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(54) **Locating apparatus for sheet processing apparatus and sheet processing apparatus incorporating such locating apparatus**

(57) A locating apparatus for locating a sheet (4) of material relative to an impression cylinder (10) of a sheet processing apparatus (2) is disclosed. The locating apparatus comprises frontlay devices (16) for engaging the to resist movement of the sheet relative to the impression cylinder in a direction of feeding of the sheet, and a sidelay assembly (20) for engaging the sheet to resist a component of movement of the sheet, relative to the impression cylinder, in a direction transverse to the feeding direction, such that the sidelay assembly has a substantially zero component of movement relative to the sheet in the feeding direction when engaging the sheet.

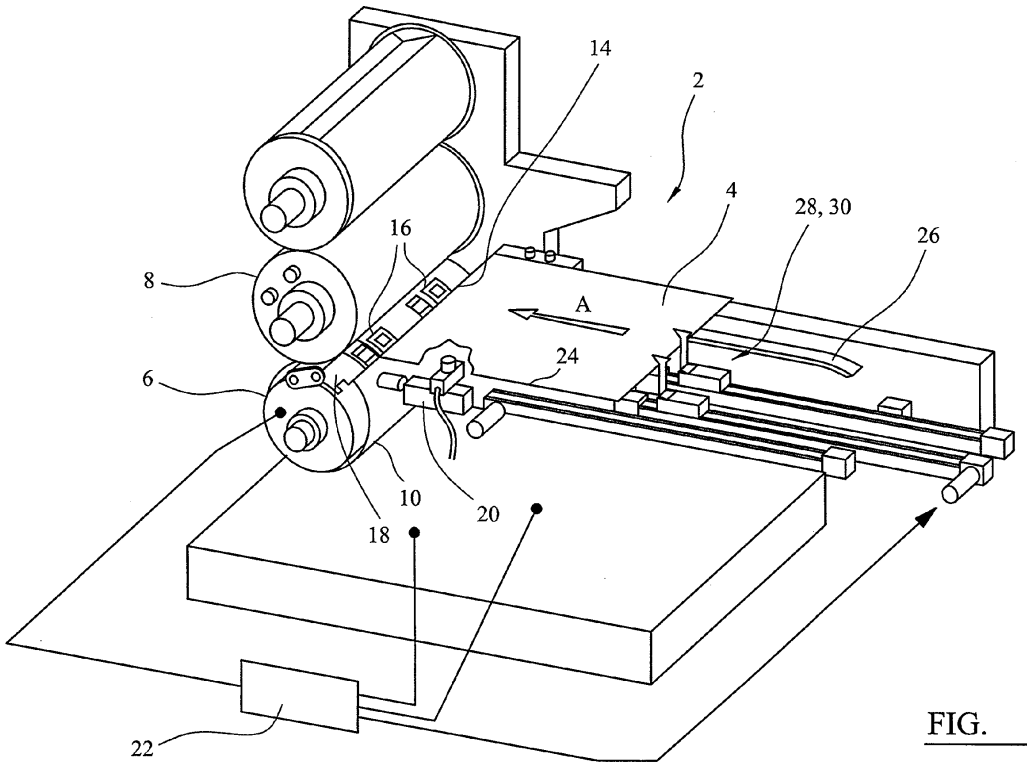


FIG. 1

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## Description

**[0001]** The present invention relates to a locating apparatus for locating a sheet of material relative to a sheet processing component of a sheet processing apparatus, and relates particularly, but not exclusively, to a locating apparatus for locating a sheet of material relative to a printing drum of a sheet printing or coating apparatus for sequentially handling individual sheets of material. The invention also relates to a sheet processing apparatus incorporating such locating apparatus.

**[0002]** In order to correctly locate a sheet of metal relative to a printing drum of a metal sheet printing machine, a leading edge of a metal sheet in the direction of sheet travel engages stops known as frontlays, and a side edge engages a stop known as a sidelay to define forward and sideways end positions respectively of the sheet. The frontlays then move in synchronisation with the drum until grippers grip the leading edge of the sheet to correctly locate the sheet relative to the drum. Because of the significant momentum of metal sheets moving at high line speed, this process handles metal sheets moving at line speed, as opposed to stationary sheets, in order to avoid significant changes of momentum of the sheet.

**[0003]** This arrangement has the drawback that if the sheet is insufficiently rectangular, sliding movement of the side edge of the sheet against the sidelay can impart a torque to the sheet, as it tries to move into engagement with the front lays, which can in turn cause misalignment of the sheet. Also, the torque applied to the sheet can cause buckling of the sheet, which can have a detrimental effect on print quality.

**[0004]** Preferred embodiments of the present invention seek to overcome one or more of the above disadvantages of the prior art.

**[0005]** According to an aspect of the present invention, there is provided a locating apparatus for locating a sheet of material relative to a sheet processing component of a sheet processing apparatus, the locating apparatus comprising:-

first engaging means for engaging a sheet of material to resist a component of movement of said sheet, relative to a sheet processing component of a sheet processing apparatus, in a direction of feeding of said sheet towards said sheet processing component; and

second engaging means for engaging said sheet to resist a component of movement of said sheet, relative to said sheet processing component, in a direction transverse to said direction of feeding, wherein said second engaging means is adapted to have a substantially zero component of movement relative to said sheet in said feeding direction when engaging said sheet.

**[0006]** By providing second engaging means for resisting a component of movement of the sheet in a direction transverse to the direction of feeding, wherein the second engaging means is adapted to have a substantially zero component of movement relative to the sheet in the feeding direction when engaging the sheet, this provides the advantage of reducing or eliminating torque applied by the second engaging means to the sheet when the sheet is insufficiently rectangular, thereby minimising the extent of buckling of said sheet. In addition, this provides the further advantage of enabling the sheet to be gripped by means of a suction head, thereby placing the sheet under tension, as opposed to compression, thereby further reducing the extent of buckling of said sheet. This in turn improves the accuracy of printing of the sheet processing apparatus when the apparatus is a sheet printing apparatus.

**[0007]** The second engaging means may comprise at least one abutment member for abutting said sheet.

**[0008]** Said second engaging means may comprise at least one first support and a plurality of said abutment members pivotably mounted to said support.

**[0009]** This provides the advantage of enabling smoother engagement of said second engaging means with said sheet.

**[0010]** The apparatus may further comprise gripper means for gripping said sheet.

**[0011]** This provides the advantage of enabling the sheet to be located under tension instead of under compression, which reduces the tendency of the sheet to buckle, especially in the case of very thin sheets. This in turn improves the accuracy of location of the sheet relative to the corresponding component of the sheet processing apparatus which improves the quality of sheet printing in the case of a sheet printing apparatus.

**[0012]** The gripper means may be mounted to said second engaging means.

**[0013]** The gripper means may comprise jaws for gripping said sheet.

**[0014]** The gripper means may be adapted to grip said sheet by means of suction.

**[0015]** This provides the advantage of enabling the gripper means to only engage the lower (i.e. unprinted or uncoated) surface of the sheet, which in turn eliminates any detrimental effect of the gripper means on print quality.

