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(72) Inventor: **Yates, David**
Leeds, LS18 4PR (GB)

(74) Representative: **Leckey, David Herbert**
Dehns
St Bride's House
10 Salisbury Square
London
EC4Y 8JD (GB)

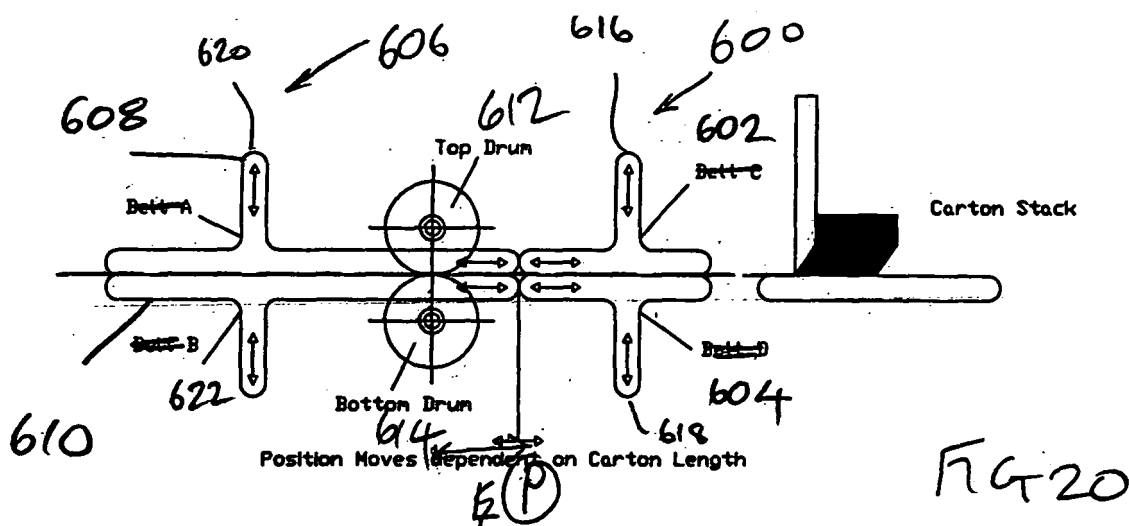
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(71) Applicant: **Chesapeake Limited**
The Broadway
Old Amersham
Buckinghamshire HP7 0UT (GB)

(54) **Rotary embossing**

(57) A rotary Braille embossing machine 500 comprises cooperating rotary drums with complementary Braille formations formed on each drum. Aspects of the set up of the drums and of the operation of the machine

are described. In certain embodiments the speed of conveyors 502, 504, 506, 510 are controlled to provide a larger gap between embossed blanks 514 on an output side than on an input side.



Description

[0001] The present invention relates to a method and apparatus for rotary embossing and in particular, but not exclusively, to a method and apparatus for embossing discrete sheet-like articles such as packaging blanks.

[0002] In recent times, it has become necessary to provide information for the visually impaired on certain types of packaging, most significantly on pharmaceutical packaging. This is usually achieved by embossing Braille characters onto the packaging. A number of machines are used for this purpose. In a first type of machine, the pattern is embossed into the packaging blank at the same time as the creases and cuts are formed in the blank. This is, however, rather slow and requires the use of multiple embossing units on a single machine. In another type of machine, the embossing takes place after the blank has been creased and cut. Such machines tend to use rotary embossing.

[0003] In a rotary embossing machine, male and complementary female formations are provided on opposed drums, between which the article to be embossed passes. The movement of the drums is synchronised, for example, by gearing, in order to ensure that the formations on the respective drums are in proper alignment. In the existing machinery, cut, creased and pre-folded blanks are fed to the embossing drums from a conveyor. The blanks are located accurately on the conveyor by flights. This ensures that the blanks are fed accurately to the embossing drums to ensure that the blanks are embossed in the correct position.

[0004] However, a drawback with the above type of machine is that the speed of delivery of blanks to the embossing drums is somewhat limited. For example, typical feed speeds are in the region of 120 metres per minute. Higher feed speeds are desirable. Accordingly, the present invention seeks to provide an alternative method of and apparatus for embossing a blank which overcomes or mitigates the above problems.

[0005] From a first aspect, therefore, the invention provides an embossing apparatus comprising: a rotary embossing drum driven by a motor and having an embossing formation; a conveyor for feeding blanks to the embossing drum; and a control, said control comprising: means responsive to a sensed position and speed of the blank and a sensed position and speed of the drum for applying a correction to the rotational position of the drum such that the blank will engage the embossing formation in the correct position as it travels past the formation.

[0006] The invention also extends to a method of embossing comprising: feeding a blank to an embossing drum; sensing a datum on the blank; determining the speed of the blank; determining the speed and angular position of an embossing formation on the blank; determining whether said blank will engage with said embossing formation in a desired position; and in the event that it is determined that the blank will not engage the embossing formation in the desired position, adjusting a ro-

tational position of the drum such that it will.

[0007] Thus the present invention, rather than relying upon blanks being fed to an embossing drum in a well defined position, as is the case where blanks are supplied by a flighted conveyor, senses individual blanks as they are fed to the embossing drum and compensates for any change in spacing between adjacent blanks which, if not corrected for, would lead to the pattern to be embossed being positioned incorrectly on the blank. The invention allows blanks to be fed to the embossing drum on conventional conveyors, at much higher speeds, leading to improved productivity.

[0008] Preferably, co-operating male and female embossing drums are provided having complementary formations formed on each. In this event, the rotational position of both drums needs to be controlled such that the blank engages the embossing formation in the correct position.

[0009] The position of the blank can be sensed by any suitable means. Such means may sense any suitable datum on the blank. The datum on the blank can be any feature on the blank, provided the position of that feature relative to the position of the desired embossing is known. For convenience, the datum may be the leading edge of the blank. The sensing means may comprise any suitable sensor, such as an optical sensing unit.

[0010] The speed of the blank can most easily be sensed by determining the surface speed of the conveyor, as the blank moves with the surface of the conveyor without slipping. The surface speed of the conveyor can easily be determined from the rotational speed of a drive of the conveyor and the radial offset of the conveyor drive surface from the drive axis. An encoder may be provided on the drive shaft to provide information regarding the rotational speed of the drive.

[0011] Knowing the speed of the blank and the position of a datum, the time taken for the blank to reach the embossing formation can be accurately calculated. Knowing this, and the rotational position of the embossing formation on the drum and the speed of rotation of the drum it is possible to determine where on the blank, relative to the datum the formation will engage the blank.

[0012] The rotational position of the embossing formation does not need to be sensed as such, but can be determined by means such as an encoder which, once the initial position of the embossing formation is determined accurately, can be used to determine the formation's rotational position at later times.

[0013] If it is determined that the embossing formation will not engage the blank in the correct position, then a rotational position of the drum can be adjusted to compensate for this.

[0014] Advantageously, the adjustment is achieved using a servo motor drive for the drum, controlled by an appropriate servo control.

[0015] In a first embodiment, the speed of rotation of the embossing drum can be adjusted so as to affect the necessary compensation. Thus, if it is determined that

the embossing formation will engage the blank ahead of the intended position, the speed of the drum may be decreased such as to bring the formation and blank into the desired relative positions. Similarly, if it is determined that the formation will engage the blank behind the intended position, the drum speed can be increased.

[0016] From a further aspect the invention provides a method of embossing an article using a rotary embossing drum, wherein the speed of rotation of the drum is adjusted in response to a sensed position of the article so as to ensure that the article is embossed by the drum in the correct position.

[0017] In an alternative arrangement, the angular position of the entire drive motor itself may be adjusted. Thus, in another arrangement a servo control may rotate the motor in its entirety around its rotational axis which will have the effect of either advancing or retarding the engagement of the formation with the blank.

[0018] In the preferred embodiment, both drums are driven by respective servo motors which are controlled independently by the control. In another arrangement, however, it would be possible to provide just a single servo motor which drives both drums through a suitable linkage. Two servo motors are preferred, however, as it reduces the inertial effects on the system.

[0019] The conveyor and embossing drum are preferably provided in a unit which can be fitted to existing machinery. In addition, the unit preferably further comprises an out feed conveyor which conveys the embossed blank to subsequent processing stations.

[0020] As is common in the conveying art, the infeed and outfeed conveyors may comprise a lower conveyor which receives a blank and an upper conveyor which is spring loaded against the lower conveyor so as to hold the blank firmly on the lower conveyor.

[0021] In one embodiment, the infeed and outfeed conveyors comprise a common lower conveyor, with separate upper conveyors arranged on the infeed and outfeed sides of the embossing unit. The lower conveyor is preferably driven by a single input, which may be taken from adjacent parts of the machinery. Alternatively, the conveyor may be driven by a separate motor whose speed is synchronised with the speed of adjacent machinery. The upper conveyor, at least on the infeed side may be adjustable in position longitudinally of the apparatus to accommodate different sizes of blanks so that they can be accurately fed to the nip between the embossing drums.

[0022] The above arrangement makes it possible for the blank not to be constrained by an upper conveyor in the region of the embossing drums. This is advantageous in that it permits the desired correction of drum position for a particular blank to occur while the preceding blank is still being embossed or is still held between the embossing drums. If the blanks were being held firmly between upper and lower conveyors while held between the drums, any relative movement between the drum surface and the conveyor (which runs at a constant speed)

would lead to either compression or tension in the blank which could lead to buckling or tearing of the blank. The absence of upper restraint means that the blank can slip slightly on the lower conveyor to accommodate the relative movement. In the absence of such a feature, the system would have to be configured only to effect a correction while no blank was between the embossing drums, which would mean leaving a larger gap between blanks. That would lead to slower blank through-put.

[0023] In preferred embodiments of the invention, therefore, the adjustment of the rotational position of the embossing formation occurs while a preceding blank is still between the embossing drums and the infeed and outfeed conveyors are positioned or configured such as to permit relative movement between the blanks and the lower conveyor as the blanks pass between the drums,

[0024] In an alternative embodiment to that described above with separate infeed and outfeed upper conveyors, common upper and lower infeed and outfeed conveyors may be provided. However, to allow for slippage of the blank relative to the lower conveyor, in a preferred arrangement, the biasing force exerted by the upper infeed conveyor section and possibly also the outfeed conveyor section against the corresponding lower conveyor sections is adjustable. This permits the spring force forcing the blank down onto the lower conveyor to be reduced or eliminated in the region of the embossing drums, thereby permitting slippage of the blank on the lower conveyor.

[0025] This arrangement may be advantageous over the arrangement described earlier where there is no upper conveyor in the region of the embossing drums. Since although there is no significant clamping between the upper and lower conveyors, the upper conveyor does prevent the blank lifting, as might otherwise happen, particularly towards the edges of the blank.

[0026] Typically the upper conveyor biasing arrangement comprises a plurality of spring loaded wheels acting against the back of the upper conveyor, and the adjustment can be effected by merely raising the wheels away from the conveyor, for example using a suitable cam mechanism.

[0027] Preferably, more than one conveyor is provided across the width of the unit to provide sufficient support for the blank. Most preferably the conveyors are adjustable laterally so as to provide support in the appropriate position.

[0028] In a yet further arrangement, each infeed conveyor and outfeed conveyor may comprise respective upper and lower conveyors.

[0029] This arrangement has several potential advantages. Firstly, it allows independent control of the speed of the infeed and outfeed conveyors should that be required. It may also simplify construction of the machine.

[0030] In order for the blanks to be supported as they pass between the embossing drums, the outfeed conveyor may extend upstream of the embossing drums. The infeed conveyor then terminates a distance upstream of the embossing drums. However, that distance

is chosen such that the blank is still accurately fed into the nip between the embossing drums by the infeed conveyor. In effect, the upstream part of the outfeed conveyor acts as a part of the infeed conveyor.

[0031] This is in itself a novel arrangement so from a further aspect, the invention provides an embossing apparatus comprising: a rotary embossing drum driven by a motor and having an embossing formation; an infeed conveyor for feeding blanks to the embossing drum; an outfeed conveyor for conveying embossed blanks away from the embossing drum; said outfeed conveyor extending to a point upstream of said embossing drum.

[0032] In an alternative arrangement, the infeed conveyor may extend downstream of the embossing drums. From a further aspect, therefore, the invention provides an embossing apparatus comprising: a rotary embossing drum driven by a motor and having an embossing formation; an infeed conveyor for feeding blanks to the embossing drum; an outfeed conveyor for conveying embossed away blanks from the embossing drum; said infeed conveyor extending to a point downstream of the embossing drum.

[0033] Preferably the position of the downstream edge of the infeed conveyor and the upstream edge of the outfeed conveyor is variable to accommodate different lengths of blank.

[0034] Preferably one or both of the conveyors is retractable to a position downstream of the embossing drums so that the drums can be accessed more easily for example for setting or removal.

[0035] This is in itself a novel arrangement so from a further aspect, the invention provides an embossing apparatus comprising: a rotary embossing drum driven by a motor and having an embossing formation; an infeed conveyor for feeding blanks to the embossing drum; an outfeed conveyor for conveying embossed away blanks from the embossing drum; a conveyor or conveyors being retractable from the drum.

[0036] In a typical apparatus, the infeed and outfeed conveyors will comprise two or more sets of belts laterally spaced apart so as to provide satisfactory support for the blank. Having independent infeed and outfeed conveyors also allows for the possibility that the relative speed of these laterally spaced conveyors may be adjusted so as to vary the angle of the blank on the conveyor. This is useful in correcting skew of the blanks.

[0037] From a further aspect the invention provides an embossing apparatus comprising: a rotary embossing drum driven by a motor and having an embossing formation; a conveyor for feeding blanks to or conveying blanks away from the embossing drum said conveyor comprising a plurality of laterally spaced belts; and means for adjusting the relative speed of said belts so as to adjust the angle of the blank on the conveyor.

