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(54) **METAL SHEET BENDING DEVICE**

(57) The apparatus for bending metal plates provided with such mechanism that, when bending metal plates by pressing downwardly the metal plates by the upper mold, there are not required to use lower molds in different size and shape. Two (2) lower bar molds in semicircular section are prepared as lower molds. Either rotary control plumb or rotary control gadget is attached to each of lower bar molds. The curbed convex surfaces of two(2) lower bar molds are placed so as to slidably rotate on the support provided with two (2) curbed concave surfaces having the groove in the inter-

mediate of the plane surfaces. The metal plate is placed on the metal contact surfaces of two (2) lower bar molds. By pressing downwardly the metal plate on the lower mold by the upper mold, the metal contact surfaces of two (2) lower bar molds are caused to rotate in the inner direction against the weight of the rotary control plumb or the resilience of the rotary control gadget, etc. Thus, the bending angle of the metal plate is made acute.

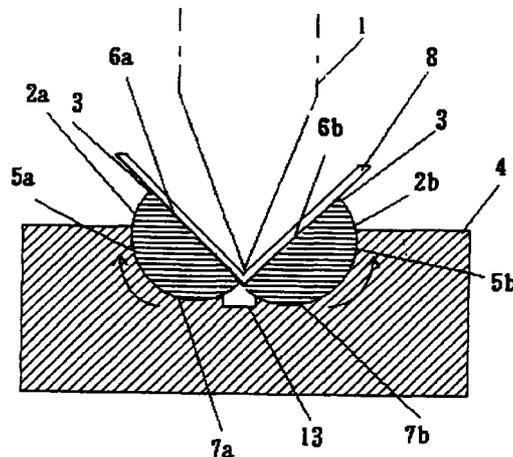


FIG. 3

Description

Technical Field

[0001] The present invention relates to the apparatus for bending metal plates by the use of special metal molds. Particularly, this apparatus is characterized in that it is provided with the rotary control gadget. Such apparatus is used as a bender for bending metal plates (press brake), oil pressure press, air pressure press, mechanical press, etc.

Background Art

[0002] Regarding the apparatus for bending metal plates by the use of metal molds, for an example, bender, there are conventionally used the lower plane mold provided with a groove therein and the upper punching mold. The metal plate is placed in the groove of the lower plane mold. Then, the metal plate is pressed into the groove of the lower mold and thereby bent.

[0003] However, there are disadvantages in the above apparatus. Since the groove of the lower plane mold is limited in size and shape, the lower plane mold is required to change the size and shape of the groove for taking care of the thickness of the metal plate to be bent and the bending degree required. Thus, several scores of the lower plane molds provided with the different size and shape of grooves are required to be prepared. This causes a larger cost in equipment. Not only that, but a space is required for storing such number of the lower plane molds. This is a problem in terms of space economy

[0004] Furthermore, the lower mold is required to be changed, whenever necessary, depending upon the purpose for which it is used. Thus, the above apparatus is labor-consuming and lowers an operational efficiency.

[0005] Particularly, when the thin metal plate is bent, the acute bending accuracy desired is not likely to be obtained because the tip part of the groove is wide. When the thick metal plate is bent, scratches are liable to be formed on the surface of the metal plate, because the groove gets tight in its tip part.

[0006] In addition, the pressure of the upper mold is rectangularly, by way of the metal plate, imposed on the groove of the lower plane mold. As there is no pressure relief, an excessive pressure causes the friction between the surface of the metal plate and the groove surface of the lower mold. Thus, there are formed scratches on the surface of the metal plate. Such scratches produce the inferior appearance on the products made of the metal plate bent in such manner. This is another disadvantage.

[0007] Furthermore, as the pressure of the upper mold is linearly concentrated on the surface of the metal plate with the groove of the lower mold at the supporting point, the physical texture of the metal plate is damaged

and deteriorated. Thus, cracks are produced therein. The physical strength thereof is lowered. When, particularly, the shoulder R of the metal plate is small, this defect is conspicuously developed.

[0008] Furthermore, the stroke of the upper mold reaches the lower dead point and bends the metal plate. Because of this mechanism, the strong pressure of the upper mold is directly transferred to the groove of the lower mold. Thus, its impact is large. Scratches and damages are caused on the groove surfaces of the lower plane molds. The groove of the lower mold tends to be abraded and worn out. These are the disadvantages of the conventional molds.

[0009] Furthermore, the metal plate is placed on the groove of the lower plane mold and then bent by pressing it down by the upper mold. When the tip part of the metal plate is bent or when the bending length is short, the metal plate tends to get out of place. Even when the tip part of the metal plate can be bent, its bending accuracy tends to be insufficient or unsatisfactory.

[0010] the object of the present invention is that, Unlike the conventional lower plane mold, the lower plane mold of the present invention is not required to use scores of plane molds in different size and shape for taking care of the thickness of metal plates to be bent or the bending degrees required. The metal plate may be optionally bent by the use of one or a few pairs of lower molds.

[0011] when bending metal plates, the aforementioned one or a few pairs of lower rotary molds are used, thereby the equipment cost is reduced and the storing place is made unnecessary or minimized. Further, the present invention makes it unnecessary to change lower molds and thereby improves work performance.

[0012] The further object of the present invention is that, when bending the metal plate by the use of the aforementioned one or a few pairs of rotary lower mold, the pressure of the upper mold is correctly conveyed to the metal plate. The pressure of the upper mold conveyed through the metal plate to the groove surface of the lower mold is caused to be released. Thus, there are formed no scratches on the metal plate from the friction between the metal surfaces and the groove surface of the lower mold and thereby improves the outer appearance of products made of bent metal plates.

[0013] The further object of the present invention is that, by receiving the pressure of the upper mold at the entire metal contact surfaces of two (2) lower bar molds, such pressure is dispersed and thereby the physical texture of the metal plate is made free from any damage or deterioration. Thereby, cracks are prevented from being formed on the metal plate. Thus, the physical strength of the metal plate is maintained.

[0014] The further object of the present invention is that, even if the stroke of the upper mold does not reach the lower dead point, it becomes possible to bend the metal plate and, thereby the shock by the pressure

(stroke) is mitigated from the upper mold. Further, there is made smaller the friction between the groove surfaces of the lower mold and the metal plate from the pressure of the upper mold. No scratches and damage are formed on the groove surface of the lower mold. Thereby, the groove of the lower mold is prevented from being abraded or worn out.

[0015] The further object of the present invention is that, even when the tip part is bent or the bending length is short, the metal plate is accurately bent without running off the groove.

[0016] In addition, the object of the present invention is to control the rotation of two (2) lower bar molds by the use of one or a few pairs of rotary lower molds having such rotary control gadget as spring, etc. without making the metal contact surfaces of two(2) bar molds run off the metal plate. The pressure of the upper mold is properly conveyed to the metal plate. Thus, the metal plate is accurately and nicely bent, adjusting the bending angle (R) of the metal plate in accordance with the object for which it is used. Thereby, the bending performance is improved.

[0017] The pressure of the upper mold is properly conveyed to the metal plate by preventing the metal contact surfaces of two (2) lower bar molds from running off the metal plates. Thus, the bending angle (R) of the metal plate is made acute and the metal plate is precisely bent. Thereby, the bending accuracy is improved. This is the further advantage of the present invention.

[0018] The further object of the present invention is that, the metal contact surfaces of the two (2) bar molds are not required to be manually restored to the original position. The metal contact surfaces of the two (2) lower bar molds are automatically caused to rotate inversely and return to the horizontal position.

Disclosure of Invention

[0019] The present invention relates to the apparatus for bending metal plates. The metal plate is bent by pressing the metal plate by the upper mold against the lower mold. Two (2) lower bar molds semicircular in section are prepared as the lower mold. For bending the plate by pressing the metal plate against the lower mold by the upper mold, two (2) bar molds semicircular in section are prepared as the lower molds. The curbed convex surfaces of two lower bar molds are slidably placed on the support provided with two (2) concave surfaces having the groove in the intermediate of the surfaces. The metal plate is placed on the metal contact surfaces of the two (2) lower bar molds. The metal plates are pressed by the upper mold against the lower mold. Simultaneously, the metal contact surfaces of two(2) lower bar molds are caused to rotate inwardly, and the metal plates is bent. The invention is characterized of being provided with such mechanism. Thereby, the metal plates are precisely bent at the acute angle.

[0020] Further, this invention is characterized in

that, referring to the aforementioned apparatus for bending metal plates, two (2) lower bar molds in normal use are removed from the two (2) curbed concave surfaces of the support, the two (2) curbed convex surfaces, semicircular in section, of the adapter forming the two (2) smaller-sized curbed concave surfaces on the two (2) curbed concave surfaces of the support, the convex surfaces of the smaller-sized two (2) lower bar molds, semicircular in section, are placed so as to rotate slidably on the two (2) smaller-sized curbed concave surfaces forming the adapter, the metal contact surfaces of the two (2) smaller-sized bar molds are caused to rotate slidably in the inner direction and thereby, metal plates are bent. This metal bending apparatus is characterized in that, when using this apparatus, the two (2) ordinary lower bar molds are replaced with the two (2) smaller-sized lower bar molds.

