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(54) **Machine for packaging articles**

(57) A packaging machine for packaging articles into cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between a first position in which articles are conveyed in channels (628, 638, 648, 658, 668 and 678) and a second position in which the articles are assembled in groups and loaded into the carton; the control mechanism comprising a series of independently controllable regulating means (630/630b, 600/600b, 640/640b, 650/650b, 660/660b, 670/670b), one regulating means being positioned in each of the channels (628, 638, 648, 658, 668

and 678) such that the transmission of articles from the first position to the second position can be controlled by opening or closing each of the regulating means (630/630b, 600/600b, 640/640b, 650/650b, 660/660b, 670/670b) and thereby the volume of articles arriving at the second position for assembly into groups is controllable, wherein the regulating means can be sequentially closed to prevent delivery of a unit volume of articles and then sequentially opened to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.

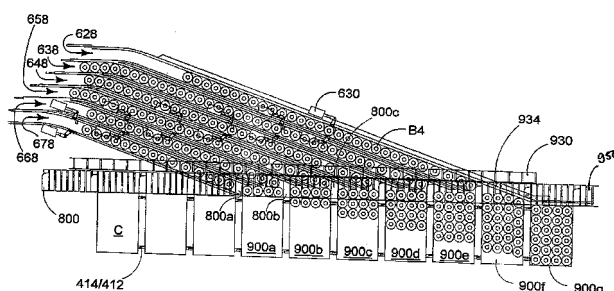


FIGURE 24

Description

[0001] The present invention relates to the packaging of articles such as cans or bottles. More specifically, but not exclusively, the invention relates to a packaging device or apparatus that is fully adaptable to package different types of articles into cartons of various sizes.

Background of the Invention

[0002] Industrial production and packaging of consumer and other types of product is conducted by machines that automatically perform a number of tasks at high-speed. One example of such an industrial production line is found in the beverage and food industry. Beer for example may be bottled at a brewery; groups of such bottles may then be assembled into packages which are then distributed to retail outlets. Bottling lines in such plants operate at high-speed and so the groups of bottles must be assembled and packaged at equally high-speeds otherwise the whole production process is slowed.

[0003] The functions performed by such packaging machines typically include, opening a carton sleeve, loading the sleeve with articles and sealing the carton to secure the articles within the carton. These processes need to be performed at high-speed and often simultaneously. An example of one such machine is disclosed in EP 0017333 to Calvert in which an end-loading machine for packaging cartons containing 24 bottles is shown.

[0004] Such specialised machines are set-up for loading one type of carton with a specific type of article, for example the Calvert machine is set-up for packaging 24 bottle cartons. In order to package a different type or number of articles or indeed to package smaller cartons for example for containing 12 cans instead of 24 bottles a new machine would have to be sourced for the new application or significant and time consuming alterations made to the machine. The machine of EP '333 whilst providing very high-throughput of goods is not versatile and cannot be readily adapted to different applications.

[0005] The present invention seeks to avoid or at least mitigate these and other problems of the prior art by providing a packaging machine that is readily adaptable to accommodate various types of article and various sizes and shape of carton.

Summary of the Invention

[0006] A first aspect of the present invention provides a packaging machine for packaging articles into cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between a first position in which articles are conveyed in channels and a second position in which the articles are assembled in groups and loaded into the carton; the control mechanism comprising a series of independently controllable regulating means, one regulating means be-

ing positioned in each of the channels such that the transmission of articles from the first position to the second position can be controlled by opening or closing each of the regulating means and thereby the volume of articles arriving at the second position for assembly into groups is controllable, wherein the regulating means can be sequentially closed to prevent delivery of a unit volume of articles and then sequentially opened to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.

[0007] Preferably, the regulating means are gate pairs that are operated in conjunction with a control unit that is linked to a drive means of each gate and operable to open and close the gates through control of those drive means, wherein at said start up of the packaging machine the control unit operates to ensure the gates are closed until such time as each channel comprises said sufficient number of articles

[0008] Preferably, each gate comprises an individual drive means in the form of a motorised switching device that is connected to a fixing means movably connected to an arm, which arm is fixedly attached to a shaft which is in turn fixedly attached to the foot. The arm, shaft and foot may in other configurations be formed from an integral piece.

[0009] Preferably, desired volume of articles is a quantity of articles that will completely fill said carton.

[0010] Preferably, the regulating means are staggered relative to one another such that the distance travelled by the articles from each regulating means and said second position is the same. Preferably, the desired volume of articles are transmitted to the second position in time to be loadable into a first of a stream of cartons to reach a position proximate the second position such that the desired volume of articles are loadable into that first carton.

[0011] A second aspect of the present invention provides a method of controlling a packaging machine for packaging articles into cartons, the method comprising: conveying articles in channels in a first position of the packaging machine; controlling the volume of articles being conveyed between that first position and a second position in the packaging machine for assembling the articles in groups and loading into cartons at the second position; regulating the transmission of articles from the first position to the second position by opening or closing regulating means disposed in each of the channels and thereby regulating the volume of articles arriving at the second position for assembly into groups; sequentially closing the regulating means to prevent delivery of a unit volume of articles and sequentially opening the regulating means to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.

[0012] A third aspect of the present invention provides a packaging machine for packaging groups of articles

into cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between an infeed position and a loading position, the volume being controlled such that only integer numbers of groups of articles are transmitted to the loading position such that the packaging machine produces only fully loaded cartons. According to another aspect, the invention provides a packaging machine for packaging groups of articles into cartons at a processing station, the packaging machine comprising an article supply mechanism, the article supply mechanism having a series of tributary channels each for supplying articles to the processing station, a carton supply mechanism for supplying cartons to the processing station and an article supply control mechanism, the article supply control mechanism comprising regulating elements disposed to control the passage of articles through each of said tributary channels, a carton integrity sensing element disposed upstream, in relation to carton flow, of the processing station and a control unit coupled both to the carton integrity sensing element and to each of the regulating elements, the control unit being configured to respond to predetermined information from the carton integrity sensing element to cause one or more of the regulating elements to be activated thereby to restrict the supply of articles from the or each tributary channel, associated with an activated regulating element, to the processing station and being configured to activate the regulating elements such that the supply of articles in said associated tributary channel is interrupted at a predetermined position dependent upon a reaction time of the activated regulating element, thereby controlling the flow of articles being supplied to the processing station.

[0013] Preferably, the article supply control mechanism comprises a plurality of tributary channels, each tributary channel having a regulating element and wherein the regulating elements are caused to be activated sequentially in turn.

[0014] Preferably, in the tributary channels are angled relative to the processing station and wherein the regulating elements in each channel are arranged in an offset staggered relationship relative to the regulating elements in the other tributary channels.

[0015] Optionally, the control unit comprises a programmable logic controller and wherein the predetermined position is calculated by the control unit and is additionally dependent upon the cycle time of the programmable logic controller.

[0016] Preferably, the predetermined position is calculated by the control unit and is additionally dependent upon a reaction time of the carton integrity sensor.

[0017] Preferably, the reaction time of the regulating elements is adaptable so that the packaging machine can be configured to accommodate different types and/or different sized groups of articles.

[0018] Optionally, each regulating element comprises a gate which is moveable from an opened position in which the supply of articles in each tributary channel is

unfettered, to a closed position in which the supply of articles in each tributary channel is interrupted.

[0019] Preferably, the gate is operable by means of an electrically driven motor.

[0020] Preferably, the article supply control mechanism additionally is configured to respond to a fault determined by the carton integrity sensing element by causing a reduction in the rate at which cartons and articles are supplied to the processing station.

[0021] Preferably, the carton integrity sensing element is disposed upstream of the regulating elements a minimum distance which is determined by the rate of packaging groups of articles into cartons.

[0022] Preferably, the predetermined position is calculated dependent upon the type or article and size of group of article packaged by the packaging machine.

[0023] Optionally, the article supply control mechanism comprises changeable lugs for conveying open ended cartons to the processing station.

[0024] Optionally, the tributary channels are disposed relative to the processing station such that articles are supplied to the processing station at an angle less than 90°.

[0025] Preferably, the width of each tributary channel is independently controllable such that the packaging machine can readily accommodate articles of different dimension.

[0026] According to another aspect, the invention provides a method for operating a packaging machine for packaging groups of articles into cartons at a processing station, the packaging machine comprising an article supply mechanism, the article supply mechanism having a series of tributary channels each for supplying articles to the processing station, a carton supply mechanism for supplying cartons to the processing station and an article supply control mechanism, the article supply control mechanism comprising regulating elements disposed to control the passage of articles through each of said tributary channels, a carton integrity sensing element disposed upstream, in relation to carton flow, of the processing station and a control unit coupled both to the carton integrity sensing element and to each of the regulating elements, the method comprising the steps of:

- (i) the carton integrity sensing element issuing a signal to the control unit upon detecting predetermined information from a carton;
- (ii) the control unit responding to that signal by causing one or more of the regulating elements to be activated thereby to restrict the supply of articles from the or each tributary channel, associated with an activated regulating element, to the processing station; and
- (iii) interrupting the supply of articles in said associated tributary channel at a predetermined position dependent upon a reaction time of the activated regulating element, thereby controlling the flow of articles being supplied to the processing station.

[0027] According to an aspect, the invention provides a processing device in which articles are processed and conveyed, a control mechanism for controlling discrete volumes of articles transferred from a supply to a main processing conveyor, the control mechanism comprising a plurality of tributary channels along which articles pass from the supply to the main processing conveyor, each of said tributary channels comprising regulating means for regulating the flow of articles from the supply to the main processing conveyor, means being provided to operate the regulating means such that the flow of articles through each tributary channel is restricted until a sufficient number of articles is present in that tributary channel where after flow through the tributary channel is unrestricted so that a desired volume of articles can be transferred to the main processing conveyor.

