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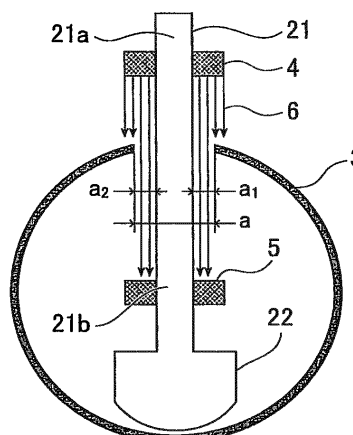
(54) **BENDING PRESS DEVICE, BENDING PRESS METHOD, DEVICE FOR PRODUCING STEEL PIPE, AND METHOD FOR PRODUCING STEEL PIPE**

(57) Provided is a bending press device and a steel pipe manufacturing device where an amount of seam gap of an open seam pipe can be appropriately controlled.

In a bending press device provided with an open seam edge measurement device where a punch pressing-down amount is set after measuring an amount of seam gap of an open seam pipe, the open seam edge

measurement device includes a light projector and a light receiver mounted on the punch, a detection circuit and a control part. The open seam edge measurement device measures an amount of gap between a punch support portion and an open seam edge of an open seam pipe which is a material to be formed, and the punch pressing-down amount is controlled based on the measured amount of gap.

[FIG. 1]



Description

Summary of Invention

Technical Field

Technical Problem

[0001] The present invention relates to a bending press device and a bending press method for manufacturing a steel pipe, a steel pipe manufacturing device, and a steel pipe manufacturing method.

Background Art

[0002] Bending press is a press method for manufacturing a product having a desired shape by performing a plurality of passes (pressings) (see PTL 1, for example). In case that bending press is applied for manufacturing a steel pipe, the bending press would be a steel pipe manufacturing method which involves pressing different portions one after another in a steel plate used as a raw material to form a steel pipe having an approximately circular cross-sectional shape. Due to such a process, the bending press can form a steel pipe having a large wall thickness and a high strength with a smaller force than a UOE method where the whole circumference of a steel pipe is formed all together.

[0003] Fig. 5 shows a method of forming a steel pipe by bending press. In Fig. 5(a), a blank part indicates a steel sheet before pressing where both edges of the steel sheet are bent by edge crimping. Firstly, a right-side portion of the steel sheet 1 from the center in the sheet width direction is formed by performing pressing, for example, 4 to 8 passes (pressing) using a punch 2 (a). Next, a left-side portion of the steel sheet 1 from the center in the sheet width direction is formed by performing pressing at same times as that in forming the right-side portion (for example, 4 to 8 passes) (b). Lastly, the center portion of the steel sheet in the sheet width direction is pressed down thus forming the steel sheet into a circular shape in cross section (c). The pressing-down performed as a last pass is referred to as a last press, and the steel sheet formed by the last press is referred to as an open seam pipe 3.

[0004] Fig. 6 is a schematic view of an open seam pipe. As shown in Fig. 6, the open seam pipe 3 is a pipe in a state where a sheet material used as a raw material is formed into a cylindrical shape, and where open seam edges 31a, 31b which face each other in an opposed manner are not welded to each other. A gap a between the open seam edges which face each other in an opposed manner is a seam gap. The pipe axis direction L of the open seam pipe 3 is same as the longitudinal direction of a punch.

Citation List

Patent Literature

[0005] PTL 1: JP-A-11-129031

[0006] A steel pipe can be manufactured by making the open seam edges of the open seam pipe formed by bending press abut each other and welding the open seam edges to each other. This welding step involves firstly performing a continuous tacking step, after forming a seam gap, in which a continuous tack welder constrains the open seam pipe so as to close the seam gap thereof; next performing a temporary welding in such a state; and thereafter, performing a main welding. The main welding involves firstly performing inside welding and next performing outside welding by submerged arc welding in general.

[0007] Since a constraining force of the continuous tack welder has an upper limit, there is a case that it is impossible to make open seam edges abut each other by constraining an open seam pipe having an amount of seam gap (a shown in Fig. 5(c)) equal to or more than a fixed amount determined corresponding to a size of a steel pipe. As a result, there is a possibility that the continuous tacking step and welding cannot be performed.

[0008] Accordingly, at the time of performing the last press in bending press, there has been a demand for making an amount of seam gap as small as possible.

