(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 January 2007 (18.01.2007)

PCT

(10) International Publication Number
WO 2007/008046 A1

(51) International Patent Classification:
B23K 11/11 (2006.01)

(21) International Application Number:
PCT/KR2006/002780

(22) International Filing Date: 14 July 2006 (14.07.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10-2005-0063503 14 July 2005 (14.07.2005) KR

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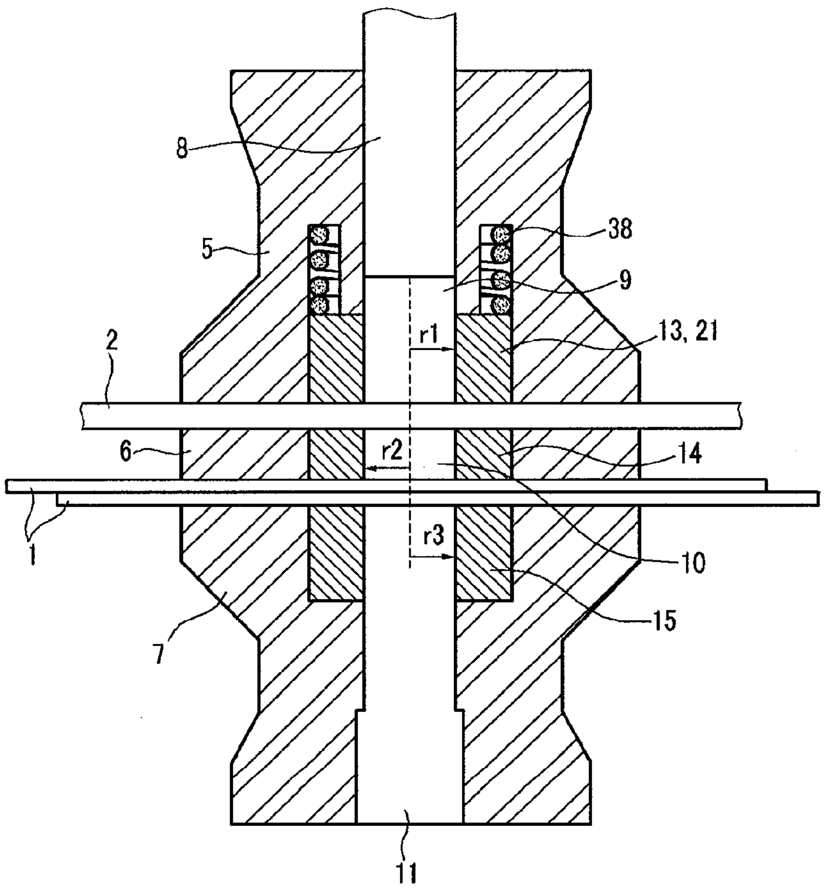
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: BONDING APPARATUS AND METHOD OF METAL PLATE



(57) Abstract: A bonding apparatus and method of metal plates simplifies a bonding process and improves bonding strength of metal plates. A bonding apparatus of metal plates may include an upper mold having a first guide pathway formed vertically inside thereof; a middle mold having a second guide pathway formed vertically inside thereof, the middle mold being disposed under the upper mold; a lower mold having a metal removing pathway formed vertically inside thereof, the lower mold being disposed under the middle mold; a heating unit for heating the metal plates and a metal tape; a punch for applying a bonding load to the metal plates; a clamping unit that applies a clamping load for clamping the metal plates to the upper mold; and a bonding unit that applies the bonding load to the punch for bonding the metal plates.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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TITLE OF THE INVENTION

BONDING APPARATUS AND METHOD OF METAL PLATE

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to bonding apparatus and method of metal plates. More particularly, the present invention relates to bonding apparatus and method of metal plates where a bonding process is simplified and bonding strength is improved.

(b) Description of the Related Art

Generally, two methods for bonding thin metal plates are known. The first method is spot welding, and the second method is rivet bonding. In spot welding, an electrical voltage is applied to overlapped metal plates, and heat is generated therein since the metal plates have electrical resistance. In this case, if a pressure is applied to the overlapped metal plates, overlapped surfaces of the metal plates are melted and the metal plates are bonded.

In rivet bonding, two metal plates are bored and bonded with a rivet.

The two methods each have merits. However, arcing and environmental pollution may occur since a high voltage is applied to the metal plates in spot welding. In addition, the resulting bonded surface may not be even.

Rivet bonding has advantages in that bonding strength is high and the bonding process is performed at room temperature. However, if one rivet is used for bonding metal plates, normal bonding force and shearing bonding force between the metal plates may be strong but the metal plates may rotate with respect to each other. Accordingly, multiple rivets must be used so that the metal plates do not rotate. In addition, manufacture of a rivet head must be done first, and holes of the metal plates must be aligned so that the rivet is inserted therein.

Recently, a self-piercing rivet bonding method has been developed in order to make up for such drawbacks of the rivet bonding method. In the self-piercing rivet bonding method, holes are bored in the metal plates and simultaneously molten pools are formed in the metal plates by frictional heat between the metal plates and the rivet, which bonds the metal plates.

However, in the self-piercing rivet bonding method, manufacture of a self-piercing rivet must be done first, and the self-piercing rivet must be rotated in order to bond the metal plates by the frictional heat.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE INVENTION

The present invention has been made in an effort to provide a bonding apparatus and method of metal plates having advantages that an electrical arc does not occur and that a self-piercing rivet does not need to be rotated and manufactured.

According to the present invention, a press-fitting process of a self-piercing rivet method is united with a spot welding method where metal plates are quickly heated by applying a high electrical voltage thereto. Therefore, a heating process of metal plates by applying a high electrical voltage thereto and a press-fitting process where a rivet member made with the same material as the metal plates is press-fitted into the metal plates are simultaneously performed. Therefore, the rivet member and the metal plates are bonded in a plastic flow state.

That is, the metal plates and a metal tape are heated to the hot plastic working temperature where an electrical arc does not occur. After that, a rivet member is made by punching the metal tape and simultaneously the rivet member is pressure fitted into the metal plates.

An exemplary bonding apparatus of metal plates according to an embodiment of the present invention may include: metal plates that are overlapped with each other; a metal tape used for bonding the overlapped metal plates, a material thereof being the same as a material of the metal plates; a metal tape transfer unit for supplying and withdrawing the metal tape; a rivet member punched from the metal tape and heated; an upper mold for clamping the metal tape by an elastic force of a coil spring that is mounted on an upper portion thereof, the upper mold guiding a punch and being used as a first electrode; a middle mold for clamping the overlapped metal plates and punching the metal tape in order to make the rivet member, the middle mold guiding the rivet member and the punch, and being used as a second electrode; a lower mold for supporting the overlapped metal plates, the lower mold being used as an extrusion die for extruding the metal plates by the rivet member, and including a shaving mold for shaving excess metal during extrusion and a third electrode; and the punch for making the rivet member by punching the metal tape, the punch press-fitting the rivet member to the overlapped metal plates by applying a load to the rivet member.

Cross-sections of the first and second guide pathways and the metal removing pathway may be circular or triangular, by which a rotation of the metal plates is restricted, according to the cross-sectional shape of the rivet member.

At least one of the first and second guide pathways, the metal removing pathway, and the punch may be used so as to restrict the rotation of the metal plates.

In addition, the exemplary bonding apparatus of the metal plates according to the embodiment of the present invention may further include a robot provided with a power supply for supplying power to the first, second, and third electrodes and a hydraulic pressure system for supplying a clamping load, an extruding load, and a shaving load, wherein the robot is moved automatically to the bonding position of the metal plates.

An exemplary bonding apparatus of metal plates according to another exemplary embodiment of the present invention, may include: an upper mold having a first guide pathway formed vertically inside thereof; a middle mold having a second guide pathway formed vertically inside thereof, the middle mold being disposed under the upper mold; a lower mold having a metal-removing pathway formed vertically inside thereof, the lower mold being disposed under the middle mold; a heating unit for heating the metal plates and a metal tape; a punch for applying a bonding load to the metal plates; a clamping unit that applies a clamping load for clamping the metal plates to the upper mold; and a bonding unit that applies the bonding load for bonding the metal plates to the punch.