[0028] Preferably, the channels are aligned in parallel relationship to one another and wherein the regulating means are positioned in a staggered relationship relative to the incoming flow of articles in those channels.

[0029] Preferably, each channel is defined by two spaced guide rails and each regulating means is moveable between an open position, wherein articles can move freely along the channel, and a closed position, wherein the movement of articles from the first position to the second position is prevented.

[0030] Preferably, each of the series of regulating means is operated sequentially, such that the regulating means of a first channel will be opened before each of the other regulating means or conversely, the regulating means of the first channel will be closed before each of the other regulating means.

[0031] Preferably, there is further provided article management means, said article management means being arranged such that if an error is noted a signal may be sent to the regulating means, which regulating means is adapted sequentially to be first closed so as to prevent delivery of a unit volume of articles, and then reopened to allow delivery of a unit volume of articles, such that either a full group of unit volume is assembled at the second position or a no group is assembled at all.

[0032] Preferably, the regulating means are adapted to be closable independently and sequentially such that the last group of articles to be assembled at the second position is a full volume group and thereafter articles are prevented from being transmitted between the first and second positions.

[0033] Preferably, the processing device is a packaging machine, the articles are bottles or cans which are being conveyed to the first position and at the second position, the bottles or cans are loaded into cartons in assembled groups of a unit volume.

[0034] Preferably, each regulating means comprises a pair of gates which are moveable between an open position, wherein each gate of the pair lies in the plane of one of the guide rails defining the channel, and a closed position, wherein the gates together form a barrier across that channel and thereby prevent movement of articles

from the first position to the second position.

[0035] According to another aspect, the invention provides a packaging machine for packaging articles such as cans or bottles into paperboard cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between a first position in which articles are conveyed in channels and a second position in which the articles are assembled in groups and loaded into the carton; the control mechanism comprising a series of independently controllable regulating means, one regulating means being positioned in each of the channels such that the transmission of articles from the first position to the second position can be controlled by opening or closing each of the regulating means and thereby the volume of articles arriving at the second position for assembly into groups is controllable.

[0036] Preferably, in start-up operation, each of the regulating means is closed until a sufficient number of articles are present at the first position, in order that upon sequentially opening the regulating means a desired volume of articles can be transmitted to the second position such that a prescribed volume of articles can be assembled and loaded into a carton.

[0037] Preferably, the regulating means can be sequentially closed to prevent delivery of a unit volume of articles and then sequentially opened to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.

[0038] According to another aspect, the invention provides a packaging machine for packaging groups of articles such as cans or bottles into paperboard cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between an infeed position and a loading position, the volume being controlled such that only integer numbers of groups of articles are transmitted to the loading position such that the packaging machine produces only fully loaded cartons.

[0039] According to another aspect, the invention provides a method for control of the volume of articles conveyed between a first position within a series of tributary channels and a second position in which articles are assembled in groups, which method comprises the steps of managing the flow through a series of regulating means arranged in staggered positions along the tributary channels.

[0040] Preferably, the method further comprises the steps of obtaining a readiness signal from the second position, and facilitating passage of articles through the regulating means only when such a readiness signal is obtained.

[0041] Preferably, wherein, upon not obtaining a readiness signal from the second position, the regulating means in each tributary channel are sequentially shut and then reopened to coincide with the obtaining of a further readiness signal.

[0042] According to another aspect, the invention pro-

vides a mechanism for use in a packaging machine capable of packaging articles of different physical dimensions, the packaging machine comprising a supply means for supplying articles to a carton, said carton being erected into a tubular structure by an opening device and being loaded from at least one end, wherein the articles are supplied to the at least one end by propagating along at least one guide path, wherein the guide path comprises a first and second guide, the first of said guides being capable of movement relative to the other guide in order to accommodate articles of different physical dimensions.

[0043] Preferably, the at least one guide is coupled to a first screw thread, the first screw thread being coupled to a drive means capable of producing rotary motion of the screw thread such that rotation of the first screw thread effects movement of the first guide.

[0044] Preferably, there comprises a second screw thread parallel to the first screw thread and wherein the second screw thread is driven by the same drive means as the first screw thread.

[0045] Preferably, the comprises a first rod parallel to the first screw thread, a first carriage device being mounted upon the first rod and first screw thread, wherein the first carriage device is coupled to the first guide to facilitate modification of the guide path to accommodate articles of different dimensions.

[0046] Preferably, there comprises a second rod parallel to the second screw thread, a second carriage device being mounted upon the second rod and the second carriage device is coupled to the first guide to facilitate modification of the guide path to accommodate articles of different dimensions.

[0047] Preferably, the drive means rotates the first and second screw threads to achieve linear movement of the first and second carriage devices to provide movement of the first guide relative to the second guide.

[0048] Preferably, there further comprises a series of first and second moveable and fixed guide track pairs, each of the moveable guide tracks being connected to one of the screw threads to facilitate the movement of the movable guide track relative to its paired fixed guide track, wherein each of the moveable tracks is moved simultaneously to ensure that each guide track pair are similarly spaced.

[0049] According to another aspect, the invention provides a packaging machine for packaging articles into cartons, the packaging machine being adapted to permit the machine to be readily adapted to produce packages of different configurations, wherein the cartons and the articles in the packages may be of various different types and/or sizes, wherein the packaging machine comprises a carton erection device, a carton conveying mechanism, an article supply device for loading the cartons from at least one end, a regulation device for regulating supply of the articles to the carton, an article grouping device, a control means, a gluing mechanism for application of glue and securing end panels of the carton, wherein all the

components may be readily adapted to accommodate a change in package configuration.

[0050] Preferably, the carton erection device for at least partially opening a sleeve into a carton comprising a mechanism controlled to function at different angular velocities, the angular velocities including a first angular velocity for opening a first type of sleeve and a second angular velocity for opening a second type of sleeve, the said mechanism including at least one suction arm, the at least partial opening of the first type of sleeve being effected by causing the suction arm to be moved substantially normal to a plane in which the sleeve is disposed and the at least partial opening of the second type of sleeve being effected by causing the suction arm to be moved both normal to the said plane and simultaneously along a vector corresponding to the motion of the sleeve in said plane which conveys the sleeve through the working reach of the cam mechanism.

[0051] Preferably, the carton conveying mechanism incorporates an endless series of spacer elements by which successive packages are spaced apart from one another by a predetermined distance, each spacer element of the series comprising a pair of carton engaging lugs in which a leading lug and a trailing lug can be adjusted from a setting in which both the leading and trailing lugs of each pair are in abutment with one another to maximise the spacing between successive spacer elements to a setting in which relative movement between the leading lug of one pair and the trailing lug of the next succeeding pair decreases the spacing between those successive spacer elements.

[0052] Preferably, the article supply means is capable of supplying a constant flow of articles to the carton conveyor.

[0053] Preferably, the article supply means comprises regulating means which are capable of interrupting the flow of articles to the carton conveyor when no carton blank is supplied to be loaded.

[0054] Preferably, the article supply means is capable of regulating the flow of articles such that cartons are loaded with the desired number of articles.

[0055] Preferably, the article grouping device gather articles from the article supply means and forms them into groups to be loaded into the carton.

[0056] Preferably, the article grouping device comprises interchangeable lugs which can be readily removed from the packaging machine.

[0057] Preferably, the interchangeable lugs can be replaced with interchangeable lugs of a different physical dimension, so as to group a different number of articles.

[0058] Preferably, the interchangeable lugs can be placed at an increased or decreased frequency so as to create smaller or larger groups of articles.

[0059] According to another aspect, the invention provides a packaging machine comprising a gluing mechanism, wherein the gluing mechanism is adapted such that whenever glue is applied to a loaded carton, the construction of the carton is always completed.

[0060] Preferably, the gluing mechanism comprises a folding and pressing device capable of folding flaps of a carton when the flow of packages through the machine has been stopped. According to another aspect, the invention provides a packaging machine comprising a means for adjusting the width of the carton conveyor mechanism such that different carton sizes may be processed by the packaging machine.

[0061] According to another aspect, the invention provides a packaging machine comprising an opening mechanism to enable said packaging machine to form cartons for containing cans or bottles, which opening mechanism comprises a cam mechanism that is controlled to function at different angular velocities, said angular velocities including a first angular velocity for at least partially opening a first type of sleeve, and a second angular velocity for at least partially opening a second type of sleeve, wherein said cam mechanism comprises a suction arm that engages said sleeve, and wherein at least partial opening of said first type of sleeve is effected causing said suction arm to move with the same speed as said first type of sleeve in a direction substantially the same as said direction of motion of said first type of sleeve and simultaneously to move normal to said direction, and wherein at least partial opening of said second type of sleeve is effected by causing said suction arm to move with a speed that is greater than that of said second type of sleeve in a direction substantially the same as said direction of motion of said second type of sleeve and simultaneously to move normal to said direction.

[0062] According to another aspect, the invention provides a machine for packaging articles comprising adaptable conveyor means to enable the machine to be readily adapted to convey cartons of alternate configurations

[0063] According to another aspect, the invention provides a packaging machine for packaging articles into cartons, having the packaging receiving mechanism for enabling the packaging machine to be adaptable such that cartons of differing configurations are loadable with articles of various size and/or shape by the packaging machine, said mechanism being controllable for synchronising feeding of said cartons and/or articles and conveying of said cartons and/or articles.