[0009] An amount of seam gap of an open seam pipe is adjusted by gradually increasing a punch pressing-down amount of an open seam pipe in the final press. When the punch pressing-down amount in the last press is increased, the amount of seam gap is decreased. To the contrary, when the punch pressing-down amount in the last press is decreased, the amount of seam gap is increased.

[0010] When the punch pressing-down is released, since a spring back occurs, a seam gap of an open seam pipe becomes larger after releasing the punch pressing-down than that during the punch pressing-down. Aiming at the decrease of the spring back after releasing the punch pressing-down, there has been proposed a technique where a punch pressing-down amount is increased in a last press such that the punch pressing-down amount is further increased even after open seam edges are brought into contact with a punch support portion thus applying bending working to the open seam pipe.

[0011] Here, when a punch pressing-down amount is excessively large, there exists a possibility that a draw-back occurs where open seam edges of an open seam pipe strongly clamp a punch support portion so that it is necessary to cut the pipe over the whole length to remove the pipe.

[0012] To overcome such a drawback, usually, an attention has been paid to prevent a punch pressing-down amount from becoming excessively large. As a result, a seam gap is liable to become large.

[0013] Conventionally, an amount of seam gap at the time of performing last press has been checked by naked

eyes of an operator. Accordingly, there exists a possibility that a punch pressing-down amount is insufficient. In this case, the last press is finished in a state where an amount of seam gap remains too large to constrain the open seam pipe by continuous tacking. To the contrary, there also exists a possibility that a punch pressing-down amount is excessively large. In this case, an amount of seam gap becomes extremely small.

[0014] Accordingly, it is an object of the present invention to provide a bending press device and a bending press method which can appropriately control an amount of seam gap of an open seam pipe.

Solution to Problem

[0015] The present invention can overcome the drawbacks of the present invention by the following means.

1. A bending press device which includes: a punch; and two linear dies which are arranged parallel to each other with a predetermined space therebetween, wherein the punch presses down a portion of a sheet-like material to be formed which is mounted on the two dies and is disposed above the space to form an open seam pipe having open seam edges which face each other in an opposed manner; a punch support portion which extends through between the open seam edges of the formed open seam pipe and supports the punch, the punch support portion being movable together with the punch in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released; an open seam edge measurement device which includes a light projector and a light receiver mounted on the punch support portion, and which measures an amount of gap between the punch support portion and the open seam edge based on a change in intensity of a measurement light irradiated from the light projector to pass through an optical path connecting an outer side and an inner side of the formed open seam pipe and to reach the light receiver, the change being caused when the optical path is blocked by the open seam edge of the open seam pipe; and a control part which controls a punch pressing-down amount based on the amount of gap measured by the open seam edge measurement device.

2. The bending press device described in 1, wherein the measurement light is a laser beam.

3. The bending press device described in 1 or 2, wherein the light projector is arranged outside the formed open seam pipe.

4. The bending press device described in any one of 1 to 3, wherein the open seam edge measurement device is mounted at least at three positions consisting of a position in the vicinity of a leading end of the punch in a longitudinal direction, a position in the vicinity of a trailing end of the punch in the longitudinal direction, and an approximately center portion of the punch in the longitudinal direction.

5. A steel pipe manufacturing device having the bending press device described in any one of 1 to 4.

6. A bending press method of using a bending press device which includes a punch and two linear dies which are arranged parallel to each other with a predetermined space therebetween, to pressing-down by the punch a portion of a sheet-like material to be formed which is mounted on the two dies and is disposed above the space, for forming an open seam pipe having open seam edges which face each other in an opposed manner, the bending press method includes the steps of: mounting a light projector and a light receiver on a punch support portion which extends through between the open seam edges of the formed open seam pipe and supports the punch, the punch support portion being movable together with the punch in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released; measuring an amount of gap between the punch support portion and the open seam edge based on a change in intensity of a measurement light irradiated from the light projector to pass through an optical path connecting an outer side and an inner side of the formed open seam pipe and to reach the light receiver, the change caused when the optical path is blocked by the open seam edge of the open seam pipe; and controlling a punch pressing-down amount based on the measured gap.

7. The bending press method according to 6, further includes steps of: measuring the amount of gap in a state where the punch pressing-down is released after performing the last press; directly finishing the pressing when the measured amount of gap is equal to or below a predetermined amount set in advance, and successively performing the pressing with a punch pressing-down amount based on the measured amount of gap when the measured amount of gap exceeds the predetermined amount set in advance.

