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(54) **DISK ROLL AND METHOD OF MANUFACTURING SEAMLESS PIPE USING THE SAME**

(57) A disk roll includes a shaft member and a circular ring member fitted to the outer circumference of the shaft member. The circular ring member has a circular ring shape and is fitted to the disk-shaped shaft member. The circular ring member includes a plurality of arcuate members arranged in the circumferential direction. The arcuate members are each secured to the outer circumfer-

ence of the shaft member by a screw, and the circular ring member is thus fitted to the shaft member. The circular ring member is made of the plurality of arcuate members instead of being integrally molded, and therefore the manufacturing cost can be reduced. Since the circular ring member can be divided into the arcuate members, it can easily be transported and mounted to the shaft member.

FIG.1A

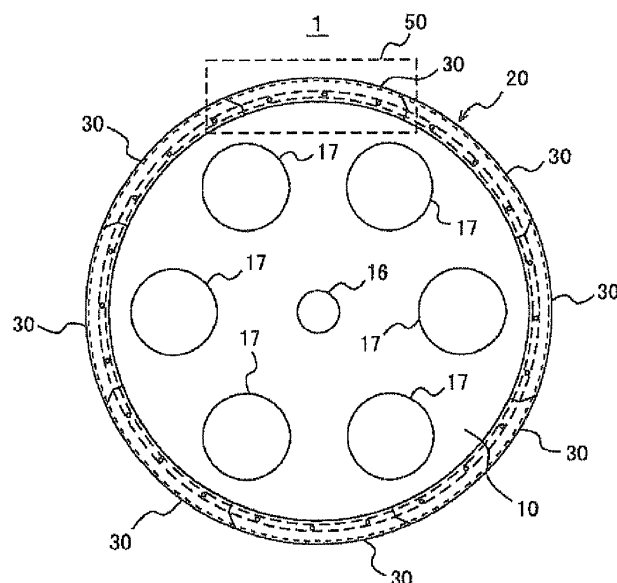
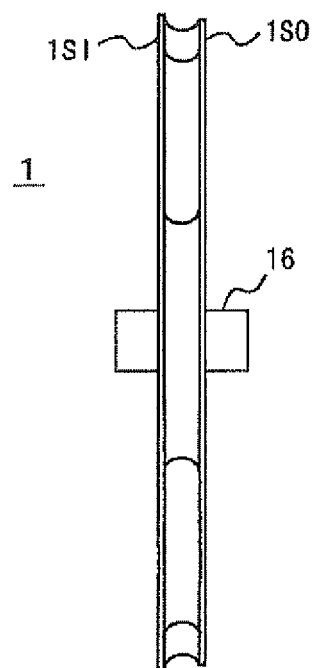


FIG.1B



Description

TECHNICAL FIELD

[0001] The present invention relates to a disk roll and a method of manufacturing a seamless pipe or tube using the same, and the invention more specifically relates to a disk roll for use in a piercer and a method of manufacturing a seamless pipe using the same.

BACKGROUND ART

[0002] A seamless pipe is produced by piercing and rolling a billet using a piercer. With reference to Figs. 10 and 11, the piercer 100 includes two disk rolls 200 provided one above the other around the pass center O and two inclined rolls 300 provided side by side around the pass center O.

[0003] As shown in Fig. 11, the outer circumferential surface 200F of the disk roll 200 is recessed in cross section. A billet 400 in the process of piercing and rolling advances as it is rotated in the circumferential direction by the inclined rolls 300. At the time, the outer circumferential surface 200F of the disk roll 200 contacts and restricts the billet 400 to suppress the swinging of the billet, so that the piercing and rolling process is stabilized.

[0004] Among the side surfaces 200SI and 200SO of the disk roll 200, the outer diameter of the side surface 200SI corresponding to the inlet side of rotation of the billet 400 rotated in the circumferential direction is greater than the outer diameter of the side surface 200SO corresponding to the outlet side of rotation of the billet 400. When the gaps G1 and G2 between the side surfaces 200SI of the disk rolls 200 and the inclined rolls 300 on the rotation inlet side of the billet 400 are large, the billet 400 being rotated protrudes from the gaps G1 and G2. The protrusion is called "peeling phenomenon." The outer diameter of the side surfaces 200SI on the rotation inlet side is enlarged and the gaps G1 and G2 between the surfaces and the inclined rolls 300 are narrowed, so that the peeling phenomenon is prevented. On the other hand, if the outer diameter of the side surface 200SO on the rotation outlet side is substantially equal to that of the side surface 200SI on the rotation inlet side, the billet 400 is excessively restricted by the disk rolls 200, which makes it harder for the billet to rotate in the circumferential direction. Therefore, the outer diameter of the side surface 200SO is smaller than that of the side surface 200SI.

[0005] As shown in Fig. 12, the disk roll 200 includes a disk-shaped shaft member 201 having a driving shaft 203 in its center and a circular ring member 202 mounted to the outer circumference of the shaft member 201 by shrinkage fitting. As described above, the outer circumferential surface 200F of the circular ring member 202 is worn as it contacts the billet 400 in the process of piercing and rolling. The worn circular ring member 202 is replaced by a new one.

[0006] However, the circular ring member 202 has a

large diameter about in the range from 1 m to 4 m. Therefore, the circular ring member 202 is not easy to transport, and it takes a large work load to take out the member from the shaft member 201 and mount a new one to the shaft member 201. The circular ring member 202 is normally integrally molded by forging a billet. This complicates the manufacturing process and pushes up the manufacturing cost.

[0007] JP 5-277511 A (Patent Document 1) and JP 8-215714 A (Patent Document 2) both disclose invention related to a disk roll. However, the invention disclosed by Patent Document 1 is directed to reducing the gap between the roll for piercing and the disk roll and the invention disclosed by Patent Document 2 is directed to piercing and rolling a thin hollow shell with a high pipe expansion ratio. In other words, they are not directed to a solution to the difficulty in manufacturing and transporting a disk roll.

DISCLOSURE OF THE INVENTION

[0008] It is an object of the present invention to provide a disk roll that can easily be manufactured and transported and a method of manufacturing a seamless pipe or tube using the same.

[0009] A disk roll according to the invention is for use in a piercer. The disk roll includes a shaft member and a circular ring member. The shaft member has the driving shaft of the disk roll in its center and has a disk shape. The circular ring member is mounted to the outer circumference of the shaft member and has an outer circumferential surface recessed in cross section. The circular ring member includes a plurality of arcuate members arranged in the circumferential direction.