[0038] In the various embodiments described above, it is important that the infeed conveyor runs at a consistent speed relative to an upstream feed unit so that blanks are presented to the infeed conveyor of the embossing

unit at a consistent spacing. If the conveyors of the embossing unit are driven by a downstream unit, the speed of that unit may vary over time, for example if there is a variable power supply or through aging of the machinery. If that occurs, the feed of blanks onto the infeed conveyor may become inconsistent.

[0039] This problem can be overcome by having a direct drive arrangement wherein the upstream unit, the infeed and outfeed conveyors of the embossing unit and the downstream unit are coupled together through a common drive mechanism e.g. a drive chain. Whilst satisfactory, this is potentially expensive as the drive of the upstream and downstream units may have to be modified to provide or receive drive to or from the embossing unit.

[0040] It is preferable, therefore to provide synchronised drives for the upstream unit, downstream unit and the infeed and outfeed conveyors.

[0041] Preferably, therefore the conveyors of the embossing unit are synchronised to operate at the same speed as the upstream feed conveyor such that blanks are fed consistently to the infeed conveyor of the unit. However, that speed is preferably variable, based on a detected speed of the downstream unit. Most preferably, the speed of the conveyors and upstream unit is lower than that of the downstream unit so that a gap is generated between the blanks as they leave the outfeed conveyor. The size of this gap can be varied by varying the relative speeds of the outfeed conveyor and the downstream unit.

[0042] The speed of the embossing unit conveyors and the upstream unit is preferably calculated as a percentage of the speed of the downstream unit, for example, 90%. Preferably an average speed of the downstream unit is used as the basis for the calculation.

[0043] The speed of the embossing unit conveyors and upstream unit may be varied continuously or only when the speed of the downstream unit varies by more than a given percentage, for example by $\pm 5\%$. Thus on start up or run down of the downstream unit the speed of the upstream units will increase and decrease in a stepwise manner.

[0044] The embossing drums are also preferably adjustable laterally of the apparatus. This allows the position of the drum to be adjusted to lay down the embossed pattern in a desired position on the blank.

[0045] For example, a typical packaging blank comprises a number of panels hingedly connected together about crease lines. The invention will allow particular panels to be embossed as required. For example, face panels of the blank may be embossed. It is possible also to emboss say a glue panel in order to treat the surface thereof. This may potentially improve the adhesion of that panel to an adjacent panel.

[0046] This is believed to be a novel arrangement in its own right, so from a further aspect, the invention provides a method of treating a packaging blank comprising embossing the adhesive receiving surface of a glue panel of the blank.

[0047] In one embodiment, embossing drum supports may be mounted on shafts extending laterally between the sides of the apparatus. The drive motor may be fixed to a side of the apparatus and have a drive shaft extending laterally across the apparatus such that irrespective of the lateral position of the drum it will be able to engage the drive shaft.

[0048] In one embodiment, where respective drive motors are provided for the respective embossing rollers, the drive motors may be arranged on opposite sides of the apparatus in order to facilitate motor positioning.

[0049] Alternatively, and preferably, each drum and its associated drive motor is mounted on a carriage which is adjustable in transversely of the apparatus on guides extending across the apparatus. Such an arrangement has the potential advantage that the drum and motor may be assembled onto the carriage away from the apparatus, thereby facilitating setting.

[0050] It will be appreciated that more than one size of embossing drum may have to be used on a machine at different times, depending, for example, on the size of blank being embossed. Preferably therefore, means are provided to accommodate different drum sizes.

[0051] In one preferred arrangement, therefore, the upper and lower embossing drums are mounted in vertically adjustable supports, preferably slidably mounted in the apparatus.

[0052] In one embodiment the respective support is engageable with an adjustable stop provided on the machine. Preferably the stop is formed as an adjustable wedge, such that depending on the position of the wedge, the support will engage with the stop at a higher or lower position. Of course, in an alternative embodiment, the wedge could instead be provided on the support and a static stop be provided on the machine.

[0053] The wedge may be mounted on the machine frame in any suitable manner, for example, in a sliding mount, or in a number of discrete positions.

[0054] The wedge is preferably a stepped wedge which may be preferably in that each step may correspond to a particular drum diameter thereby facilitating setting.

[0055] The above arrangements are advantageous in their own right, so from a further aspect, the invention provides an embossing apparatus comprising a pair of supports for opposed embossing drums, said supports cooperating with the machine through being an adjustment wedge or cam for adjusting the relative vertical positions of the supports.

[0056] Preferably a pair of spaced apart adjustment wedges or cams is provided for each drum support.

[0057] The above described arrangement may potentially provide very accurate positioning of the drums. However, it will be appreciated that in use, some degree of fine adjustment may be needed to accommodate, for example the thickness of the blank material, wear in component parts etc. To accommodate this, at least one drum (and preferably only one) support preferably engages the

above mentioned wedge through a further, fine adjustment wedge. This arrangement of wedge engaging wedge provides for a wide range of accurate adjustment.

[0058] The fine adjustment wedge may be moved by any suitable means such as a lead screw.

[0059] It will be appreciated that if a separate set of embossing drums is provided for each blank length then the machine may operate at high speed with relatively little if any correction required provided the gap between the cartons fed to the machine is very small (for example 1 to 2mm) and provided that gap is smaller than the accepted positional tolerance of the embossing on the blanks.

[0060] The embossing formation may be of any desired type. Preferably however, it is a Braille formation.

[0061] The embossing drum may comprise any suitable number of embossing formations. For example, depending on the size of the blank being embossed, the drum may contain two, three or even more embossing patterns so that more than one blank is embossed per revolution of the embossing drum.

[0062] It is also possible within the scope of the invention to provide a plurality of pairs of embossing drums in the unit to allow different regions of the blank to be embossed simultaneously. Thus, for example, more than one panel of a packaging blank may be embossed. In such arrangements, the drum pairs are preferably spaced laterally across the unit and are preferably arranged on a common drive spindles driven by the same motor or motors. Provided the drum pairs are correctly positioned one relative to the other when the machine is set up, they will maintain their proper relative rotational position such that the patterns embossed in the different positions maintain the correct relative positions.

[0063] From a further aspect therefore, the invention provides a rotary embossing machine comprising a plurality of rotary embossing drums arranged on a common drive spindle.

[0064] It will also be appreciated that it is important to correctly align the respective formations on the drums of the or each drum pair. As stated previously, each drum and its associated drive motor is preferably mounted on a carriage which is adjustable transversely of the apparatus in guides which extend across the apparatus. That has the advantage that the drum and motor may be assembled on the carriage away from the apparatus thereby facilitating setting.

[0065] In a preferred embodiment of the invention, means are provided for setting the relative rotational positions of the drums of each pair on a setting jig. In one preferred embodiment, a setting member is provided on one or other of the drums for engagement in a corresponding formation on the other drum such that when a drive coupling for each drum is located with respect to a predetermined datum position, the drums may be loosened on their drive shaft and then rotationally positioned such that the setting member engages in the formation, at which point the drums can be locked into position on

their respective drive shafts.

[0066] Although this may provide accurate positioning of the drums in most cases, there is the possibility that because of, for example wear in the setting formations, there will be some rotational or other misalignment between the drums once the drums are actually located on the embossing machine. Accordingly, in a preferred embodiment, the embossing apparatus includes means for allowing the relative rotational position of the respective drums to be adjusted in a setting operation. This in itself is a novel and inventive arrangement, so from a further aspect, the present invention provides a method for aligning and embossing formations on an embossing machine, comprising rotating one embossing drum relative to the other *in situ* on the machine to align one drum with the other.

[0067] This rotation is preferably effected by rotating the drive shaft of one of the drums relative to the other. This may be done manually, but more preferably it is done through operating the drive motor for that drum to rotate the drum by an appropriate amount.

[0068] A preferred embodiment of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a side view of an apparatus in accordance with the invention;

Figure 2 shows a similar view to Figure 1 but with various components removed for clarity;

Figure 3 shows an end view of the apparatus of Figure 1;

Figure 4 shows a top plan view of the apparatus of Figure 1;

Figure 5 shows schematically a control for the apparatus;

Figure 6 shows an embossing drum for use in the apparatus of Figure 1;

Figure 7 shows an embossing plate for use in the embossing drum of Figure 6;

Figure 8 shows a perspective view of a second apparatus in accordance with the invention;

Figure 9 shows a front view of the apparatus of Figure 8;

Figure 10 shows a side view of the apparatus of Figure 8;

Figure 11 shows the apparatus of Figure 8 from a different perspective and having additional components;

Figure 12 shows a subassembly of the apparatus of Figure 8;

Figure 13 shows a further subassembly of the apparatus of Figure 8;

Figure 14 shows a yet further subassembly of the apparatus of Figure 8;

Figure 15 shows the conveyor belt arrangement of the apparatus of Figure 8; Figure 16 shows an exploded detail of Figure 15;

Figure 17 shows an exploded view of an alternative

coupling between an embossing drum and servo motor;

Figure 18 shows the coupling of Figure 17 assembled;

Figure 19 shows a further embodiment of the invention;

Figure 20 shows a yet further embodiment of the invention; and

Figure 21 shows the embodiment of Figure 20 in a different configuration.

[0069] Referring to Figures 1 to 4, a rotary embossing apparatus 2 comprises, in broad terms, an infeed conveyor 4, an outfeed conveyor 6 and a rotary embossing unit 8 arranged between the infeed and outfeed conveyors 4, 6.

[0070] The unit 2 is arranged between upstream and downstream units not shown. The upstream unit typically will comprise a prefolding unit which takes cut and creased blanks from a magazine and prefolds them to facilitate subsequent gluing. The downstream unit is typically a folding and gluing unit.

[0071] Returning to the unit 2, in more detail, the unit 2 comprises side plates 10,12 which are joined by cross-braces 14,16. Mounted to one side plate 10 are first and second spindles 20,22. On the first spindle 20 are mounted a first pulley 24 and second pulley 26. On the second spindle 22 are mounted first, second and third pulleys 28,30,32. The first pulley 24 mounted on first spindle 20 receives drive from an adjacent downstream unit (not shown) through a belt 33. The drive is transferred across the unit through the smaller diameter pulleys 26,28. The larger diameter pulley 30 on the second spindle 22 rotates with the smaller diameter pulley 28 and provides drive through a belt 35 to an upstream unit (not shown).

[0072] The innermost pulley 32 on spindle 22 is used to drive the infeed and outfeed conveyors 4,6. In particular, the pulley is connected by a belt 37 to a further pulley 34, mounted on a spindle 36 which extends between the side plates 10, 12. Mounted on the spindle 36 are two belt drive assemblies including a drive belt pulley 38, although more such pulleys may be provided if required. A conveyor belt 40 extends around the drive pulley 38, around respective sets of rollers 42,44 arranged on the infeed and outfeed sides of the unit, around a tensioning roller 46 and guide rollers 48. The position of the drive pulleys 38 on the spindle 36 may be adjusted by loosening adjustment bolts 50. It will thus be seen that a single belt 40 forms part of both the infeed and outfeed conveyors 4,6.

[0073] Arranged above the respective drive belts 40 are upper and lower belt units 52,54. These units each comprise a belt 56 which travels around four guide rollers 58 and which is spring loaded against the drive belt 40 by spring rollers 60 provided in each unit. The upper units 52,54 are not driven other than by friction with the lower drive belt or blanks thereon. The upper belt units 52,54 are also mounted to the unit in such a manner that they

may be moved both laterally in the unit and also longitudinally so that they may move closer together or further apart.

[0074] The embossing unit 8 comprises a male drum 70 and a female drum 72. The male drum 70 is mounted onto a shaft 74 for rotation therewith. The female drum 72 is mounted onto a shaft 76 for rotation therewith. At one end the shaft 74 is supported by a bearing 78 in an end plate 80 which is moveable vertically relative to the side plate 12 by means of a turn screw arrangement 82. The other end of the shaft is coupled to the output shaft 84 of a servo motor 86 by means of a coupling sleeve 88. The servo motor 86 is mounted to a further end plate 90 which is also mounted moveably with respect to the side plate 10 by virtue of a turn screw arrangement 92.

[0075] Two shafts 94,96 extend between the side plates 80,90. These shafts 94,96 serve to mount upper drum supports 98,100. As can be seen in Figure 1, the drum supports 98, 100 are generally triangular in shape. The upper drum 70 is located in the drum supports 98,100 by respective bearings 102,104. This mounting arrangement stabilises the position of the drum and counteracts any forces which may act on the drive shaft 74.

[0076] The lower, female drum 72 is mounted in a similar manner. At one end the shaft 76 is supported by a bearing 78a in an end plate 80a. The other end of the shaft 76 is coupled to the output shaft 84a of a servo motor 86a by means of a coupling sleeve 88a. The servo motor 86a is mounted to a further end plate 90a. The lower drum 72 may be mounted vertically adjustable in the apparatus by virtue of turn screw arrangements not shown.

[0077] Two shafts 94a, 96a extend between the side plates 80a, 90a. These shafts 94a, 96a serve to mount the lower drum supports 98a, 100a. As can be seen in Figure 1, the drum supports 98a, 100a are generally triangular in shape. The lower drum 72 is located in the drum supports 98a, 100a by respective bearings 102a, 104a. This mounting arrangement stabilises the position of the drum and counteracts any forces which may act on the drive shaft 76.

[0078] It will be noted that the servo motor 86 which drives the male drum 70 and the servo motor 86a which drives the female drum 72 are arranged at opposite sides of the apparatus in order to facilitate their mounting on the apparatus..

[0079] The drum supports 98, 100, 98a, 100a, can be moved along the shafts 94, 96, 94a, 96a to a desired position by loosening hydraulic clamping fasteners 106, 106a provided on each support.