8. A steel pipe manufacturing method comprising steps of: forming an open seam pipe by the bending press method according to 6 or 7; abutting open seam edges of the open seam pipe each other; and welding the abutted open seam edges.

Advantageous Effects of Invention

[0016] According to the present invention, bending press can be performed while appropriately controlling an amount of seam gap of an open seam pipe. Accordingly, a manufacturing efficiency of an open seam pipe is enhanced, and a manufacturing efficiency of a steel pipe is also enhanced along with the enhancement of the manufacturing efficiency of the open seam pipe and hence, the present invention is industrially extremely useful.

Brief Description of Drawings

[0017]

[Fig. 1] A schematic view for explaining the constitution of an open seam edge measurement device of a bending press device and a method of measuring an amount of seam gap of an open seam pipe according to one embodiment of the present invention.

[Fig. 2] A schematic view showing an example of the schematic constitution of the open seam edge measurement device and a control system of a punch pressing-down amount.

[Fig. 3] A view showing the distribution of an amount of gap when a last press operation is performed without using the open seam edge measurement device.

[Fig. 4] A view showing the distribution of an amount of gap when a last press operation is performed using the open seam edge measurement device.

[Fig. 5] A view for explaining a method of forming a steel pipe by bending press.

[Fig. 6] A view for explaining an open seam pipe.

Description of Embodiments

[0018] The bending press device according to one embodiment of the present invention includes an open seam edge measurement device capable of monitoring an amount of seam gap of an open seam pipe in a last press, wherein the bending press device can control a punch pressing-down amount based on information measured by the measurement device.

[0019] Fig. 1 is a schematic view for explaining the constitution of an open seam edge measurement device of a bending press device according to one embodiment of the present invention and a method of measuring an amount of seam gap of an open seam pipe thereby. Fig. 1 is also a cross-sectional view taken in the direction orthogonal to the pipe axis direction. In the drawing, numeral 3 indicates an open seam pipe, numeral 4 indicates light projectors, numeral 5 indicates light receivers, numeral 6 indicates a light beam, numeral 22 indicates a punch, and numeral 21 indicates a punch support portion. Numeral 21a indicates an upper portion of the punch support portion 21, and numeral 21b indicates a lower portion of the punch support portion 21. The upper portion 21a and the lower portion 21b are respectively positioned outside and inside of the open seam pipe 3 at the time of performing the last punch. "a" indicates an amount of seam gap, and "a1", "a2" respectively indicate distances between the punch support portion 21 and open seam edges of the open seam pipe, that is, amounts of gaps.

[0020] The open seam edge measurement device of the bending press device shown in the drawing includes: the light projectors 4 which are mounted on the upper portion 21a of the punch support portion 21 of the punch 22; and the light receivers 5 which are mounted on the

lower portion 21b of the punch support portion 21 corresponding to the direction that a light beam is irradiated from the light projectors 4. Due to such a constitution, an optical path which connects the inside and the outside of the open seam pipe 3 is formed between the light projectors 4 and the light receivers 5. When amounts of seam gaps a1, a2 are decreased, a portion of or the whole optical path is blocked by the open seam edges. Accordingly, by detecting a change in intensity of a measurement light which reaches the light receivers 5 through the optical path, the amounts of seam gaps a1, a2 can be measured.

[0021] From a viewpoint of linearity and intensity of a light beam, the light projectors 4 and the light receivers 5 are preferable to be a laser beam projector and a laser beam receiver respectively. As the light projectors 4, it is also possible to use an LED (light-emitting diode) having high brightness. In this case, the light receiver 5 corresponding to wavelength of a light irradiated from the light projector 4 may be provided.

[0022] The light projectors 4 are mounted on left and right sides of the punch support portion 21 respectively such that the light projectors 4 are arranged orthogonal to the longitudinal direction of the punch support portion 21 (pipe axis direction of the open seam pipe). The light receivers 5 are also mounted on left and right sides of the punch support portion 21 such that the light receivers 5 also correspond to the respective laser beam projectors 4. The punch support portion 21 moves together with the punch in the direction that a steel material is pressed down or in the direction that the pressing-down is released. Accordingly, from a viewpoint of enhancing gap measurement accuracy, it is preferable to mount the light projectors 4 and the light receivers 5 on the punch support portion 21 by way of members which are formed of a raw material or a mechanism which blocks vibrations generated at the time of performing a press operation. For example, it is possible to mount the light projectors 4 and the light receivers 5 on the punch support portion 21 by way of a resin layer having a vibration absorbing function.

