



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
06.10.2010 Bulletin 2010/40

(51) Int Cl.:
B21D 24/00 (2006.01) **B21D 25/04** (2006.01)
B21D 43/00 (2006.01) **B30B 15/30** (2006.01)

(21) Application number: **08859822.2**

(86) International application number:
PCT/JP2008/067475

(22) Date of filing: **26.09.2008**

(87) International publication number:
WO 2009/075134 (18.06.2009 Gazette 2009/25)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(72) Inventors:
• **ISHIGURO, Katsunori**
Toyota-shi
Aichi 473-8501 (JP)
• **FURUHASHI, Masaki**
Toyota-shi
Aichi 473-8501 (JP)

(30) Priority: **13.12.2007 JP 2007322507**

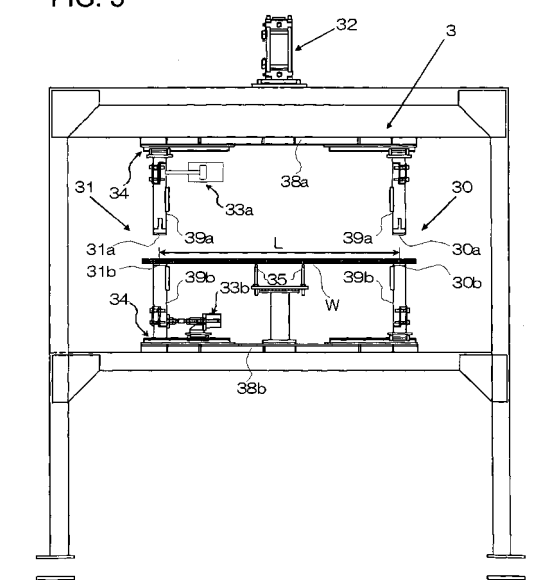
(74) Representative: **RACKETTE Partnerschaft**
Patentanwälte
Postfach 1310
79013 Freiburg (DE)

(71) Applicant: **Aisin Takaoka Co., Ltd.**
Toyota-shi, Aichi 473-8501 (JP)

(54) **ENERGIZATION HEATING DEVICE AND HOT PRESS FORMING DEVICE HAVING IT AND CONDUCTION HEATING METHOD**

(57) To provide a conduction heating apparatus which is capable of preventing distortion of a work due to conduction heating as much as possible, and stably supplying a conduction heated work to the downstream step of conduction heating, and a hot press forming apparatus having the conduction heating apparatus, and a hot press forming method. The conduction heating apparatus 3 that performs conduction heating while clamping a work W to be hot press-formed by a clamping mechanism (30, 31, and the like) to apply tension to the work W, in which the clamping mechanism (30, 31, and the like) has a stationary clamping member 30 and a movable clamping member 31, a lifting up/down cylinder 32 for the stationary clamping member 30 and the movable clamping member 31, and tensioning cylinders 33a and 33b that drive the movable clamping member 31 along the planar direction of the work W, and in conduction heating, the stationary clamping member 30 clamps one side of the work W and hold it, and the movable clamping member 31 moves while holding the other side of the work W according to thermal deformation of the work W, which applies tension to the work W corresponding to the thermal deformation of the work W.

FIG. 3



Description

TECHNICAL FIELD

5 [CROSS-REFERENCE TO RELATED APPLICATION]

[0001] The present invention is based on and claims the benefit of the priority of Japanese Patent Application No. 2007-322507 (filed on December 13, 2007), and the disclosure of which is incorporated herein in its entirety by reference thereto.

10 The present invention relates to a conduction heating apparatus and a hot press forming apparatus having the conduction heating apparatus, and further to a conduction heating method. In particular, the present invention relates to a conduction heating apparatus built in a hot press forming apparatus, and a conduction heating method executed in the hot press forming apparatus.

15 BACKGROUND ART

[0002] As one of the methods of mass-producing vehicle parts requiring high-strength, a hot press forming technique or a die quenching technique is employed. The die quenching technique is a technique in which a steel plate is heated to at approximately 900°C, and the steel plate is thereafter rapidly cooled simultaneously with press forming, to quench a formed product. Further, for the heating of a steel plate, conventionally, a continuous heating furnace installed separately from the press forming apparatus is generally used.

[0003] On the other hand, in Patent Document 1, there is disclosed a hot press forming method using a conduction heating mechanism for heating a steel plate. In detail, in Patent Document 1, there is disclosed the hot press forming method for a metal plate comprising the successive steps of "respectively attaching electrodes to one or more places of the both ends of a metal plate inside a metal die or in the vicinity of the die outside the metal die, applying an electric current between the electrodes to heat the metal plate to at a predetermined processing temperature by Joule heat, and performing hot press forming".

[0004] The conduction heating mechanism in Patent Document 1 has a pair of right and left clamping electrodes moving along a longitudinal direction of a work, and the pair of right and left clamping electrodes respectively clamps the both ends in the longitudinal direction of the work during conduction heating, to apply pulling force to the work in the right and left directions along the longitudinal direction of the work. The pair of right and left clamping electrodes is out of movement during conduction heating and a distance between the right and left clamps is fixed.

[0005] Patent Document 1: Japanese Patent Kokai Publication No. JP-P2002-18531A

35 DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006] The disclosure in Patent Document 1 described above is herein incorporated by reference. The analysis set forth below is given by the present invention.

According to the conduction heating mechanism of Patent Document 1, there is a problem that the work is greatly distorted and the central portion of the work droops down regardless of an application of pulling force to a work during conduction heating.

[0007] The reason for the problem is that a clamping distance between the pair of right and left clamps is fixed regardless of the fact that a work expands according to a temperature rise during conduction heating. That is, since the both ends of the work are restrained at the fixed positions in conduction heating, as a result, the central portion of the work easy to be thermally deformed due to a temperature rise droops down by its own weight.

[0008] Therefore, according to the conduction heating mechanism in Patent Document 1, it is difficult to stably supply a work to the downstream steps of conduction heating. The reason for that is that, since a distortion of a work due to conduction heating is great, it is difficult to perform positioning of the work, and the greatly distorted portion thereof may interfere with the holding members of a conveying mechanism or a die of a hot press mechanism.

[0009] It is an object of the present invention to provide a conduction heating apparatus which is capable of preventing a distortion of a work due to conduction heating as much as possible, and stably supplying a conduction heated work to the downstream steps of conduction heating, and a hot press forming apparatus having the conduction heating apparatus, and a conduction heating method.

