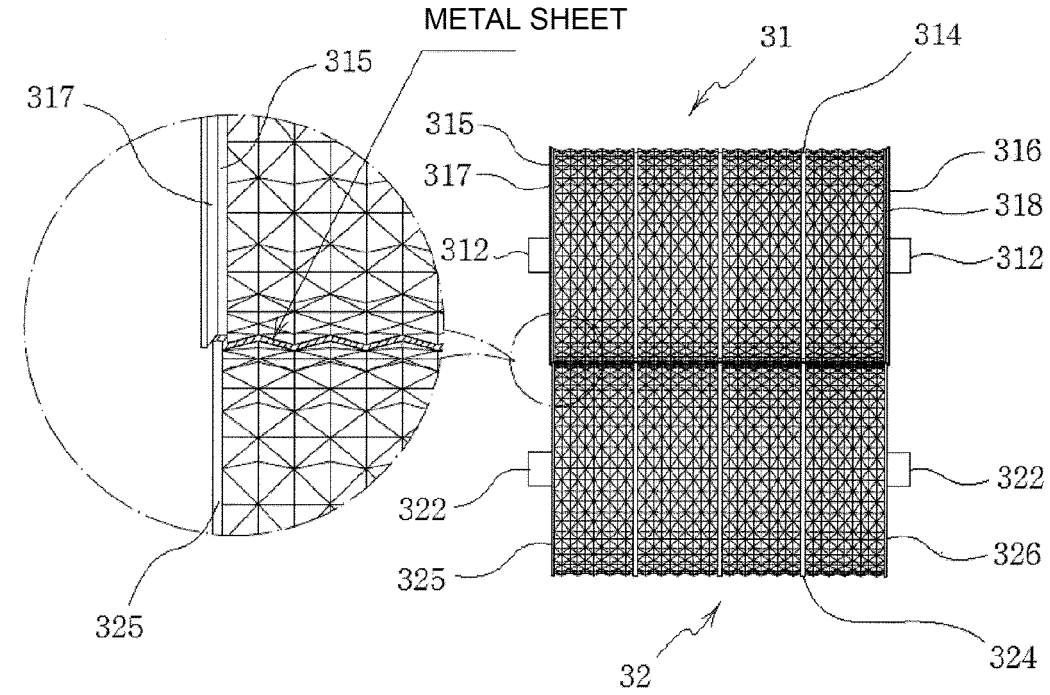
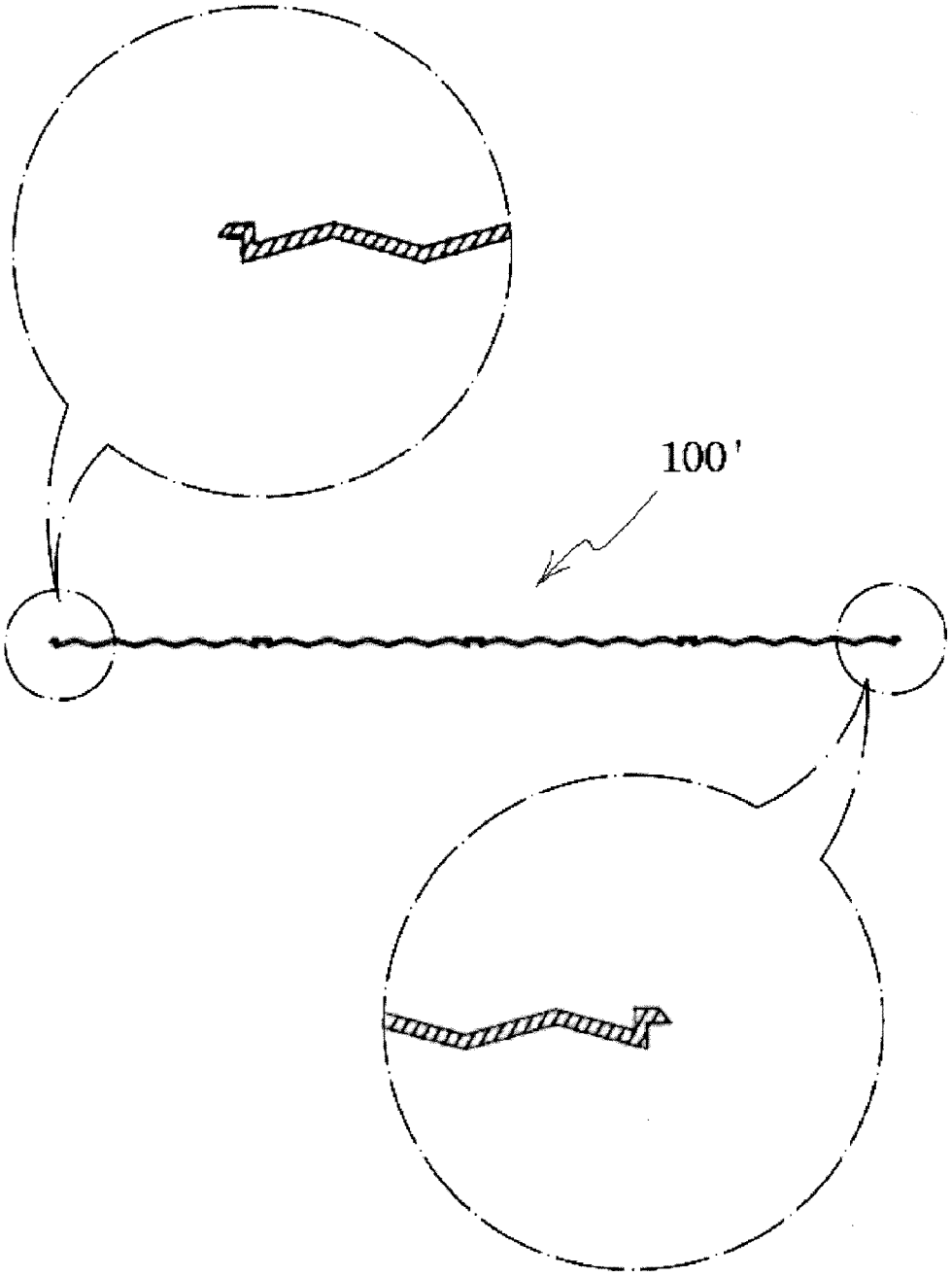
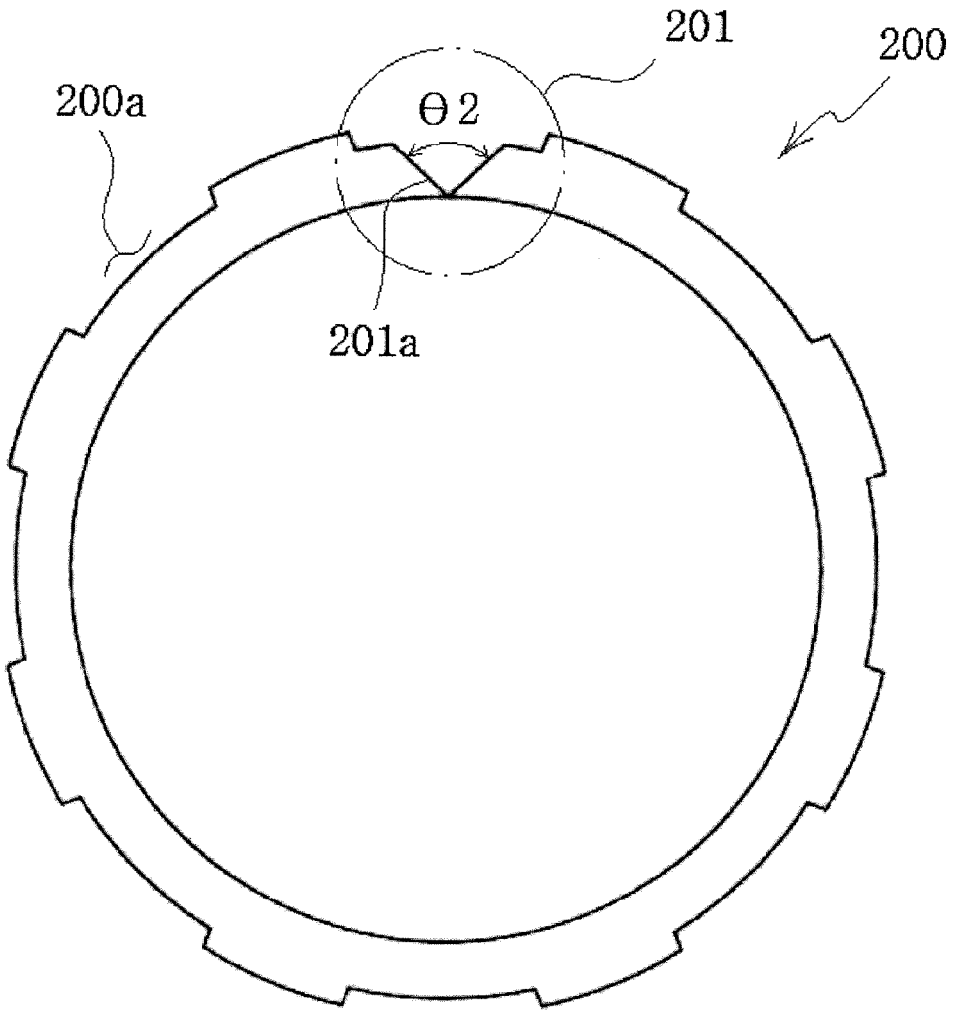