[0023] It is sufficient for a light beam which is irradiated toward the light receivers 5 from the light projectors 4 to have a width which enables the measurement of amounts of gaps a1, a2 between the punch support portion 21 and the open seam edges 31a, 31b of the open seam pipe 3 at the time of starting the last punch pressing-down. An irradiation shape of the beam is not particularly defined. That is, as a light source of the light projector 4, one light source which can irradiate a light beam having a cross section with a width which enables the measurement of the amounts of gaps a1, a2 may be used. Alternatively, a plurality of minute light sources may be arranged within a range with a width which enables the measurement of the amounts of gaps a1, a2. From a viewpoint of facilitating easy calculation for obtaining the seat gap amount, the light projector 4 may preferably be formed such that a plurality of laser beam sources are arranged equidistantly linearly, and the light receivers 5 also can measure

a laser beam at positions which respectively correspond to the plurality of laser beam sources.

[0024] An amount of seam gap a is a sum of a thickness of the punch support portion 21, the gap amount a_1 and the gap amount a_2 . When a laser beam is used as the light source, a kind of the laser beam is not particularly limited. However, it is desirable that the laser beam is a visible beam which an operator can observe with his naked eyes.

[0025] The open seam edge measurement device has a calculation function of calculating a pressing-down amount of the punch 22 using an amount of seam gap a as one of calculation factors, and a control function of outputting the obtained pressing-down amount to a press function of the bending press device.

[0026] Although the case where the light projectors 4 are arranged above the light receivers 5 (outside the open seam pipe) has been explained heretofore, as the case opposite to the above-mentioned case, the light receivers 5 may be arranged above the light projectors 4 (outside the open seam pipe). Further, in place of the arrangement where the light projector 4 and the light receiver 5 are arranged to face each other in an opposed manner, for example, an apparatus having both a function of the light projector and a function of the light receiver may be arranged at the position indicated by 4 in the drawing, and a reflector which reflects a light irradiated from the position indicated by 4 to the position indicated by 4 may be arranged at the position indicated by 5. In this case, a light irradiated from the light projector reciprocates along an optical path which connects the outside and the inside of the open seam pipe, and reaches the light receiver. Also in this case, the positions of the open seam edges 31a, 31b of the open seam pipe 3 can be obtained based on intensity of a light which reaches the light receiver, and amounts of gaps a_1 , a_2 can be measured.

[0027] Fig. 2 is a schematic view showing an example of the schematic constitution of the open seam edge measurement device and a control system of a punch pressing-down amount. A light beam 6 irradiated from the light projector 4 reaches the light receiver 5. When the open seam edges 31a or 31b of the open seam pipe 3 exist between the light projector 4 and the light receiver 5, only a portion of the light beam 6 irradiated from the light projector 4 reaches the light receiver 5. A detection output of the light receiver 5 is inputted to the detection circuit 40, and amounts of gaps a_1 , a_2 which are distances between the punch support portion 22 and the open seam edges 31a, 31b of the open seam pipe are measured.

[0028] Information on the measured amounts of gaps a_1 , a_2 is transmitted to a punch pressing-down amount control part 421 in the control part 42. The punch pressing-down amount control part 421 calculates punch pressing-down amounts which are further necessary for acquiring the amounts of gaps a_1 , a_2 based on a result of a preparatory test performed in advance or the past records, and instructs a punch pressing-down amount to

the punch 2. The punch 2 presses with an instructed punch pressing-down amount.

[0029] It is preferable to provide the open seam edge measurement device at least at three positions (positions in the vicinity of both ends and the approximately center) in the pipe axis direction of the open seam pipe, that is, in the longitudinal direction of the punch support portion 21. Due to such a constitution, the tendency of a change in amounts of seal gaps can be understood over the whole pipe axis direction of the open seam pipe. By adjusting a punch pressing-down amount in the punch longitudinal direction, for example, based on such understanding, the amounts of seam gaps can be decreased and can be made uniform over the whole length of the open seam pipe in the pipe axis direction.

[0030] A press operation using the bending press device according to the present invention may preferably be performed as follows.

