April 30, 1968 J. O. GUSTAVSSON 3,380,274

BORDERING MACHINE AND METHOD OF BORDERING PLATES BY MEANS OF THE MACHINE

Filed Dec. 16, 1964

4 Sheets-Sheet 1

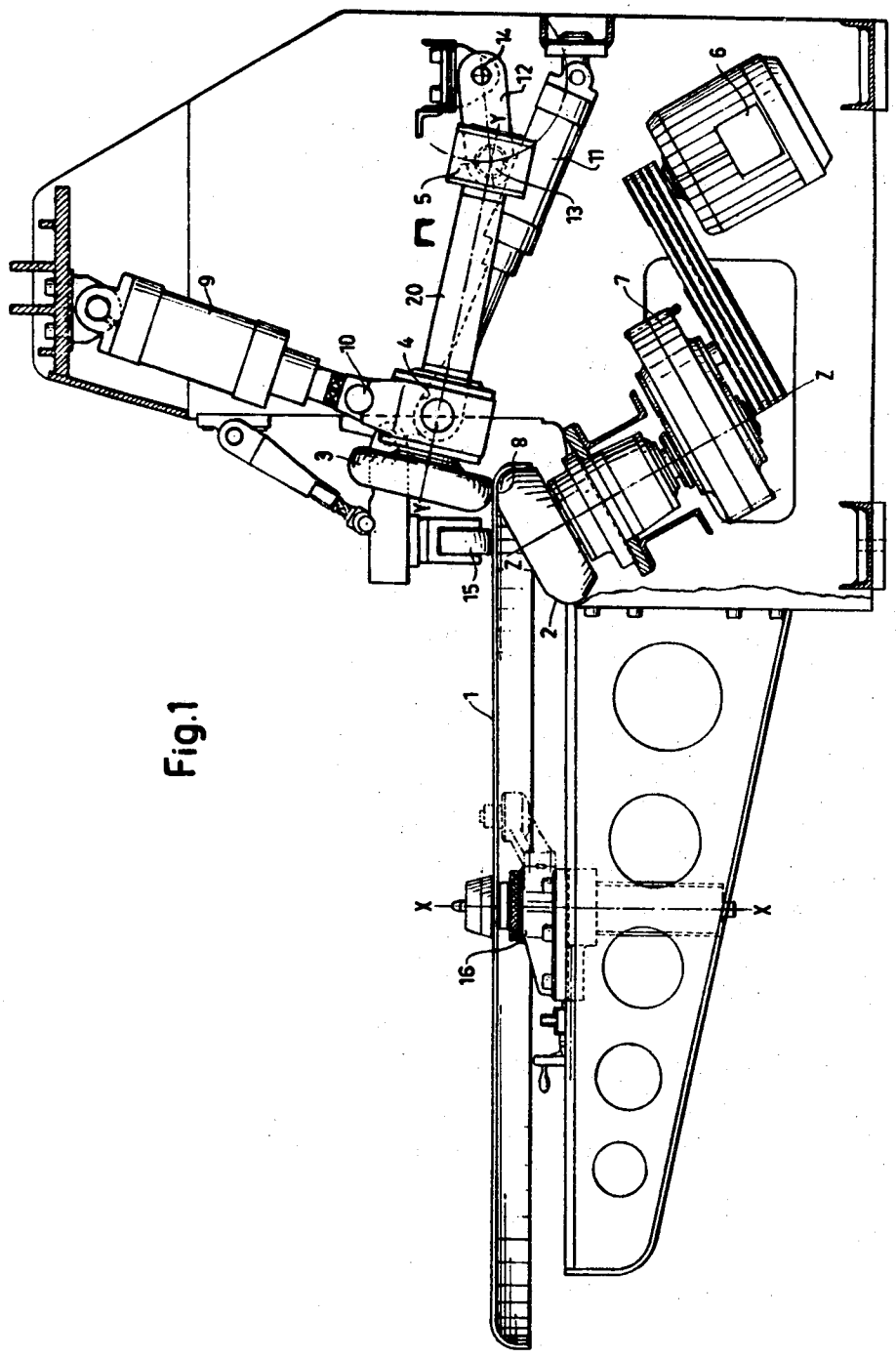

Fig.1

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Fig.2