[0080] An optical sensor 108 is mounted to the unit in a position shown schematically in the Figures at upstream of the embossing drums 70, 72. These sensors detect the leading edge of blank 110 as it passes between them and feed this information to a servo control 112 for the apparatus as will be described further below.

[0081] The control ensures that the blank 108 engages with the drums 70,72 so that the embossed pattern on

the blank is in the correct position. This control is illustrated schematically in Figure 4.

[0082] The servo control 110 comprises a controller 120 which receives an input signal 122 from the optical sensor 108 when the leading edge 110 of the blank 106 is detected. The controller 120 also receives a second input 124 from an encoder 126 which is mounted on the spindle 36 of the lower elevator belt 40. The input 124 is representative of the rotary speed of the spindle 36. From the signal 124, and knowing the diameter of the belt drive pulley 50, the controller 120 can calculate the speed of the conveyor belt 40 and therefore the speed of the blank 110 which is travelling on the belt 40.

[0083] The controller 120 further receives a third input 128 from the servo motor 86, e.g. from an encoder associated with a shaft of the motor 86. The third input is representative of the rotational position of the drum and thus the embossing formation at the time the leading edge of the blank 110 is detected by the sensor 108. With this information and knowing the speed of the servo motor 86, which is derived from a further input 130 (or from the input 128), the controller 120 can calculate how long it will take for the blank 110 to engage with the embossing formation and whether this engagement will take place at the desired position. If the controller 120 calculates that it will not, then it sends an output signal 132 to the servo motor either increasing or decreasing the speed of the servo motor such that the embossing formation will engage the blank in the correct position.

[0084] As there is no upper conveyor belt in the region of the drums 70, 72, the correction can take place even when the preceding blank is still between the embossing drums 70, 72, the blank being able to slip slightly relative to the lower conveyor belt 40. In fact, for the reasons explained in the introduction to this application it is preferred that the correction does take place while the preceding blank is still between the embossing drums 70, 72.

[0085] It will be understood that when the apparatus is first operated it will be necessary to register the correct position of the drum relative to the blank which can then be taken as a starting point for subsequent determination of the rotational position of the drum.

[0086] Whilst Figure 4 shows just a single servo motor being controlled in this manner, in the preferred embodiment both servo motors are controlled in this manner.

[0087] Turning now to Figure 6, a drum 70 is shown in an exploded view. The drum 70 comprises a drum body 150 having a groove 152 formed in its peripheral surface 154. The inner edge 156 of the groove is angled outwardly as shown in the detail A. The groove 152 receives an embossing plate 158 which is secured in position by a clamping collar 160 which locates over a shoulder 162 formed on the drum body 150. Six equispaced bolts 164 secure the clamping collar 160 to the drum body 150. The upper edge 166 of the clamping plate 160 is chamfered as shown detail B.

[0088] The embossing plate 158 is formed with an embossing formation, e.g. a Braille formation 168 on its ex-

ternal surface. As shown in Figure 7, the longitudinal edges 170, 172, 170 of the plate are formed as a chamfer such that when engaged with the drum body 150 and clamped by the collar 160 they form a dovetail joint to firmly anchor the plate 158 on the drum body 150. Registration means may be provided on the drum body 150 and the plate 158 such that they are aligned correctly in the circumferential direction.

[0089] In manufacturing the embossing plate 158, it may be attached to a suitable support, for example a plastic support and the chamfered edges 170, 172 machined into the plate 158 whilst on that support. This considerably facilitates manufacture of the plate.

[0090] In use, therefore, blanks 110 (which are typically of cardboard, paperboard, plastics or other foldable sheet material) will be fed to the unit from an upstream unit where the blanks may have been prefolded to work creases to facilitate subsequent folding and gluing. The blanks are received by the infeed conveyor 4 and fed to the embossing unit 6. The leading edge of each blank will be sensed by the optical sensor 104 and communicated to the control 120. This determines, from the speed of the blank 106 and the rotational position and speed of the embossing drums 70, 72 whether the blanks will engage the embossing formations on the drums in the correct position. If they will not, the control will adjust the rotational speed of the drums to compensate for any estimated error. This happens for each and every blank.

[0091] After embossing, the embossed blanks are received by the outfeed conveyor 6 which will feed them to a downstream unit, for example a gluing and folding machine.

[0092] Speeds of up to 400m/minute are achievable with the present invention which is a considerable improvement on existing machinery.

[0093] The embossing drums 70, 72 may emboss any desired part of the blank 110 by being positioned in the appropriate lateral position in the unit. Thus, for example, the embossing drums 70, 72 may emboss a face panel 112 of the blank 110, or even a glue panel 114 of the blank.

[0094] Moreover, more than one pair of embossing drums may be provided across the unit, mounted on further supports similar to those described above and driven by the motors 86, 86a. Thus one or more panels of the blank 110 may be embossed simultaneously.

[0095] A second embodiment of the invention is now described with reference to Figures 8 to 16.

[0096] As in the earlier embodiment, the embossing apparatus is intended to be arranged between upstream and downstream units, not shown. Certain features aspects of the apparatus, for example the sensing and control features are similar to those of the first embodiment and will not, therefore be described, but there are several significant differences, as will become apparent from the description below.

[0097] The apparatus 200 comprises side plates 202, 204 which are joined together at top and bottom by re-

spective pairs of bracing plates 206, 208. As shown in Figures 11 and 15, the unit comprises a pair of transversely spaced in feed and outfeed conveyors 210. The conveyors are supported on plates 212, 214, which are joined together by means not shown. The lower plates 212 are mounted for transverse sliding movement on a pair of shafts 216 extending between the side plates 202, 204. A belt drive shaft 218 also extends between the side plates 202, 204 and drives the belts of the conveyors 210 by respective drive wheels 220 arranged on the shaft 218. A drive motor 222 is arranged at one end of the drive shaft 218. This is a different arrangement from the earlier embodiment where drive was effected through a coupling to adjacent machine units.

[0098] The lateral position of the conveyor units 210 can be adjusted on the shafts 216 by means of adjustment screws 224. Further details of the conveyor units 210 will be given below.

[0099] The apparatus 200 further comprises respective pairs of embossing drums 230. The construction of the drums *per se* is generally as described in the earlier embodiment, although they are supported in the apparatus in a different manner. In this regard, an upper pair of male drums 232 is mounted on an upper shaft 234 while a pair of female drums 236 is mounted on a lower shaft 238. Details of the lower drum arrangement are shown in Figures 12 and 13.

[0100] With reference to Figure 12, a shaft 238 passes through the drums 236 which can be properly spaced apart on the shaft 238 by means, for example, of one or more spacers 240. Each drum 236 is held in position on the shaft 238 by an ETP clamp 242. Such clamps 242 are well known in the art and may not therefore be described further here. The shaft 238 is supported by bearings in support blocks 244 which are mounted to a carriage 246.

[0101] The assembly of shaft 238, drums 236 and carriage 246 is mounted as a unit to a base plate 248. The base plate 248 comprises a dovetail profiled slideway 250 whose edges are defined by rails 252, 254. One rail 252 is fixed relative to the base plate 248 but the other rail 254 is moveable vertically with respect to the base plate 248 by virtue of respective pneumatic cylinders 256 mounted to the underside of the base plate 248.

[0102] Turning now to Figure 13, the inboard end 258 of the shaft 238 is coupled to a servo motor 260 by virtue of a coupling 262. The coupling 262 comprises an Oldham coupling 264 and ETP clamp 266 attached to the Oldham coupling 264. The ETP clamp 266 clamps down onto the shaft end 258 and into a bore on the Oldham coupling 264 to secure the two components together. A housing 270 is provided around the coupling 262 and is bolted to the front face of the servo motor 260. The coupling 262 is supported within the housing 270 by a pair of bearings 278. The housing 270 is provided with a dovetail at its lower end for engagement in the slideway 250. A block 272 mounted on a lead screw 274 mounted to the base plate 248 engages the housing 270.

[0103] In order to set the correct lateral position of the drums 236, the pneumatic cylinders 256 are extended so as to raise the side guide 254 to allow the carriage 246 to be mounted to the base plate 248. The shaft 238 can then be joined to the servo motor 260 to form a unitary assembly using the ETP clamp 266. The desired lateral position of the drum/servomotor assembly can be obtained by rotation of the lead screw 274 which moves the block 272 and thereby the drum/servo motor subassembly along the base plate 248. When the subassembly is in the correct position, the cylinders 256 can be retracted so as to clamp down the rail 254 against the carriage 246 thereby securing the carriage 246 in position on the base plate 248.

[0104] To set the relative rotational position of the drums 236 and motor 260, an alignment rod 279 can be passed through alignment openings (not shown) in the drums 236 and housing 270.

[0105] The base plate 248 is mounted in a support frame 280 which has keyways 282 which engage with runners 284 mounted to the side plates 202, 204 as shown in Figure 8. The vertical position of the frame 280 is adjustable by a mechanism which will be described further below in the context of the upper drum support mechanism. The frame 280 is moveable up and down in the runners by virtue of the pneumatic cylinders 286 mounted to the side plates 202, 204.

[0106] The upper drums 232 are mounted to an upper base plate 290 in a similar manner to that described above. Thus, for example, as shown in Figure 14, the base plate 290 is provided with pneumatic cylinders 292 for raising and lowering the moveable guide 294 of the base plate 290. The upper base plate 290 is mounted to an upper support frame 296, the upper support frame 296 is provided with keyways 298 for engagement with the guides 284. As can be seen in Figure 8, the upper frame 296 is moveable up and down along these guides by virtue of further pneumatic cylinders 300 fixed with respect to the side plates 202, 204.

[0107] The upper surface 302 of the upper base plate 290 is provided with respective dovetail slides 304 which each receive a slidable, tapering block 306. The blocks 306 are moveable back and forth along the slides 304 by means of servo motors 308 which drive lead screws 309.

[0108] The cross frame members 208 are provided with a pair of stepped wedge members 310 with which the tapered wedges 306 engage in use. This is shown, for example, in Figure 9. The stepped wedge members 310 are moveable from side to side on the cross braces 208 such that different steps on each stepped wedge may align with the respective tapered wedges 306. This allows the vertical position of the upper support frame 296 and thus the upper drums 232 to be varied. This is necessary in order to compensate for different size drums. The tapered wedges 306 are held against the stepped wedges 310 by virtue of the pneumatic cylinders 300.

[0109] A similar arrangement is provided on the lower base plate 248 so that the vertical positions of both the upper and lower drums 232, 236 is made possible.

[0110] The stepped wedges give a relatively coarse adjustment of the positions of the upper and lower support frames 296, 280. A finer adjustment can be obtained by means of the tapering wedges 306. In particular, by operating the servo motor 308, the tapering wedges 306 can be moved backwards and forwards relative to the stepped wedges 310 thereby allowing a finer adjustment in the vertical position of the upper frame 296. Furthermore, by simultaneously moving the respective tapering wedges 306 to different positions, the upper support frame 296 may be caused to tilt at an angle across the apparatus. This may be useful in adjusting the vertical position of one pair of drums relative to another.

[0111] The lower support frame 280 is not provided with a movable tapering wedge mechanism as described above and is maintained perpendicular to the side plates 202, 204 throughout its adjustment through its stepped wedges.

[0112] As discussed above, the conveyor mechanism of the present embodiment is different from that of the first embodiment. Rather than having separate upper infeed and outfeed conveyor belts, the present invention has a single upper conveyor 210,

[0113] Referring to Figure 15, each conveyor comprises a lower conveyor belt 320 and an upper conveyor belt 322. The lower belt 320 is driven by drive wheel 220 and passes around a series of rollers in a similar manner to the belt 40 of the first embodiment. The upper belt 322 is not driven, other than by frictional engagement with the lower belt 320 or the blanks on the blower belt 320. The upper belt 322 also passes around a plurality of rollers, at least some of which 324 are spring loaded against the lower belt 320. The upper belt 322 has an infeed side 326 and an outfeed side 328

[0114] The spring biasing force of the sprung rollers 324 can be adjusted by a mechanism which is best seen in Figure 16, which shows a detail of a part of Figure 15 with certain components removed for clarity.

[0115] Each sprung roller 324 comprises a roller 330 mounted on an arm 332 which is pivotally mounted about a spindle axis 334. The arm 332 and thus the roller 330 are biased downwardly by a spring 336.

[0116] An adjustment mechanism 338 comprises a pivotally mounted shaft 340 attached to an adjustment handle 342. The shaft has a cam surface 344 for engagement with a follower surface 346 provided at the upper end of the arm 332. The cam surface 344 has first and second flats 348, 350 provided at outer and inner diameters.

[0117] When the outer diameter flat surface portion 348 engages the follower surface 346, the follower surface is pushed down so as to rotate the arm 332 against the force of the spring 336, thereby lifting the roller 330 away from the back of the upper conveyor belt 322. When the inner diameter flat 350 engages the follower surface

346, the roller arm is allowed to rotate down so as to allow the roller 330 to engage the back of the conveyor belt 322.

[0118] The effect of this will now be explained in the context of the operation of the apparatus.

[0119] In essence the apparatus operates in the same manner as that of the first embodiment. Thus, as blanks are moved through the apparatus on the conveyors 210, the control system adjusts the angular positions of the drums 232, 236 to allow for the accurate embossing of the pattern on the blank approaching the drums 232, 236. Depending on the size of the blank and drums, one or more of the sprung rollers 324 adjacent the drums 232, 236 may be adjusted as described above so as to relieve the spring pressure on the upper conveyor belt 322 and thus allow the blanks to slip relative to the lower conveyor belt 320 as they pass through the drums, thereby allowing a fast throughput of blanks. The precise number of rollers 324 to be adjusted in this manner will depend on the particular blank and drum sizes. It will be understood that even though the upper belt is not biased against the lower belt in the drum region, the presence of the upper belt will stop the blank lifting from the lower conveyor belt 320, which might otherwise occur at high speeds.

