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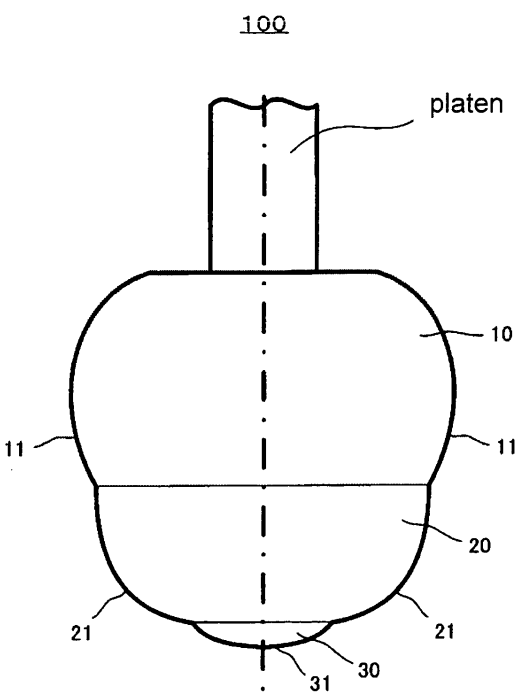
(54) PUNCH DEVICE FOR U-PRESS IN UOE STEEL TUBE MANUFACTURING PROCESS

(57) The present invention provides a punch device for U-press in a UOE steel pipe manufacturing process capable of coping with various manufacturing pipe sizes and reducing the width of a U-shaped pipe after U-press less than that by a conventional punch device for U-press. The punch device (100) used in the UOE steel pipe manufacturing process comprises a first punch part (10) having semi-cylindrical press faces (11), (11) on both side-faces, a second punch part (20) disposed in contact with the lower side of the first punch part (10) and having semi-cylindrical press faces (21), (21), which are the same as or different from the press faces (11), on both side-faces, and a third punch part (30) disposed in contact with the lower side of the second punch part (20) and having a downward semi-cylindrical press face (31).

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a punch device for U-press in UOE steel pipe manufacturing process.

Background Art

[0002] UOE steel pipe is a pipe or tube (hereinafter, refer to "pipe" as "pipe or tube") used for line pipe for transporting mainly petroleum, natural gas, and the like. The name of UOE comes from its representative manufacturing process. UOE steel pipe manufacturing process which consists of about 20 major processes includes a crimping process (C-process) to bend the end of a steel plate, a U-process to obtain U-shaped pipe, and O-process to obtain hollow cylindrical pipe. A steel plate processed by such manufacturing processes is then treated with a welding process, an expanding (Expander) process, and an inspection process to become an end-product (UOE steel pipe).

[0003] In the above processes, C-process of the UOE steel pipe is a crimping process to bend the vicinity of end of a steel plate in the width direction in proportion to the diameter of the pipe. Its object is to reduce the load for forming in O-process and to minimize the peaking which is a remaining steel-plate end as a flat portion.
In U-process after the above C-process, the flat plate having crimped-end is formed into U-shaped pipe by using a press (U-press) having self-opening dies, and is formed into a shape capable of being transported into an apparatus for 0-process. Further, in O-process, the U-shaped pipe treated by U-process is formed into O-shaped pipe by using a press (O-press) having self-closing dies. At this point, in order to improve the precision of the size, a little aperture is given to the pipe under O-press.
A steel pipe internally or externally welded after O-process, in many cases, still does not meet the required size regarding diameter and roundness of an end-product steel pipe. So, such a pipe is set right by pipe expansion (cold expansion) after welding. In this pipe expansion process, residual stress introduced by the above processes and welding is removed by providing plastic elongation over the all steel-pipe wall thickness.

[0004] UOE steel pipes manufactured through such processes, as the size of pipe product is varied, usually need to change the tool in each step of C-process, U-press, O-press, and pipe expansion depend on the size of pipe product. But, it takes long time to change U-punches for U-press apparatus, and it costs enormously if U-punches need to be made per each pipe product size. Thus, a U-punch which is capable of coping with plural manufacturing pipe sizes is needed.

[0005] Studies about U-punch which is capable of coping with plural manufacturing pipe sizes have been done. For example, Patent Document 1 discloses an art relates to a U-punch device which is possible to telescopically adjust the punch dimensions by adjusting the cylinder accompanying with the U-punch. According to this U-punch device, when (two or more) pipes whose manufacturing pipe sizes are approximate each other, punch exchange is not necessary. Moreover, it says, processing by using this device makes it possible to keep the shape of pipe after U-press constant.

[0006] Patent Document 1: Japanese Patent Application Laid-Open No. 59-109116

Disclosure of the Invention

Problems to be Solved by the Invention

[0007] However, the punch incorporated in the U-punch device disclosed in Patent Document 1 simply has two types of punches having different curvature radiuses each other. So, when a rocker assembly type U-press is used, the punch can not provide enough curvature to the pipe.

[0008] On the other hand, in recent years, demand of high-strength line pipe capable of high-pressure transportation is increasing for the improvement of transportation efficiency. When such a high-strength material is processed by a conventional U-punch device, degree of spring back (release from bending) of the material caused after U-press becomes larger. Therefore, if the opening width of U-shaped pipe particularly after U-press is larger than the diameter of dies of O-press apparatus, the U-shaped pipe cannot be transported and inserted into the O-press apparatus.

[0009] Accordingly, an object of the present invention is to provide a punch device for U-press in UOE steel pipe manufacturing process, which is capable of coping with various manufacturing pipe sizes and reducing the width of U-shaped pipe less than that by a conventional punch device for U-press.