[0021] Further, the aforementioned of the present invention for bending metal plates is characterized by using the lower bar molds wherein the adjoining curbed convex surfaces of the lower bar molds, semicircular in section, positioned in parallel is cut off in the perpendicular direction against the metal contact surfaces. Lower bar molds are made thinner. The space between the lower bar molds is made smaller. Thereby, the bending performance of the metal plate is further improved.

[0022] The present invention relates to the apparatus for bending metal plates. The metal plate is bent by pressing the metal plate by the upper mold against the lower mold. Two (2) lower bar molds semicircular in section are prepared as the lower mold. For bending the plate by pressing the metal plate against the lower mold by the upper mold, two (2) bar molds semicircular in section are prepared as the lower molds. A rotary control plumb is attached to the upper outer lengthwise end of the curbed concave surface of each lower bar mold. The curbed convex surfaces of two lower bar molds are slidably placed on the support provided with two (2) concave surfaces having the groove in the intermediate of the surfaces. The metal plate is placed on the metal contact surfaces of the two (2) lower bar molds. The metal plates are pressed by the upper mold against the lower mold. Simultaneously, the metal contact surfaces of two(2) lower bar molds are caused to rotate inwardly against the gravity of the rotary control plumb, and the metal plates is bent. The invention is characterized of being provided with such mechanism. Thereby, Further, the present invention is characterized by being provided with the following mechanism. The metal plate is bent by pressing the metal plate against the lower mold. Two (2) lower bar molds semicircular in section are prepared as the lower mold. The rotary control gadget, such as spring, etc. is attached to the alligator or concave surface of each lower bar mold. These two (2) lower bar molds are slidably placed on the support provided with two (2) curbed concave surfaces having the groove in the intermediate of the surfaces. The metal plate is put on the metal contact surfaces of two (2) lower bar molds

and the metal plate is pressed against the lower mold by the upper mold. Simultaneously, the metal contact surfaces of two (2) lower bar molds are caused to rotate inwardly against such restraint as the resilience, etc. of the rotary control gadget, etc. This improves the accuracy of the metal plate bending.

Brief Description of Drawings

[0023]

Figure 1 is a view in extend elevation in perspective of the apparatus for bending metal plates comprising the upper mold, two (2) lower bar molds semicircular in section and the support.

Figure 2 is a view in section of the apparatus for bending metal plates showing that two (2) lower bar molds semicircular in section are placed in such manner as to rotate slidably on the curbed concave surfaces of the support for bending metal plates.

Figure 3 is a view in section of the apparatus for bending metal plates showing that two (2) lower bar molds rotate slidably and thereby the metal contact surface are inclined in V-shape and the metal plate is bent.

Figure 4 is a view in extend elevation in perspective of lower bar molds in 2/3 circular section, with 1/3 thereof being cut off lengthwise.

Figure 5 is a view in extend elevation in perspective of lower bar molds, provided with the rotary control plumbs in 1/3 circular section, with 2/3 thereof being cut off lengthwise.

Figure 6 is a view in section of the apparatus for bending metal plates showing that the adapter is placed on the curbed concave surfaces of the support from which two (2) lower bar molds are removed and that the two (2) smaller-sized lower bar molds, semicircular in section, are placed so as to rotate slidably on the two (2) smaller-sized curbed concave surfaces forming the adapter.

Figure 7 is a view in section of lower bar molds, provided with the rotary control plumbs showing that the adjoining curbed convex surfaces of the lower bar molds are cut off in the perpendicular direction against the metal contact surfaces.

Figure 8 is a view in section of apparatus for bending metal plates showing that the metal contact surfaces of two (2) lower bar molds run off the metal plates and the bending angles of the metal plates become inaccurate and obtuse.

Figure 9 is a view in section of the apparatus for bending metal plates showing that two (2) lower bar molds, provided with the rotary control plumbs, semicircular in section are placed in such manner as to rotate slidably on the curbed concave surfaces of the support for bending metal plates.

Figure 10 is a view in section of the apparatus for bending metal plates showing that lower bar molds

provided with the rotary control plumbs rotate slidably and thereby the metal contact surfaces are inclined in V-shape and the metal plate is bent.

Figure 11 is a view in extend elevation in perspective of lower bar molds, provided with the rotary control plumbs in 1/3 circular section, with 2/3 thereof being cut off lengthwise.

Figure 12 is a view in extend elevation in perspective of lower bar molds, provided with the rotary control plumbs in 2/3 circular section, with 1/3 thereof being cut off lengthwise.

Figure 13 is a view in section of lower bar molds, provided with the rotary control plumbs showing that the adjoining curbed convex surfaces of the lower bar molds are cut off in the perpendicular direction against the metal contact surfaces.

Figure 14 is a view in section of the apparatus for bending metal plates showing that two (2) lower bar molds, provided with the rotary control plumbs, semicircular in section are placed in such manner as to rotate slidably on the curbed concave surfaces of the support for bending metal plates.

Figure 15 is a view in section of the apparatus for bending metal plates showing that lower bar molds provided with the rotary control gadgets rotate slidably and thereby the metal contact surfaces are inclined in V-shape and the metal plate is bent.

Figure 16 is a view in extend elevation of the lower bar molds, provided with the rotary control gadgets, and being in 1/3 circular section.

Figure 17 is a view in extend elevation of the lower bar molds, provided with the rotary control gadgets, and being in 2/3 circular section.

Figure 18 is a view in section of the apparatus showing that the adjoining curbed convex surfaces of the lower bar molds provided with rotary control gadgets are cut off in the perpendicular direction against the metal contact surfaces and are placed in such manner as to rotate slidably on the curbed concave surfaces of the support.

Figure 19 is a view in perspective of the apparatus of the present invention for bending metal plates showing that springs are directly attached to the lower bar molds.

Best Embodiment of Invention

[0024] Referring to accompanying drawings, one example of the apparatus of the present invention for bending metal plates is hereinafter described.

[0025] As shown in Figure 1, the metal mold of the apparatus comprises the ordinary upper punch shape mold 1 and the lower mold 3 consisting of two (2) lower bar molds 2a and 2b semicircular in section. Some of apparatuses for bending metal plates comprise these two (2) lower bar molds 2a and 2b semicircular in section additionally placed on the support 4.

[0026] The two (2) bar molds 2a and 2b semicircu-

lar in section are provided with curbed convex surfaces 5a and 5b thereunder and metal contact surfaces 6a and 6b thereon. The curbed convex surfaces 5a and 5b of these two (2) bar molds 2a and 2b are placed, as shown in Figure 2, on the curbed concave surfaces 7a and 7b formed on the support 4. When pressure is imposed on the inner ends of metal contact surfaces 6a and 6b of the two (2) lower bar molds 2a and 2b, as shown in Figure 3, the curbed convex surfaces 5a and 5b of the two (2) bar molds 2a and 2b are caused to rotate slidably and metal contact surfaces 6a and 6b are caused to incline.

[0027] As mentioned above, the metal plate 8 is pressed downwardly by lowering the upper mold 1. The metal contact surfaces 6a and 6b of the two (2) lower bar molds 2a and 2b are caused to rotate slidably in the inner direction. For bending the metal plate 8, there is provided the groove 13 spacious enough to lower the upper mold 1 between the curbed concave surfaces 7a and 7b formed on the support 4.

[0028] The lower bar molds 2a and 2b are made in semicircular in section. In addition to those semicircular in section, as shown in Figure 4, the round bar is lengthwise cut off in about 2/3 section. As shown in Figure 5, the round bar is lengthwise cut off in about 1/3 in section. These are included in the concept of "semicircular section" of the present invention.

[0029] Then, As shown in Figure 2, the stroke of the upper mold 1 is caused to move down to the position of the desired bending angle and simultaneously the metal contact surfaces 6a and 6b of the low bar molds 2a and 2b are caused to be inclined in the V-shape. Thus, the metal plate 8 is acutely bent in the V-shape.

[0030] At this time, the downward pressure of the upper mold 1 is accepted and dispersed at the entire metal contact surfaces 6a and 6b of the two (2) lower bar molds. Thus, there are caused no scratches on the metal plate 8 from the friction between the metal plate 8 and the lower bar molds. The resultant product made of such metal plate is provided with good outer appearance.

[0031] In addition, when mending the metal plate 8, the stroke of the upper mold 1 is not caused to move down to the position immediately before the separation of the metal contact surfaces 6a and 6b at their inner ends, namely, the position as previously shown in Figure 3. Thus, the stroke thereof is suspended halfway. In such way, the bending degree of the metal plate 8 may be undoubtedly allowed to be made obtuse.

[0032] The bending degree of the metal plate 8 may be adjusted by the stroke of the upper mold 1. When the stroke of the upper mold 1 is shallow, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are slightly inclined. The bending degree of the metal plate 8 becomes larger.

[0033] Further, when the stroke of the upper mold 1 is deep, the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are largely inclined. The bending

angle of the metal plate 8 becomes acute.

[0034] The bending degree of the metal plate may be likewise adjusted by the position of metal contact surfaces 6a and 6b of lower bar molds 2a and 2b. The metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are cut off, as shown in Figure 4, lengthwise in about 1/3 of the round bar section. Namely, when the metal contact surfaces 6a and 6b are positioned above in semicircular section, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are more inclined by the slidable rotation of two (2) lower bar molds 2a and 2b.

[0035] Further, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are cut off lengthwise, as shown in Figure 5, in about 2/3 of the round bar section. Namely, when the metal contact surfaces 6a and 6b are positioned below in semicircular section, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are less inclined by the slidable rotation of two lower bar molds 2a and 2b.