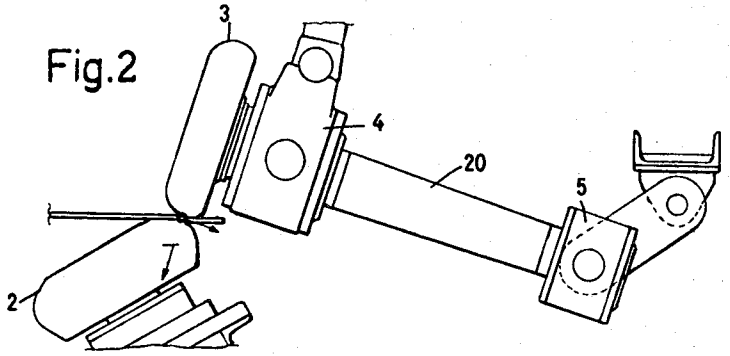

Fig.3

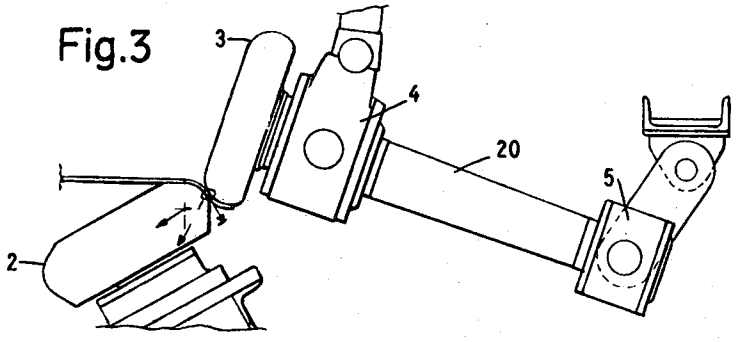

Fig.4

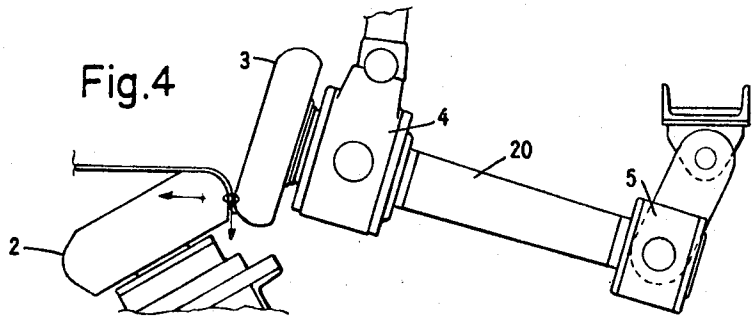

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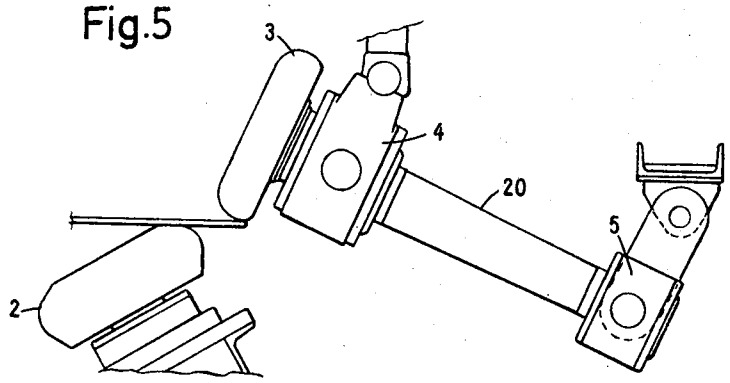
Fig.5