Means for Solving the Problems

[0010] Hereinafter, the present invention is described in detail. Also, reference numerals in the attached drawings are quoted in the bracket to help understanding of the present invention. However, the invention is not limited by the em-

bodiments disclosed in such drawings.

[0011] The present invention of claim 1 is a punch device for U-press (100) in UOE steel pipe manufacturing process. This device comprises a first punch part (10) having semi-cylindrical press faces (11), (11) on both side-faces, a second punch part (20) disposed in contact with the lower side of the first punch part (10) and having semi-cylindrical press faces (21), (21) on both side-faces, which are the same as or different from that of the press faces (11), a third punch part (30) disposed in contact with the lower side of the second punch part (20) and having downward semi-cylindrical press face (31). Whereby, this invention provides the punch device for U-press (100), so as to solve the above-mentioned problems.

[0012] According to the invention of claim 1, it is possible to provide a punch device for U-press (100) which is capable of reducing the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press.

[0013] The invention of claim 2 is a punch device for U-press (100) according to claim 1, wherein the first punch part (10) and/or the second punch part (20) are/is capable of enlarging or reducing the distance between the press faces (11) and (11) and/or the distance between the press faces (21) and (21).

[0014] According to the invention of claim 2, it is possible to provide a punch device for U-press (100) which is capable of reducing the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press, and which is capable of coping with various manufacturing pipe sizes.

Effects of the Invention

[0015] According to the present invention, it is possible to provide a punch device for U-press in UOE steel pipe manufacturing process, which is capable of coping with various manufacturing pipe sizes and reducing the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press.

Brief Description of the Drawings

[0016]

Fig.1 is a schematic view showing an embodiment of a punch device of the present invention;
Fig.2 is a schematic view of the width of U-shaped pipe;
Fig.3 is a schematic view showing a pattern of conventional punch device;
Fig.4 is a view showing a pattern of conventional punch device using U-press;
Fig.5 is a view showing a pattern of punch device of the invention using U-press;
Fig.6 is a schematic view showing U-process by using the punch device of the invention;
Fig.7 is a schematic view showing an embodiment of a punch device of the invention; and
Fig.8 is a schematic view showing a punch device for U-press applying the invention.

Description of the reference numerals

[0017]

5	U-shaped pipe
10	first punch part
11, 21, 31	press face
20	second punch part
30	third punch part
100, 200	punch device for U-press

Best Mode for Carrying Out the Invention

[0018] Hereinafter, the present invention is described based on the embodiments shown in the drawings.
Fig.1 is a schematic view showing an embodiment of a punch device for U-press of the present invention.
A punch device for U-press 100 of the present invention comprises a first punch part 10, a second punch part 20, and a third punch part 30. The first punch part 10 has semi-cylindrical press faces 11, 11 of curvature radius R1 on both side-faces. The second punch part 20 which is disposed in contact with the lower side of the first punch part 10 has semi-cylindrical press faces 21, 21 of curvature radius R2 on both side-faces. And, the third punch part 30 is disposed in contact with the lower side of the second punch part 20 and has downward semi-cylindrical press face 31 of curvature radius R3.
Such a constitution of the punch device for U-press of the invention, as described later, makes it possible to efficiently

deform the U-shaped pipe than ever before. Therefore, it is capable of reducing the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press. Fig. 2 is a schematic view of the width of U-shaped pipe. Hereinafter, the wording "width of U-shaped pipe" means a maximum width of U-shaped pipe 5, which is perpendicular to the pipe-axis direction of U-shaped pipe 5 and is in the horizontal direction.

[0019] In order to make the description of the punch device of the invention easier, a constitutional example of a conventional punch device is schematically shown in Fig.3. The conventional punch device includes: a pair of punch A having semi-cylindrical steel-pipe press faces, and a punch B having downward semi-cylindrical steel-pipe press faces, wherein a curvature radius of press faces in the pair of punch A is at least larger than the above R1 and R2. A schematic view showing a rocker assembly type U-press using a conventional punch device is shown in Fig.4. This type of U-press has a punch device and a pair of rocker dies 50, 50 to be used for processing U-shaped pipe 45. The pair of rocker dies 50, 50 respectively have rocker shoes 51, 52, and rotation center 53 immobile during processing operation.

In the U-press using a conventional punch device, the shape of side part (i.e., an area from a part where the U-shaped pipe is in contact with the punch A to the U-shaped pipe end. Hereinafter, same as this.) of U-shaped pipe 45 is determined by the press faces provided for a pair of rocker dies 50, 50 and a pair of punch A, it is difficult to sufficiently deform the side parts of U-shaped pipe 45. Particularly, if the U-shaped pipe 45 being processed by a conventional punch device consists of high-strength material, unless sufficient deformation is made by U-press, degree of its spring back after U-press tends to be larger. When the degree of spring back becomes larger, it becomes difficult to transport the U-shaped pipe after U-press into the O-press apparatus; this eventually lowers the steel-pipe productivity. On the other hand, it says that reducing the width of U-shaped pipe sufficiently in U-process makes it possible to obtain a U-shaped pipe which is capable of being transported into the O-press apparatus after U-process. Thus, by the present invention, a U-shaped pipe which is capable of being transported into the O-press apparatus is obtained, by carrying out U-press with use of punch device having three types of punch parts to reduce the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press.

