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(54) **Reciprocating workpiece feeding apparatus**

(57) Workpiece feeding apparatus including a device for holding a workpiece, the device being at one end of an arm 11, 12, the other end of the arm being mounted so as to be vertically movable and rotatable in guides 14, 15, a lever to cause such vertical and rotational movement connected at one end to the arm and drivable, at its other end, by a reciprocating drive means, said other end of the lever being constrained by a guide with a curved central part between generally straight end parts and shaped so that the resultant movement of said one end of the arm is generally horizontal between two points which in use are above feeding and working positions of the workpieces and is generally vertical between the two points and the feeding and working positions.

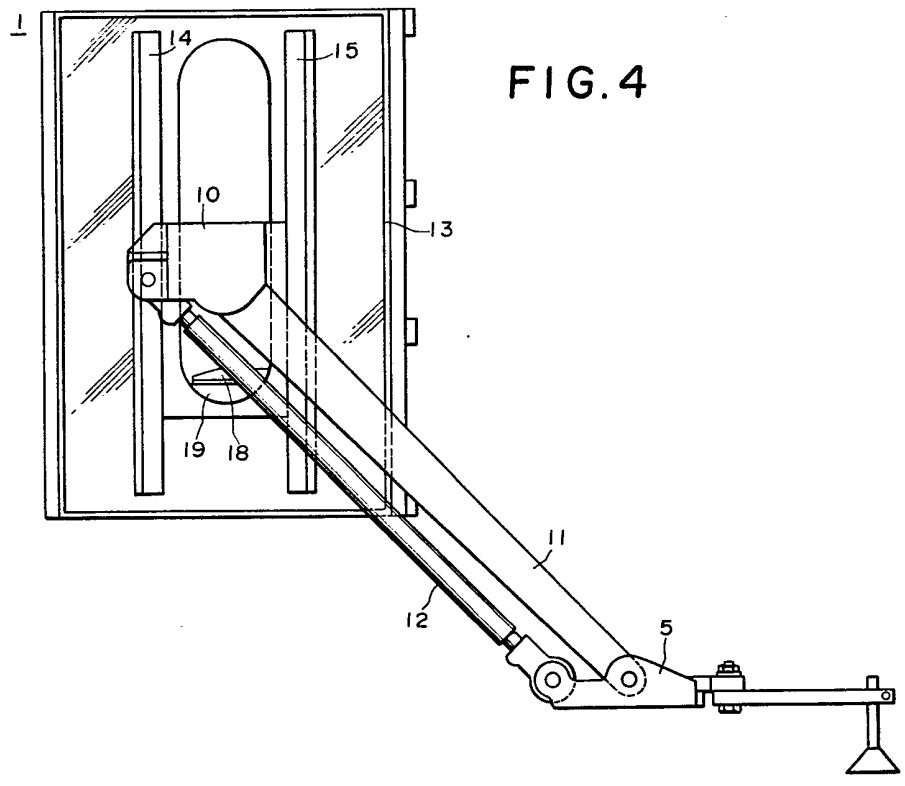

FIG. 4

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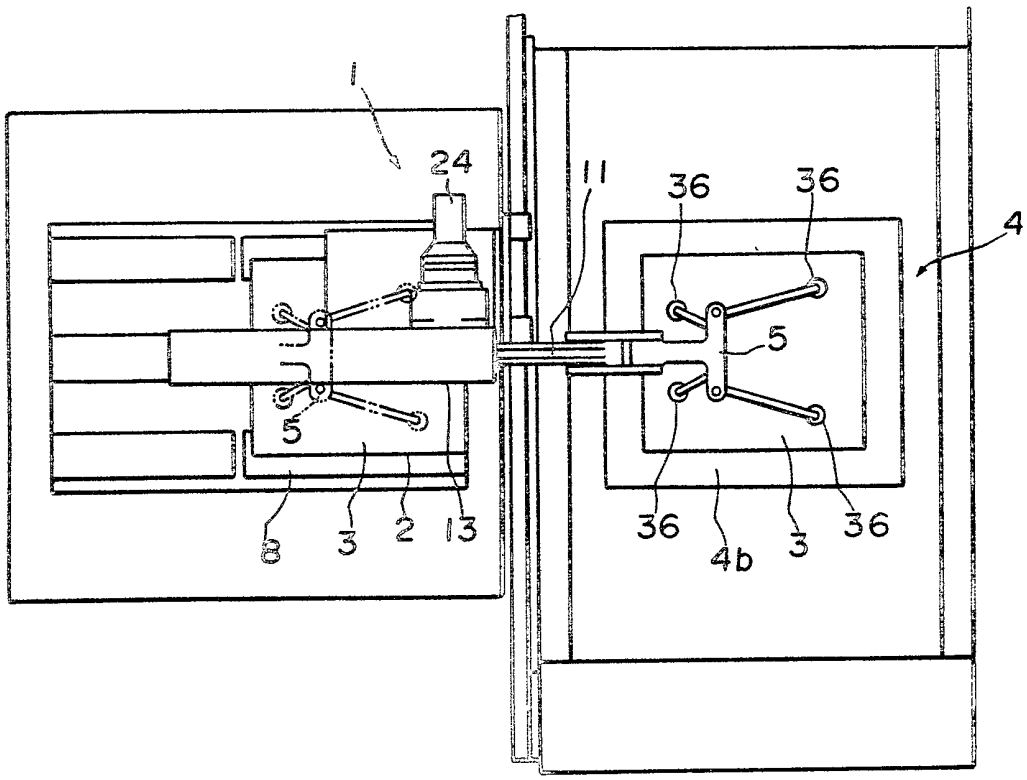
FIG. 1