Both the upper and middle molds may clamp the metal tape, which is used for a rivet member, and both the middle and lower molds may clamp the metal plates.

Material of the metal tape may be the same as material of the metal plates.

The exemplary bonding apparatus of the metal plates according to another embodiment of the present invention may further include a lower mold transfer unit that moves the lower mold in a horizontal direction.

The exemplary bonding apparatus of the metal plates according to another embodiment of the present invention may further include a metal tape transfer unit that moves the metal tape in the horizontal direction.

The metal tape transfer unit may include: transfer rollers disposed on both sides of the upper mold; a metal tape supply roller disposed on one side of the clamping unit, the metal tape being wound thereon; and a metal tape withdrawal roller disposed on the other side of the clamping unit, the metal tape being withdrawn thereto after being punched.

The exemplary bonding apparatus of the metal plates according to another embodiment of the present invention may further include a clamping mold for clamping the metal tape, wherein the clamping mold is disposed on an interior circumference of the upper mold.

An elastic member, which applies an elastic force downwardly to the clamping mold, may be interposed between the upper mold and the clamping mold.

The elastic member may be a coil spring.

The heating unit may include: a first electrode formed on an interior circumference of the clamping mold; a second electrode formed on an interior circumference of the middle mold; and a third electrode formed on an interior circumference of the lower mold.

Heat may be generated in the metal plates and the metal tape when an electrical current is applied thereto, since electrical resistance thereof is high.

The first, second, and third electrodes may be respectively wound by a high frequency inducing coil.

In addition, another heating unit may include: a first laser source for heating the metal tape, the first laser source mounted on a lower side of the punch; and a second laser source for heating the metal plates, the second laser source mounted on an interior circumference of the lower mold.

The first and second guide pathways may have the same radius.

The radius of the metal removing pathway may be smaller than the radius of the second guide pathway.

The first and second guide pathways and the metal removing pathway may have cylindrical shapes.

In addition, the first and second guide pathways and the metal removing pathway may have triangular-prism shapes.

A bonding unit cylinder of the bonding unit may be formed at a clamping unit piston of the clamping unit.

An exemplary bonding method of metal plates according to an embodiment of the present invention may include: disposing a lower mold under a bonding position of overlapped metal plates in order to bond the overlapped metal plates; meeting the central axis of a second guide pathway to the center of the bonding position; simultaneously clamping the overlapped metal plates by a middle mold and a metal tape by a coil spring; quickly heating the metal tape that is clamped by the coil spring by applying an electrical current between a first electrode and a second electrode; making a heated rivet member by punching the clamped metal tape with a punch that is inserted in a first guide pathway; quickly heating the overlapped metal plates by applying an electrical current between the second electrode contacted to an upper side of the overlapped metal plates and a third electrode contacted to a lower side of the overlapped metal plates; press-fitting the heated rivet member into the metal plates that are clamped between the middle mold and the lower mold by a compression load of the punch; and bonding the overlapped metal plates with the rivet member by an extruding pressure and a shearing force when the heated rivet member and the heated overlapped metal plates in a state of plastic flow are extruded through a metal removing pathway, a radius of which is smaller than a radius of the second guide pathway.

The metal tape may be quickly heated by applying the electrical current between the second electrode connected to a power supply and the first electrode, the metal plates may be quickly heated by applying the electrical current between the second electrode and the third electrode connected to the power supply, the first, second, and third electrodes may have a cylindrical shape of the same central axis, the metal tape may be punched in the first guide pathway, the punched rivet member may be passed through the second guide pathway and is press-fitted into the heated portion of the metal plates, the metal plates may be extruded and bonded through plastic flow, and simultaneously excess metal may be pushed to the metal removing pathway when the punch is moved through the first and second guide pathways.

A high frequency inducing coil may be wound onto the first and second electrodes, the metal tape disposed between an upper mold and the middle mold may be quickly heated by an induced current of the high frequency inducing coil, a high frequency inducing coil may be wound onto the second and third electrodes, and the metal plates disposed between the middle mold and the lower mold may be quickly heated by an induced current of the high frequency inducing coil.

The metal tape disposed between the upper mold and the middle mold may be quickly heated by a first laser source mounted on a lower side of the punch, and the metal plates disposed between the middle mold and the lower mold may be quickly heated by a second laser source mounted on the metal removing pathway.

The punched metal tape may be withdrawn and wound onto a metal tape withdrawal roller by a metal tape transfer unit when the punch returns after the metal tape wound onto a metal tape supply roller is unwound and punched so that the metal tape is continuously supplied and withdrawn, and the metal tape supply roller may be replaced when the metal tape is consumed.

A lower side of the punch may be moved to an upper side of the overlapped metal plates so that protruding metal is not made when the rivet member is press-fitted into the metal plates, and the lower mold connected to a lower mold transfer unit may slide in a horizontal direction and shave the excess metal adhered to a lower side of the overlapped metal plates.

The heated metal plates in plastic flow may be bonded by a repetitive compressive load of the rivet member when the heated rivet member is press-fitted into the metal plates clamped between the middle mold and the lower mold after the rivet member is made by the punch.

An exemplary bonding method of metal plates according to another embodiment of the present invention may include: clamping the overlapped metal plates with a lower mold and a middle mold; disposing a metal tape over the overlapped metal plates by the middle mold and a upper mold; heating the overlapped metal plates and the metal tape with a heating unit; making a rivet member by punching the metal tape; and press-fitting the rivet member into the overlapped metal plates with a punch.

In addition, the exemplary bonding method of the metal plates according to another embodiment of the present invention may further include removing excess metal that is pushed out during press-fitting.

The excess metal may be removed and the metal plates may be shaved by moving the lower mold in a horizontal direction, coincidently.

A first guide pathway may be formed vertically in the upper mold, a second guide pathway may be formed vertically in the middle mold, and a metal removing pathway may be formed vertically in the lower mold.

The first and second guide pathways may have the same radius.

The radius of the metal removing pathway may be smaller than the radius of the second guide pathway.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a part of an exemplary bonding apparatus of metal plates according to an embodiment of the present invention.

FIG. 2A is a cross-sectional view that shows a process in which a metal tape is punched according to an exemplary bonding apparatus of a metal plate according to an embodiment of the present invention.

FIG. 2B is a cross-sectional view that shows a process in which a rivet member is press-fitted into metal plates according to an exemplary embodiment of the present invention.

FIG. 2C is a cross-sectional view that shows a process in which excess metal is pushed out when a rivet member is press-fitted into metal plates according to an exemplary embodiment of the present invention.

FIG. 2D is a cross-sectional view that shows a process in which excess metal is removed according to an exemplary embodiment of the present invention.

FIG. 3 is a schematic diagram of a heating unit according to an exemplary embodiment of the present invention.

FIG. 4 is a schematic diagram of another heating unit according to an exemplary embodiment of the present invention.

FIG. 5 is a schematic diagram of the other heating unit according to an exemplary embodiment of the present invention.

FIG. 6 is a cross-sectional view that shows a process in which excess metal is removed when a lower mold is moved in a horizontal direction according to an exemplary embodiment of the present invention.

FIG. 7 is a schematic diagram showing a shape and an arrangement of a rivet member according to an exemplary embodiment of the present invention.

FIG. 8 is a cross-sectional view of an exemplary bonding apparatus of metal plates according to an embodiment of the present invention.

FIG. 9 is a schematic diagram showing that an exemplary bonding apparatus of metal plates according to an embodiment of the present invention is mounted on a robot.

