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

BIEGEPRESSVORRICHTUNG, BIEGEPRESSVERFAHREN, VORRICHTUNG ZUR HERSTELLUNG EINES STAHLROHRS UND VERFAHREN ZUR HERSTELLUNG EINES STAHLROHRS

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Description

Technical Field

[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
PTL 2: WO 2012/100802 A1

Summary of Invention

Technical Problem

[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 drawback 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] PTL 2 discloses a device and a method in accordance with the preamble of each independent claim, in which the light projector and light receiver are both disposed inside the pipe and a light pattern from the light projector is used to measure the internal contour of the pipe.

[0015] 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

[0016] The present invention is defined by the claims.

Advantageous Effects of Invention

[0017] 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

[0018]

[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

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] An amount of seam gap a is a sum of a thickness of the punch support portion 21, the gap amount a1 and the gap amount a2. 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.

[0026] 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.

[0027] 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 a1, a2 can be measured.

[0028] 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 a1, a2 which are distances between the punch support portion 22 and the open seam edges 31a, 31b of the open seam pipe are measured.

[0029] Information on the measured amounts of gaps a1, a2 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 a1, a2 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.

[0030] 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.

[0031] A press operation using the bending press device according to the present invention may preferably be performed as follows.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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

[0036] 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.

[0037] 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.

[0038] 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, without leaving the scope of the invention as defined by the claims.

[0039] 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.

[0040] By allowing the light source to have a cross section 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

[0041]

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 (22);
two linear dies which are arranged parallel to each other with a predetermined space therebetween, wherein the punch (22) is adapted to press 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 (3) having open seam edges (31a, 31b) which face each other in an opposed manner;
a punch support portion (21) which is adapted to support the punch (22), the punch support portion (21) having an upper portion (21a) arranged to be positioned outside the open seam pipe (3) and the punch support portion (21) arranged to extend through the open seam edges (31a, 31b) to a lower portion (21b) positioned inside the open seam pipe at the time of pressing, the punch support portion (21) being movable together with the punch (22) in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released;
a measurement device; and
a control part (42) which is arranged to control a punch pressing-down amount based on a measurement by the measurement device; **characterised in that**:

the measurement device is an open seam edge measurement device which includes a light projector (4) and a light receiver (5) mounted on the punch support portion (21), a first one of the light projector (4) and the light receiver (5) being mounted on the upper portion (21a) of the punch support portion (21) while the other one is mounted on the lower portion (21b) of the punch support portion (21) at a position facing the first one to form an optical path, and the measurement device adapted to measure an amount of gap (a_1, a_2) between the punch support portion and the open seam edge (31a, 31b) based on a change in intensity of a measurement light irradiated from the light projector (4) to pass through the optical path and to reach the light receiver (5), the change being caused when the optical path is blocked by the open seam edge (31a, 31b) of the open seam pipe; and
the control part is adapted to control a punch pressing-down amount based on the amount of gap (a_1, a_2) measured by the open seam edge measurement device.

2. A bending press device comprising:

a punch (22);
two linear dies which are arranged parallel to each other with a predetermined space therebetween, wherein the punch (22) is adapted to press 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 (3) having open seam edges (31a, 31b) which face each other in an opposed manner;
a punch support portion (21) which is adapted to support the punch (22), the punch support portion (21) having an upper portion (21a) arranged to be positioned outside the open seam pipe (3) and the punch support portion (21) arranged to extend through the open seam edges (31a, 31b) to a lower portion (21b) positioned inside the open seam pipe at the time of pressing, the punch support portion (21) being movable together with the punch (22) in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released;
a measurement device; and
a control part (42) which is arranged to control a punch pressing-down amount based on a measurement by the measurement device; **characterised in that**:

the measurement device is an open seam edge measurement device which includes a light projector (4) and a light receiver (5) mounted on the upper portion (21a) of the punch support portion (21) and further, a reflector, which reflects a light irradiated from the light projector (4), mounted to the lower portion (21b) of the punch support portion (21) at a position facing the light projector to form an optical path, the measure-

ment device adapted to measure an amount of gap (a_1, a_2) between the punch support portion (21) and the open seam edge (31a, 31b) based on a change in intensity of a measurement light irradiated from the light projector (4) to pass through the optical path and to reach the light receiver (5), the change being caused when the optical path is blocked by the open seam edge (31a, 31b) of the open seam pipe; and
the control part is adapted to control a punch pressing-down amount based on the amount of gap (a_1, a_2) measured by the open seam edge measurement device.

3. The bending press device according to claim 1 or 2, wherein the measurement light is a laser beam.

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 (22) in a longitudinal direction, a position in the vicinity of a trailing end of the punch (22) in the longitudinal direction, and an approximately center portion of the punch (22) 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 (22) and two linear dies which are arranged parallel to each other with a predetermined space therebetween, to pressing-down by the punch (22) 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 (3) having open seam edges (31a, 31b) which face each other in an opposed manner, the bending press method comprising the steps of:

mounting a light projector (4) and a light receiver (5) on a punch support portion (21) which extends through between the open seam edges (31a, 31b) of the formed open seam pipe (3) and supports the punch (22), the punch support portion (21) being movable together with the punch (22) in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released; and
controlling a punch pressing-down amount based on measurement using the light projector (4) and light receiver (5); **characterised by**:

arranging either one of the light projector (4) or the light receiver (5) outside of the formed open seam pipe (3) while the other one is positioned inside of the formed open seam pipe;
measuring an amount of gap (a_1, a_2) between the punch support portion (21) and the open seam edge (31a, 31b) based on a change in intensity of a measurement light irradiated from the light projector (4) 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 (5), the change caused when the optical path is blocked by the open seam edge (31a, 31b) of the open seam pipe; wherein said step of controlling a punch pressing-down amount is based on the measured gap (a_1, a_2).