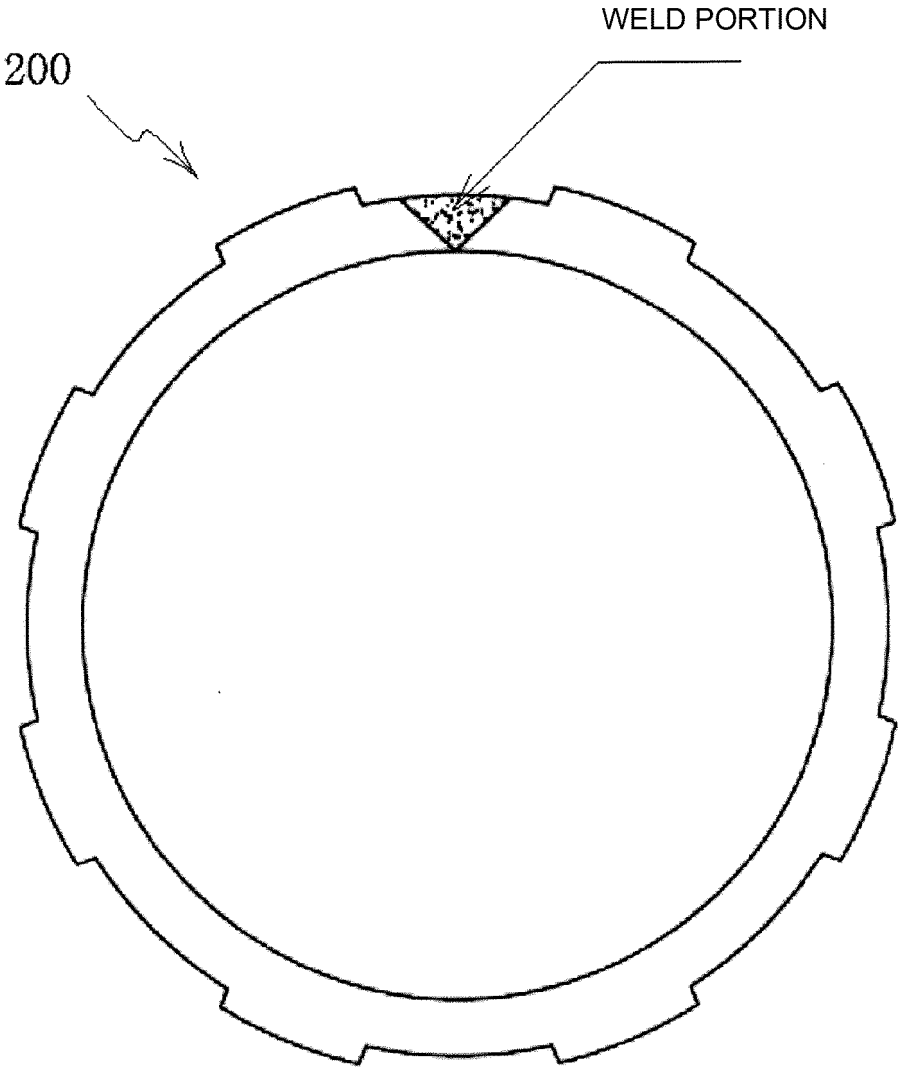
[Figure 13]



