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I-36100 Vicenza (IT)(54) **Manipulator for the accurate rotational and translational movement of sheet materials.**

(57) The manipulator is of the type capable of making accurate rotational and translational movements with sheet materials so that mechanical operations such as the bending of the edges can be carried out, characterized in that it comprises a table for supporting and holding the sheets (27), the table having a leg (2), the leg acting by means of an adhesive action of the reversible type upon the same. The adhesive action may be of the magnetic and/or pneumatic type.

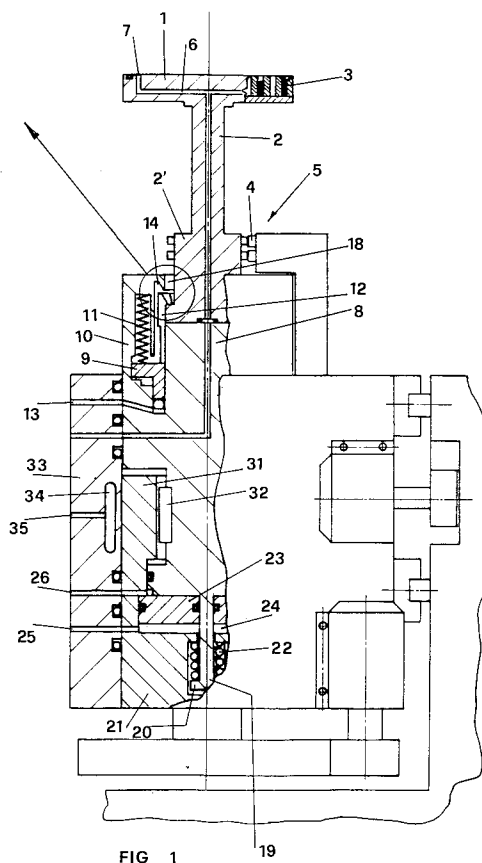


FIG. 1

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FIELD OF THE INVENTION

The present invention relates to a manipulator of the type capable of effecting accurate rotational and translational movements with sheet material so that mechanical operations can be performed upon the same.

Manipulators for sheet metal in the form of flat sheets which are capable of taking the latter from a loading area and then carrying them to a bending press which bends one or more of their edges have been known for a long time.

These manipulators necessarily have a structure which allows them to pick up and secure sheets in an accurately positioned manner and maintain these positions throughout the handling process. Therefore there is no need to engage the sheets on the working machine in any position in any subsequent operation which has to be performed.

These sheets, once bent, or welded together in a suitable manner, are used in the motor industry to manufacture the body shells of vehicles, in the construction of electrical appliance for home use such as refrigerators, washing machines, air conditioning equipment, and for the manufacture of shelving for furniture and the like.

Manipulators are known in the present state of the art which comprises in particular a chuck with two opposite jaws located vertically capable of grasping a single sheet in the loading area so that it can be carried to the press. These chucks can rotate about their own axis in one direction or another, thus causing rotation of the sheet, which can be subjected to a bending operation on each of its sides.

One of these known devices provides that the two jaws of the chuck be mounted at the ends of a C-shaped structure which is only capable of linear movement, thus the chuck remains always turned towards the section in which the sheet is inserted into the press. The step of loading the sheets onto the manipulator must necessarily take place in a transverse direction with respect to the direction of movement of the manipulator. The main disadvantage of this device resides in the fact that it is absolutely impossible to load a sheet onto the manipulator before the latter has released the preceding sheet and has completed its return motion to the rear so as to reach a position behind the loading device.

In addition, because the manipulator, which is a heavy structure, makes a forward movement exactly equal to movement made by the sheet, it is clear that a motor of considerable power must be used, a fact which results in an increase in the power consumption needed to move the device.