[0010] Since the circular ring member of the disk roll according to the invention includes the plurality of arcuate members arranged in the direction of the same circumference, the circular ring member does not have to be integrally molded. This can reduce the manufacturing cost. The circular ring member is divided into the arcuate members and therefore can easily be transported.

[0011] The outer diameter of one side surface of the circular ring member is preferably larger than the outer diameter of the other side surface. The arcuate members each have an inner surface ridge formed along an edge of the inner circumferential surface on the side surface side having a larger outer diameter. The shaft member has an outer surface ridge formed along one side edge of the outer circumferential surface and fitted to the inner surface ridge. One of the inner and outer surface ridges has a screw hole at a surface opposed to the other ridge. The other of the inner and outer surface ridges has a through hole in a position opposed to the screw hole, and a screw is inserted into the through hole and the screw hole to securely mount the arcuate member to the shaft member.

[0012] In this way, as the arcuate member is mounted to the shaft member, the inner surface ridge of the arcuate

member is fitted to the outer surface ridge of the shaft member. During piercing and rolling, a billet advances from the side surface of the disk roll having a larger outer diameter (hereinafter referred to as "inlet side surface") to the side surface having a smaller outer diameter (hereinafter referred to as "outlet side surface"). Therefore, during the piercing and rolling, force directed from the inlet side surface to the outlet side surface acts upon the arcuate members, so that the inner surface ridge continues to be energized toward the outer surface ridge. Therefore, it is unlikely that the arcuate members come off from the shaft member and are damaged during the piercing and rolling.

[0013] One of the inner and outer surface ridges preferably has a fitting ridge formed in the circumferential direction at a surface opposed to the other ridge. The other of the inner and outer surface ridges has a groove fitted to the fitting ridge in a position opposed to the fitting ridge.

[0014] In this way, when the arcuate members are mounted to the shaft member, the fitting ridge and the groove are fitted to each other, so that the arcuate members are unlikely to be shifted in the radial direction (vertical direction). In short, the shakiness of the arcuate members in the radial direction can be suppressed. Therefore, it is unlikely that the circular ring member has a step between the arcuate members adjacent to each other and therefore the pipe or tube can be less prone to flaws.

[0015] The outer surface ridge preferably has the screw hole at a surface opposed to the inner surface ridge and the inner surface ridge has the through hole in a position opposed to the screw hole. The diameter of the through hole is greater than the diameter of a screw head from the inlet side to a prescribed position deeper than the height of the screw head and smaller than the diameter of the screw head from the prescribed position to the outlet side.

[0016] In this way, the screw head can be fitted inside the inner surface ridge and does protrude from the inlet side surface. In order to prevent a billet in the process of piercing and rolling from being subjected to the peeling phenomenon, the inlet side surface of the disk roll must be close to the inclined rolls, so that the gaps between the disk rolls and the inclined rolls are reduced. If the screw head protrudes from the inlet side surface, the gaps cannot be reduced. The screw head is fitted inside the inner surface ridge and thus prevented from protruding from the inlet side surface, so that the gaps between the disk rolls and the inclined rolls can be reduced, which suppress the generation of peeling.

[0017] Both end surfaces of each of the arcuate members are preferably inclined to the inner circumferential surface and adjacent arcuate members are fitted to each other by their opposed end surfaces.

[0018] When the advancing speed of a billet in the process of piercing and rolling is different from the rotation speed of the disk roll, the billet surface and the outer

circumferential surface of the disk roll slide against each other in the advancing direction. A gap formed at the end contact part of adjacent arcuate members if any makes it easier for the billet to partly come into the gap. If the billet thus partly comes in, the ends of the arcuate members become more prone to cracks. If the gap extends as the part of the billet enters, corners of the ends of the arcuate members are more likely to contact the billet and the billet is prone to flaws. Both end surfaces are inclined to the inner circumferential surface, and therefore if a gap forms between adjacent arcuate members, it is unlikely that a part of the billet enters the gap. In this way, cracks and flaws at the ends can be suppressed.

[0019] A method of manufacturing a seamless pipe or tube according to the invention uses a piercer having inclined rolls and the above-described disk rolls. The method of manufacturing a seamless pipe according to the invention includes the steps of determining whether the advancing speed of a billet determined by the number of revolutions of the inclined roll is greater than the rotation speed of the disk roll, providing, in the piercer, disk rolls in which both end surfaces of each of the arcuate members on the outer circumferential surface side are more inclined to the rotation direction of the disk roll than on the inner circumferential side if the advancing speed of the billet is higher than the rotation speed of the disk roll and disk rolls in which both end surfaces of each of the arcuate members on the inner circumferential surface side are more inclined to the rotation direction of the disk roll than on the outer circumferential side if the advancing speed of the billet is lower than the rotation speed of the disk roll, based on the determination result, and piercing and rolling the billet into a seamless pipe or tube using the piercer including the disk roll.

[0020] In this way, arcuate members to apply are determined in consideration of the result of comparison between the advancing speed of the billet and the rotation speed of the disk roll. Therefore, if a gap forms at the end surface contact part of adjacent arcuate members, the gap extends in the direction opposite to the relative speed of the billet to the disk roll from the outer circumferential surface to the inner circumferential surface. Consequently, a part of the billet can be prevented from coming into the gap during the piercing and rolling.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1A is a side view of a disk roll according to an embodiment of the invention;

Fig. 1B is a front view of the disk roll shown in Fig. 1A;

Fig. 2 is an enlarged view of the region 50 in Fig. 1;

Fig. 3 is a sectional view taken along line III-III in Fig. 2;

Fig. 4 is a schematic view for use in illustrating force acting upon an arcuate member in the disk roll during piercing and rolling;

Fig. 5 is a schematic view of the structure of a roll piercer when the advancing speed of a billet is higher than the rotation speed of a disk roll;

Fig. 6 is a schematic view of the structure of a roll piercer when the advancing speed of a billet is lower than the rotation speed of a disk roll;

Fig. 7 is a sectional view of a disk roll having another structure different from that in Fig. 3;

Fig. 8 is a sectional view of a disk roll having yet another structure different from those in Figs. 3 and 7;

Fig. 9 is a sectional view of a disk roll having yet another structure different from those in Figs. 3, 7, and 8;

Fig. 10 is a side view of a roll piercer using a conventional disk roll;

Fig. 11 is a schematic view of the conventional roll piercer viewed from the outlet side of a billet; and

Fig. 12 is a schematic view of the structure of the disk roll in Figs. 10 and 11.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] Now, an embodiment of the present invention will be described in detail in conjunction with the accompanying drawings, in which the same or corresponding portions are denoted by the same reference characters and their description will not be repeated.