[0120] Of course modifications may be made to the embodiments described above without departing from the scope of the invention. For example, an alternative form of coupling may be provided between the embossing drums and their servo motor drives.

[0121] As shown in Figure 17, an alternative coupling 400 comprises a drive plate 402 which is suitably bolted to the servo drive, a plastics coupling member 404 and a flexible coupling member 406 e.g. of steel or other metallic material.. The drive plate 402 comprises a pair of drive teeth 408 which engage in a slot 410 formed between two ribs 412 projecting from a face 414 of the plastics coupling member 404. The flexible coupling member 406 comprises a pair of drive teeth 416 which engage in a slot 418 formed between two ribs 420 projecting from a second face 422 of the plastics coupling member 404. The flexible coupling member 406 further comprises a slot 424 which extends circumferentially for a limited distance, e.g. 180-270°, around the coupling member 406 to impart some flexibility to the coupling member 406. As shown in Figure 18, the part 426 of the coupling member 406 behind the slot 424 is provided with a further slot 428 and clamping means, e.g. a clamping screw 430, for clamping the flexible coupling onto the shaft 234, 238. This coupling allows the embossing drum carriage 246 to be coupled very simply to the servo motor by sliding the carriage 246 into position and then locking it in position.

[0122] The coupling also allows the relative rotational positions of the embossing drums 232, 236 to be set. In particular, a pair of embossing drums 232, 236 may be positioned adjacent one another on a setting jig having parallel guides. The respective drive coupling 404 for each drum is aligned to a common datum, for example

a horizontal datum. The coupling member 406 for each drum may then be loosened and the drums 232, 236 rotated on their respective shafts 234, 238 until the drums are in the correct rotational position. For example, one of the drums may be provided with a locating element such as a pin which registers in a precision machined hole in one of the drums and is moved into engagement with a corresponding hole in the mating drum. This accurately positions the drums one relative to the other, at which point the couplings 406 may be tightened once more and the pin removed. The respective drums can then be removed from the setting jig and installed with the couplings 412 in a horizontal position on the machine as to accurately position the drums one relative to the other.

[0123] It is of course possible that due to wear, for example, even though the drums may seemingly accurately align on the jig, when they are introduced to the machine, there may, in fact, be some misalignment of the rotational position of the drums. In order to compensate for such an eventuality, the embossing apparatus is preferably provided with means which allows the relative rotational positions of the drums to be adjusted one relative to the other so that accurate alignment of the embossing formations is achieved. This can be checked, for example, by lowering the upper drum 232 down into a location which results in a very shallow impression on a carton blank during set up. An operator can then check if the male formation, for example a Braille pin, is accurately aligned with the female hole. If it is not, the Braille formation will appear asymmetrical.

[0124] Any lateral discrepancy can be adjusted by moving the upper or lower cassette by lead screws transversely of the machine. A rotational position adjustment can be provided either manually through a suitable adjustment mechanism or electrically through the motor which drives the respective drum, e.g. the servo motor in the servo motor arrangements described above. Very fine adjustments can be performed in this way. This centring adjustment assists in producing a centrally positioned Braille pin in the hole which produces the best formed Braille with minimal cracking of the surface of the blank.

[0125] While the invention has been described with reference to embossing Braille patterns, it may of course be used to emboss other patterns. Also, whilst intended primarily for embossing packaging, the present invention may have many applications outside that field.

[0126] Also, while the embodiments described show two sets of embossing drums, the apparatus may of course operate with just one set of drums.

[0127] A further modification of the apparatus is illustrated in Figure 19. In this embodiment, the infeed conveyor 502 and outfeed conveyor 504 of the embossing unit are driven by servomotors not shown. The feed conveyor 506 of an upstream magazine unit 508 is also driven by a servo motor such that the speed of all three conveyors is the same.

[0128] The conveyor 510 of a downstream unit 512 is driven by means such as a servomotor. The speed of the downstream conveyor 510 is sensed by any suitable means, e.g. by an encoder sensing rotation of the drive shaft for the conveyor 510. The speed of the conveyor is averaged over a given time period and the averaged speed used to control the speed of the upstream conveyor 506 and the unit conveyors 502, 504. The speed of those conveyors 502, 504, 506 is controlled to be a desired percentage, e.g. 90%, of the speed of the downstream conveyor 510 during operation. This ensures that a suitable gap will be created on the downstream conveyor 510 between blanks 514 leaving the outfeed conveyor 504. On start up and run down of the downstream conveyor, the speed of the upstream units may increase or decrease in a stepwise manner, for example when the speed of the downstream unit changes in speed by $\pm 5\%$.

[0129] A further embodiment of the invention is disclosed in Figures 20 and 21.

[0130] In this embodiment, the infeed conveyor 600 comprises upper and lower infeed belts 602, 604. The outfeed conveyor 606 comprises upper and lower outfeed belts 608, 610. As in the earlier embodiments, respective sets of infeed and outfeed conveyors 600, 606 are spaced apart laterally of the apparatus.

[0131] The outfeed belts 608, 610 extend to a position P upstream of the embossing drums 612, 614, while the infeed belts 602, 604 terminate upstream of the drums at the position P. For each blank, the position P is chosen such that the blank is fed into the nip between the drums 612, 614 by the infeed belts 602, 604, the blank being able to move relative to the outfeed belts 608, 610 upstream of the drums. The upstream portions of the outfeed belts 608, 610 therefore act merely to loosely support the blanks as they are fed to the drums 612, 614.

[0132] The position P can be changed by lengthening or shortening the adjustment loops 616, 618, 620, 622 in the belts.

[0133] As shown in Figure 21, this mechanism may also be used to retract the outfeed conveyor completely from between the drums 612, 614. This will allow the drums 612, 614 to be accessed easily, for example for removal.

[0134] The infeed and outfeed conveyors 600, 606 can be driven as in the earlier embodiments. Preferably, however, they are driven by servomotors as discussed above as this will allow, for example, the speed of laterally spaced infeed conveyor or outfeed conveyor belts to be varied relative to each other which will allow for the angular position of the blanks on the conveyors to be adjusted and corrected for example if they become skewed on the conveyor.

Claims

1. A method of aligning Braille embossing formations on an embossing machine, comprising rotating one

embossing drum relative to the other *in situ* on the machine to align one drum with the other.

2. The method of claim 1 wherein the rotation is effected by rotating the drive shaft of one of the drums relative to the other.

3. The method of claim 2 wherein the rotation is effected through operating the drive motor for the drum to rotate the drum by an appropriate amount..

4. An embossing apparatus comprising:

a rotary embossing drum driven by a motor and having an embossing formation;
an infeed conveyor for feeding blanks to the embossing drum;
an outfeed conveyor for conveying embossed blanks away from the embossing drum;
said outfeed conveyor extending to a point upstream of said embossing drum.

5. An embossing apparatus comprising:

a rotary embossing drum driven by a motor and having an embossing formation;
an infeed conveyor for feeding blanks to the embossing drum;
an outfeed conveyor for conveying embossed away blanks from the embossing drum;
said infeed conveyor extending to a point downstream of the embossing drum.

6. The apparatus of claim 4 or 5 wherein the position of the downstream edge of the infeed conveyor and the upstream edge of the outfeed conveyor is variable to accommodate different lengths of blank.

7. The apparatus of claim 4, 5 or 6 wherein one or both of the conveyors is retractable to a position downstream of the embossing drums.

8. An embossing apparatus comprising:

a rotary embossing drum driven by a motor and having an embossing formation;
an infeed conveyor for feeding blanks to the embossing drum;
an outfeed conveyor for conveying embossed away blanks from the embossing drum;
a conveyor or conveyors being retractable from the drum.

9. The apparatus of any of claims 4 to 8 wherein said infeed and outfeed conveyors comprise two or more sets of belts laterally spaced apart, the relative speed of these laterally spaced conveyors being adjusted so as to vary the angle of a blank on the conveyor.

10. An embossing apparatus comprising:

a rotary embossing drum driven by a motor and having an embossing formation;
 a conveyor for feeding blanks to or conveying blanks away from the embossing drum said conveyor comprising a plurality of laterally spaced belts; and
 means for adjusting the relative speed of said belts so as to adjust the angle of the blank on the conveyor.

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11. An apparatus comprising:

an embossing apparatus having an infeed conveyor and an outfeed conveyor;
 an upstream conveyor for feeding blanks to said infeed conveyor;
 a downstream conveyor for receiving embossed blanks from the outfeed conveyor; and
 synchronised drives for the upstream, downstream, infeed and outfeed conveyors.

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12. The apparatus of claim 11 wherein the infeed and outfeed conveyors are synchronised to operate at the same speed as the upstream conveyor.

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13. The apparatus of claim 12 wherein the speed of the upstream conveyor is variable, based on the speed of the downstream conveyor.

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14. The apparatus of claim 13 wherein the speed of the infeed and outfeed conveyors is lower than that of the downstream unit so that a gap is generated between the blanks as they leave the outfeed conveyor.

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15. The apparatus of claim 14 wherein the speed of the infeed and outfeed conveyors and the upstream conveyor is calculated as a percentage of the speed of the downstream conveyor.

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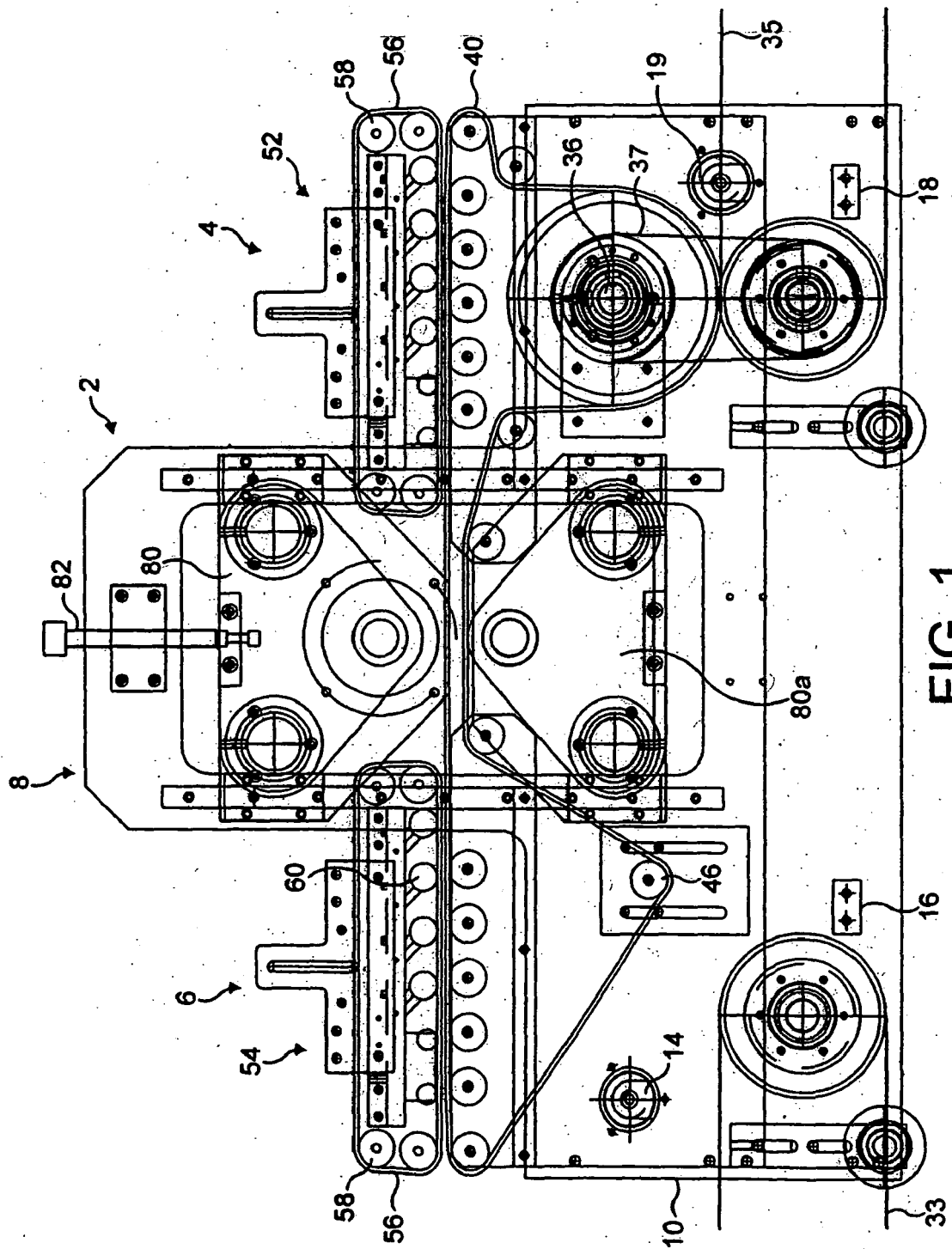
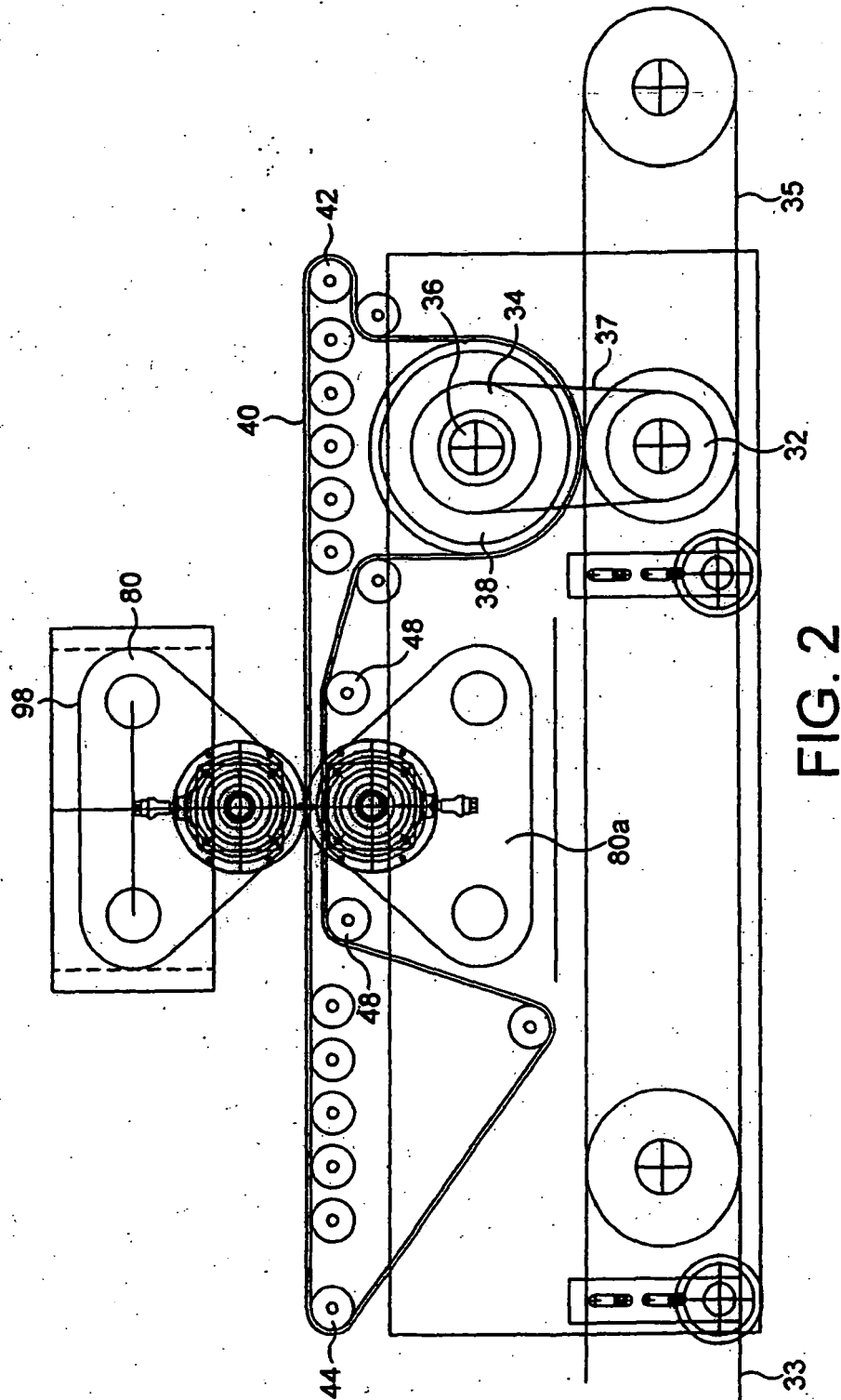