MEANS TO SOLVE THE PROBLEM

[0010] According to a first aspect of the present invention, there is provided a conduction heating apparatus that performs conduction heating onto a work to be hot press formed while clamping the work by a clamping mechanism under application of tension to the work, in which the clamping mechanism comprises: a stationary clamping member which clamps one side of the work to be free to hold the one side of the work, and is fixed in position or capable of being freely fixed in position along a predetermined direction, and a movable clamping member which clamps the other side of the work to be free to hold the other side of the work, and is free to move along the predetermined direction; and in conduction heating, the stationary clamping member holds the one side of the work at a fixed position, and the movable clamping member moves along the predetermined direction while holding the other side of the work according to a thermal deformation along the predetermined direction of the work, which applies tension to the work. The predetermined direction is a principal direction in which the work is easy to expand due to a thermal deformation, and is the same direction as a longitudinal direction of the work, or a direction along the upper and lower planes or the pressing plane of the work, for example.

[0011] According to a second aspect of the present invention, there is provided a conduction heating apparatus that performs conduction heating onto a work to be hot press formed while clamping the work by a clamping mechanism under application of tension to the work, in which the clamping mechanism comprises: first and second clamping members that clamp the work at different clamping positions respectively, to apply tension to the work; a clamping direction driving mechanism driving the first and second clamping members to clamp the work; and a clamping distance varying mechanism varying a clamping distance between the first and second clamping members according to a thermal deformation of the work upon conduction heating.

[0012] According to a third aspect of the present invention, there is provided a hot press forming apparatus comprising: the conduction heating apparatus according to the present invention; and a hot press mechanism that hot press-forms the work heated by the conduction heating apparatus.

[0013] According to a fourth aspect of the present invention, there is provided a conduction heating method for performing conduction heating onto a work to be hot press-formed while clamping the work under application of tension to the work, the method comprising: a clamping step of applying tension to the work while clamping one side and the other side of the work respectively to hold the work; a conduction heating step of performing conduction heating onto the clamped work; and a tension applying step during conduction heating of clamping the one side of the work at a fixed position and moving the other clamping position of the other side of the work along with the work subject to be thermally deformed, to apply tension to the work upon the conduction heating.

EFFECT OF THE INVENTION

[0014] According to the present invention, during the conduction heating, a clamping position at which the work is held or a clamping distance thereof is moved or varied along with the work that will be thermally deformed preferably according to an amount of the thermal deformation of the work, in particular, according to thermal expansion or stretch thereof. Thereby appropriate tension is applied to the work during conduction heating, to prevent a distortion of the work due to a temperature rise, in particular, to prevent the central portion of the work from greatly drooping, which keeps the work in a flat state as much as possible. As a result, in the case where the conduction heated work is conveyed to the hot press mechanism on the downstream side, interference of the work with the components of the conveying mechanism or the hot press mechanism is prevented.

[0015] According to the present invention, during conduction heating, one side of a work is clamped at a fixed position by the stationary clamping member. Thereby preventing a shift in position for work positioning caused by a thermal deformation of the work or a movement of the movable clamping member. As a result, in the case where the conduction heated work is conveyed to the hot press mechanism on the downstream side, it is easy to deliver the work to the conveying mechanism or the hot press mechanism, and which makes work positioning easy in the hot press forming step. Thus the conduction heated works are stably supplied.

[0016] In this way, the present invention by which it is possible to stably supply a conduction heated work to the downstream step, contributes to hot press forming, in particular, making the die quenching into high-cycle. Further, in the case where the clamps serve as electrodes as well, as described above, according to the present invention, since a work is kept in a flat state as much as possible in the conduction heating, uniform heating for the work is expected.

BRIEF DESCRIPTIONS OF THE DRAWINGS

[0017]

Fig. 1 is an appearance diagram of a hot press forming apparatus into which a conduction heating apparatus is

built, according to an Example of the present invention.

Figs. 2A to 2C are diagrams of three planes for explanation of a mechanical structure of the conduction heating apparatus and the hot press forming apparatus shown in Fig. 1. Fig. 2A is a top plan view thereof, Fig. 2B is a front view thereof, and Fig. 2C is a side view thereof.

Fig. 3 is an enlarged view of Fig. 2C.

Fig. 4 is a block diagram for explanation of a control configuration of the conduction heating apparatus shown in Fig. 3. (A) to (F) of Fig. 5 are process drawings for explanation of operations of the conduction heating apparatus shown in Figs. 3 and 4.

Fig. 6 is a process drawing for explanation of a problematic point of a conduction heating apparatus according to a comparative example in which a clamping distance L is fixed.

EXPLANATION OF SIGNS

[0018]

15	1	Hot-press forming apparatus
	2	Feeding mechanism
	3	Conduction heating apparatus
	4	Hot press mechanism
20	5	Transfer mechanism
	6	Control mechanism
	7	Conveying conveyor
	30	Stationary clamping member
	30a, 30b	Upper and lower clamps
25	31	Movable clamping member
	31a, 31b	Upper and lower clamps
	32 mechanism)	Lifting up/down cylinder (lifting up/down direction driving
	33a, 33b	Upper and lower tensioning cylinders (movable clamping member driving mechanism, clamping distance varying mechanism)
30	34, 34	Upper and lower translatory guides
	(30, 31, 32, 33a, 33b, 34)	Clamping mechanism
	35	Support rod
	36a	Current sensor
	36b	Temperature sensor
35	36c	Lifting up/down position sensor
	36d	Movable clamping member position sensor
	36e	Control board (control means, microcomputer)
	37	Energizing mechanism (Conducting mechanism)
	37a	Energizing switch (Conducting switch)
40	38a, 38b	Upper and lower frames
	39a, 39b	Upper and lower support pillars (support members)
	41	Die, Cooling die
	51	A pair of parallel arms
	52a to 52c	Cylinders (driving means)
45	53a to 53c	Holding members (clamps, holding means)
	54	Support bar
	L, L+	Clamping distances
	P	Power source
	P0	Feeding position
50	P1	Energizing position (Conducting position)
	P2	Processing position
	P3	Discharging position
	W	Work
	D	Distance between variable clamping position and left end of
55	work W	in the drawing at the start of energization
	E	Distance between variable clamping position and left end of
	work W	in the drawing at the termination of energization

PREFERRED MODES OF THE INVENTION

[0019] According to a preferred exemplary embodiment of the present invention, the clamping mechanism has a lifting up/down direction driving mechanism that drives the stationary clamping member and the movable clamping member to freely lift up/down along a thickness direction of the work, to clamp the work, and a movable clamping member driving mechanism that drives the movable clamping member to freely move along the predetermined direction.