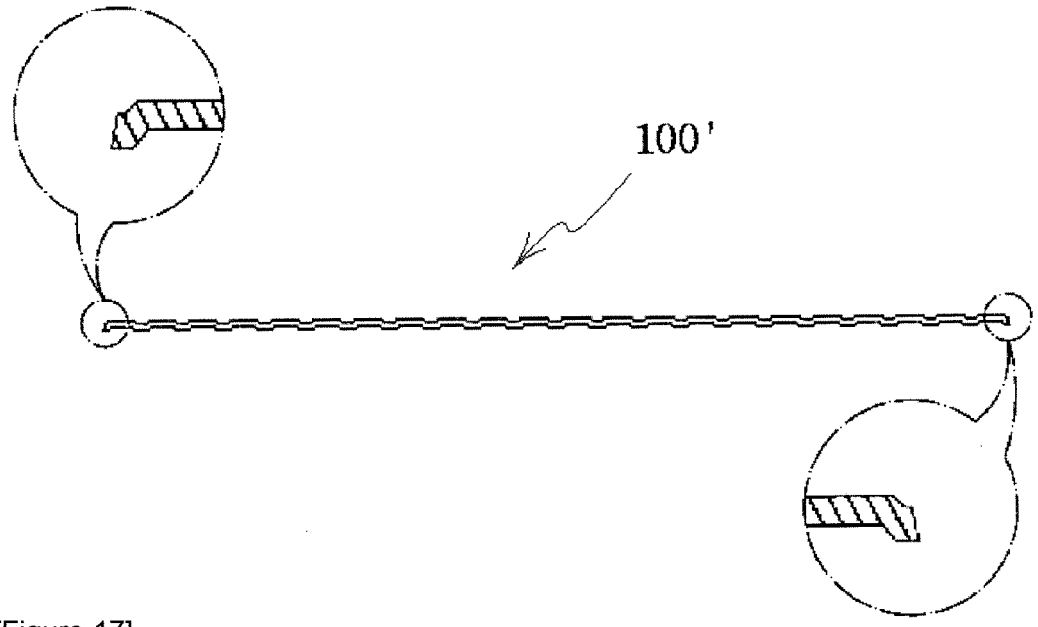
[Figure 14]



[Figure 15]



[Figure 16]