[0036] Referring to another embodiment of the present invention, two (2) lower bar molds 2a and 2b constituting the lower bar molds 3 employed for the aforementioned apparatus for bending metal plates are removed, as shown in Figure 6, from the two (2) curbed concave surfaces 7a and 7b of the support 4. The adapter 9 is removably placed on the two (2) curbed concave surfaces 7a and 7b of this support 4.

[0037] More particularly, the two (2) smaller-sized concave surfaces 10a and 10b are formed on the upper part of the adapter 9. Simultaneously, there are formed thereunder two (2) curbed convex surfaces 11a and 11b semicircular in section. The two (2) curbed convex surfaces 11a and 11 b, semicircular in section, of the adapter 9 are placed on the two (2) curbed concave surfaces 7a and 7b of the support 4. The two (2) smaller-sized lower bar molds 12a and 12b, semicircular in section, are placed so as to rotate slidably on the two (2) smaller-sized curbed concave surfaces 10a and 10b of the adapter 9. Thus, the metal plate 8 is bent, as mentioned above.

[0038] Further, the metal plate bending mechanism by means of two (2) smaller-sized lower bar molds 12a and 12b semicircular in section placed on the adapter 9 is the same as mentioned above. Therefore, the explanation thereof is omitted.

[0039] Referring to the material for the adapter 9, the same material is used as for the aforementioned lower bar molds 2a and 2b. Further, the size of the two (2) curbed convex surfaces 11a and 11b of the adapter 9 is made the same as that of the curbed convex surfaces 5a and 5b of the two (2) lower bar molds 2a and 2b. Further, the length and thickness of two (2) smaller-sized lower bar molds 12a and 12b of the adapter 9 may be optionally determined by the thickness and quality of the metal plate 8 to be bent and the desired bending angle of the metal plate 8, etc. In an ordinary case, the lower bar molds 12a and 12b would be sufficient, if 3 ~

100cm in length and if 0.5 ~ 100mm in thickness respectively. The metal contact surfaces 6a and 6b of two (2) lower bar molds 12a and 12b would be sufficient, if 0.3mmx 3cm ~ 100mm x 200cm in size.

[0040] In addition, referring to the aforementioned apparatus for bending metal plates, the two (2) lower bar molds 2 and 2b, provided with the adjoining curved convex surfaces, constituting the upper mold 3 are cut off lengthwise and perpendicularly, as shown in Figure 7, against the metal contact surfaces 6a and 6b and the surface 10 is formed. Two (2) lower bar molds 2a and 2b are placed more closely in parallel. Thereby, the bending angle of the metal plate 8 may be made smaller. Thereby, the thickness of lower bar molds 2 and 2b may be made smaller.

[0041] Reference is made to the material for lower bar molds 2a and 2b. Any materials provided with higher hardness and abrasion resistance may be preferably used, such as metal mold steel, bearing steel, chrome-molybdenum steel, etc. Ordinary steel and surface-hardened steel may also be used.

[0042] The length and thickness of lower bar molds 2a and 2b may be optionally determined by the thickness and quality of the metal plate 8 to be bent and the desired bending angle of the metal plate 8, etc. In an ordinary case, the lower bar molds 2a and 2b would be sufficient, if 1 ~ 500 cm in length and if 0.5 ~ 300 cm in diameter respectively. The metal contact surfaces 6a and 6b area of lower bar molds 2a and 2b would be sufficient, if 1 x 5 cm~300 x 500 cm in size.

[0043] Now referring to the material for the support 4, there may be used the same material as that for lower bar molds 2a and 2b. The size of the support 4 would be satisfied if it is made larger than two (2) lower bar molds 2a and 2b.

[0044] Reference is made to the apparatus for bending metal plates involving the use of the special type of lower molds mentioned above. Contrary to the conventional plane molds, there is no need to use scores of lower plane molds different in size and shape for taking care of the thickness of metal plates to be bent and bending degree desired. There is used the lower mold 3 comprising one or a few pairs of lower bar molds 2a and 2b. This lower mold is provided with a function to bend the metal plate 8 at the optional angle. This brings about a cost reduction in equipment. The storing place is made smaller-sized. As it is not necessary to change the lower mold, work efficiency is improved.

[0045] In addition, when bending the metal plate 8, the downward pressure of the upper mold 1 is reduced and further the downward pressure of the upper mold 1 on the lower mold 3 is released through the metal plate 8. Because of such release, no scratches are caused by the friction between the metal plate 8 and lower bar molds 2a and 2b. The resultant metal plate 8 is provided with better outer appearance.

[0046] However, there are still disadvantages in the apparatus. When bending the thick metal plate 8 by the

pressure of the upper mold 1, the lower bar molds 2a and 2b of the mold 3 rotate smoothly. Because of such smooth rotation, as shown in Figure 8, the metal contact surfaces 6a and 6b tend to run off the metal plate 8. It is hard for the pressure of the upper mold 1 to be properly transferred to the metal plate 8. Thus, the bending angle (R) of the metal plate 8 is insufficient and the desired bending angle is not satisfactorily obtained

[0047] Further, after the stroke of the upper mold 1 reaches the lower dead point and bends the metal plate 8, the upper mold 1 is caused to return to the original position. Then, the bent metal plate 8 is taken out of the lower mold 3. It is required that the lower bar molds 2a and 2b of mold 3 be caused to rotate inversely so that the lower bar molds 2a and 2b of the mold 3 may return to the horizontal position. However, the lower bar molds 2a and 2b are not capable of being satisfactorily restored to their original positions by their own weight alone. Their restoration requires manual labor. Thus, work performance is lowered. This is another disadvantage.

[0048] Then, when it is necessary to overcome the aforementioned disadvantage, it is preferred that an improvement, as mentioned below, be made on the metal-bending apparatus employing the special lower mold.

[0049] Furthermore, improvements in the metal mold of the present invention are hereinafter described. as shown in Figure9 ,The lower mold 3 comprises two lower bar molds 2a and 2b semicircular in section. The rotary control plumb is attached to the upper lengthwise ends on the curved concave surfaces of two (2) lower bar molds 2a and 2b. These two lower bar molds 2a and 2b are placed on the support 4. This is the structure of the apparatus provided with the rotary control gadgets for bending metal plates.

[0050] Two (2) lower bar molds 2a and 2b semicircular in section are provided with the curved convex surfaces 5a and 5b thereunder and the metal contact surfaces 6a and 6b thereon. The curved convex surfaces 5a and 5b of these two (2) lower bar molds 2a and 2b are placed on the two (2) curved concave surfaces 7a and 7b formed on the support 4. When a force is added to the inner ends of the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b, the curved convex surfaces 5a and 5b of two (2) lower bar molds 2a and 2b are caused to rotate slidably in the inner direction and the metal contact surfaces 6a and 6b are caused to incline in the V-shape.

[0051] For bending metal plate 8, the metal plate 1 is placed on the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b. Thereafter, as shown in Figure 10, the upper mold 1 is caused to move downwardly and the metal plate 8 is pressed downwardly. While so doing, the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are caused to rotate slidably in the inner direction in such manner as to be in the V-shape against the plumb of the rotary control plumbs

15. Thus, the bending of metal plate 8 is started.

[0052] Then, the stroke of the upper mold 1 is caused to move down to the position of the desired bending angle and simultaneously the metal contact surfaces 6a and 6b of the low bar molds 2a and 2b are caused to be inclined in the V-shape. Thus, the metal plate 8 is acutely bent in the V-shape. At this time, the downward pressure of the upper mold 1 is accepted and dispersed at the entire metal contact surfaces 6a and 6b of the two (2) lower bar molds. Thus, there are caused no scratches on the metal plate 8 from the friction between the metal plate 8 and the lower bar molds. The resultant product made of such metal plate is provided with good outer appearance.

[0053] In addition, when bending the metal plate 8, the stroke of the upper mold 1 is not caused to move down to the position immediately before the separation of the metal contact surfaces 6a and 6b at their inner ends, namely, the position as shown in Figure 10. This to say, the stroke thereof is suspended halfway. Thus, the bending degree of the metal plate 8 may be allowed to be made obtuse.

[0054] When the metal plate 8 is bent up to the desired bending degree, the downward motion of the upper mold 1 is stopped. The upper mold 1 is caused to move upwardly and the pressing force is relieved. The metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are caused to automatically return to the horizontal position by the weight of the rotary control plumb 15. Then, the bent metal plate is taken out of the lower mold 3. Thereafter, the aforementioned operation may be repeated, whenever necessary.

[0055] The lower bar molds 2a and 2b provided with the spring 16 are made in semicircular in section. In addition to those semicircular in section, as shown in Figure 11, the round bar is lengthwise cut off in about 2/3 section. As shown in Figure 12, the round bar is lengthwise cut off in about 1/3 in section. These are included in the concept of "semicircular section" of the present invention.

[0056] The bending degree of the metal plate 8 may be adjusted by the stroke of the upper mold 1. When the stroke of the upper mold 1 is shallow, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are slightly inclined. The bending degree of the metal plate 8 becomes larger.

[0057] Further, when the stroke of the upper mold 1 is deep, the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are largely inclined. The bending angle of the metal plate 8 becomes acute.