Structure

[0023] With reference to Figs. 1A and 1B, a disk roll 1 is provided in a piercer 100 in place of the disk roll 200 shown in Figs. 10 and 11. The disk roll 1 includes a shaft member 10 and a circular ring member 20 fitted to the outer circumference of the shaft member 10.

[0024] The shaft member 10 has a disk shape and has the driving shaft 16 of the disk roll 1 in its center. In Figs. 1A and 1B, a plurality of through holes 17 are provided at equal intervals in the circumferential direction in order to reduce the weight of the disk roll 1 as a whole.

[0025] The circular ring member 20 has a circular ring shape and is fitted to the shaft member 10. The outer circumferential surface of the circular ring member 20 has a recessed arcuate shape in cross section. Note that the cross sectional shape may be a recessed groove shape. The outer circumferential surface contacts a billet in the process of piercing and rolling and can restrict the billet to some extent, so that the surface serves as a guide.

[0026] Among two side surfaces of the circular ring member 20, the side surface corresponding to the rotation inlet side of the billet rotated in the circumferential direction (hereinafter referred to as "inlet side surface") 1SI has an outer diameter greater than that of the side surface corresponding to the rotation outlet side of the billet (hereinafter referred to as "outlet side surface") 1SO. This is for preventing the billet from being subjected

to the peeling phenomenon in the process of piercing and rolling.

[0027] The circular ring member 20 includes a plurality of arcuate members 30 arranged in a line in the circumferential direction. The arcuate members 30 are each secured to the outer circumference of the shaft member 10 using screws.

[0028] In this way, the circular ring member 20 of the disk roll 1 according to the embodiment is made of the plurality of arcuate members 30 and therefore does not have to be integrally molded. Therefore, the manufacturing cost can be reduced. In addition, the circular ring member can be transported and mounted/detached to/from the shaft member 10 more easily as it is divided into the arcuate members 30.

[0029] With reference to Figs. 2 and 3, the circular ring member 20 is divided into the arcuate members 30, each of which has arcuate side surfaces. A ridge (hereinafter referred to as "inner surface ridge") 33 is formed along the edge of the inlet side surface 30SI on the inner circumferential surface 31 of the arcuate member 30. At the fitting surface 34 of the inner surface ridge 33, a ridge (hereinafter referred to as "fitting ridge") 35 is formed along the edge of the inner surface ridge 33, i.e., in the circumferential direction.

[0030] On the other hand, on the outer circumferential surface 11 of the shaft member 10, a ridge (hereinafter referred to as "outer surface ridge") 12 is formed along one side edge and a groove 14 is formed in a position at the fitting surface 13 of the outer surface ridge 12 opposed to the fitting ridge 35.

[0031] When the arcuate member 30 is mounted to the shaft member 10, the inner surface ridge 33 of the arcuate member 30 is fitted to the outer surface ridge 12 of the shaft member 10 and the fitting ridge 35 is fitted to the groove 14. The inner surface ridge 33 is provided with through holes 36 that extend to the fitting surface 34 from the inlet side surface 30SI. The outer surface ridge 12 has a screw hole 15 in the position of the fitting surface 13 opposed to the through hole 36. As screws 40 are inserted and threadably fitted to the screw holes 15, the arcuate members 30 are securely mounted to the shaft member 10. In Fig. 2, three through holes 36 are provided at each of the arcuate members 30 in the circumferential direction of the disk roll 1 but the number of the through holes 36 may be one or more.

[0032] As shown in Fig. 4, during piercing and rolling, the billet 400 advances as it rotates from the inlet side surface of the disk roll 1 to the outlet side surface. Therefore, force F0 directed from the inlet side surface 30SI to the outlet side surface 30SO acts upon the arcuate members 30 during the piercing and rolling, so that the inner surface ridge 33 is pressed against the outer surface ridge 12 by the force F0. Therefore, the arcuate members 30 are more securely mounted to the shaft member 10 using the force F0 received from the billet 400 in the process of piercing and rolling. In this way, an excessive load is unlikely to be applied on the screws 40 during the pierc-

ing and rolling, and screws 40 are not easily flawed.

[0033] As shown in Fig. 3, the screw head 41 of the screw 40 is inserted to the through hole 36. The screw head 41 does not protrude from the inlet side surface 30SI. More specifically, at the through hole 36, the diameter D1 of the through hole 36 from the inlet side surface 30SI, from which the screw 40 is inserted, to the position of a depth L1 longer than the height L0 of the screw head 41 is greater than the diameter D0 of the screw head 41. The diameter D2 of the screw hole 36 from the position of the depth L1 to the fitting surface 34 is smaller than the diameter D0 of the screw head 41.

[0034] Since the through hole 36 is formed to have this shape, the screw head 41 is fitted inside the inner surface ridge 33 and does not protrude from the inlet side surface 30SI. In order to suppress the billet 400 in the process of piercing and rolling from being subjected to the peeling phenomenon, the inlet side surface 30SI of the disk roll 1 must be provided close to the inclined rolls 300, so that the gaps G1 and G2 between the disk roll 1 and the inclined rolls 300 are as small as possible. If the screw heads 41 protrude from the inlet side surface 30SI, the gaps G1 and G2 cannot be reduced for the space corresponding to the protrusion. As the screw heads 41 are fitted inside the inner surface ridge 33, the gaps G1 and G2 can be reduced, and the peeling phenomenon can be suppressed.

[0035] As shown in Fig. 2, both end surfaces 37 of each of the arcuate members 30 are flat and inclined with respect to the inner circumferential surface 31. Two adjacent arcuate members 30 are fitted to each other by the opposed end surfaces 37. More specifically, one end surface 37 of each of the arcuate members 30 is inclined at an angle of θ° ($0^\circ < \theta < 180^\circ$) with respect to the inner circumferential surface 31 and the other end surface 37 is inclined at an angle of $180 - \theta^\circ$ with respect to the inner circumferential surface 31. The angle of one of the end surfaces 37 is θ° and the other angle is $180 - \theta^\circ$. Therefore, the end surfaces of adjacent arcuate members 30 are fitted to each other.