[0020] A schematic view showing a rocker assembly type U-press using a punch device 100 of the invention is shown in Fig.5. In this type of U-press, a steel plate treated with C-process is deformed such that the cross-section becomes U-shape by the punch device 100 and rocker dies 50, 50. The punch device 100 of the invention has three punch parts 10, 20, and 30; meanwhile, the rocker dies 50, 50 respectively have rocker shoes 51, 52 and a rotation center 53 immobile during processing operation.

In the U-press shown in Fig.5, side parts of the U-shaped pipe 5 is deformed by a pair of press faces 11, 11 provided for punch part 10, and a pair of press faces 21, 21 provided for punch part 20, as well as rocker shoes 51, 51 and 52, 52. In the punch device 100 of the invention, the curvature radiuses R1 of the press faces provided for the punch part 10 and the curvature radiuses R2 of the press faces provided for the punch part 20 are smaller than that of press faces of the punch (hereinafter, described as "punch A") of the conventional device which deforms side-faces of U-shaped pipe. Further, compared with the conventional punch device, the punch device 100 can provide bending to a part nearer to the end of U-shaped pipe by the press faces 11, 11 provided for the punch 10. For these reasons, if U-press is carried out with use of punch device 100 of the invention, the side parts of U-shaped pipe 5 is effectively deformed. Consequently, it is capable of restraining the degree of spring back of U-shaped pipe and reducing the width of a U-shaped pipe.

[0021] Hence, carrying out U-shaped pipe process with use of the press faces having a divided smaller curvature radius, it is possible to carry out a process capable of reducing the width of U-shaped pipe less than that by a conventional punch device for U-press. While, in the conventional punch device, if required size of U-shaped pipe is processed by reducing size of curvature radius of press faces of punch A, punch A needs to be replaced by a punch having a smaller curvature radius, as it is necessary to reduce the size of punch A itself in order to reduce the size of curvature radius of press faces. On the contrary, since the punch device 100 of the invention includes punch parts 10 and 20 having press faces with a smaller size of curvature radius than that of punch A, even though steel pipes of different sizes (such as thickness) and materials are to be produced, enlarging or reducing the distance between the press faces of punch part 10 and the distance between the press faces of punch part 20 is simply sufficient to adjust the device. Therefore punch A is not needed to be replaced to other one which has a smaller size of curvature radius. Thus, if U-press is carried out by the punch device for U-press 100 of the invention, it is possible to easily reduce the width of U-shaped pipe less than that by a conventional punch device for U-press. Further, as described above, if U-shaped pipe process is carried out with use of the punch device 100 of the invention, it is capable of reducing the width of a U-shaped pipe less than that by a conventional punch device for U-press. Thereby, a U-shaped pipe after U-press is easily transported into O-press apparatus, which makes it possible to improve the steel pipe productivity.

[0022] The punch device for U-press 100 of the invention may be an integrated punch device having punch parts 10, 20, and 30. For example, it may also be a punch device consists of plural components being provided with different pieces per punch part.

[0023] A schematic view showing a rocker assembly type U-process using a punch device 100 of the invention is shown in Fig.6. A steel plate, which end is crimped by C-process, is transported in between a pair of rocker dies 50, 50 and a punch device 100. And, the plate is put between rocker shoes 51, 51 of the rocker dies and a third punch part 30

(referred to Fig.6 (a)). Then, the punch device 100 moves in downward direction (direction of gravitational force) to gradually process the steel plate into U-shaped pipe (referred to Fig.6 (b)). As a result of the movement of device 100, from the point when the steel plate makes contact with rocker shoe 52, the rocker dies 50, 50 rotate around the rotation centers 53, 53, the U-process of the steel plate is proceeded. When the steel plate is processed into U-shaped pipe in this way, the processed U-shaped steel plate is further put between rocker shoes 51, 51, 52, and 52 of the rocker dies and punch parts 10, 20, and 30 of the punch device 100. Finally, it is processed into a U-shaped pipe having a shape capable of being transported into O-press apparatus for O-process (referred to Fig.6 (c)).

[0024] A schematic view showing a second embodiment of the punch device for U-press of the invention is shown in Fig.7.

A punch device 200 of the invention includes a first punch part 10, a second punch part 20, and a third punch part 30. Among these punch parts, the first punch part 10 and the second punch part 20 disposed in contact with the lower side of the first punch part 10 is capable of enlarging or reducing the distance between press faces 11 and 11 having semi-cylindrical press faces of curvature radius R1, and the distance between press faces 21 and 21 having semi-cylindrical press faces of curvature radius R2, respectively. The press faces 11 and 11 are provided to both sides of the first punch part 10, and the press faces 21 and 21 are also provided to both sides of the second punch part 20. The third punch part 30 disposed in contact with the lower side of the second punch part 20 has a downward semi-cylindrical press face 31 of curvature radius R3.

In the description for the punch device 200 of the second embodiment of the invention, a vertical direction in Fig.7 is described as "pipe-axis direction" of the U-shaped pipe being U-pressed by the punch device. A right-and-left direction in Fig.7 is described as "right-and-left direction" of a U-shaped pipe.