7. A bending press method of using a bending press device which includes a punch (22) and two linear dies which are arranged parallel to each other with a predetermined space therebetween, to pressing-down by the punch (22) 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 (3) having open seam edges (31a, 31b) which face each other in an opposed manner, the bending press method comprising the steps of:

mounting a light projector (4) and a light receiver (5) on a punch support portion (21) which extends through between the open seam edges (31a, 31b) of the formed open seam pipe (3) and supports the punch (22), the punch support portion (21) being movable together with the punch (22) in the direction that the material to be formed is pressed down or in the direction that the pressing-down is released; and
controlling a punch pressing-down amount based on measurement using the light projector (4) and light receiver (5); **characterised by**:

positioning the light projector (4) and the light receiver (5) at the outside of the formed open seam pipe (3) and, further, mounting a reflector which reflects light irradiated from the light projector (4), disposed on the inside of the formed open seam pipe (3) at a position facing the light projector (4);
measuring an amount of gap (a_1, a_2) between the punch support portion (21) and the open seam edge (31a, 31b) based on a change in intensity of a measurement light irradiated from the light projector (4) 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 (5), the change caused when the optical path is blocked by the open seam edge

(31a, 31b) of the open seam pipe; wherein said step of controlling a punch pressing-down amount is based on the measured gap (a_1, a_2) .

8. The bending press method according to claim 6 or 7, further comprising steps of:

measuring the amount of gap (a_1, a_2) 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 (a_1, a_2) 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 (a_1, a_2) when the measured amount of gap exceeds the predetermined amount set in advance.

9. A steel pipe manufacturing method comprising steps of:

forming an open seam pipe (3) by the bending press method according to any one of claims 6, to 8;
abutting open seam edges (31a, 31b) of the open seam pipe (3) to each other; and
welding the abutted open seam edges (31a, 31b).

Patentansprüche

1. Biegepressvorrichtung, bestehend aus:

einem Stanzstempel (22);
zwei linearen Formen, die parallel zueinander mit einem vorgegebenen Abstand angeordnet sind, wobei der Stanzstempel (22) dafür ausgelegt ist, einen Teil eines zu formenden blattartigen Materials, das auf den beiden Formen angebracht und über dem Raum angeordnet ist, nach unten zu drücken, um ein Rohr (3) mit offener Naht zu bilden, das offene Nahtkanten (31a, 31b) aufweist, die einander in entgegengesetzter Weise gegenüberliegen;
einem Stanzstempel-Stützabschnitt (21), der dafür ausgelegt ist, den Stanzstempel (22) zu stützen, wobei der Stanzstempel-Stützabschnitt (21) einen oberen Abschnitt (21a) aufweist, der so angeordnet ist, dass er außerhalb des Rohrs (3) mit offener Naht positioniert ist, und der Stanzstempel-Stützabschnitt (21) so angeordnet ist, dass er sich durch die Kanten (31a, 31b) mit offener Naht zu einem unteren Abschnitt (21b) erstreckt, der zum Zeitpunkt des Pressens innerhalb des Rohrs mit offener Naht positioniert ist,
wobei der Stanzstempel-Stützabschnitt (21) zusammen mit dem Stanzstempel (22) in der Richtung, in der das zu formende Material nach unten gedrückt wird, oder in der Richtung, in der das Niederdrücken freigesetzt wird, bewegt werden kann;
einer Messvorrichtung; und
einem Steuerteil (42), das angeordnet ist, um einen Stanzstempel-Niederdrückbetrag auf der Grundlage einer Messung durch die Vorrichtung zu steuern; **dadurch gekennzeichnet, dass**:

die Vorrichtung zum Messen von offenen Nahtkanten eine Vorrichtung zum Messen von offenen Nahtkanten ist, die einen Lichtprojektor (4) und einen Lichtempfänger (5) aufweist, die an dem Stanzstempel-Stützabschnitt (21) angebracht sind, wobei ein erster von dem Lichtprojektor (4) und dem Lichtempfänger (5) an dem oberen Abschnitt (21a) des Stanzstempel-Stützabschnitts (21) angebracht ist, während der andere an dem unteren Abschnitt (21b) des Stanzstempel-Stützabschnitts (21) an einer Position angebracht ist, die dem ersten gegenüberliegt, um einen optischen Pfad zu bilden, und der dafür ausgelegten Vorrichtung zum Messen einer Größe an Spalt (a_1, a_2) zwischen dem Stanzstempel-Stützabschnitt und der offenen Nahtkante (31a, 31b) auf der Grundlage einer Änderung der Intensität eines Messlichts, das von dem Lichtprojektor (4) ausgestrahlt wird, um durch den optischen Pfad zu laufen und den Lichtempfänger (5) zu erreichen, wobei die Änderung bewirkt wird, wenn der optische Pfad durch die offene Nahtkante (31a, 31b) der Rohrstütze mit offener Naht blockiert wird; und
ein Steuerteil dafür ausgelegt ist, eine Stanzstempel-Niederdrückgröße auf der Grundlage der Spaltgröße (a_1, a_2) zu steuern, die von der Vorrichtung zum Messen der offenen Nahtkante gemessen wird.