[0036] In this way, both end surfaces 37 are inclined with respect to the inner circumferential surface 31, so that a part of the billet 400 can be prevented from coming into the contact part 38 between arcuate members 30 adjacent to each other during the piercing and rolling as will be described.

Piercing and Rolling

[0037] A method of manufacturing a seamless pipe or tube using the disk roll 1 having the structure as described above is as follows.

[0038] To start with, in a roll piercer 100 to be used, it is determined whether the advancing speed of a billet 400 in the process of piercing and rolling is greater than the rotation speed of the disk roll 1. The advancing speed of the billet 400 in the process of piercing and rolling is calculated based on the rotation speed of the inclined

rolls 300. Therefore, the determination can be made before piercing and rolling is actually carried out.

[0039] As shown in Fig. 5, if the advancing speed V400 of the billet 400 is more than the rotation speed V1 of the disk roll 1 as the result of determination, in a disk roll 1 to be used, the outer circumferential side 371 of the end surface 37 of each of the arcuate members 30 is more inclined to the rotation direction of the disk roll than the inner circumferential surface side 372. Note that the inclined rolls are not shown in Fig. 5.

[0040] When the advancing speed of the billet 400 is different from the rotation speed of the disk roll 1, the billet surface and the outer circumferential surface 39 of the disk roll 1 slide against each other in the lengthwise direction of the billet 400. The sliding causes a part of the billet 400 to come into the contact part 38 between arcuate members 30 adjacent to each other. If the billet 400 thus comes in, a gap forms at the contact part 38 and cracks may form at the ends of the arcuate members 30 in some cases. Furthermore, it can be expected that if the gap extends, a corner of the end of the arcuate member 30 will flaw the billet.

[0041] In the disk roll 1 having the structure shown in Fig. 5, a gap forming at the contact part 38 if any extends from the outer circumferential surface 39 toward the inner circumferential surface 31 in the opposite direction to the direction of the relative speed Vr of the billet to the rotation speed of the disk roll 1. Therefore, during the piercing and rolling, it is unlikely that a part of the billet 400 comes into the gap. In this way, cracks at the end of the arcuate members 30 and flaws on the billet can be suppressed.

[0042] If it is determined that the advancing speed V400 of the billet is less than the rotation speed V1 of the disk roll 1, in a disk roll 1 to be used, the inner circumferential surface side 372 of the end surface 37 of each of the arcuate members 30 is more inclined to the rotation direction of the disk roll 1 than the outer circumferential surface side 371 as shown in Fig. 6.

[0043] In this way, a gap forming at the contact part 38 if any extends in the opposite direction to the direction of the relative speed Vr of the billet to the disk roll 1 from the outer circumferential surface 39 to the inner circumferential surface 31, and therefore a part of the billet 400 is unlikely to come into the gap.

[0044] When a seamless pipe or tube is produced by the foregoing method, the ends of the arcuate members 30 can be prevented from being cracked and the billet surface can be prevented from being flawed.

[0045] Note that in the structure in Fig. 2, the fitting ridge 35 is provided along the edge of the fitting surface 34 of the inner surface ridge 33 but the fitting ridge 35 may be formed in the circumferential direction on a surface of fitting surface 34 other than at the edge side as shown in Fig. 7. As shown in Fig. 8, the fitting ridge 35 may be formed on the fitting surface 13 and a groove 14 corresponding to the fitting ridge 35 may be formed at the fitting surface 34. A through hole 36 may be provided at the outer surface ridge 12 of the shaft member 10 and

a screw hole 15 may be provided in a corresponding position of the arcuate member 30. Furthermore, as shown in Fig. 9, the inner surface ridge 33 may be fitted to the outer surface ridge 12 without forming the fitting ridge 35 and the groove 14.

[0046] According to the embodiment, two disk rolls 1 are provided one above the other around the pass center O, while they may be provided side by side. In this case, the inclined rolls 300 are provided one above the other.

[0047] Although the embodiment of the present invention has been described, the same is by way of illustration and example only and is not to be taken by way of limitation. The invention may be embodied in various modified forms without departing from the spirit and scope of the invention.

Claims

1. A disk roll for use in a piercer, comprising:

a disk-shaped shaft member including a driving shaft of said disk roll in its center; and
a circular ring member mounted to an outer circumference of said shaft member and having an outer circumferential surface recessed in cross section,

said circular ring member including a plurality of arcuate members arranged in the circumferential direction.

2. The disk roll according to claim 1, wherein an outer diameter of one side surface of said circular ring member is larger than an outer diameter of the other side surface,
said arcuate members each include an inner surface ridge formed along an edge of an inner circumferential surface on the side surface side having the larger outer diameter,
said shaft member includes an outer surface ridge formed along one side edge of the outer circumferential surface and fitted to said inner surface ridge,
one of said inner and outer surface ridges has a screw hole at a surface opposed to the other, said other of said inner and outer surface ridges has a through hole in a position opposed to said screw hole, and a screw is inserted into said through hole and said screw hole to securely mount said arcuate member to said shaft member.

3. The disk roll according to claim 2, wherein one of said inner and outer surface ridges includes a fitting ridge formed in the circumferential direction at a surface opposed to the other, and
said other of said inner and outer surface ridges has a groove fitted to said fitting ridge in a position opposed to said fitting ridge.

4. The disk roll according to claim 2, wherein said outer surface ridge has the screw hole at a surface opposed to said inner surface ridge and said inner surface ridge has the through hole in a position opposed to said screw hole, and

a diameter of said through hole is greater than a diameter of a screw head from an inlet side to a prescribed position deeper than a height of said screw head and smaller than the diameter of said screw head from said prescribed position to an outlet side.

5. The disk roll according to any one of claims 1 to 4, wherein both end surfaces of each said arcuate member are inclined to the inner circumferential surface and adjacent arcuate members are fitted to each other by their opposed end surfaces.

6. A method of manufacturing a seamless pipe or tube using a piercer having inclined rolls, comprising the steps of:

preparing a disk roll including a disk-shaped shaft member having a driving shaft in its center and a circular ring member mounted to the outer circumference of said shaft member and having an outer circumferential surface recessed in cross section, said circular ring member including a plurality of arcuate members arranged in the circumferential direction, both end surfaces of each said arcuate member being inclined to a inner circumferential surface thereof, adjacent arcuate members being fitted to each other by their opposed end surfaces;
determining whether the advancing speed of a billet determined by the number of revolutions of said inclined roll is higher than the rotation speed of said disk roll;
providing, in said piercer, a disk roll in which both end surfaces of each said arcuate member on an outer circumferential surface side thereof are more inclined to the rotation direction of the disk roll than on the inner circumferential side if the advancing speed of said billet is higher than the rotation speed of said disk roll, and a disk roll in which both end surfaces of each said arcuate member on the inner circumferential surface side are more inclined to the rotation direction of the disk roll than on the outer circumferential side if the advancing speed of said billet is lower than the rotation speed of said disk roll, based on said determination result; and
piercing and rolling said billet into a seamless pipe or tube using the piercer including said disk roll.