[0025] A punch device 200 of the invention includes a first screw 15 and a second screw 25 at a respective end of the first punch part 10 and the second punch part 20 in the pipe-axis direction as a means for moving punch. In the punch device 200, the distance between press faces 11 and 11 of the first punch part 10, and the distance between press faces 21 and 21 of the second punch part 20 can be enlarged or reduced by rotating the first screw 15 and the second screw 25. For example, if the inner diameter of a pipe is large, each press face can be moved in a direction where the distance between a pair of press faces 11 and 11, and the distance between a pair of press faces 21 and 21 are enlarged, by rotating the screw 15 and 25, respectively, in clockwise direction. On the other hand, if the inner diameter of a pipe is small, each press face can be moved in a direction where the distance between a pair of press faces 11 and 11, and the distance between a pair of press faces 21 and 21 are reduced, by rotating the screw 15 and 25, respectively, in anti-clockwise direction.

An embodiment of the punch device 200 of the invention, as described above, is not limited to the embodiment which is capable of enlarging or reducing the distance between the press faces of the first punch part 10 and the distance between the press faces of the second punch part 20. It may be another embodiment which is capable of enlarging or reducing the distance between press faces of either of the first punch part 10 or the second punch part 20.

[0026] Having such an embodiment as the punch device of the invention, a punch device 200 such that two or less punch parts are able to enlarge or reduce the distance between press faces can be obtained. In particular, if the direction of the press face movement is defined as right-and-left direction of U-shaped pipe, it is possible to easily deform U-shaped pipes of the various manufacturing pipe sizes by using the single punch device 200. Moreover, as the punch device 200 has three punch parts 10, 20, and 30, similar to the punch device 100 of the first embodiment of the invention, it is also possible to reduce the degree of spring back of the pipe after U-press. Therefore, according to the invention, it is possible to provide a punch device for U-press 200 in UOE steel pipe manufacturing process, which is capable of coping with various manufacturing pipe sizes and reducing the width of U-shaped pipe after U-press less than that by a conventional punch device for U-press.

In the invention, the relation between the direction of screw rotation and the direction of press face movement is not limited by the embodiments described above. Further, means for moving punch provided to the punch device for U-press of the invention is not limited to screws, any kind of means which is capable of moving each punch effectively can be suitably used. Furthermore, the punch device for U-press 200 of the invention may be an integrated punch device having punch parts 10, 20, and 30. For example, it may also be a punch device consists of plural components being provided with different pieces per punch part.

Examples

[0027] Hereinafter, the invention will be more specifically described by way of the following examples.

In the manufacturing of a UOE steel pipe with its outer diameter 609.6mm, thickness 14mm (hereinafter, described as "test steel-pipe 1") and a UOE steel pipe with its outer diameter 711.2mm, thickness 14mm (hereinafter, described as "test steel-pipe 2"), tests were carried out in accordance with the following conditions. Further, in the following tests, rocker assembly type U-press was used, and number of U-pressing was determined to be once. Yield stress of the test steel-pipes 1 and 2 were 750MPa.

(Condition 1)

[0028] U-press against the test steel-pipes 1 and 2 were carried out with use of punch device for U-press of the invention having means for moving punch. A schematic view of punch device for U-press applying the invention is shown in Fig. 8. A punch device based on this condition includes the first punch part 10 having a pair of semi-cylindrical press faces of curvature radius R1, the second punch part 20 having a pair of semi-cylindrical press faces of curvature radius R2, and the third punch part 30 having a downward semi-cylindrical press face of curvature radius R3, as well as the first screw 15 and the second screw 25. X1 and X2 in Fig.8 mean amount of movement of press faces (sliding amount) in horizontal direction at the first punch part 10 and the second punch part 20.

[0029] Curvature radius R1, R2, and R3 of each punch part of the punch device used in this example, as well as a sliding amount X1 of the first punch part 10 and a sliding amount X2 of the second punch part 20 are shown in Table 1.

[0030]

[Table 1]

	Test steel-pipe 1	Test steel-pipe 2
R 1 (mm)	130	130
R 2 (mm)	125	125
R 3 (mm)	120	120
X 1 (mm)	-20	30
X 2 (mm)	-10	15

[0031] Here, value of X1 and X2 are positive, it means that each punch part was moved towards the direction where the distance between a pair of press faces of each punch part was enlarged (hereinafter, described as "enlarging direction"). And, value of X1 and X2 are negative, it means that each punch part was moved towards the opposite direction to the direction previously described (hereinafter, described as "reducing direction"). Moreover, in this condition, U-press was carried out against two test steel-pipes by using the single punch device, curvature radius of press faces of each punch part provided for the punch device for test steel-pipe 1 is same as that for test steel-pipe 2.

(Condition 2)

[0032] U-press against the test steel-pipes 1 and 2 were carried out with use of conventional punch device having two types of punch parts each of which shape is different. Curvature radius of press faces of each punch part used for U-press against test steel-pipe 1 and 2 are shown in Table 2.

[0033]

[Table 2]

	Test steel-pipe 1	Test steel-pipe 2
r 1 (mm)	190	230
r 2 (mm)	110	140

[0034] In Table 2, r1 and r2 respectively represent curvature radius of press faces of punch A and punch B shown in Fig.3.

(Results)

[0035] The punch device used under condition 1 (hereinafter, describe as "example".) included the first punch part 10 having a pair of press faces movable and the second punch part 20 having a pair of press faces movable. So, when pressing against test steel-pipe 1 was carried out, the pair of press faces at each punch part was moved to the reducing direction. Also, when pressing against test steel-pipe 2 was carried out, the pair of press faces at each punch part was moved to the enlarging direction. By moving each press face in this manner, the punch device of the invention according to the example was able to coping with plural manufacturing pipe sizes. In addition, even though the manufacturing pipe sizes were different, the punch device of the invention does not need to change its punch parts. Whereby, this example could save the time for punch change due to the change of manufacturing pipe sizes, which conventional punch devices

needed.
On the other hand, the punch device used under condition 2 (hereinafter, described as "comparative example".) in itself could not cope with two steel pipes (test steel-pipes 1 and 2). So, every time the manufacturing pipe sizes were different, the punch needed to be changed. Hence, time for changing punches was necessary.