2. Biegepressvorrichtung, bestehend aus:

einem Stanzstempel (22);
zwei linearen Formen, die parallel zueinander mit einem vorgegebenen Abstand angeordnet sind, wobei der Stanzstempel (22) dafür ausgelegt ist, einen Teil eines zu formenden blattartigen Materials, das auf den beiden Formen angebracht und über dem Raum angeordnet ist, nach unten zu drücken, um ein Rohr (3) mit offener Naht zu bilden, das offene Nahtkanten (31a, 31b) aufweist, die einander gegenüberlie-

gen;
einem Stanzstempel-Stützabschnitt (21), der dafür ausgelegt ist, den Stanzstempel (22) zu stützen, wobei der Stanzstempel-Stützabschnitt (21) einen oberen Abschnitt (21a) aufweist, der so angeordnet ist, dass er außerhalb des Rohrs (3) mit offener Naht positioniert ist, und der Stanzstempel-Stützabschnitt (21) so angeordnet ist, dass er sich durch die Kanten (31a, 31b) mit offener Naht zu einem unteren Abschnitt (21b) erstreckt, der zum Zeitpunkt des Pressens innerhalb des Rohrs mit offener Naht positioniert ist, wobei der Stanzstempel-Stützabschnitt (21) zusammen mit dem Stanzstempel (22) in der Richtung, in der das zu formende Material nach unten gedrückt wird, oder in der Richtung, in der das Niederdrücken freigesetzt wird, bewegt werden kann;
einer Messvorrichtung; und
einem Steuerteil (42), das angeordnet ist, um einen Stanzstempel-Niederdrückbetrag auf der Grundlage einer Messung durch die Vorrichtung zu steuern; **dadurch gekennzeichnet, dass**:
die Vorrichtung zum Messen von offenen Nahtkanten eine Vorrichtung zum Messen von offenen Nahtkanten ist, die einen Lichtprojektor (4) und einen Lichtempfänger (5) aufweist, die an dem oberen Abschnitt (21a) des Stanzstempel-Stützabschnitts (21) angebracht sind, und ferner einen Reflektor, der Licht reflektiert, das vom Lichtprojektor (4) ausgestrahlt wird, befestigt am unteren Abschnitt (21b) des Stanzstempel-Stützabschnitts (21) an einer Position, die dem Lichtprojektor gegenüberliegt, um einen optischen Pfad zu bilden, wobei die Vorrichtung zum Messen einer Größe des Spaltes (a_1, a_2) zwischen dem Stanzstempel-Stützabschnitt (21) und der offenen Nahtkante (31a, 31b) auf der Grundlage einer Änderung der Intensität eines Messlichts ausgelegt ist, das von dem Lichtprojektor (4) ausgestrahlt wird, um durch den optischen Pfad zu laufen und den Lichtempfänger (5) zu erreichen, wobei die Änderung bewirkt wird, wenn der optische Pfad durch die offene Nahtkante (31a, 31b) der Rohrstütze mit offener Naht blockiert wird; und das Steuerteil dafür ausgelegt ist, eine Stanzstempel-Niederdrückgröße auf der Grundlage der Spaltgröße (a_1, a_2) zu steuern, die von der Vorrichtung zum Messen der offenen Nahtkante gemessen wird.

3. Biegepressvorrichtung nach Anspruch 1 oder 2, bei der das Messlicht ein Laserstrahl ist.

4. Biegepressvorrichtung nach einem der Ansprüche 1 bis 3, wobei die Vorrichtung zum Messen der offenen Nahtkante an mindestens drei Positionen angebracht ist, die aus einer Position in der Nähe eines vorderen Endes des Stanzstempels (22) in einer Längsrichtung, einer Position in der Nähe eines hinteren Endes des Stanzstempels (22) in der Längsrichtung und einem annähernd mittleren Abschnitt des Stanzstempels (22) in der Längsrichtung bestehen.

5. Vorrichtung zur Herstellung von Stahlrohren mit einer Biegepressvorrichtung nach einem der Ansprüche 1 bis 4.

6. Biegepressverfahren zur Verwendung einer Biegepressvorrichtung, die einen Stanzstempel (22) und zwei lineare Formen aufweist, die parallel zueinander mit einem vorgegebenen Abstand angeordnet sind, um durch den Stanzstempel (22) einen Abschnitt eines zu formenden blattförmigen Materials, das auf den beiden Formen montiert und über dem Raum angeordnet ist, zum Formen eines Rohrs (3) mit offener Naht, das offene Nahtkanten (31a, 31b) aufweist, die einander gegenüberliegen, niederzudrücken, wobei das Biegepressverfahren die folgenden Schritte aufweist:

Anbringen eines Lichtprojektors (4) und eines Lichtempfängers (5) an einem Stanzstempel-Stützabschnitt (21), der sich zwischen den offenen Nahtkanten (31a, 31b) des geformten Rohres (3) mit offener Naht hindurch erstreckt und den Stanzstempel (22) trägt, wobei der Stanzstempel-Stützabschnitt (21) zusammen mit dem Stanzstempel (22) in der Richtung, in der das zu formende Material nach unten gedrückt wird, oder in der Richtung, in der das Niederdrücken freigesetzt wird, bewegt werden kann; und
Steuerung einer Stanzstempel-Niederdrückgröße auf der Grundlage von Messungen mit dem Lichtprojektor (4) und Lichtempfänger (5); **gekennzeichnet durch**:

Anordnen entweder des Lichtprojektors (4) oder des Lichtempfängers (5) außerhalb des geformten Rohres (3) mit offener Naht, wobei das andere Element innerhalb des geformten Rohres mit offener Naht angeordnet ist; Messen einer Größe des Spalts (a_1, a_2) zwischen dem Stanzstempel-Stützabschnitt (21) und der offenen Nahtkante (31a, 31b) auf der Grundlage einer Änderung der Intensität eines Messlichts, das vom Lichtprojektor (4) ausgestrahlt wird, um durch einen optischen Pfad zu laufen, der eine Außenseite und eine Innenseite des geformten Rohrs mit offener Naht verbindet und den Lichtempfänger (5) erreicht, wobei die Änderung bewirkt wird, wenn der optische Pfad durch die offene Nahtkante (31a, 31b) des Rohrs mit offener Naht blockiert

wird; wobei
der Schritt der Steuerung der Größe des Niederdrückens eines Stanzstempels auf dem gemessenen Spalt (a_1, a_2) basiert.

7. Biegepressverfahren unter Verwendung einer Biegepressvorrichtung, die einen Stanzstempel (22) und zwei lineare Formen aufweist, die parallel zueinander mit einem vorgegebenen Abstand dazwischen angeordnet sind, um durch den Stanzstempel (22) einen Abschnitt eines zu formenden blattförmigen Materials, das auf den beiden Formen montiert und über dem Raum angeordnet ist, zum Formen eines Rohres (3) mit offener Naht, das offene Nahtkanten (31a, 31b) aufweist, die einander gegenüberliegen, niederzudrücken, wobei das Biegepressverfahren die folgenden Schritte aufweist:

Anbringen eines Lichtprojektors (4) und eines Lichtempfängers (5) an einem Stanzstempel-Stützabschnitt (21), der sich zwischen den offenen Nahtkanten (31a, 31b) des geformten Rohres (3) mit offener Naht hindurch erstreckt und den Stanzstempel (22) trägt, wobei der Stanzstempel-Stützabschnitt (21) zusammen mit dem Stanzstempel (22) in der Richtung, in der das zu formende Material nach unten gedrückt wird, oder in der Richtung, in der das Niederdrücken freigegeben wird, bewegt werden kann; und
Steuerung einer Stanzstempel-Niederdrückgröße auf der Grundlage von Messungen mit dem Lichtprojektor (4) und Lichtempfänger (5); **gekennzeichnet durch**:

Positionieren des Lichtprojektors (4) und des Lichtempfängers (5) an der Außenseite des geformten offenen Nahtrohrs (3) und ferner Anbringen eines Reflektors, der das von dem Lichtprojektor (4) abgestrahlte Licht reflektiert, der an der Innenseite des geformten offenen Nahtrohrs (3) an einer dem Lichtprojektor (4) zugewandten Stelle angeordnet ist; Messen einer Größe des Spalts (a_1, a_2) zwischen dem Stanzstempel-Stützabschnitt (21) und der offenen Nahtkante (31a, 31b) auf der Grundlage einer Änderung der Intensität eines Messlichts, das von dem Lichtprojektor (4) ausgestrahlt wird, um durch einen optischen Weg zu laufen, der eine Außenseite und eine Innenseite des geformten Rohrs mit offener Naht verbindet, und den Lichtempfänger (5) erreicht, wobei die Änderung bewirkt wird, wenn der optische Weg durch die offene Nahtkante (31a, 31b) des Rohrs mit offener Naht blockiert wird; wobei
der Schritt der Steuerung der Größe des Niederdrückens eines Stanzstempels auf dem gemessenen Spalt (a_1, a_2) basiert.

8. Biegepressverfahren nach Anspruch 6 oder 7, das ferner folgende Schritte aufweist:

Messen der Größe des Spalts (a_1, a_2) in einem Zustand, in dem das Niederdrücken des Stanzstempels nach der Ausführung der letzten Pressung ausgesetzt wird;
direktes Beenden des Pressens, wenn die gemessene Größe des Spalts (a_1, a_2) kleiner oder gleich einer vorgegebenen, im Voraus festgelegten Größe ist, und
sukzessives Durchführen des Pressens mit einem Stanzstempel-Niederdrückbetrag auf der Grundlage der gemessenen Größe des Spalts (a_1, a_2), wenn die gemessene Größe des Spaltes die vorgegebene, im Voraus festgelegte Größe überschreitet.

9. Verfahren zur Herstellung von Stahlrohren, das folgende Schritte aufweist:

Formen eines Rohres (3) mit offener Naht durch das Biegepressverfahren nach einem der Ansprüche 6 bis 8; Aneinanderstoßen von offenen Nahtkanten (31a, 31b) des offenen Nahtrohres (3); und
Schweißen der aneinanderstoßenden offenen Nahtkanten (31a, 31b).