Brief Description of the Drawings

[0064] Exemplary embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which;

Figure 1 illustrates a perspective view of an opening device having a moveable wheel and suction arm according to one feature of the exemplary packaging machine of the present invention;

Figure 2 illustrates a side view of the device of Figure 1 wherein the suction arm is in contact with a flat sleeve of a hexagonal cross section carton;

Figure 3 illustrates a side view of the opening device

of Figure 1 wherein the suction arm has partially opened the sleeve of the hexagonal carton;

Figure 4 illustrates a side view of the device of Figure 1 wherein the uppermost edges of the partially opened sleeve are fed into a belt and roller assembly;

Figure 5 illustrates a side view of the device of Figure 1 wherein the suction arm is in contact with a flat sleeve of a rectangular cross section carton;

Figure 6 illustrates a side view of the device of Figure 1 wherein the suction arm has partially opened the sleeve of the rectangular carton;

Figure 7 illustrates a side view of the device of Figure 1 wherein the uppermost edges of the partially opened rectangular sleeve are fed into a belt and roller assembly;

Figure 8 illustrates a second suction arm of an opening device according to an alternative embodiment of the present invention;

Figure 9 is a side view of part of a conveyor employed by a packaging machine an embodiment of the present invention;

Figures 10A and 10B illustrate lugs from the conveyor of Figure 9, the lugs corresponding (interchangeably as according to use) to a first and second lug of a spacer element;

Figures 10C and 10D illustrate a first, leading lug in registry with a second, trailing lug;

Figure 10E illustrates lugs from an alternative embodiment of the conveyor of Figure 9, the lugs in abutment with one another;

Figure 11 illustrates movement tracks provided on a packaging machine of one embodiment of the present invention, the tracks provided with pin components according to a preferred optional feature of the present invention;

Figure 12 shows a plan view of lugs carried on two opposed spaced movement tracks;

Figures 13 to 15 illustrate schematically how a variation in pitch may be achieved by adjusting the relative positions of respective leading and trailing lugs of successive spacer elements so as to accommodate different sizes and configurations of articles and/or cartons to be assembled on the conveyor;

Figure 16 shows a plan view of adjustable in-feed lanes by which articles are conveyed along tributary channels from a bottling or filling machine into the packaging machine;

Figure 17 shows a plane view of a jack system provided on the packaging machine of one embodiment of the invention, to facilitate the adjustment of the width of the tributary channels so that the packaging machine can accommodate different sized articles;

Figure 18 shows a combined plan view of the in-feed lanes and jack system of Figures 16 and 17;

Figure 19 shows four adjustable guide lanes of the in-feed mechanism of the packaging machine and illustrates the relative position of gates or valve means that form part of a control mechanism;

Figure 20 shows a full plan view of the tributary adjustable guide channels of Figure 19, each with a pair of gates for controlling the flow of articles within the channels;

Figure 21 shows a front and side view of an exemplary gate which provides a valve means for closing a channel;

Figure 22 illustrates the gate of Fig. 21 as housed within a guide rail of one of the channels of the article in-feed mechanism as shown in Fig 21;

Figure 23 illustrates the gate of Figure 22 in a closed position which can be used to prevent the in-feed or articles conveyed in one channel;

Figure 24 is a schematic plan view of the article in-feed mechanism and loading mechanism of one embodiment of the present invention;

Figure 25 shows a perspective close-up view of an adjustable lug bar according to one feature of the packaging machine;

Figures 26 -27 are schematic plan views of a conveyor and lug bar arrangements demonstrating how the lug bars can be changed to facilitate the loading of different sized cartons with different numbers of bottles;

Figures 29A and 29B illustrate a first step of operation of a securing mechanism used to secure the end panels of carton in a closed position during a change-over operation of a packaging machine;

Figures 30A and 30B illustrate a second step of operation of the securing mechanism Figures 29A and 29B;

Figures 31 A and 31 B illustrate a final step of operation of the securing mechanism Figures 29A and 29B;

Figure 32 illustrates schematically a mechanism for adjusting the width of the packaging machine showing the packaging machine in a first position and Figure 33 illustrates schematically a mechanism for adjusting the width of the packaging machine showing the packaging machine in a second position.

Detailed Description of the Exemplary Embodiments of the Invention

[0065] The present invention provides a packaging machine sub-assembly devices therefore and methods for packaging articles. According to one embodiment the invention provides a packaging machine that is adaptable to package cartons of various dimensions with various types of article. In particular the packaging machine of the exemplary embodiment to be described is readily adaptable so that for example, the machine can be switched from packaging cartons containing four bottles to cartons containing twenty-four cans. The packaging machine is provided with a number of exemplary features and mechanisms that allow the machine to be quickly reconfigured for alternative applications. The downtime associated with reconfiguring the packaging machine of

the present embodiment for an alternative application is in the region of only 20 - 30 minutes. Additionally the packaging machine is provided with a series of mechanisms that control the flow of articles through the machine such that only cartons that contain a complete group or full complement of articles are produced.

[0066] In one embodiment to be described herein the packaging machine is an end-loading machine as is known in the art, however upon reading the foregoing description it will be apparent to one skilled in the art that the various features which enable the packaging machine to be readily adapted for a variety of packaging applications may be applied to other types of packaging machine and therefore the present invention should not be construed as being limited to a packaging machine of the end-loading type.

[0067] In general the end-loading packaging machine of the preferred embodiment comprises a hopper or other means for feeding folded and pre-glued flat carton sleeves. The sleeves or flat cartons are then opened to form a tubular arrangement and conveyed by means of lugs downstream, towards the articles. In this example, the open-ended cartons are loaded from one side only. The articles, i.e. cans or bottles to be loaded into the cartons are supplied from the canning or bottling line and funnelled into tributary channels which feed the bottles or cans toward the conveyed cartons. The tributary channels are angled with respect to the open ends of the cartons and the bottles or cans are supplied by six incoming channels. Lug bars are provided for collating the articles into groups of the number of articles to be loaded into each carton and as the open ended cartons are conveyed past the ends of the tributary channels the articles are moved into the carton. The completely loaded cartons are then closed by folding upper and lower end closure panels over the carton ends and are secured closed by means of adhesive. The loaded and closed cartons are then conveyed between two pressure belts which ensure that the end closure panels are securely adhered together.

[0068] The packaging machine of the invention will now be described in detail, first turning to the opening mechanism; Figure 1 shows a perspective view of an opening device 10 including a cam wheel 20. Figure 1 shows the cam wheel 20, to the front face of which are mounted suction arms 22, only one of which is illustrated for enhanced clarity. Also illustrated is a carton sleeve 60, composed of six panels hinged one to another, intended for being opened into a carton of hexagonal cross section. The carton sleeve 60 is a fully enclosed carton of the type normally used for bottles. The carton comprises top, bottom and side wall panels, hinged together in series and upper and lower end closure panels which are used for closing the ends of the carton. The carton sleeve is hexagonal in cross-section because the top panel is smaller than the bottom panel and the end closures are slightly tapered such that a fully formed carton fits securely around an assembled group of bottles.

[0069] Illustrated in Figure 1 are two suction arm heads 30, each mounted on lowermost ends of the suction arm 22 and which are each capable of forming a vacuum seal between the suction arm 22 and a flat surface, such as the top panel of the carton sleeve 60. Suction arm 22 is shown at its lowermost point at which the respective suction arm heads 30 have been brought into contact with the top panel of sleeve 60, forming a vacuum seal between the suction arm 22 and the top panel. The sleeve 60 is travelling tangentially to the cam wheel 20 along a conveyor means 28. The specific arrangement and number of suction arm heads 30 are considered unessential to the core inventive concept of the present invention and may be altered from the arrangement as illustrated without departing from the scope of the invention. Also illustrated in Figure 1 are belt systems 24 each having a plurality of rollers 26. Each belt system 24 includes an uppermost surface that follows a two stage incline away from a plane composed of the topmost surface of the conveyor means 28. The two stage incline comprises of a first stage that is at an angle to the plane, and a second stage that is at a smaller angle to the plane than that of the first stage. The arrangement of the rollers is such that the bottommost point of the periphery of each roller substantially comes into contact with the topmost surface of a respective belt 24.

[0070] The belt 24 comprises a guide 32 for accepting portions of a sleeve 60 as the sleeve 60 moves along the conveyor means 28.

[0071] Figures 2, 3 and 4 illustrate three points during the process of partially opening the hexagonal sleeve 60.

[0072] Figure 2 illustrates the start point of the process, and is equivalent to the arrangement described above in relation to Fig 1. The suction arm heads 30 have formed a vacuum seal between the suction arm 22 and the top panel of carton sleeve 60.

[0073] Figure 3 illustrates the device 10 after having partially opened the sleeve 60. Lower peripheral portions or lower end closure panels of the carton sleeve 60 are retained under rails running along side the conveyor means 28. The lower end closure panels are hinged to bottom panel of the sleeve 60, which remains in contact with the conveyor means after the opening device 10 has partially opened the carton 60. The presence of the rails ensures that the bottom panel of the sleeve 60 remains in contact with the conveyor means 28 when the suction arm begins to open the sleeve 60.

[0074] Figure 3 further illustrates how the cam wheel 20 has rotated such that the suction arm has been displaced both in the direction of the motion of the topmost surface of the conveyor means, and also some distance normal to the plane comprising the topmost surface of the conveyance means. A gearing system within the cam wheel 20 is employed to ensure that the suction arm remains perpendicular to the conveyor means as the cam wheel 20 rotates. In this manner, the top panel, of sleeve 60, is maintained substantially parallel to a plane comprising the topmost surface of the conveyance means.

Thus, the path of the suction arm heads 30 results in the top panel being moved away from, whilst remaining parallel to the plane of the topmost surface of the conveyance means 28. The opening device 10 is structured such that the top panel of the sleeve 60 remains in substantial vertical alignment with a given point on the topmost surface of the conveyance means 28, whilst attached to one of the suction arms 22. The motion of the top panel relative to the said given point is therefore substantially normal to the plane comprising the topmost surface of the conveyance means 28.