[0020] According to a preferred exemplary embodiment of the present invention, the stationary clamping member and the movable clamping member respectively have pairs of upper and lower clamps facing each other along the thickness direction of the work to freely pinch the work. According to this aspect, clamping of the work is made stable, and it is easy to secure a moving stroke of the movable clamping member.

[0021] According to a preferred exemplary embodiment of the present invention, the lower clamps spaced from each other along the predetermined direction or the longitudinal direction of the work between the pairs of upper and lower clamps which the stationary clamping member and the movable clamping member respectively have, are a pair of electrodes for energizing the work. According to this aspect, power saving, downsizing of the mechanisms, and uniform heating for the work are expected.

[0022] According to a preferred exemplary embodiment of the present invention, the stationary clamping member and the movable clamping member respectively have pairs of upper and lower clamps facing each other along the thickness direction of the work to freely pinch the work, and portions of the upper clamps pinching the work are of convex curved shapes, and portions of the lower clamps pinching the work are of planar shapes. According to this aspect, clamping is made stable. Further, in the case where the clamps serve as electrodes as well, the electrodes are prevented from unevenly abutting to the work, which prevents local overheating in the work.

[0023] According to a preferred exemplary embodiment of the present invention, the apparatus comprises a droop preventing member which is disposed beneath a central portion of the work during conduction heating, the droop preventing member freely support the central portion. It is more preferable that the droop preventing member is a plurality of pins provided upright along the vertical direction. According to such an aspect, without interfering with supplying of a work to the conduction heating apparatus or discharging thereof to the downstream side, it is possible to prevent or restrain a droop of the central portion of the work in conduction heating.

[0024] According to a preferred exemplary embodiment of the present invention, the clamping mechanism has clamps or clamps serving as electrodes as well for elastically clamping the work. It is more preferable that the clamping mechanism has supporting member(s) or supporting pillar(s) to which the clamp(s) or the clamp(s) serving as electrode(s) as well are attached, and the supporting member(s) include base portion(s), attachment portion(s) which is (are) directly or indirectly connected to the base portion(s) and to which the clamp(s) or the clamp(s) serving as electrode(s) as well are attached, and elastic portion(s) which is (are) directly or indirectly inserted between the base portion(s) and the attachment portion(s) so as to exert elastic force along the clamping direction between the base portion(s) and the attachment portion(s). According to this aspect, a contacting area between the clamp(s) and the work is increased, and a uniform clamping load is exerted onto the work, thereby stabilizing the clamping, and increasing a contacting area between the electrode(s) and the work, which prevents local overheating in the work.

[0025] In a preferred exemplary embodiment of the present invention, it suffices to perform conduction heating so as to heat the work up to a temperature possible for hot pressing. For example, in the case of steel works, it suffices to perform conduction heating between an A1 transformation temperature and a liquid-phase precipitation temperature, for example, from 850 to 1,200°C.

[0026] The present invention is suitably applied to heating and further heat-forming of works of various materials which can be subjected to conduction heating and hot processing, and in particular, to die quenching. For example, the present invention is suitably applied to forming steel system, aluminum system, and other various metal materials. The present invention is suitably applied to heating and, in addition, hot forming of not only general steel plates, but also plated steel plates (for example, galvanized steel plates, alloyed fused zinc hot dip galvanized steel plates, aluminum plated steel plates, and the like).

EXAMPLES

[0027] Hereinafter, an example of the present invention will be described with reference to the drawings. Fig. 1 is an appearance diagram of a hot press forming apparatus into which a conduction heating apparatus according to an example of the present invention is built.

[0028] Referring to Fig. 1, in a hot press forming apparatus 1, a conduction heating apparatus 3 to which works are supplied one by one from a robotic type feeding mechanism 2, a die quenching hot press mechanism 4 disposed so as to be thermally isolated on the downstream side of the conduction heating apparatus 3, and a transfer mechanism 5 that at least carries a conduction heated work from the conduction heating apparatus 3 to the hot press mechanism 4 and carries a formed product from the hot press mechanism 4 to a discharging position are built into the apparatus 1.

Note that a conveying conveyor 7 for discharging a formed product or a completed article from the discharging position of the apparatus 1 is additionally installed in the hot press forming apparatus 1.

[0029] The work feeding mechanism 2 is a robotic mechanism, and takes out works one by one from a magazine in which a plurality of works or blanks are contained, to supply those one by one to the conduction heating apparatus 3.

[0030] The conduction heating apparatus 3 performs clamping of a fed work and a releasing thereof and performs energization (electric conduction) to the work to which tension by the clamping is applied, to heat the work.

[0031] The hot press mechanism 4 hot presses and rapidly-cools a heated work to form a formed product from the work.

[0032] The transfer mechanism 5 has a plurality of holding mechanisms or holding members that hold works or formed products or release the holdings thereof at a feeding position at which a work is fed into the hot press forming apparatus 1 or the conduction heating apparatus 3, an energizing position at which the conduction heating apparatus 3 energizes (applies electric conduction to) a work, a processing position at which the hot press mechanism 4 hot press-forms a work, and a discharging position at which a formed product is discharged out of the hot press forming apparatus 1, and respectively reciprocate between the feeding position and the energizing position, between the energizing position and the processing position, and between the processing position and the discharging position.

[0033] Figs. 2A to 2C are diagrams of three planes (views) for explanation of the conduction heating apparatus and the hot press forming apparatus shown in Fig. 1. Fig. 2A is a top plan view thereof, Fig. 2B is a front view thereof, and Fig. 2C is a side view thereof. Fig. 3 is an enlarged view of Fig. 2C. Note that Fig. 2C shows a state in which upper clamps 30a and 31a are at lifted-up positions, and a movable clamping member 31 is moved to the end portion.

[0034] Referring to Figs. 2A to 2C and Fig. 3, in the hot press forming apparatus 1, a feeding position P0 at which a work W is fed, an energizing position P1 at which conduction heating by the conduction heating apparatus 3 is performed, a processing position P2 at which hot press forming or die quenching by the hot press mechanism 4 is performed, and a discharging position P3 at which a formed product is discharged out of the hot press forming apparatus 1 are set at regular pitches in the order from the upstream side toward the downstream side along a conveying direction.