[0031] When the pressing-down is released by elevating the punch after the open seam pipe is pressed down, a spring back occurs in the open seam pipe. Accordingly, it is preferable to measure amounts of seam gaps of the open seam pipe in a state where a pressing-down force is removed.

[0032] In the last press, plastic deformation is applied to the open seam pipe by performing pressing-down with a predetermined pressing-down amount. The pressing-down amount is set to a value which falls within a range where the open seam edges of the open seam pipe are not brought into contact with the punch support portion or within a range where the open seam edges are separated from the punch support portion when a pressing-down force is removed even when the open seam edges are brought into contact with the punch support portion, for example. Thereafter, the pressing-down force is removed, and amounts of seam gaps of the open seam pipe in a pressing-down force removed state are measured. Set punch pressing-down amounts are increased based on the amounts of seam gaps so as to press down the open seam pipe again. This operation is repeated until predetermined amounts of seam gaps are obtained. Setting of punch pressing-down amounts based on amounts of seam gaps can be performed by reference to a result of a preliminary test or the past records.

[0033] The manufacturing device of a steel pipe according to one embodiment of the present invention may preferably include, besides the above-mentioned bending press device, a continuous tack welding device, an inner surface welding device, and an outer surface welding device. The manufacturing device may preferably also include a pipe enlarging device when necessary.

[0034] In manufacturing a steel pipe using the manufacturing device having the above-mentioned constitution, an open seam pipe which is manufactured using the bending press device in accordance with the above-mentioned method is transferred from the bending press device. Next, continuous tack welding is applied to open seam edges of the open seam pipe using a continuous

tack welding device. Thereafter, main welding may be performed in order of inner surface welding and outer surface welding. To enhance circularity of the steel pipe, it is preferable to enlarge the steel pipe to which main welding is applied using the pipe enlarging device. A pipe enlarging step is performed while usually setting a pipe enlarging ratio (a ratio of an amount of change in an outer diameter of the pipe after enlarging the pipe with respect to the outer diameter of the pipe before enlarging the pipe) to a value which falls within a range from 0.3% to 1.5%. From a viewpoint of a balance between a circularity enhancing effect and ability which the pipe enlarging device is required to possess, the pipe enlarging ratio may preferably be set to a value which falls within a range from 0.5% to 1.2%.

Example

[0035] Steel pipes having outer diameters of 20 inches to 56 inches and pipe thicknesses of 12.7 mm to 50.8 mm are manufactured under two conditions, that is, the condition where the open seam edge measurement device of the bending press device according to the present invention is used, and the condition where such an open seam edge measurement device is not used. The open seam edge measurement device is used in the last press performed using the bending press device.

[0036] Fig. 3 shows the distribution of amounts of gaps (values measured after the last press) when the last press operation is performed while controlling an amount of seam gap with naked eyes of an operator without using the open seam edge measurement device, and Fig. 4 shows the distribution of amounts of gaps when the open seam edge measurement device is used. When the open seam edge measurement device is used, it is possible to decrease the unevenness of amounts of seam gaps. Accordingly, the largest amount of seam gap can be decreased, and there is no case where the open seam pipe cannot be constrained by the continuous tack welding device. Further, there is no case where the open seam edges are strongly brought into contact with the punch support portion.

[0037] Although the preferred embodiment of the present invention has been explained heretofore, the present invention is not limited to such an embodiment, and various modifications, improvements and the like are conceivable.

[0038] For example, when the light projectors and the light receivers are arranged on left and right sides of the punch support portion, even when a gap amount a1 on the right side and a gap amount a2 on the left side cannot be set equal, it is possible to accurately measure an amount of seam gap. On the other hand, when the gap amount a1 on the right side and the gap amount a2 on the left side can be set equal, it may be possible to provide the light projector and the light receiver only on either one of the left side and the right side.

[0039] By allowing the light source to have a cross sec-

tion of a predetermined width or by arranging a plurality of minute light sources within a range with a predetermined width, it is possible to increase the resolution of the gap amount measurement. However, even when one minute light source is arranged on both left and right sides of the punch support portion or only on one of the left and right sides of the punch support portion, it is possible to detect that an amount of gap becomes below a certain value. Also in this case, it is possible to perform an appropriate control of the gap amount by making a step of increasing a punch pressing-down amount by the last press finer, for example.