[0058] Further, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are cut off lengthwise, as shown in Figure 11, in about 2/3 of the round bar section. Namely, when the metal contact surfaces 6a and 6b are positioned below in semicircular section, the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are less inclined by the slidable rotation of two lower bar molds 2a and 2b.

[0059] In addition, referring to the aforementioned apparatus for bending metal plates, the two (2) lower bar molds 2 and 2b, provided with the adjoining curved convex surfaces, constituting the upper mold 3 are cut off lengthwise and perpendicularly, as shown in Figure 13, against the metal contact surfaces 6a and 6b and the surface 10 is formed. Two (2) lower bar molds 2a and 2b are placed more closely in parallel. Thereby, the bending angle of the metal plate 8 may be made smaller. Thereby, the thickness of lower bar molds 2 and 2b may be made smaller.

[0060] The shape of rotary control plumb 15 provided at lower bar molds 2a and 2b may be in the shape of bar, board, block, or anything which may be used as a plumb. Further, the weight of the rotary control plumb 15 is required to be $1/5 \sim 1/20^{\text{th}}$ against the lower bar molds 2a and 2b.

[0061] When the weight of the rotary control plumb 15 is less than $1/20^{\text{th}}$ against the lower bar molds 2a and 2b, the metal contact surfaces 6a and 6b tend to run off the metal plate 8. Furthermore, it becomes harder for the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b to return to the horizontal position. Thus, such small plumb is improper. On the contrary, when the weight of the rotary control plumb 15 is in excess of $1/5$ against the lower bar molds 2a and 2b, the rotary control plumb 15 becomes too heavy. An excessive force is required for lifting it up. The downward pressure of the upper mold 1 is required to be made proportionately larger. This would cause extra loss of energy and is improper.

[0062] Referring to the material for the rotary control plumb 15, any material provided with higher hardness and abrasion resistance may be used, such as metal mold steel, bearing steel, chrome-molybdenum steel, etc. Ordinary steel and ordinary surface-quenched steel may be also used.

[0063] The length and thickness of the rotary control plumb 15 may be optionally determined by the length of the lower bar molds 2a and 2b, the thickness and quality of the metal plate 8 to be bent, the bending angle of the metal plate 8,

[0064] When bending the metal plate 8 by the downward pressure of the upper mold 1, there are observed several disadvantages. For example, the lower bar molds 2a and 2b run off the metal plate 8 and the downward pressure of the upper mold 1 is not properly conveyed to the metal plate 8. Further, when the bending angle of the metal plate 8 is loose, metal contact surfaces 6a and 6b separate from each other. The bending angle of the metal plate 8 is likewise loosened and the bending accuracy is lowered. After the metal plate 8 is bent by the upper mold 1 and the bent metal plate is taken out from the lower mold 3, some work is required to return lower bar molds 2a and 2b to the horizontal position. With reference to such disadvantages, the

[0065] Now, an example of the improved metal

mold is hereinafter described. As shown in Figure 10, the apparatus for bending metal plates comprises the ordinary upper punch type mold 1 and the lower mold 3 consisting of two (2) lower bar molds 2a and 2b semicircular in section. This apparatus is further provided with the spring 16 as the rotary control gadget attached to the alligator parts of the lower bar molds 2a and 2b. The two lower bar molds 2a and 2b are placed on the support 4.

[0066] The two (2) lower bar molds 2a and 2b semicircular in section are provided with the curbed convex surfaces 5a and 5b thereunder and the metal contact surfaces 6a and 6b thereon. The curbed convex surfaces 5a and 5b of these lower bar molds 2a and 2b are placed on the two curbed concave surfaces 7a and 7b formed on the support 4. When a force is conveyed to the inner ends of the metal contact surfaces 6a and 6b to the lower bar molds 2a and 2b. As shown in Figure 10, the curbed convex surfaces 5a and 5b of two (2) lower bar molds 2a and 2b are caused to rotate slidably in the inner direction and the metal contact surfaces 6a and 6b are inclined in the V-shape.

[0067] For bending the metal plate 8, the metal plate 8 is placed on the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b. Thereafter, as shown in Figure 11, the upper mold 1 is caused to move downwardly and the metal plate 8 is pressed in the downward direction. The metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are caused to rotate slidably in the inner direction against the resilience of the spring 16. Thus, the bending of the metal plate is caused to start. The rotation of the metal contact surfaces 6a and 6b of the lower bar molds 2a and 2b is controlled by the resilience of the spring 16 as the rotary control gadget. The metal contact surfaces 6a and 6b are assuredly pressed to the metal plate 8. The metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are made not to slip away from the metal plate 8 and the downward pressure of the upper mold 1 is properly conveyed to the metal plate 8.

[0068] Then, the stroke of the upper mold 1 is caused to move down to the position of the desired bending angle and simultaneously the metal contact surfaces 6a and 6b of the lower bar molds 2a and 2b are caused to be inclined in the V-shape. Thus, the metal plate 8 is acutely bent in the V-shape. At this time, the downward pressure of the upper mold 1 is accepted and dispersed at the entire metal contact surfaces 6a and 6b of the two (2) lower bar molds. Thus, there are caused no scratches on the metal plate 8 from the friction between the metal plate 8 and the lower bar molds. The resultant product made of such metal plate is provided with good outer appearance.

[0069] In addition, when bending the metal plate 8, the stroke of the upper mold 1 is not caused to move down to the position immediately before the separation of the metal contact surfaces 6a and 6b at their inner ends, namely, the position as previously shown in Fig-

ure 15. Thus, the stroke thereof is suspended halfway. In such way, the bending degree of the metal plate 8 may be undoubtedly allowed to be made obtuse.

[0070] When the metal plate 8 is bent up to the desired bending angle, the downward movement of the upper mold 1 is caused to stop. When the upper mold 1 is lifted up and the downward pressure is released, the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are caused to return automatically to the horizontal position with the help of the resilience of the spring 16 as the rotary control gadget. Thereafter, the bent metal plate 8 is taken out of the lower mold 3. Thereafter, the same operation may be repeated, whenever necessary.

[0071] The lower bar molds 2a and 2b provided with the spring 16 are made in semicircular in section. In addition to those semicircular in section, as shown in Figure 12, the round bar is lengthwise cut off in about 2/3 section. As shown in Figure 13, the round bar is lengthwise cut off in about 1/3 in section. These are included in the concept of "semicircular section" of the present invention.

[0072] Reference is made to the bending degree of the metal plate 8. This degree may be adjusted by the stroke of the upper mold 1. When the stroke of the upper mold 1 is shallow, the metal contact surfaces 6a and 6b of lower bar molds 2a and 2b are less inclined and the bending angle of the metal plate 8 becomes obtuse. Further, when the stroke of the upper mold 1 is deep, the metal contact surfaces 6a and 6b of two lower bar molds 2a and 2b are largely inclined and the bending angle of the metal plate 8 becomes acute.

[0073] The bending degree of the metal plate 8 may be likewise adjusted by the positions of the metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b. For example, the metal contact surfaces 6a and 6b of two lower bar molds 2a and 2b provided with the spring 16 are those, as shown in Figure 12, cut off lengthwise and horizontally in about 2/3 section of the round bar. In this case, the metal contact surfaces 6a and 6b are below positioned in semicircular section. The metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are less inclined by the slidable rotation of two lower bar molds 2a and 2b.

[0074] In addition, the metal contact surfaces 6a and 6b of the two (2) lower bar molds are those, as shown in Figure 17, cut off in about 1/3 section of the round bar. In this case, the metal contact surfaces 6a and 6b are above positioned in semicircular section. The metal contact surfaces 6a and 6b of two (2) lower bar molds 2a and 2b are more inclined by the slidable rotation of two lower bar molds 2a and 2b.

[0075] In addition, referring to the aforementioned apparatus for bending metal plates, the two (2) lower bar molds 2a and 2b, provided with the adjoining curbed convex surfaces, constituting the lower mold 3 provided with the spring 16, are cut off lengthwise and perpendicularly, as shown in Figure 14, against the metal contact

surfaces 6a and 6b and the surface 10 is formed. Two (2) lower bar molds 2 and 2b are placed more closely in parallel. Thereby, the bending angle of the metal plate 8 may be made smaller. Thereby, the thickness of lower bar molds 2 and 2b may be made smaller as mentioned above.

[0076] Reference is made to the spring 16 provided at the lower bar molds 2a and 2b. The springs may be attached to the alligators of the lower bar molds 2a and 2b. When the lower bar molds 2a and 2b are not provided with the alligator, as shown in Figure 15, the spring may be attached to the groove or pin, etc. provided at the lower bar molds 2a and 2b.

[0077] Further, any ordinary spring may be used as the spring 16. In addition to the spring, there may be used any expansible gadgets, as shown in Figure 18, such as the piston 17, damper, absorber, etc., if such gadgets are capable of controlling, when bending the metal plate 8, the rotation of the lower bar molds 2a and 2b and returning the rotated lower bar molds 2a and 2b to the horizontal position.

[0078] Reference is made to the materials for the lower bar molds 2a and 2b and alligator parts. The most suitable materials are metal mold steel, bearing steel, chrome-molybdenum steel, etc. provided with hardness and abrasion resistance. Ordinary steel and ordinary surface-quenched steel may be also

[0079] The length and thickness of lower bar molds 2a and 2b and alligator may be optionally determined by the thickness and quality of the metal plate 8 to be bent, the bending angle thereof, etc. In normal case, the lower bar molds 2a and 2b may be satisfied, if in the range of 1 ~ 500 cm in length, and in the range of 0.5 ~ 300 cm in thickness. The metal contact surfaces 6a and 6b of the lower bar molds 2a and 2b may be satisfied, if in the range of 1 x 5 cm ~ 300 x 00 cm in size.