[0035] The conduction heating apparatus 3 has a clamping mechanism (30, 31, 32, 33a, 33b, 34) which will be described later, an energizing mechanism (refer to an energizing mechanism 37 in Fig. 4) having electrodes contacting the work W, wirings for electrically connecting between the electrodes and an electric power source and an energizing switch, and a plurality of pins 35 serving as droop preventing members which are disposed beneath the central portion of the work W during conduction heating and provided upright along the vertical direction, to freely support the central portion of the work W.

[0036] The clamping mechanism (30, 31, 32, 33a, 33b, 34) has a stationary (positionally fixed) clamping member 30 and a movable clamping member 31 (first and second clamping members), a lifting up/down cylinder 32 serving as a lifting up/down direction driving mechanism or a clamping direction driving mechanism for the stationary clamping member 30 and the movable clamping member 31, upper and lower tensioning cylinders 33a and 33b serving as a movable clamping member driving mechanism that moves the movable clamping member 31 along the predetermined direction or a clamping distance varying mechanism responding to a thermal deformation of the work W, and upper and lower translatable guides 34 and 34 guiding a movement of the movable clamping member 31.

[0037] The stationary clamping member 30 which clamps one side of the work W along its longitudinal direction or horizontal direction of the work W at a fixed position to freely hold the same side and has a function of positioning the work W as well. The movable clamping member 31 clamps the other side of the work W to freely hold the other side and to freely move along the predetermined direction or the horizontal direction. In conduction heating, the stationary clamping member 30 holds the one side of the work at the fixed position, and on the other hand, the movable clamping member 31 moves while holding the other side of the work W according to a thermal deformation of the work W. By the stationary clamping member 30 and the movable clamping member 31, tension is applied to the work W so as to prevent the central portion of the work W from drooping as much as possible in conduction heating. In particular, tension acting forward a moving direction of the movable clamping member 31 is applied to the work W.

[0038] The stationary clamping member 30 and the movable clamping member 31 respectively have the pairs of upper and lower clamps 30a and 30b, and 31a and 31b, respectively, facing each other along the thickness direction of the work W to freely pinch the work W. The pair of lower clamps 30b and 31b spaced from each other along the longitudinal direction of the work W among the pairs of upper and lower clamps 30a and 30b, and 31a and 31b which the stationary clamping member 30 and the movable clamping member 31 respectively have, is a pair of electrodes for energizing (applying electric current conduction to) the work W.

[0039] The lifting up/down cylinder 32 drives the upper clamps 30a and 31a of the stationary clamping member 30 and the movable clamping member 31 to freely lift up/down (ascend/descend) along the thickness direction of the work W, to clamp the work W and hold it. The upper and lower tensioning cylinders 33a and 33b drive the movable clamping member 31 to freely move along the predetermined direction, i.e., the longitudinal direction or horizontal direction of the work W. The upper and lower tensioning cylinders 33a and 33b exert a biasing force to the movable clamping member 31 in order for the movable clamping member 31 not to slide along the work W at the time of moving the movable clamping member 31 in conduction heating. Note that the stationary clamping member 30 is provided fixedly (stationarily)

in position along the predetermined direction, or provided so as to be capable of varying its initial position according to a shape of the work W by an air cylinder, a motor, or the like.

[0040] The clamps 30a, 30b, 31a, and 31b are respectively attached to the end portions of upper and lower support pillars 39a and 39b. The upper support pillars 39a and 39a are attached to an upper frame 38a which is free to lift up/down, and the upper frame 38a is connected to the lifting up/down cylinder 32. The lower support pillars 39b and 39b are attached to an immobile lower frame 38b. The upper and lower translatory guides 34 and 34 and the tensioning cylinders 33a and 33b are respectively disposed onto the upper and lower frames 38a and 38b. Note that it is possible to drive the upper and lower clamps 31a and 31b of the movable clamping member 31 with one cylinder or the like.

[0041] The hot press mechanism 4 has a cooling die 41 for performing hot pressing to rapidly cool the work conveyed from the energizing position P1 by the transfer mechanism 5, at the processing position P2 after the work W is conduction heated at the energizing position P1.

[0042] The transfer mechanism 5 has a pair of parallel arms 51 extending along the conveying direction of the work W, cylinders (not shown) serving as driving means that drive the pair of parallel arms 51 to freely move in a reciprocating manner along the conveying direction, a lifting up/down direction perpendicular to the conveying direction, and a width direction perpendicular to the conveying and lifting up/down directions, and a plurality of clamps (not shown) serving as holding mechanisms or holding members which are attached plurally to the pair of parallel arms 51 at predetermined intervals along the conveying direction, and hold a work W or a formed product when the pair of parallel arms 51 approaches each other along the width direction, and release the holding when the pair of parallel arms 51 is separated from each other. The plurality of clamps are disposed at regular pitches on the pair of parallel arms 51 so as to correspond to the distances between the feeding position P0, the energizing position P1, the processing position P2, and the discharging position P3. Note that a servo motor or the like may be employed as driving means in place of the cylinders serving as driving means.

[0043] Moreover, the transfer mechanism 5 has a support rod 54 that supports or guides a work W thermally deformed such that its central portion droops due to conduction heating between the energizing position P1 and the processing position P2. The support rod 54 is inclined so as to be higher toward the downstream side in the conveying direction such that the side of the processing position P2 is made higher than the side of the energizing position P1. The inclined angle of the support rod 54 is set in accordance with a material of works W, a heating temperature, and a stroke width in the lifting up/down direction of the transfer mechanism 5.

[0044] Fig. 4 is a block diagram for explanation of a control configuration of the conduction heating apparatus 3 shown in Fig. 3. Referring to Fig. 4, the conduction heating apparatus 3 comprises the stationary clamping member 30 and the movable clamping member 31 (first and second clamping members), the lifting up/down cylinder 32, the upper and lower tensioning cylinders 33a and 33b, a current sensor 36a detecting an amount of electric current applied to a work W, a temperature sensor 36b detecting a temperature of the work, a lifting up/down position sensor 36c detecting positions in the lifting up/down direction of the stationary clamping member 30 and the movable clamping member 31, a movable clamping member position sensor 36d detecting a position in a moving direction position of the movable clamping member 31, the energizing mechanism 37 controlling energization (electric conduction) to the work W, and a control board (microcomputer) 36e serving as means for controlling the lifting up/down cylinder 32, the upper and lower tensioning cylinders 33a and 33b, and the energizing switch 37a on the basis of information detected by the sensors 36a to 36d. The energizing (conducting) mechanism 37 is composed of the pair of lower clamps 30b and 31b serving as electrodes as well, a direct-current or alternating-current power source P, the energizing switch 37a which is connected between the direct-current or alternating-current power source P and the lower clamps 30b and 31b to switch on/off energization (conduction) to a work W, the current sensor 36a, and the temperature sensor 36b.

