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Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number:

0 325 840
A2

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 88310544.7

(51) Int. Cl.4: **B21D 5/02**

(22) Date of filing: 09.11.88

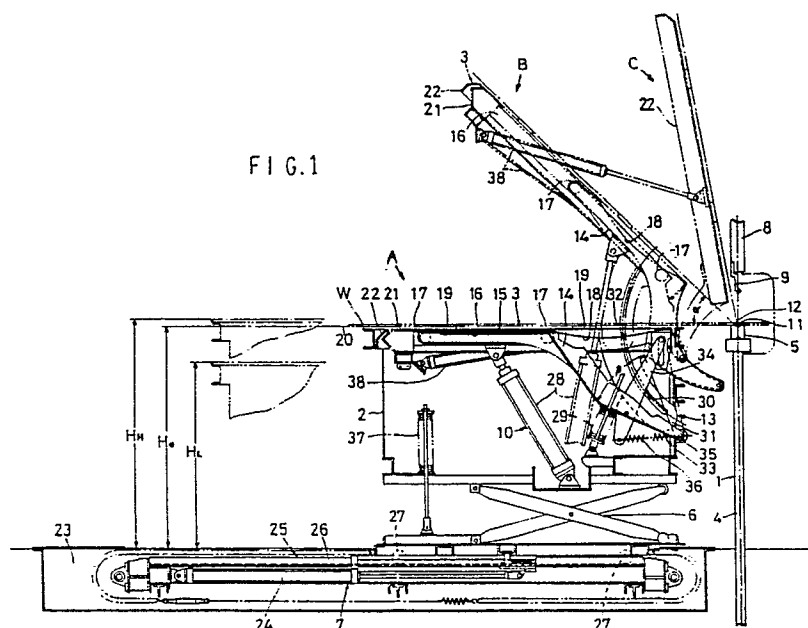
(30) Priority: 29.01.88 JP 19950/88

(43) Date of publication of application:
02.08.89 Bulletin 89/31(84) Designated Contracting States:
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(54) Workpiece-supporting device for bending machines.

(57) A device to support a workpiece being bent by a bending machine such as a press brake. The rising angle of a table on which the workpiece is mounted is made smaller than that of an arm which raises the table at the beginning of the bending work, though the two angles are again made the same at the work. The workpiece which curves convexly swelling upwards at the beginning of the work can be supported well by the table throughout the bending work.

FIG.1



WORKPIECE SUPPORTING DEVICE FOR BENDING MACHINES

BACKGROUND OF THE INVENTION

The present invention relates to a device to support a workpiece which being bent by a bending machine such as a press brake.

A press brake to bend heavy workpieces such as steel sheets is usually equipped with a device to support the workpiece which is raised as the processing progresses. The device functions to prevent the workpiece from bending at a shoulder of a die of the press brake because of the dead load as well as force of inertia, as well as to remove the workpiece from the press brake after the processing is completed.

The device comprises typically a fundamental frame placed before a bed of the press brake. The frame is equipped with an arm pivotally fixed to the frame near the bed so that its rear half, or the farther one from the bed, is directed to the die on the bed. The rear half of the arm supports a table by way of a guidance means, which allows the table to approach or go away from the die. The table is so positioned before the processing starts that its top is on the same level with that of the die. A raising means is provided to raise the table by means of the arm in synchronization with the processing of the workpiece by the press brake. The device is also equipped with a position control means which maintains the distance between the table and die throughout the processing.

The guidance means usually comprises a pair of guide rails extending toward the die along the table top which supports the workpiece and two pairs of members to be guided by the rails, arranged at an appropriate interval between each pair. The members are actually sliders or rollers which slide or roll on the rails. The rails and members are arranged alternatively either on the bottom of the table or on the rear half of the arm. Because the guide rails extend straight, the arm and table are raised at the same angle.

Generally speaking, when workpieces are bent by bending machines, as the punch advances downward after it gets in touch with the workpiece, the workpiece is bent while supported at ridges where the top of the die meets surfaces forming a processing groove. Portions of the workpiece between and outside the ridges would be lowered and raised at the same speed if the workpiece were a perfectly rigid body. Actually, however, the workpiece is a sheet or plate of steel or iron and not the rigid body. Therefore, while portions outside and near the ridges are raised at an approximately same speed as the portion between the ridges is lowered, portions far from the ridges rise at a lower

speed and accordingly behind the portions near the ridges because of the dead load as well as force of inertia. As a result, elastic deformation is caused and the workpiece curves convexly, swelling upwards, near the die. It is known that the elastic deformation is apparent particularly at the beginning of the processing where the processing is most rapidly. The deformation usually disappears as the processing by the punch progresses and becomes more and more slow.