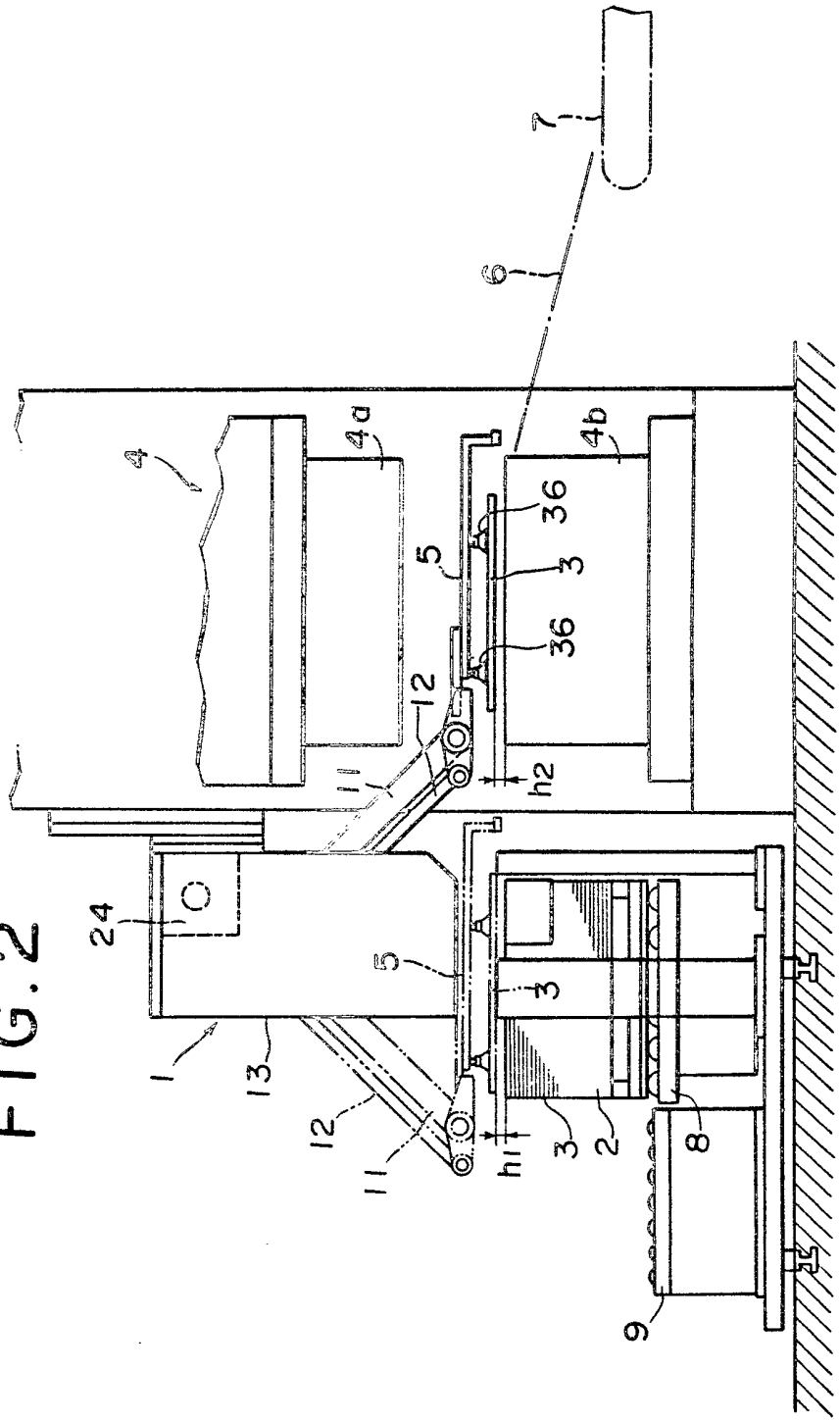