In another manipulator of a known type provision is made for the chuck to be supported by a portal structure, which itself is only capable of linear movement from the loading area to the press. The main disadvantage of this structure resides in the fact that they are of a considerable size transversely because the distance between the two columns must be greater than the major diagonal of the sheet being handled in order that the latter can be rotated. In addition the portal guides are substantially stressed and tend to be deformed giving rise in the final analysis to some inaccuracy in the bending operations. In addition, also in this case, the entire considerable mass of the portal must be moved by an amount equal to the displacement imparted to the sheet. In comparison with the first device described hereinabove, it is possible, however, to place a new sheet in the loading area as soon as the portal moves from the loading area towards the bending area, provided that the sheet once it has been bent is released from the manipulator and is carried away by other suitable means after the manipulator has moved backwardly and prior to the time the manipulator moves with a new sheet.

Both the above mentioned devices have jaws which can be made to rotate only of an angle of 90° and 180°. This fact excludes the possibility of working with a panel which is not of rectangular shape.

A further type of manipulator, described in German Patent No. 310902, on the other hand is only capable of operating with sheets which have a previously provided central hole. In this case, provision is made for the two jaws of the chuck to be joined together by means of a screw which passes through this hole. This device can block the sheets in various positions. However, in addition to the disadvantage due to the fact that it can only work with drilled sheets, substantial drawbacks result in the stages of loading and unloading of the sheets.

Italian Patent No. 1,220,216 in the name of the same inventor as the present invention describes a manipulator which has a supporting structure for the upper jaw in the shape of a double T, which structure is hinged on the side opposite to the side in which the upper jaw is placed, on the carriage which can move along a guide placed in a direction which is perpendicular with respect to the direction of the path travelled by the sheet to reach the press. On the contrary, the lower jaw is mounted on a vertical shaft which constitutes the connecting pin between the lateral end of the support structure and a longitudinal carriage, which is capable of moving in the direction of forward movement of the sheet.

This latter manipulator has the advantage over the two manipulators described hereinabove that

very much less power is required to move its movable components to effect the same operation. In addition, this latter type of manipulator permits to place a new sheet in the loading area as soon as the preceding sheet has been carried to the bending press, in particular the loading can take place even when the manipulator has returned to the position to pick up a new sheet.

SUMMARY OF THE INVENTION

The object of this invention is to provide a manipulator which has functional features comparable to and if possible better than the manipulator of the issued Italian patent, but which is structurally very much simpler than this manipulator as well as the other known manipulators.

The crux of the present invention resides in providing the manipulator with a sheet handling and supporting member which operate by means of adhesion of a reversible type. This adhesive action may for example be achieved by means of permanent magnets or electromagnets. As an alternative the adhesive effect may be achieved by creating a vacuum, brought about by Pneumatic means between the sheet and the surface supporting it. It is also possible to provide for magnetic and pneumatic action to operate together in a single manipulator.

The dependent claims cover some special embodiments which render the manipulator particularly effective in use.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will now be described in detail with reference to a particular embodiment given by way of a non-restrictive example, with the aid of the appended drawings, in which:

Fig. 1 is an elevational view of the device according to the invention, partially in cross-section.

Figs. 2 and 3 show a detail of the device, in two different operating conditions.

Figs. 4, 5 and 6 show three different positions of the sheet supporting member.

Figs. 7, 8 and 9 are top views of the device according to the invention, in three different stages of operation.

Fig. 1 shows that the device according to the invention provides for the sheet supporting member to consist of a supporting table 1, which is in turn supported by a leg 2, which can rotate about its own vertical axis. The leg is in turn inserted into a structure 5 in a manner which will be more particularly described hereinbelow, which leg has the possibility of moving by means which will also

more particularly be described herein below, in order to enable the table to act effectively as a handling member. The fundamental feature of this table resides in the fact that means of adhesion to the sheets of a reversible type are provided.

These means may comprise electromagnets 3 which are capable of attracting the sheets being handled, specifically by forces of the electromagnetic type. It is clear, however, that these electromagnets may be replaced by permanent magnets capable of performing the same functions. Fig. 1 shows sliding contacts 4 which provide an electrical feed to electromagnets 3, which are located on a member which is capable of rotating about a vertical axis.