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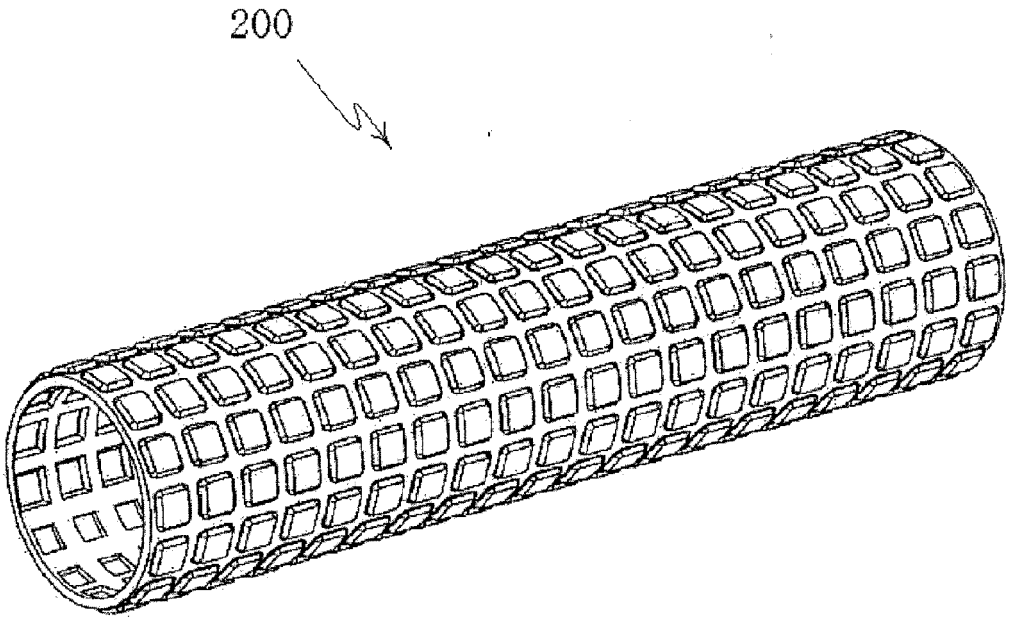
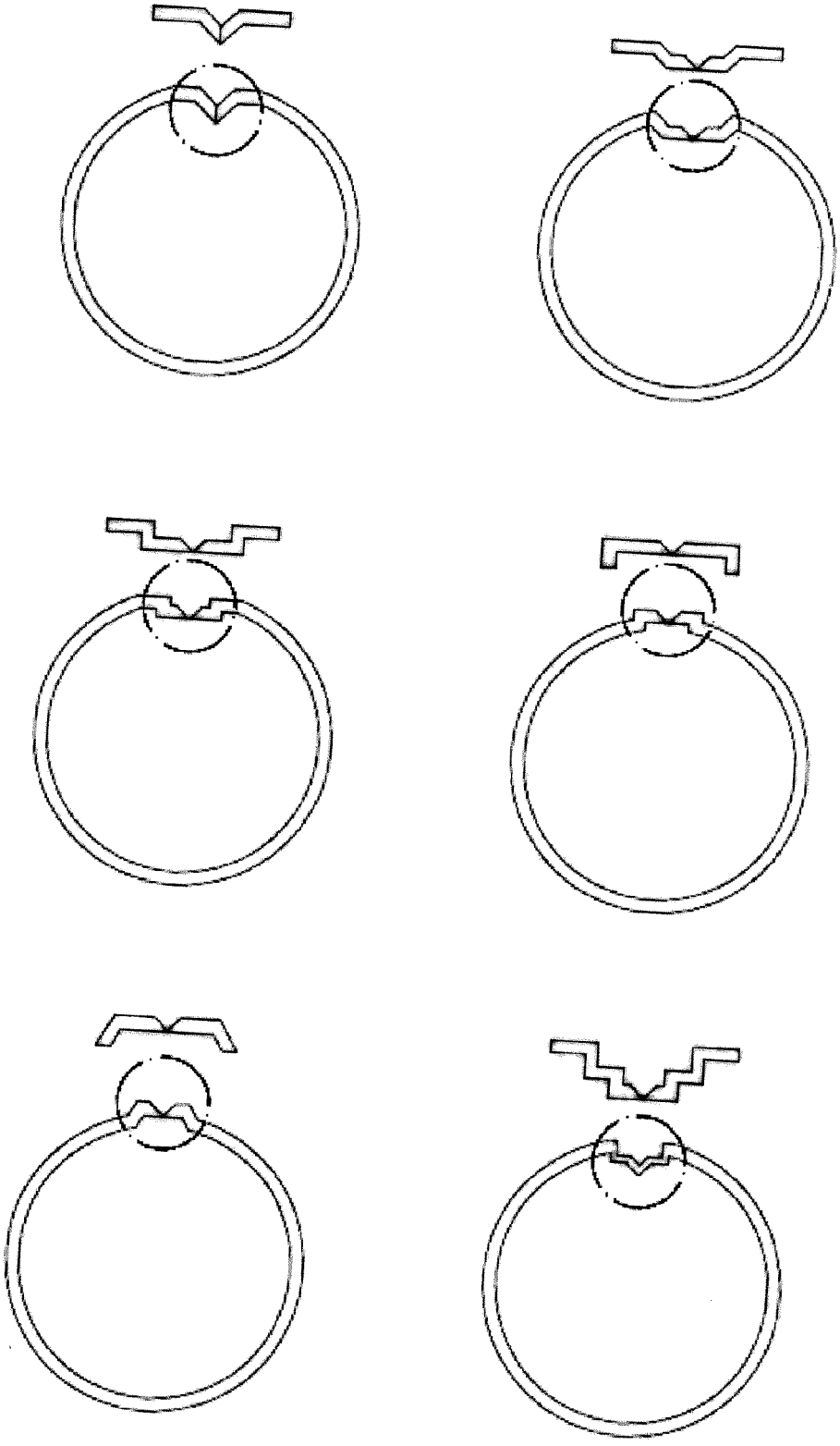
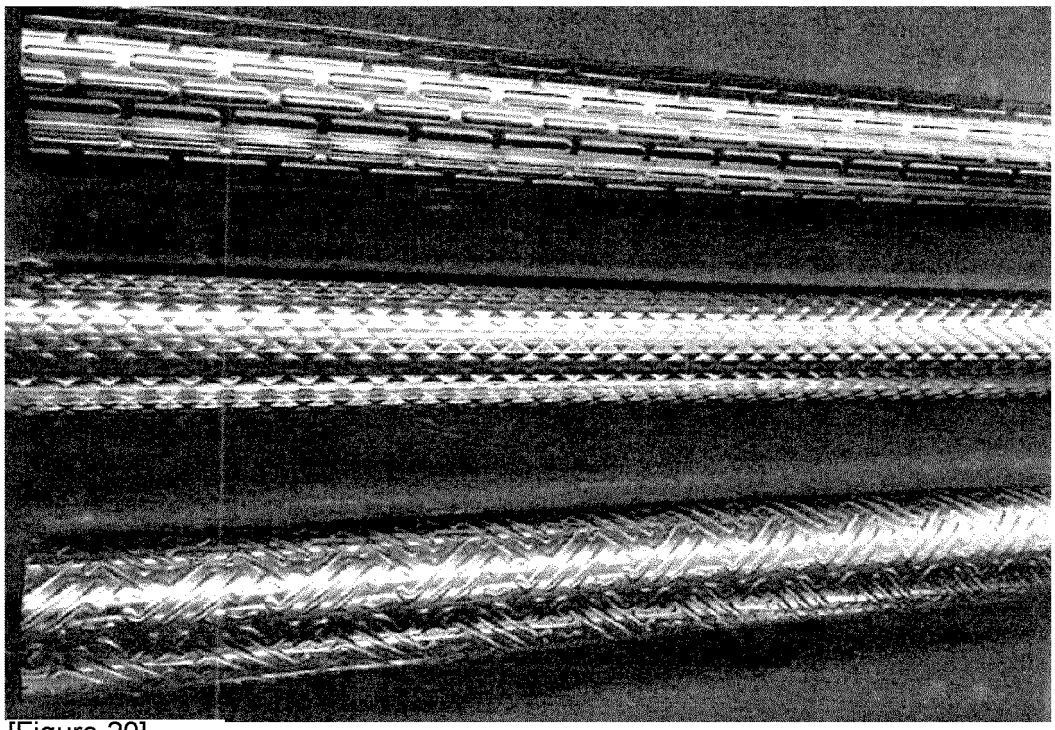