The table top can not follow up well the workpiece, particularly at the beginning of the processing, because the rise of the table is controlled in synchronization with descent of the punch or of the portion of the workpiece between the ridges. As a result, plastic deformation may be caused, at the ridges of the die for instance, or the workpiece curved apart the table may vibrate which causes the point of the workpiece where the punch should be applied to displace.

SUMMARY OF THE INVENTION

It is accordingly a general object of the present invention to provide a device to support the workpiece which is capable of well following up the workpiece which is raised while curving convexly.

To attain the object of the present invention, a front portion of the guide rails, that is near the die, swells downwards convexly. Directly after the processing starts, the members running on the rails reach the swelling portion and push up the front end of the table as they advance further along the portion. The angle by which the table is raised is made smaller than that by which the arm is raised over a predetermined range of the latter angle at the early stages of the processing, which allows the table to follow the workpiece well even when the workpiece curves convexly, swelling upwards. The plastic deformation as well as vibration of the workpiece can be prevented as a result.

After the rollers pass the summit of the swelling portion, the displacement of the table front diminishes as the rollers further proceed. The angles by which the arm and tables are raised agree with each other when the bending of the workpiece is completed.

The displacement of the table front in connection with the arm can be controlled in correspondence with the rise of the arm. The angle by which the table is raised, for instance, can be made larger than that by which the arm is raised when the arm rises highest, which permits the arm raising means to be of a smaller size.

An embodiment of the present invention is now described by way of an example and with reference to the accompanying drawings, wherein:

Figure 1 is a side elevational view in a cross section of an embodiment of the workpiece-supporting device for a press break according to the present invention;

Figure 2 is a diagram illustrating action of the arm and table of the supporting device;

Figure 3 is a schematic side view of the supporting device when the workpiece is mounted on the table;

Figure 4 is a schematic side view of the supporting device when the workpiece is positioned between the punch and die of the press break;

Figure 5 is a schematic side view of the supporting device when the workpiece is positioned on the die;

Figure 6 is a schematic side view of the supporting device after processing of the workpiece is completed;

Figure 7 is a schematic side view of the supporting device when the workpiece are lifted apart the die;

Figure 8 is a schematic side view of the supporting device after the workpiece is withdrawn out of the press break;

Figure 9 is a schematic side view of the supporting device when the workpiece is returned to the original position after the processing; and

Figure 10 is a timing chart illustrating time relation between actions of parts of the supporting device.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

The workpiece-supporting device of the present invention comprises a fundamental frame 2 placed in front of a press break 1. A table 3 having a plane top is supported by the frame 2. The frame 2 and table 3 can be shifted toward or away from the press brake by means of a shifting means 7.

The frame 2 and table 3 are positioned in the rear, or farthest from the press brake, as illustrated in Figures 3 and 9, to mount a workpiece W such as a steel plate onto the table at a predetermined position from a conveyor not illustrated in the drawings or return the workpiece from the table to the conveyor. On the other hand, they are positioned in the front or nearest the press brake as illustrated in Figures 4-7 while the workpiece is processed. When the frame 2 and table 3 are in the front, the point of the workpiece to which the punch of the press brake is to be applied is located vertically

above the center line of a groove 11 which is cut on the top of a die 5.

The shifting means 7 comprises an air cylinder 24 and a guidance means 25 as illustrated in Figure 1. The air cylinder 24 is fixed at one end in a pit 23 and connected at the other to a lifting means 6, which carries the frame 2 and table 3. The forward and backward movement of the lifting means carrying the frame and table is guided by the guidance means 25, which further comprises a pair of parallel guide rails 26 and two pairs of guide rollers 27. The guide rails 26, which is made of channel steel, extend in the pit 23 toward the press break. The pairs of the guide rollers 27, arranged at an appropriate distance between each other, roll on the rails 26.

The other structure of the shifting means 7 than described above is also applicable as far as the frame 2 and table 3 can be carried to and from between the front and rear positions.