Possible Application in Industry

[0080] As mentioned above, the excellent advantage of the present invention is that the downward pressure of the upper mold 1 is properly conveyed to the metal plate by controlling the rotation of the lower bar molds 2a and 2b and the metal contact surfaces are caused not to run off the metal plate, and the bending angle (R) of the metal plate may be made acute.

[0081] Further, according to the present invention, when the metal plate is bent by the metal mold, the downward pressure of the upper mold conveyed by way of the metal plate to the groove surface of the lower mold have been reduced by halves. At the same time, that pressure is released by the rotation of the metal contact surfaces of the two (2) lower bar molds. Thus, there are caused no scratches from the friction between the metal plate and the groove surface of the lower mold. Thus, the product made of the metal plate bent thereby has the better outer appearance. This is the advantage of the present invention.

[0082] Further, according to the present invention, when the metal plate is bent, the downward pressure of the upper mold is accepted and dispersed at the entire metal contact surfaces of two lower bar molds, there is neither damage nor deterioration in the physical texture of the metal plate. There are made no cracks in the metal plate. Not only that, but the inherent physical strength is maintained.

[0083] Further, according to the present invention, even when the stroke of the upper mold does not reach the lower dead point, it is possible to bend the metal plate. Because of this, the shock by the stroke of the upper mold is mitigated. There is minimized the effect of friction cause between the groove surface of the lower mold and the metal plate by the downward pressure of the upper mold. Thus, scratches and damages are eliminated on the groove surfaces of the lower molds. This prevent the lower mold groove from being abraded and worn out and contributes to the longer life of the metal molds. The work performance of the metal mold is stabilized and may be used semi-permanently.

[0084] There is the further advantage of the present invention that, even when the tip part of the metal plate is bent or the bending length is short, the metal plate does not run off the apparatus and is nicely bent. Thus the bending accuracy is improved.

[0085] Further, according to the present invention, the metal contact surfaces of the two lower bar molds are automatically caused to return to the horizontal position. There is no need for restoring manually the metal contact surfaces of the two lower bar molds to the original position. Thus, the bending processes of the metal plates are remarkably improved.

Claims

1. The apparatus for bending metal plates wherein, making two(2) lower bar molds semicircular in section as the lower molds and attaching rotary control plumbs to the lengthwise upper end part of curbed concave surfaces of the two (2) lower bar molds, further preparing the support for carrying two (2) lower bar molds, placing the curbed convex surfaces of the two (2) lower bar molds on the support provided with two (2) curbed concave surfaces having the groove in the intermediate of the surfaces, placing the metal plate on the metal contact surfaces of two (2) lower bar molds, pressing the metal plate toward the lower molds by the upper mold, simultaneously for bending the metal plate by rotating the metal contact surfaces of two (2) lower bar molds in the inner direction, causing the metal contact surfaces of two (2) lower bar molds to slidably rotate, and controlling the metal contact surfaces as to place them assuredly to the metal plate for bending metal plates.
2. The apparatus for bending metal plates according

to Claim 1 wherein, causing two (2) smaller-sized lower bar molds to be removed from the two (2) curbed concave surfaces of the support, placing the two (2) curbed convex surfaces, semicircular in section, of the adapter forming the two (2) smaller-sized curbed concave surfaces on the two (2) concave surfaces of the support, placing the convex surfaces of the two (2) smaller-sized lower bar molds, semicircular in section, so to rotate slidably on the two (2) smaller-sized concave surfaces forming the adapter, placing a metal plate on the metal contact surfaces of the two (2) smaller-sized lower bar molds, and thereby pressing the metal plate on the two (2) smaller-sized lower bar molds by the upper mold and simultaneously causing the metal contact surfaces of the two (2) smaller-sized lower bar molds to rotate slidably in the inner direction for bending the metal plate.

3. The apparatus for bending metal plates according to Claim 1 or Claim 2 wherein there are used the lower bar molds semicircular in section the adjoining curbed convex surfaces of which are positioned in parallel and cut off perpendicularly against the metal contact surfaces.

4. The apparatus for bending metal plates wherein, making two(2) lower bar molds semicircular in section as the lower molds and attaching rotary control plumbs to the lengthwise upper end part of curbed concave surfaces of the two (2) lower bar molds, further preparing the support for carrying two (2) lower bar molds, placing the curbed convex surfaces of the two (2) lower bar molds on the support provided with two (2) curbed concave surfaces having the groove in the intermediate of the surfaces, placing the metal plate on the metal contact surfaces of two (2) lower bar molds, pressing the metal plate toward the lower molds by the upper mold, simultaneously for bending the metal plate by rotating the metal contact surfaces of two (2) lower bar molds in the inner direction against the gravity of the rotary control plumbs, causing the metal contact surfaces of two (2) lower bar molds to slidably rotate, and controlling the metal contact surfaces as to place them assuredly to the metal plate for bending metal plates.

5. The apparatus for bending metal plates wherein, making two(2) lower bar molds semicircular in section as the lower molds, attaching such rotary control gadgets as springs, etc. to the alligator or the curbed metal contact surfaces each of the two (2) lower bar molds, and attaching rotary control plumbs to the lengthwise upper end part of curbed concave surfaces of the two (2) lower bar molds, further preparing the support for carrying two (2) lower bar molds, placing the curbed convex sur-

faces of the two (2) lower bar molds on the support provided with two (2) curbed concave surfaces having the groove in the intermediate of the surfaces, placing the metal plate on the metal contact surfaces of two (2) lower bar molds, pressing the metal plate toward the lower molds by the upper mold, simultaneously for bending the metal plate by rotating the metal contact surfaces of two (2) lower bar molds in the inner direction against the gravity of the rotary control plumbs, causing the metal contact surfaces of two (2) lower bar molds to slidably rotate, and controlling the metal contact surfaces as to place them assuredly to the metal plate for bending metal plates.