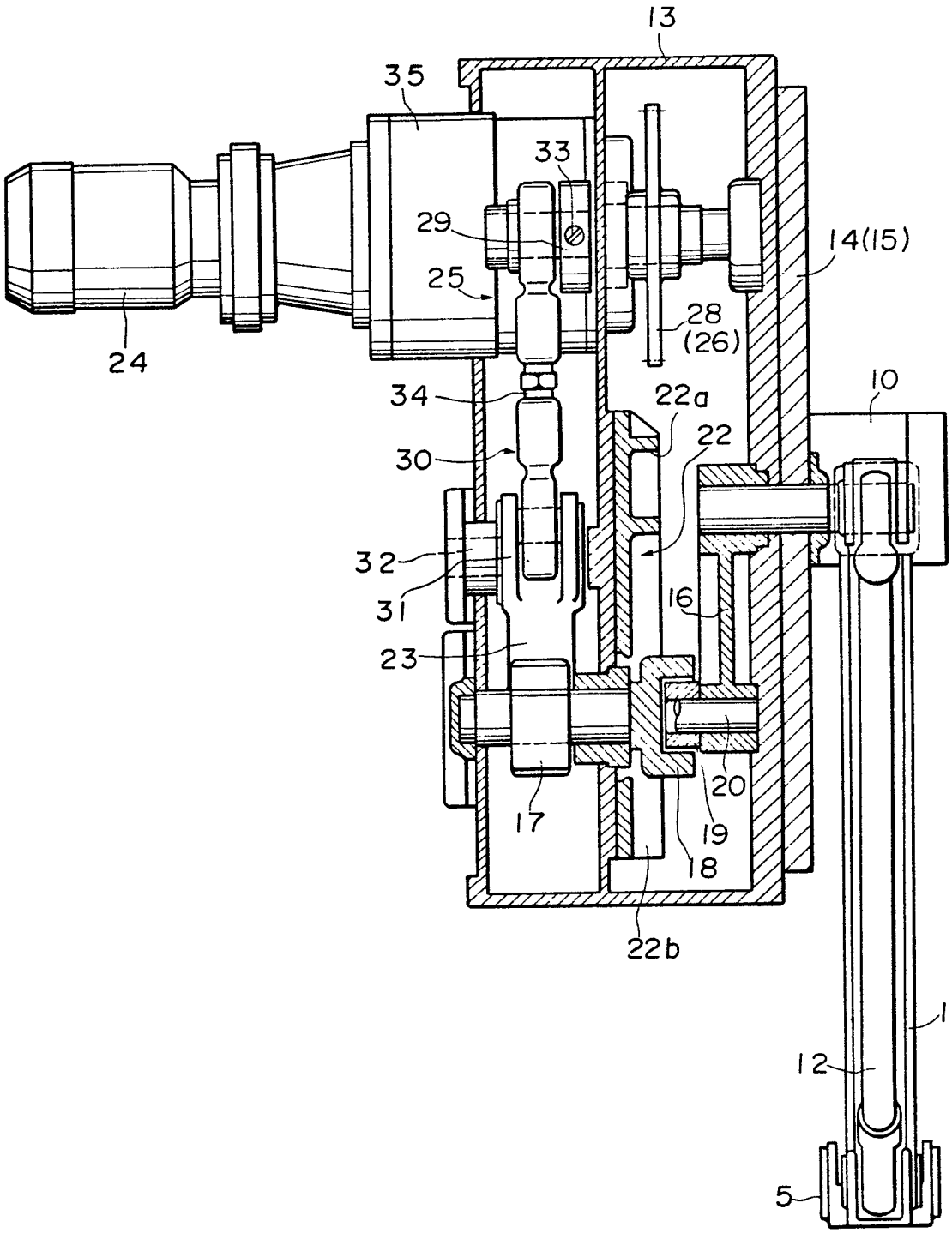