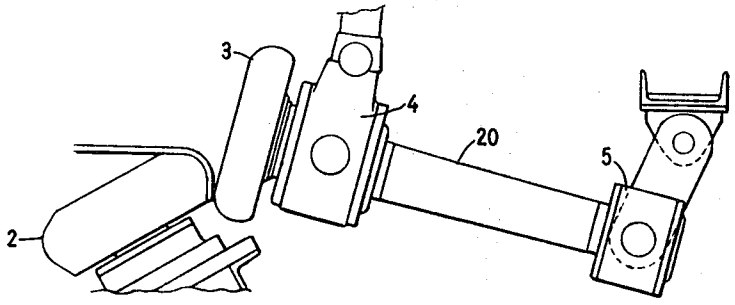


Fig.6

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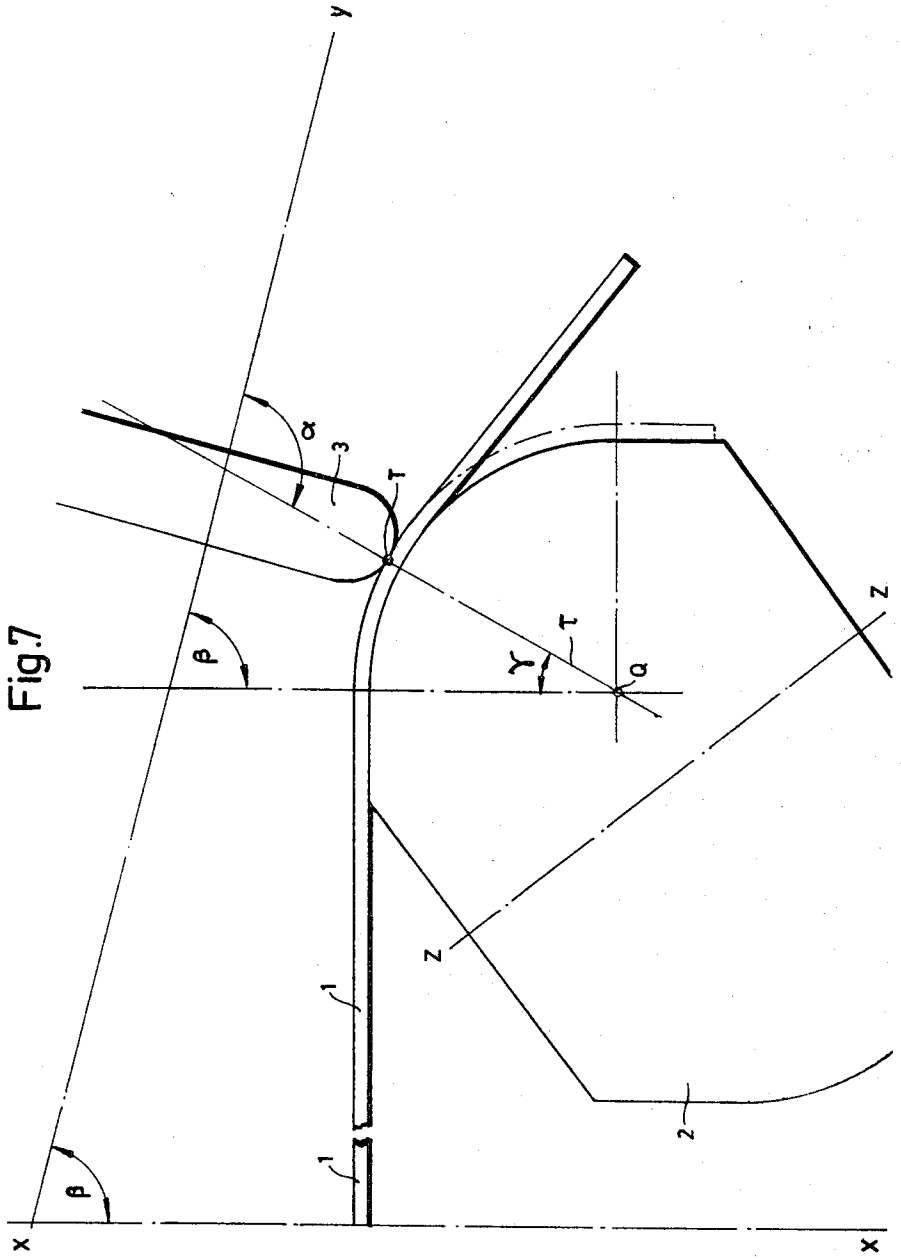
Fig.7



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3,380,274

BORDERING MACHINE AND METHOD OF BORDERING PLATES BY MEANS OF THE MACHINE

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8 Claims. (Cl. 72—85)

ABSTRACT OF THE DISCLOSURE

A machine for flanging the edge of a plane or dished plate comprises means supporting the plate for rotation, a forming roller engaging one side of the plate and having a curved cross section and a pressure roller engaging the opposite side of the plate at approximately the location of the forming roller. The pressure roller has a curved cross sectional contour and is carried by a shaft which is supported by a first bearing adjacent the pressure roller and a second bearing spaced from the pressure roller. Both of the bearings are on the opposite side of the pressure roller from the center of rotation of the plate. The second bearing is pivotally supported and coordinated means is provided for moving the first bearing both parallel to the shaft and perpendicular to the shaft to apply controlled pressure to the pressure roller in a direction toward the forming roller. Preferably the second bearing is supported by link means pivotally connected to the second bearing and to a fixed support. The means for moving the first bearing is preferably operated by fluid pressure.