[0075] Figure 3 also illustrates the point at which the upper end closure panels of the carton which are located along either side of the top panel are guided, by guides 32, between the rollers 26 and the belts 24. The top end closure panels are hinged to the top panel and are of sufficient structural integrity such that the top panel may be orientated, and the entire sleeve transported, by the incline and motion of a topmost surface of the belts 24. As the sleeve 60 is guided between the belt 24 and the rollers 26, the top panel is released from the vacuum seal with the suction arm 22.

[0076] Figure 4 illustrates the way in which the rotary action of the belt 24 maintains the linear motion of sleeve 60 after it has reached a terminal end of conveyance means 28. The lower end closure panels are still retained by lower guide rails 27, which extend beyond the terminal end of the conveyance means 28 for the full length of the belt system 24. The incline of the belt 24 achieves the effect of further separating the top panel and the bottom panel of the carton such that the sleeve 60 becomes increasingly opened. At the point whereby the upper end closure panels of the top panel reach the terminal end of the belt, the sleeve 60 is substantially fully opened and can be conveyed toward the article supply ready for loading.

[0077] Figures 5, 6 and 7 illustrate three points during the process of partially opening a sleeve 70 that is formed of four panels each hinged one to the next. The opened carton formed from sleeve 70 is rectangular in cross-section and is commonly loaded with cans. When folded flat the top panel of the carton only partially overlays the bottom panel of the carton. To open the carton from the flat sleeve the top panel must be moved quicker relative to the bottom panel, i.e. in order to be opened into a carton of rectangular cross section, the top panel is required to pass through a different path to that required in order to open the hexagonal sleeve 60.

[0078] Such an alteration in the path is not readily possible by previously known devices that rely upon cam paths wherein the path of the cam is fixed and the suction pads are limited in their application to the predetermined path as built.

[0079] One embodiment of the present invention provides an adaptable opening mechanism that is suitable for use with different types of carton and makes such an alteration in the suction cup path possible by employing an electrically powered cam wheel of variable rotational

speed. When considering the cyclic motion of the suction arm 22 about the cam wheel 20 from a point of reference on the topmost surface of the conveyance means 28, it can be appreciated that the speed of the cam wheel will effect alteration in the path of the suction arm 22 and therefore the said panel of the sleeve 70.

[0080] Figure 5 illustrates the start point of the process. The suction arm heads 30 have formed a vacuum seal between the suction arm 22 and the top panel of the sleeve 70. Due to the difference in the geometry of sleeve 70 in comparison to sleeve 60, the top panel with which the vacuum seal is made is in a different position to that with which a vacuum seal would have been made had the sleeve been of the geometry of sleeve 60 of Figure 1. In the case of sleeve 70, the panel with which a vacuum seal is formed is the first of two uppermost panels to pass along the conveyance means 28.

[0081] Figure 6 illustrates the device 10 after having partially opened the sleeve 70. Lower end closure panels of the sleeve 70 are retained under guide rails 27 running along side the conveyance means 28. The lower end closure panels are hinged to edges of the bottom panel of the sleeve 70, which will remain lowermost after the device 10 has opened the carton. The presence of the guide rails 27 ensures that the lowermost panel of the sleeve 70 remains in contact with the conveyance means 28 which the suction arm partially opens the sleeve 60.

[0082] The cam wheel 20 has rotated such that the suction arm has been displaced both in the direction of the motion of the topmost surface of the conveyance means, and also some distance normal to the plane comprising the topmost surface of the conveyance means 28. A gearing system within the cam wheel 20 ensures that the suction arm remains in the same orientation as the cam wheel 20 rotates. In this manner, the top panel, of sleeve 70 is maintained substantially parallel to the plane of the conveyance means. Thus, the path of the suction arm heads 30 results in the said panel being moved away from, whilst remaining parallel to the plane comprising the topmost surface of the conveyance means 28. In order to partially open the carton, it is necessary for the top panel to possess a greater velocity in the direction of motion of the topmost surface of the conveyance means 28, than the velocity of the bottom panel (the bottom panel being in contact with and travelling at the same speed as the conveyance means).

[0083] This is in contrast to the process for opening the sleeve 60 of Figure 3 during which the corresponding said panel is required to have the same velocity as a given point on the topmost surface of the conveyance means, in the aforementioned direction.

[0084] Figure 6 also illustrates the point at which end closure panels of the top panel of sleeve 70 are located along either side of the said panel transverse to the direction of motion of the topmost surface of the conveyance means 28, are guided, by guides 32, between the rollers 26 and the belts 24. The end closure panels are hinged to the said panel of sleeve 70 and are of sufficient

structural integrity that the said panel may be orientated, and the entire sleeve transported, by the incline and motion of a topmost surface of the belts 24. As the sleeve 70 is guided between the belt 24 and the rollers 26, the said panel is released from the vacuum seal with the suction arm 22.

[0085] Figure 7 illustrates the way in which the rotary action of the belt 24 maintains the linear motion of the sleeve 70 after it reaches a terminal end of the conveyance means 28. The lower end closure panels of sleeve 70 are still retained by guide rails 27, which extend beyond the terminal end of the conveyance means 28 for the full length of the belt system 24. The incline of the belt 24 achieves the effect of further separating the top panel from the bottom panel such that the sleeve 70 becomes increasingly opened. At the point whereby the sleeve 70 reaches the terminal end of the belt it is substantially fully opened and is then conveyed towards the article supply, for loading.

[0086] Figures 1 to 7 each illustrate only one of the suction arms 22 connected to the cam wheel 20, for enhanced clarity.

[0087] Turning to the invention in general, it is possible to employ multiple suction arms 22, the maximum number being determined by the size of the sleeves 60/70 and the desired throughput capacity of the device.

[0088] Figure 8 illustrates a preferred embodiment of the opening device of the present invention in which two suction arms 22 are controlled by the cam wheel 20. It is envisaged that any number of suction arms may be employed without departing from the scope of the invention. It is also envisaged that the angular velocity of the cam wheel could be further controlled in order to facilitate the movement of the top panel relative to the bottom panel of a different type of carton to thereby facilitate the opening of further types of carton and thus increasing the adaptability of the packaging machine to a variety of package types. Additionally other means capable of moving the top panel of the cartons at different speeds and accelerations relative to the bottom panel may be used to open the carton blanks. By having a mechanism that is readily programmable and which allows the opening of a variety of carton blanks a packaging machine is provided wherein little or no downtime of the machine is incurred to adapt the machine to packaging a variety of carton types.

[0089] Out the out feed end of the opening device, the open tubular cartons are conveyed in a line along a fixed base plate by means of lugs 412, 414 which not only convey the opened cartons but maintain the opened cartons in an upright configuration. In Figure 9, there is shown in use a part of an exemplary packaging machine 410 for the assembly of cartons A, which machine incorporates the conveyor 420. There is shown a conveyor 420 for conveying the open-ended cartons A to be loaded, and it is provided with one or more lugs 412, 414 on either side of the conveyor 420.

[0090] The conveyor 420 comprises a number of lugs

412, 414 grouped as one or more spacer elements, each spacer element comprising a pair of lugs 412, 414. Each such pair is separable, one lug 412, from the other 414, and the two lugs 412, 414 of such a pair are each moveable independently of the other, along a movement track 440 provided to facilitate the displacement of a series of lugs 412, 414 in a forward and backward direction.

[0091] As such, in operation, at least one, leading, lug 412 can be rapidly displaced relative to the position of another, trailing lug 414 so as to vary the spacing between adjacent lugs 412, 414. The resultant change in pitch on the conveyor 420 allows for easy accommodation of different sizes or configurations of article or in this non-limiting example, carton A with a rapid change-over leading to minimal downtime before the conveyor 420 continues in operation. Figures 13, 14 and 15 schematically illustrate the process of adapting the pitch by movement of the lugs 412, 414.

[0092] An alternative interlocking arrangement for the lugs 412a, 414a is illustrated in Figure 10E of the present invention, and may be employed so as to confer additional lateral stability to the pair of lugs 412a, 414a in use.

[0093] In particular, it is preferred but not required that this interlocking arrangement of lugs 412a, 414a be employed along one side of a conveyor 420 in use, and that the arrangement of lugs 412, 414, substantially as shown in Figures 10A to 10D, is employed along the opposite side of the conveyor 420. Most preferably, the interlocked set of lugs 412a, 414a is employed on the side of the conveyor 420 from which the cartons A are loaded for example, with bottles. Still more preferably, the set of lugs 412a, 414a nearest the loading side of the cartons A is adapted to be of slightly wider form than the lugs 412, 414 on the opposite side of the conveyor 420. As such, in this preferred case the interlocking set of lugs 412a, 414a has sufficient stability and strength that the interlocking set of lugs 412a, 414a may optionally be used alone to convey cartons A along the conveyor 420. In this way the cartons for containing as few as four bottles held in a 2x2 configuration can be opened, conveyed and loaded by the packaging machine of the present invention. The spacing between the two sides of the conveyor 420 does not therefore limit the packaging machine to the application of packaging cartons of a minimum width.

[0094] In order to maximise the possible distribution in pitch lengths that can be provided by the lugs 412, 414 of the present invention, the lugs 412, 414 are preferably arranged in pairs, adapted to be spatially complementary to one another, in order that they may fit together to form effectively single lugs, each maximally separated from the next. This fitting together of complementary sets of lugs 412, 414 is illustrated in Figures 10A, 10B and 10C.

[0095] It is preferable that the lugs 412, 414 are so adapted along an edge which engages the cartons A to be assembled as to bias the cartons A into a desired configuration. In Figure 9, each pair of lugs 412, 414 has been brought together so that the two lugs 412, 414 are in abutment, and so as to maximise the pitch between

successive pairs of lugs 412, 414.