FIG. 2

FIG. 3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35
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29
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14(15)
28
(26)
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22a
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22
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32
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16
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19
17
18
22b
11
12
5

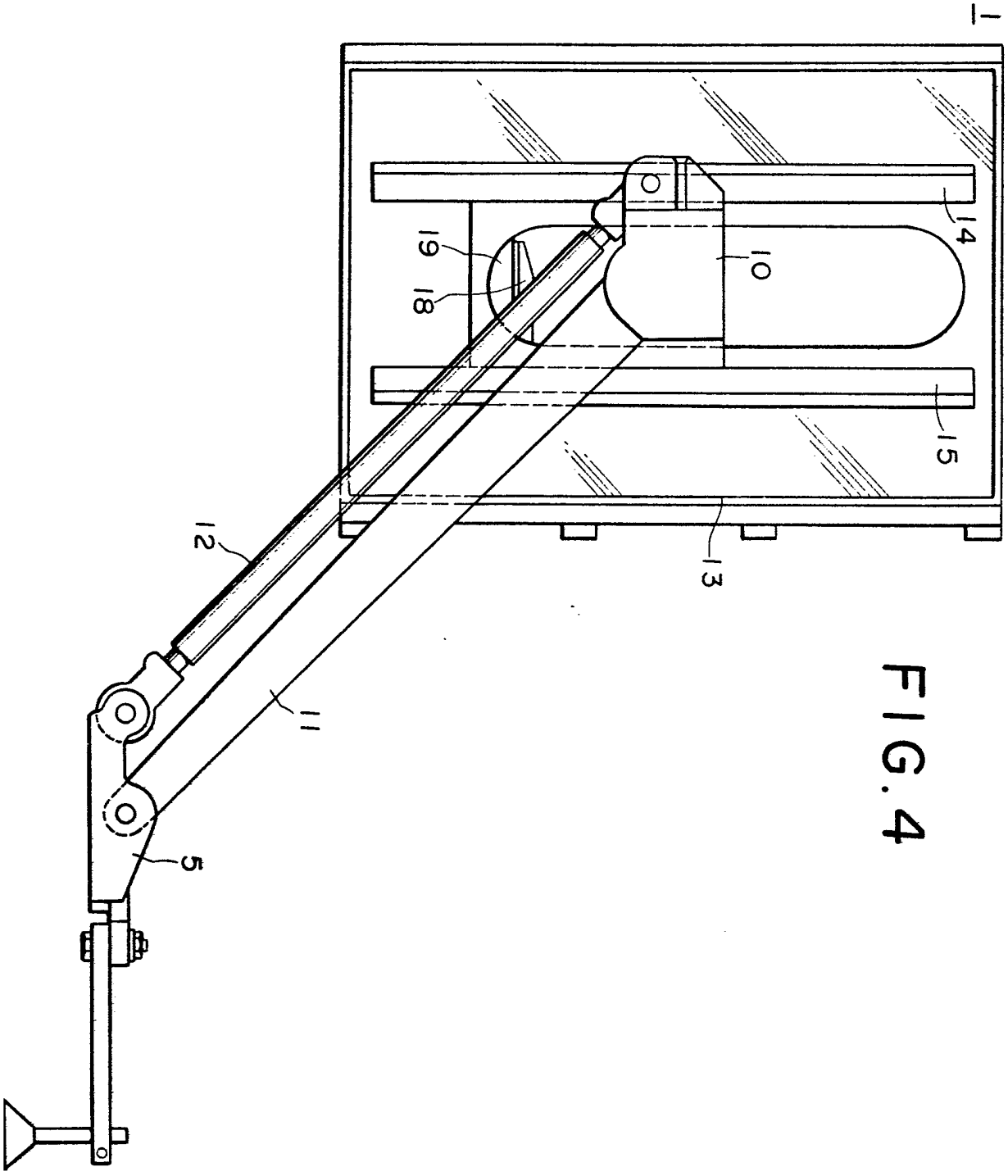
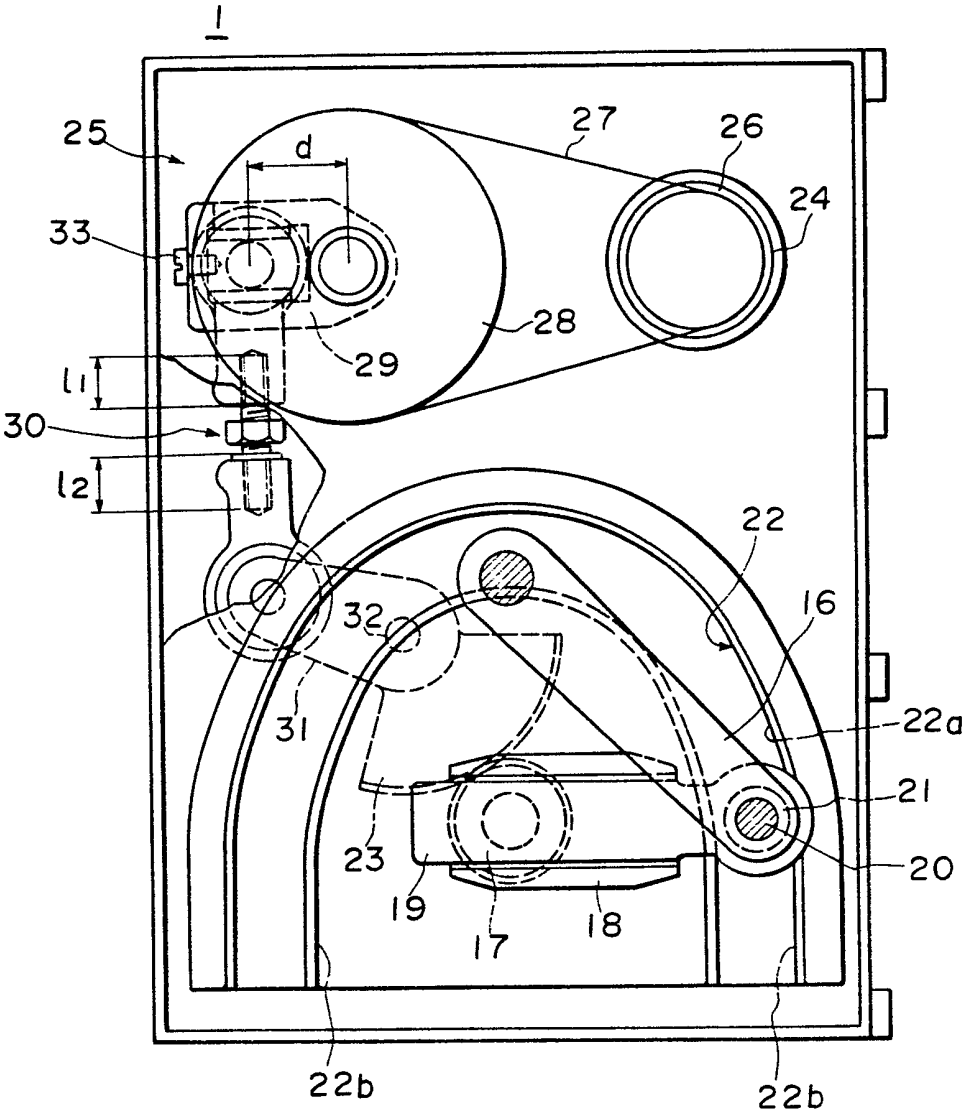


FIG.4

FIG. 5


1
25
d
27
26
24
33
28
29
l1
30
l2
22
16
32
31
22a
21
23
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19
17
18
22b
22b

SPECIFICATION

Apparatus for feeding a workpiece

The present invention relates to apparatus for feeding a workpiece.

