(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 993 884 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.04.2000 Bulletin 2000/16

(51) Int. Cl.[7]: **B21D 19/04**

(21) Application number: **99119897.9**

(22) Date of filing: **07.10.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **12.10.1998 IT TO980862**

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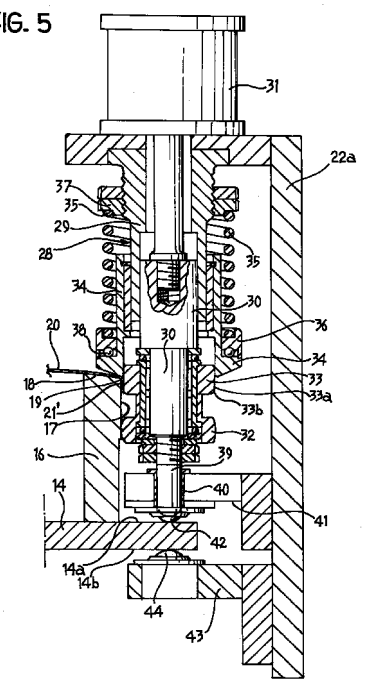
(54) Apparatus and method for flanging sheet metal edges

(57) On a rotatable table (14) there is mounted a pattern (15) on which a workpiece (20) to be flanged is fixed in such a way that a sheet metal edge (21) of this projects laterally from a peripheral edge (19) of the pattern (15). A flangeing head (23) is thrust by an hydraulic cylinder (24) to press a roller (27) laterally against the edge (21) to be flanged and towards a vertical surface (17) which co-operates to form the edge (19). The roller (27) is thrust between an initial raised position from which a tapered portion (33b) of the roller (27) contacts the edge (21) when it is not deformed, and a lowered position in which the edge is folded (21') beyond the edge (19) and pressed between a widened portion (33a) of the roller and the vertical surface of (17).

FIG. 5



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Description

[0001] The present invention relates to a machine and a process for flangeing the edges of sheet metal work pieces or blanks.

[0002] In the automobile industry the operation of flangeing sheet metal edges is normally performed by utilising, for each type of work piece, a suitable stamp which applies the stresses necessary to flange the edges of the sheet metal as established by the design.

[0003] The automobile industry tends always to become displaced towards specialised sectors or niches, having low production volumes. In particular, the heavy transport sectors and agricultural machinery sectors require a reduction in costs in order to be more economically competitive on the market and to appeal to a wider clientele. This gives rise therefore to the need to research sheet metal working technologies suitable for medium and low volume production, therefore reducing the fixed investments. Because in small and medium production runs the fixed costs heavily affect the final cost of the pressed elements it is necessary to reduce to the minimum the number of presses dedicated solely to a particular type, which are notoriously expensive tools.

[0004] Machines for flangeing the edges of metal sheets are known comprising a flangeing head equipped with a flangeing roller free to rotate about a vertical axis, fixing means for a work piece having a sheet metal peripheral edge to be flanged, and drive means for causing relative movement between the fixing means and the flangeing head in such a way that the roller follows the peripheral edge to be flanged. Examples of arrangements of this general type are described in JP-A-09220620, SU-A-1196072, EP-A-0698430.

[0005] It is the object of the present invention to provide a versatile flangeing machine adaptable to work metal sheets of variable shapes and dimensions.

[0006] This object is achieved, according to a first aspect of the present invention, by a machine having the characteristics set out in Claim 1.

[0007] In accordance with the second aspect of the present invention a flangeing process as defined in Claim 13 is proposed.

[0008] Other important characteristics are set out in the other dependent claims.

[0009] The characteristics and advantages of the invention will become more widely apparent from the detailed description of an embodiment, made with reference to the attached drawings, given by way of indicative and non-limitative example, in which:

Figure 1 is a side elevation of a flangeing machine according to the present invention;

Figure 2 is a perspective view from above of the machine of Figure 1;

Figure 3 is a perspective view from above of the machine of Figure 2 during a working phase on a workpiece;

Figure 4 is an elevation view, on an enlarged scale, and partially in section, of a flangeing head with which the machine of Figure 1 is provided, shown in an initial working phase; and

Figure 5 is a view of the flangeing head of Figure 4 in a subsequent working phase.

[0010] First making reference to Figures 1 and 2, the reference numeral 10 generally indicates a support structure with an upper horizontal plane 11; on the structure 10, beneath the plane 11, there is mounted a motor unit 12 which, via a transmission 13, drives a rotatable table 14 mounted rotatably on the upper part of plane 11, to turn about a vertical axis y.