[0096] The outer edges of the combined pair of lugs 412, 414 are adapted in the example shown in Figure 9 to be wider in their top portions 422, 424 than at their middles, so that the top portion of each carton A held between these lugs 412, 414 is biased inwardly of that carton A structure, so as to achieve the desired tapered "gable-ended" carton A for use with bottles. In the alternative case, for example, of a flat-edged carton A as typically used for containing cans, a simple, substantially oblong-shaped lug 412, 414 is substituted.

[0097] In the case of the gable-ended carton A, the configuration of the present invention brings clear advantages. Particularly, when adjacent lugs 412, 414 are brought into close registry by movement of at least one lug 412, 414 along its movement track 440 and relative to another, the resulting effective double-lug has a substantially Y-shaped configuration. However, the two lugs 412, 414 retain their ability to bias their respective adjacent cartons A into the gable-ended configuration, even when they are spaced apart by a further movement of one relative to the other along its movement track 440, so as to accommodate a smaller size of carton A as illustrated in Figure 15.

[0098] One optional aspect of the present invention provides that one or more of the lugs 412, 414 be disposable about an articulated pivot means (not shown), and may preferably be pivoted about said pivot means by actuator means so as to cause the lug 412, 414 to be pushed toward an adjacent article A, to aid the article A being biased into a desired configuration.

[0099] It will be understood that the lugs 412, 414 are not at all limited in shape within the scope of the present invention, and could adopt any configuration so as to be complementary to the desired configuration of the cartons A to be assembled on the conveyor 420.

[0100] Indeed, according to a further preferred optional feature of the present invention, one or more of the lugs 412, 414 may easily be changed for those of a different configuration, so as to accommodate a different set of articles A on the conveyor 420.

[0101] According to this feature of the present invention, one or more of the movement tracks 440 is provided with a series of pin components 430, exemplified by those as shown in Figure 13. These pin components 430 are preferably so constructed and arranged as to securably engage the lugs 412, 414. The pin components 430 are more preferably so arranged as to be capable of being moved by a movement track 440 in the backward and forward directions Y, Z with respect to the direction of movement of the conveyor 420.

[0102] Preferably, the securement is brought about by the provision of a securement means 416, 418 within a lug 412, 414; typically, though not of necessity, this securement means 416, 418 takes the form of a short bar or pin. The securement means 416, 418 is so constructed and arranged as to co-operate with a complementary securement portion 432 of the pin component 430. This

complementary securement portion 432 preferably comprises a slit or aperture within the outer form of the pin component 430.

[0103] Optionally, there may be provided a plurality of securement portions 432 at different heights on the pin component 430, each able to co-operate with the securement means 416, 418 of a lug 412, 414. As such, a lug 412, 414 may be mounted on the pin component 430 at any one of a plurality of heights, thereby providing for the accommodation of a plurality of different heights of carton A on the conveyor 420.

[0104] More preferably, the securement means 416, 418 of the lug 412, 414 is spring-loaded such that it may easily be disposed out of co-operation with the securement portion 432 of the pin component 430 by hand. This further facilitates the rapid change-over between different shapes and sizes of lug 412, 414 to allow for adaptation of the arrangement, to accommodate a different configuration or size of a carton A on the conveyor 420 with a minimal conveyor downtime.

[0105] The lug pairs 412, 414 are readily moveable to accommodate different width, shape and height of carton and are moveable relative to another such that the pitch or frequency of cartons conveyed within the packaging machine can always be maximised thereby ensuring maximum throughput of cartons. It can also be seen from Figure 12 that the conveyor 420, which in this example takes the form of a fixed metal base plate, is adjustable such that the two movement tracks 440 can be moved closer together and hence enable the packaging machine to be readily adapted to cartons of different depth for example the machine can be used cartons containing four bottles held in a 2 x 2 array as easily as it can be used for a carton containing twenty-four cans held in a 4 x 6 array. To this end the opening device and lug mechanism co-operate such that if the pitch is doubled, for example in moving from a 4x4 carton (see Figure 13) to a 2x2 carton (see Figure 15) the frequency of the opening device can easily be increased, in this case doubled, to accommodate the increased throughput which is expected when the cartons are smaller.

[0106] The adaptability of the opening device to change its cycle frequency allows the pitch of the whole machine to be change easily. Additionally, within a cycle the opening device wheel 20 can follow a varied speed pattern so that the top panel of a carton for containing four bottles is separated from the bottom panel quickly enough in synchrony with the increase speed of carton feed and conveyance.

[0107] Once the open-ended cartons are erected the articles, whether they are cans or bottles and fed from the supply means. A schematic illustration of the loading mechanism and carton supply means is shown in Figure 24. Bottles B4 or indeed cans are funnelled from a filling line (not shown) into tributary channels 628, 638, 648, 658, 668 and 678. In this example the articles (cans or bottles) are supplied to the open ended cartons along six tributary channels. Each of the channels has a minimum

width of approximately 3cm and can be widened by up to approximately 20cm. In this way different sized articles can safely be accommodated by the channels and the spacing of the articles at the out feed end of the tributary channels is controlled. The adjustable channel width is facilitated by a jack system. The jack system will now be described with reference to figures 16 to 20.

[0108] The tributary channels or guide lanes 628, 638, 648, 658, 668, 678 can be adjusted in width to accommodate articles of different diameters, or widths. Since each lane 628, 638, 648, 658, 668, 678 is of substantially the same construction the operation of the system will be described with reference to lane 628; it being understood that each of the other lanes operates similarly.

[0109] Lane 628 is comprised of a fixed guide 615 and a moveable guide 625, wherein an article, such as a bottle B4 is driven down the lane 628 by a conveyor, (not shown in figures 16-20). The jack system is shown in Figure 17 and together the article supply channels and the jack system are shown in figure 18. Referring to figures 17 and 18 it can be seen that lane 628 can be adjusted in width by moving moveable guide 625, where this movement is achieved by rotation of a first and second screw thread 742a and 742b respectively. Screw threads 742a and 742b are parallel to each other and are in a spaced apart relationship. Rotation of screw threads 742a and 742b is achieved by a single drive means 724, in the preferred embodiment this drive means is a servo motor.

[0110] Drive means 724 is coupled to screw thread 742b by a coupling means 760 in the preferred embodiment this is a belt and pulley arrangement, however, it will be appreciated that alternative configurations may be used such as a chain and sprocket, or gear linkage. It will also be appreciated that the choice of pulley size, sprocket size or gear ratios will allow the angular speed of the screw thread 742a to be stepped up or down from that of the servo motor 724.

[0111] Screw thread 742a is coupled to screw thread 742b via coupling means 750. It will be appreciated that the coupling 750 between screw threads 742a and 742b is such that screw thread 742a rotates at substantially the same angular velocity as screw thread 742b.

[0112] Coupled to the screw threads 742a and 742b are two carriages 744a. Carriages 744a are coupled via a complementary screw thread to screw thread 742a and 742b.

[0113] The moveable guide 625 of lane 628 is coupled to both carriages 744a. One of the carriages 744a is additionally coupled to a rod 740 the other of the carriages 744a is coupled to a rod 730. Rod 730 runs parallel in to screw thread 742b (and in a spaced apart relationship). Rod 740 runs parallel and in a spaced apart relationship with screw thread 742a.

[0114] The rods 730 and 740 prevent the carriages 744a from rotating when the screw threads 742a and 742b are rotated by the drive means 724. In this way, the carriages 744a are forced to travel linearly along their respective screw thread 742a or 742b. Furthermore it will

be appreciated that both carriages 744a move with the same linear speed, and over equal distance, upon rotations of the screw threads 742a and 742b by drive means 724. In this way movement of the moveable guide 625 is achieved such that the width of lane 628 can be adjusted depending upon the size of article to be conveyed along the lane 628.

[0115] Rods 730 and 740 are mounted in frame 780 in a fixed manner whilst the screw threads 742a and 742b are mounted in the frame 780 such that they can be freely rotated, for example, they may be coupled to the frame 780 by a bearing (not shown). Additionally each moveable guide 625, 635, 645, 655, 665, 675 is coupled to the screw threads 742a and 742b via carriage 744a, 744b, 744c, 744d, 744e, 744f respectively.

[0116] In the preferred embodiment each moveable lane is coupled to two screw threads 742a and 742b, however, it will be appreciated that the movement of guides 625, 635, 645, 655, 665, 675 could be achieved with one screw thread, and that only one carriage per moveable guide would be required.

[0117] Referring to figure 20, it can be seen that the moveable guides 625, 635, 645, 655, 665, 675 are coupled at the input end of the lanes 628 - 678 to fixed guide portions which are substantially parallel to the screw threads 742a, 742b and the rods 730, 740.

[0118] It is desirable that the articles traversing along the lanes 628, 638, 648, 658, 668 and 678 do not experience a transition when entering the adjustable width section of the lanes 628, 638, 648, 658, 668, 678. This is achieved by ensuring that the fixed guide portions are flush with the fixed guides 614, 624, 634, 654. In addition, the moveable guides 625, 635, 645, 655, 675 comprise a section which slides within the fixed guide portions. The fixed guide portions comprise a recess to receive a protrusion of the moveable guides, wherein the protruding part of the moveable guide is flush with sections of the fixed guide portion on either side of the recess.

[0119] The mechanism herein described for adjusting the width of channel 628 is similar to the mechanism used for adjusting the widths of the other channels and indeed in this arrangement each of the moveable guides is connected to a screw thread 742a, 742b which is driven by the same servo motor 724 such that the tributary guide channels 628, 638, 648, 658, 668 and 678 are adjusted simultaneously and by the same relative adjustment. Therefore the spacing of the articles exiting each tributary channel is carefully controlled. This enables the coupling between the article feed and the carton pitch to be closely and carefully controlled. In this way the packaging machine can be adapted from an application wherein cartons containing six narrow diameter cans in a 2 x 3 array are packaged to an application wherein twelve large diameter bottles contained in a 4 x 3 array can be readily facilitated.