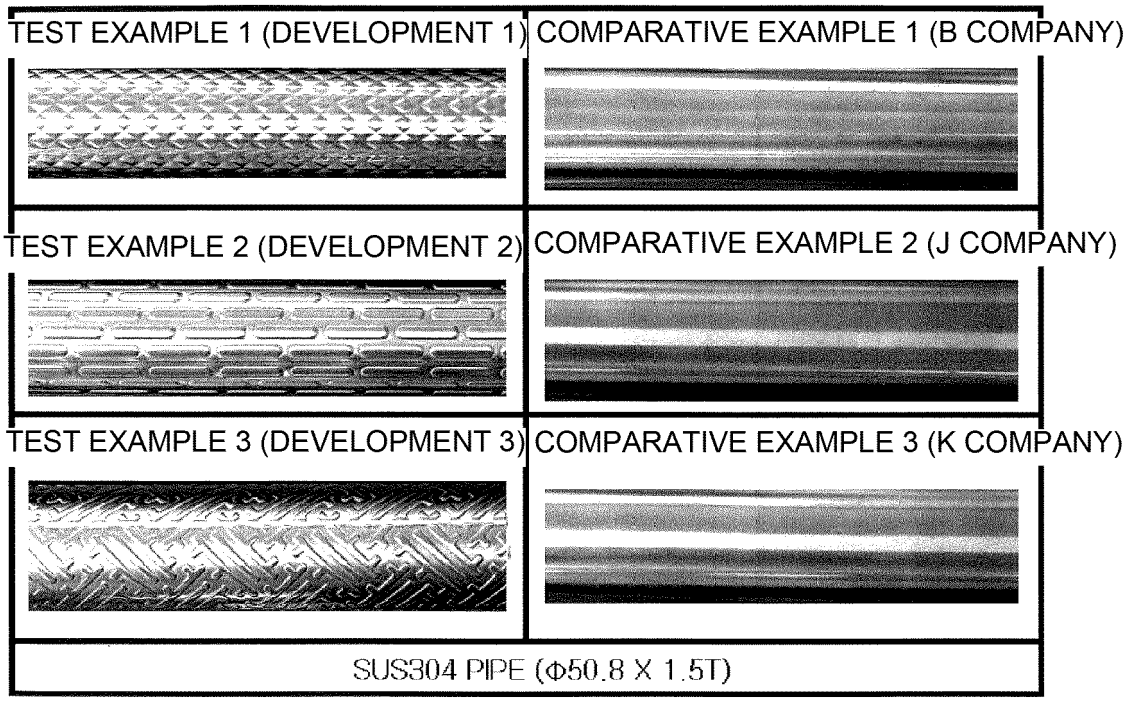
[Figure 18]