[0011] On the rotatable table 14 is fixed a shaped pattern 15 preferably of resin, forming a perimeteral wall 16 which extends vertically. The wall 16 has an essentially vertical outer surface 17 and an essentially horizontal upper surface 18; these surfaces are disposed at an angle forming an edge or corner 19 (Figures 4 and 5) which defines a peripheral fold line for the formation of a perimeteral flange on a sheet metal workpiece 20 associated from above with the pattern 15. It is intended, however, that such surfaces can also be inclined differently from what has been illustrated in the present example, forming between them angles different from 90° or variable along the periphery of the pattern, depending on the shape of the workpiece 20 to be flanged and the requirements of the designs.

[0012] As illustrated in Figures 2 and 3, the perimeteral wall 16 is dimensioned and shaped in such a way as to present an outline corresponding to the associated workpiece 20 the sheet metal edges 21 of which are to be folded or flanged perpendicularly to the main plane in which the workpiece lies, starting from an undeformed condition (Figure 4) in which the edges project horizontally from the vertical wall 16 of the shaped pattern 15, to end up at a final flanged condition (Figure 5) in which the edges are folded horizontally against the vertical outer surface 17 as will be explained in more detail herein below. The height of the vertical wall 16 measured with respect to the rotatable table 14, can be constant or variable along its perimeter as in the example of Figures 2 and 3, depending on the particular shape of the workpiece to be worked.

[0013] The sheet metal workpiece 20 to be flanged is retained on the shaped pattern 15 preferably by means of magnets (not illustrated for simplicity) and centred in the correct position by means of a plurality of reference pins (not illustrated) projecting vertically from the shaped model which are inserted into corresponding apertures (not illustrated) preliminarily provided in the workpiece.

[0014] On the upper plane 11 is mounted an arm 22 turnable about a vertical axis y'; at its free end 22a the arm 22 carries a flangeing head, generally indicated 23, which in use is thrust against the wall 16 by means of an

actuator 24, in this example a hydraulic cylinder, having a first end pivoted at 25 to the fixed structure 10 and a second end pivoted at 26 to the pivoted arm 22.

[0015] Making reference to Figure 4, the flangeing head 23 comprises a vertically extendable device generally indicated 28 mounted on the free end 22a of the pivoted arm.

[0016] The device 28 comprises an upper cylindrical element 29 fixed with respect to the end 22a and a lower movable element 30 telescopically guided by the upper element 29 and actuated by a hydraulic cylinder 31 fixed to the end 22a of the arm 22.

[0017] A flangeing roller 27 is fixed axially in a freely rotatable manner about the lower moveable element 30 so as to be displaceable vertically together with it. In the preferred embodiment the roller 27 has the shape of a solid of rotation in which there is a pair of radially projecting vertically spaced annular formations 32 and 33. The lower annular formation 32 is able to roll against the vertical surface 17 of the walls 16, whilst the upper formation 33, which serves to fold the sheet metal edge 21, forms an upper cylindrical portion 33a which joins with a lower downwardly tapered portion 33b at an angle of about 45°.

[0018] The flangeing head includes a second auxiliary roller 34 freely rotatable about the upper element 29 of the telescopic device 28, which serves to exert a downward pressure on the metal sheet 20, pressing it against the upper support surface 18 of the wall 16 close to the edge 21 to be deformed, for the purpose of maintaining the peripheral part of the metal sheet in the correct position against the shaped body 15. To this end the auxiliary roller 34 is pressed downwardly by a spring 35, the bottom of which acts on a bearing ring 36 and the top of which engages against a biasing ring nut 37 threadedly coupled to the fixed cylindrical element 29 to adjust the position of the ring nut and therefore the thrust on the ring 36; between this ring and the auxiliary roller 34 are interposed rolling elements 38.

[0019] The lower end 39 of the movable telescopic element 30 is slidably guided in a cylindrical bush 40 supported by the arm 22 by means of a first horizontal bracket 41 the bottom of which carries a support ball 42 which rolls against the upper horizontal surface 14a of the rotatable table 14. A second horizontal bracket 43 is fixed to the arm 22 and carries a support ball 44 which rolls against the lower horizontal surface 14b of the table 14. The brackets 41, 43 are vertically spaced in such a way as to pinch the table 14 slidably and thereby stabilise the vertical position of the flangeing head 23, and constitute means which resist the upward vertical reaction which the head 23 is subjected to by the effect of the thrust which this exerts downwardly against the edge of the metal sheet 20.

[0020] The surfaces 14a, 14b project laterally from the vertical surface 17 of the pattern 15 and extend beyond the vertical axis of the head 23; in an equivalent embodiment the surfaces 14a, 14b are formed integrally with the pattern 15.