FIG. 1



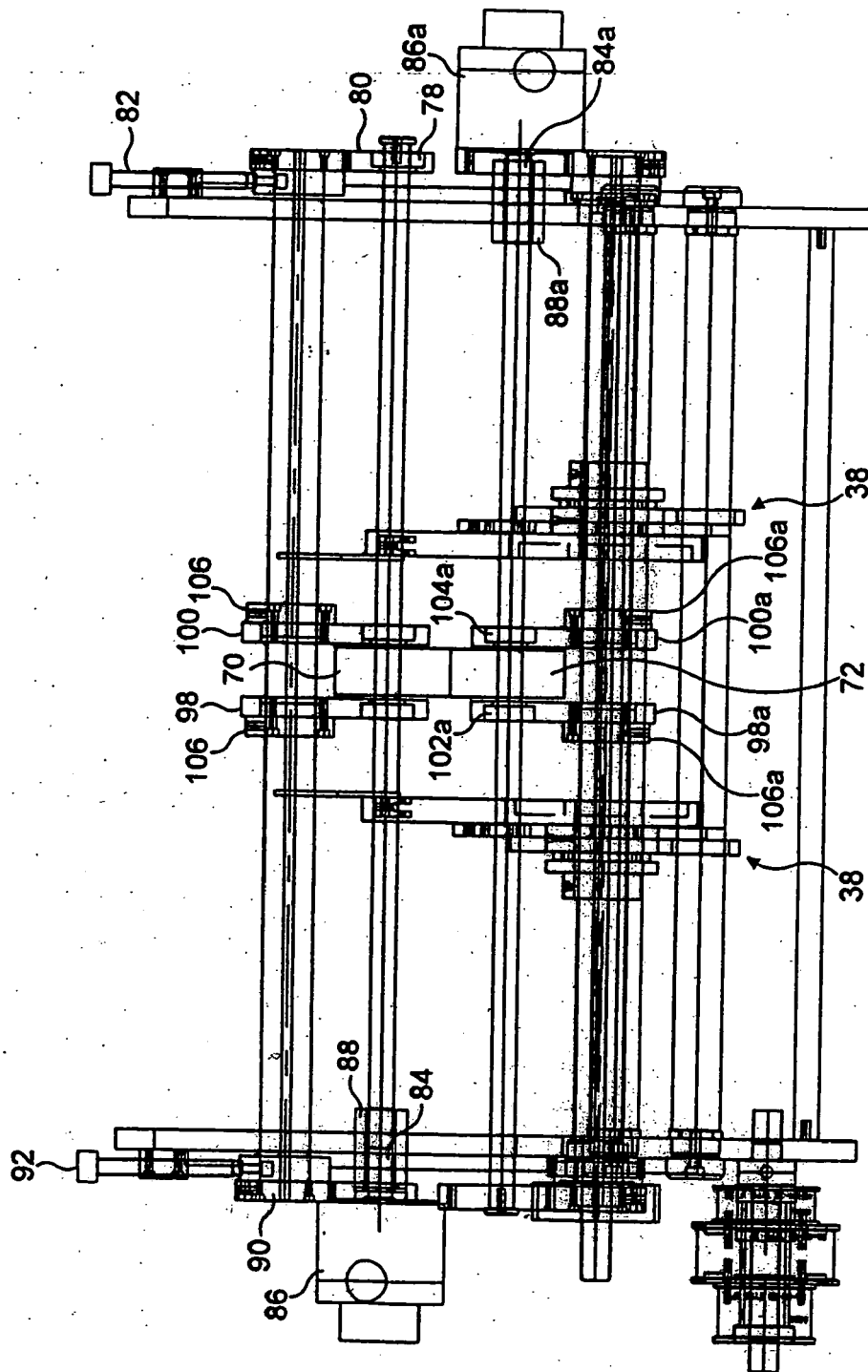


FIG. 3

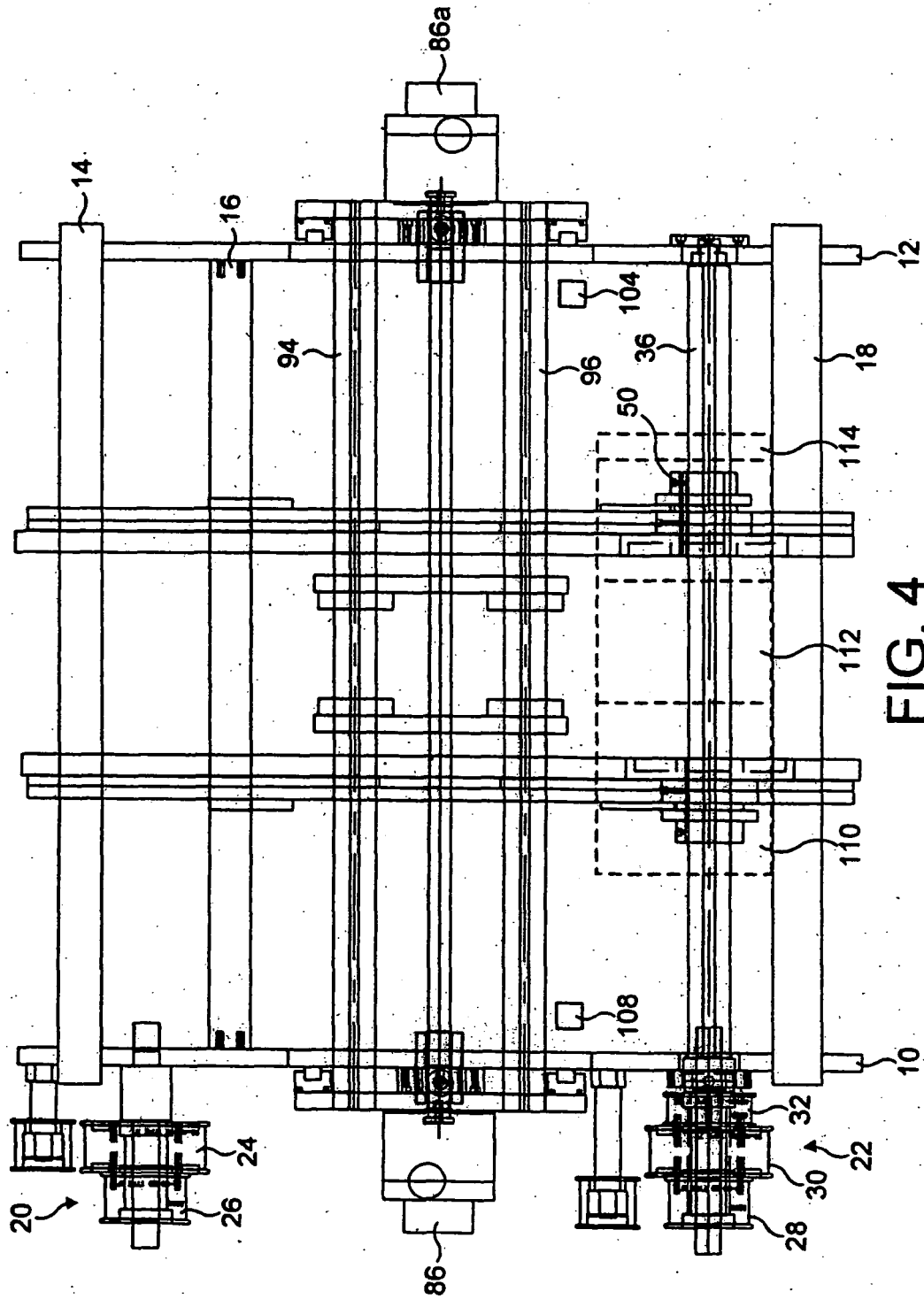
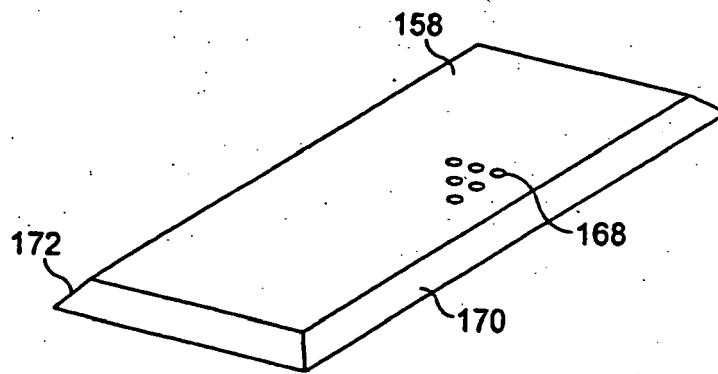
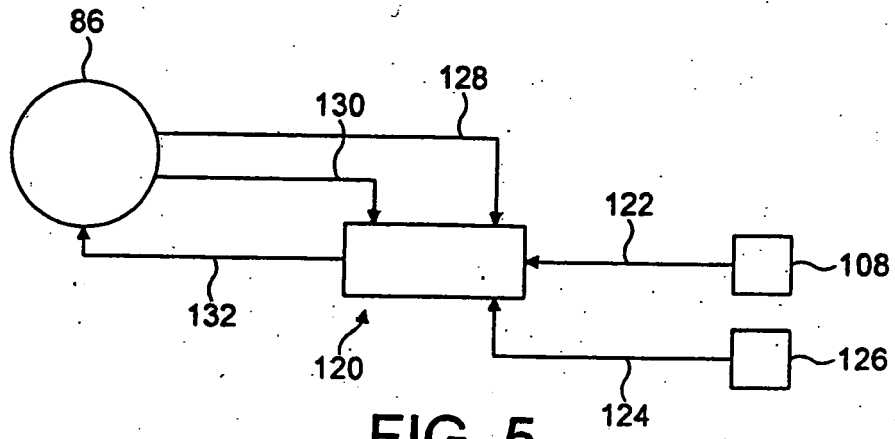