The present invention refers to a bordering machine and method of bordering plates by means of the machine. Within the field of sheet-metal working there is the task of forming circular or oval plates in such a way that the edge is bent into a flange. The plates may be either plane or dished. The cross section of the flange may be either sharply bent or provided with a certain bending radius. In the last mentioned case the profile of the flange may terminate in the arc-shaped portion or a straight cylindrical portion may connect to the arc-shaped portion. End plates of the kind in question are manufactured either by being pressed in a specific pressing tool formed in accordance with the configuration of the end wall or by being successively bent between tools engaging the plate or sheet-metal in one point. One form of such bending is so called roller bending. In such bending the plate is guided past a working station with a forming roller shaped in accordance with the desired flange profile, a pressure roller engaging said forming roller and compressing the plate successively during the working operation against the forming roller until the edge of the plate conforms to the profile of the forming roller.

Machines of various constructions for carrying out such roller bending are known. The machines are usually provided with a supporting or backing forming roller for sharp bending or radius bending. Against this roller a pressure roller is working, which e.g. may be carried in a pivoted segment in such a way that the segment turns about a point coinciding with the corner of the flange (in sharp bending) or with the center of the arc of the flange profile cross section (in radius bending). The pressure roller may then have the form of a straight cylinder (cf. the British Patent No. 516,287) or a rolling body having a rounded working profile (cf. offprint from "Blech," September 1958, No. 9). It is also known to mount the pressure roller on a shaft whose bearings are on the same

side of the pressure roller, remote from the workpiece. In such a case the shaft of the pressure roller may be, e.g. perpendicular to the axis of rotation of the plate, the shaft then being parallelly displaceable and the roller displaceable along its axis for the purpose of having the pressure roller assuming the positions at the working point necessary for the operation. In this case the pressure roller has a conveniently rounded working profile (cf. the U.S. Patent No. 2,594,819 to Stenson). However, from certain points of view it is inconvenient always to allow the axis of the pressure roller to maintain the same direction in relationship to the axis of the plate. As a matter of fact, the pressure roller should exhibit a direction of axis suitable to each working position in order to attain a favourable effect in forming the plate, so that the forming forces are applied in a favourable direction and so that rubbing between the plate and the pressure roller is avoided as far as possible. In order to satisfy these requirements machines have already been proposed which have the axis of the pressure roller adjustable with various angles of inclination in relation to the axis of rotation of the plate (cf. the Austrian Patent No. 219,931 to Boldrini).

The present invention relates to a bordering machine for roller bending of the edge portion of circular or oval or dished sheet-metal end plates, the edge of the plate being worked between a supporting forming roller and a pressure roller engaging the forming roller and a cantilevered pressure roller engaging the forming roller and having its shaft mounted on the side opposite to the workpiece, the working position and axial direction of the pressure roller being subject to a suitable change during the course of the operation so as to obtain a favourable working procedure in various cases of operation. The one pressure roller bearing, that adjacent the working point, is adapted to be adjusted under the action of power sources (hydraulic cylinders), one acting substantially vertical and one or more acting substantially horizontal, while the other bearing of the pressure roller shaft, that remote from the working point, is mechanically guided by links so that the shaft will assume, in dependence of the position of the working point, an inclination suitably adjusted to each working point.

The invention further relates to a method of bordering plates by means of the machine as disclosed in greater detail below.

The invention will be further described with reference to the accompanying drawings, wherein FIG. 1 shows an embodiment of the machine according to the invention, while FIGS. 2–6 illustrate various methods of operation, FIGS. 2–4 in connection with successive bending and FIGS. 5–6 in connection with free bending (see below). FIG. 7 illustrates the method according to the invention.

The circular end plate **1** rotates about an axis X—X. The peripheral portion of the plate is supported by a forming roller **2** with a fixed axis and is engaged by a pressure roller **3** rotating about the axis Y—Y. A shaft **20** of the pressure roller is rotatably mounted at **4** and **5**. The forming roller rotates about its axis Z—Z and is driven by a motor **6** by way of a transmission **7**. By frictional contact with the plate **1**, said plate is caused to rotate so that its edge passes the working area **8**. The front bearing point **4** of the pressure roller is engaged by a pressure cylinder **9**, which acts substantially vertically through a bearing point **10**. The pressure cylinder acts in a plane containing the axes X—X, Y—Y and Z—Z (the plane of the drawing). The bearing point **4** is further engaged by two pressure cylinders **11** which act substantially horizontally and are situated one on either side of the plane of the drawing. The bearing point **4** is guided laterally between two parallel guide planes, one on either side of the plane of the drawing and parallel to said plane. The remote

bearing point 5 is guided by two links 12, one on either side of the plane of the drawing. These links are pivotally mounted on two pins 13 at the bearing point 5 and pivot about a fixed centre 14. The end plate 1 is supported in front of the working area by a number of adjustable backing rollers 15. The rotational center (axis X—X) of the plate is provided with an adjustable centering device 16 for different radii.