FIG. 1

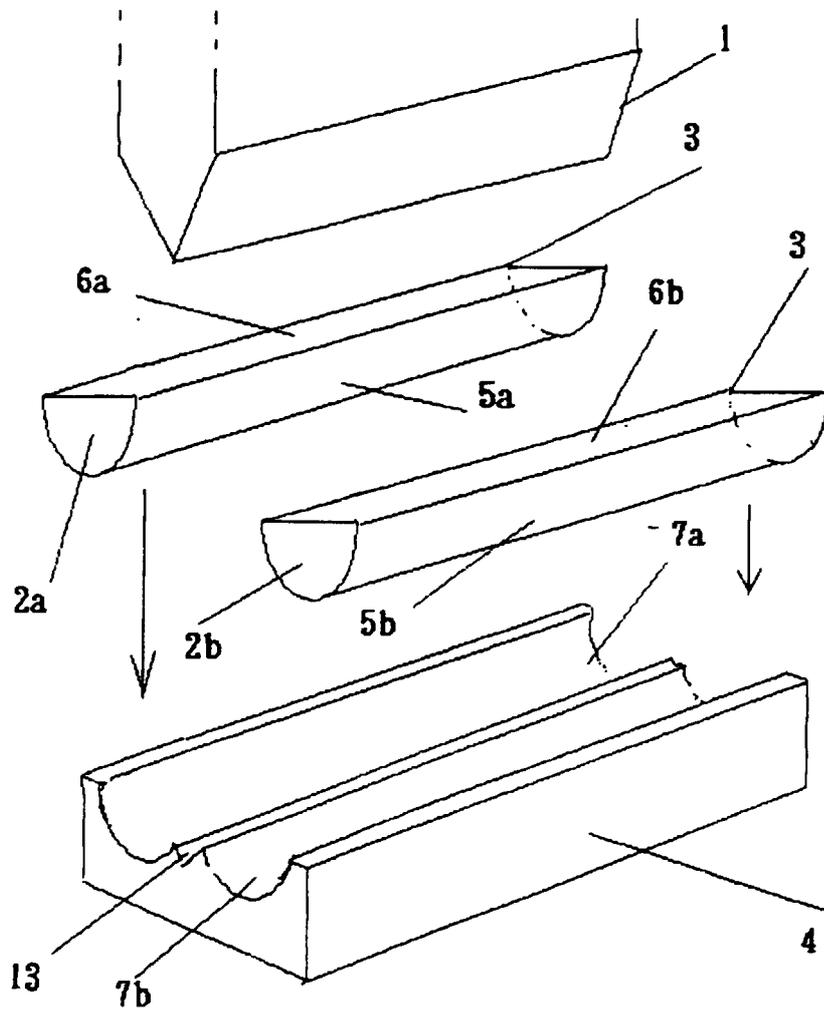


FIG. 2

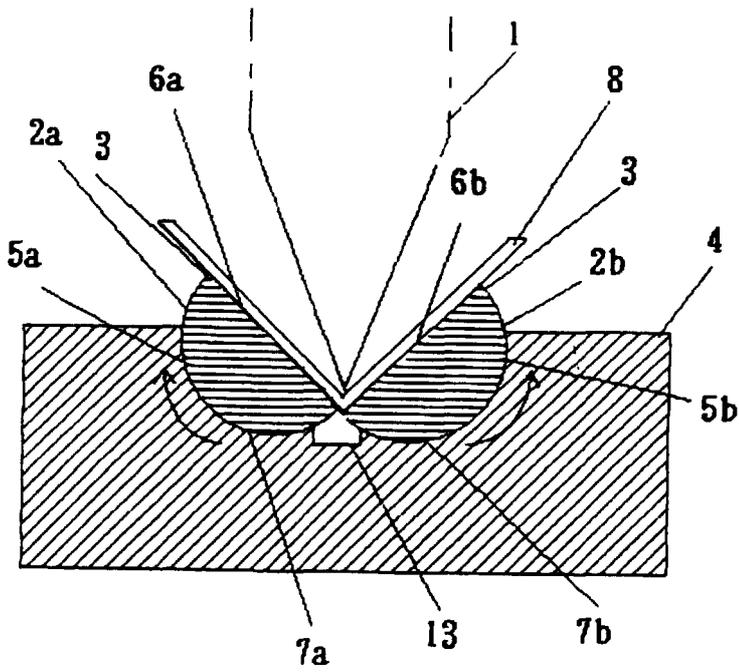
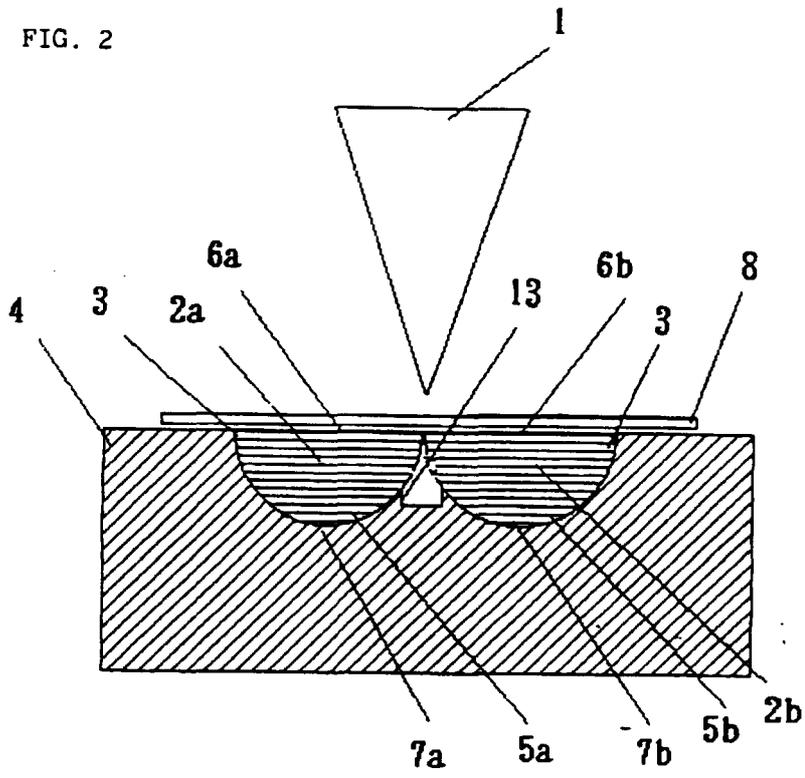


FIG. 3

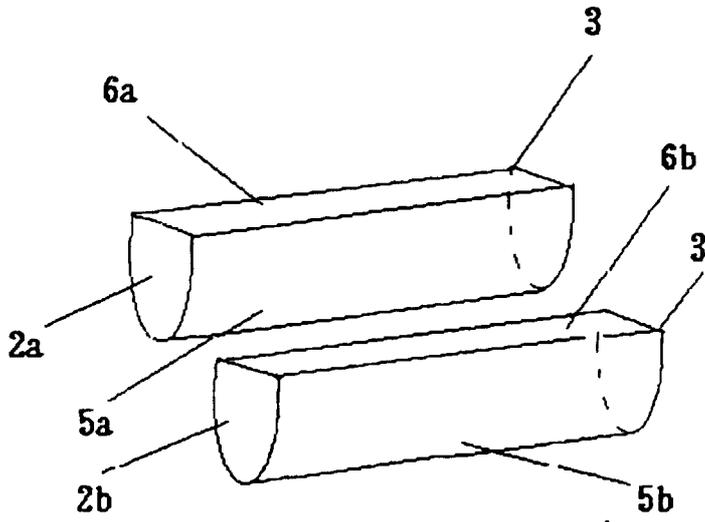


FIG. 4

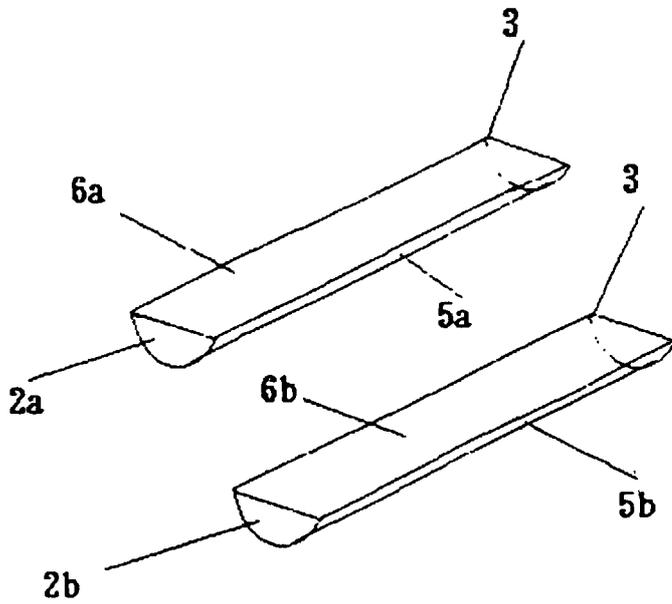


FIG. 5

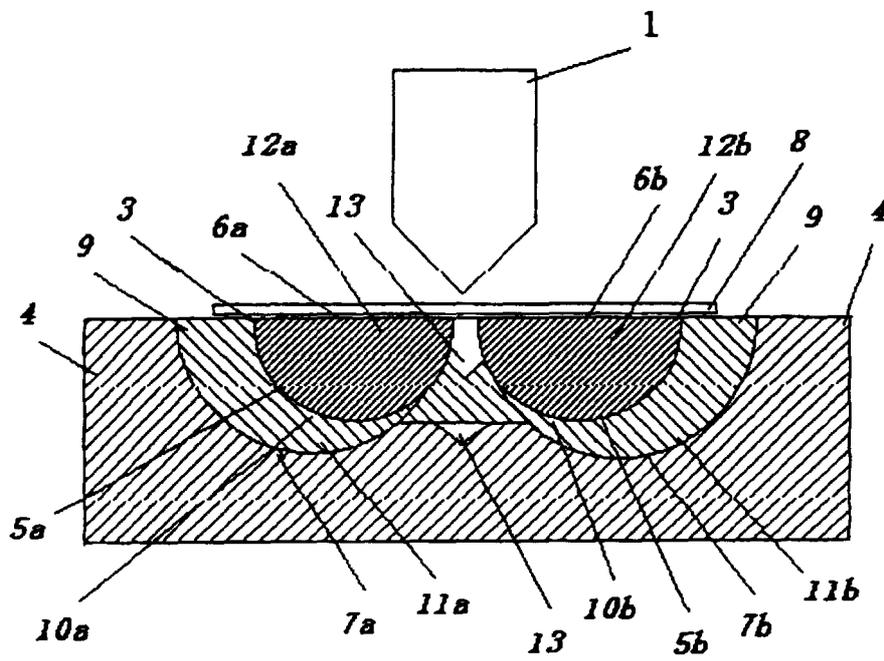


FIG. 6

FIG. 7

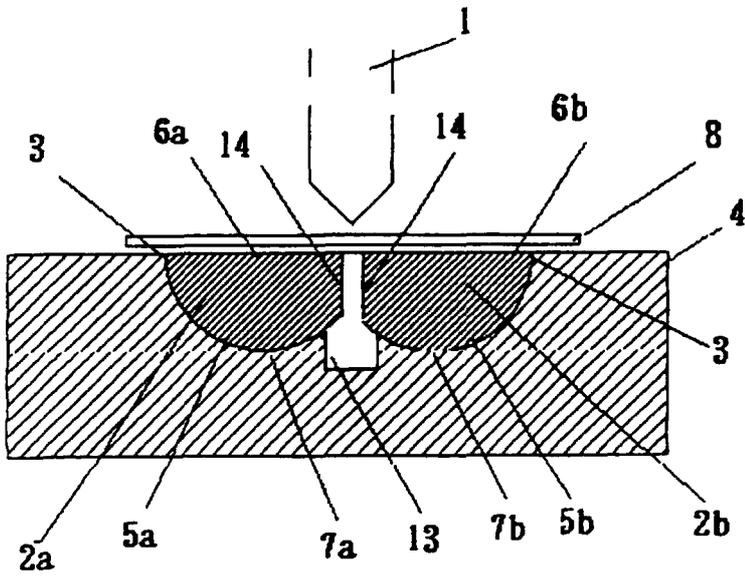
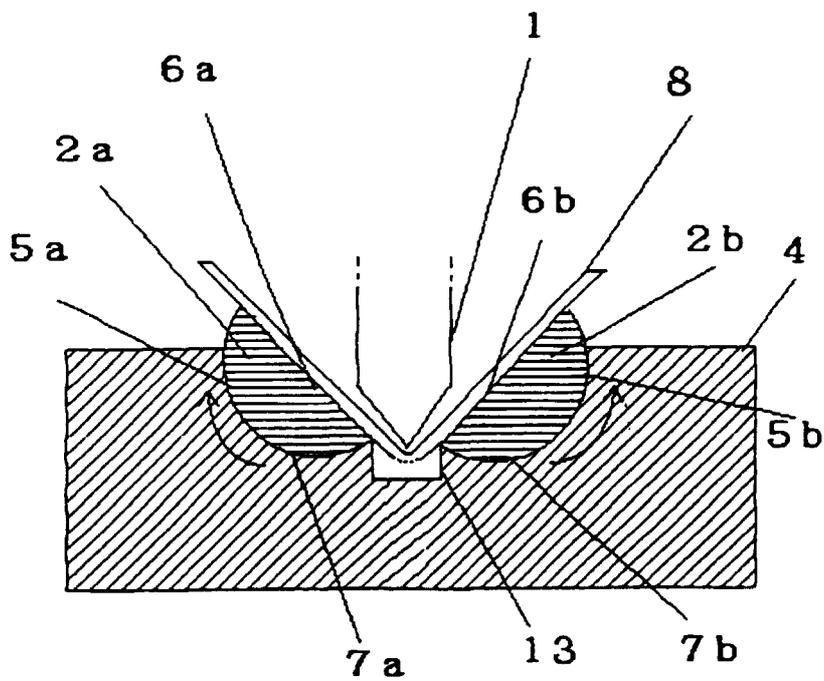