As auxiliary or alternative means to the magnets described hereinabove, conduits 6 for the purpose of permitting holding the sheets, having ends 7 coming to a focus at the upper surface of table 1 and which are connected to means not illustrated in the figure, and in any event of a known type, may be used. These latter means are capable of creating a vacuum in the conduits, giving rise to a "sucking effect" such as to ensure that a sheet placed on the upper surface of table 1 is retained.

It is clear that adhesion of the magnetic type will be preferably used for holding sheets made of ferromagnetic material, while the pneumatic system will be used to hold sheets made of non-magnetic materials. The pneumatic system, which is theoretically more advantageous because it can operate with any kind of material, however, is not capable of giving rise to adhesive forces of the magnitude typical of the forces provided by the magnetic system. On the contrary, the latter achieves better results with magnetic sheets of substantial thickness.

Fig. 1 also shows that the lower end of leg 2 of table 1 has an enlarged base 2'. This base rests on an underlying cylindrical symmetrical member 8. This in turn is surrounded at its lower part by an annular member 9, which together with the base and the cylindrical member 8 lies within the cylindrical structure 10. Between the base of this cylindrical structure in an upper position and the annular member 9 there are provided elastic means 11 which tend to hold the annular member in the lower position.

The means which ensure the mutual blockage of the base 2' and cylindrical member 8 comprise fillets 12 which are located axially in relation to the lateral surfaces of the aforesaid members, the lower portions of which are fixed to the annular member 9. In particular the ends of the fillets are shaped in such a manner that under normal operation they can clamp onto the upper surface of the widened lower portion 2' of leg 2 (see in particular Fig. 2).

The lower portion of the annular member 9 is placed in contact with the end of a conduit 13. By injecting hydraulic fluid into the latter the annular member is raised, overcoming the effect of elastic means 11. The result is that fillets 12, which surround the entire lateral surface of the enlarged base 2', advantageously are caused to slide.

At the top of the cylindrical structure 10 there is provided an annular recess 14 ending in a border 15, the latter having a bevel 16, of a shape 17 corresponding to the shape of the upper ends of fillets 12.

The annular border is constructed in such a way that when the fillets rise following the injection of hydraulic fluid into conduit 13, there is reciprocal interference between the two bevels 16 and 17. The result is that the fillets are caused to spread apart (Fig. 3) releasing leg 2, which can then be raised from cylindrically symmetrical member 8 and withdrawn from cylindrical structure 10 via hole 18 provided in the top. In this manner supporting table 1 can be replaced extremely simply and quickly by another table so as to adjust the device to sheets of different size. Again Fig. 1 shows that cylindrically symmetrical member 8 ends at its lower end in an extension 19 which has a widened lower portion 20.

An annular sleeve 21 is placed around the lower part of extension 19. Between portion 20 and the upper part of sleeve 21 there are elastic means 22 which operate so as to press extension 19 and therefore the entire member 8 downwardly. On the contrary, around the upper part of extension 19 there is a disc 23 which can move within a chamber 24, the latter having substantially the same dimensions in the radial direction but is longer in the longitudinal direction. This chamber 24 is placed in connection through conduit 25 with means for the injection of pressurized hydraulic fluid into the chamber, with the result that the disc is raised to the position illustrated in the figure, while the part under the chamber is obviously filled with hydraulic fluid.

The raising of disc 23 also causes the cylindrically symmetrical member 8 and extension 19 thereof to be raised, with the result that elastic means 22 are compressed, and this ultimately results in supporting table 1 being raised.

A further conduit 26 is provided and through it pressurized hydraulic fluid can enter the space between the upper surface of disc 23 and the portion of the surface of member 8 facing the latter, with the result that the entire member 8 is in this case raised.

In Figs. 4, 5 and 6 the device according to the invention is illustrated in its highest raised position, an intermediate position and its lowest position respectively. The highest position corresponds to

the stage of translation and rotation of sheet 22 (Fig. 9), while the intermediate position illustrated in Fig. 5 corresponds to the working stage (Fig. 8).

On the contrary, the position shown in Fig. 6 corresponds to the stage where the sheet has to be delivered to the manipulator or has already been taken up by the manipulator.

Fig. 7 in particular shows the stage in which sheet 27 is delivered to the manipulator in order to be carried to press 28, while suitable press means 29 is capable of taking the already folded sheet 30 from the latter.