Bending of the border flange may be carried out either as a so-called successive bending or as a so-called direct or free bending or as something between the two.

Successive bending is suitably carried out in comparatively thin plate. This operation closely conforms to the so-called spinning or flow turning. Here the edge portion of the plate is compressed and rolled between the forming roller and the pressure roller in such a way that the edge of the plate is successively caused to conform to the profile of the forming roller (FIGS. 2, 3, 4).

In free bending the pressure roller engages the outer portion, not supported or backed, of the edge of the plate and forms the border or flange by bending the plate material across the forming roller (FIGS. 5, 6). This method is convenient for thicker plate.

In each operational position the pressure roller 3 should be able to be applied to the plate 1 while having a suitable direction of force and in such a way that the plate is worked by a suitable portion of the working surface of the pressure roller 3. According to the invention this function is fulfilled, in successive bending as well as in free bending, by the action by only two mutually perpendicular power sources 9, 11 (in doubling the pressure cylinder 11—one on either side of the plane of the drawing—these two cylinders together provide the substantially horizontally acting power source, each cylinder having half the power). First the case "successive bending" according to FIGS. 2, 3 and 4 is considered. Here the plate is to be compressed between the forming roller and the pressure roller. At the beginning of the operation the force of the pressure roller is directed substantially downwards under the action of the power source 9. According as the bending proceeds, the force is to be applied more and more horizontally, thus the horizontal power source 11 being more and more loaded. In the final position (FIG. 4) the force is horizontal. Because of the forming power a certain further component of force is obtained in the direction of movement of the pressure roller along the profile of the flange, so that the resulting force will be directed further downwards.

In bordering comparatively great forces are involved. For this reason it is desirable to apply the power sources near the working point in order to concentrate the flow of forces and to avoid secondary bearing pressures. Said desire is complied with by an arrangement in accordance with the present invention where the remote bearing point 5 is comparatively little loaded.

Further, the pressure roller should have such an inclination that it engages the plate along a limited outer portion of its periphery where the rolling off takes place most readily.

About the working point the working surface of the pressure roller should be bent away comparatively abruptly, so that forming of the plate material becomes concentrated to the necessary extent.

It should also be avoided that the forming roller touches the plate along an extended contact surface in such a way that rubbing occurs between the plate and contact roller.

From the above it will be appreciated that the axis of the pressure roller should form an angle with the axis of rotation of the plate which angle, during the final stage anyway, is less than 90°, as otherwise an unfavourable rubbing occurs between the front surface of the pressure roller and the periphery of the plate. It could be conceived to meet the above mentioned demands by having the pressure roller displaced along the profile with its axis parallel to itself (translatory displacement) and inclined to the axis of rotation of the plate. However, this calls for rather comprehensive guiding means without any possibility to concentrate the application of force to the working point.

An effective and simple solution of the problem is offered by the device according to the present invention. During working the pressure roller travels downwards along the profile of the flange. At the same time its remote bearing point is lower so that the axis inclination during the previous state is substantially maintained. During the final stage of the working operation the front bearing point at the pressure roller is lowered relatively more than the remote bearing point, not more, however, than a sufficient inclination of the pressure roller is maintained. In each position the necessary pressure against the plate may be readily adjusted as to magnitude and direction by the vertical and horizontal power sources being applied. The forming power is transmitted substantially at the front bearing point, only small reaction forces being created at the remote bearing point.

In free bending the pressure roller does not follow the profile of the flange or border but engages the outer periphery of the unsupported edge portion of the plate. During working the pressure roller is moved substantially downwards and towards the forming roller to a final position according to FIG. 6. Also in this case the same prerequisites and basic problems as in successive bending apply.