[0036] Width of U-shaped pipe after U-press according to the example and the comparative example are shown in Table 3. In Table 3, standardized values provided by dividing the width of U-shaped pipe by a width of O-press device are shown.

[0037]

[Table 3]

	Test steel-pipe 1	Test steel-pipe 2
Example	0.90	0.95
Comparative Example	1.05	1.12

[0038] According to Table 3, regarding the U-shaped pipe after U-press of the example with use of the punch device of the invention, width of both of test steel-pipes 1 and 2 are less than the diameter of O-press dies. And, values in Table 2 became below 1. Thus, the width of U-shaped pipe after U-press with use of the punch device of the invention is less than the diameter of O-press dies. Hence, both pipes could be transported into O-press device without any modifications. Meanwhile, U-press of comparative example could not sufficiently avoid spring back in U-shaped pipe. So, the values shown in Table 3 became more than 1, and the width of U-shaped pipe after U-press became larger than the diameter of O-press dies. Therefore, it was impossible for both of test steel-pipes 1 and 2 of the comparative example to transport the U-shaped pipes after U-press into O-press apparatus without any modifications.

[0039] The above has described the punch device of the present invention which is assured that it is capable of coping with different sizes of steel-pipes and reducing the width of U-shaped pipe. Together with this, the effectiveness of the punch device for U-press of the invention having three different shapes of punches and means for moving punch is also assured.

Claims

1. A punch device for U-press in a UOE steel pipe manufacturing process comprising:

a first punch part having semi-cylindrical press faces on both side-faces,
a second punch part disposed in contact with the lower side of said first punch part and having semi-cylindrical press faces on both side-faces, which are the same as or different from that of said press faces,
a third punch part disposed in contact with the lower side of said second punch part and having downward semi-cylindrical press face.

2. A punch device for U-press according to claim 1, wherein said first punch part and/or said second punch part are/is capable of enlarging or reducing the distance between said press faces.