Various types of apparatus are known for feeding workpieces to machine tools such as presses. In each type of apparatus, the device holding the workpiece is always moved along the same path between the feed position and the working position. This requires various positioning mechanisms which add to the complexity of the system. For instance, if the feed position differs in height from the working position, an extra device such as an intermediate table which is vertically slidable in synchronism with the movement of the holding device is needed.

The aim of the present invention is to reduce these difficulties.

According to the present invention there is provided workpiece feeding apparatus including a device for holding a workpiece, the device being at one end of an arm, the other end of the arm being mounted so as to be vertically movable and rotatable, a lever to cause such vertical and rotational movement connected at one end to the arm and drivable, at its other end, by a reciprocating drive means, said other end of the lever being constrained by a guide with a curved central part between generally straight end parts and shaped so that the resultant movement of said one end of the arm is generally horizontal between two points which in use are above feeding and working positions of the workpieces and is generally vertical between the two points and the feeding and working positions.

The invention allows provision of automatic feeding apparatus that is driven with a single motor and can cause a device for holding the workpiece to be repeatedly moved both vertically and horizontally along a predetermined path between feed and working positions. In preferred forms, the invention allows easy adjustment of the amount of vertical movement at either the feed position or the working position or both.

The invention will be more clearly understood from the following description which is given by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a plan view showing one embodiment of the feeding apparatus of the present invention associated with a press;

Fig. 2 is a front view of the apparatus of Fig. 1;

Fig. 3 is a partially cut side view showing part of the interior of the feeding apparatus;

Fig. 4 is a front view of the apparatus with its front cover removed; and

Fig. 5 is a front view showing part of the interior of the apparatus.

In Figs. 1 and 2, an automatic feeding apparatus generally indicated at 1 is mounted in front of the upper part of a press 4 and is slidable both horizontally and vertically. A plurality of workpieces 3 typically in a rectangular sheet form are stacked on a tray 2 of the apparatus in a feed position, and they are automatically and continuously fed to the working position of the press 4 at a predetermined feed rate. The uppermost workpiece on the tray is carried by a device 5 with vacuum suction cups and transferred to a postion between an upper mould 4a and a lower mould 4b of the press, where it is pressed into a predetermined shape. The pressed workpiece is picked up by a suitable means (not shown) and forwarded to a conveyor 7 through a chute 6 indicated by the dot-dash line in Fig. 2. In use, a tray 2 of the feeding apparatus from which all workpieces have been ejected is displaced from a main table 8 on which the tray rests and instead, another tray (not shown) loaded with workpieces is picked up from an adjacent side table 9. To achieve smooth feeding of the workpieces, the workpiece on the top of the tray, and thus in the feed position, is preferably flush with the position of the top of the lower mould 4b. Even if the two positions are different in height, however, smooth feeding of the workpieces can be accomplished by adjusting the automatic feeding apparatus 1 in a manner which will be described later.

The construction and operation of the automatic feeding apparatus 1 of the present invention are now described in more detail with reference to Figs. 3 and 4. The device 5 with vacuum suction cups 36 is connected to one end of each of two parallel arms 11 and 12 which are pivotally mounted at their other ends in a bracket 10. The bracket 10 is guided by two rails 14 and 15 with slide bearings that are attached to the frame 13 of the apparatus 1 and which permit the bracket to move only vertically. The bracket 10 is driven vertically by a lever 16 of which one end is pivotally mounted in the bracket 10 coaxially with and to rotate with the arm 11. Movement of the arm 11 and thus device 5 can be brought about in two ways. Firstly, by vertical movement upon vertical sliding movement of the bracket 10. Secondly, by rotation relative to the bracket 10 together with the arm 16. The arm 16 causes both movements, singly or together. Such movements can result in the device 5 moving vertically and/or horizontally. To bring about these movements, the other end of the lever 16 is linked by a shaft 20 to one end of a slider 19 which is slidably held in a holder 18 having generally U-shaped cross-section. The holder 18, together with a pinion 17, is rotatably mounted on the frame 13. The shaft 20 engages a guide groove 22 having an inverted U-shaped path by means of rollers 21 fitted around the shaft 20. When the holder 18 is rotated by driving power transmitted to the pinion 17, the slider 19 rotates with the holder 18 and changes its direction, and it may also slide in the holder. Thereupon, the shaft 20 is moved along the guide groove 22, and the lever 16 causes the bracket 10, and upper end of arm 11, to reciprocate vertically. If lever 16 rotates about bracket 10, then arm 11 also rotates. The guide groove 22 has a generally inverted U-shape and is fixed to the frame 13. It