[0045] Next, the operations of the conduction heating apparatus 3 will be described.

(A) to (F) of Fig. 5 are process drawings for explanation of the operations of the conduction heating apparatus shown in Fig. 3 and Fig. 4 according to an example of the present invention. Note that the illustrations of the upper and lower support pillars are omitted in (A) to (F) of Fig. 5, and the illustrations of the upper and lower frames are omitted in (E) of Fig. 5. Further, (F) of Fig. 5 is a top plan view of (E) of Fig. 5. Fig. 6 is a process drawing for explanation of a problematic point of a conduction heating apparatus according to a comparative example in which a clamping distance L is fixed.

[Clamping Process]

[0046] Referring to (A) and (B) of Fig. 5, the work W is held by holding members 53 of the pair of parallel arms 51 which the transfer mechanism 5 has, and the work W is conveyed to the energizing position P1 of the conduction heating apparatus 3 shown in Fig. 2A by the cylinders 52a, to be placed on the pair of lower clamps 30b and 31b. Next, after the pair of parallel arms 51 is spaced from each other by the cylinders 52c, the pair of parallel arms 51 is lifted up by the cylinders 52b, thereby delivering (hand over) the work W to the side of the conduction heating apparatus 3.

[0047] Referring to (C) and (D) of Fig. 5, the upper clamps 30a and 31a of the stationary clamping member 30 and the movable clamping member 31 at the lifted-up position are lifted down by the lifting up/down cylinder 32. In accordance

with this operation, on the side of the stationary clamping member 30, one side of the work W is clamped to be held at a fixed position by the pair of upper and lower clamps 30a and 30b, to perform positioning of the work W, and on the other hand, on the side of the movable clamping member 31, the other side of the work is clamped to be held by the pair of upper and lower clamps 31a and 31b. Note that the initial clamping distance is set to "L".

[0048] Note that separate cylinders for setting or keeping the initial positions of the pair of upper and lower clamps 30a and 30b of the stationary clamping member 30 may be respectively connected to the pair of upper and lower support pillars 39a and 39b. Note that, in place of these cylinders, a servo motor or the like capable of performing positioning may be employed.

[Conduction Heating Process]

[0049] The lower clamps 30b and 31b spaced from each other in the longitudinal direction of the work W serve as electrodes as well, and energization (conduction) to the work W is started through the pair of the lower clamps 30b and 31b. Note that portions of the upper clamps 30a and 31a for clamping the work W are formed to be convex curved shapes, and portions of the lower clamps 30b and 31b for clamping the work W are formed to be planar shapes, thereby improving its clamping performance and bringing about uniform heating.

[0050] Further, by use of the bar-shaped clamps and bar-shaped electrodes with sufficient lengths along the width direction of the work W and the conveying direction of the work are used as the upper and lower clamps 30a, 30b, 31a, and 31b, the clamping performance is improved and uniform heating is expected. The widths of the clamps 30a, 30b, 31a, and 31b are set to be the same as the width of the work W or longer to a certain extent than the width of the work W, and in the case where the width of the work W is set to be longer, it is preferably set to be longer by approximately several% to 20%.

[Tension Applying Process in Conduction Heating Process]

[0051] Referring to (E) and (F) of Figs. 5, as an energizing time proceeds, an energizing current is accumulated, or a temperature of the work W increases, during conduction heating, the pair of upper and lower clamps 31a and 31b of the movable clamping member 31 gradually move toward the end portion in the longitudinal direction of the work W synchronously with a length of stretching of the work W thermally expanding while holding the other side of the work W, by the upper and lower tensioning cylinders 33a and 33b. Thereby, making tension act on the work W forward the moving direction of the movable clamping member 31. Further, a clamping distance at the termination of conduction heating is elongated to be "L+" relative to the clamping distance "L" at the start of conduction heating. That is, in conduction heating, a clamping distance is elongated by a stretched length of the work W, i.e., an amount of "L+"-"L". Note that, given that the distance between the clamping position by the upper and lower clamps 31a and 31b and the left end of the work W in the drawing at the start of conduction heating in (D) of Fig. 5 is "D", and the distance between the clamping position by the upper and lower clamps 31a and 31b and the left end of the work W in the drawing at the termination of conduction heating in (E) of Fig. 5 is "E", "D" and "E" are the same length, or "E" that is a distance after thermal expansion is slightly longer than "D" that is a distance before thermal expansion.

[0052] In this way, according to the conduction heating apparatus according to an example of the present invention, since it is possible to always apply appropriate tension to the work W stretching according to a temperature rise at an appropriate clamping position during conduction heating, drooping of the central portion of the work W due to conduction heating is prevented as much as possible.

[0053] In contrast thereto, according to the conduction heating apparatus according to the comparative example shown in Fig. 6, the two clamping positions are fixed, and the clamping distance between the both is "L" which is constant. That is, since the positions of tying up the both ends in the longitudinal direction of the work W are invariable, it is impossible to continue to apply effective tension to the work W stretching according to a temperature rise during the conduction heating, which causes its central portion to droop or warp upward.

INDUSTRIAL APPLICABILITY

[0054] The conduction heating apparatus according to the present invention is suitably built into a hot press forming apparatus, in particular, a die quenching apparatus. Further, the conduction heating apparatus and the conduction heating method according to the present invention are applied to heating of a plate material made of metal to be hot press formed, and in particular, of a lengthwise plate material. In detail, the conduction heating apparatus and the conduction heating method according to the present invention are applied to heating of vehicle parts requiring mass productivity before forming, for example, heating of various types of reinforcing members for vehicle bodies, in particular, door beams, bumper reinforcements, and the like before hot press forming.

The modifications and adjustments of the exemplary embodiment and example are possible within the scope of all the

disclosures (including the claims) of the present invention, and further on the basis of the basic technical concept. Further, a wide variety of combinations and selections of various disclosed elements are possible within the scope of claims of the present invention.