The lifting means 6 comprises a table lifter which further comprises pairs of bars each consisting of two bars crossing each other as illustrated in Figure 1. The structure enables the frame and table to be lifted and lowered very accurately. The lifting means 6 is so constructed that it can lift and lower the table 3 at least between a standard position HO and a high position Hh as illustrated in Figure 1. The table 3 is positioned at the standard position HO while the workpiece is processed, where the bottom of the workpiece W mounted on the table is in touch with the top of the die 5. After the processing finishes, the table is lifted to the high position Hh to lift the workpiece W off the processing groove 11. The other structure than described above is also applicable as long as it can lift and lower the table 3 at least between the standard and high positions HO and Hh.

Preferably, the lifting means 6 is so constructed that it can lower the table 3 to a low position Hl as illustrated in Figure 1. When the workpiece W has been bent so deep, for example, that it will touch a punch 9 of the press brake if withdrawn horizontally, the table 3 is lowered from the high position Hh to the low position Hl while being withdrawn to the rear. The workpiece is thus able to pass obliquely between the punch 9 and die 5. Figures 7 and 8 illustrate such oblique lowering of the workpiece.

After the table 3 is positioned in the front and the punch 9 gets in contact with the workpiece W, the table 3 at the standard position HO is raised by a raising means 10 to support the portion of the workpiece which is raised on a ridge 12 of the die 5 as the punch 9 descends and the processing progresses. In the present embodiment, the table 3 is raised from a horizontal position A to an inclined position B as indicated in Figures 1 and 2 in

synchronization with the processing. The workpiece is raised at about 45° at the inclined position B. The punch 9 is lifted off the workpiece after the processing finishes. The table 3 is then shifted to the rear by the shifting means 7 and returned to the horizontal position by the raising means 10. The distance between the table 3 and ridge 12 is maintained by a position control means 13 throughout the raising and lowering of the table.

The raising means 10 comprises an air cylinder 28 to raise the table 3 by way of the arm 14 and a supporting spring 29 to support the weight of the arm, table and workpiece at early stages of the processing. The supporting spring 29 is provided to nullify the load onto the air cylinder 28 at the beginning of the processing as well as to absorb any shock which occurs when the table returns to the horizontal position after the processing is completed. Additionally, a cushion is separated inside the cylinder 28, though not illustrated in the drawings, wherein pressure increases as the cylinder extends. The extension of the cylinder 28 is thus stopped very smoothly when the table reaches the inclined position.

Any other structure is applicable to the raising means 10 as long as the arm 14 is able to be raised and lowered around a fulcrum shaft 35 to raise and lower the table 3 between the inclined and horizontal positions.

The arm 14 is so incorporated in the system that its rear half, or the farther one from the die 5, is always directed toward the die throughout the processing. The table 3 supported by the rear half is able to move to and fro along the rear half while being guided by a guidance means.

The position control means 13 comprises a pair of parallel position control boards 31, a pair of position control pins 32 and, preferably, a supporting means 33. The parallel boards 31 are fixed under the table 3 with an appropriate distance between each other. They have congruent position control grooves 30 opened therein respectively. Each of the grooves 30 is an arc of which center is the ridge 12. The position control pins 32 are fixed on the sides of the fundamental frame 2 to be inserted movably in the grooves 30. The distance between the table 3 and ridge 12 is maintained irrespective of the angle α , by which the table is raised, by the position control means 13 which pushes the table away from the ridge as the table is raised. Any other structure of the position control means 13 is applicable as long as it can maintain the distance between the table and ridge throughout the operation.

The supporting means 33 is preferably included in the position control means 13, which comprises a link lever 34 and coil spring 36. The top end of the link lever 34 is connected to the front of

the table 3, slidably in the vertical direction to the table top, while the middle of the lever is connected to the arm 14 with a pivot as illustrated in Figure 1. The coil spring 36 on the other hand connects between the bottom end of the link lever 34 and the fulcrum shaft 35.

The higher the table 3 is raised, the larger weight of the table 3 falls on the position control pins 32. The supporting means 33 is provided to share the weight so that the pins 32 and boards 31 can be of a smaller size. The supporting means is, however, not indispensable to the present invention. Even when it is added to the system, the structure is not restricted to the above-described one.

The guidance means 15 comprises a pair of guide rails 16 and two pairs of guide rollers 17. The guide rails 16 are fixed under the table 3. The guide rollers 17 are attached to both the sides of the rear half of the arm 14 with an appropriate distance between the pairs so that they can roll on the rails 16. The table 3 is pushed away from the ridge 12 by the position control means 13 as the arm 14 is raised while being guided by the guidance means 15.