On the contrary, Fig. 8 shows the bending stage in which another sheet which is to be bent may be placed behind the manipulator in such a manner that the latter can pick it up immediately after it has freed itself from the other sheet which is then folded.

Finally Fig. 9 shows that the manipulator is also capable, as a result of its ability to rotate about a vertical axis, of bringing the various edges of the sheet which require bending into the appropriate position on press 28 in sequence.

With reference to Fig. 1, it will be seen that member 31 is present in a recess in the cylindrically symmetrical member 8, and is connected to member 8 by means of a key 32.

Laterally with respect to the upper part of sleeve 31 there is an external supporting member 33 in which is provided a cavity 34 which is also placed in communication through conduit 35 with a member which is capable of injecting pressurized hydraulic fluid into this cavity, causing deformation of the walls of the cavity. This device may also act as a means for securing member 8 and therefore table 1 in a well-defined angular position. Of course, this securing device may be replaced by other means which block the rotation of the device without going beyond the scope of the invention.

Finally it should be stressed that the particular embodiment of the manipulator illustrated in Fig. 1 provides means for movement to and from the press which is wholly identical to the press present in the device described in patent No. 1,220,216 previously cited. In this respect it should be noted that this device may be replaced by any other device capable of performing the same function without again going beyond the scope of the invention.

From what has been described hereinabove it is clear that the device according to the invention is particularly simple and operative from the point of view of both construction and function.

Claims

1. A manipulator capable of effecting the accurate rotational and translational movement of sheets

whereby mechanical operations may be performed upon said sheets, characterized in that it incorporates a member for supporting and holding said sheets, said member acting upon said sheets by means of a reversible adhesive force.

2. The manipulator according to claim 1, characterized by the fact that it comprises means for creating a magnetic adhesive force between said sheet supporting and holding member and each of said sheets. 10
3. A manipulator according to claim 2, characterized by the fact that said means are electromagnet. 15
4. A manipulator according to claim 2, characterized by the fact that said means are of permanent magnets 20
5. A manipulator according to claim 1, characterized by the fact that it comprises means for creating a vacuum at the interface between said supporting member and each of said sheets. 25
6. A manipulator according to claim 5 characterized by the fact that it additionally comprises magnetic means for providing an adhesive force. 30
7. A manipulator according to claim 1, characterized by the fact that the sheet supporting and holding member comprises a supporting table 35 (1), a leg (2) supported by said table (1), said leg having a widened lower base (2'), a cylindrical symmetrical member (8) supporting said leg, said cylindrical symmetrical member having a lower part, a top part and generatrices, 40 an annular member (9) surrounding said lower part, a plurality of fillets (12) located along said generatrices of the member (8) and the lower part of said leg (2), said fillets clamping against said widened portion of said base (2'), a fixed 45 cylindrical structure (10) surrounding said fillets, said fixed cylindrical structure (10) having a top and an orifice (18) therein, whereby said leg (2) is allowed to go through said orifice (18), said orifice having edges, said fillets having an upper part, the edges of said orifice having a shape corresponding to the shape of said upper part of said fillets, elastic means (11) being provided between said annular member (9) and the top of said cylindrical member (8), and means adapted to raise said annular member (9) and said fillets, whereby said widened lower base (2') of said leg (2) is 50 55

released and said supporting table (1) is rapidly replaced.

8. The manipulator according to claim 1 which incorporates means for adjusting the said table to the size of said sheets.
9. The manipulator according to claim 1 which has means for securing said member supporting and holding each of said sheets in a well-defined angular position.