<Description of Reference Numerals Indicating Primary Elements in the Drawings>

1 : metal plate	2 : metal tape
3 : rivet member	5 : upper mold
6 : middle mold	7 : lower mold
8 : punch	9 : first guide pathway
10 : second guide pathway	11 : metal removing pathway
12 : power supply	13 : first electrode
14 : second electrode	15 : third electrode
16 : heating unit	17 : high frequency inducing coil
18 : first laser source	19 : second laser source
20 : metal tape transfer unit	21 :clamping mold
23 : metal tape supply roller	24 : metal tape
25 : metal tape withdrawal roller	26 : excess metal
28 : robot upper arm	29 : robot lower arm
30 : connecting portion	31: clamping unit
32 : bonding unit	33 : lower mold transfer unit
34 : transfer roller	35 : supporter

36 : excess metal collecting home
37 : robot
38 : coil spring
39 : clamping unit piston
40 : bonding unit cylinder

DETAILED DESCRIPTION OF THE EMBODIMENTS

An exemplary embodiment of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

As shown in FIG. 1 and FIG. 8, an exemplary bonding apparatus of metal plates according to an embodiment of the present invention includes a supporter 35, an upper mold 5, a middle mold 6, a lower mold 7, a heating unit 16, a punch 8, a clamping unit 31, a bonding unit 32, a metal tape transfer unit 20, and a lower mold transfer unit 33.

The supporter 35 supports the bonding apparatus of the metal plates according to the embodiment of the present invention.

A first guide pathway 9 is formed vertically inside the upper mold 5. The first guide pathway 9 guides the punch 8.

The middle mold 6 is disposed under the upper mold 5. A second guide pathway 10 is formed vertically inside the middle mold 6. The second guide pathway 10 guides the punch 8.

Both the upper mold 5 and the middle mold 6 clamp a metal tape 2 for making a rivet member 3.

A clamping mold 21 for clamping the metal tape 2 is disposed on an interior circumference of the upper mold 5.

In addition, an elastic member for applying an elastic force downwardly to the clamping mold 21 is interposed between the upper mold 5 and the clamping mold 21.

The elastic member may be a coil spring 38.

The lower mold 7 is disposed under the middle mold 6. A metal removing pathway 11 is formed vertically inside the lower mold 7. The metal removing pathway 11, as shown in FIG. 8, leads to an excess metal collecting home 36. Excess metal 26 is pushed to the excess metal gathering home 36 through the metal removing pathway 11 after the metal plates 1 are bonded.

Both the middle mold 6 and the lower mold 7 clamp the overlapped metal plates 1.

The first and second guide pathways 9 and 10 and the metal removing pathway 11 have cylindrical shapes with the same central axis.

As shown in FIG. 1, radius r1 of the first guide pathway 9 is the same as radius r2 of the second guide pathway 10 so as to guide the punch 8. However, radius r3 of the metal removing pathway 11 is smaller than radius r2 of the second guide pathway 10 so as to bond the metal plates 1 with the rivet member 3.

Meanwhile, as shown in FIG. 7, the first and second guide pathways 9 and 10 and the metal removing pathway 11 may have triangular-prism shapes. In this case, the bonded metal plates 1 are restricted in rotation since a cross-section of the punched rivet member 3 is triangular. In addition, pluralities of the first and second guide pathways 9 and 10 and the metal removing pathway 11 may be formed and the metal plates 1 may be bonded with the rivet members 3 at multiple bonding positions. The bonded metal plates 1 are restricted in rotation by means of such disposition of the bonding positions.

Here, the cross-section of the rivet member 3 has a circular shape or a triangular shape, but is not limited to such shapes. It is understood that a person of an ordinary skill in the art can arbitrarily select the cross-sectional shape of the rivet member 3.

The heating unit 16 heats the metal plates 1 and the metal tape 2 to the temperature where a plastic flow occurs.

The heating unit 16, as shown in FIG. 3, includes three electrodes 13, 14, and 15. A first electrode 13 is disposed over a second electrode 14 connected to a power supply 12. The metal tape 2 disposed between the first and second electrodes 13 and 14 is quickly heated when an electrical current is applied between the first and second electrodes 13 and 14. In addition, a third electrode 15 connected to the power supply 12 is disposed under the second electrode 14. The metal plates disposed between the second and third electrodes 14 and 15 are quickly heated when an electrical current is applied between the second and third electrodes 14 and 15.

Cross-sections of the first, second, and third electrodes 13, 14, and 15 are circular in shape with the same central axis. In addition, the metal plates 1 and the metal tape 2 have high electrical resistance so that heat is generated therein when the electrical current is applied thereto.

Another heating unit 16 according to an embodiment of the present invention, as shown in FIG. 4, includes the first, second, and third electrodes 13, 14, and 15 wound with a high frequency inducing coil 17. The first, second, and third electrodes 13, 14, and 15 heat the metal plates 1 and the metal tape 2 quickly. That is, the high frequency inducing coil 17 connected to the power supply 12 winds around the first and second electrodes 13 and 14. Therefore, the metal tape 2 disposed between the upper mold 5 and the middle mold 6 is quickly heated by an induced current. In addition, the high frequency inducing coil 17 connected to the power supply 12 winds around the second and third electrodes 14 and 15. Therefore, the metal plates 1 disposed between the middle mold 6 and the lower mold 7 are quickly heated by an induced current.

The other heating unit 16 according to an embodiment of the present invention, as shown in FIG. 5, includes a first laser source 18 mounted on a lower side of the punch 8 and a second laser source 19 mounted on an interior circumference of the lower mold 7. The first and second laser sources 18 and 19 heat the metal tape 2 and the metal plates 1. That is, the metal tape 2 disposed between the upper mold 5 and the middle mold 6 is quickly heated by the first laser source 18 mounted on the lower side of the punch 8, and the metal plates 1 disposed between the middle mold 6 and the lower mold 7 are quickly heated by the second laser source 19 mounted on the interior circumference of the lower mold 7.

The heating unit 16 is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

That is, any heating unit 16 that heats the metal tape 2 and the metal plates 1 in the molds so as to bond the metal plates 1 through plastic flow may be applied to the present invention. In addition, the heating unit 16 heats the metal tape 2 and the metal plates 1 to the temperature where the metal plates 1 and the metal tape 2 undergo the plastic flow, but do not melt.

The punch 8 is connected to the bonding unit 32 and transmits a pressure from the bonding unit 32. The punch 8 applies a bonding load to the metal plates 1. The punch 8 moves downwardly along the first guide pathway 9, and makes the rivet member 3 by punching the metal tape 2.

After that, the punch 8 moves further downwardly along the second guide pathway 9, and press-fits the rivet member 3 to the metal plates 1. In this case, the punch 8 moves to and stops on an upper surface of the overlapped metal plates 1 so as to press-fit the rivet member 3 to the metal plates 1 since the radius r3 of the metal removing pathway 11 is smaller than the radius r2 of the second guide pathway 10.

The cross-sectional shape of the punch 8 is the same as that of the first and second guide pathways 9 and 10.

The clamping unit 31 is coupled with an upper side of the upper mold 5. The clamping unit 31 applies a clamping load for clamping the metal plates 1 to the upper mold 5. A hydraulic pressure cylinder may be used as the clamping unit 31.

The bonding unit 32 is coupled with an upper side of the punch 8, and applies the bonding load to the punch 8. A hydraulic pressure cylinder may be used as the bonding unit 32. In addition, a bonding unit cylinder 40 of the bonding unit 32 is formed at a clamping unit piston 39 of the clamping unit 31. Therefore, when a hydraulic pressure is applied to the clamping unit 31 and the clamping unit piston 39 moves downwardly, the bonding unit cylinder 40 moves downwardly together with the clamping unit piston 39 and applies the bonding load to the punch 8. In addition, the size of a bonding apparatus of metal plates may be reduced by such structure.

The metal tape transfer unit 20 includes transfer rollers 34, a metal tape supply roller 23, and a metal tape withdrawal roller 25.

The transfer rollers 34 are mounted on both sides of the upper mold 5. The transfer rollers 34 transfer the metal tape 2.

The metal tape supply roller 23 is mounted on one side of the clamping unit 31. The metal tape 2 is wound onto the metal tape supply roller 23. The metal tape supply roller 23 supplies the metal tape 2 to a bonding apparatus of metal plates.