**[0016]** According to another aspect of the present invention, there is provided a sheet processing apparatus comprising:-

at least one sheet processing component adapted to apply material to a surface of a sheet of material; and
at least one locating apparatus as defined above.

**[0017]** The sheet processing apparatus may be a sheet printing apparatus.

**[0018]** The sheet processing apparatus may be a sheet coating apparatus.

**[0019]** Preferred embodiments of the invention will now be described, by way of example and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view of a sheet processing apparatus embodying the present invention;

Figure 2 is a plan view of a first embodiment of a sidelay assembly of the apparatus of Figure 1;

Figure 3 is a side view of the sidelay assembly of Figure 2 viewed in the direction of travel of the sheet;

Figure 4 is a plan view of a sheet gripper assembly of the apparatus of Figure 1;

Figure 5 is a side view of the gripper assembly of Figure 4 viewed in the direction of travel of the sheet;

Figure 6 is a side view of a second embodiment of a sidelay assembly of the apparatus of Figure 1;

Figure 7 is a plan view of the sidelay assembly of Figure 6;

Figure 8 is a schematic side view of a sheet feeding apparatus of the apparatus of Figure 1;

Figure 9 is a detailed view of part of a pusher head of the apparatus of Figure 8;

Figure 10 is a schematic view of part of the apparatus of Figure 1;

Figure 11 is a graph of a force profile provided by a gripping apparatus of the apparatus of Figure 10; and

Figure 12 is a graph of force profiles provided by conventional gripper apparatus.

**[0020]** Referring to Figure 1, a sheet processing apparatus 2 such as a sheet printing apparatus or a sheet coating apparatus embodying the present invention applies ink or coating material to a metal sheet 4 at a gap 6 between a blanket cylinder 8 and an impression cylinder 10.. Registration of a leading edge 14 of the sheet 4 with the impression cylinder 10 is achieved by means of a pair of frontlay devices 16 with accompanying grippers (not shown) which co-operate with respective notches 18 in the impression cylinder 10 to limit forward travel in the direction of arrow A of the sheet 4 and move with the impression cylinder 10 to cause registration of the leading edge 14 of the sheet 4 with the cylinder 10.

**[0021]** At the same time, a sidelay assembly 20 moves in synchronisation with the frontlay devices 16 by means of a controller 22 and provides a stop for limiting movement of the side edge 24 of the sheet 4 in a direction transverse to arrow A, while moving with the sheet along a support 26 in the direction of arrow A. The sheet 4 is fed to the gap 6 between the rollers 8, 10 by means of a suitable feeder apparatus 28, 30 (Figures 6 to 9). In addition, movement of the sheet 4 can be controlled by means of a gripper apparatus in the form of a feeder table 90 (Figure 10) comprising an array of electromagnets 92 which can be controlled by the controller 22 to vary the force applied to the sheet 4.

**[0022]** Referring to Figures 2 and 3, the sidelay assembly 20 comprises a pair of spaced apart reference pins 32 rotatably mounted to a support plate 34 having an inclined surface 36 adjacent the pins 32 facing the side edge 24 of the sheet 4. The support plate 34 is pivotably mounted to a support shaft 38 which is in turn attached to a carriage 40 (Figure 1) for movement along axes parallel and perpendicular to arrow A in Figure 1 to enable the sidelay assembly 20 to approach a desired position in a direction perpendicular to arrow A while at the same time moving with the sheet 4 in the direction of arrow A such that the component of movement of the sidelay assembly 20 relative to the sheet 4 in the direction of arrow A is substantially zero. As the pins 32 come into contact with the side edge 24 of the sheet 4, the support plate 34 can pivot about the support shaft 38 to accommodate deviations in rectangularity of the sheet 4 without imparting reaction torque to the sheet 4.

**[0023]** Referring to Figures 4 and 5, a gripper assembly 42 is positioned between the two reference pins 32 for gripping the side edge 24 of the sheet 4 when the sheet 4 reaches its desired sidelay position in a direction perpendicular to arrow A. The gripper assembly 42 comprises a two axis actuator 44 for opening and closing upper 46 and lower 48 jaws, and moving the upper 46 and lower 48 jaws into engagement with the edge 24 of the sheet 4 in the direction of arrow B shown in Figure 5. A spring 50 biases the jaws 46, 48 away from the sheet 4 so that when the sheet 4 engages the reference pins 32, a small preload against the pins 32 is ensured. The gripper assembly 42 pulls the sheet 4 into registration with the reference pins 32, and a further gripper assembly (not shown) on the opposite side of the sheet 4 pulls the sheet 4 in the opposite direction with a smaller force than the gripper assembly 42 shown in Figures 4 and 5 to place the sheet 4 under tension to ensure it is stable and flat across its width. This minimises any tendency of the sheet 4 to buckle and therefore improves accuracy of registration of the sheet 4 in the gap 6 between the rollers 8, 10. The controller 22 ensures that the jaws 46, 48 of the sidelay gripper assembly 42 open and the gripper assembly 42 is retracted after the frontlay grippers (not shown) have closed, and the sidelay grippers 42 then start their return path in preparation for the next sheet 4. A further actuator 51 assists in disengaging lower jaw 48 from sheet 4.

**[0024]** Referring to Figures 8 and 9, a feeder apparatus 30 for urging the sheet 4 in the direction of arrow A comprises a pusher head 52 mounted via a pusher arm 54

to a lever 56 pivotally mounted about a pivot 58 and carrying a cam follower wheel 60 which engages a cam surface 62. The lever 56 is pivotally connected at its end remote from the cam follower wheel 60 with a connector 64 which is slidably located at its other end in a main body 66. The main body 66 moves in the direction of arrow A with the cam follower wheel 60 in engagement with the cam surface 62 such that the cam follower wheel 60 moves up a first inclined surface 68 of the cam surface 62 to raise the pusher arm 54 and pusher head 52 into the plane of the sheet 4 to engage a rear edge of the sheet 4 while moving forwards in the direction of arrow A.

**[0025]** Referring to Figure 9, the pusher head 52 has a curved profile 70 such that it gradually engages the trailing edge of the sheet 4 to reduce forces applied to the sheet 4 to minimise the tendency of the sheet 4 to buckle. The main body 66 is urged further in the direction of arrow A so that the cam follower wheel 60 moves along a second inclined surface 72 of the cam surface 62, the second inclined surface 72 being less steep than the first inclined surface 68, to cause the pusher head 52 to further urge the sheet 4 in the direction of arrow A. The cam follower wheel 60 then engages a third inclined surface 74 of the cam surface 62, the third inclined surface 74 being steeper than the first 68 and second 72 inclined surfaces, which causes the lever 56 to pivot clockwise about the pivot 58 which causes the connector 64 to rotate anticlockwise against the action of compression spring 76 to lower the pusher arm 54 and pusher head 52 away from the plane of the sheet 4. This allows the main body 66 to then be retracted in the direction opposite to arrow A to prepare for engagement with the trailing edge of the next sheet 4. The arrangement shown in Figures 8 and 9 has the advantage over a feeding apparatus mounted to a continuous track in that a larger proportion of the cycle of movement of the feeder apparatus can occur with the pusher head 52 in engagement with the sheet 4, thereby improving efficiency of operation of the feeder apparatus.