[0120] To change the machine from such a first application to a second application the packaging machine will be stopped. In order to finely control the flow of bottles

a control mechanism is also provided within the packaging machine. This will now be described with reference to Figures 20 to 28.

[0121] Figure 20 is an illustrative plan view of the six adjustable tributary channels 628, 638, 648, 658, 668 and 678. Each channel is defined by a fixed guide 615, 614, 624, 634, 644 654 and a moveable guide 625, 635, 645, 655, 665, 675 and is provided with a regulator element or valve means, which in this exemplary embodiment takes the form of a pair of gates 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b.

[0122] Each of the gate pairs 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b can be moved from an open position in which the gate lies substantially within the same plane as one of the guides, 615/625, 614/635, 624/645, 634/655, 644/665, 654/675 to a closed position wherein the gate pairs 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b form a barrier across and block the flow of articles within the adjacent channel 628, 638, 648, 658, 668 and 678. In some applications the regulator element may take an alternative form to a gate or may comprise only a single gate which can be used to restrict the flow of articles in a tributary channel by blocking the flow of articles in that channel. A single gate may be preferable for operations where the adjustable tributary channel 628, 638, 648, 658, 668 and 678 is only of a narrow width.

[0123] Figures 21 to 23 illustrate the form and operation of a single gate 600. Since each of the gates takes an equivalent form only one gate will be described in any detail, it being understood that the other gates of this embodiment are the same. Each gate comprises an individual drive means 610, which in this case is a motorised switching device which is connected to a fixing means 608. Fixing means 608 in turn is movably connected to arm 606. The arm 606 is fixedly attached to a shaft 604 which is in turn fixedly attached to the foot 602. The arm 606, shaft 604 and foot 602 may in other configurations be formed from an integral piece.

[0124] The shaft 606, as can be seen most clearly in Figure 22 is housed within a post integrally formed with the guide track 614. An aperture 622 is provided in the guide track 614 for accommodating the foot 602 of the gate when the gate 600 is in the open position. To close the gate, the arm 606 is rotated relative to the fixing means 608 which thereby rotates the shaft 604 and hence foot 602 such that the foot 602 is moved perpendicularly to the guide track 614 and lies across the guide channel 638 as shown in Figure 20. Although each gate is independently operable, in normal use each gate of a gate pair 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b is operated synchronously and in like manner such that a pair will either be open or closed at any one time. The arrangement of gate pairs 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b being open and closed of Figure 20 is for illustrative purposes only and to show the independent movement of each gate of a gate pair.

[0125] The gates or regulator elements 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b are staggered relative to one another. Due to the angle of the tributary channel relative to the line of the open ended cartons, as can be best seen in Figures 20 and 24 the length between the regulator or gate pair 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b and an out feed end of each channel 628, 638, 648, 658, 668 and 678 is approximately equal. At the outfeed end of the channel the supplied articles meet open ended cartons; this is known as a processing station. The present invention could be utilised in other applications wherein the articles may take various forms and at the processing station a process is performed which is not necessarily the loading or packaging of groups of articles into cartons.

[0126] In operation the regulator elements (gate pairs 630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b) are operated in conjunction with a control unit 700 such as a computer processing unit (CPU) linked to each of the drive means 610. This enables each gate pair to be opened or closed in response to a signal received at the control unit 700. For example in a start up operation the gates will each be closed until such time as each tributary channel 628, 638, 648, 658, 668 and 678 comprises a sufficient number of articles, such as bottles. A sufficient number will be the number of bottles required from each channel to fill a carton completely. For example to fill the cartons C shown in Figure 24, twenty-four bottles are needed. Each channel 628, 638, 648, 658, 668 and 678 will provide four of these bottles such that the six channels together provide the group of 24 bottles necessary to completely fill a carton C such as fully loaded carton 900g.

[0127] The gate pairs will remain closed at least until each channel comprises four bottles. The bottles are supplied from the bottling line and once the bottles are supplied to the packaging machine and funnelled into the tributary guide channels loading of the cartons can and needs to commence. The gate pairs will be opened sequentially starting with the gate pair 670/670b of the innermost channel 678. The bottles will be conveyed along the channel and are corralled along the channel in part by the incoming supply of bottles and partly by a conveyor means. Upstream of the article supply, a carton supply means feeds flat folded blanks, which are delivered by the hopper and opened by the opening device; the opened tubular structure will then be supported by a lug pair 412, 414 and conveyed towards the supply means. Meanwhile the bottles of channel 678 are conveyed towards the open-end of the channel 678 and the gate pair of the adjacent channel 668 will be opened and bottles in that channel will be conveyed towards the open end of channel 668.

[0128] To assist in the spacing and conveying of the articles within the channels one or more conveyor means 930 are provided. Each of these conveyor means is provided with partitions 934 such that the spacing between

each bottle is substantially the same as the width of an article, in this example a bottle being supplied by the channels. Each partition is provided with an adaptable head such that the width between each partition 934 can be adjusted by removing the head and easily replacing the head with a narrower or wider head as required. In this way the spacing between the partitions of conveyor 930 can be quickly and accurately changed in line with the bottles or articles being manipulated by the packaging machine. The conveyor 930 runs parallel to the direction of travel of the carton blanks and ensures that each bottle is moving in time with the moving cartons. Each bottle still has an element of momentum in a direction substantially parallel with the guide track of its channel such that each bottle as it reaches the exit end of its channel is correctly spaced from the neighbouring bottles and is travelling at the same speed as the cartons and toward the open-ended carton. A further conveyor 950 lies adjacent and parallel to the conveyor 930. The further conveyor 950 comprises a series of lug bars 800, 800a and 800b which are removable to be interchanged with lug bars 805 and 810 which will hereinafter be described in greater detail.

[0129] The lug bars 800 are sized to achieve desired pitch spacing between them and are shaped to facilitate the grouping and movement of the bottles for loading into the carton. Each lug bar 800 is provided with a leading straight edge 814 and a tapered rounded edge 812. The leading straight edge helps to intercept the bottles for picking out a select number of bottles from a channel and the rounded trailing edge 812 encourages the bottles to move into the open ended tubular sleeve. The lugbars of this application are provided such that they are readily removable from the plated conveyor track 950. The plated conveyor track comprises plates 822a, 822b, 822c and 822d etc and periodically a plate 822c is provided with a shaped groove 820 that can receive a complementary shaped tongue provided along a bottom edge of the lug bar. The structure and arrangement of the lug bars 800 and conveyor plates 822c enables the lugbars to be interchangeable with other sized lug bars, for example lug bars 805 and 810 which are schematically illustrated in Figures 26 to 28. Larger lug bars are provided to accommodate a pitch of three bottles B3 whereas narrower lug bars 810 are used to separate out the bottles in groups of two bottles B2 wherein the frequency of the lug bars is increased. The two conveyors 930, 950 and respective partitions 934 and lugbars 800 are conveyed beneath the guide tracks, 615/625, 614/635, 624/645, 634/655, 644/665, 654/675.

[0130] As the bottles of the first and second channels 678 and 668 are conveyed towards the exit end of their respective channels the gate pair 650/650b of the next channel 658 is opened. Sequentially the other gate pairs are opened such that bottles from each channel are conveyed towards the exit end of their channel. As the open ended tubular carton approaches the out feed end of the innermost channel 678, lug bar 800 intercepts the bottle

feed to siphon and separate off a set of four bottles from the innermost channel, as the bottle feed continues and the lug bars 800a and 800b pass beneath each of the channels further sets of four bottles are siphoned from each of the tributary channels. The bottles, still retain an element of momentum in line with the channel, and are encouraged by the lug bars into the open end of the carton, by the time the carton 900 reaches the exit end of the outermost channel 628 a group of twenty four bottles has been separated from those allowed through by the regulators. Between them the regulators or gates control the flow of bottles so that the bottles are only fed in integer numbers of twenty four bottles. The volume of articles on the out feed end of the regulators is controlled in this way to ensure that only fully loaded cartons are produced by the packaging machine.

[0131] In the start-up mode, the regulating gates are sequentially opened so that the first carton through the machine collects a full set of 24 bottles. This control mechanism offers a distinct advantage over prior art machines wherein several cartons are fed and partially filled before a fully loaded carton is achieved. This not only wastes bottles during the start up but also when the prior art machines are stopped. The present invention however provides a control mechanism in conjunction with the regulating gates that prevents such wastage and even more beneficially can prevent the feed of bottles if a carton is misfed.

[0132] For example, a carton integrity sensing element disposed downstream of the blank feed hopper or carton supply mechanism (not shown in the drawings), and disposed upstream relative to a processing station where the articles (cans or bottles) are loaded into the cartons is used to detect that a blank has not been fed or that the incorrect type of blank has been fed. The carton integrity sensing element may be configured such that it can recognise for example, the type, style, size and position of the cartons being fed. If the sensing element notes a fault with one or more of these predetermined parameters then the carton integrity sensing element will transmit a signal to the central control unit 700 which will memorise the location or pitch of the missing or incorrect blank. The central control unit will respond to the fault determined by the sensing element by transmitting a signal to each of the regulating elements in turn so that in accordance with the pitch of the cartons being filled and the speed of the packaging machine, gates 670/67b of the innermost lane will be closed. Sequentially thereafter the other regulating elements (630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b) will be closed to prevent the flow of bottles toward the empty pitch. The operation of the regulating elements (630/630b, 600/600b, 640/640b, 650/650b, 660/660b and 670/670b) to control the passage of articles through the tributary channels 628, 638, 648, 658, 668 and 678 is carefully timed and synchronised such that the faulty pitch that will arrive at the processing station is not filled with articles, but thereafter, when the carton integrity sensing elements does

not issue a fault signal, the regulating elements are opened in time for the next succeeding correct carton blank to be completely filled with articles. If only one blank has not been fed then the control unit 700 will cause the regulating elements to be opened in time for the supply of bottles to be restarted so that the next blank which has been correctly fed and conveyed towards the processing station will be loaded. Again the regulator elements are opened sequentially so that the bottles are fed in integer multiples of 24 bottles and so that the bottles or articles are timed to be received at the processing station. The timing of the opening of the regulator elements after a faulty carton has passed, is dependent upon the format of articles and cartons being loaded and the control unit is configured to be adjustable in that respect so that the regulator elements are closed only for the duration of the faulty pitch or pitches and then opened after a delay time which is calculated by considering the size of carton and article and the speed of conveyance of the cartons through the packaging machine.