The metal tape withdrawal roller 25 is mounted on the other side of the clamping unit 31. The metal tape 2, after being punched, is withdrawn to the metal tape withdrawal roller 25.

After the metal tape 2 wound onto the metal tape supply roller 23 is unwound and supplied to a bonding apparatus of metal plates by the transfer rollers 34, the punch 8 moves downwardly so as to punch the metal tape 2 and bond the metal plates 1. After that, while the punch 8, the bonding unit 32, and the clamping unit 31 return to their original positions, the metal tape 2 is wound onto the metal tape withdrawal roller 25. Therefore, the metal tape 2 is continuously supplied to a bonding apparatus of metal plates. In addition, when the metal tape 2 is used up, a new metal tape 2 is replaced on the metal tape supply roller 23. An impact load or a repetitive load may be applied to the punch 8 by a hydraulic pressure system or a pneumatic pressure system, and a person of ordinary skill in the art can arbitrarily choose a load type and a pressure applying system within the scope of the present invention.

The lower mold transfer unit 33 is coupled with the lower mold 7. The lower mold transfer unit 33 moves the lower mold 7 in a horizontal direction. A hydraulic pressure cylinder may be used as the lower mold transfer unit 33.

As shown in FIG. 9, an exemplary bonding apparatus of metal plates according to an embodiment of the present invention may be mounted on a robot 37 that is used for spot welding. In this case, a bonding apparatus of metal plates further includes connecting portions 30 connected to a robot upper arm 28 and robot lower arm 29. Therefore, a bonding apparatus of metal plates is mounted on the robot 37 used for spot welding, and the first, second, and third electrodes 13, 14, and 15 are connected to the power supply 12. After that, the robot 37 including the hydraulic pressure system or the pneumatic pressure system for supplying the clamping load and bonding load is moved to the bonding position, and the metal plates 1 are bonded.

Meanwhile, the metal tape 2 and the metal plates 1 are made with the same material so that the metal plates 1 are easily bonded.

Hereinafter, referring to FIG. 2 and FIG. 6, an exemplary bonding method of metal plates according to an embodiment of the present invention will be described in detail.

As shown in FIG. 2, after the bonding position of the overlapped metal plates 1 is located above the metal removing pathway 11 of the lower mold 7, the center of the second guide pathway 10 is met with the center of the bonding position. After that, the metal plates 1 are clamped by the middle mold 6 and the lower mold 7. In addition, the metal tape 2 is clamped by the upper mold 5 and the middle mold 6.

After that, the heating unit 16 receives power from the power supply 12 and heats the metal tape 2 and the metal plates 1.

After that, the punch 8 moves downwardly through the first guide pathway 9, and punches the metal tape 2 so as to make the rivet member 3.

After that, the punch 8 moves further downwardly through the second guide pathway 10, and press-fits the rivet member 3 into the overlapped metal plates 1. In this case, downward movements of the rivet member 3 and the metal plates 1 is restricted by an upper side of the metal removing pathway 11 since the radius r3 of the metal removing pathway 11 is smaller than the radius r2 of the second guide pathway 10. Thus, the rivet member 3 and the metal plates 1 are bonded through the plastic flow.

Meanwhile, as shown in FIG. 6, excess metal 26 that is pushed downwardly during a bonding process is removed when the lower mold 7 is moved horizontally by the lower mold transfer unit 33. In this case, the lower mold 7 removes the excess metal 26 and simultaneously shaves lower sides of the bonding position of the metal plates 1 and the rivet member 3. In addition, the excess metal 26 is gathered in the excess metal gathering home 36 through the metal removing pathway 11.

A body of a vehicle has been previously welded mainly according to a spot welding method. According to the method, the metal plates mainly used as the body of the vehicle have high electrical resistances, and thus melt well when a high electrical current is applied thereto. On the contrary, light metal plates having low electrical resistances do not melt well when a high electrical current is applied thereto. However, according to the present invention, the heated light metal plates are bonded through the plastic flow, and thus an arc may not occur. In addition, according to the present invention, the metal plates are bonded by press-fitting the rivet member into the heated metal plates. Thus, the metal plates may be bonded with a small bonding load but with strong bonding strength.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. A bonding apparatus of metal plates, comprising:

metal plates that are overlapped each other;

a metal tape used for bonding the overlapped metal plates, and material thereof being the same as material of the metal plates;

a metal tape transfer unit for supplying and withdrawing the metal tape;

a rivet member punched from the metal tape and heated;

an upper mold for clamping the metal tape by an elastic force of a coil spring that is mounted on an upper portion thereof, the upper mold guiding a punch and used as a first electrode;

a middle mold for clamping the overlapped metal plates and punching the metal tape in order to make the rivet member, the middle mold guiding the rivet member and the punch, and used as a second electrode;

a lower mold for supporting the overlapped metal plates, the lower mold being used as an extrusion die for extruding the metal plates by the rivet member, a shaving mold for shaving excess metal during extrusion, and a third electrode; and

the punch for making the rivet member by punching the metal tape, the punch press-fitting the rivet member to the overlapped metal plates by applying a load to the rivet member.

2. A bonding method of metal plates, comprising:

disposing a lower mold under bonding position of overlapped metal plates in order to bond the overlapped metal plates;

meeting the central axis of a second guide pathway to the center of the bonding position;

simultaneously clamping the overlapped metal plates with a middle mold and a metal tape by a coil spring;

quickly heating the metal tape that is clamped by the coil spring by applying an electrical current between a first electrode and a second electrode;

making a heated rivet member by punching the clamped metal tape with a punch that is inserted in a first guide pathway;

quickly heating the overlapped metal plates by applying an electrical current between the second electrode contacted to an upper side of the overlapped metal plates and a third electrode contacted to a lower side of the overlapped metal plates;

press-fitting the heated rivet member into the metal plates that are clamped between the middle mold and the lower mold by a compression load of the punch; and

bonding the overlapped metal plates with the rivet member by an extruding pressure and a shearing force when the heated rivet member and the heated overlapped metal plates in a state of plastic flow are extruded through a metal removing pathway, the radius of which is smaller than the radius of the second guide pathway.

3. The method of claim 2, wherein the metal tape is quickly heated by applying the electrical current between the second electrode connected to a power supply and the first electrode, the metal plates are quickly heated by applying the electrical current between the second electrode and the third electrode connected to the power supply, the first, second, and third electrodes are cylindrically shaped with the same central axis, the metal tape is punched in the first guide pathway, the punched rivet member is passed through the second guide pathway and is press-fitted into the heated portion of the metal plates, the metal plates are extruded and bonded through plastic flow, and simultaneously, excess metal is pushed to the metal removing pathway when the punch is moved through the first and second guide pathways.

4. The method of claim 2, wherein a high frequency inducing coil is wound onto the first and second electrodes, the metal tape disposed between an upper mold and the middle mold is quickly heated by an induced current of the high frequency inducing coil, a high frequency inducing coil is wound onto the second and third electrodes, and the metal plates disposed between the middle mold and the lower mold are quickly heated by an induced current of the high frequency inducing coil.

5. The method of claim 2, wherein the metal tape disposed between the upper mold and the middle mold is quickly heated by a first laser source mounted on a lower side of the punch, and the metal plates disposed between the middle mold and the lower mold are quickly heated by a second laser source mounted on the metal removing pathway.

6. The method of claim 2, wherein the punched metal tape is withdrawn and wound onto a metal tape withdrawal roller by a metal tape transfer unit when the punch returns after the metal tape wound onto a metal tape supply roller is unwound and punched so that the metal tape is continuously supplied and withdrawn, and the metal tape supply roller is replaced when the metal tape is consumed.

7. The method of claim 2, wherein a lower side of the punch is moved to an upper side of the overlapped metal plates so that protruding metal is not made when the rivet member is press-fitted into the metal plates, and the lower mold connected to a lower mold transfer unit slides in a horizontal direction and shaves the excess metal adhered to a lower side of the overlapped metal plates.