**[0026]** Referring to Figures 6 and 7, a second embodiment of a sidelay assembly 20 is shown. The sidelay assembly 20 has a pair of reference pins 32 for engaging a side edge 24 of the sheet 4, the reference pins 32 being rotatably mounted to a support plate 34 which is in turn pivotably connected to carriage 40 by means of a support pin 36. A sheet feeding apparatus 28 includes a suction gripper 78 mounted to the carriage 40 and having a suction head 80 for gripping the underside of the edge 24 of the sheet 4 by means of suction. As the sheet 4 approaches the sidelay assembly 20 and the carriage 40 carrying the reference pins 32 approaches the side edge 24 of the sheet 4 under the action of two-axis actuator 82, the suction head 80 extends sideways underneath the path of travel of the sheet 4. The suction head 80 is then moved upwards towards the underside of the sheet 4 and suction switched on. The sheet 4 is then pulled into registration against the reference pins 32. A similar suction operated gripper (not shown) arranged on the opposite side of the sheet 4 pulls the sheet 4 with a lower force than that applied by the sidelay assembly 20 shown in Figures 6 and 7, to bring the sheet 4 into tension to ensure stability across its width. When the front lay grippers (not shown) have engaged the leading edge 14 of the sheet 4, the suction applied to suction head 80 is switched off, thereby releasing the sheet 4 from the feeding apparatus 28. The carriage 40 then retracts and starts its return path to engage the side edge 24 of the next sheet 4. The arrangement of Figures 6 and 7 provides the advantage that since it grips the bottom surface of the sheet 4, it has no effect on the printing area on the top surface of the sheet 4, which enables it to be used if there is no margin for a non-printed area. The arrangement of Figures 6 and 7 can also be constructed in a more compact and lightweight manner while also making the mechanism simpler by removing the need for actuation of a mechanical gripper. Also, any additional degree of freedom in the direction of arrow A can be compensated for the servo tracking performance by means of the flexible nature of a bellowed suction head 80.

**[0027]** Referring to Figure 10, a support table 90 for the sheet 4 has an array of electromagnets 92 which can be activated to grip the sheet 4, the electromagnetic force being varied by means of selective switching of the electromagnets by means of the controller 22. The support table 90 further includes a conveyor comprising a series of generally parallel conveyor belts 94 on which the sheet 4 rests and is urged by the conveyor belts 94 into engagement with the electromagnets 92 of the support table. As the sheet 4 slides over the support table 90, the controller 22 selectively switches on the electromagnets 92 to cause an initial increase in attractive force on the sheet 4 as the sheet comes into engagement with the support table 90, and then decreases the attractive force on the sheet 4 as the sheet 4 approaches roller 10 to provide a force profile 93 as shown in Figure 11. This contrasts with the force profile 96 as shown in Figure 12 for a conventional vacuum support table and force profile 98 for a conventional magnetic support table, which has the disadvantage that the increase in force as the sheet 4 approaches roller 10 can give rise to excessive friction acting on and buckling or deformation of the sheet 4, which has a detrimental effect on the accuracy of location of the sheet 4 relative to the roller 10.

**[0028]** It will be appreciated by persons skilled in the art that the above embodiments have been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims. For example, the support table 90 can use an array of suction devices in addition to, or as an alternative to, the electromagnets 92.

## Claims

**1.** A locating apparatus for locating a sheet of material

relative to a sheet processing component of a sheet processing apparatus, the locating apparatus comprising:-

first engaging means for engaging a sheet of material to resist a component of movement of said sheet, relative to a sheet processing component of a sheet processing apparatus, in a direction of feeding of said sheet towards said sheet processing component; and

second engaging means for engaging said sheet to resist a component of movement of said sheet, relative to said sheet processing component, in a direction transverse to said direction of feeding, wherein said second engaging means is adapted to have a substantially zero component of movement relative to said sheet in said feeding direction when engaging said sheet.

**2.** An apparatus according to claim 1, wherein the second engaging means comprises at least one abutment member for abutting said sheet.

**3.** An apparatus according to claim 2, wherein said second engaging means comprises at least one first support and a plurality of said abutment members pivotably mounted to said support.

**4.** An apparatus according to any one of the preceding claims, further comprising gripper means for gripping said sheet.

**5.** An apparatus according to claim 4, wherein the gripper means is mounted to said second engaging means.

**6.** An apparatus according to claim 4 or 5, wherein the gripper means comprises jaws for gripping said sheet.

**7.** An apparatus according to any one of claims 4 to 6, wherein the gripper means is adapted to grip said sheet by means of suction.

**8.** A sheet processing apparatus comprising:-

at least one sheet processing component adapted to apply material to a surface of a sheet of material; and

at least one locating apparatus according to any one of the preceding claims.