Revendications

1. Dispositif de presse à cintrer comprenant :

un poinçon (22) ;
deux matrices linéaires qui sont agencées parallèlement l'une à l'autre avec un espace prédéterminé entre elles, dans lequel le poinçon (22) est adapté pour presser une partie d'un matériau de type feuille devant être formé qui est monté sur les deux matrices et est disposé au-dessus de l'espace pour former un tube à bords rapprochés non soudés (3) ayant des bords rapprochés non soudés (31a, 31b) qui se font face l'un à l'autre d'une manière opposée ;
une partie de support de poinçon (21) qui est adaptée pour supporter le poinçon (22), la partie de support de poinçon (21) ayant une partie supérieure (21a) agencée pour être positionnée à l'extérieur du tube à bords rapprochés non soudés (3) et la partie de support de poinçon (21) étant agencée pour s'étendre à travers les bords rapprochés non soudés (31a, 31b) vers une partie inférieure (21b) positionnée à l'intérieur du tube à bords rapprochés non soudés au moment de la pression, la partie de support de poinçon

(21) étant mobile conjointement avec le poinçon (22) dans la direction où est pressé le matériau devant être formé ou dans la direction où la pression est relâchée ;
un dispositif de mesure ; et
une partie de commande (42) qui est agencée pour commander une quantité de pression de poinçon sur la base d'une mesure faite par le dispositif de mesure ; **caractérisé en ce que** :

le dispositif de mesure est un dispositif de mesure de bords rapprochés non soudés qui inclut un projecteur de lumière (4) et un récepteur de lumière (5) montés sur la partie de support de poinçon (21), un premier du projecteur de lumière (4) et du récepteur de lumière (5) étant monté sur la partie supérieure (21a) de la partie de support de poinçon (21) alors que l'autre est monté sur la partie inférieure (21b) de la partie de support de poinçon (21) à une position faisant face au premier pour former une trajectoire optique, et le dispositif de mesure étant adapté pour mesurer une quantité d'écartement (a_1, a_2) entre la partie de support de poinçon et le bord rapproché non soudé (31a, 31b) sur la base d'un changement d'intensité d'une lumière de mesure rayonnée à partir du projecteur de lumière (4) pour passer à travers la trajectoire optique et pour atteindre le récepteur de lumière (5), le changement étant causé lorsque la trajectoire optique est bloquée par le bord rapproché non soudé (31a, 31b) du tube à bords rapprochés non soudés ; et
la partie de commande est adaptée pour commander une quantité de pression de poinçon sur la base de la quantité d'écartement (a_1, a_2) mesurée par le dispositif de mesure de bords rapprochés non soudés.

2. Dispositif de presse à cintrer comprenant :

un poinçon (22) ;
deux matrices linéaires qui sont agencées parallèlement l'une à l'autre avec un espace prédéterminé entre elles, dans lequel le poinçon (22) est adapté pour presser une partie d'un matériau de type feuille devant être formé qui est monté sur les deux matrices et est disposé audessus de l'espace pour former un tube à bords rapprochés non soudés (3) ayant des bords rapprochés non soudés (31a, 31b) qui se font face d'une manière opposée ;
une partie de support de poinçon (21) qui est adaptée pour supporter le poinçon (22), la partie de support de poinçon (21) ayant une partie supérieure (21a) agencée pour être positionnée à l'extérieur du tube à bords rapprochés non soudés (3) et la partie de support de poinçon (21) étant agencée pour s'étendre à travers les bords rapprochés non soudés (31a, 31b) vers une partie inférieure (21b) positionnée à l'intérieur du tube à bords rapprochés non soudés au moment de la pression, la partie de support de poinçon (21) étant mobile conjointement avec le poinçon (22) dans la direction où est pressé le matériau devant être formé ou dans la direction où la pression est relâchée ;
un dispositif de mesure ; et
une partie de commande (42) qui est agencée pour commander une quantité de pression de poinçon sur la base d'une mesure faite par le dispositif de mesure ; **caractérisé en ce que** :

le dispositif de mesure est un dispositif de mesure de bords rapprochés non soudés qui inclut un projecteur de lumière (4) et un récepteur de lumière (5) montés sur la partie supérieure (21a) de la partie de support de poinçon (21) et en outre, un réflecteur, qui réfléchit une lumière rayonnée à partir du projecteur de lumière (4), monté sur a partie inférieure (21b) de la partie de support de poinçon (21) à une position faisant face au projecteur de lumière pour former une trajectoire optique, le dispositif de mesure étant adapté pour mesurer une quantité d'écartement (a_1, a_2) entre la partie de support de poinçon et le bord rapproché non soudé (31a, 31b) sur la base d'un changement d'intensité d'une lumière de mesure rayonnée à partir du projecteur de lumière (4) pour passer à travers la trajectoire optique et pour atteindre le récepteur de lumière (5), le changement étant causé lorsque la trajectoire optique est bloquée par le bord rapproché non soudé (31a, 31b) du tube à bords rapprochés non soudés ; et
la partie de commande est adaptée pour commander une quantité de pression de poinçon sur la base de la quantité d'écartement (a_1, a_2) mesurée par le dispositif de mesure de bords rapprochés non soudés.