A raising control means 18 is provided on the rails 16, nearer to the bed than the guide rollers 17 at the beginning of the processing, which curves convexly, swelling downwards. After the table 3 starts being raised and the front pair of the rollers 17 reach the raising control, the front end of the table is pushed up by degrees by the rollers proceeding along the raising control. After the rollers pass the summit of the raising control, the displacement of the table front is removed as the raising continues. As a result, the rising angle α of the table 3 is made smaller than the rising angle β of the arm 14 through a predetermined range of the angle β .

A number of fixing devices 19 are provided on the table top at appropriate intervals to fix the workpiece W on the table 3 while the workpiece is taken away from the press brake. Though, strictly speaking, the follow-up surface 20 which is in contact with the workpiece is determined by the tops of the fixing means 19, the follow-up surface 20 is illustrated in Figure 2 as coinciding with the table top for the sake of simplicity of the drawing.

Any kinds of fixing devices, such as electric magnets or vacuum absorption devices, will do as the devices 19 as far as they can firmly fix the workpiece W on the table 3. The vacuum absorption devices are preferred in the present embodiment because they can fix the workpiece irrespective of its intensity of magnetism. The fixing devices 19 functions while, after the processing has been completed, the punch is lifted off the workpiece, the workpiece is lifted off the die and with-

drawn out of the press break, and the table returns to the rear horizontal position.

Additionally, the table 3 is divided into a middle table 21 and a pair of side tables 22 at both sides of the middle table. The middle and side tables are linked by means of a pivot and the bottoms of the middle and side tables are connected by a pair of second air cylinders. The side tables 22 can be raised to a standing position C as illustrated in Figure 1 by extending the air cylinders after the table 3 reaches the inclined position B. The fixing devices 19 are provided on the side tables 22 so that the workpiece can be fixed between the inclined and standing positions B and C. When the front end of the bent workpiece W is positioned higher than the tip of the punch 9 after both the punch and workpiece have been lifted off the die 5, the side tables are raised further to the position C together with the bent workpiece so that the workpiece can be withdrawn out of the press brake horizontally without touching the tip.

The side tables 22 are equipped, though not illustrated in the drawings, on their tops with ball or roller bearings to facilitate the mounting of the workpiece onto the table 3 as well as removing thereof from the table.

The weight of the table and workpiece falls more and more on a front portion of the fundamental frame 2 as the table and workpiece are raised. A supporting spring 37 is therefore provided connecting the frame 2 with the base of the lifting means 6 to prevent the rear portion of the frame 2 from being raised.

Plate bending work is achieved as follows by the press break equipped with the follow-up supporting device of the present invention, under the control of a program incorporated in the system, or following instructions provided by the operator to the system:

At setting step, the fundamental frame 2 is positioned in the rear while the table 3 is laid horizontally at the high position Hh so that a workpiece W is mounted thereon at a predetermined position with a conveyor not illustrated. The frame 2 is then shifted to the front position as illustrated in Figure 4 by extending the air cylinder 4 of the driving means 7, where the point of the workpiece to which the punch should be applied is positioned vertically above the center line of the groove 11. The table 3 is then descended to the standard position HO and the setting of the workpiece W in the press brake 1 is completed.

At processing step, the ram 8 starts descending and the table 3 starts being raised when the punch 9 gets in touch with the workpiece W.

The load against the punch 9, which is comparatively small at the early stages of the processing, increases as the processing progresses be-

cause of work hardening. As a result, the descending speed of the punch 9, as well as the rising speed of the workpiece W outside the ridge 12, becomes smaller and smaller. Diminution of the descending speed is represented for instance by a sine curve.

In the preferred embodiment, since the total weight of the arm, table and workpiece is wholly supported by the supporting spring 29 at the beginning of the processing, the air cylinder 28 starts extension with no considerable mechanical resistance when pressure air starts being supplied to the air cylinder. As the air cylinder 28 extends, the supporting spring 29 also extends and the weight of the arm, table and workpiece gradually becomes shared by the air cylinder 28. Additionally, pressure increases in the cushion cylinder of the cylinder 28 by degrees as the cylinder extends. The extension speed of the air cylinder 28 is thus the largest at the beginning of the extension and diminishes as the extension progresses.

Both the descent of the punch and extension of the air cylinder are at the highest speed at the beginning of the processing and diminish thereafter, which means the table 3 can follow up well the workpiece W. Plastic deformation at the ridge, as well as oscillation on the table, of the workpiece W, which may be caused by the prior art because of the separate rising of the table and workpiece, can thereby be prevented.