consists of a curved part 22a and straight parts 22b provided on both sides of the curved part 22a. When shaft 20 moves in curved part 22a, the combined vertical and rotational movement imparted to lever 16, and thus to arm 11, causes the end of arm 11 holding device 5 to move only horizontally. When shaft 20 moves in either straight part 22b, arm 16 moves only vertically. In this case bracket 10 and arm 11 and device 5 also move only vertically.

In order to drive the holder 18 in rotation, the pinion 17 is meshed with a sector gear 23 which can be rotated through about 90 degrees by a motor 24 having an air clutch brake. The rotating force of the motor 24 is first transmitted from a coaxial sprocket 26 via a chain 27 to a sprocket 28 of larger diameter than sprocket 26. The power is further transmitted to the sector gear 23 through a swinging mechanism 25 including an eccentric plate 29, a rod 30 of adjustable length and an arm 31 connected to the lower end of the rod 30. The sector gear 23 is integral with the arm and is pivotally mounted on a pin 32. After the sprocket 28 has made each single turn, the air clutch 35 stops rotation and the device 5 rests above the feed position ready for the next transport step. The eccentric plate 29 is fixed to the sprocket 28 and holds one end of the rod 30 at a position displaced from the axis of the sprocket 28 by a distance d, which is adjustable according to the extent to which a screw 33 is threaded into the eccentric plate 29. Another screw 34 threadedly extends into an upper part of the rod 30 by a length l_1 and into a lower part of the rod by a length l_2, and the sum of the threaded lengths (l) can be easily adjusted. The threaded length (l) and the aforementioned distance (d) are important parameters for determining the movement characteristics of the swinging mechanism 25.

The operational sequence of the automatic feed apparatus 1, which starts in the position where the device 5 is above the working position as shown in Figs. 1 and 2 is now described. The shaft 20 has already moved along the curved part 22a of the guide groove 20 and is now lowered generally vertically along one of the straight parts 22b by counterclockwise rotation of the sector gear. When this happens, the lever 16 connecting the bracket 10 and shaft 20 is lowered without any rotation, due to the vertical guides for the bracket 10, so the device 5 is lowered vertically down. When the device is lowered to the working position, the suction applied to cups 36 is removed momentarily, to release the workpiece, and almost at the same time, the sector gear 23 starts to rotate clockwise and the device 5, disconnected from the workpiece, begins to rise vertically. After ascending to the position shown in Fig. 5, the shaft 20 moves along the curved area 22a and the lever 16 not only rises but rotates gradually from the inclined position to a vertical position. As a result, the bracket 10 moves upward and the device 5 is moved horizontally while maintaining the height indicated in Figs. 2 and 4.

When the sector gear 23 has moved to the extreme end of its clockwise rotation, the bracket 10 is at its highest position and at that time, the device 5 passes right under the bracket 10. In this situation, the eccentric 29 is in a position where it has been rotated by nearly 180 degrees from the position indicated in Fig. 5. When the device 5 has passed right under the bracket 10, the shaft 20 continues to move by inertia along the curved part 22a. As a result, the device 5 moves horizontally to a position above the feed position and then the air clutch 35 is disconnected from the sector gear 23, and its braking action causes the sprocket 28 to stop rotating, and the device 5 rests right above the feed position in preparation for the next transport step.