FIG. 4



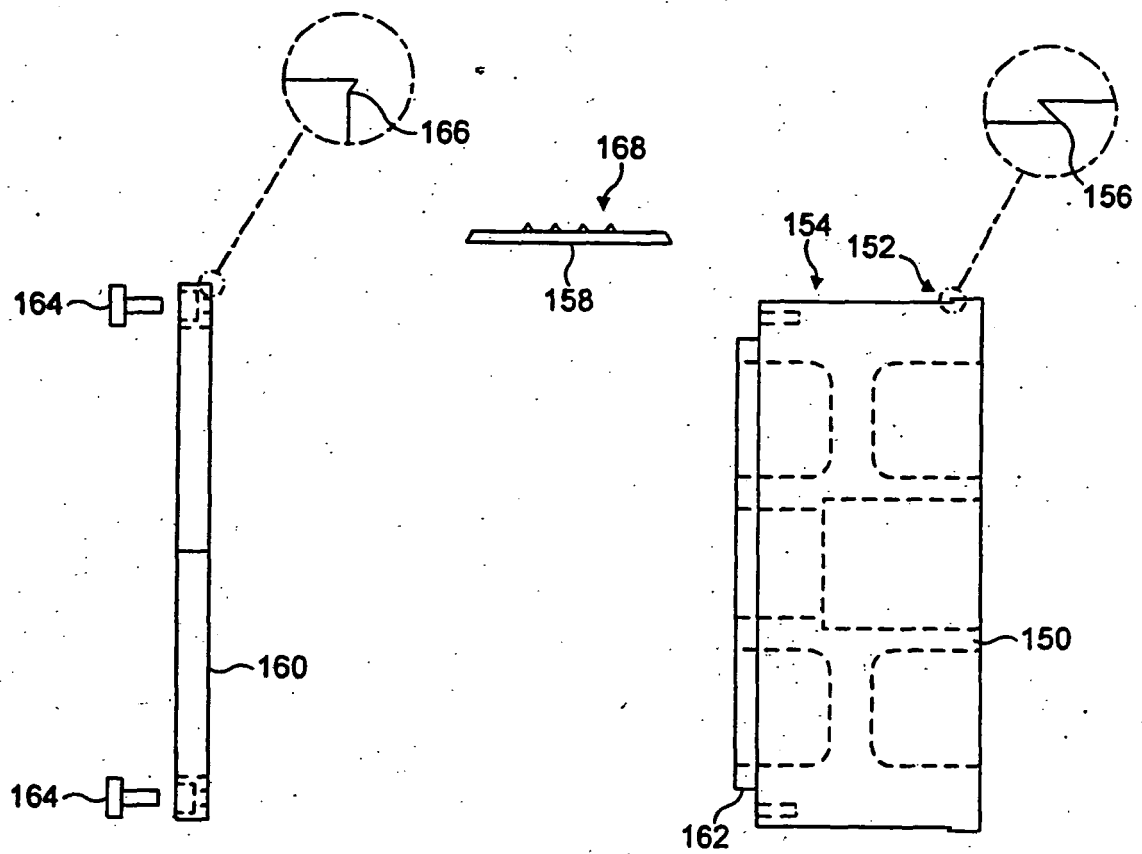


FIG. 6

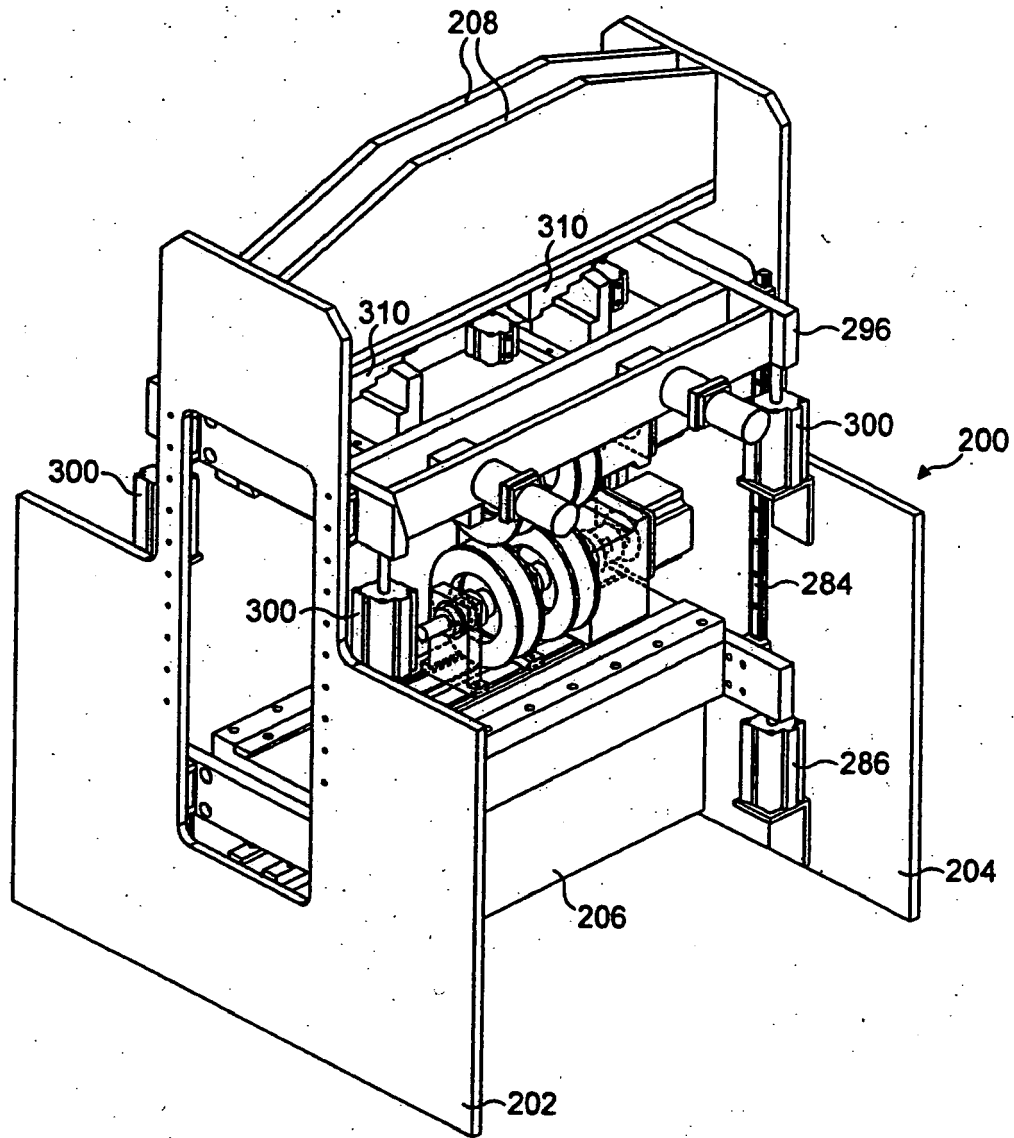


FIG. 8

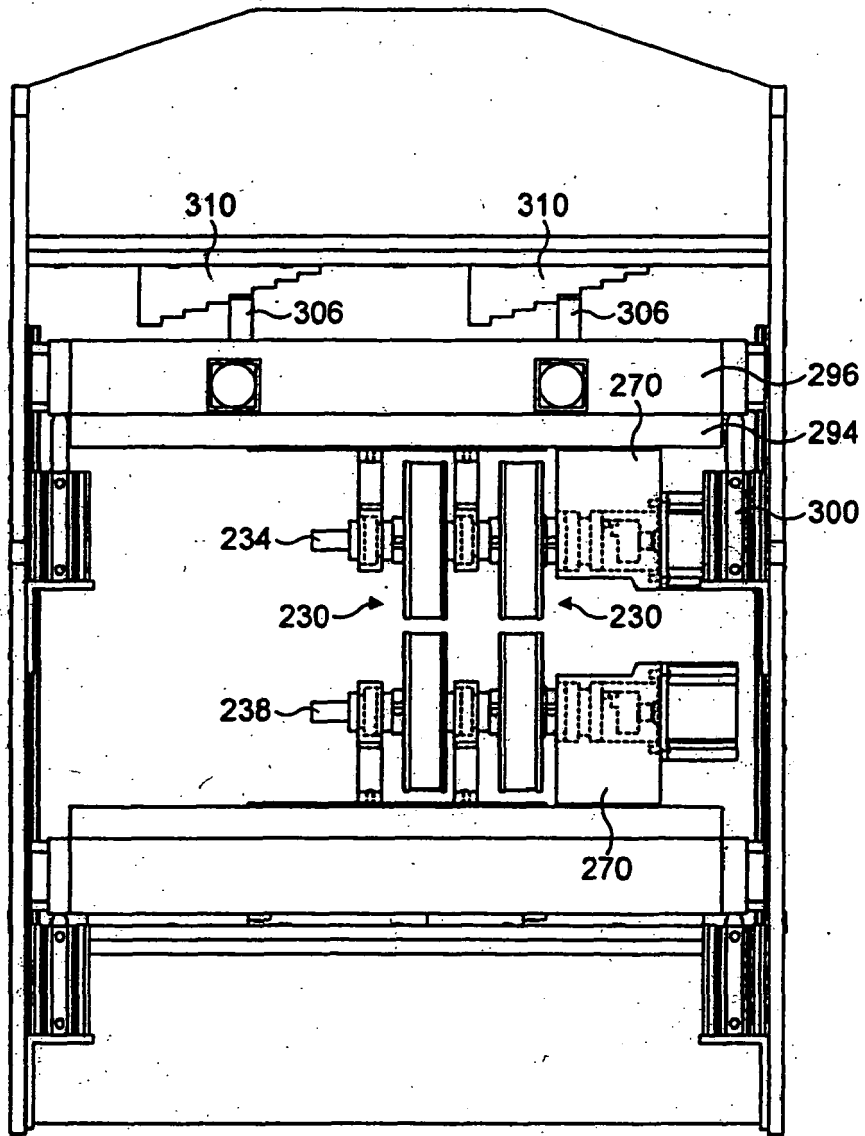


FIG. 9