Because of the air pressure in the cushion cylinder which increases as the air cylinder 28 extends, the extension of the air cylinder can be stopped very smoothly when the table is fully raised. Since the table 3 stops extension without no considerable shock, any displacement of the workpiece at the stop can be avoided.

As described above, at the early stages where the rising speed of the workpiece is comparatively high, elastic deformation of the workpiece is caused near the die, which makes the workpiece curve upwards convexly. The rising angle of a portion remote from the die, in other words, is smaller than that of a portion near the die. In the present invention, the front pairs of the guide rollers 17 advancing along the raising control means 18 pushes upwards the front end of the table at the early stages and thereby makes the rising angle α of the table smaller than the rising angle β of the arm, as pointed to by an arrow B in Figure 2. After the rollers pass the summit of the raising control, the displacement of the table front is removed by degrees as the raising continues. The angles α and β agree again when the front rollers 17 pass over the raising control. As a result, the separate rising of the workpiece and table is prevented even at the early stages of the processing. Plastic deformation of the workpiece at the ridge 12, as well as oscilla-

tion and displacement thereof on the table, can be prevented.

The table 3 is in the inclined position as illustrated in Figure 6 when the punch 9 has pressed down the workpiece W to the bottom of the groove 11 and the processing has finished. Next, at withdrawal step, the ram 8 and punch 9 are lifted after the workpiece is fixed on the table by the fixing means 19. The table 3 is then lifted to the high position Hh with the lifting means 6 to separate the bent workpiece from the die 5 as illustrated in Figure 7. The workpiece is then withdrawn from the press brake 1 by contracting the air cylinder 24 of the driving means 7 and returning the frame 2 and table 3 to the rear, before or after the table is again laid horizontally. When the front end of the bent workpiece may get in touch with the lifted punch if shifted horizontally, for instance when the workpiece has been bent so deep or protrudes so far from the press brake, the workpiece can pass obliquely between the punch 9 and die 5 by achieving the horizontal shift of the table to the rear simultaneously with lowering of the same to the low position Hl. In this case the table 3 is laid horizontally only after the withdrawal to the rear has been completed. The table 3 can be returned to the horizontal state also smoothly because the supporting spring 29 absorbs the shock, which prevents the workpiece from rebounding and displacing on the table.

Thereafter, the table 3 is again lifted to the standard position HO with the lifting means 6 and the bent workpiece is transferred onto a conveyor, which carries the workpiece away, and one cycle of the processing is completed.

The way of the processing is not restricted to the one described above. For example, when the workpiece is bent not so deep or does not protrude so far, the table 3 may not be lifted to the high position Hh but returned from the inclined position B to the horizontal position A simultaneously with lifting of the punch 9 before shifted to the rear. The order of withdrawal to the rear, lowering to the horizontal state and lifting to the high position is exchangeable with each other or can be performed simultaneously. The table positions where the workpiece is mounted onto and removed from the table can be determined freely and can be different from each other.

While the embodiments of the present invention, as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

Claims

1. A device to support a workpiece being bent by a bending machine such as a press brake, which workpiece curves convexly, swelling upwards, at early stages of the bending, comprising: a fundamental frame placed in front of the bending machine;

an arm fixed pivotally to the fundamental frame so that its farther half from the bending machine is always directed to the die of the bending machine; a table supported by said half of the arm above the fundamental frame, on which the workpiece is mounted;

a raising means which raises the table together with the workpiece in synchronization with the progress of the bending;

a position control means which pushes the table away from the die of the bending machine as the table is raised so that distance is maintained between the table and die throughout the bending work;

a pair of guide rails extending parallel to both of the table top and said half of the arm either under the table or on said half of the arm;

two pairs of members attached to the other one of the table bottom or said half of the arm than bearing the guide rails which move on the guide rails during the bending work when the table is pushed away from the die by the position control means;

a raising control means which shifts the table end nearer the die upwards or downwards so that the angle by which the table is raised is made smaller than the angle by which the arm is raised over a predetermined range of the latter.

2. A device as recited in Claim 1 further comprising a lifting means which is able to shift the fundamental frame together with the table in the vertical direction between a position higher than the die at which the workpiece is mounted on the table and another position which is lower than the die.