Reference Sign List

[0040]

1:	steel sheet
2, 22:	punch
3:	open seam pipe
4:	light projector
5:	light receiver
6:	light beam
21:	punch support portion
21a:	upper portion
21b:	lower portion
31a, 32b:	open seam edge
40:	detection circuit
42:	control part
421:	punch pressing-down amount control part
a:	amount of seam gap
a1, a2:	amount of gap
L:	pipe axis direction

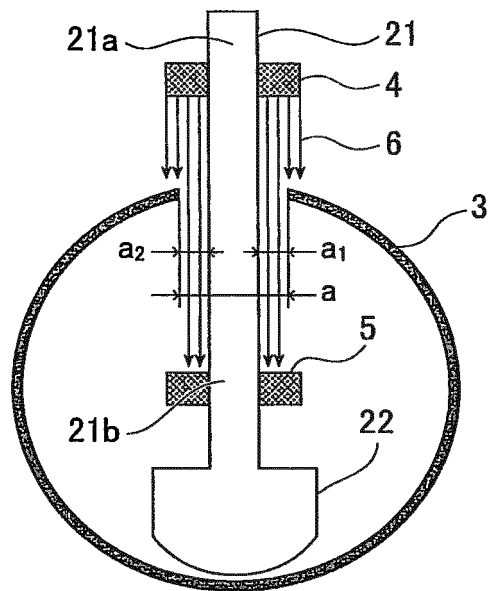
Claims

1. A bending press device comprising:

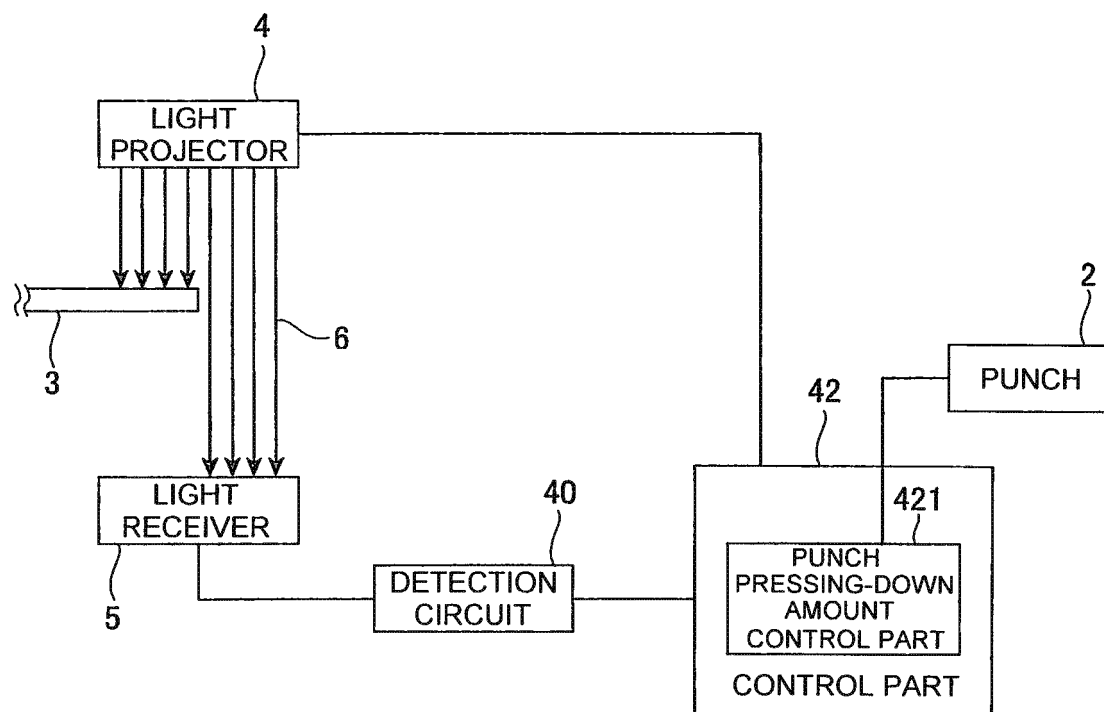
a punch;
two linear dies which are arranged parallel to each other with a predetermined space therebetween, wherein the punch presses down a portion of a sheet-like material to be formed which is mounted on the two dies and is disposed above the space to form an open seam pipe having open seam edges which face each other in an opposed manner;
a punch support portion which extends through between the open seam edges of the formed open seam pipe and supports the punch, the punch support portion being movable together with the punch in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released;
an open seam edge measurement device which includes a light projector and a light receiver mounted on the punch support portion, and