8. The method of claim 2, wherein the heated metal plates in plastic flow are bonded by a repetitive compressive load of the rivet member when the heated rivet member is press-fitted into the metal plates clamped between the middle mold and the lower mold after the rivet member is made by the punch.

9. The apparatus of claim 1, wherein cross-sections of the first and second guide pathways and the metal removing pathway are circular or triangular, by which rotation of the metal plates is restricted, according to a cross-sectional shape of the rivet member.

10. The apparatus of claim 1 or claim 9, wherein at least one of the first and second guide pathways, the metal removing pathway, and the punch is used so as to restrict the rotation of the metal plates.

11. The apparatus of claim 1, further comprising a robot provided with the power supply for supplying power to the first, second, and third electrodes and a hydraulic pressure system for supplying a clamping load, an extruding load, and a shaving load,

wherein the robot is moved automatically to the bonding position of the metal plates.

12. A bonding apparatus of metal plates, comprising:

an upper mold having a first guide pathway formed vertically inside thereof;

a middle mold having a second guide pathway formed vertically inside thereof, the middle mold being disposed under the upper mold;

a lower mold having a metal removing pathway formed vertically inside thereof, the lower mold being disposed under the middle mold;

a heating unit for heating the metal plates and a metal tape;

a punch for applying a bonding load to the metal plates;

a clamping unit that applies a clamping load for clamping the metal plates to the upper mold; and

a bonding unit that applies the bonding load for bonding the metal plates to the punch.

13. The bonding apparatus of claim 12, wherein both the upper and middle molds clamp the metal tape that is used for a rivet member, and both the middle and lower molds clamp the metal plates.

14. The bonding apparatus of claim 13, wherein material of the metal tape is the same as material of the metal plates.

15. The bonding apparatus of claim 12, further comprising a lower mold transfer unit that moves the lower mold in a horizontal direction.

16. The bonding apparatus of claim 13, further comprising a metal tape

transfer unit that moves the metal tape in a horizontal direction.

17. The bonding apparatus of claim 16, wherein the metal tape transfer unit comprises:

transfer rollers disposed on both sides of the upper mold;

a metal tape supply roller disposed on one side of the clamping unit, the metal tape being wound thereon; and

a metal tape withdrawal roller disposed on the other side of the clamping unit, the metal tape being withdrawn thereto after being punched.

18. The bonding apparatus of claim 12, further comprising a clamping mold for clamping the metal tape,

wherein the clamping mold is disposed on an interior circumference of the upper mold.

19. The bonding apparatus of claim 18, wherein an elastic member that applies an elastic force downwardly to the clamping mold is interposed between the upper mold and the clamping mold.

20. The bonding apparatus of claim 19, wherein the elastic member is a coil spring.

21. The bonding apparatus of claim 18, wherein the heating unit comprises:

a first electrode formed on an interior circumference of the clamping mold;

a second electrode formed on an interior circumference of the middle mold; and

a third electrode formed on an interior circumference of the lower mold.

22. The bonding apparatus of claim 21, wherein heat is generated in the metal plates and the metal tape when an electrical current is applied thereto since electrical resistance thereof is high.

23. The bonding apparatus of claim 21, wherein the first, second, and third electrodes are respectively wound by a high frequency inducing coil.

24. The bonding apparatus of claim 12, wherein the heating unit comprises:

a first laser source for heating the metal tape, the first laser source mounted on a lower side of the punch; and

a second laser source for heating the metal plates, the second laser source mounted on an interior circumference of the lower mold.

25. The bonding apparatus of claim 12, wherein the first and second guide pathways have the same radius.

26. The bonding apparatus of claim 25, wherein the radius of the metal removing pathway is smaller than the radius of the second guide pathway.

27. The bonding apparatus of claim 12, wherein the first and second guide pathways and the metal removing pathway have cylindrical shapes.

28. The bonding apparatus of claim 12, wherein the first and second guide pathways and the metal removing pathway have triangular-prism shapes.

29. The bonding apparatus of claim 12, wherein a bonding unit cylinder of the bonding unit is formed at a clamping unit piston of the clamping unit.

30. A bonding method of metal plates, comprising:

clamping the overlapped metal plates with a lower mold and a middle mold;

disposing a metal tape over the overlapped metal plates by the middle mold and an upper mold;

heating the overlapped metal plates and the metal tape with a heating unit;

making a rivet member by punching the metal tape; and press-fitting the rivet member into the overlapped metal plates with a punch.

31. The bonding method of claim 30, further comprising removing excess metal that is pushed out during press-fitting.

32. The bonding method of claim 31, wherein the excess metal is removed and the metal plates are shaved by moving the lower mold in a horizontal direction, coincidently.

33. The bonding method of claim 30, wherein a first guide pathway is formed vertically in the upper mold, a second guide pathway is formed vertically in the middle mold, and a metal removing pathway is formed vertically in the lower mold.

34. The bonding method of claim 33, wherein the first and second guide pathways have the same radius.

35. The bonding method of claim 34, wherein the radius of the metal removing pathway is smaller than the radius of the second guide pathway.