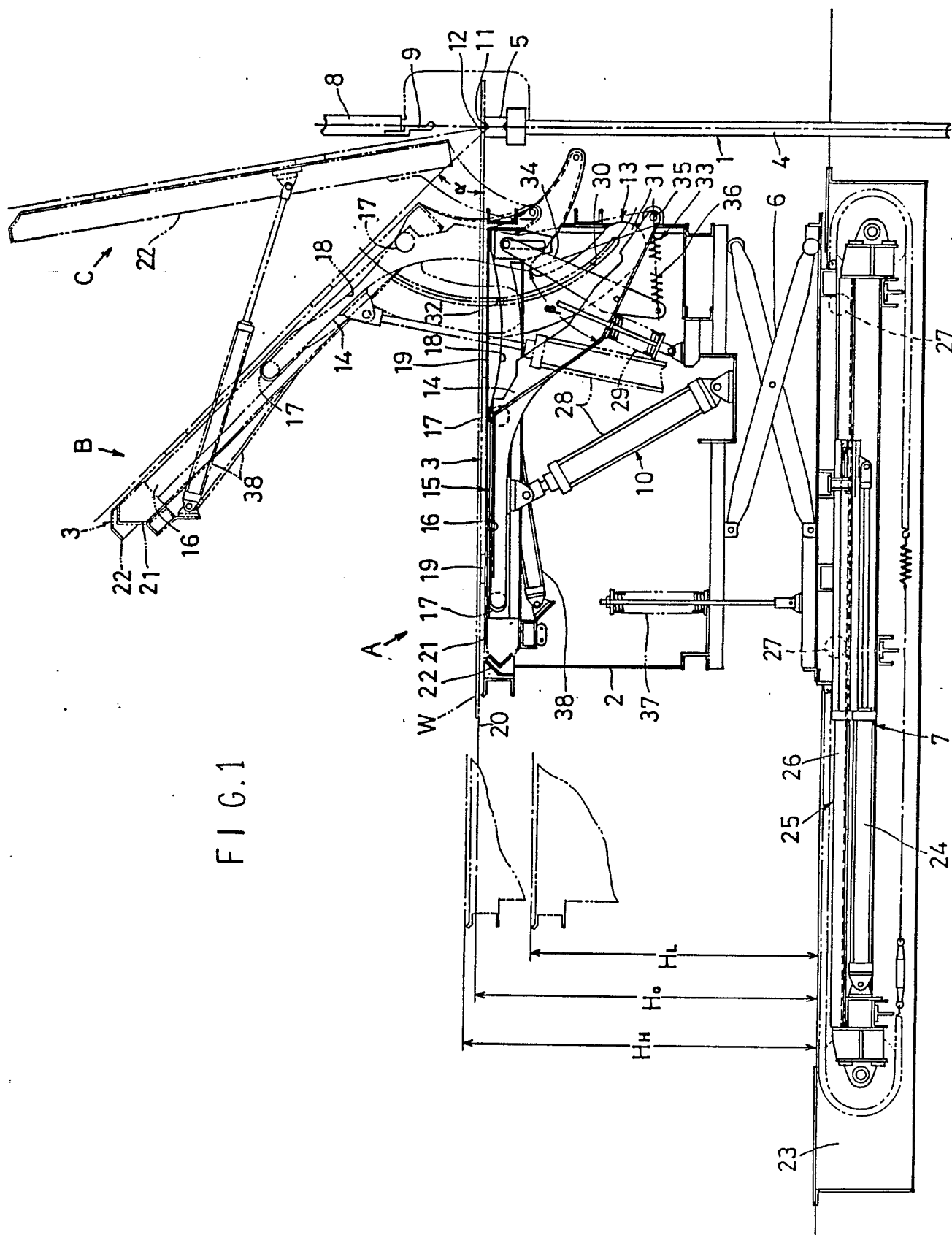
3. A device as recited in Claim 1 or 2 of which the table comprises:

a middle table;

a pair of side tables located on both sides of the middle table respectively;

a pivot extending through the ends nearer to the die of the middle and side tables;

a second raising means connecting the bottoms of the middle and side tables which further raises the side tables together with the workpiece after the bending work is completed.