- which measures an amount of gap between the punch support portion and the open seam edge based on a change in intensity of a measurement light irradiated from the light projector to pass through an optical path connecting an outer side and an inner side of the formed open seam pipe and to reach the light receiver, the change being caused when the optical path is blocked by the open seam edge of the open seam pipe; and
a control part which controls a punch pressing-down amount based on the amount of gap measured by the open seam edge measurement device.
2. The bending press device according to claim 1, wherein the measurement light is a laser beam.
 3. The bending press device according to claim 1 or 2, wherein the light projector is arranged outside the formed open seam pipe.
 4. The bending press device according to any one of claims 1 to 3, wherein the open seam edge measurement device is mounted at least at three positions consisting of a position in the vicinity of a leading end of the punch in a longitudinal direction, a position in the vicinity of a trailing end of the punch in the longitudinal direction, and an approximately center portion of the punch in the longitudinal direction.
 5. A steel pipe manufacturing device having the bending press device according to any one of claims 1 to 4.
 6. A bending press method of using a bending press device which includes a punch and two linear dies which are arranged parallel to each other with a predetermined space therebetween, to pressing-down by the punch a portion of a sheet-like material to be formed which is mounted on the two dies and is disposed above the space, for forming an open seam pipe having open seam edges which face each other in an opposed manner, the bending press method comprising the steps of:
 - mounting a light projector and a light receiver on a punch support portion which extends through between the open seam edges of the formed open seam pipe and supports the punch, the punch support portion being movable together with the punch in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released;
 - measuring an amount of gap between the punch support portion and the open seam edge based on a change in intensity of a measurement light irradiated from the light projector to pass through an optical path connecting an outer side and an
 - inner side of the formed open seam pipe and to reach the light receiver, the change caused when the optical path is blocked by the open seam edge of the open seam pipe; and
 - controlling a punch pressing-down amount based on the measured gap.
 7. The bending press method according to claim 6, further comprising steps of:
 - measuring the amount of gap in a state where the punch pressing-down is released after performing the last press;
 - directly finishing the pressing when the measured amount of gap is equal to or below a predetermined amount set in advance, and successively performing the pressing with a punch pressing-down amount based on the measured amount of gap when the measured amount of gap exceeds the predetermined amount set in advance.
 8. A steel pipe manufacturing method comprising steps of:
 - forming an open seam pipe by the bending press method according to claim 6 or 7;
 - abutting open seam edges of the open seam pipe each other; and
 - welding the abutted open seam edges.

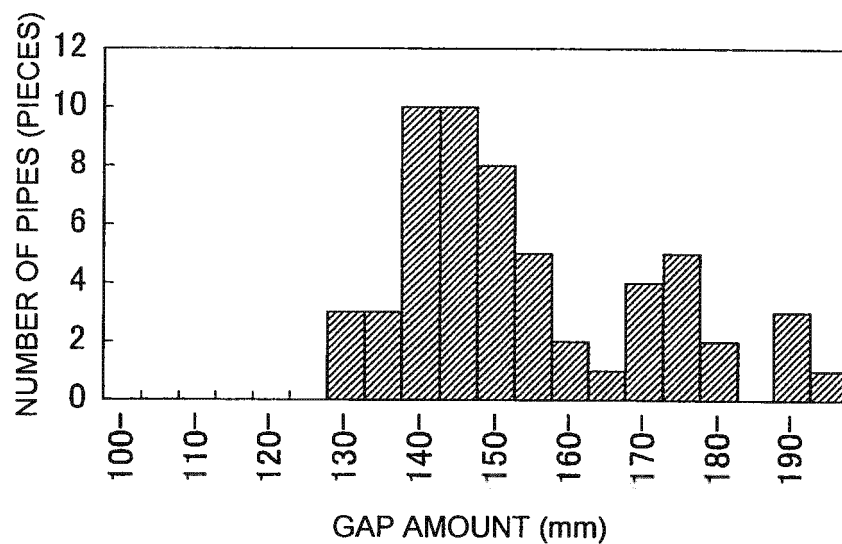
[FIG. 1]