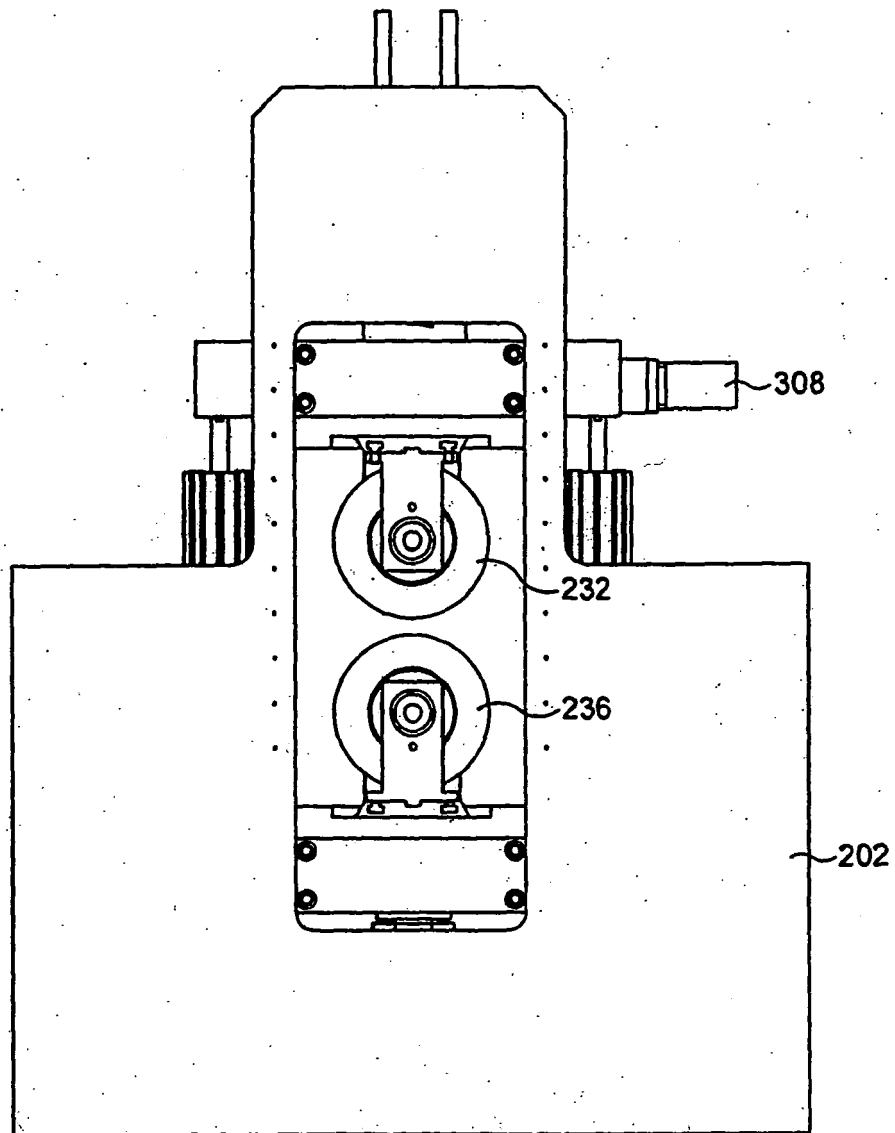


FIG. 10

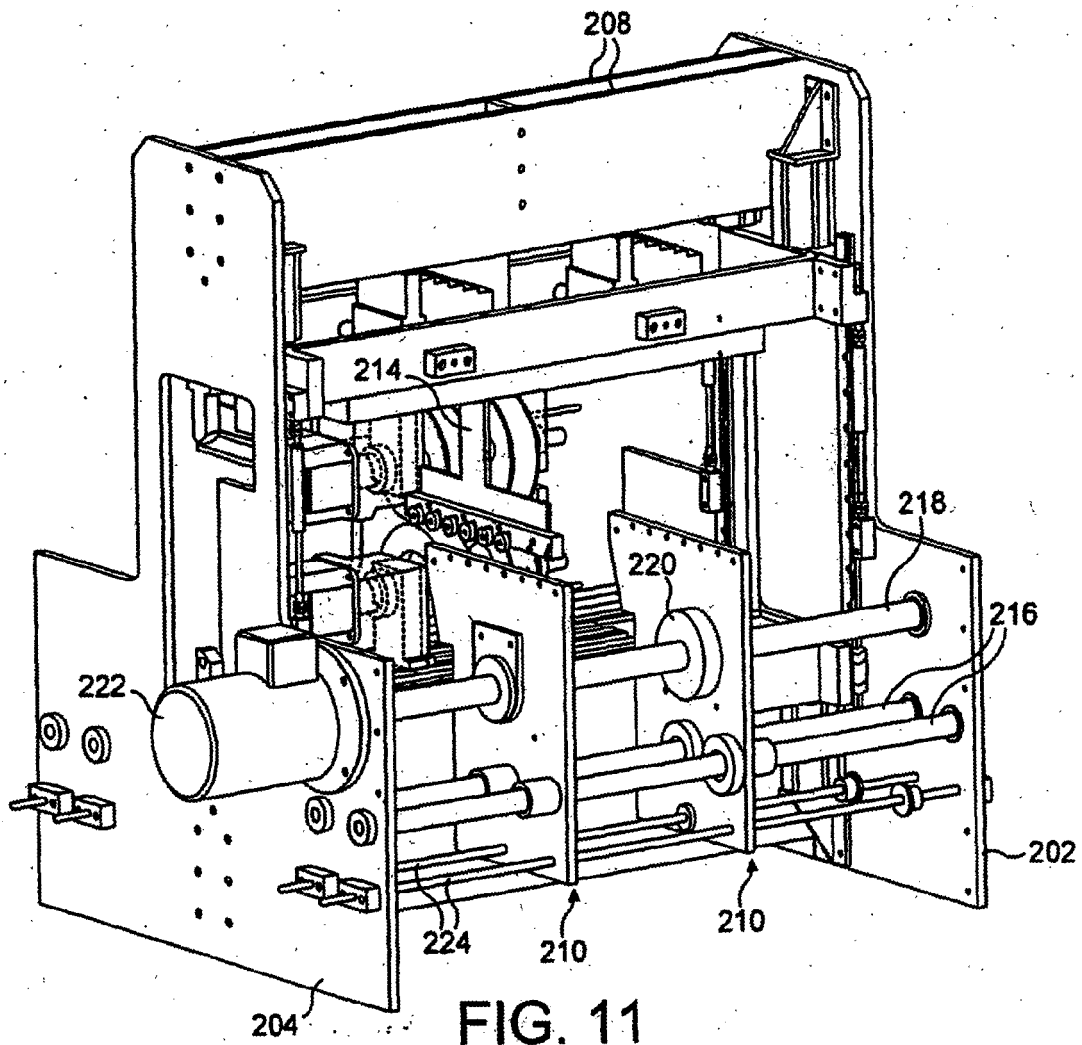
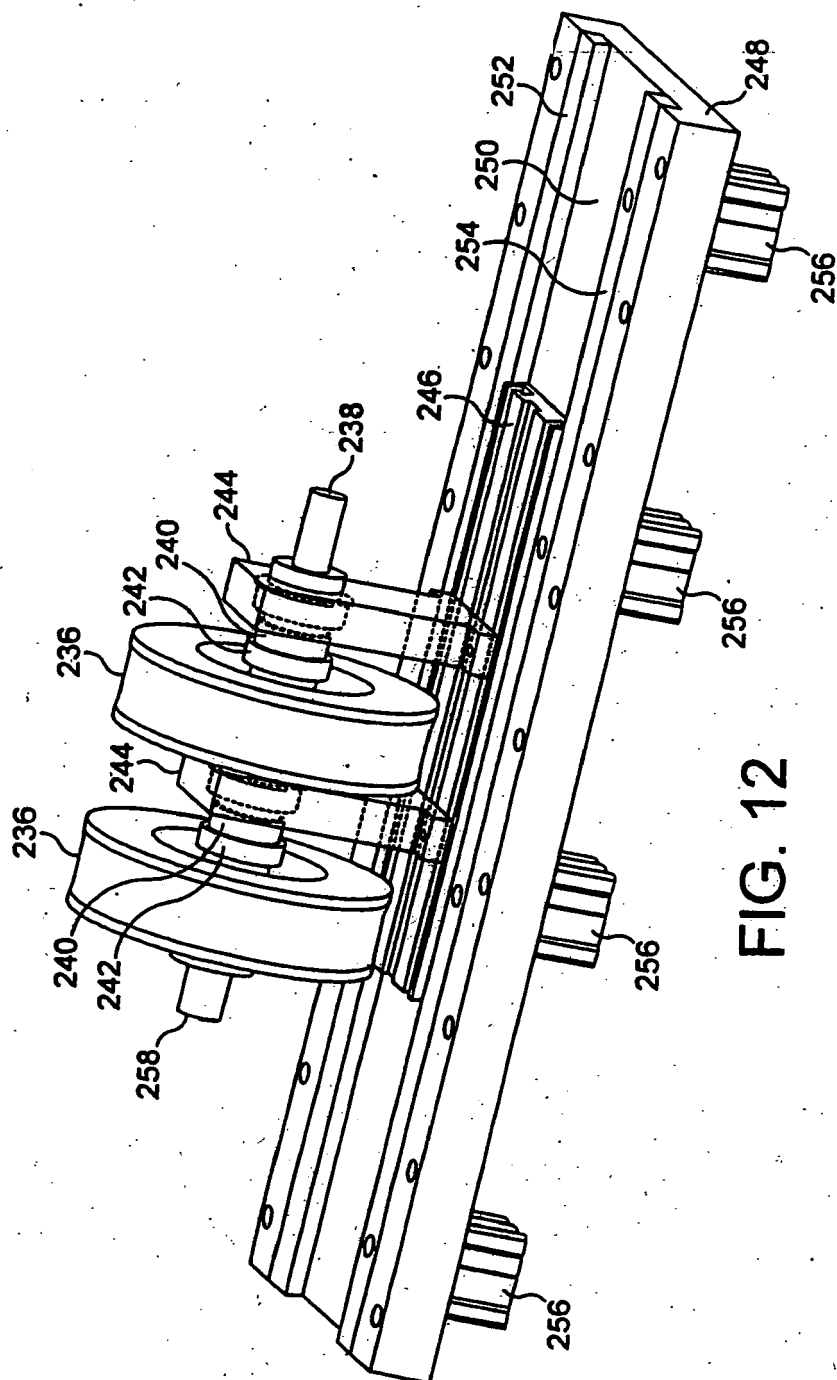
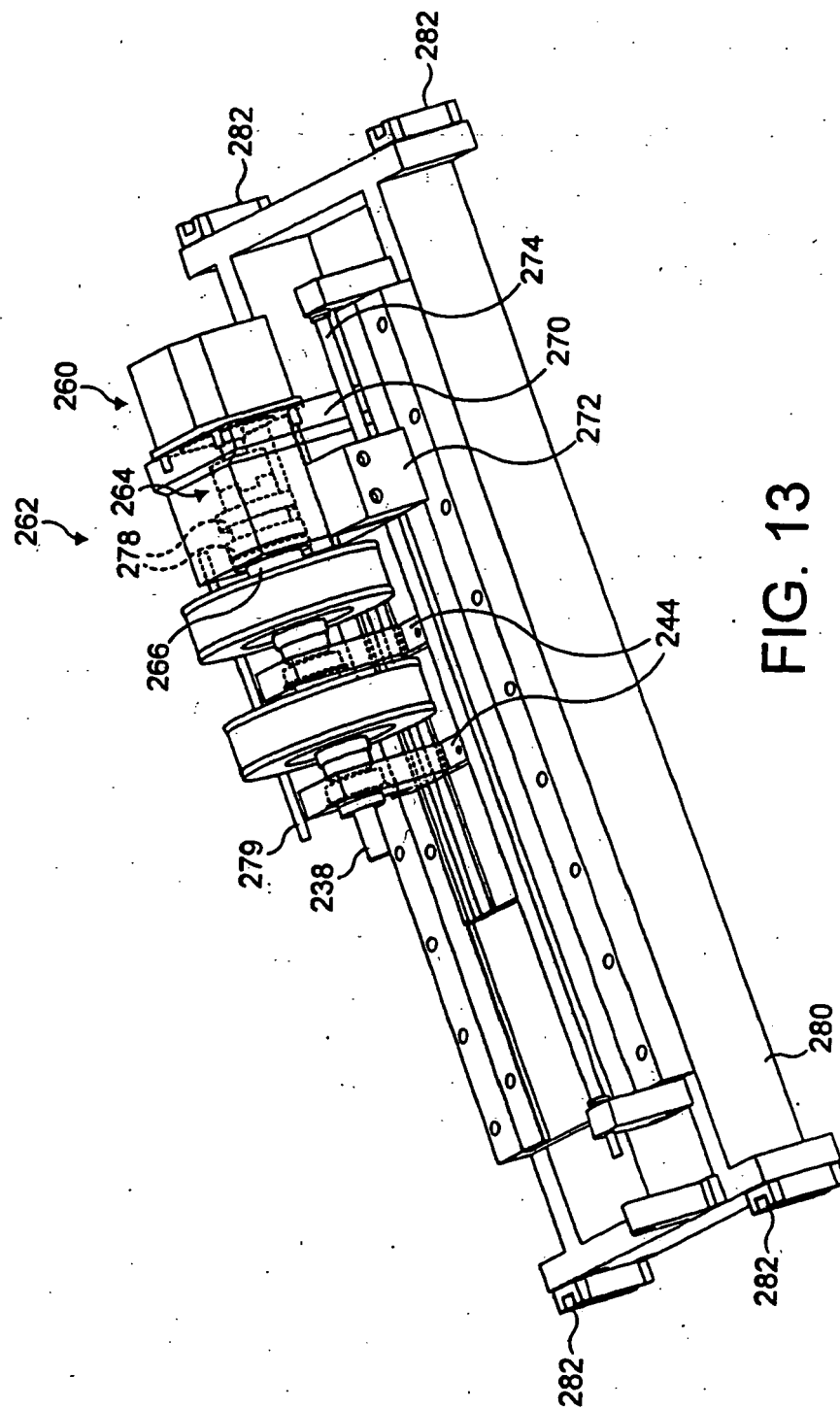