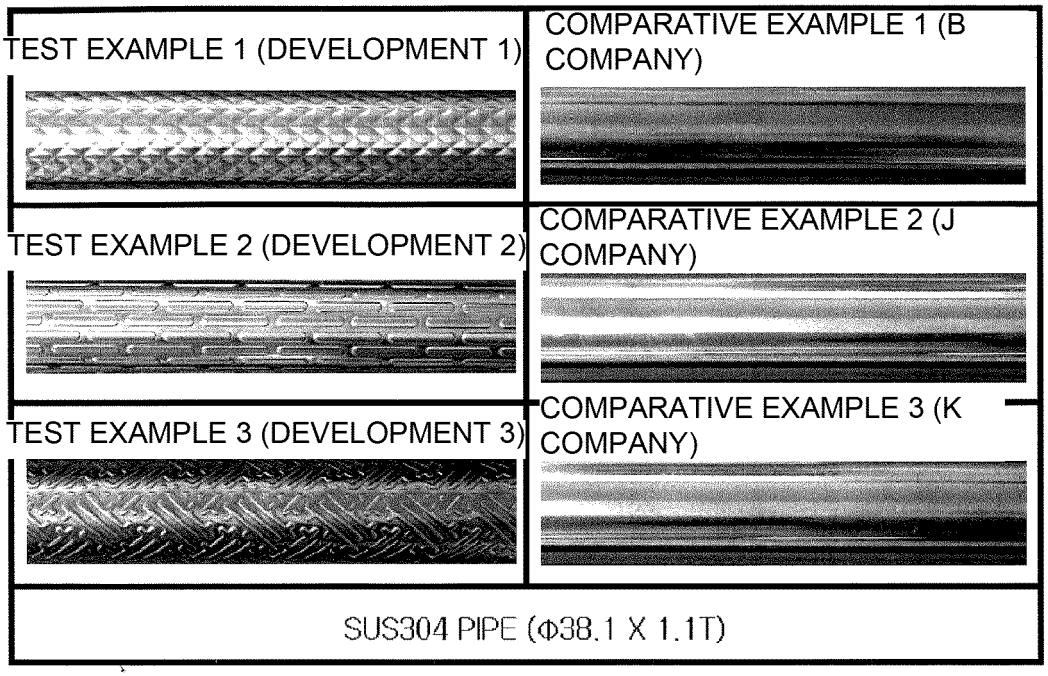
[Figure 19]



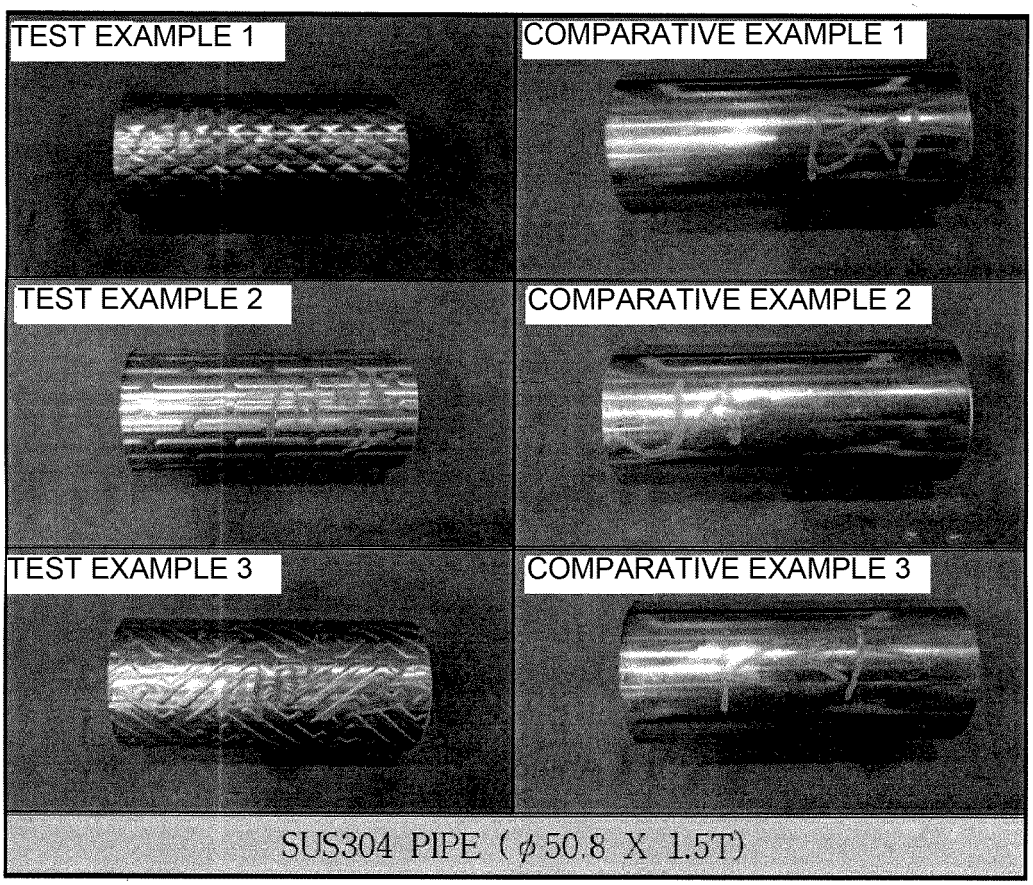
[Figure 20]