FIG.1A

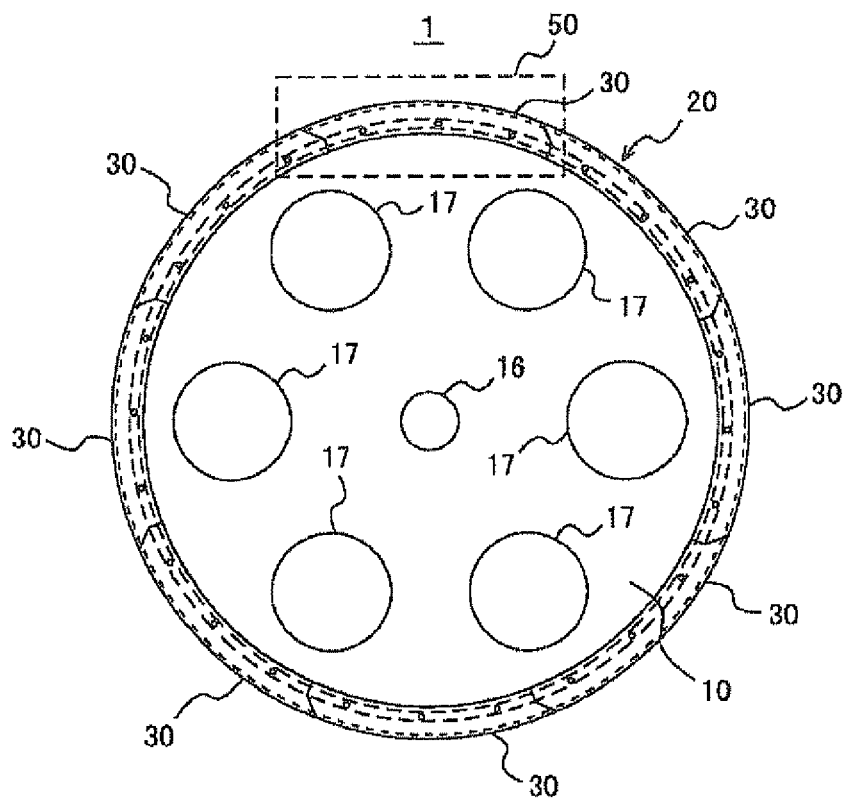


FIG.1B

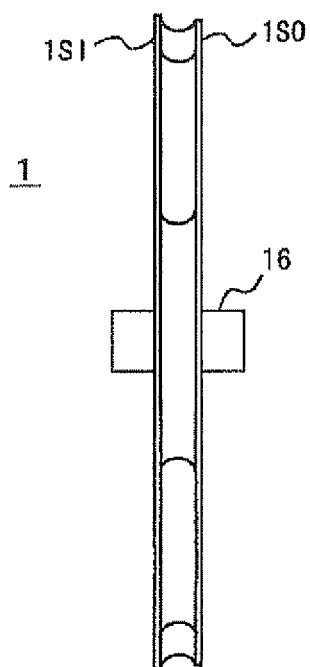


FIG.2

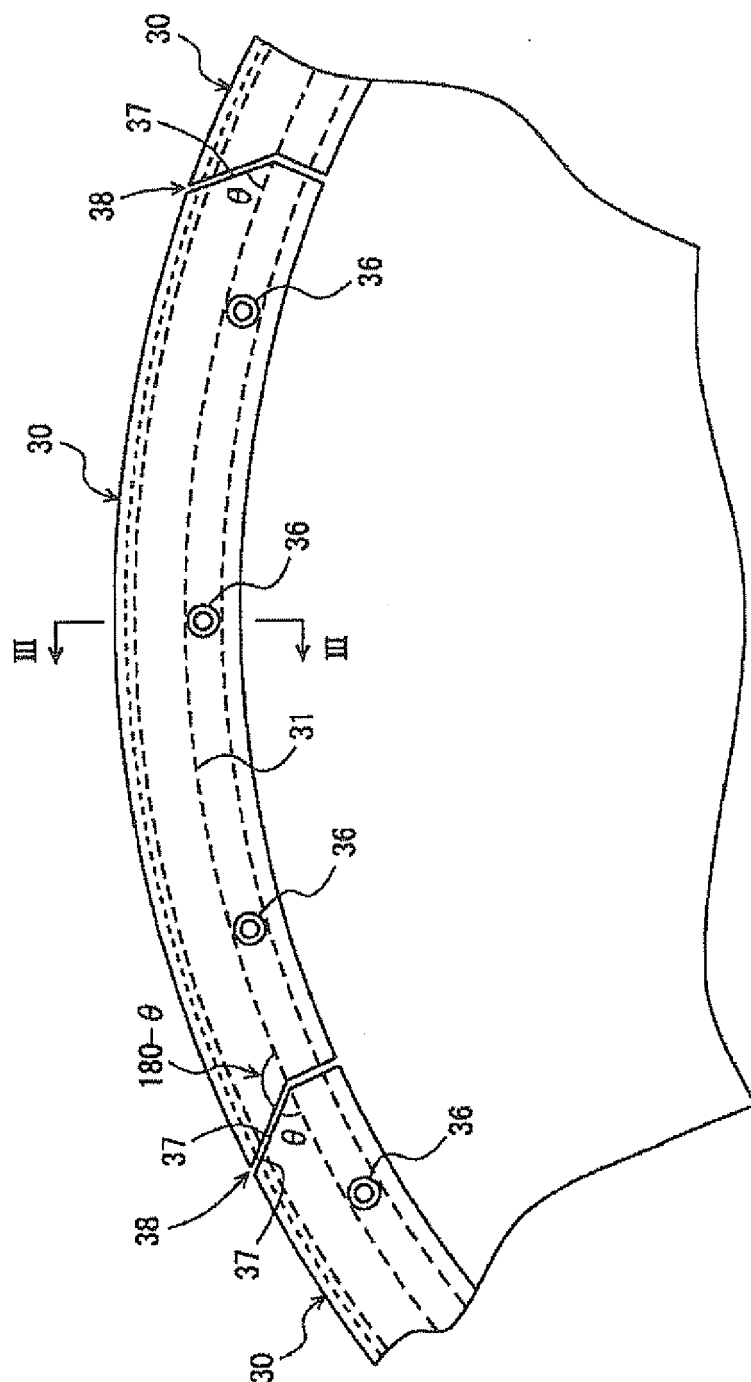


FIG.3

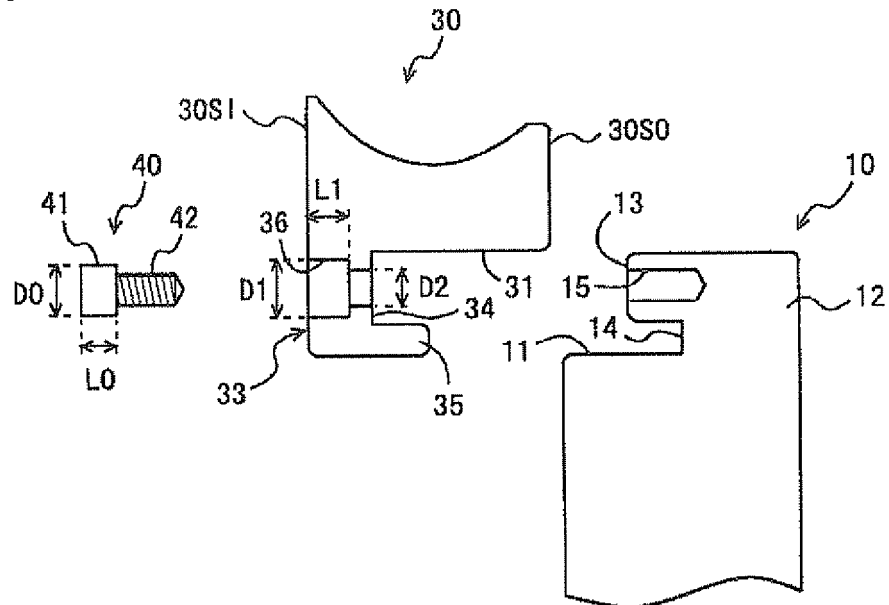


FIG.4

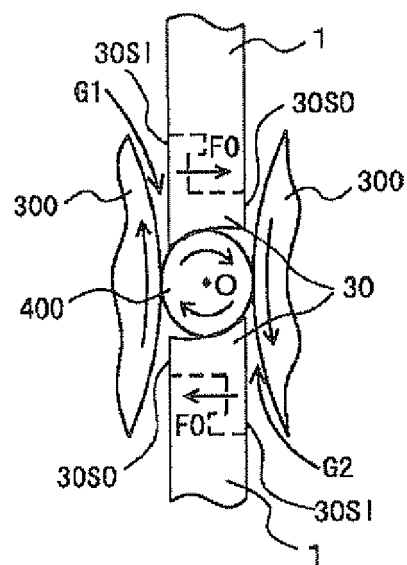


FIG.5

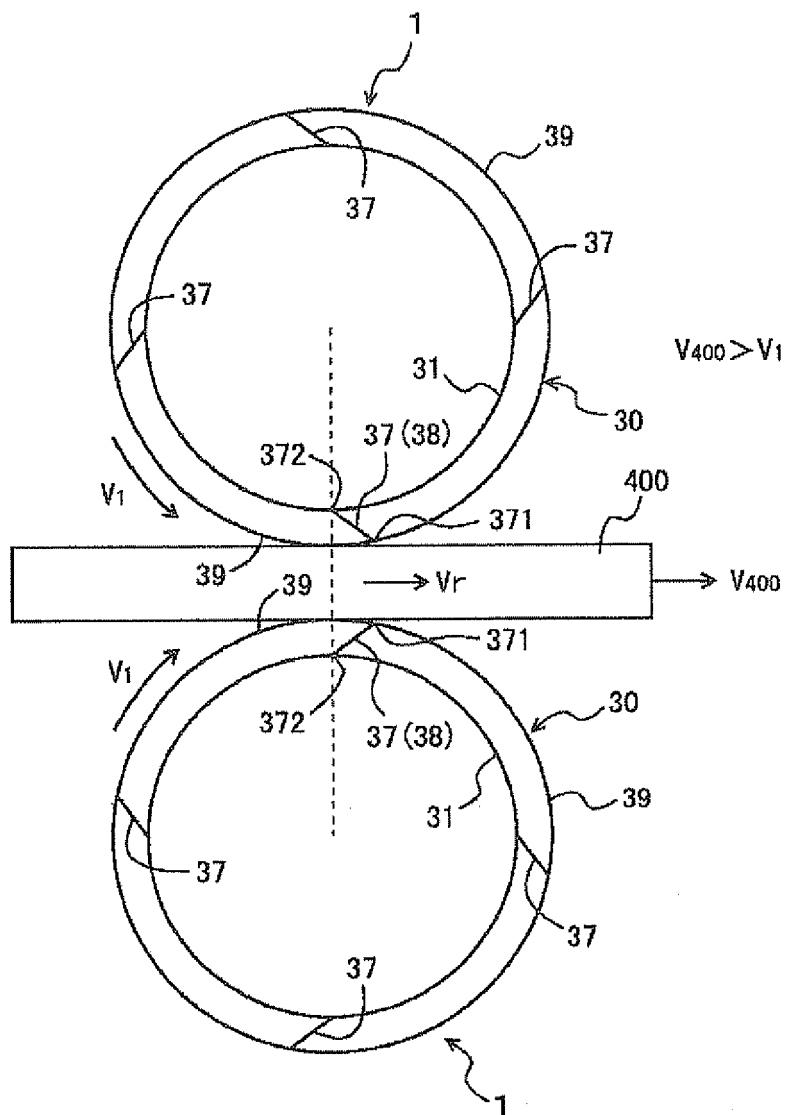


FIG.6

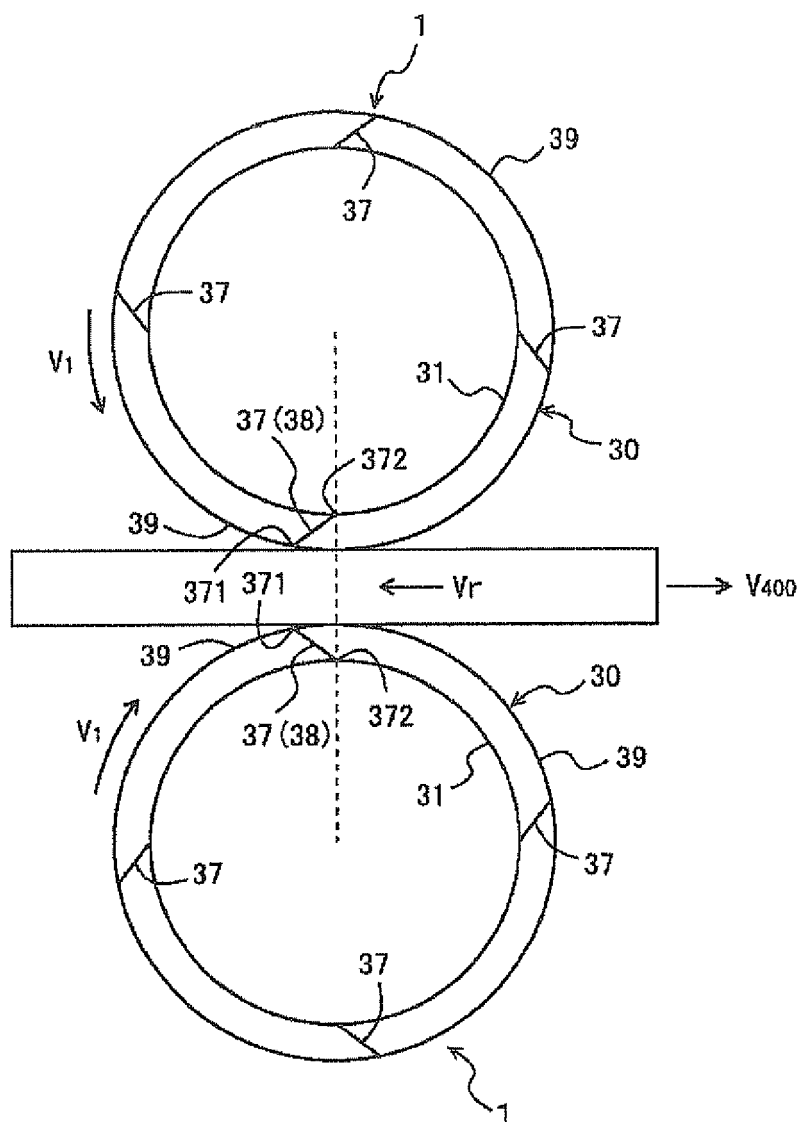


FIG.7

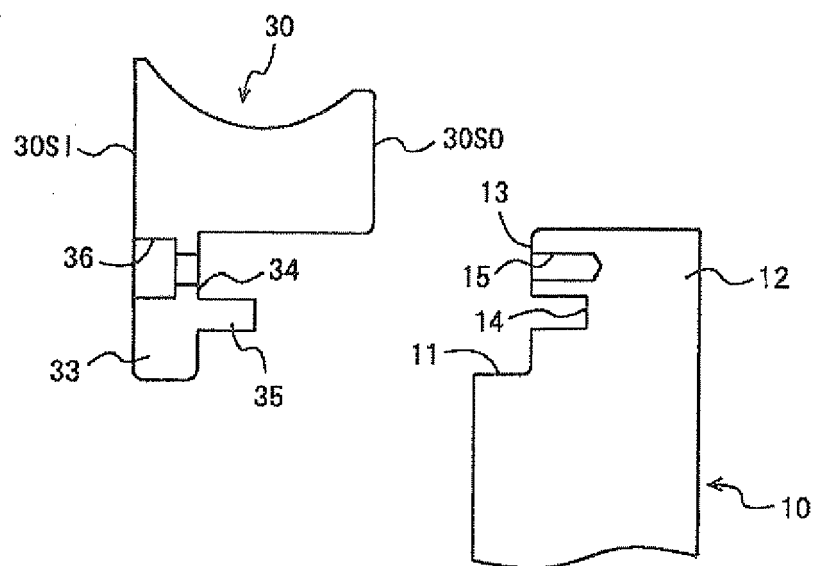