FIG. 1

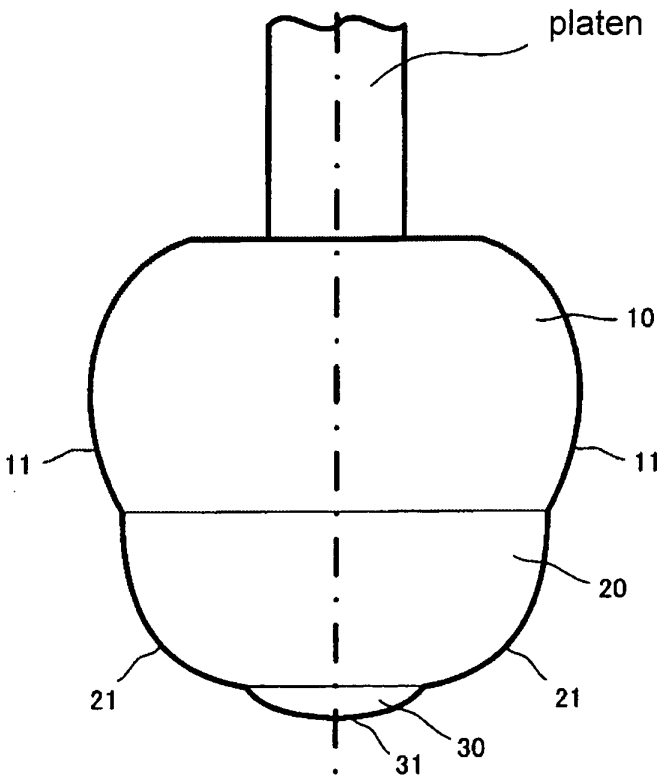


FIG. 2

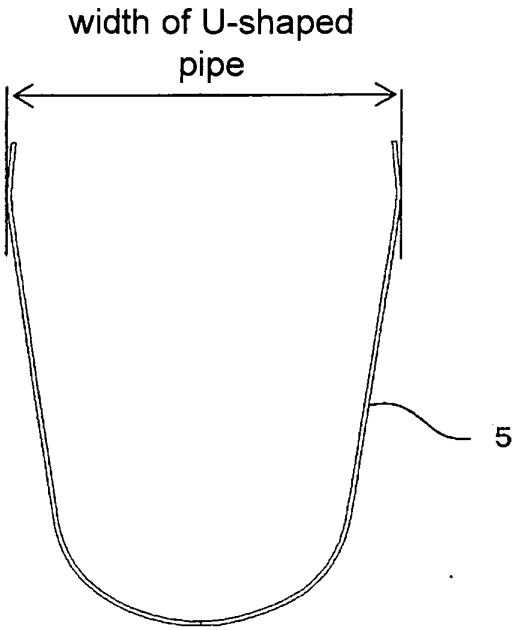


FIG. 3

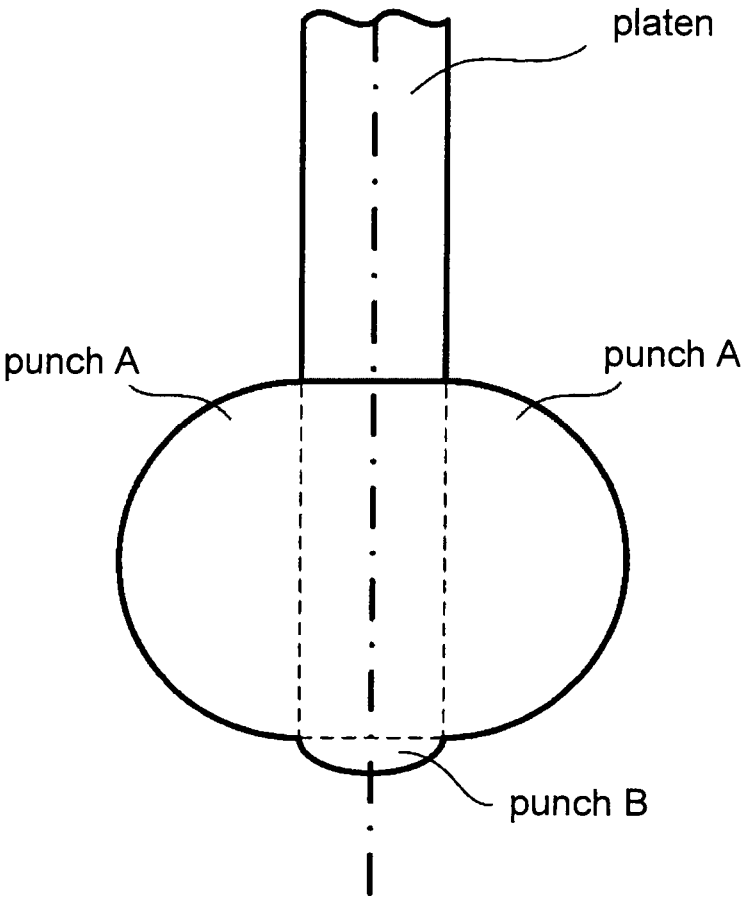


FIG. 4

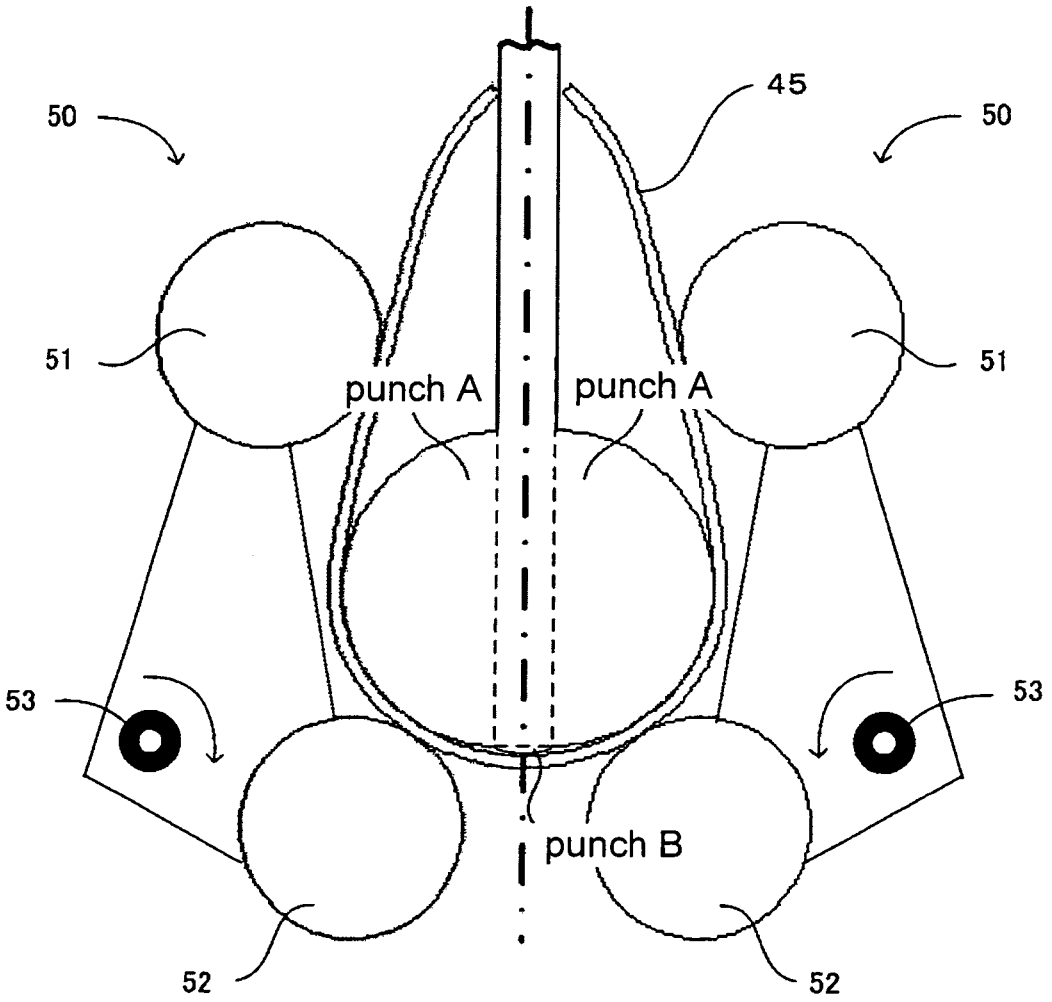


FIG. 5

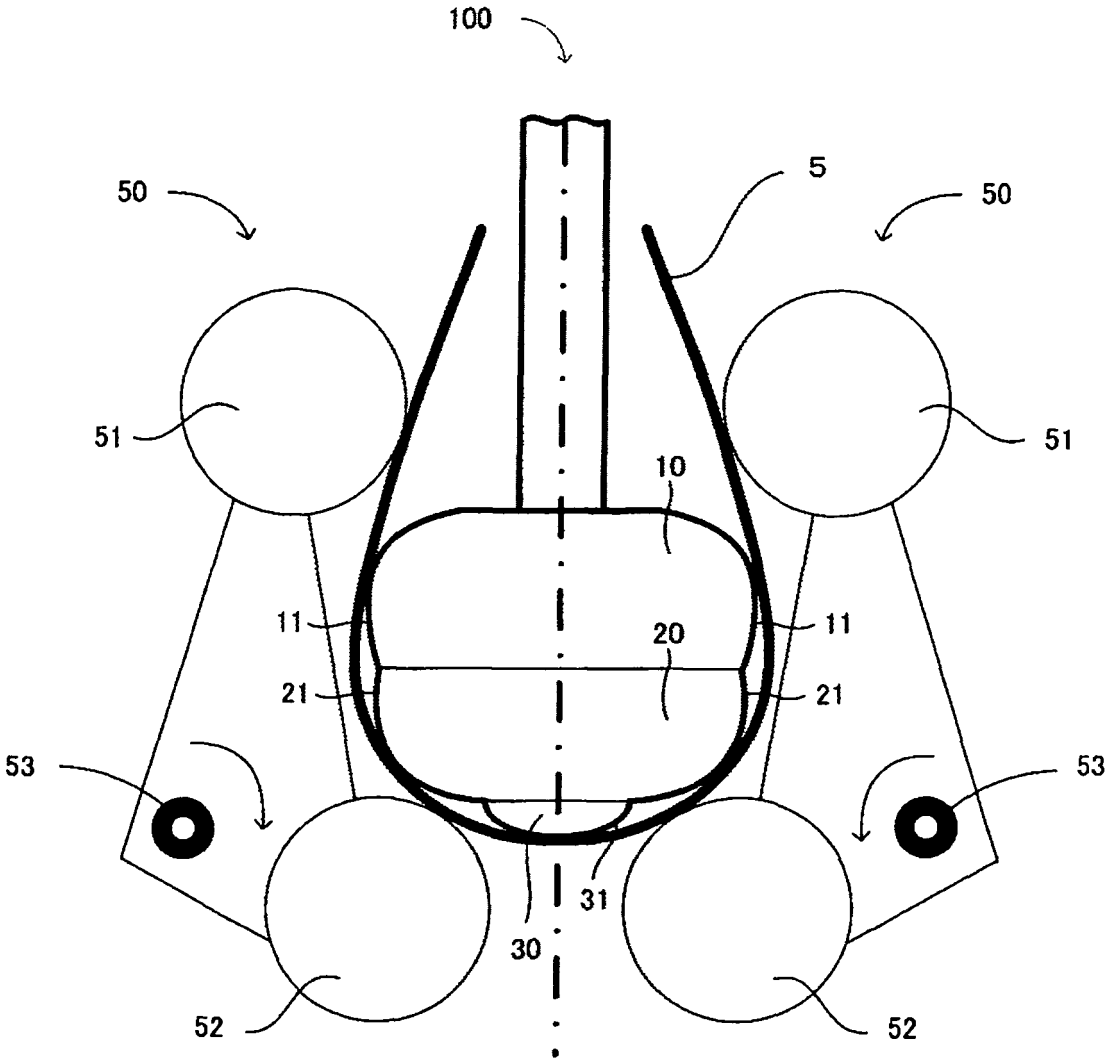


FIG. 6

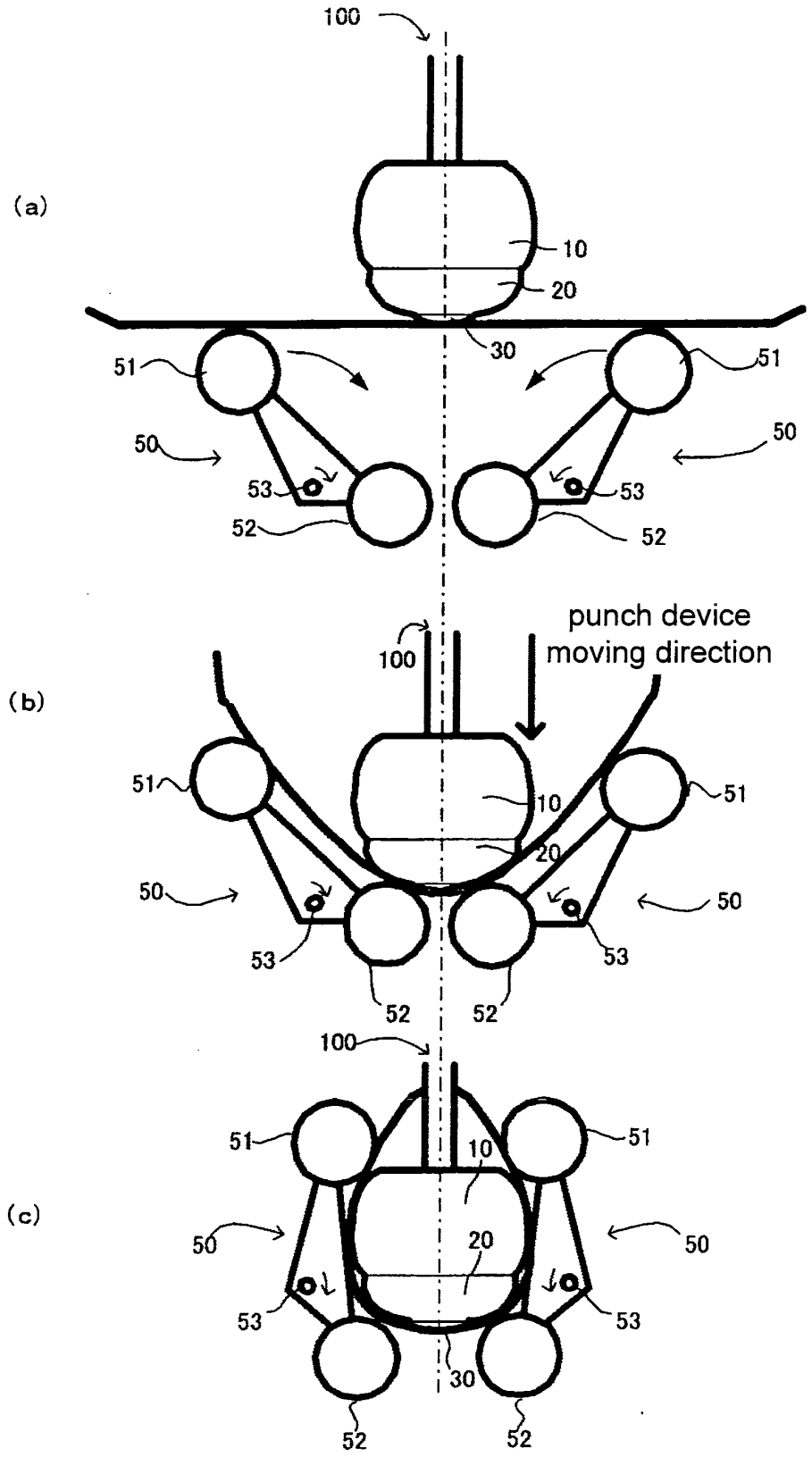

(a)
100
10
20
30
51
51
50
50
53
53
52
52
(b)
punch device
moving direction
100
51
51
10
20
50
50
53
53
52
52
(c)
100