[0133] By controlling the article flow to such a fine degree there is no wastage of bottles, but more importantly no unwanted downtime of the packaging machine due to bottles being fed when there is no blank present is prevented. Additionally when the packaging machine is desired to be adapted for an alternative application, the packaging line can be quickly shut down.

[0134] In order to control the flow of articles to such a fine degree, many factors of the packaging machine have to be considered so that the timing of the operation of the regulating elements is precise. This is particularly important where glass bottles are the articles loaded into cartons. The regulating elements (gates in the embodiment illustrated), intercept the flow of articles and must do so precisely between the last article required from a tributary channel for loading into the preceding correct carton and the first article that will be required from that channel for loading into the next succeeding correct carton. To facilitate the interception of the articles so that damage to the articles is minimised, the timing of the closing of the regulating element is such that the gates are opened in the space between two closely neighbouring articles. The primary factors considered in calculating this timing are the speed of the machine, the response time associated with the carton integrity sensing element, the processing time of the control unit (having a cycle time which is dependent upon for example a programmable logic controller comprised within the control unit), the reaction time of other hardware involved in the operation of the regulating elements and the reaction time or speed of deployment of each regulating element themselves.

[0135] In some embodiments of the invention, it is envisaged that the speed of conveyance of the articles and cartons will be slowed upon issuance of a fault signal by the carton integrity control sensor. The timing of the activation of the regulating elements will also therefore depend upon the rate of deceleration of the packaging ma-

chine. By decelerating the machine the reaction and response times of the various elements, as discussed above, becomes less critical. The slower the machine is running the less significant the reaction time is to the operation of the regulating elements as they have sufficient time to be deployed correctly between two specific articles as necessary and the reaction and delay times are small compared to the time between the articles passing the regulating elements. Ideally however the machine is maintained at a reasonable operating speed (at least 50% of normal operating speed, the normal operating speed is approximately 250 packs per minute (ppm)) despite a fault being detected. In this instance the reaction times need to be anticipated so that the regulating elements are "activated" early to account for the finite reaction or response time of each of the elements involved in actually causing the regulating elements to block the path of the articles being conveyed.

[0136] The reaction time is calculated depending upon the factors discussed above by the control unit, additionally the reaction time is adjustable by an external operator to account for inconsistencies in the reaction times. For example on average the electrovalve which moves the gate from an open position to a closed position may take 10ms from receiving an instruction to operate to actually operating. This reaction time is itself variable, 10ms is only an average and the range of reaction times of all the regulating elements may actually be $10\text{ms} \pm 5\text{ms}$. To account for variations in the overall reaction time the calculated time is therefore adjustable by an operator to finely tune the timing of the regulating elements.

[0137] An additional optional feature of the present invention is illustrated in conjunction with Figures 29A to 31 B wherein a mechanism is provided for ensuring that the lower and upper end closure panels of the cartons are secured together if the packaging machine is stopped and a fully loaded carton has not exited the packaging machine in the normal manner. During continuous operation of the packaging machine, once loaded the cartons are conveyed to a closing and gluing station as described above. If however the packaging machine is stopped, glue G may have been applied to the lower end closure panels of the carton by a gluing means 570, but because the packaging machine and hence conveyor mechanism has been stopped the loaded carton with glue applied is not conveyed to the closing and pressing means which are provided to ensure that the cartons are each properly secured shut, so an emergency securement means is provided which in such circumstances will automatically be deployed to both close the glued lower end closure panels 540 and press them against the upper end closure panels. The emergency securement means each comprise arms 500 which are driven by pistons 510 which are linked to the arm 510 by fixing means 520. The arm is operated by the piston to push the lower end closure panels upwardly; the two arms are then simultaneously pressed against the closed ends of the carton to seal them shut.

[0138] As previously stated, the conveyor means 420 is in this example a metal base plate upon which the open ended tubular cartons slide. The packaging machine of the present example has yet a further optional feature that the conveyor plate 1020 (as illustrated schematically in Figures 32 and 33) can be made such that a central portion is lowered within the machine assembly and the movement tracks 440 upon which the lugs 412, 414 are conveyed can be moved towards one another. Not only are the base plates adjustable but the one side of the whole assembly including the closing and gluing mechanism is moveable relative to the side of the packaging machine housing the article supply means by a piston means. Other suitable means may be used for facilitating the adjustment of the width of the entire packaging machine.

[0139] It is clearly envisaged by the present applicants that the features of the particular preferred embodiment described hereinbefore could be altered without departure from the scope of the present invention. For instance, it will be understood that the spacer element may equally employ more than two lugs in co-operation with one another, and still fall within the scope of the present invention.

[0140] It will further be understood that whilst terms such as "top," "middle," "centre," "first," and "second" have on occasion been used through this specification, they do not limit the respective components to which they refer to any particular position or orientation. Further, it will be understood that any particular configuration of lug 412, 414, or of pin component 430, or of securement means 416, 418, may be adopted without a departure from the scope of the present invention.

[0141] References to directional features such as 'topmost', 'uppermost' and 'lowermost' do not restrict the inventive concept and it is entirely within the scope of the invention that other embodiments may be used in which such directional features are altered. For example, the entire device could theoretically be mounted vertically, with suitable adjustment of the conveyance means, such that the sleeve 60/70 could no longer be described as being placed upon the topmost surface of the conveyance means, such an embodiment would, however, clearly still fall within the scope of the inventive concept.

[0142] It will further be understood that references to "cam," "cam mechanism" and "cam wheel" are meant as illustrative descriptors only, and do not limit their respective components to any particular configuration.

The following are statements of invention:

[0143] In or for a processing device in which articles are processed and conveyed, a control mechanism for controlling discrete volumes of articles transferred from a supply to a main processing conveyor, the control mechanism comprising a plurality of tributary channels along which articles pass from the supply to the main processing conveyor, each of said tributary channels

comprising regulating means for regulating the flow of articles from the supply to the main processing conveyor, means being provided to operate the regulating means such that the flow of articles through each tributary channel is restricted until a sufficient number of articles is present in that tributary channel where after flow through the tributary channel is unrestricted so that a desired volume of articles can be transferred to the main processing conveyor.

[0144] Preferably, the channels are aligned in parallel relationship to one another and wherein the regulating means are positioned in a staggered relationship relative to the incoming flow of articles in those channels.

[0145] Preferably, each channel is defined by two spaced guide rails and each regulating means is moveable between an open position, wherein articles can move freely along the channel, and a closed position, wherein the movement of articles from the first position to the second position is prevented.

[0146] Optionally, each of the series of regulating means is operated sequentially, such that the regulating means of a first channel will be opened before each of the other regulating means or conversely, the regulating means of the first channel will be closed before each of the other regulating means.

[0147] Additionally, there is further provided article management means, said article management means being arranged such that if an error is noted a signal may be sent to the regulating means, which regulating means is adapted sequentially to be first closed so as to prevent delivery of a unit volume of articles, and then reopened to allow delivery of a unit volume of articles, such that either a full group of unit volume is assembled at the second position or a no group is assembled at all.

[0148] Preferably, the regulating means are adapted to be closable independently and sequentially such that the last group of articles to be assembled at the second position is a full volume group and thereafter articles are prevented from being transmitted between the first and second positions.

[0149] Preferably, the processing device is a packaging machine, the articles are bottles or cans which are being conveyed to the first position and at the second position, the bottles or cans are loaded into cartons in assembled groups of a unit volume.

[0150] Optionally, each regulating means comprises a pair of gates which are moveable between an open position, wherein each gate of the pair lies in the plane of one of the guide rails defining the channel, and a closed position, wherein the gates together form a barrier across that channel and thereby prevent movement of articles from the first position to the second position.

[0151] A packaging machine for packaging articles such as cans or bottles into paperboard cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between a first position in which articles are conveyed in channels and a second position in which the articles are assembled

in groups and loaded into the carton; the control mechanism comprising a series of independently controllable regulating means, one regulating means being positioned in each of the channels such that the transmission of articles from the first position to the second position can be controlled by opening or closing each of the regulating means and thereby the volume of articles arriving at the second position for assembly into groups is controllable.

[0152] Preferably, in a start-up operation, each of the regulating means is closed until a sufficient number of articles are present at the first position, in order that upon sequentially opening the regulating means a desired volume of articles can be transmitted to the second position such that a prescribed volume of articles can be assembled and loaded into a carton.

[0153] Preferably, the regulating means can be sequentially closed to prevent delivery of a unit volume of articles and then sequentially opened to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.

[0154] A packaging machine for packaging groups of articles such as cans or bottles into paperboard cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between an infeed position and a loading position, the volume being controlled such that only integer numbers of groups of articles are transmitted to the loading position such that the packaging machine produces only fully loaded cartons.

[0155] A method for control of the volume of articles conveyed between a first position within a series of tributary channels and a second position in which articles are assembled in groups, which method comprises the steps of managing the flow through a series of regulating means arranged in staggered positions along the tributary channels.

[0156] Preferably, the method further comprises the steps of obtaining a readiness signal from the second position, and facilitating passage of articles through the regulating means only when such a readiness signal is obtained.

[0157] Optionally, upon not obtaining a readiness signal from the second position, the regulating means in each tributary channel are sequentially shut and then reopened to coincide with the obtaining of a further readiness signal.