FIG.8

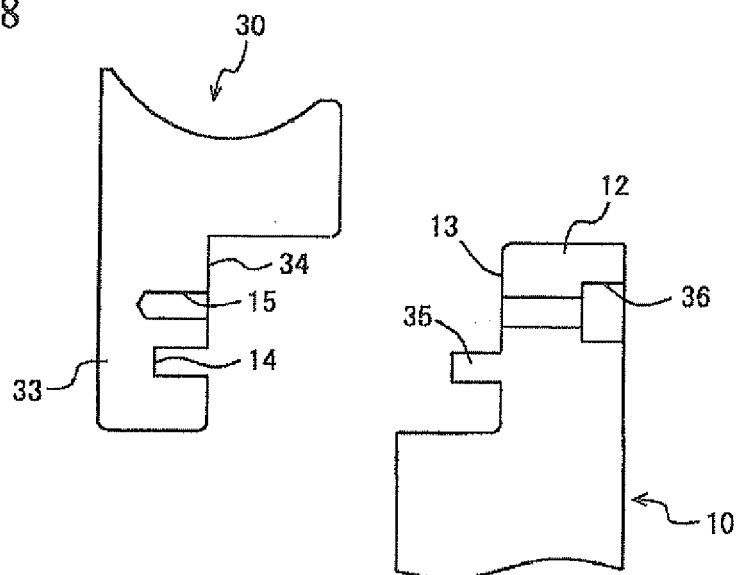


FIG.9

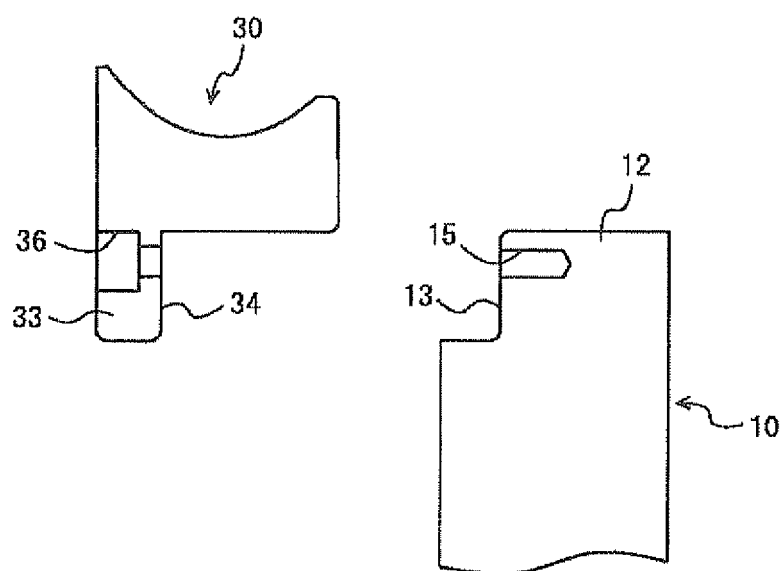


FIG.10

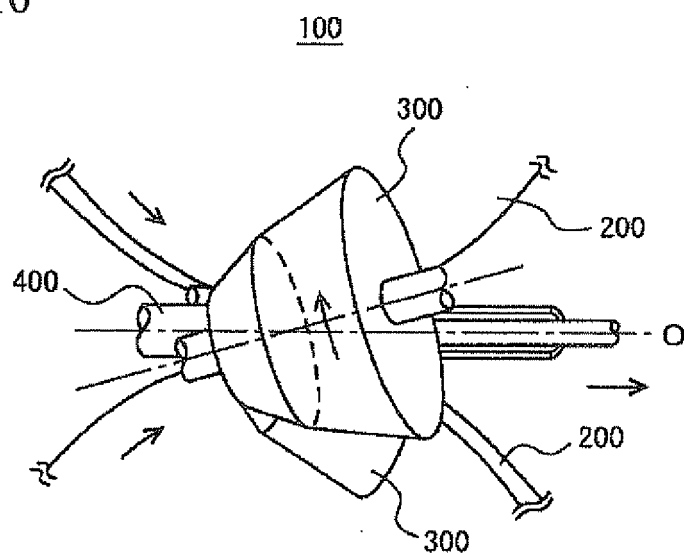


FIG.11

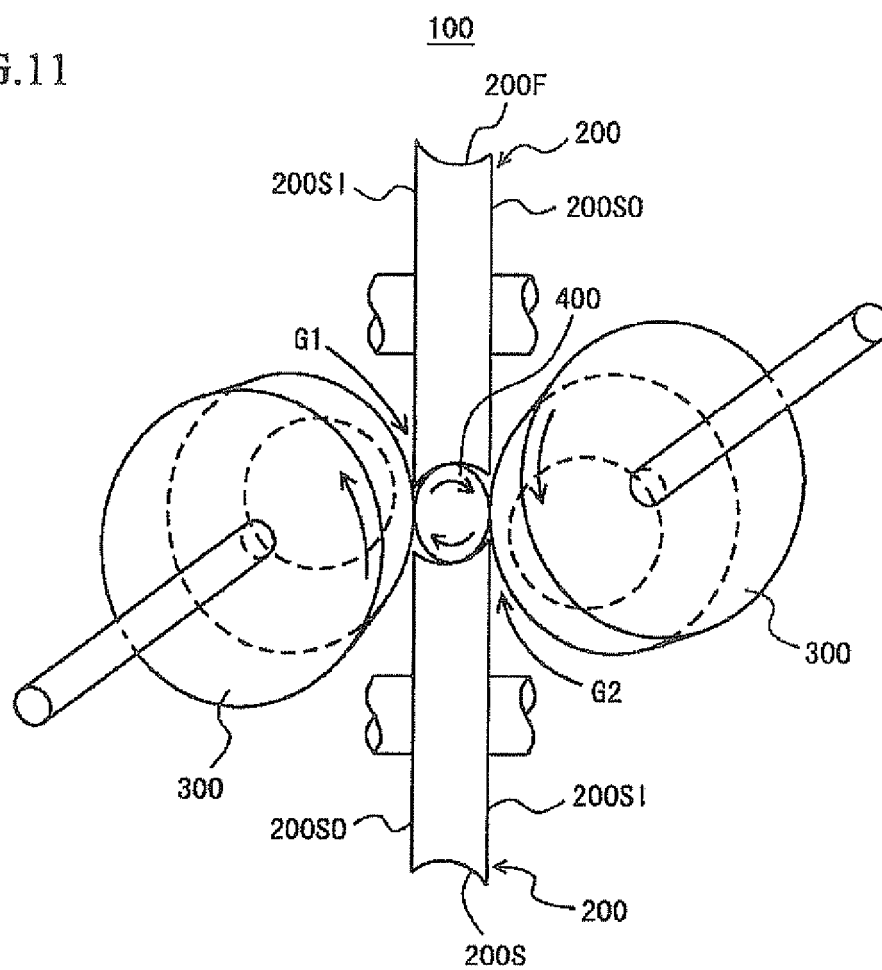
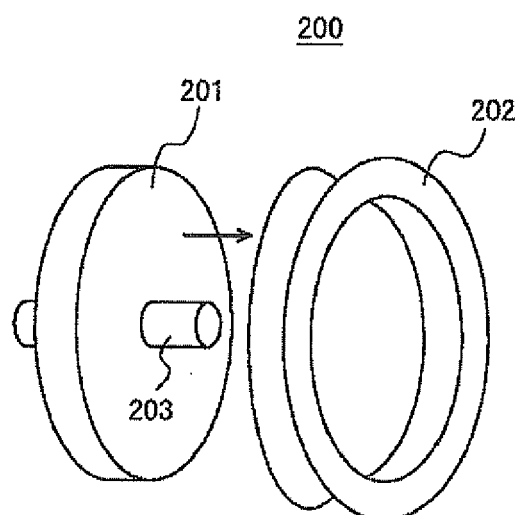


FIG.12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/052763

A. CLASSIFICATION OF SUBJECT MATTER

B21B23/00(2006.01) i, B21B19/04(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)

B21B23/00, B21B19/04, B21B39/14

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
 Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 76228/1986 (Laid-open No. 189803/1987) (Kawasaki Steel Corp.), 03 December, 1987 (03.12.87), Claims; column 8, lines 2 to 11; Figs. 1, 5 (Family: none)	1 2-6
A	JP 2005-349415 A (Sumitomo Metal Industries, Ltd.), 22 December, 2005 (22.12.05), Fig. 6 (Family: none)	2-6

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

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Date of the actual completion of the international search
08 May, 2007 (08.05.07)Date of mailing of the international search report
15 May, 2007 (15.05.07)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5277511 A [0007]
- JP 8215714 A [0007]