51
51
10
50
20
50
53
53
30
52
52

FIG. 7

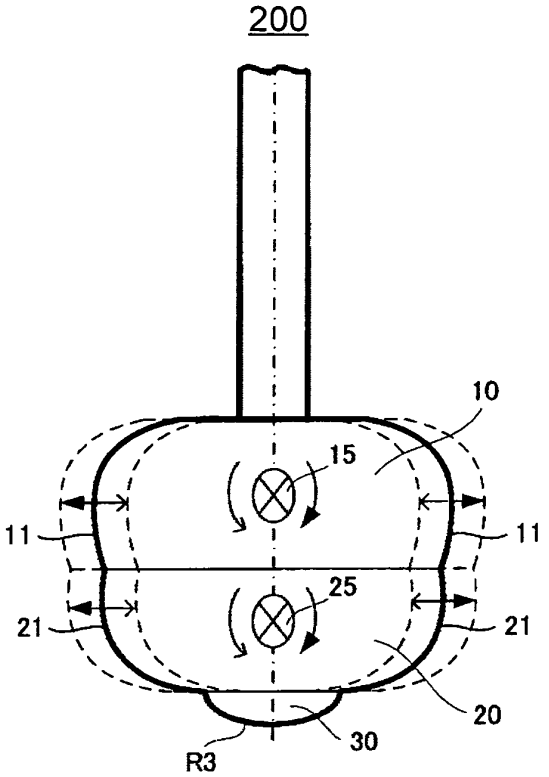
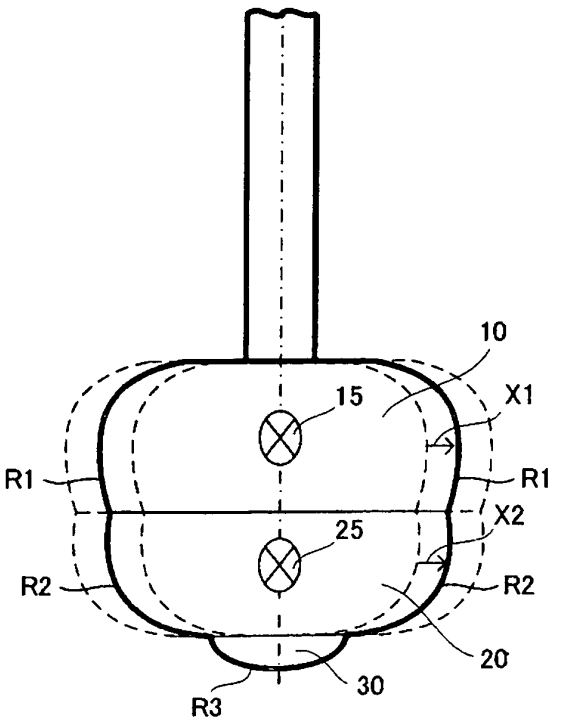


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/007219

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B21D5/01, B21C37/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B21D5/01, B21C37/08

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 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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.
A	JP 2002-86213 A (NKK Corp.), 26 March, 2002 (26.03.02), Full text (Family: none)	1,2
A	JP 55-70420 A (Nippon Steel Corp.), 27 May, 1980 (27.05.80), Full text (Family: none)	1,2

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 July, 2005 (07.07.05)	26 July, 2005 (26.07.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 59109116 A **[0006]**