Claims

1. A conduction heating apparatus that performs conduction heating onto a work to be hot press-formed while clamping the work by a clamping mechanism under application of tension to the work, wherein the clamping mechanism comprises:

a stationary clamping member which clamps one side of the work to freely hold the one side of the work, and is fixed in position or capable of being freely fixed in position along a predetermined direction, and a movable clamping member which clamps the other side of the work to freely hold the other side of the work, and to freely move along the predetermined direction; and wherein in conduction heating, the stationary clamping member holds the one side of the work at a fixed position, and the movable clamping member moves along the predetermined direction while holding the other side of the work according to a thermal deformation along the predetermined direction of the work to apply tension to the work.

2. The conduction heating apparatus according to claim 1, wherein; the clamping mechanism comprises:

a lifting up/down direction driving mechanism that drives the stationary clamping member and the movable clamping member to freely lift up/down along a thickness direction of the work to clamp the work, and a movable clamping member driving mechanism that drives the movable clamping member to freely move along the predetermined direction.

3. The conduction heating apparatus according to claim 1 or 2, wherein the stationary clamping member and the movable clamping member respectively have pairs of upper and lower clamps facing each other along the thickness direction of the work to freely pinch the work.

4. The conduction heating apparatus according to claim 3, wherein the lower clamps spaced from each other along the predetermined direction, among the pairs of upper and lower clamps which the stationary clamping member and the movable clamping member respectively have, are a pair of electrodes for energizing the work.

5. The conduction heating apparatus according to claim 3 or 4, wherein portions of the upper clamps pinching the work are of convex curved shape, and portions of the lower clamps pinching the work are of planar shape.

6. The conduction heating apparatus according to any one of claims 1 to 5, comprising a droop preventing member which is disposed beneath a central portion of the work during conduction heating, the droop preventing member freely supports the central portion.

7. The conduction heating apparatus according to claim 6, wherein the droop preventing member is a plurality of pins provided upright along the vertical direction.

8. A conduction heating apparatus that performs conduction heating onto a work to be hot press-formed while clamping the work by a clamping mechanism under application of tension to the work, wherein the clamping mechanism comprises:

first and second clamping members that clamp the work at different clamping positions, respectively, to apply tension to the work; a clamping direction driving mechanism driving the first and second clamping members to clamp the work; and a clamping distance varying mechanism varying a clamping distance between the first and second clamping members according to a thermal deformation of the work upon conduction heating.

9. A hot press forming apparatus comprising:

the conduction heating apparatus according to any one of claims 1 to 8; and
a hot press mechanism that hot press-forms the work heated by the conduction heating apparatus.

- 5 **10.** A conduction heating method for performing conduction heating onto a work to be hot press-formed while clamping the work under application of tension to the work, the method comprising:

clamping for applying tension to the work while clamping one side and the other side of the work, respectively, to hold the work;

10 conduction heating for performing conduction heating onto the clamped work; and

applying a tension in the conduction heating by clamping the one side of the work at a fixed position and moving the other clamping position of the work along with the work thermally deforming upon the conduction heating.