FIG. 8



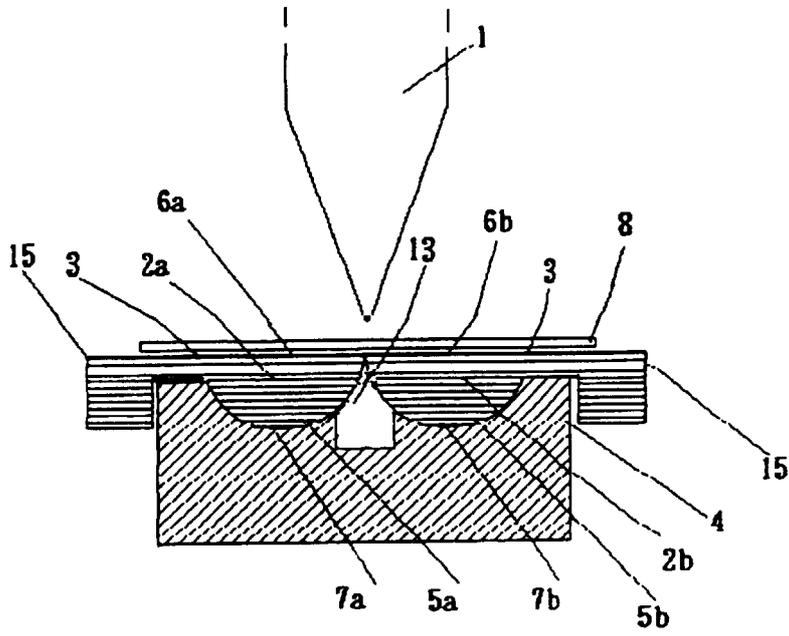


FIG. 9

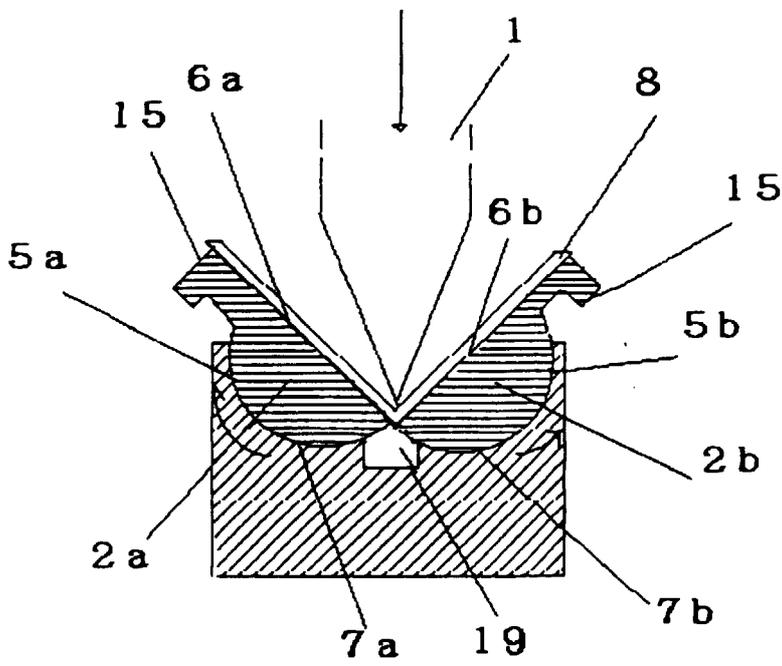


FIG. 10

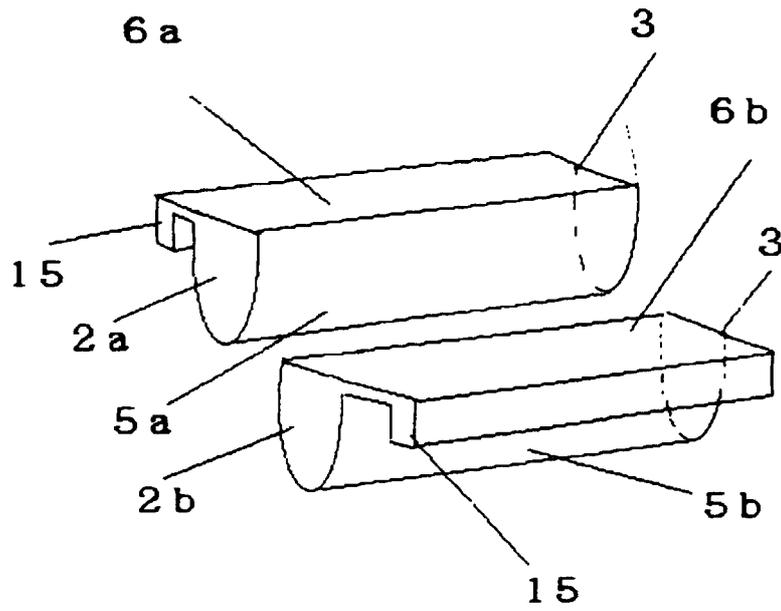
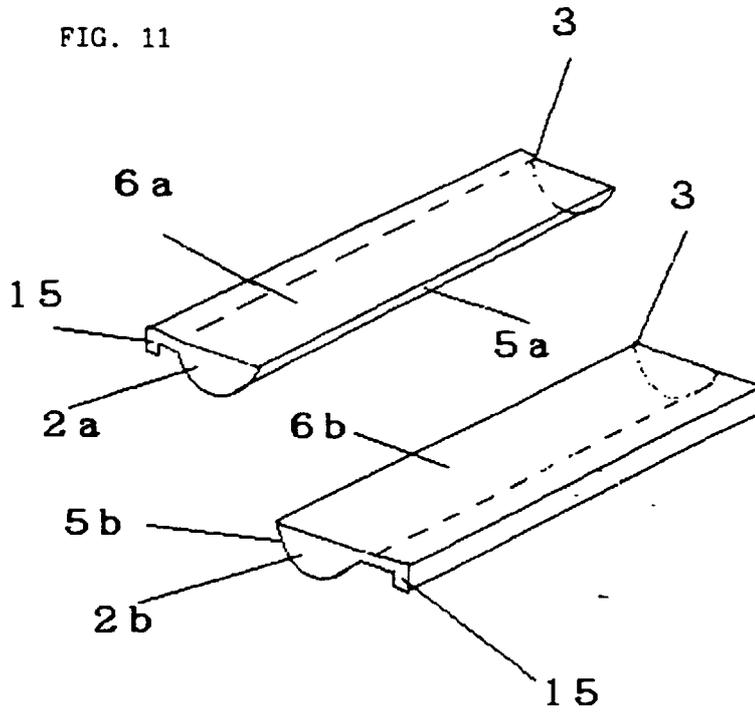