The automatic feed apparatus 1 thus has a swinging mechanism 25 with an eccentric plate 29 that converts the rotating force of the motor 24 to the rotary oscillating motion of the sector gear 23. This drives the slider 19 in rotation and the slider is guided by the groove 22 so as to follow a predetermined path such as to move the device 5 horizontally and vertically. This simple arrangement is sufficient to transfer the workpiece 3 from the feed position to the working position. In particular, the horizontal and vertical movements of the device can be repeated precisely without any special positioning device but using only the rotating force of the single motor 24, and this leads to a significant reduction in manufacturing and maintenance costs.

In Fig. 2, the amount of purely vertical movement of the device in the vicinity of the feed position is indicated by h_1 and the corresponding amount in the working position is indicated by h_2. The respective values of h_1 and h_2 and their ratio can be adjusted by simply changing the parameters l and d of the swinging mechanism 25. To increase the values of h_1 and h_2 without changing their ratio, the threaded length (l) of the screw 34 threaded into the parts of the rod 30 may be increased to permit the slider 19 to swing through a wider arc. Conversely, the values of h_1 and h_2 can be decreased by reducing the length (l). To change the ratio of h_1 to h_2, the screw 33 may be used to decrease the distance (d) between one end of the rod 30 and the centre of the sprocket 28, thus shifting the swinging centre of the slider 19 towards the working position, and by so doing, h_1 can be reduced with little change in h_2. Conversely, by increasing the distance (d), h_2 can be decreased with little change in h_1. In this way, the automatic feed apparatus can also provide simple adjustment of the amount of vertical movement of the device 5 at both or either of the feed and working positions. Therefore, even if the feed position and the working position cannot be made equal in height either to dimensional limitations on the tray 2 loaded with workpieces 3 or to the small floor area on which the press 4 is to be installed, the apparatus 1 is capable of feeding the workpieces very smoothly.

In the illustrated embodiment, the device 5 for holding the workpiece 3 is provided with vacuum suction cups 36, but the device may use other holding devices such as electromagnetic cups or chucks. The apparatus of the present invention can be used with machine tools other than presses.

As described above, a motor is used in a simple apparatus which is sufficient to transfer the workpiece from the feed position to the working position, and furthermore, the apparatus is capable of moving the holding device repeatedly along predetermined

paths without any special positioning mechanism, and this leads to a great reduction in manufacturing and maintenance costs. Also, the amount of vertical movement of the device in both the feed and working positions can be controlled by adjusting the range of angles travelled by the lever 16. Therefore, even if the feed position and the working position differ in height, the apparatus is capable of feeding the workpiece smoothly from the feed position to the working position.

As a further advantage, the feed apparatus can be mounted directly on a press without using a special mounting table, so the apparatus can be installed in a small area. The feed apparatus can be mounted in front of the upper part of the press in such a manner that it is movable both horizontally and vertically so it will not hamper mould replacement or repair and inspection jobs.

CLAIMS

1. Workpiece feeding apparatus including a device for holding a workpiece, the device being at one end of an arm, the other end of the arm being mounted so as to be vertically movable and rotatable, a lever to cause such vertical and rotational movement connected at one end to the arm and drivable, at its other end, by a reciprocating drive means, said other end of the lever being constrained by a guide with a curved central part between generally straight end parts and shaped so that the resultant movement of said one end of the arm is generally horizontal between two points which in use are above feeding and working positions of the workpieces and is generally vertical between the two points and the feeding and working positions.

2. Apparatus according to claim 1, wherein the reciprocating drive includes means to adjust the extent of reciprocation imparted to said other end of the lever so as to vary the extent of said generally vertical portions of movement of said one end of the arm.

3. Apparatus according to claim 1 or 2, wherein the reciprocating drive includes means to adjust the central point of the reciprocal movement of the said other end of the lever so that the ratio of the vertical portions of movement of said one end of the arm is adjusted.

4. Apparatus according to claim 1, 2 or 3, wherein the reciprocal drive includes a member connected to the said other end of the lever and slidable in a rotatable holder.

5. Apparatus according to any preceding claim, wherein the holder is rotated by an arm eccentrically mounted on a rotatable disc, the disc being motor driven.

6. Workpiece feeding apparatus constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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