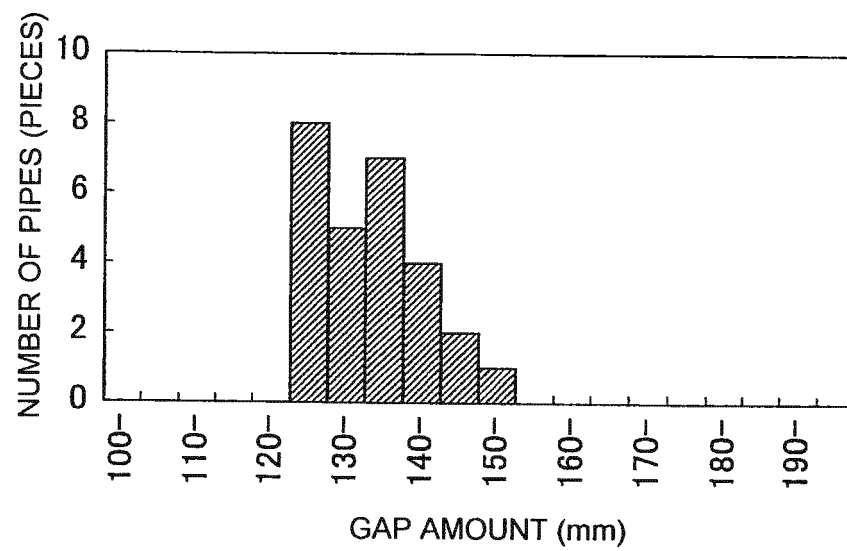
[FIG. 2]



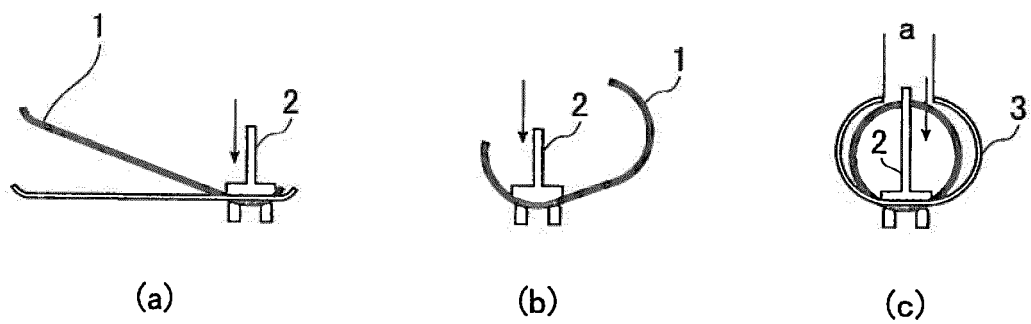
[FIG. 3]



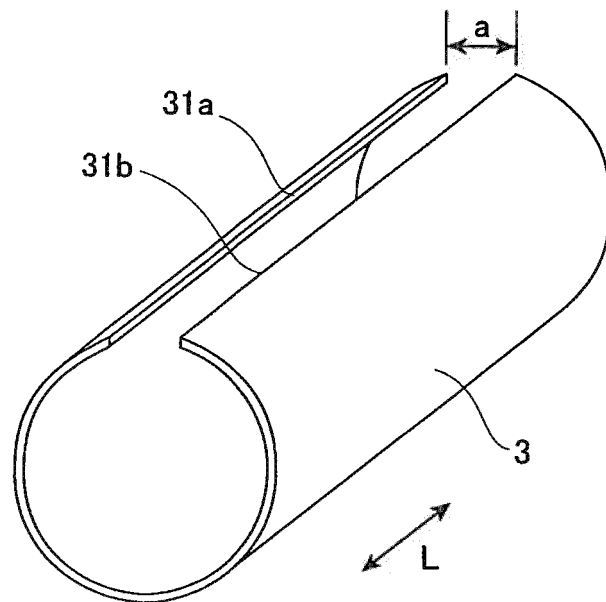
[FIG. 4]



[FIG. 5]



[FIG. 6]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/003204

A. CLASSIFICATION OF SUBJECT MATTER

B21D5/01(2006.01)i, B21C51/00(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)

B21D5/01, B21C51/00, B21C37/06, 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 1996-2013
 Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2012/100802 A1 (SMS MEER GMBH), 02 August 2012 (02.08.2012), fig. 1 to 2 & DE 102011009660 A1	1-8
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☒ 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
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Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/003204

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-129031 A (Mitsubishi Heavy Industries, Ltd.), 18 May 1999 (18.05.1999), fig. 1 to 8 (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11129031 A [0005]