[0021] The function of the machine according to the present invention is as follows.

[0022] The table 14 is driven to rotate by displacing the wall 16 and the edges 21 of the metal sheet relative to the flangeing head 23 which is pressed laterally against the wall 16 of the shaped body 15 by the arm 22 by means of the actuator 24.

[0023] As illustrated in Figure 4, the auxiliary roller 34 maintains the metal sheet 20 in contact with the upper surface 18 of the wall 16. By actuating the hydraulic cylinder 31 of the flangeing head the roller 27 is slowly and progressively displaced downwardly causing engagement of the tapered lower portion 33b with the edge 21 which projects out from the wall 16. Because of the downward movement of the roller 27 and the lateral thrust exerted by the actuator 24, this roller imposes on the edge 21 a force directed downwardly and towards the wall 16, progressively folding the edge 21 against the vertical surface 17 whilst table 14 rotates. As work continues the edge 21 is pressed by the upper cylindrical portion 33b of the roller 27 and constrained to reproduce the angle formed by the surfaces 17 and 18. In this way an inclined flange 21' as illustrated in Figure 5 is obtained.

[0024] Optionally, according to a variant (not illustrated) of the machine according to the invention, means can be provided to effect a vertical adjustment of the height of the head 23 with respect to the rotatable table 14. Such adjustment means may be disposed equally on the end 22a of the pivoted arm 22 and/or in correspondence with the vertical pin 45 by which the arm is pivoted to the structure 10.

[0025] The shape of the flangeing roller 27 is variable in dependence on the type and the thickness of the metal sheet to be flanged. Moreover, the flangeing head may also comprise other rollers or cam means (not illustrated) serving to guide the head and balance the forces and reactions generated during working.

[0026] In the preferred embodiment, the extension of the hydraulic cylinder 24 is controllable in dependence on the instantaneous angular position of the rotatable table 14 to apply to the flangeing head a substantially constant lateral force sufficient to fold the edge of the metal sheet 20. Similarly, the motor unit 12 is also controllable by known control means (not illustrated for simplicity) operable to vary the speed of rotation of the rotatable table instantaneously in dependence on the angular position of the table depending on the particular shape of the workpiece to be flanged; preferably, the movements of the actuator and of the table will be controlled and synchronised by means of a single computerised control system.

[0027] These arrangements advantageously allow the flangeing head to follow the edges of the workpiece to be flanged at a substantially constant speed and to fold a flange in a progressively uniform manner taking account of the fact that the workpiece to be flanged gen-

erally has a non-circular shape; thus, when the workpiece is rotated, the distance of the edges from the axis of rotation y of the table continuously vary and therefore, at a constant angular velocity, the speed of travel of the head along the edges of the workpiece will be variable.

[0028] Naturally, the principle of the invention remaining the same, the embodiments and details of constructions can be widely varied with respect to what has been described and illustrated purely by way of none-limitative example, without departing from the ambit of the invention as defined in the attached claims.

Claims

1. A machine for flangeing the edges of metal sheets, characterised in that it comprises, in combination:

rotatable support means (14) driven to rotate about a substantially vertical axis, operable to support a pattern (15) adapted to hold a workpiece (20) to be flanged in such a way that a sheet metal edge (21) therefore projects laterally from a peripheral edge (19) of the pattern (15) defined by an essentially horizontal peripheral surface (18) disposed at an angle with respect to an essentially vertical lateral surface (17) ;
a flangeing head (23) equipped with at least one flangeing roller (27) free to rotate about a vertical axis,
first actuator means (24) acting on the flangeing head (23) to press the said at least one roller (27) laterally towards the essentially vertical surface (17) with the said edge (21) interposed, during rotation of the workpiece (20) and the pattern (15);
second actuator means (29, 31) mounted on the flangeing head (23) to press the said at least one roller (27) axially between a first position in which a tapered portion (33b) of the roller (27) initially contacts the said edge (21) in undeformed condition, and a second position, axially spaced from the first position, in which the edge (21') beyond the edge (19) is folded and pressed between a widened portion (33a) of the roller and the said essentially vertical surface (17).

2. A machine according to Claim 1, characterised in that the flangeing head (23) includes a second roller (34) freely rotatable about a vertical axis, associated with vertical thrust means (35) operable to press the workpiece (20) downwardly against the upper surface (18) of the pattern (15).

3. A machine according to Claim 2, characterised in that the said thrust means (35) are resilient and provided with means (37) for adjusting the said vertical thrust.