3. Dispositif de presse à cintrer selon la revendication 1 ou 2, dans lequel la lumière de mesure est un faisceau laser.

4. Dispositif de presse à cintrer selon l'une quelconque des revendications 1 à 3, dans lequel le dispositif de mesure de bords rapprochés non soudés est monté au moins au niveau de trois positions constituées d'une position au voisinage d'une extrémité avant du poinçon (22) dans une direction longitudinale, d'une position au voisinage d'un bord arrière du poin-

çon (22) dans la direction longitudinale, et d'une position approximativement centrale du poinçon (22) dans la direction longitudinale.

5. Dispositif de fabrication de tube d'acier ayant un dispositif de presse à cintrer selon l'une quelconque des revendications 1 à 4.

6. Procédé de presse à cintrer utilisant le dispositif de presse à cintrer qui inclut un poinçon (22) et deux matrices linéaires qui sont agencées parallèlement l'une à l'autre avec un espace prédéterminé entre elles, pour presser au moyen du poinçon (22) une partie d'un matériau de type feuille devant être formé qui est monté sur les deux matrices et est disposé au-dessus de l'espace, pour former un tube à bords rapprochés non soudés (3) ayant des bords rapprochés non soudés (31a, 31b) qui se font face d'une manière opposée, le procédé de presse à cintrer comprenant les étapes de :

montage d'un projecteur de lumière (4) et d'un récepteur de lumière (5) sur une partie de support de poinçon (21) qui s'étend à travers l'espace entre les bords rapprochés non soudés (31a, 31b) du tube à bords rapprochés non soudés (3) formé et supporte le poinçon (22), la partie de support de poinçon (21) étant mobile conjointement avec le poinçon (22) dans la direction où est pressé le matériau devant être formé ou dans la direction où la pression est relâchée ; et commande d'une quantité de pression de poinçon sur la base d'une mesure au moyen du projecteur de lumière (4) et du récepteur de lumière (5) ; **caractérisé par** :

l'agencement de l'un ou l'autre du projecteur de lumière (4) et du récepteur de lumière (5) à l'extérieur du tube à bords rapprochés non soudés (3) formé alors que l'autre est positionné à l'intérieur du tube à bords rapprochés non soudés formé ;
la mesure d'une quantité d'écartement (a_1, a_2) entre la partie de support de poinçon (21) et le bord rapproché non soudé (31a, 31b) sur la base d'un changement d'intensité d'une lumière de mesure rayonnée à partir du projecteur de lumière (4) pour passer à travers une trajectoire optique reliant un côté extérieur et un côté intérieur du tube à bords rapprochés non soudés formé et pour atteindre le récepteur de lumière (5), le changement étant causé lorsque la trajectoire optique est bloquée par le bord rapproché non soudé (31a, 31b) du tube à bords rapprochés non soudés ; dans lequel ladite étape de commande d'une quantité de pression de poinçon est basée sur l'écartement (a_1, a_2) mesuré.

7. Procédé de presse à cintrer utilisant un dispositif de presse à cintrer qui inclut un poinçon (22) et deux matrices linéaires qui sont agencées parallèlement l'une à l'autre avec un espace prédéterminé entre elles, pour presser au moyen du poinçon (22) une partie d'un matériau de type feuille devant être formé qui est monté sur les deux matrices et est disposé au-dessus de l'espace, pour former un tube à bords rapprochés non soudés (3) ayant des bords rapprochés non soudés (31a, 31b) qui se font face d'une manière opposée, le procédé de presse à cintrer comprenant les étapes de :

montage d'un projecteur de lumière (4) et d'un récepteur de lumière (5) sur une partie de support de poinçon (21) qui s'étend dans l'espace entre les bords rapprochés non soudés (31a, 31b) du tube à bords rapprochés non soudés (3) formé et supporte le poinçon (22), la partie de support de poinçon (21) étant mobile conjointement avec le poinçon (22) dans la direction où est pressé le matériau devant être formé ou dans la direction où la pression est relâchée ; et commande d'une quantité de pression de poinçon sur la base d'une mesure au moyen du projecteur de lumière (4) et du récepteur de lumière (5) ; **caractérisé par** :

le positionnement du projecteur de lumière (4) et du récepteur de lumière (5) à l'extérieur du tube à bords rapprochés non soudés (3) et, en outre, montage d'un réflecteur qui réfléchit la lumière rayonnée à partir du projecteur de lumière (4), disposé à l'intérieur du tube à bords rapprochés non soudés (3) à une position faisant face au projecteur de lumière (4) ;
la mesure d'une quantité d'écartement (a_1, a_2) entre la partie de support de poinçon (21) et le bord rapproché non soudé (31a, 31b) sur la base d'un changement d'intensité d'une lumière de mesure rayonnée à partir du projecteur de lumière (4) pour passer à travers une trajectoire optique reliant un côté extérieur et un côté intérieur du tube à bords rapprochés non soudés formé et pour atteindre le récepteur de lumière (5), le changement étant causé lorsque la trajectoire optique est bloquée par le bord rapproché non soudé (31a, 31b) du tube à bords rapprochés non soudés ; dans lequel ladite étape de commande d'une quantité de pression de poinçon est basée sur l'écartement (a_1, a_2) mesuré.