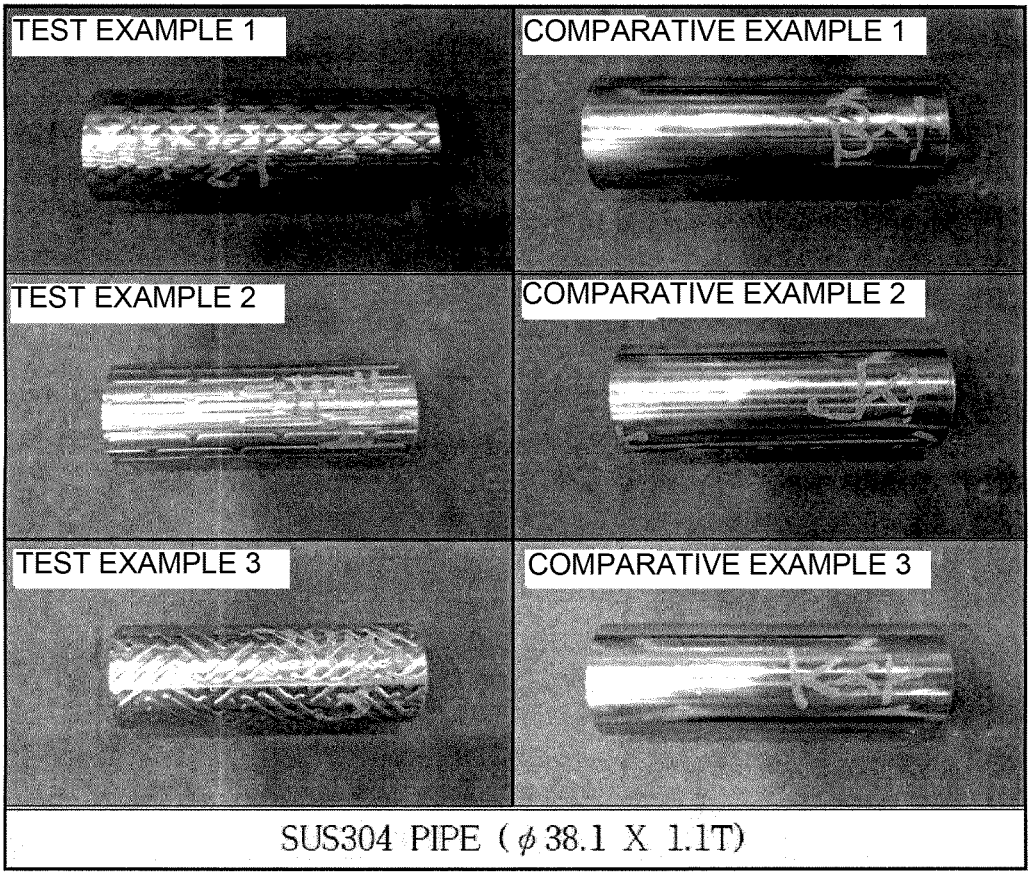
[Figure 21]