**9.** An apparatus according to claim 8, wherein the sheet processing apparatus is a sheet printing apparatus.

**10.** An apparatus according to claim 8 or 9, wherein the sheet processing apparatus is a sheet coating apparatus.

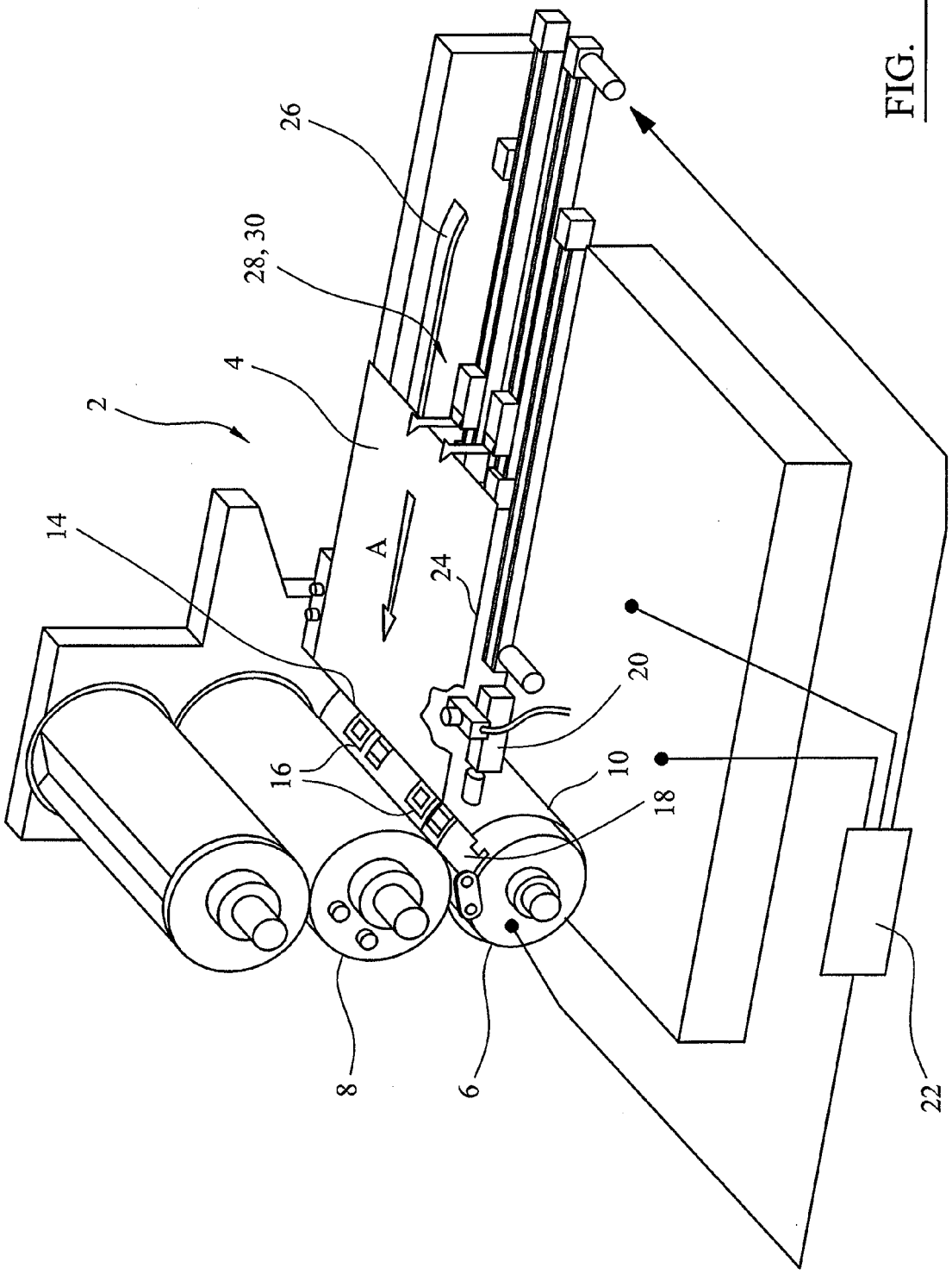



FIG. 1

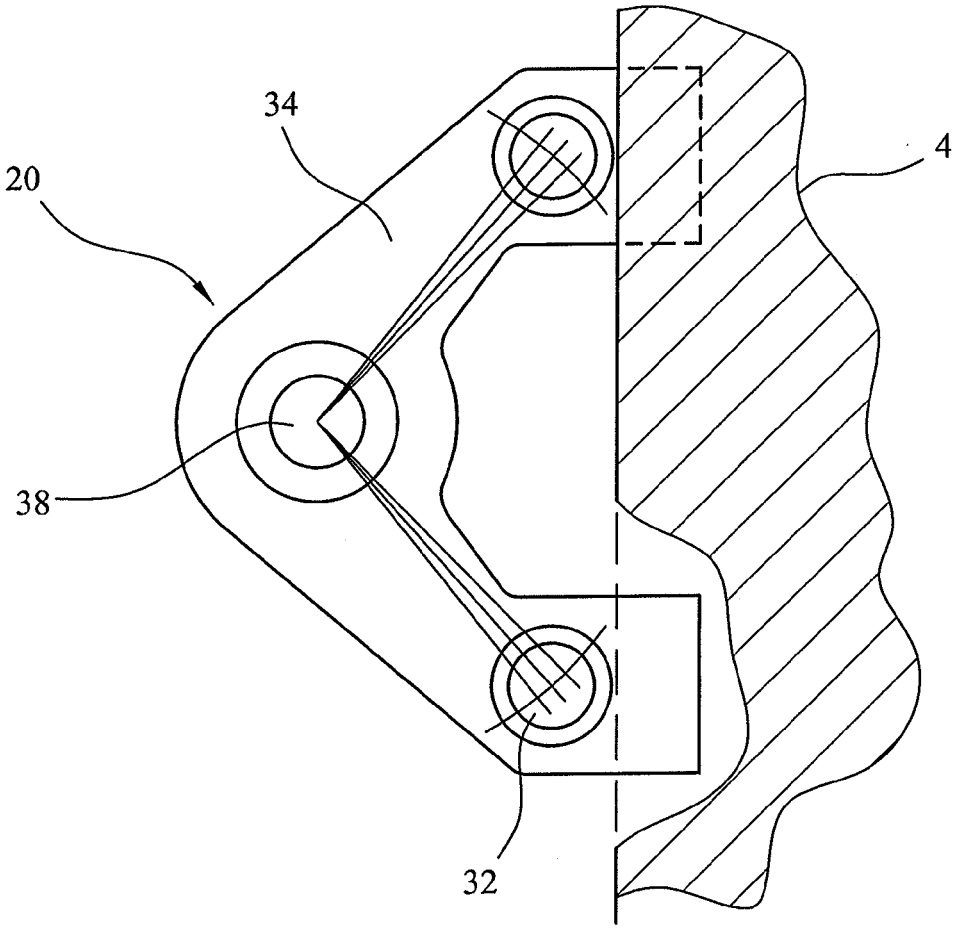



FIG. 2

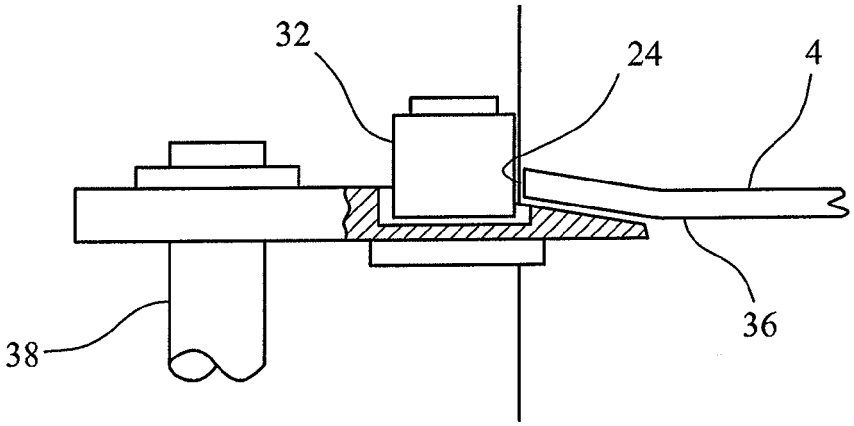



FIG. 3

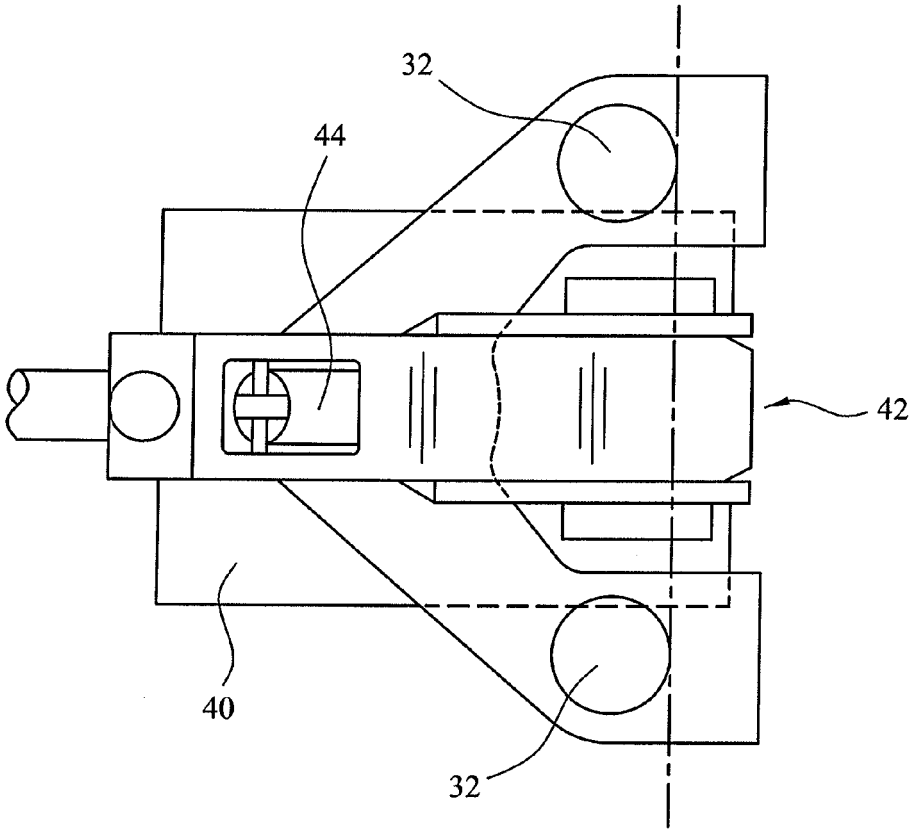