8. Procédé de presse à cintrer selon la revendication

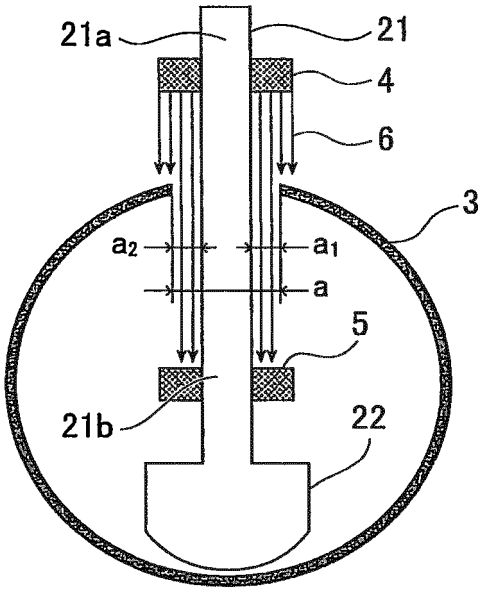
6 ou 7, comprenant en outre les étapes de :

mesure de la quantité d'écartement (a_1, a_2) dans un état où la pression du poinçon est relâchée après réalisation de la dernière pression ;
achèvement direct de la pression lorsque la quantité d'espace (a_1, a_2) mesurée est inférieure ou égale à une quantité prédéterminée définie à l'avance, et
réalisation successive de la pression avec une quantité de pression de poinçon basée sur la quantité d'espace (a_1, a_2) mesurée lorsque la quantité d'espace mesurée dépasse la quantité prédéterminée définie à l'avance.

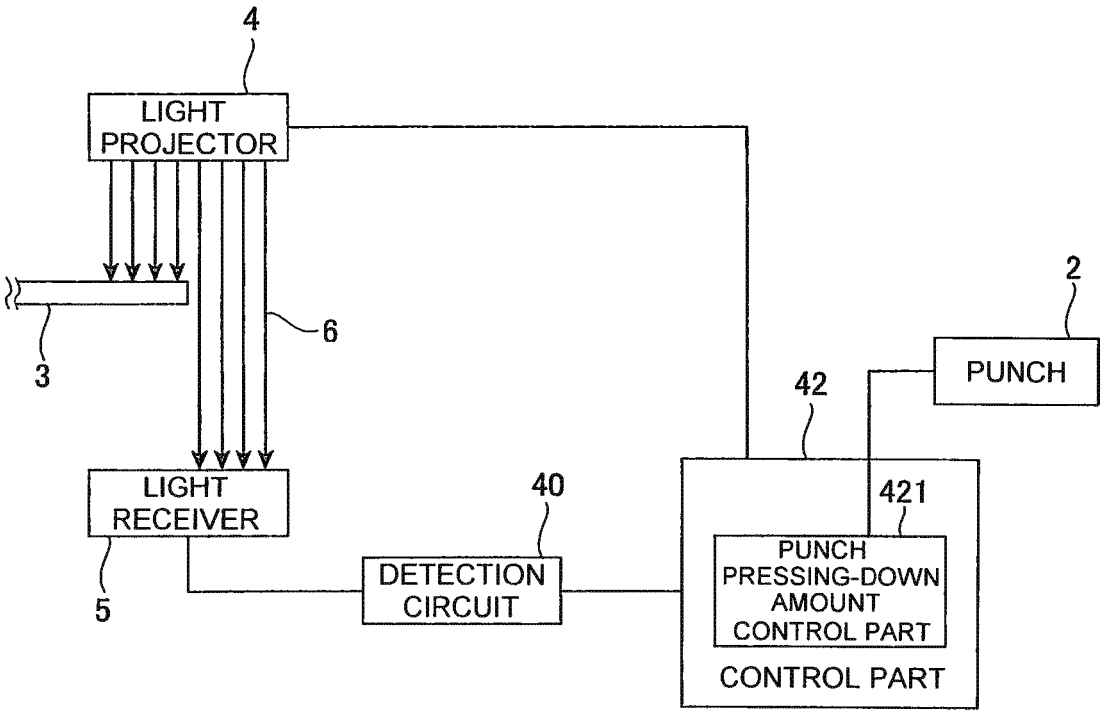
9. Procédé de fabrication de tube d'acier comprenant les étapes de :

formation d'un tube à bords rapprochés non soudés (3) au moyen du procédé de presse à cintrer selon l'une quelconque des revendications 6 à 8 ;
mise bout à bout des bords rapprochés non soudés (31a, 31b) du tube à bords rapprochés non soudés (3) ; et
soudage des bords rapprochés non soudés (31a, 31b) mis bout à bout.

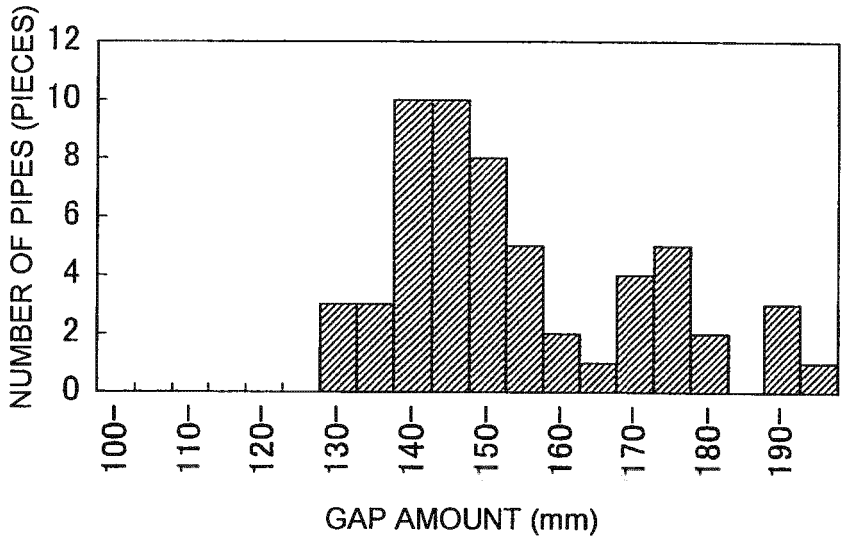
[FIG. 1]