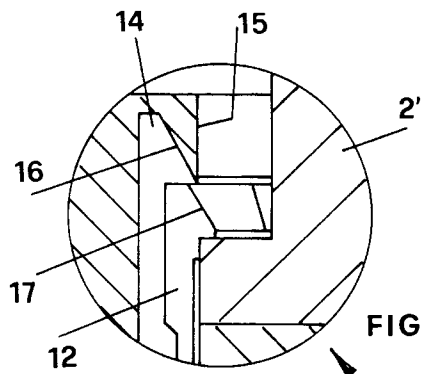


FIG. 2

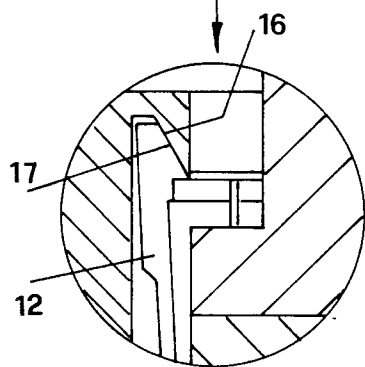


FIG. 3

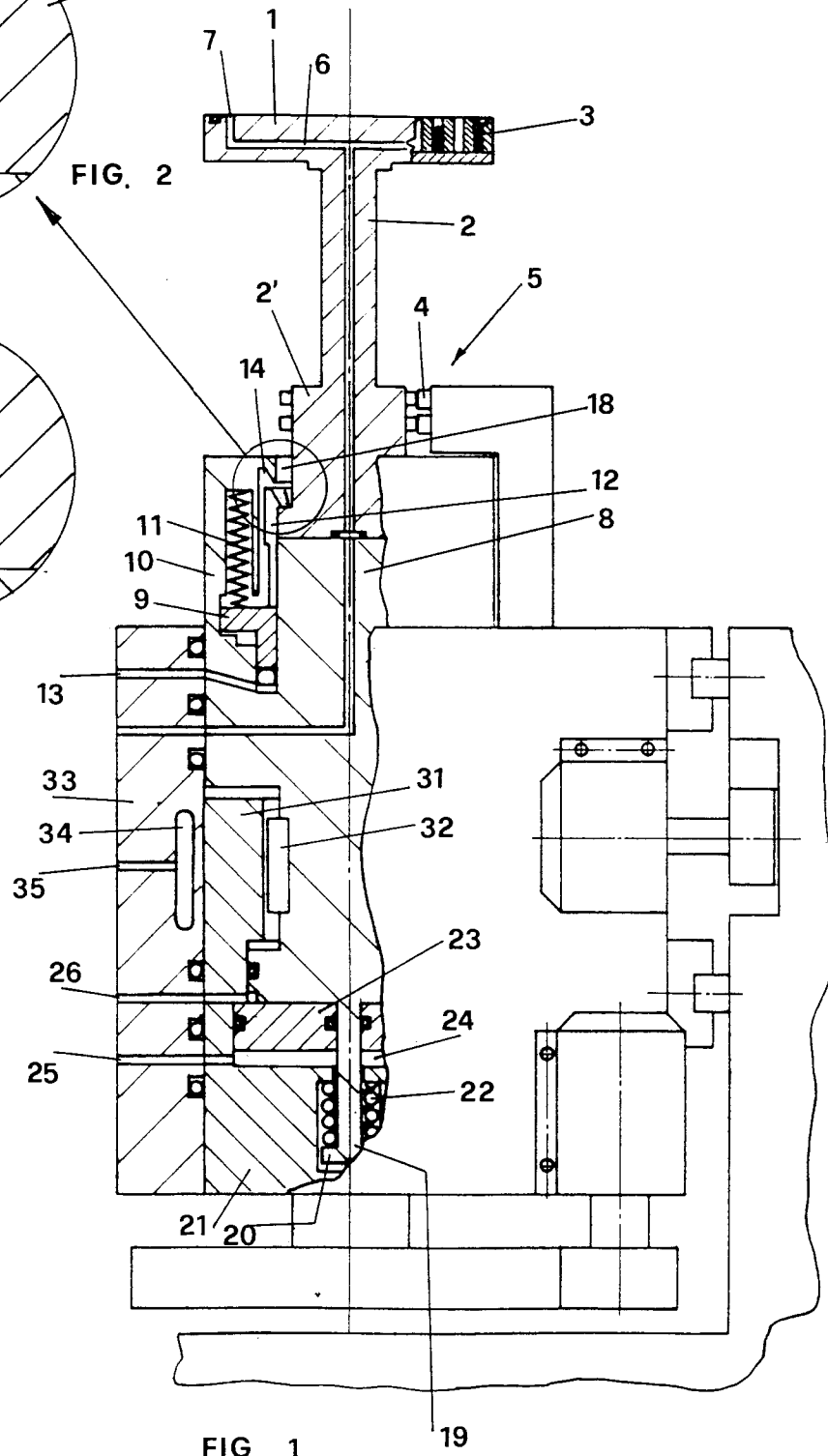
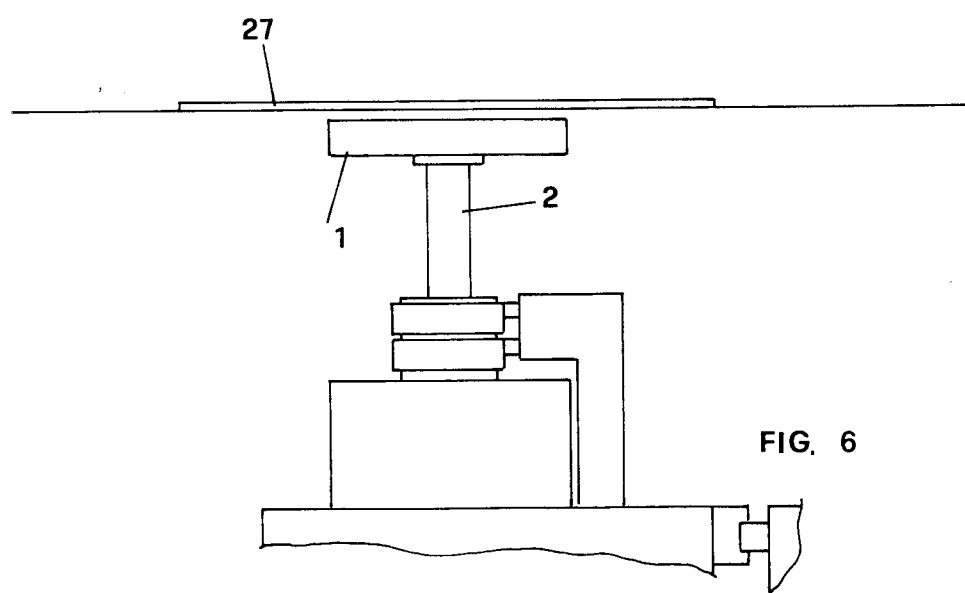