15

20

25

30

35

40

45

50

55

FIG. 1

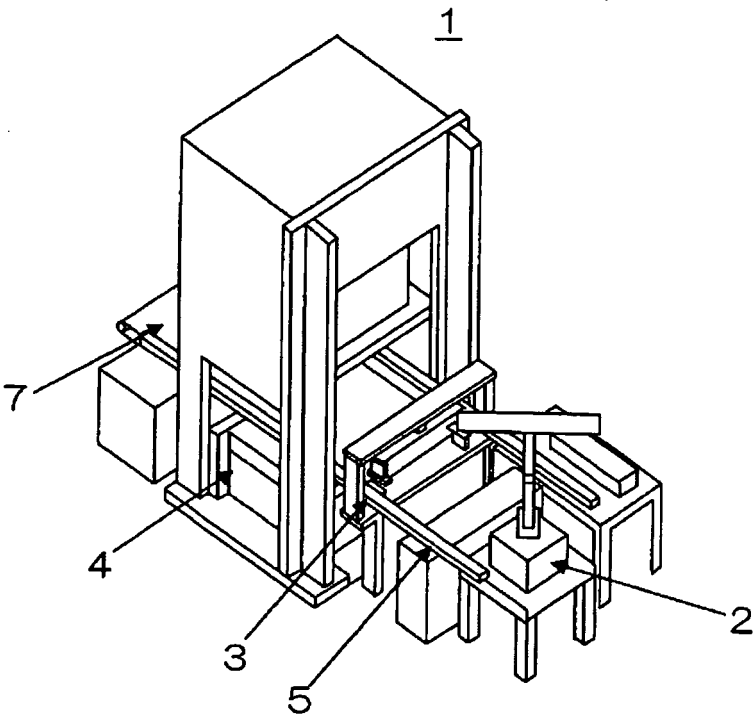


FIG. 2A

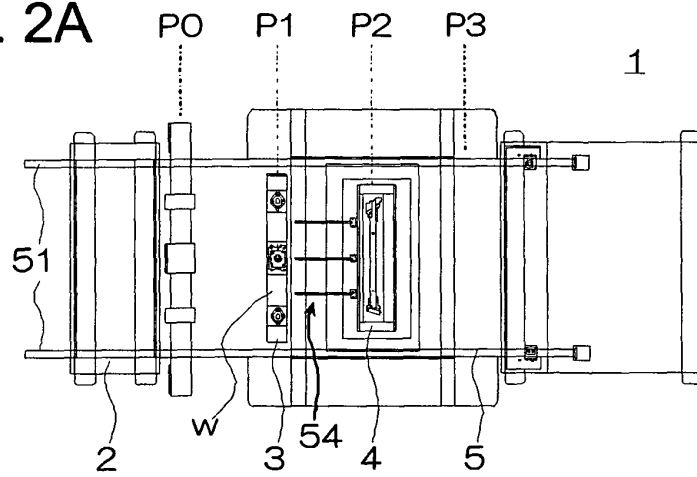


FIG. 2B

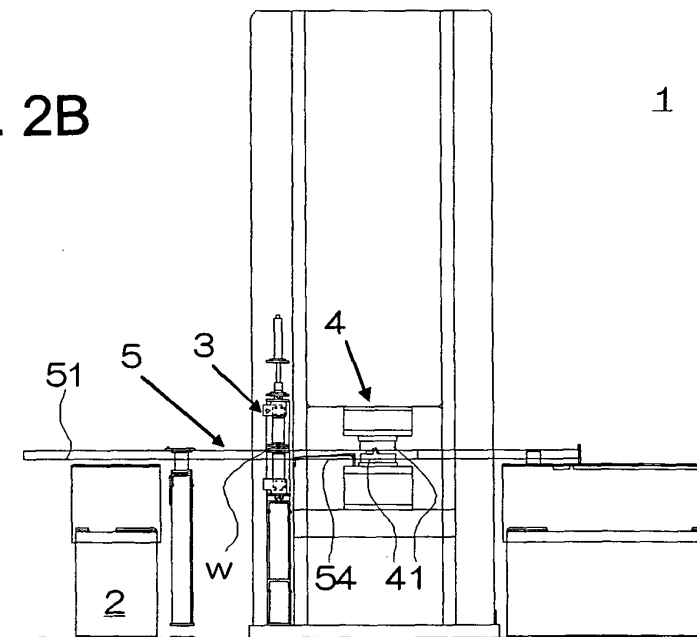


FIG. 2C

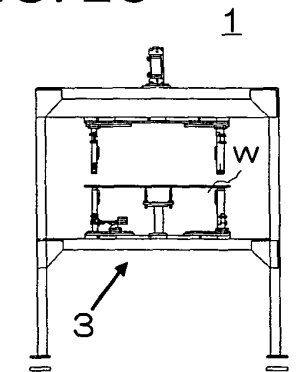


FIG. 3

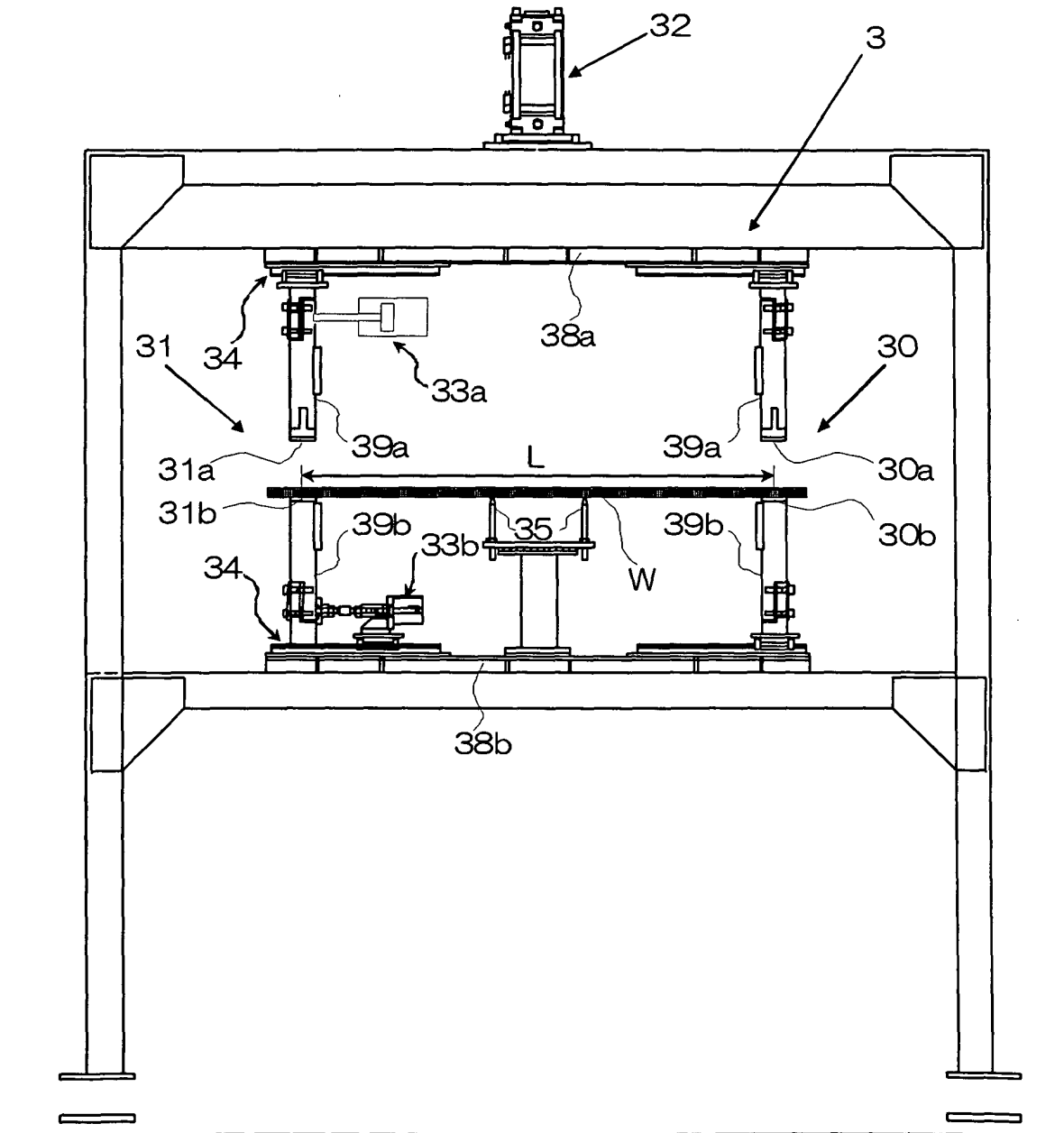


FIG. 4

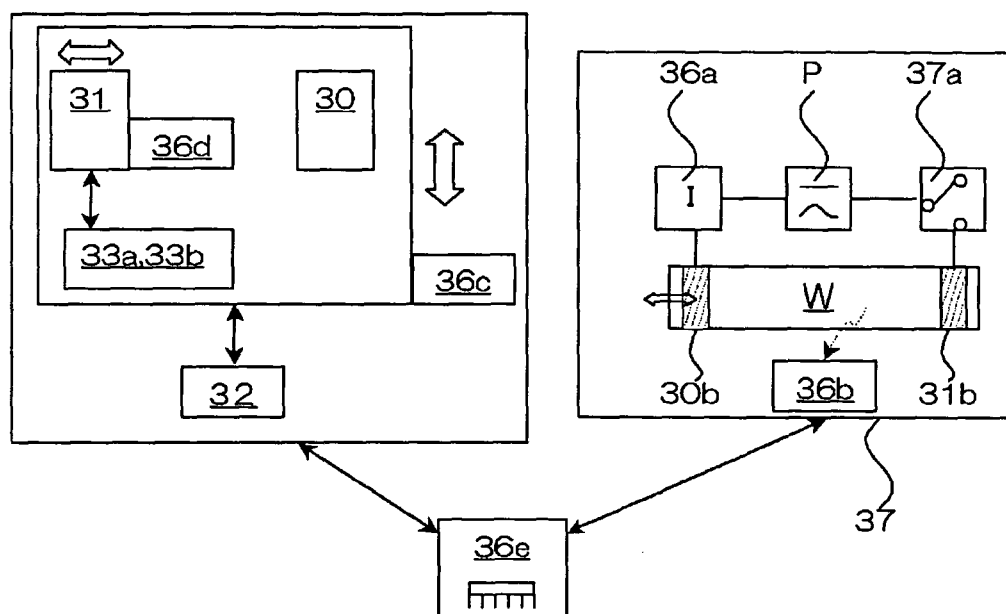


FIG. 5

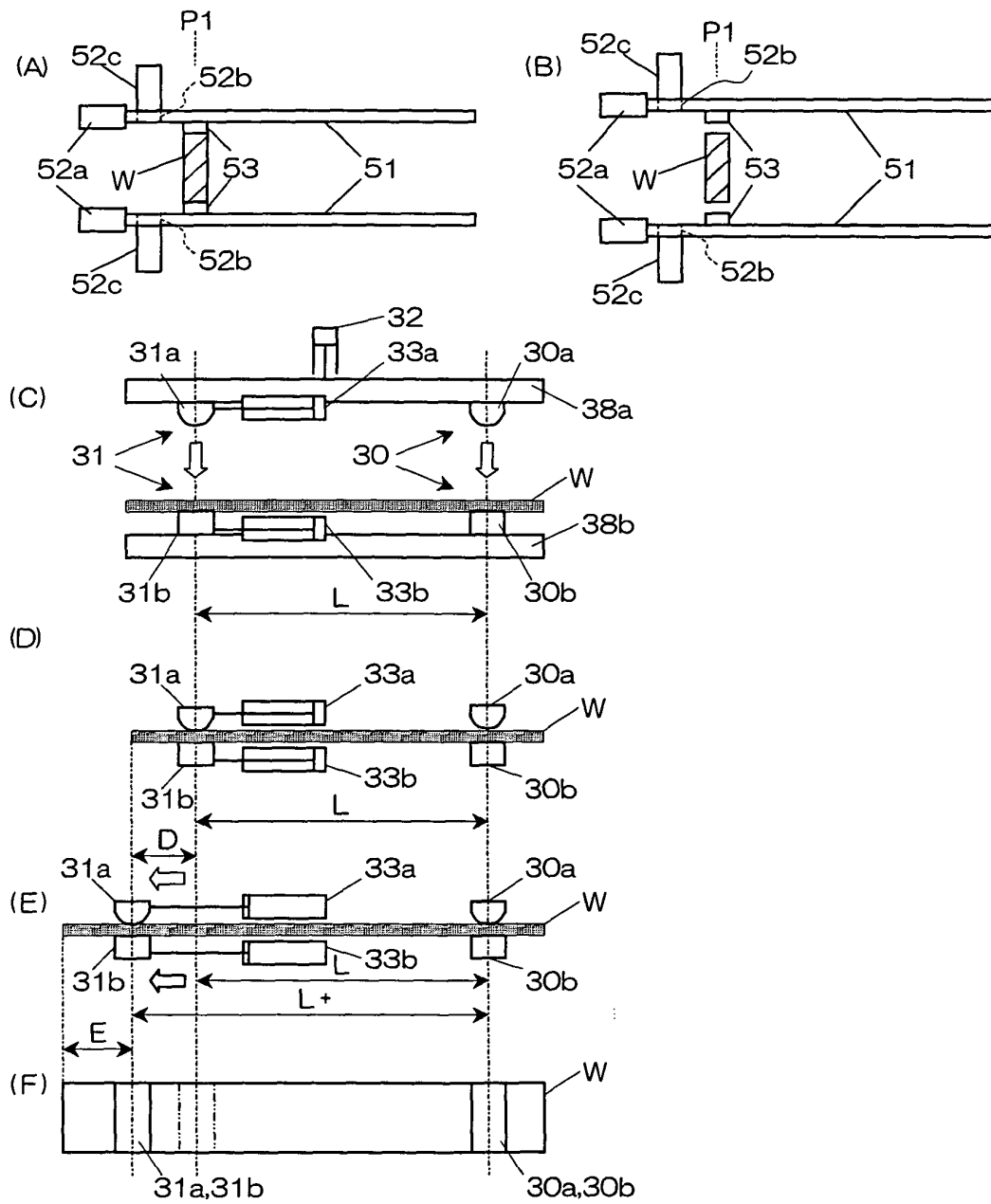
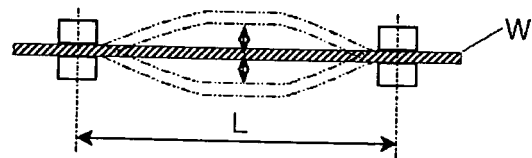


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/067475

A. CLASSIFICATION OF SUBJECT MATTER		
B21D24/00(2006.01)i, B21D25/04(2006.01)i, B21D43/00(2006.01)i, B30B15/30(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) B21D24/00, B21D25/04, B21D43/00, B30B15/30		
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 1996-2008 Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2002-248525 A (Sumitomo Metal Industries, Ltd.), 03 September, 2002 (03.09.02), Claims; Par. Nos. [0030], [0040] (Family: none)	1, 3, 4, 8-10 2, 5-7
Y	JP 2004-106035 A (Nippon Steel Corp.), 08 April, 2004 (08.04.04), Par. Nos. [0012], [0013]; Fig. 3 (Family: none)	2, 5
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 11 December, 2008 (11.12.08)		Date of mailing of the international search report 22 December, 2008 (22.12.08)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/067475

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 54566/1990 (Laid-open No. 17400/1992) (Mitsubishi Motors Corp.), 13 February, 1992 (13.02.92), Fig. 1 (Family: none)	6, 7

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2007322507 A [0001]
- JP P200218531 A [0005]