FIG. 4

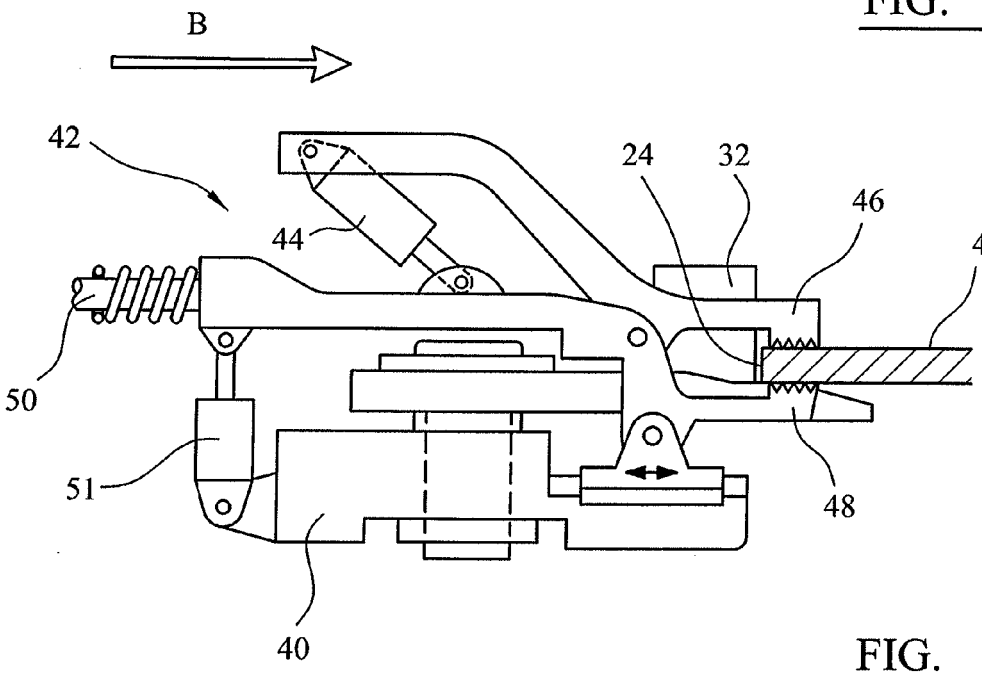



FIG. 5

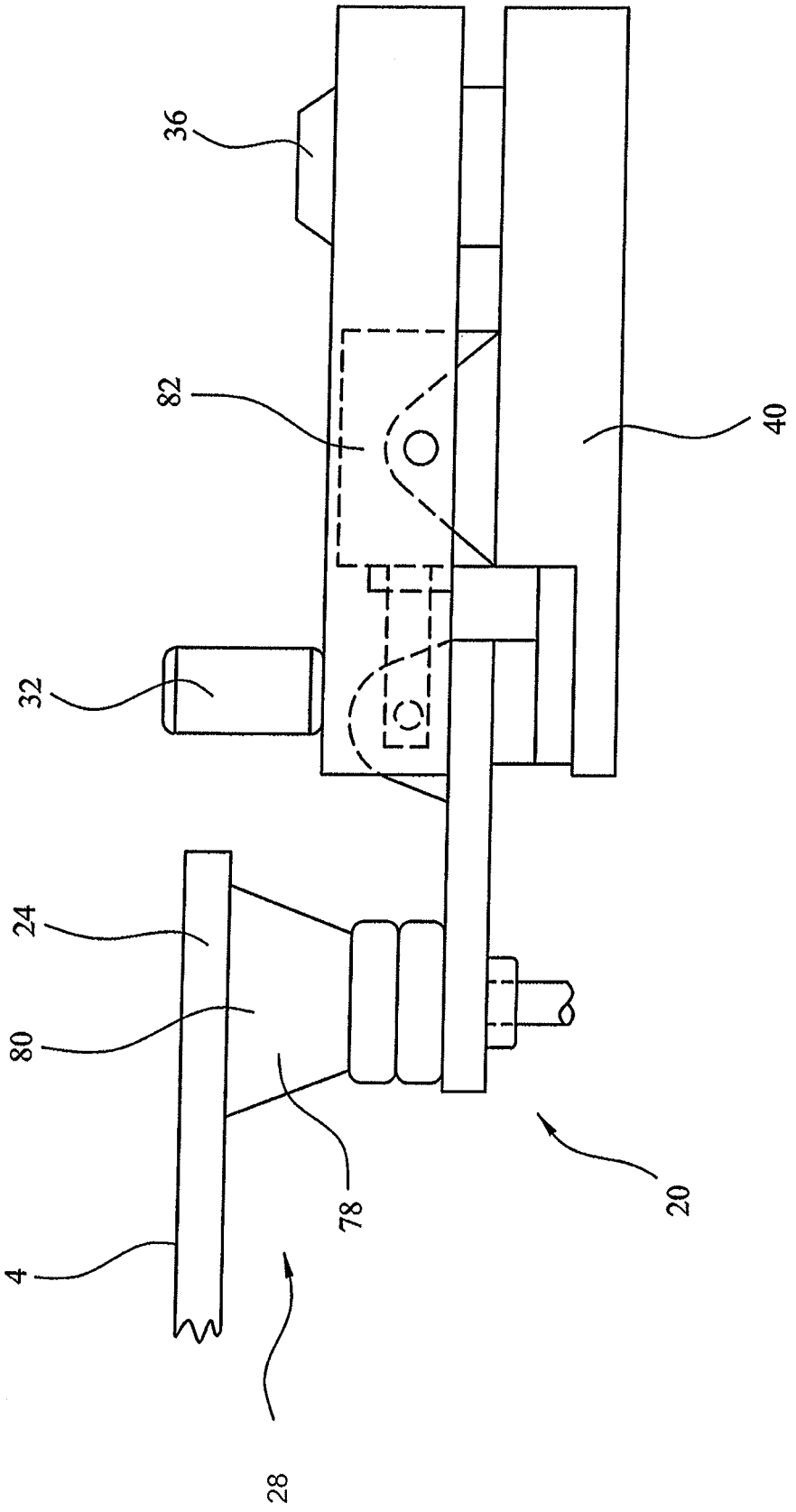



FIG. 6

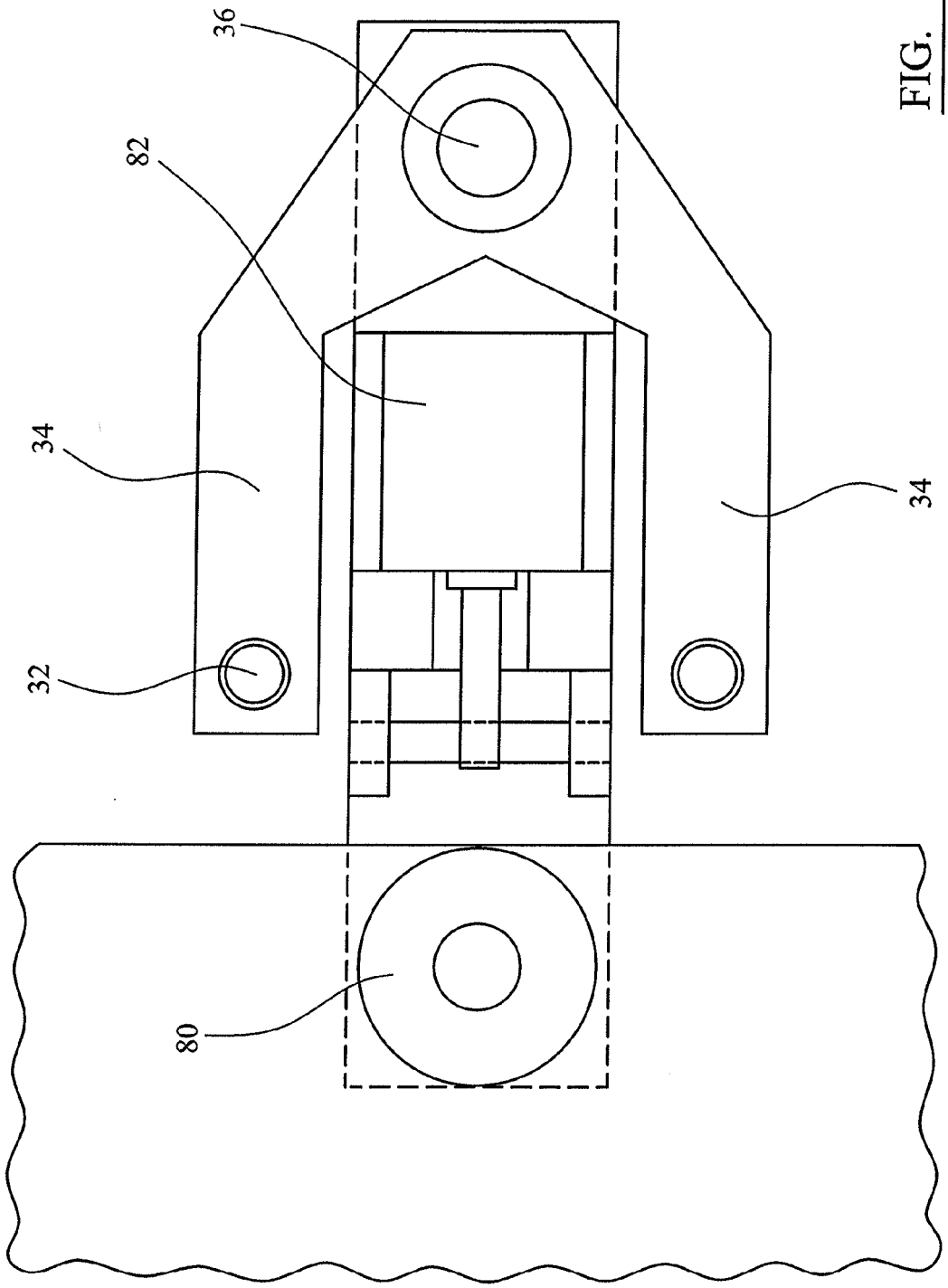
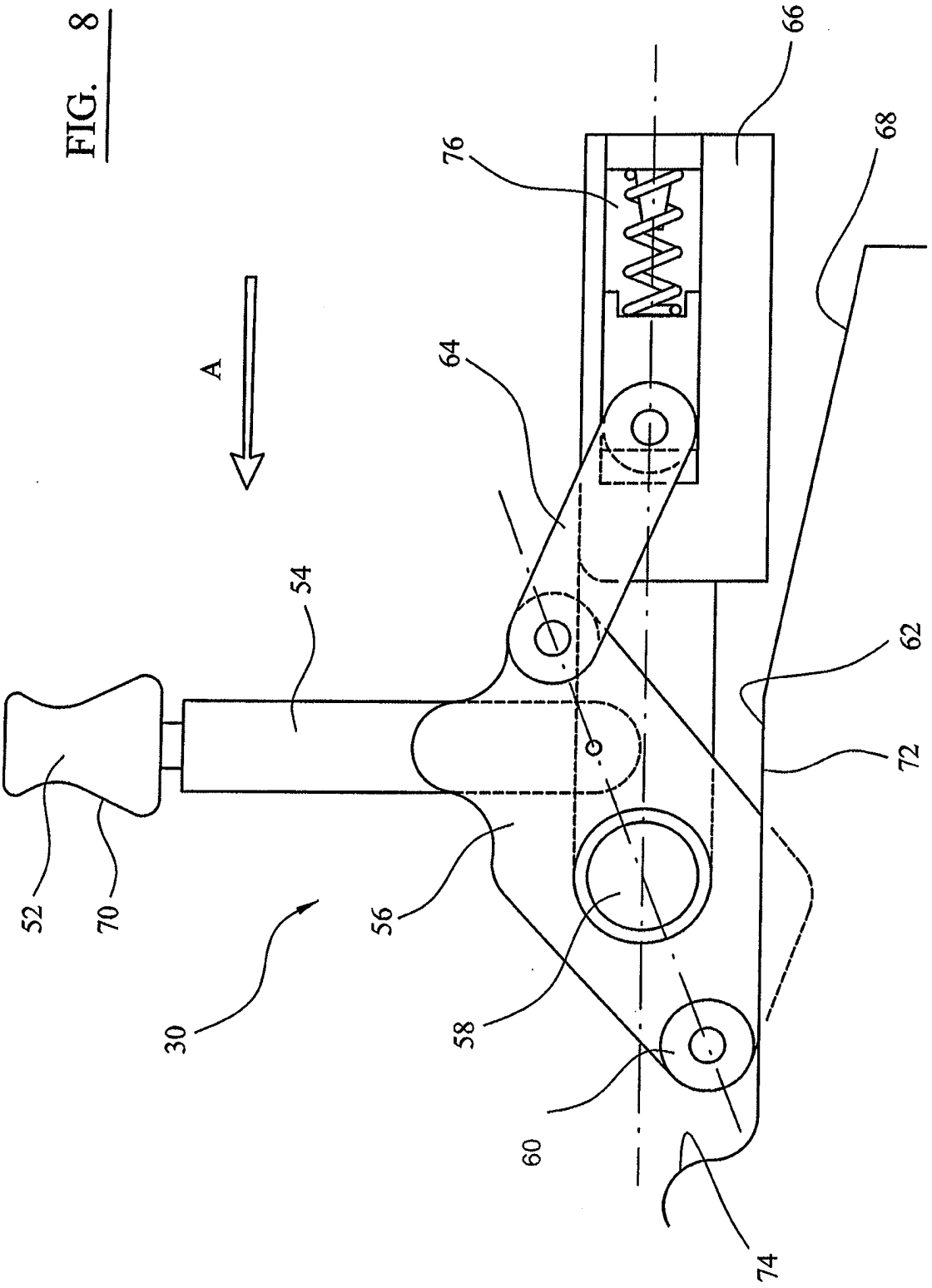