FIG. 12

FIG. 13

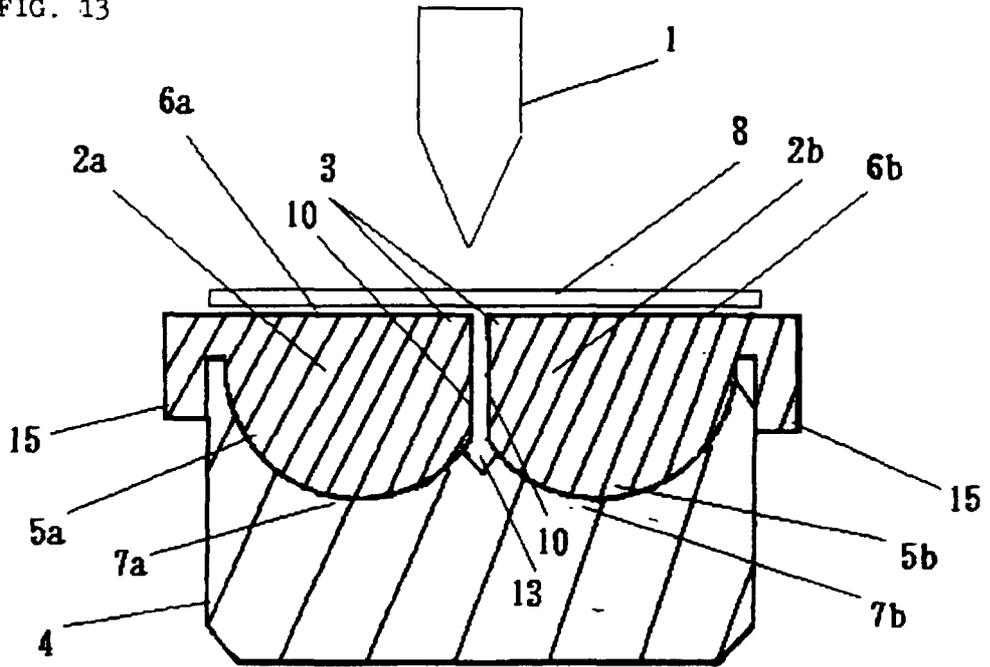
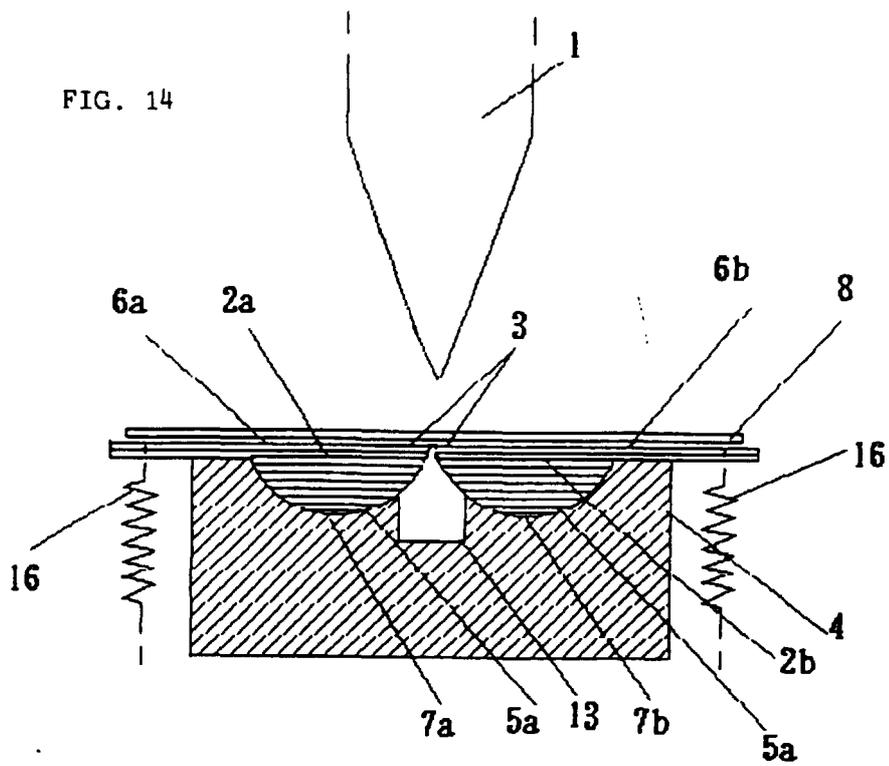


FIG. 14



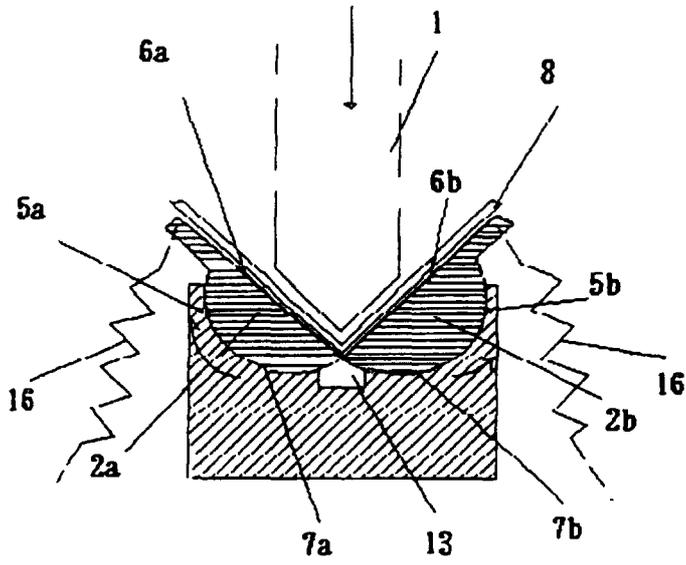


FIG. 15

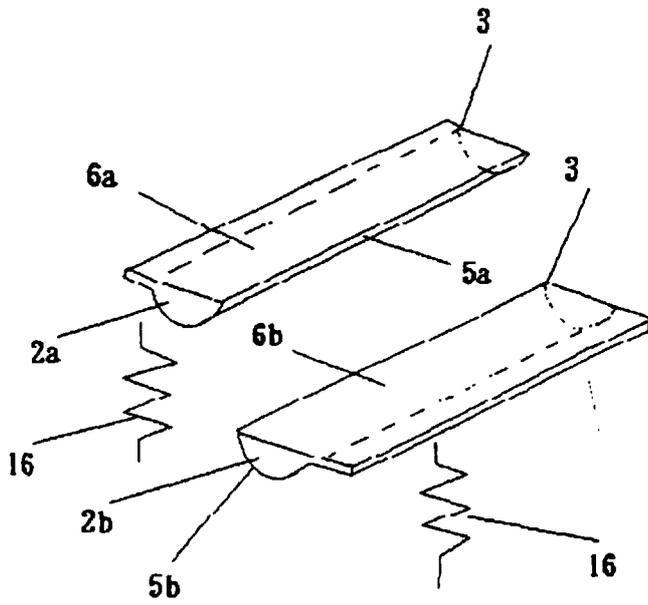
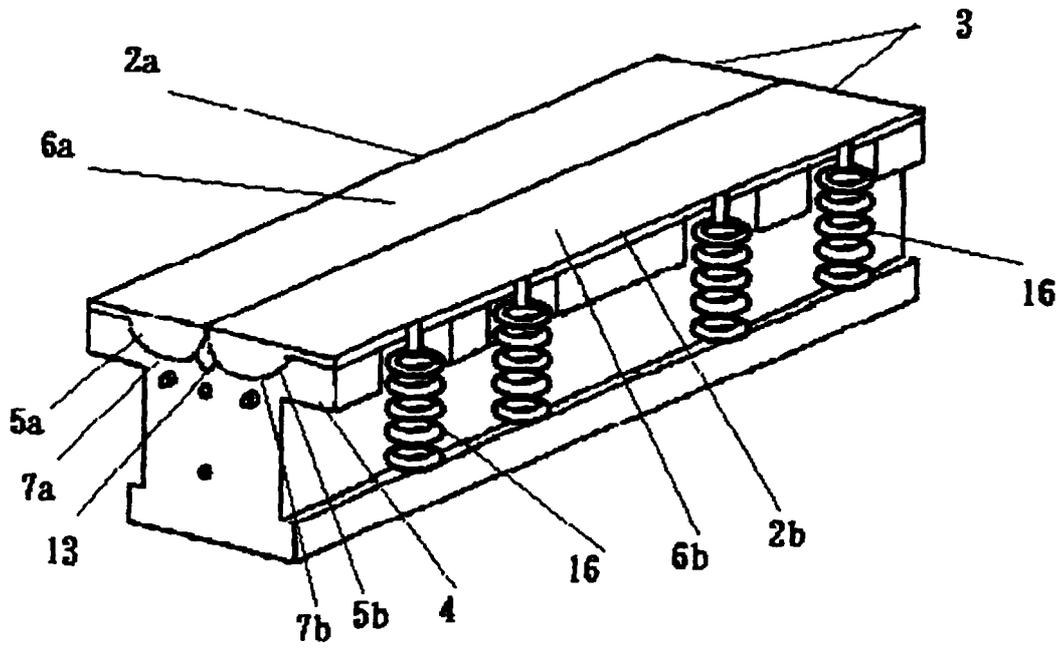


FIG. 16

FIG. 19



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/06702

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁶ B21D 5/01		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁶ B21D 5/01		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-1999 Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999		
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, 2-99222, A (Kobe Steel, Ltd.), 11 April, 1990 (11.04.90), Fig. 3 Fig. 3 (Family: none)	1 2-5
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.72265/1990 (Laid-open No.14010/1991) (NKK CORPORATION), 13 February, 1991 (13.02.91), Figs. 1 to 2 Figs. 1 to 2 (Family: none)	1 2-5
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.120304/1988 (Laid-open No.42718/1990) (Kobe Steel, Ltd.), 23 March, 1990 (23.03.90), Figs. 1 to 5 Figs. 1 to 5 (Family: none)	1 2-5
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> 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 document 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 14 December, 1999 (14.12.99)	Date of mailing of the international search report 21 December, 1999 (21.12.99)	
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	
Facsimile No.	Telephone No.	

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/06702

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 3-124317, A (Nisshin Steel Co., Ltd.), 27 May, 1991 (27.05.91), Fig. 1 (Family: none)	1-5

Form PCT/ISA/210 (continuation of second sheet) (July 1992)