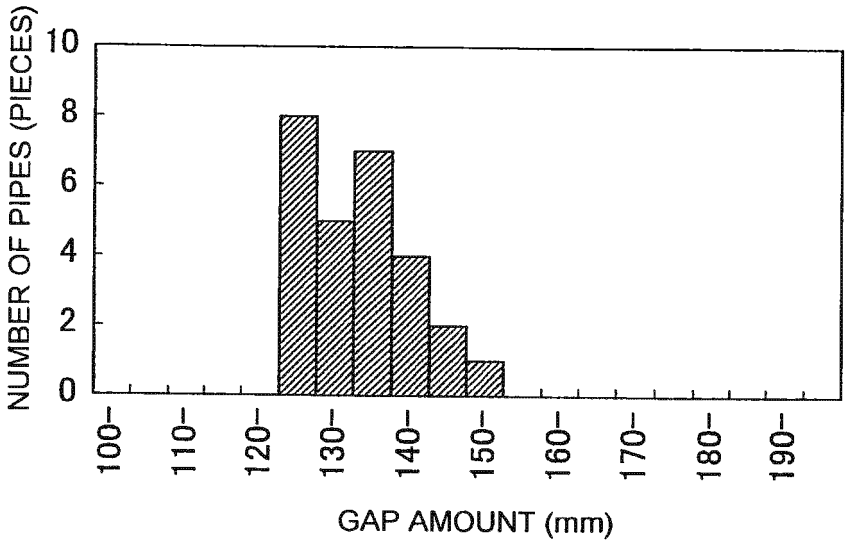
[FIG. 2]


4
LIGHT PROJECTOR
6
3
2
PUNCH
42
LIGHT RECEIVER
40
421
5
DETECTION CIRCUIT
PUNCH PRESSING-DOWN AMOUNT CONTROL PART
CONTROL PART

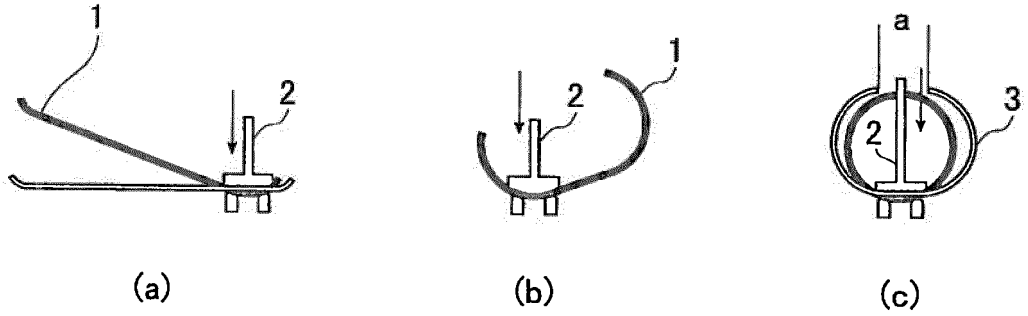
[FIG. 3]


NUMBER OF PIPES (PIECES)
0
2
4
6
8
10
12
100
110
120
130
140
150
160
170
180
190
GAP AMOUNT (mm)

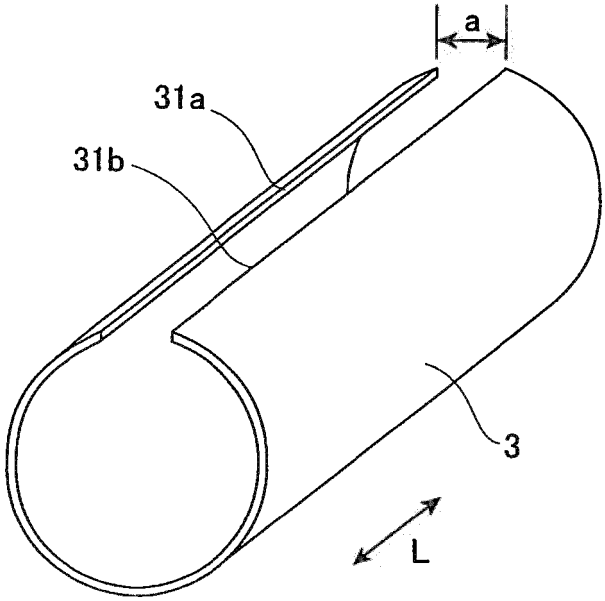
[FIG. 4]


NUMBER OF PIPES (PIECES)
10
8
6
4
2
0
100–
110–
120–
130–
140–
150–
160–
170–
180–
190–
GAP AMOUNT (mm)

[FIG. 5]


1
2
(a)
1
2
(b)
a
2
3
(c)

[FIG. 6]



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11129031 A **[0005]**
- WO 2012100802 A1 **[0005]**