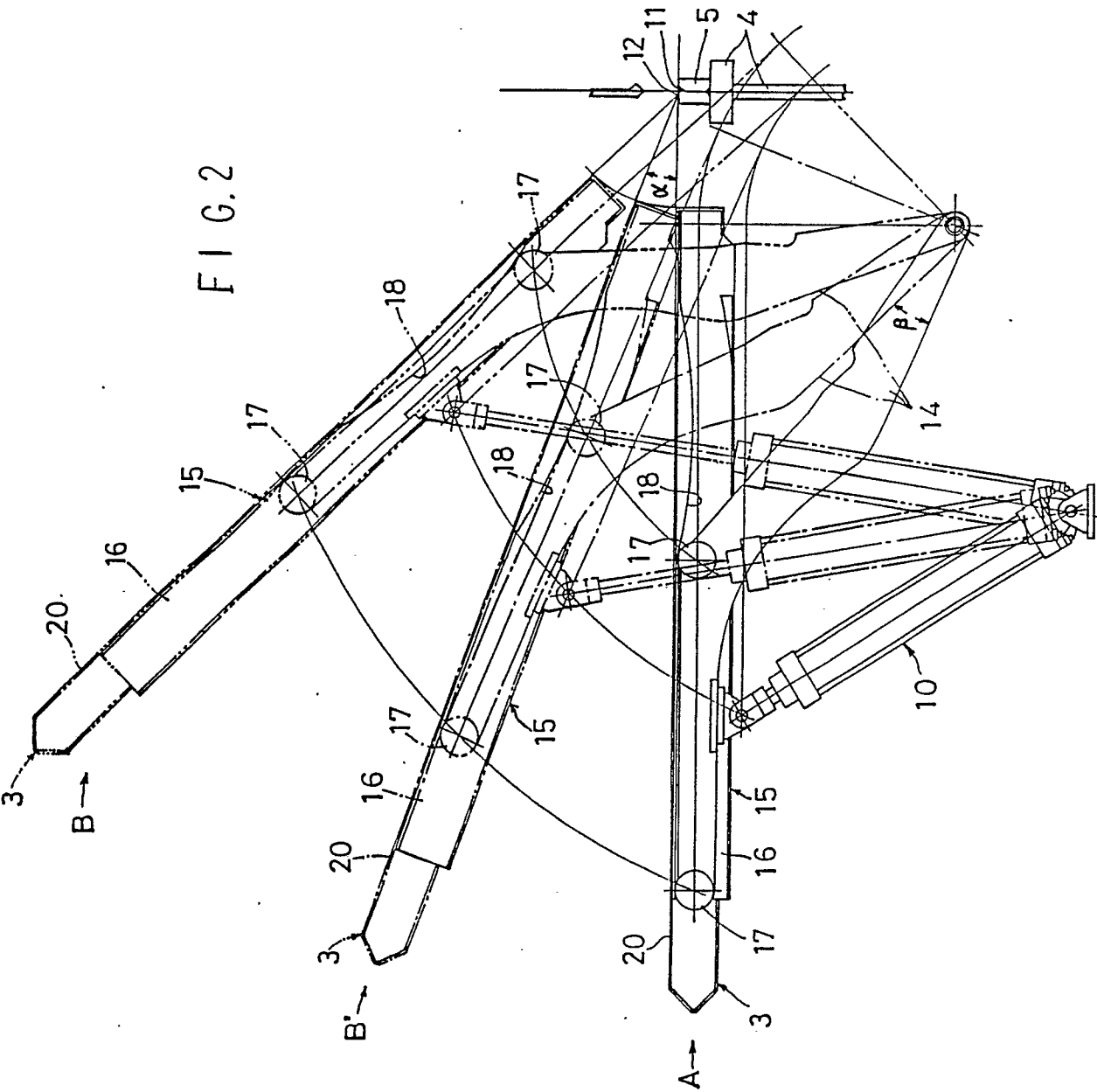


FIG.3

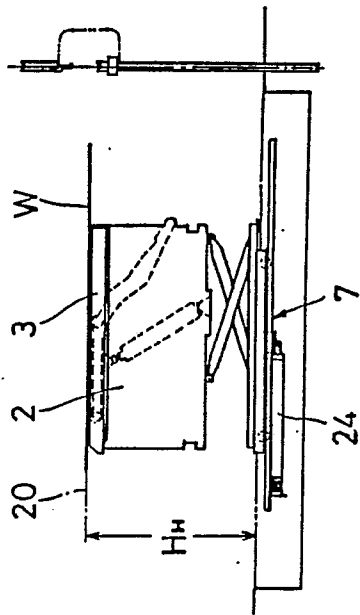


FIG.4

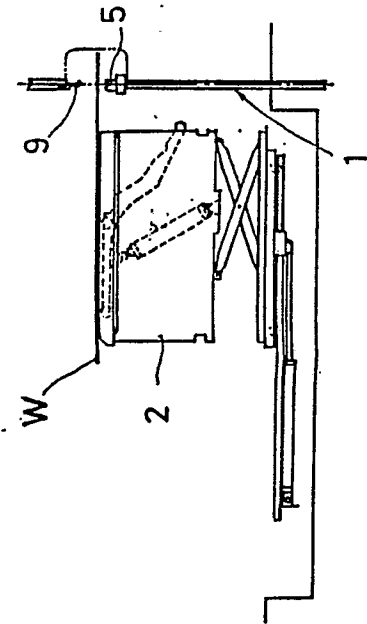


FIG.5

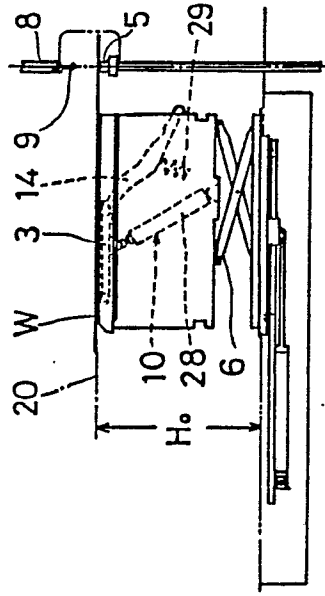


FIG.6