4. A machine according to Claim 1, characterised in that the flangeing head (23) is mounted at the free end (22a) of an arm (22) pivoted about a vertical axis and coupled to the said first actuator means (24); the free end (22a) of the pivoted arm (22) is provided with lower axial stop means (43, 44) able to contact a lower horizontal surface (14b) fixed for rotation to the pattern (15) to resist upward axial movements of the said free end (22a).

5. The machine according to Claim 4, characterised in that the free end (22a) of the pivoted arm (22) is further provided with upper axial stop means (41, 42) able to contact an upper horizontal surface (14a) fixed for rotation with the pattern (15) to resist downward axial movements of the said free end (22a).

6. A machine according to Claim 1, characterised in that the said upper axial stop means (41) comprise a seat (40) for guiding a vertically slidable element (30, 39) on which the flangeing roller (27) is mounted in a freely rotatable manner.

7. A machine according to Claim 1, characterised in that the said flangeing head (23) comprises rolling means (32) able in use to roll against the said essentially vertical surface (17).

8. A machine according to Claim 1, characterised in that the said at least one roller (27) has a shape of a solid of rotation in which there is found a pair of vertically spaced radially projecting formations (32, 33):

a lower annular formation (32) being able to roll, in use, against the said essentially vertical surface (17); and
an upper annular formation (33) acting to fold the sheet metal edge (21) having an upper cylindrical portion (33a) which joins a downwardly tapered lower portion (33b).

9. A machine according to Claim 8, characterised in that the said lower portion is tapered downwardly at an angle of about 45°.

10. A machine according to Claim 1, characterised in that the said pattern (15) is coupled to motor means (12) controllable in such a way as to vary the speed of rotation of the pattern (15) in dependence on its instantaneous angular position.

11. A machine according to Claim 1, characterised in that the said first actuator means (24) are controllable in such a way as to vary the position of the flang-

eing head from the axis of rotation of the pattern (15) in dependence on the instantaneous angular position of the pattern so as to apply to the flangeing head a substantially constant lateral pressure around the entire perimeter of the workpiece.

12. that the movements of the first actuator means and the rotatable pattern (15) are controlled and synchronised by means of a single control system.

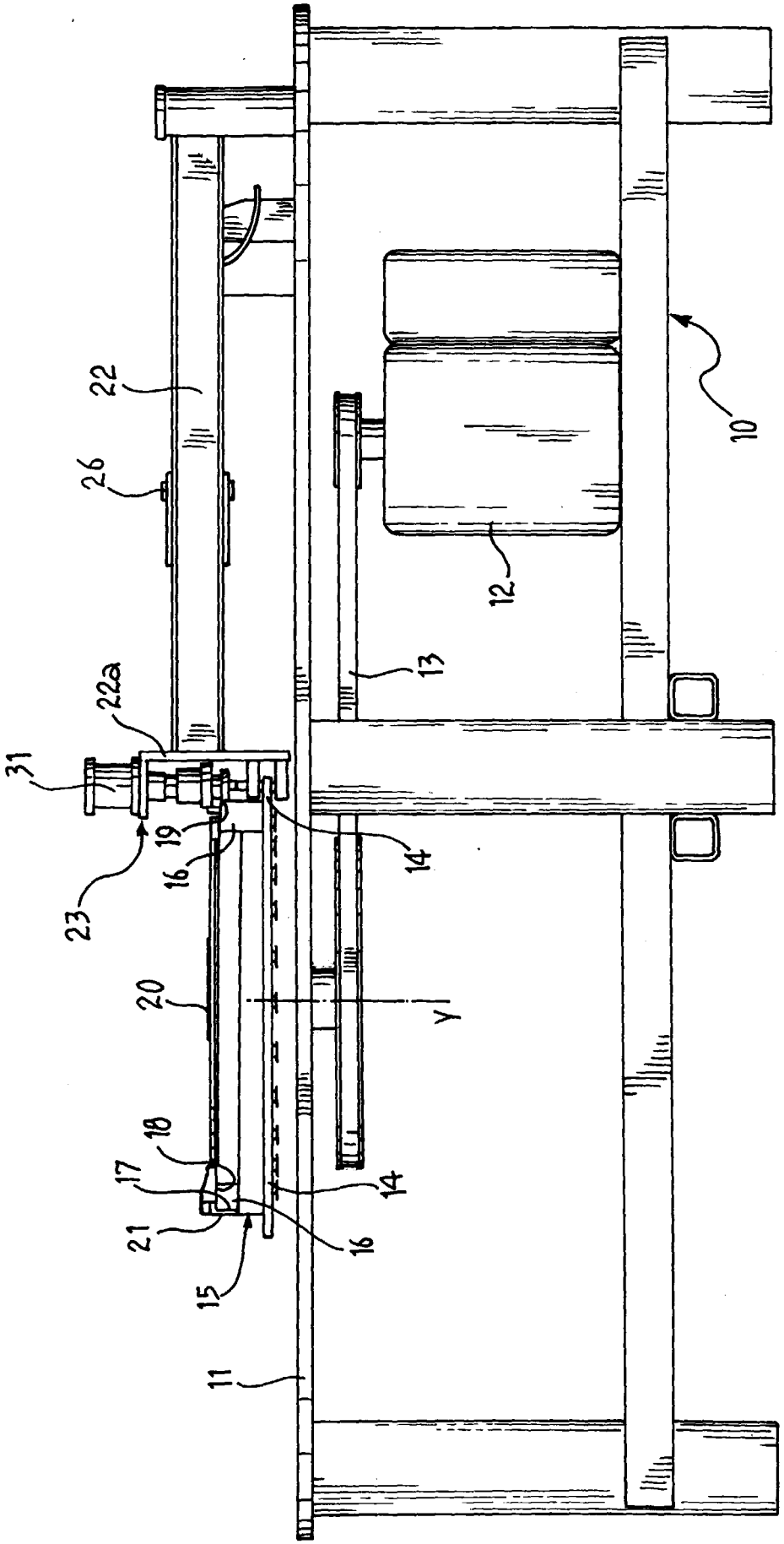
13. A process for flangeing the edges of metal sheets comprising the steps of:

providing a shaped model (15) having an essentially horizontal peripheral surface (18) and forming an edge (19) with an essentially vertical lateral surface (17), the said edge defining a peripheral fold line for the formation of a peripheral flange of workpiece (20) with metal sheet edges (21) ;
providing a workpiece (20), with a sheet metal edge (21) to be flanged, dimensioned to project laterally from the said edge (19) of the pattern (15);
securing the said workpiece (20) onto the said pattern (15) in such a way that the said edge (21) projects laterally from the peripheral edge (19) of the pattern (15);
controlling the pattern (15) and the workpiece (20) to rotate together about a substantially vertical axis,
pressing laterally against the said edge (21) the tapered portion (33b) of a flangeing roller (27) free to rotate about a vertical axis, and
progressively displacing the roller (27) along its axis folding said edge (21') beyond the edge (19) to bring the said roller into a position in which a widened portion (33a) thereof presses the folded edge (21') against the said essentially vertical surface (17).

14. A process according to Claim 13, further comprising the step of:

pressing a second freely rotatable roller (34) against the workpiece (20) close to the edge (21) to hold the said workpiece against the upper surface (18) of the pattern (15).

FIG. 1



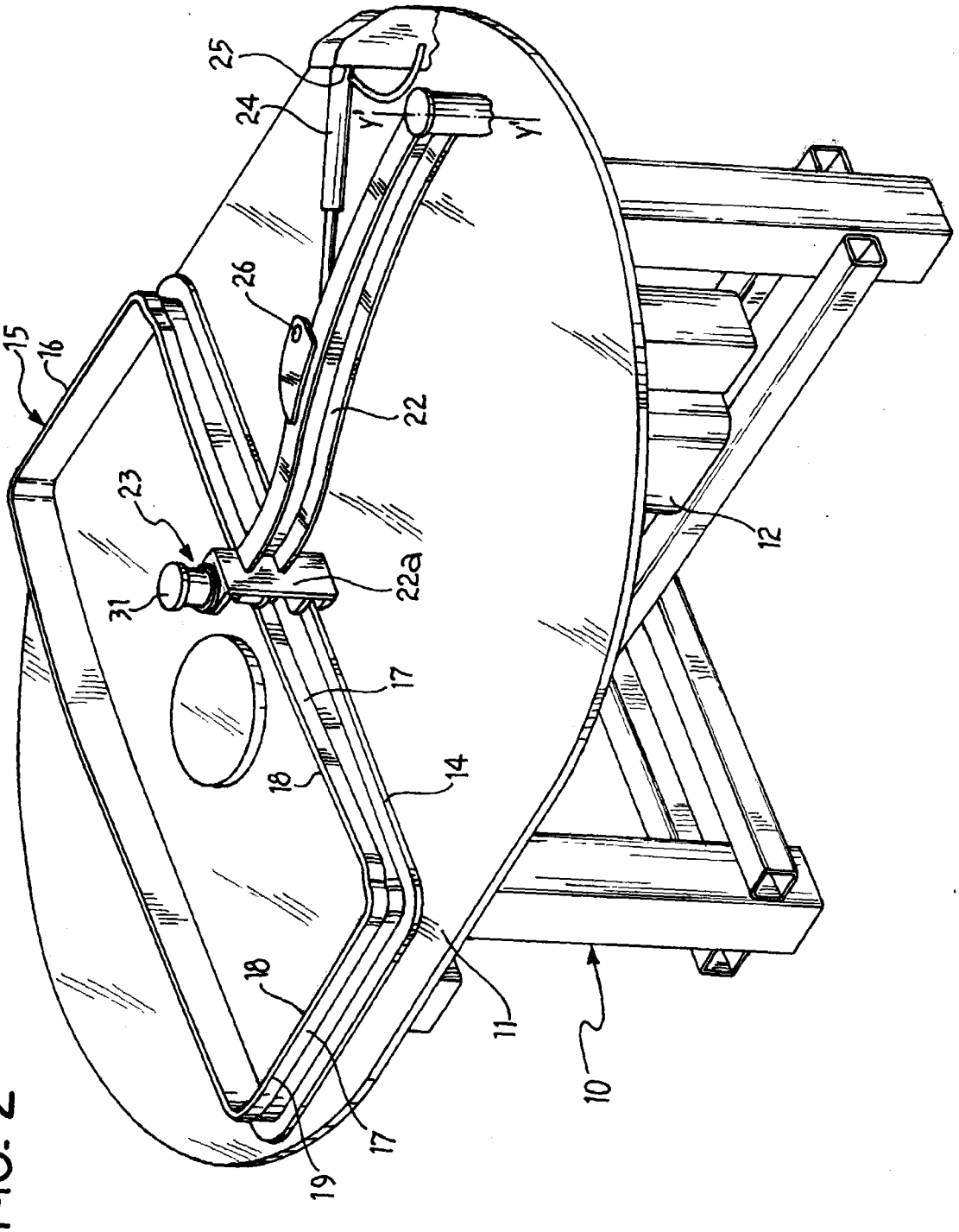


FIG. 2

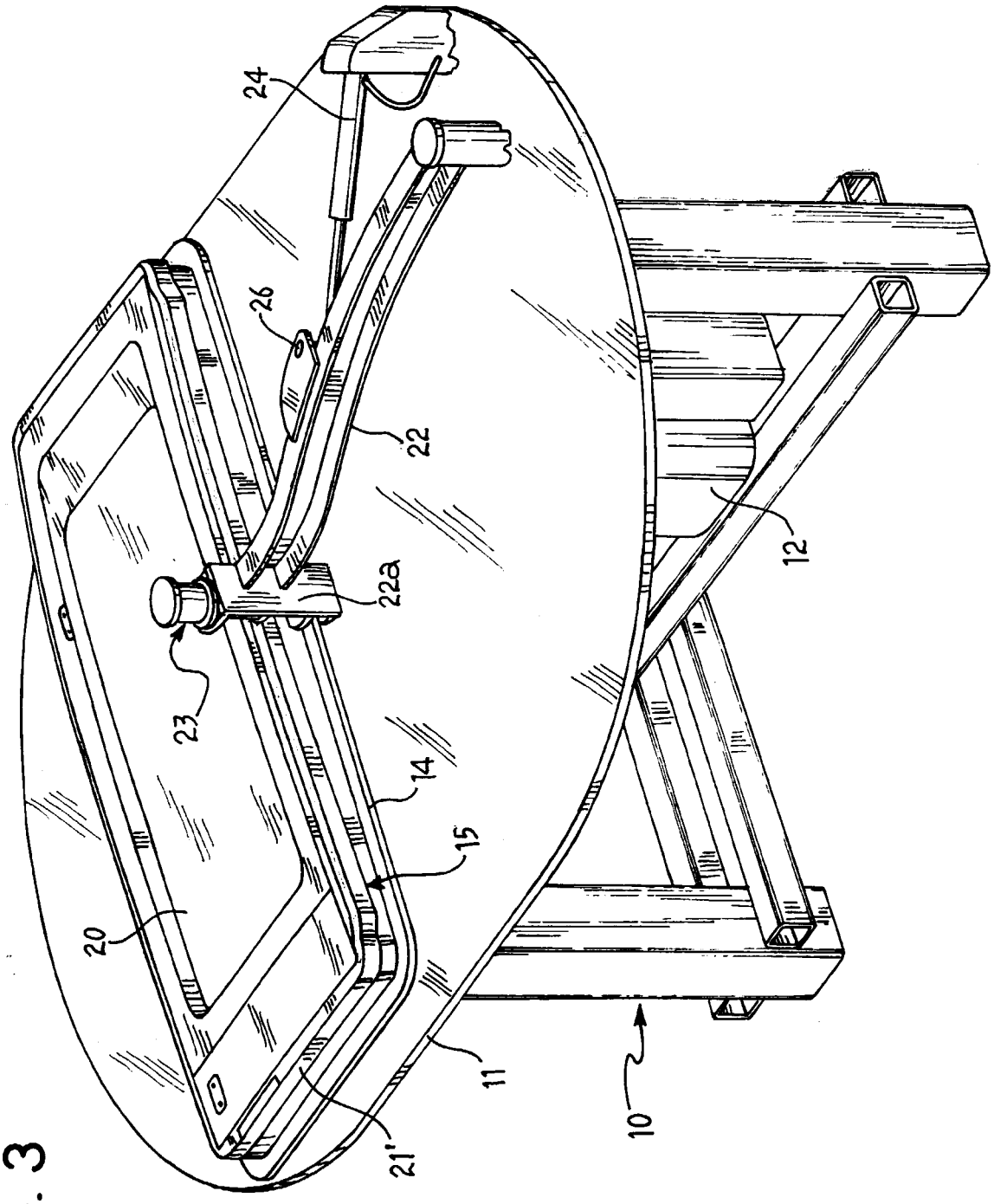


FIG. 3

FIG. 4

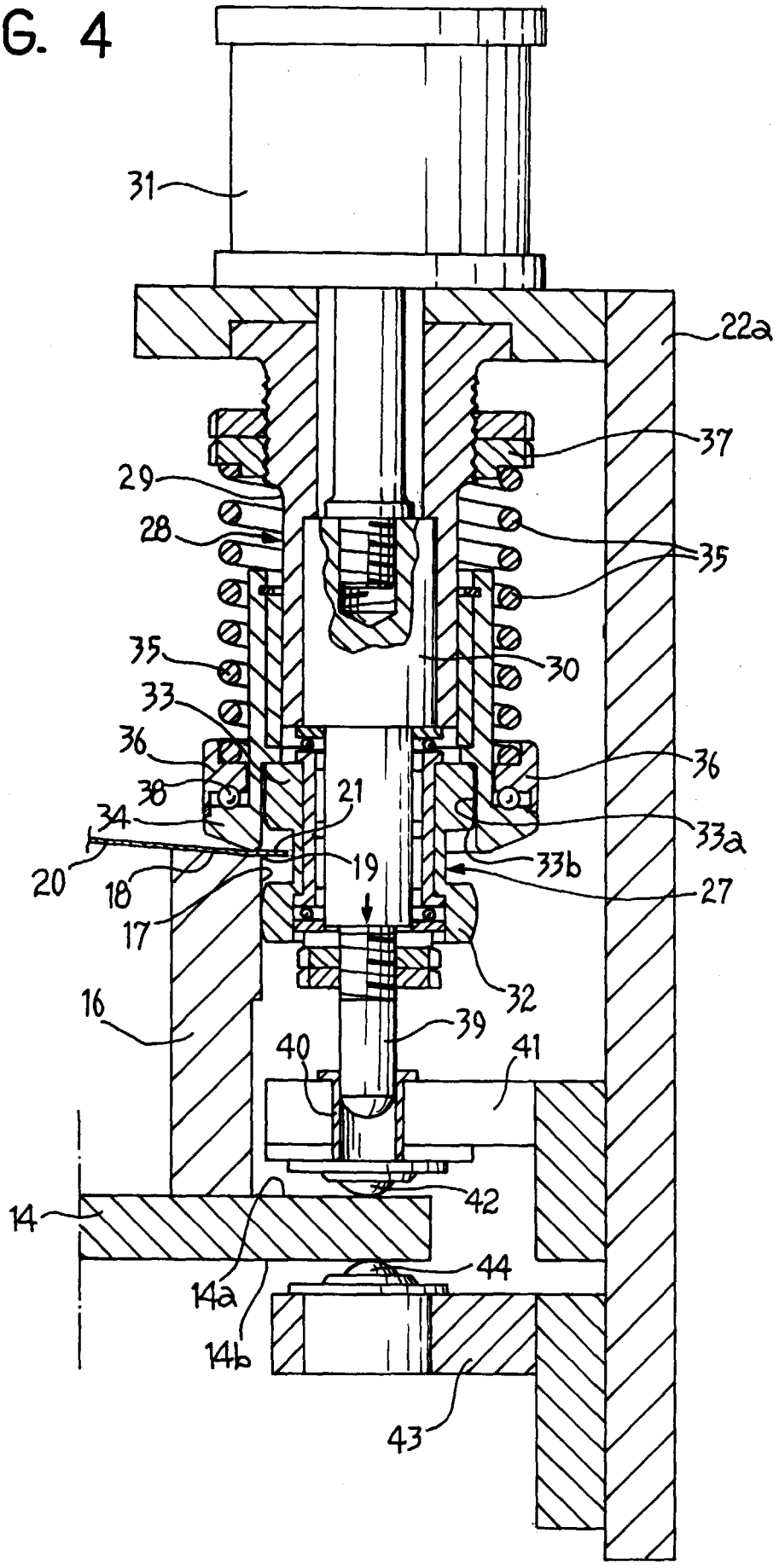

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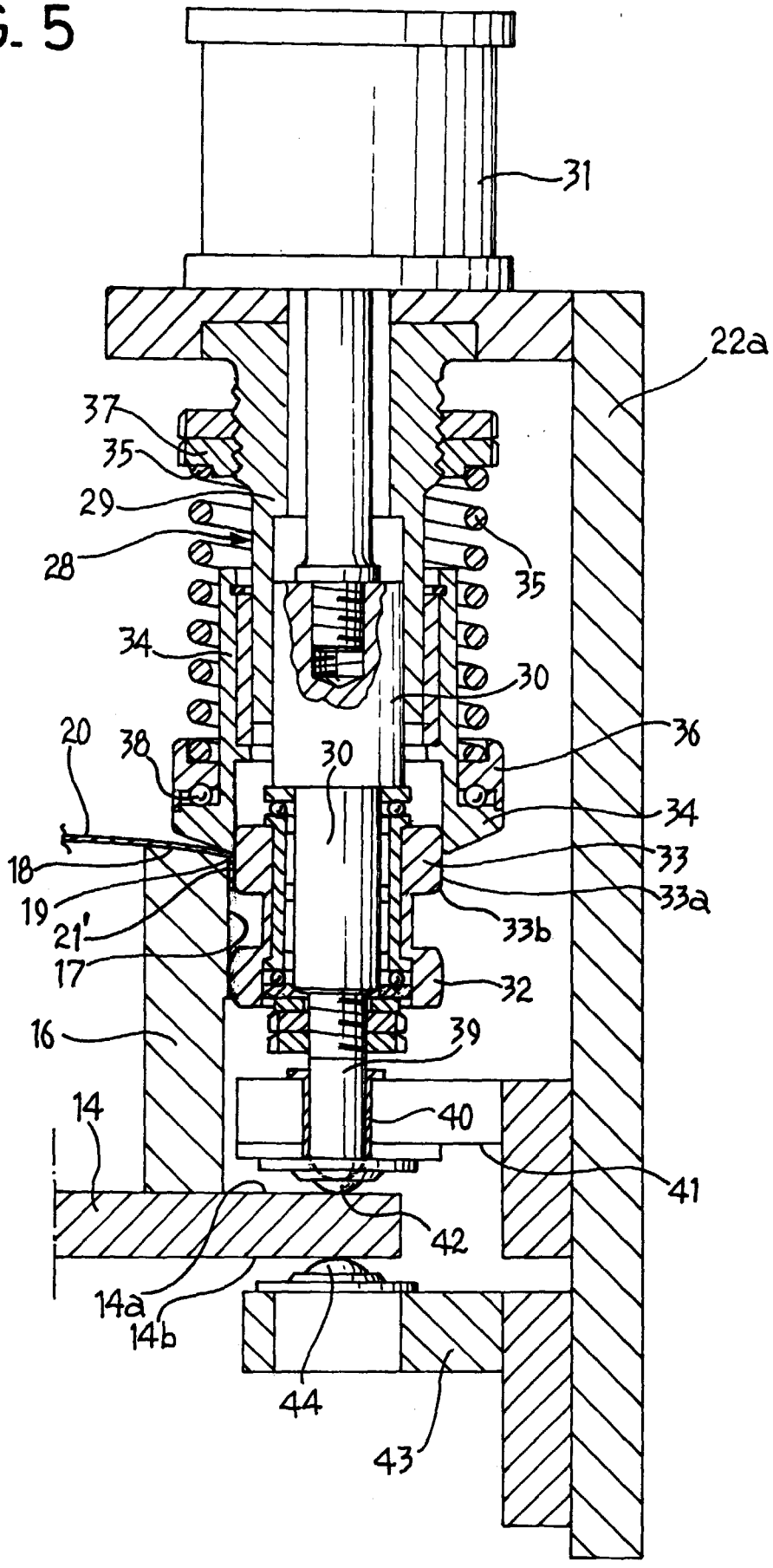
FIG. 5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