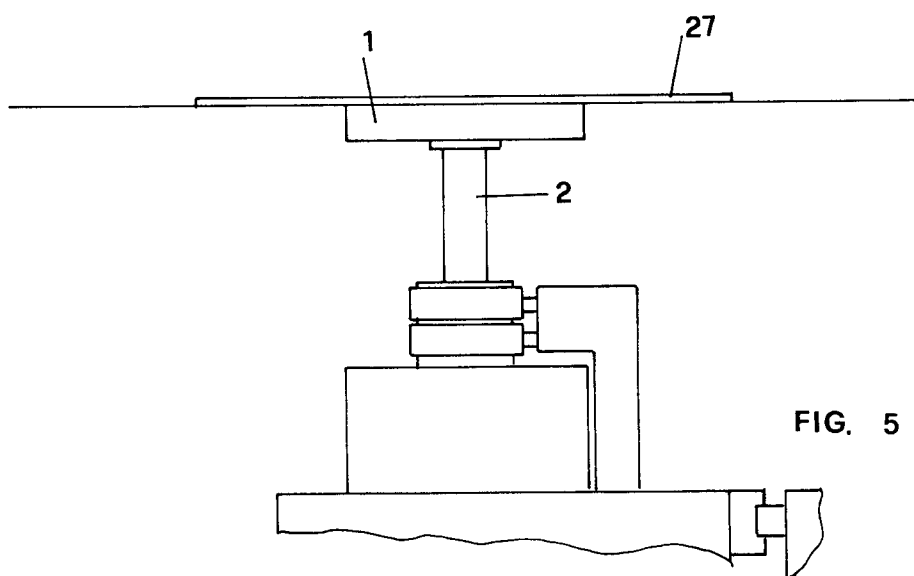
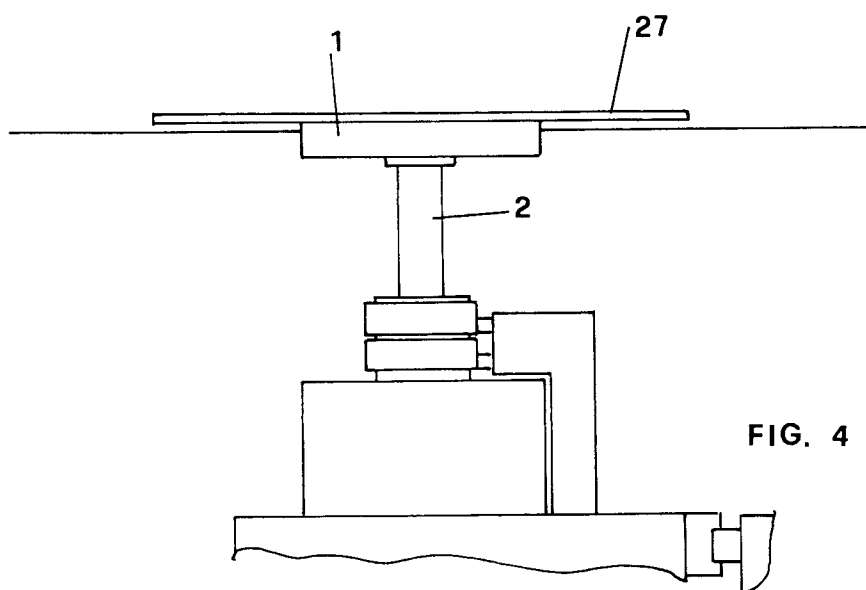