FIG.1

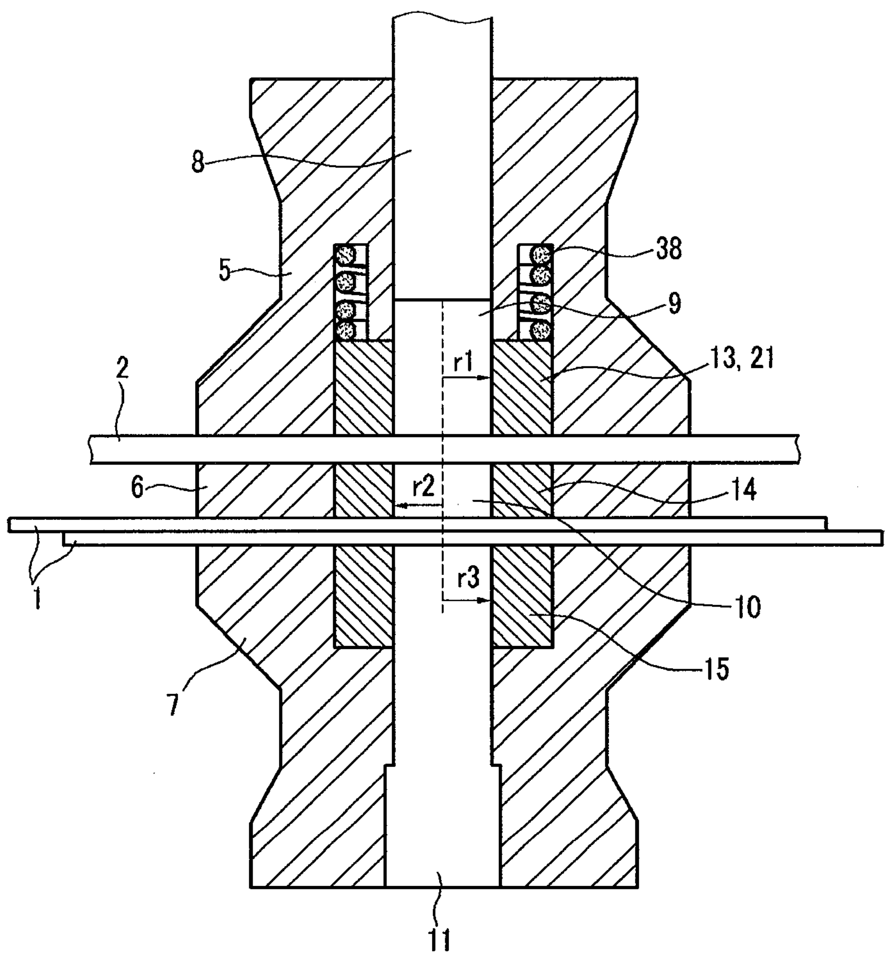


FIG.2A

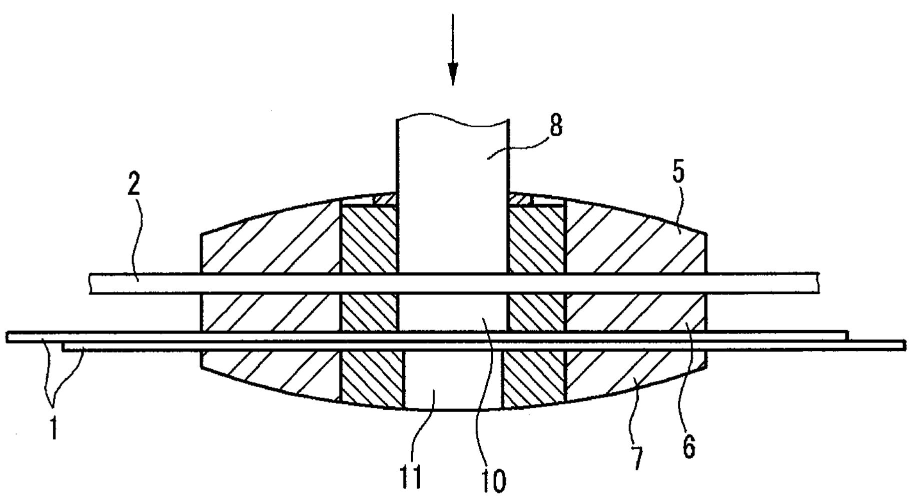


FIG.2B

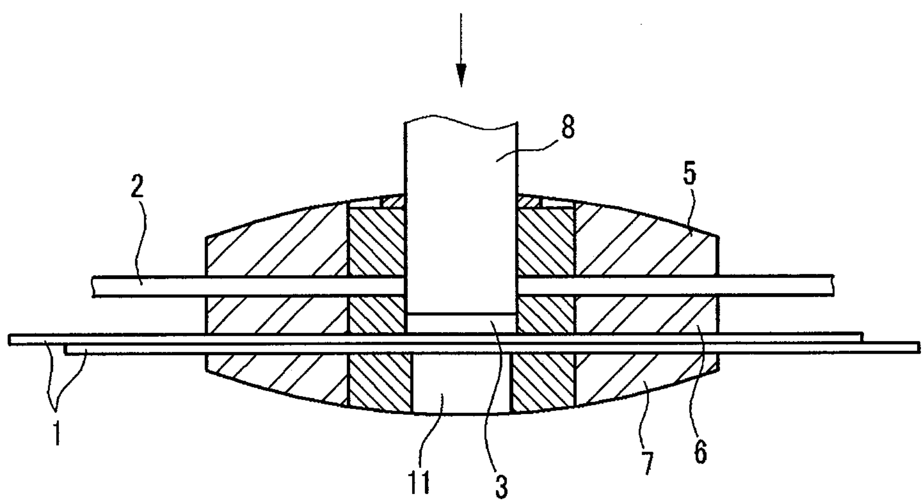


FIG.2C

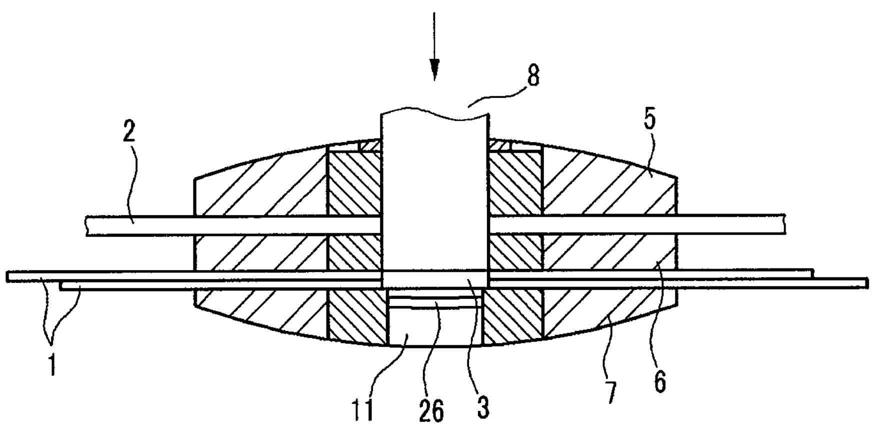


FIG.2D

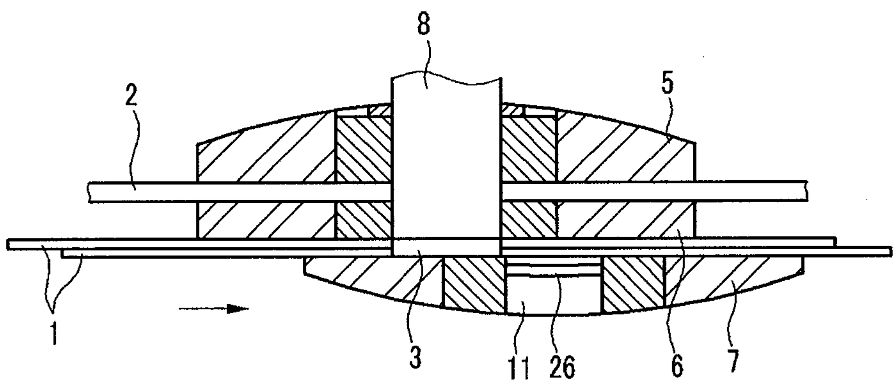


FIG.3

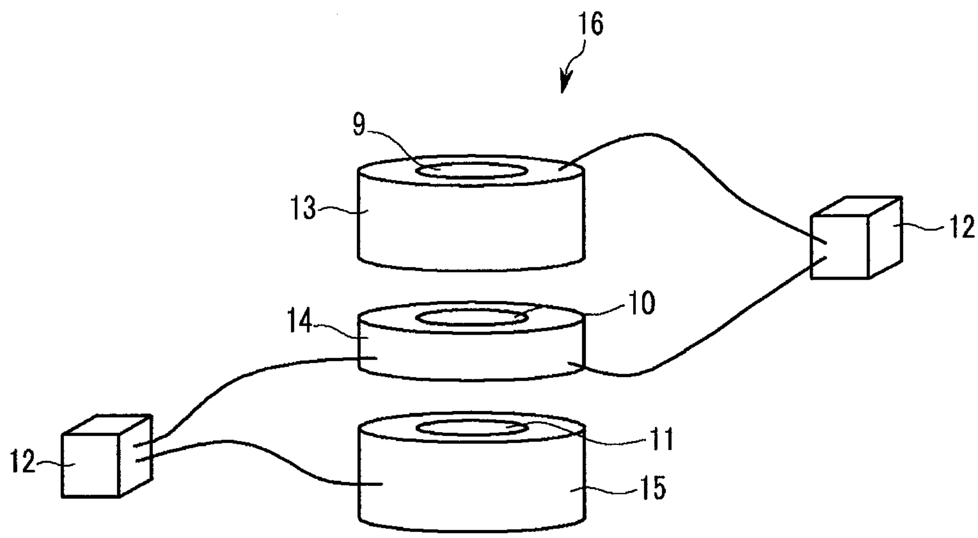


FIG.4

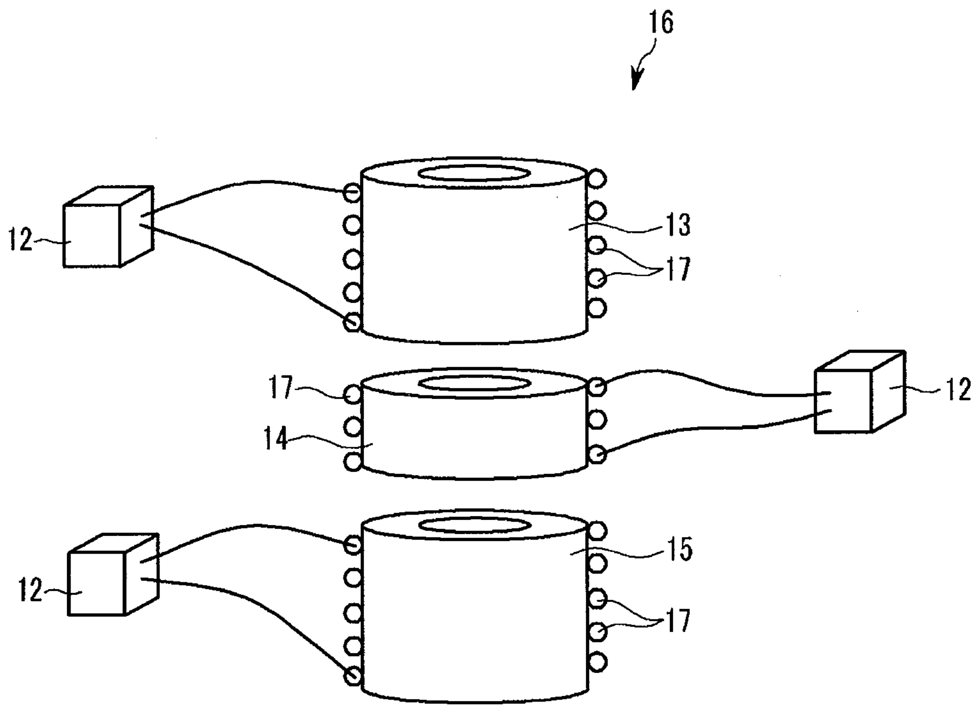


FIG.5

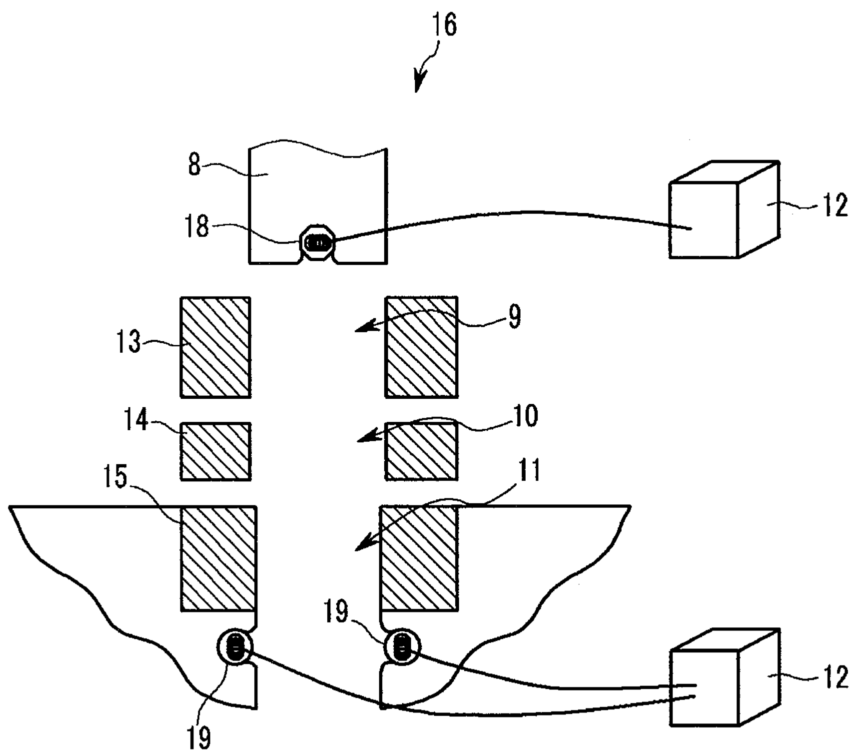


FIG.6

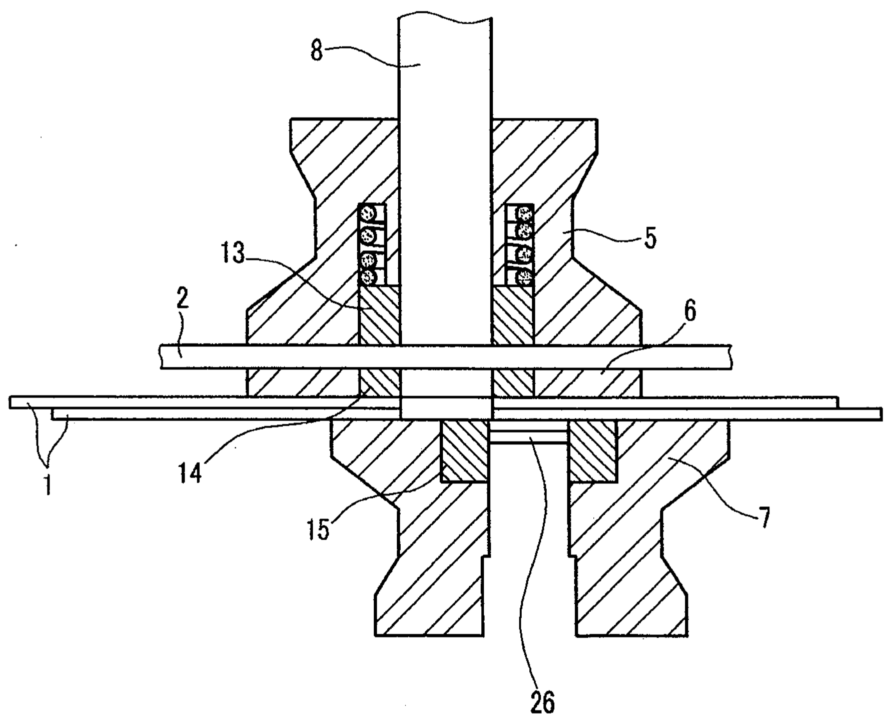


FIG.7

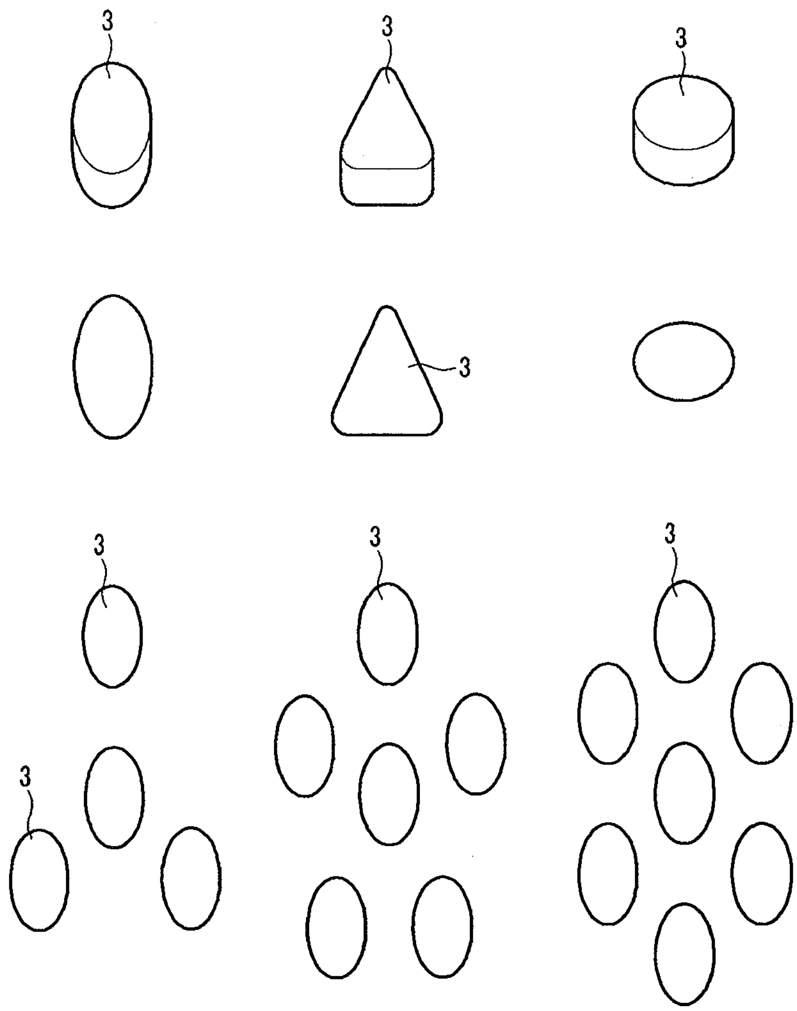


FIG.8

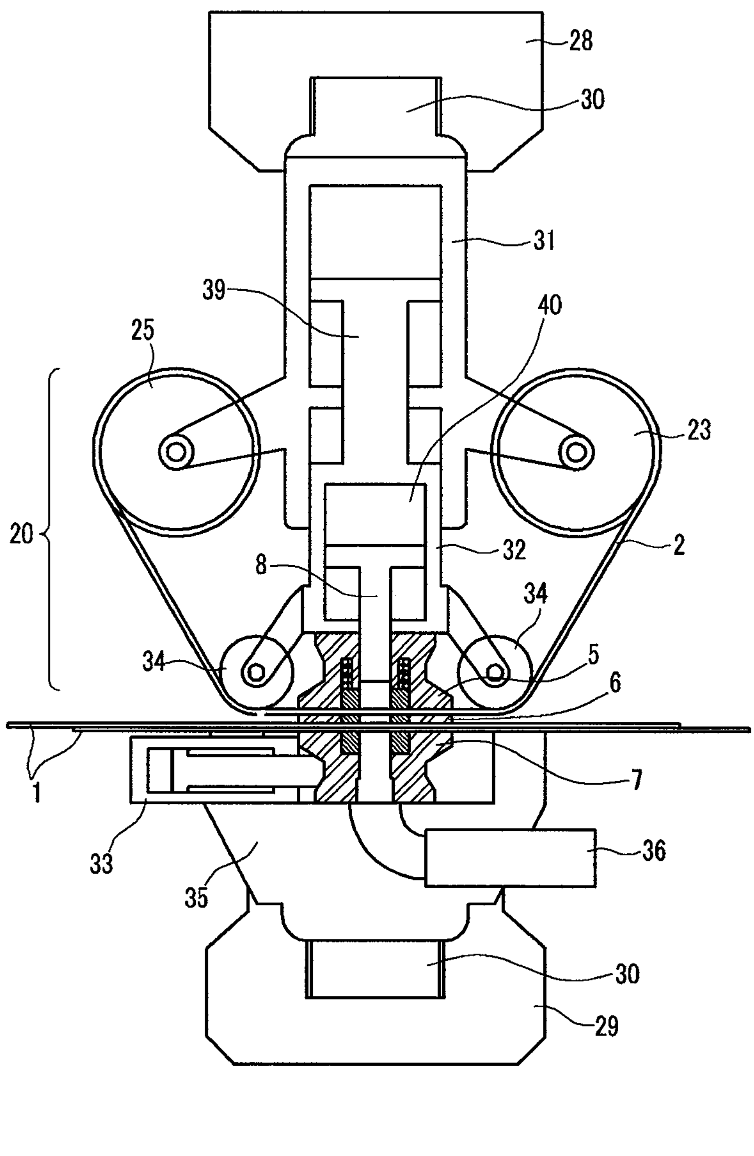
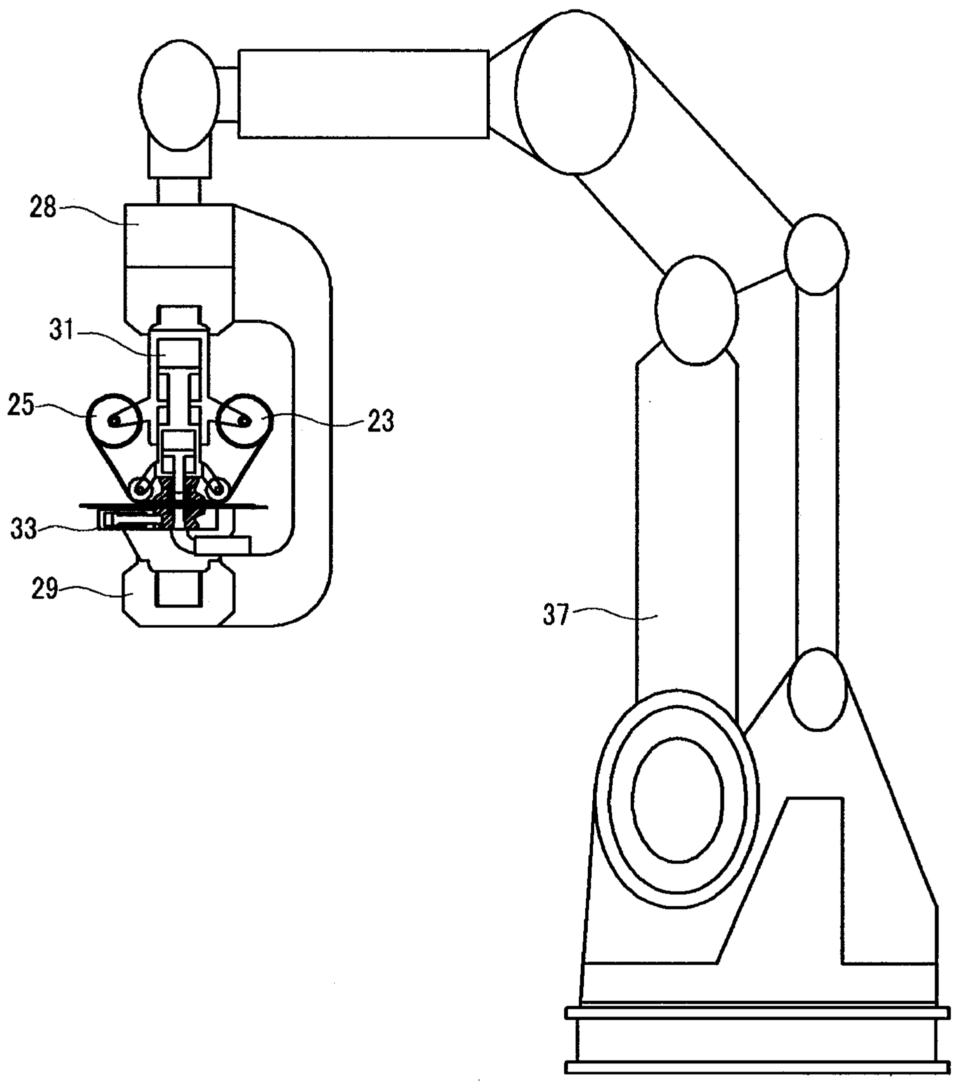


FIG.9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/002780

A. CLASSIFICATION OF SUBJECT MATTER

B23K 11/11(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)

IPC8 B29C 29/64, B23K 11/10, B23K 20/12, B21B 15/00

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

Korean Patents and applications for inventions since 1975
Utility models and applications for Utility Models since 1975
JapaneseUtility Models and application for Utility Modrls since 1975

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

Patents and Utility Search System at KIPO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 0880572 A (Tamita haujingu Wear Co. Ltd.) 26. March 1996	1-35
A	US 5739498 A (Akane Co.) 14 April 1998 See the abstract and claims 1 - 12	1-35
A	JP 2001321967 A (Sumitomt Light Metal Ind. Ltd.) 10 May 2000 See the abstract and claims 1 - 7	1-35
A	US 5884832 A (Hirachi, Ltd.) 23 March 1999 See the abstract and claims 1 - 19	1-35

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

* Special categories of cited documents:
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"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	Date of mailing of the international search report
21 NOVEMBER 2006 (21.11.2006)	**21 NOVEMBER 2006 (21.11.2006)**

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Facsimile No. 82-42-472-7140	Telephone No. 481-5524

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2006/002780

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 0880572 A	26.03.1996	None	
US 5739498 A	14.04.1998	None	
JP 2001321967 A	10.05.2000	None	
US 5884832 A	23.03.1999	None	