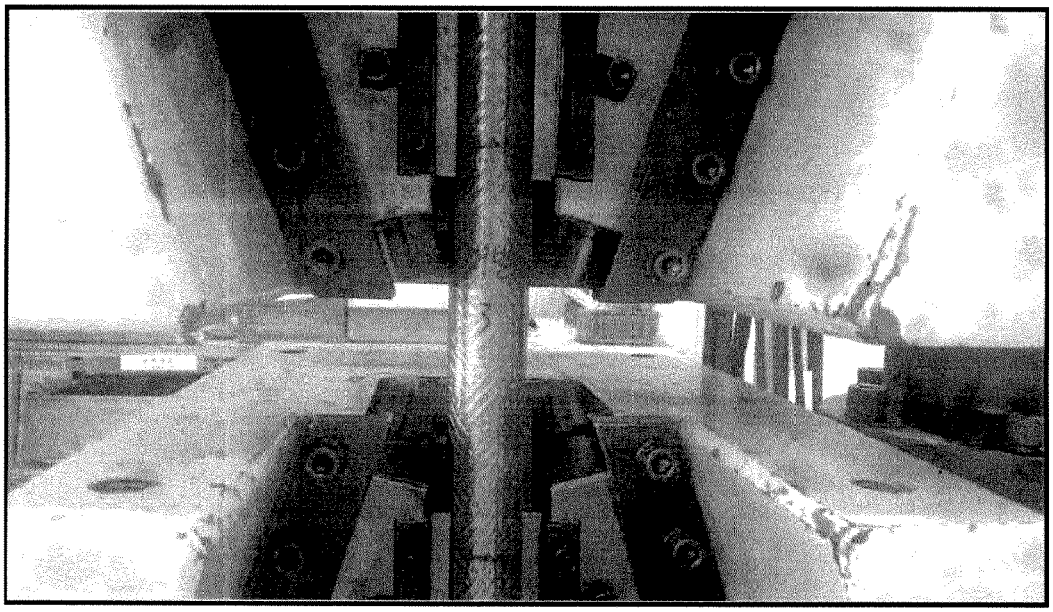
[Figure 22]



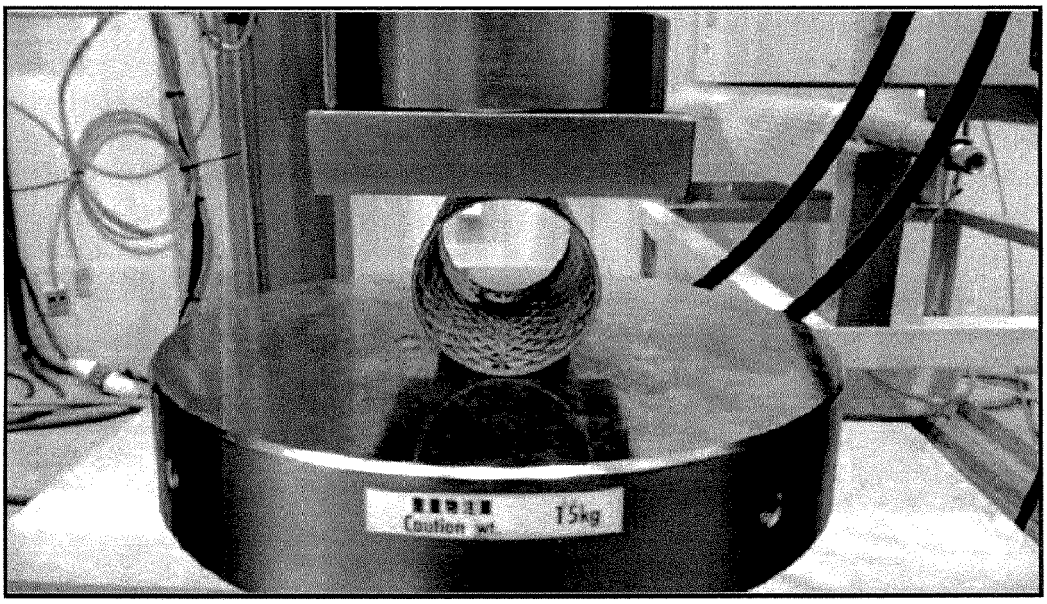
[Figure 23]



[Figure 24]



[Figure 25]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/016554

A. CLASSIFICATION OF SUBJECT MATTER

B21C 37/08(2006.01)i, B21H 8/00(2006.01)i, B21H 8/02(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)

B21C 37/08; B21B 1/00; B21B 39/00; B21B 39/02; B21D 17/04; B21D 22/04; B21D 5/10; B21D 5/12; B23K 9/025; B21H 8/00; B21H 8/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: uncoiler, guide roller, embossing machine, tube mill, roller

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2009-0055882 A (DM STS CO., LTD.) 03 June 2009 See paragraphs [0015]-[0019], [0028], [0032] and figures 1-6.	1-4
A	KR 10-2017-0116616 A (DOOSUNG MOTOR CO., LTD.) 20 October 2017 See paragraphs [0028], [0036] and figures 3, 7.	1-4
A	KR 10-2010-0011099 A (HYUNDAI STEEL COMPANY) 03 February 2010 See paragraph [0030] and figure 1.	1-4
A	JP 5463863 B2 (NIPPON STEEL & SUMITOMO METAL) 09 April 2014 See paragraphs [0017]-[0020] and figure 1.	1-4
A	KR 10-1995-0031263 A (SMS SCHLOEMANN-SIEMAG AKTIENGESELLSCHAFT) 18 December 1995 See claims 1-7 and figures 1-2.	1-4

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 APRIL 2019 (05.04.2019)	**05 APRIL 2019 (05.04.2019)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2018/016554

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 101611572 **[0009]**
- KR 10404895 **[0010]**
- KR 101399231 **[0011]**
- KR 101017890 **[0014]**
- KR 101604011 **[0014]**