FIG. 11





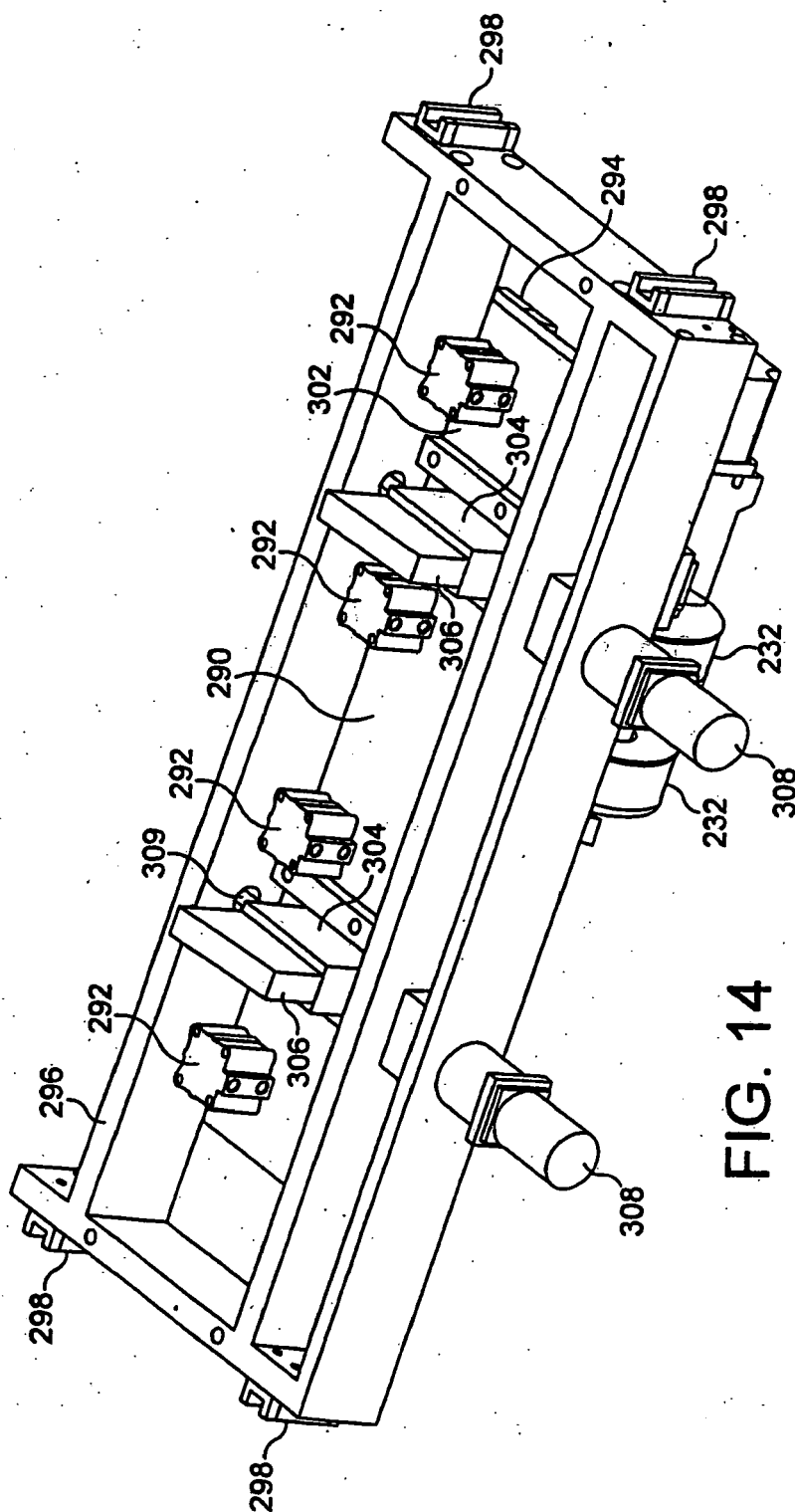


FIG. 14

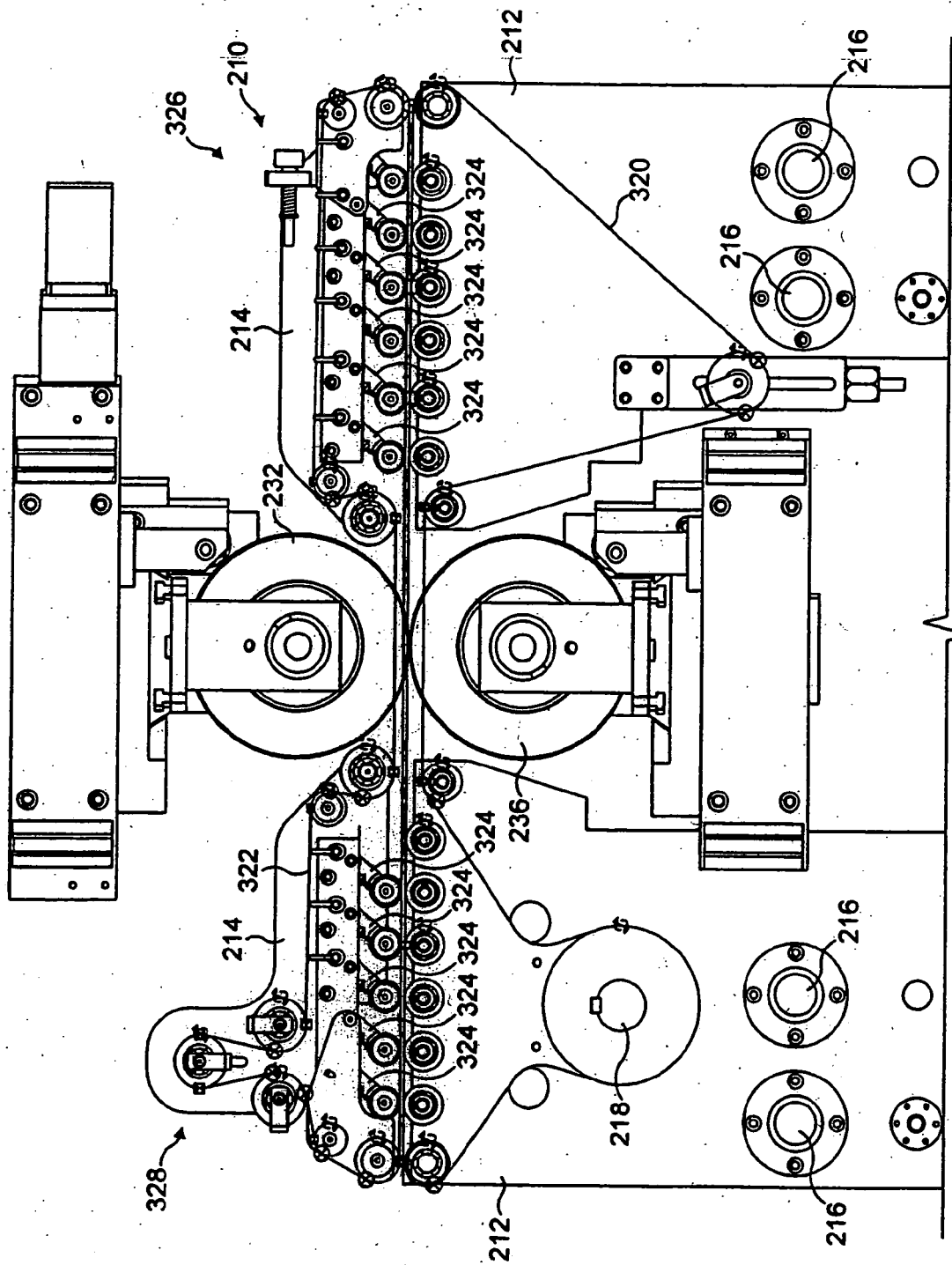


FIG. 15

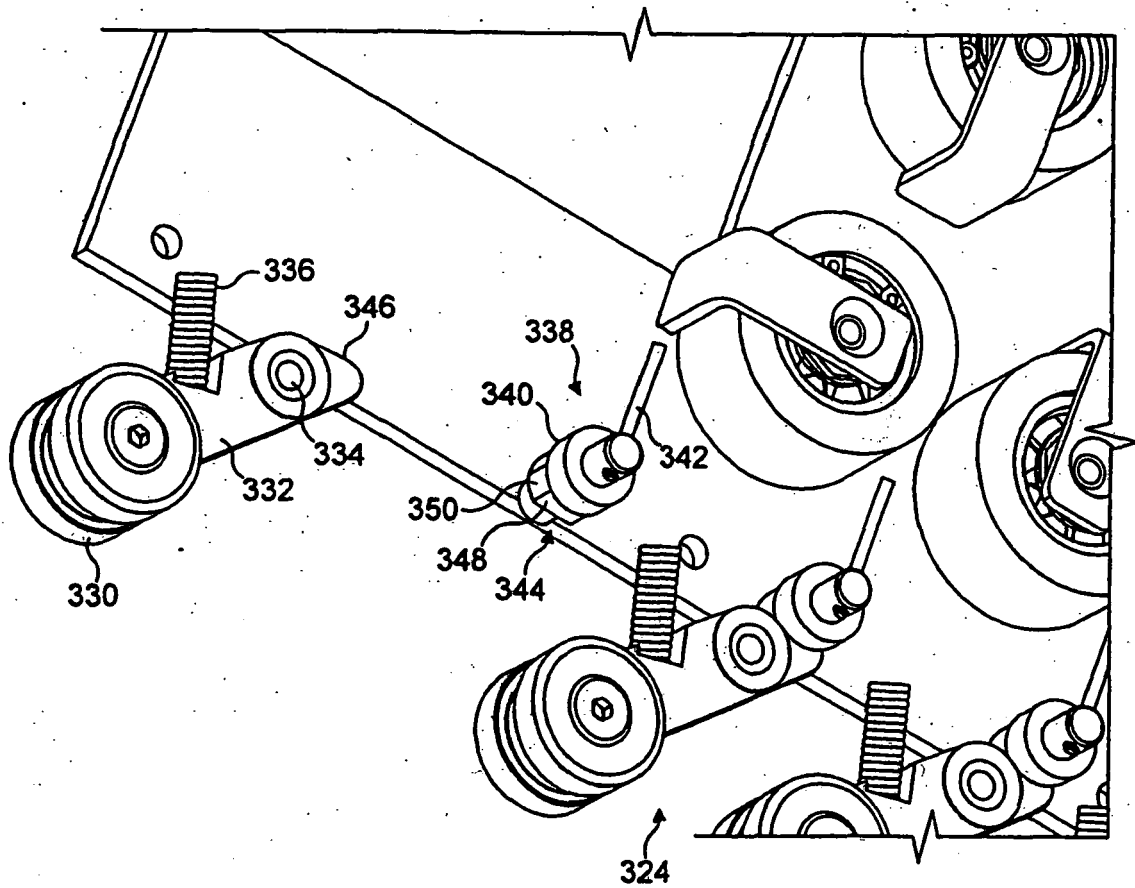


FIG. 16

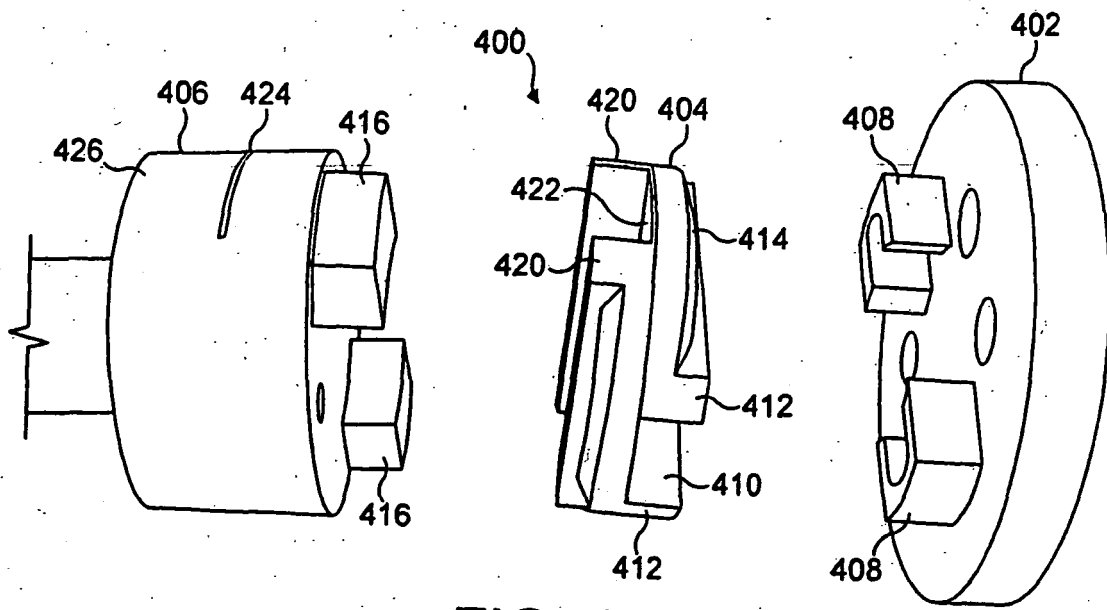


FIG. 17

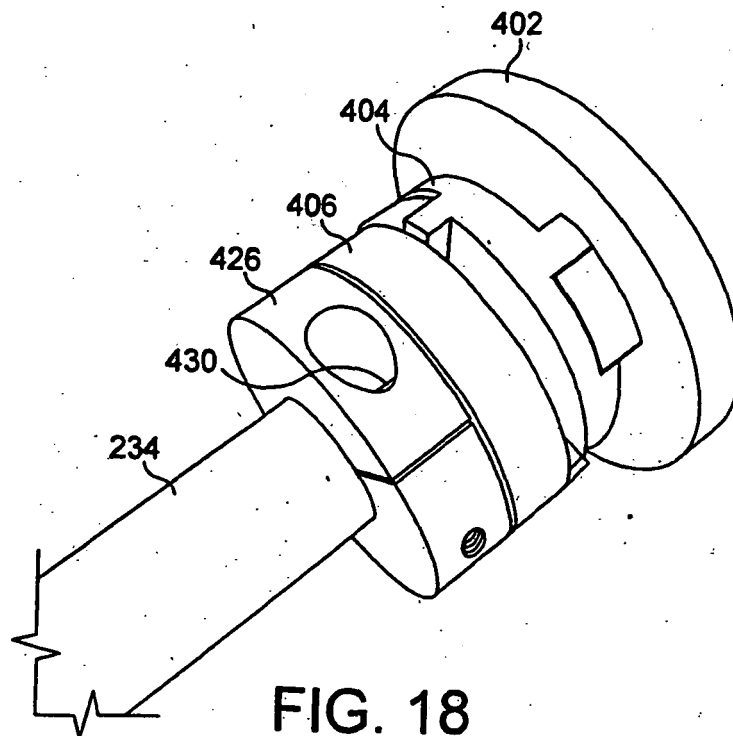


FIG. 18

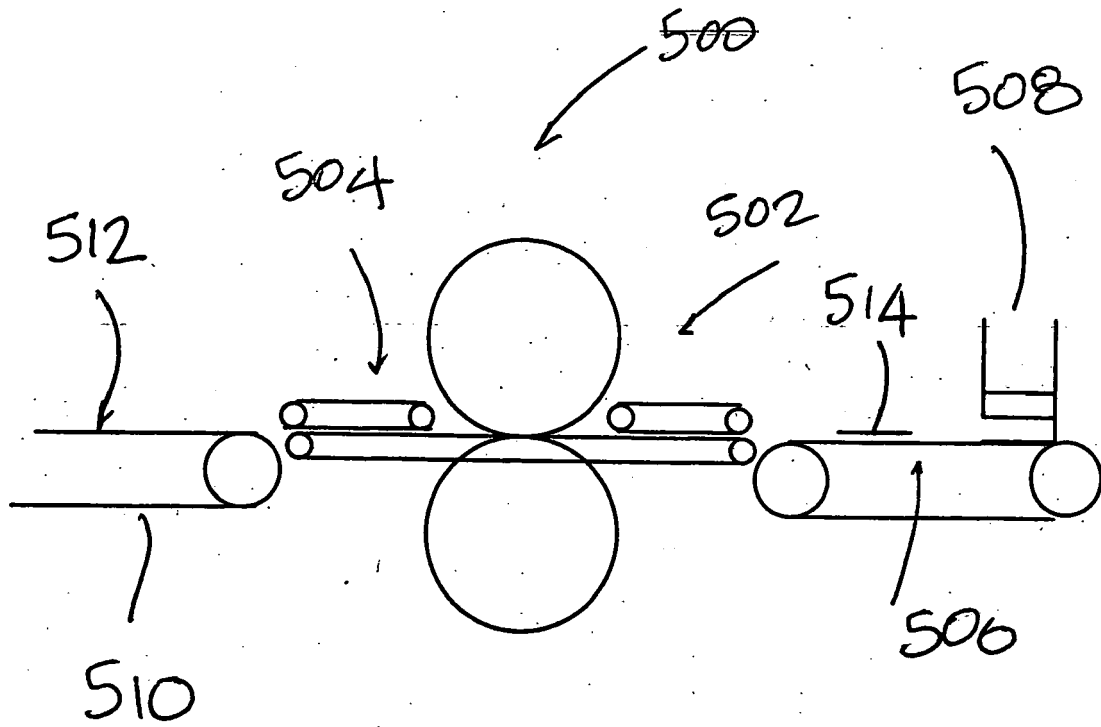


FIG 19