FIG. 7

FIG. 8



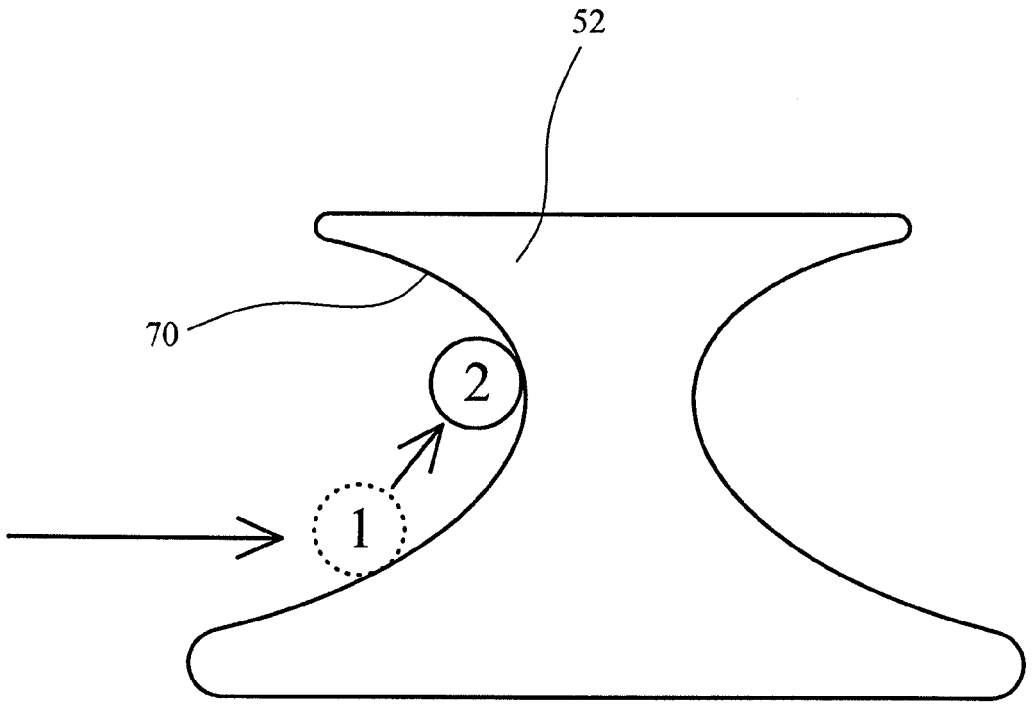



FIG. 9

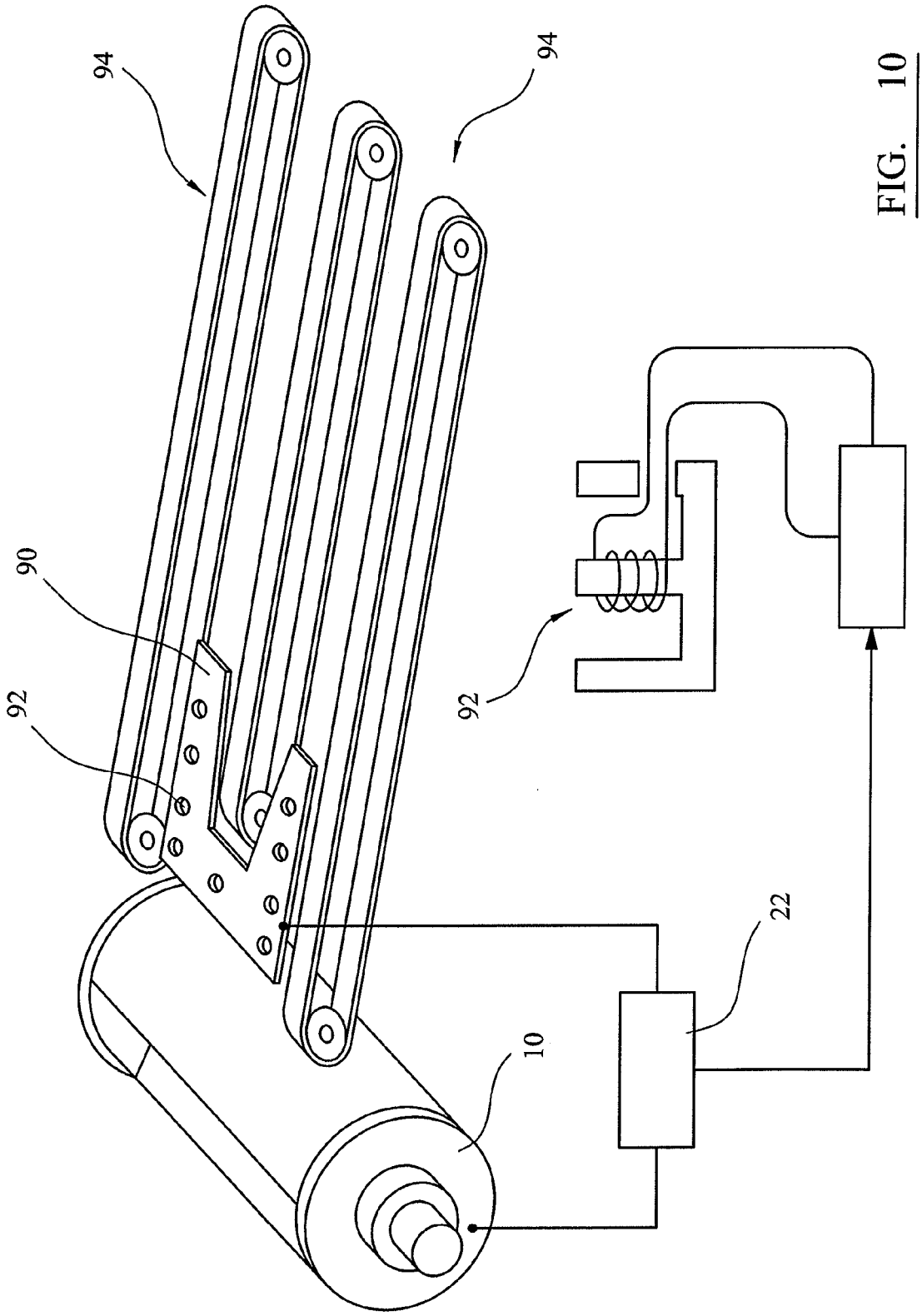



FIG. 10

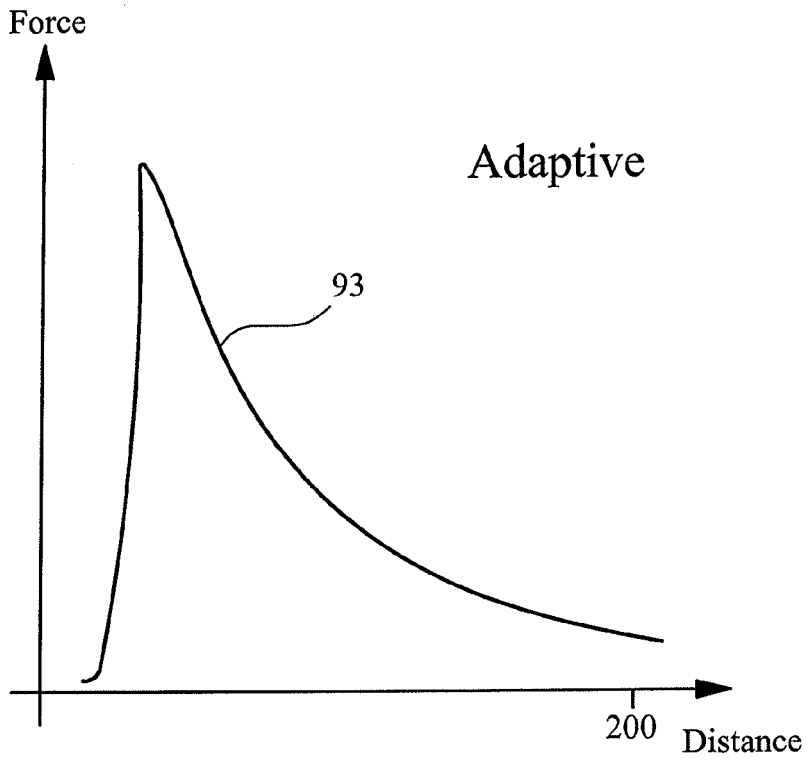

Force
Adaptive
93
200
Distance

FIG. 11

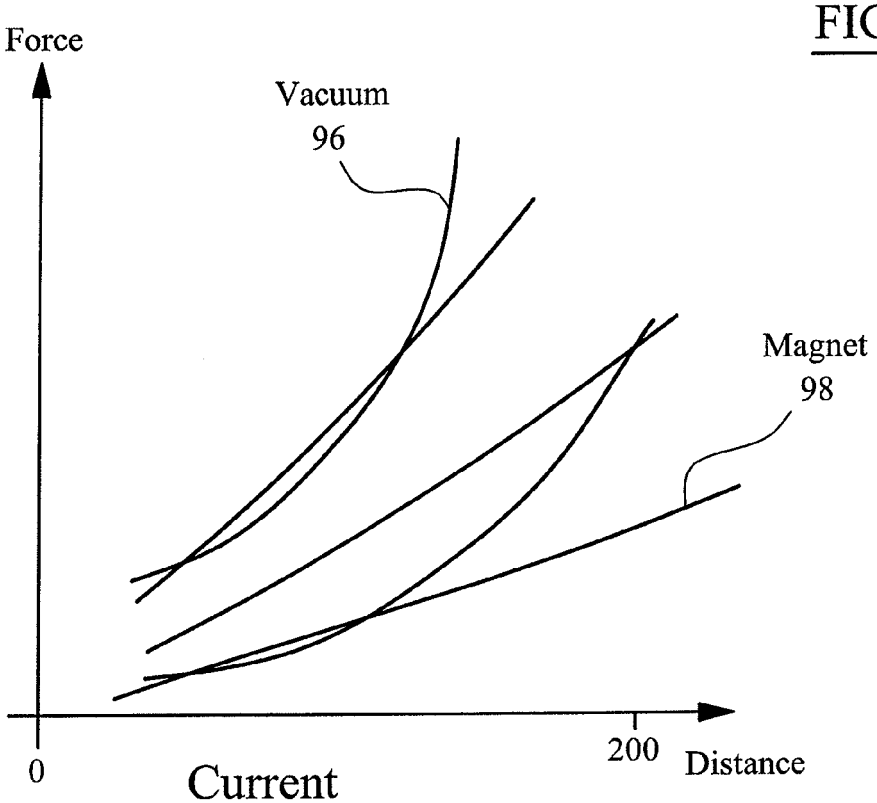

Force
Vacuum
96
Magnet
98
0
200
Distance
Current
State of Art

FIG. 12

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# EUROPEAN SEARCH REPORT

Application Number
EP 13 15 2364

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | WO 99/52711 A1 (CRABTREE GATESHEAD LTD [GB]; STEVEN ANDREW [GB])<br>21 October 1999 (1999-10-21)<br>* page 3, line 1 - page 5, line 16; figures 1,2 *<br>----- | 1-3,8-10 | INV.<br>B65H9/10 |
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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 13 June 2013 | Henningsen, Ole |

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 15 2364

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13-06-2013

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