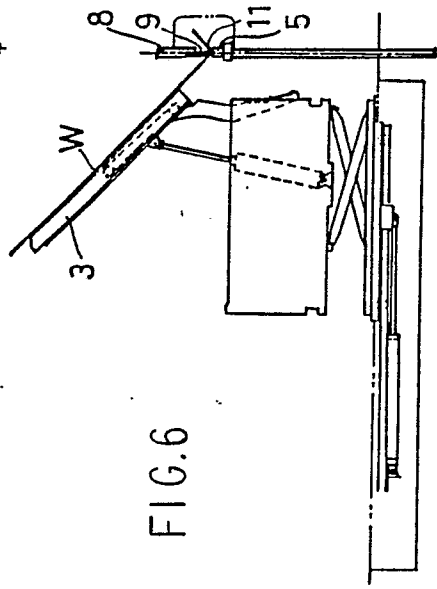


FIG.9

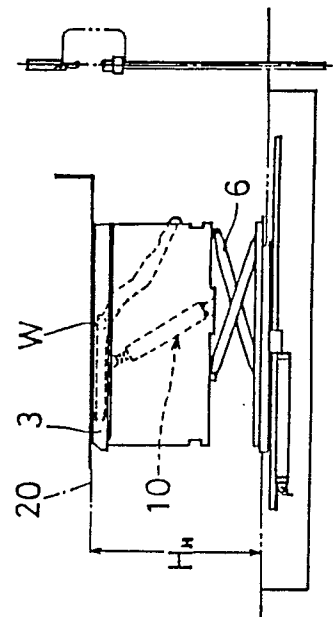


FIG.8

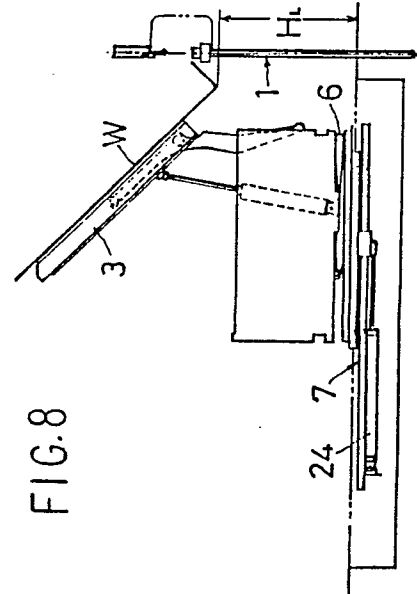
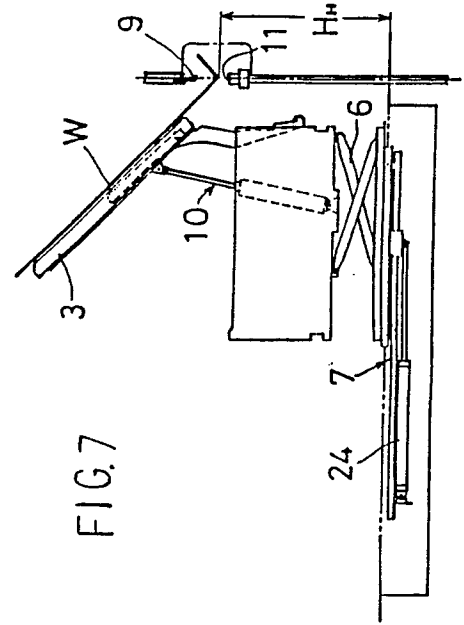


FIG.7



F I G. 10