FIG. 1



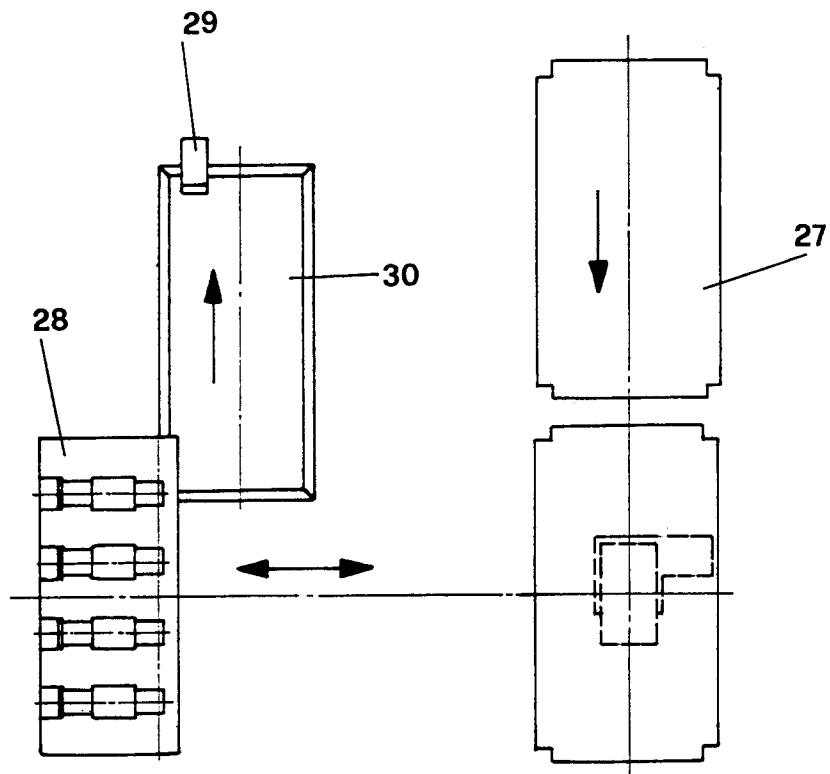


FIG. 7

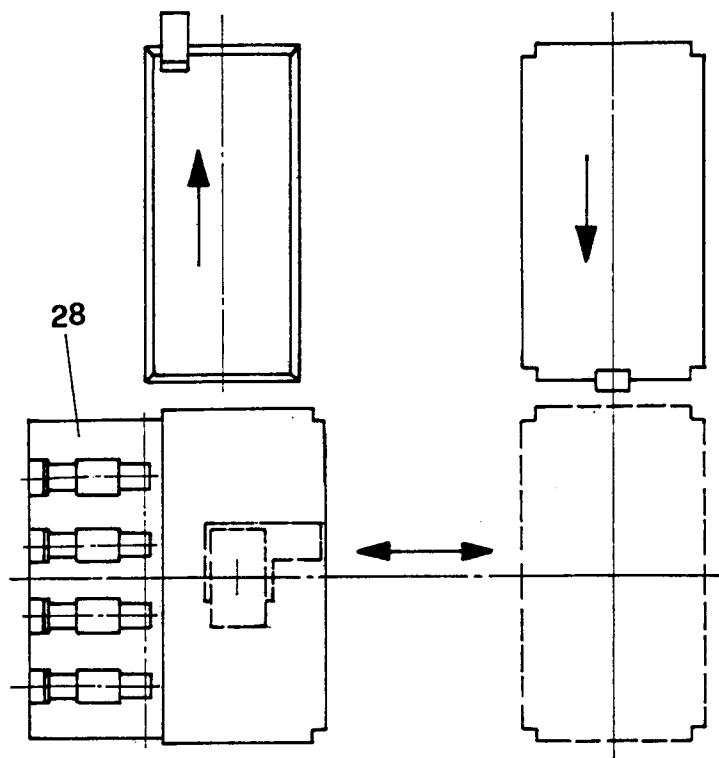


FIG. 8

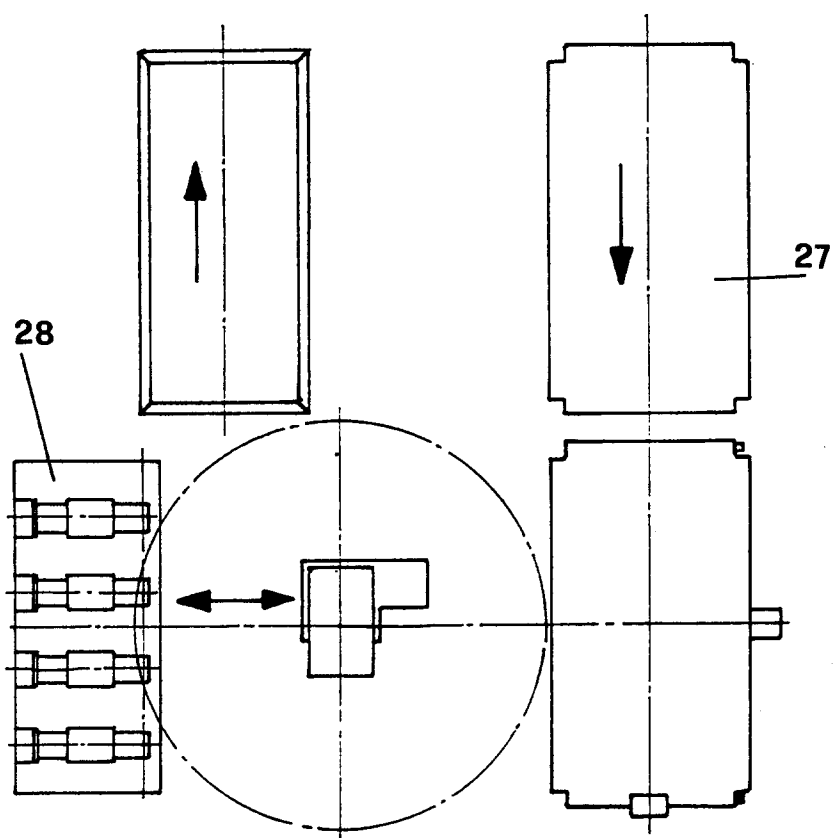


FIG. 9