As will be seen from the above description, working of the plate may be carried out by a suitable continuous control of the adjustment of the pressure roller 3 in relationship to the plate 1 and the forming roller 2, respectively. It has now turned out to be very advantageous to guide or direct the pressure roller 3 or its axis Y—Y in accordance with the programme corresponding to certain angular relations. This programme is disclosed below with reference to FIG. 7 where corresponding members (the plate 1, the forming roller 2, the pressure roller 3) are designated by the same reference characters as in FIG. 1. In addition, Q designates the center of curvature of the cross-sectional profile arc of the forming roller 2, and r designates the radius from the point Q to the tangential point T between the plate 1 and the pressure roller 3. During the proceeding bending operation the point T on the plate 1 travels outwards towards the periphery of the plate 1, for which reason the angle γ between the radius r and the axis of rotation X—X of the plate 1 increases continuously. As the axis Y—Y of the pressure roller 3 is swung during the proceeding bending operation—as appearing from the above description of the operation of the machine—also the angle β between the axis X—X of the plate 1 and the axis Y—Y of the pressure roller 3 will be continuously changed. Now, the guiding programme for the axis Y—Y should be established in such a way that the angle α between, on the one hand, the axis Y—Y of the pressure roller 3 and, on the other, the appropriate radius between (the fixed) point Q and (the travelling) point T is continuously increasing during the course of the bending operation. Thereby is ensured that during the whole bending operation the pressure roller 3 will exert a pull on the plate 1 in the direction from the center of the plate outwards towards the periphery of the plate which is to a very great advantage to the output of the operation, i.e. because possibly occurring tendencies towards peripheral wrinkling or creasing of the plate 1 are efficiently counteracted thereby.

The magnitude of the angle α at a certain moment of the bending operation will depend—as will be readily appreciated—partly on the magnitude of the angle γ and partly on the position of the axis Y—Y in the same moment. From this it follows that the change of the angle β during the bending operation does not necessarily have to mean a continuous increase. On the contrary, the angle α can be increased solely as a consequence of the

increase of the angle γ. Then the angle β may remain constant—at least during a certain period of the bending operation—and it may even decrease during said partial period. Excellent working results have been attained by means of the machine according to the exemplificative embodiment (FIG. 1) by guiding the axis Y—Y in accordance with the above given rule for the angle α, the angle β somewhat decreasing in the beginning of the bending operation to then also increase.

FIG. 7 illustrates the angular conditions in relation to successive bending. However, as a matter of principle the same conditions prevail when the direct or free bending is concerned.

What is claimed is:

1. A machine for flanging the edge of a plane or dished plate comprising means supporting said plate for rotation, a forming roller engaging one side of said plate near its periphery and having a curved cross section, a pressure roller engaging the opposite side of said plate at approximately the location of said forming roller, said pressure roller having a curved cross sectional contour, a shaft of said forming roller, said pressure roller having a curve carrying said pressure roller, means for supporting and moving said and pressure roller shaft including first movable bearing means adjacent said pressure roller and second movable bearing means spaced from said roller, said first and second bearing means both being located on the opposite side of said pressure roller from the center of rotation of said plate, means pivotally supporting said second bearing means, first means connected to and acting on said first bearing means to move said first bearing means approximately crosswise of said shaft, second means connected to and acting on said first bearing means to move said first bearing means approximately lengthwise of said shaft, and means for coordinating said first means and said second means to apply controlled pressure to said pressure roller in a direction towards said forming roller.

2. A flanging machine according to claim 1, in which the means for supporting and moving said shaft and pressure roller cooperate to guide the pressure roller in relation to the forming roller to increase continuously during the flanging operation the angle between the axis of said shaft and a line connecting the center of curvature of the forming roller cross section with the point of engagement of said plate by said pressure roller.

3. A flanging machine according to claim 1, in which the means supporting said second bearing means comprises link means pivotally connected with said second bearing means and to a fixed support.

4. A flanging machine according to claim 1, in which said first means for moving said first bearing means comprises a first hydraulic means connected to said first bearing means and acting on said first bearing means in a direction approximately crosswise of said shaft and said second means for moving said first bearing means comprises a second hydraulic means connected to said first bearing means and acting on said first bearing means in a direction approximately lengthwise of said shaft.

5. A flanging machine according to claim 4, in which each said hydraulic means comprises a fluid pressure cylinder and piston device pivotally connected to said first bearing means and to fixed supports.

6. A flanging machine according to claim 5, in which said means supporting said second bearing means comprises link means pivotally connected with said second bearing means and to a fixed support and in which, in maximum extended condition of said second hydraulic means, the distance from said first bearing means to the pivotal connection of said link means to said fixed support is less than the combined length of said shaft and said link means.

7. A flanging machine according to claim 1, in which said forming roller is rotatable about an axis disposed at an acute angle to the plane of rotation of said plate.

8. A flanging machine according to claim 1, in which said forming roller is power driven and said pressure roller is freely rotatable.

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