[0158] A mechanism for use in a packaging machine capable of packaging articles of different physical dimensions, the packaging machine comprising a supply means for supplying articles to a carton, said carton being erected into a tubular structure by an opening device and being loaded from at least one end, wherein the articles are supplied to the at least one end by propagating along at least one guide path, wherein the guide path comprises a first and second guide, the first of said guides being capable of movement relative to the other guide in order

to accommodate articles of different physical dimensions.

[0159] A packaging machine for packaging articles into cartons, the packaging machine being adapted to permit the machine to be readily adapted to produce packages of different configurations, wherein the cartons and the articles in the packages may be of various different types and/or sizes, wherein the packaging machine comprises a carton erection device, a carton conveying mechanism, an article supply device for loading the cartons from at least one end, a regulation device for regulating supply of the articles to the carton, an article grouping device, a control means, a gluing mechanism for application of glue and securing end panels of the carton, wherein all the components may be readily adapted to accommodate a change in package configuration.

[0160] Optionally, the carton erection device for at least partially opening a sleeve into a carton comprising a cam mechanism controlled to function at different angular velocities, the angular velocities including a first angular velocity for opening a first type of sleeve and a second angular velocity for opening a second type of sleeve, the cam mechanism including at least one suction arm, the at least partial opening of the first type of sleeve being effected by causing the suction arm to be moved substantially normal to a plane in which the sleeve is disposed and the at least partial opening of the second type of sleeve being effected by causing the suction arm to be moved both normal to the said plane and simultaneously along a vector corresponding to the motion of the sleeve in said plane which conveys the sleeve through the working reach of the cam mechanism.

[0161] Additionally, wherein the carton conveying mechanism incorporates an endless series of spacer elements by which successive packages are spaced apart from one another by a predetermined distance, each spacer element of the series comprising a pair of carton engaging lugs in which a leading lug and a trailing lug can be adjusted from a setting in which both the leading and trailing lugs of each pair are in abutment with one another to maximise the spacing between successive spacer elements to a setting in which relative movement between the leading lug of one pair and the trailing lug of the next succeeding pair decreases the spacing between those successive spacer elements.

[0162] Preferably, the article supply means is capable of supplying a constant flow of articles to the carton conveyor.

[0163] Optionally, the article grouping device gather articles from the article supply means and forms them into groups to be loaded into the carton.

[0164] Preferably, the article grouping device comprises interchangeable lugs which can be readily removed from the packaging machine.

[0165] Additionally, the interchangeable lugs can be replaced with interchangeable lugs of a different physical dimension, so as to group a different number of articles.

[0166] Preferably, the interchangeable lugs can be

placed at an increased or decreased frequency so as to create smaller or larger groups of articles.

5 Claims

1. A packaging machine for packaging articles into cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between a first position in which articles are conveyed in channels (628, 638, 648, 658, 668 and 678) and a second position in which the articles are assembled in groups and loaded into the carton; the control mechanism comprising a series of independently controllable regulating means (630/630b, 600/600b, 640/640b, 650/650b, 660/660b, 670/670b), one regulating means being positioned in each of the channels (628, 638, 648, 658, 668 and 678) such that the transmission of articles from the first position to the second position can be controlled by opening or closing each of the regulating means (630/630b, 600/600b, 640/640b, 650/650b, 660/660b, 670/670b) and thereby the volume of articles arriving at the second position for assembly into groups is controllable, wherein the regulating means can be sequentially closed to prevent delivery of a unit volume of articles and then sequentially opened to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all.
2. The packaging machine according to claim 1 wherein the regulating means are gate pairs (630/630b, 600/600b, 640/640b, 650/650b, 660/660b, 670/670b) that are operated in conjunction with a control unit (700) that is linked to a drive means (610) of each gate and operable to open and close the gates through control of those drive means, wherein at said start up of the packaging machine the control unit operates to ensure the gates are closed until such time as each channel (628, 638, 648, 658, 668, 678) comprises said sufficient number of articles
3. The packaging machine according to claim 1 or claim 2 wherein each gate comprises an individual drive means 610 in the form of a motorised switching device that is connected to a fixing means (608) movably connected to an arm (606), which arm (606) is fixedly attached to a shaft (604) which is in turn fixedly attached to the foot (602). The arm (606), shaft (604) and foot (602) may in other configurations be formed from an integral piece.
4. The packaging machine according to claims 1 to 3 wherein said desired volume of articles is a quantity of articles that will completely fill said carton.

5. The packaging machine according to claims 1 to 4 wherein the regulating means are staggered relative to one another such that the distance travelled by the articles from each regulating means and said second position is the same. 5
6. The packaging machine according to claims 1 to 5 wherein said desired volume of articles are transmitted to the second position in time to be loadable into a first of a stream of cartons to reach a position proximate the second position such that the desired volume of articles are loadable into that first carton. 10
7. A method of controlling a packaging machine for packaging articles into cartons, the method comprising: conveying articles in channels (628, 638, 648, 658, 668 and 678) in a first position of the packaging machine; controlling the volume of articles being conveyed between that first position and a second position in the packaging machine for assembling the articles in groups and loading into cartons at the second position; regulating the transmission of articles from the first position to the second position by opening or closing regulating means disposed in each of the channels (628, 638, 648, 658, 668 and 678) and thereby regulating the volume of articles arriving at the second position for assembly into groups; sequentially closing the regulating means to prevent delivery of a unit volume of articles and sequentially opening the regulating means to allow delivery of a unit volume of articles such that either a full group of a unit volume of articles is assembled to provide a fully loaded carton or no group is assembled at all. 15 20 25 30 35
8. A packaging machine for packaging groups of articles into cartons, the packaging machine having a control mechanism for controlling the volume of articles being conveyed between an infeed position and a loading position, the volume being controlled such that only integer numbers of groups of articles are transmitted to the loading position such that the packaging machine produces only fully loaded cartons. 40 45

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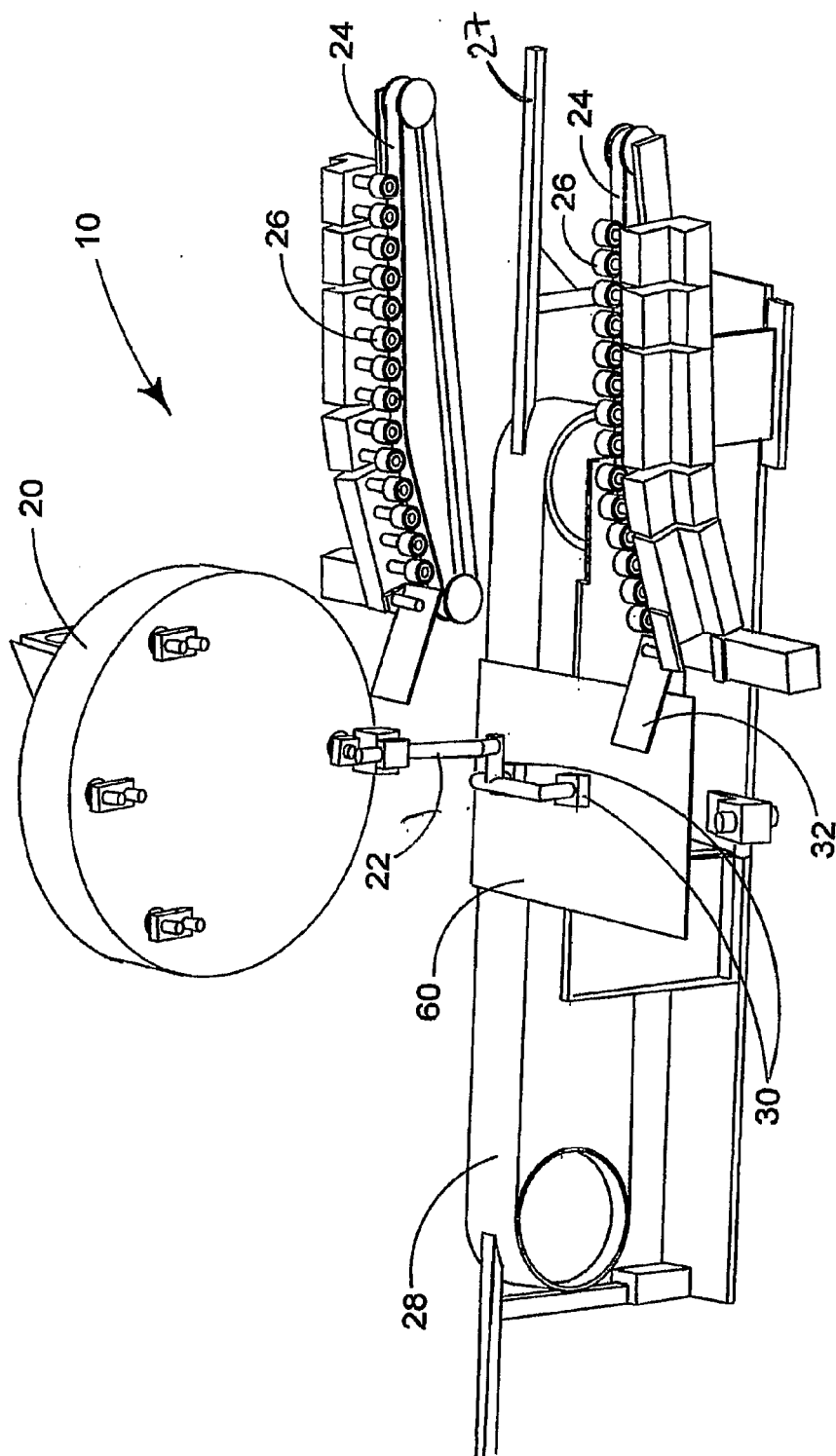


FIGURE 1

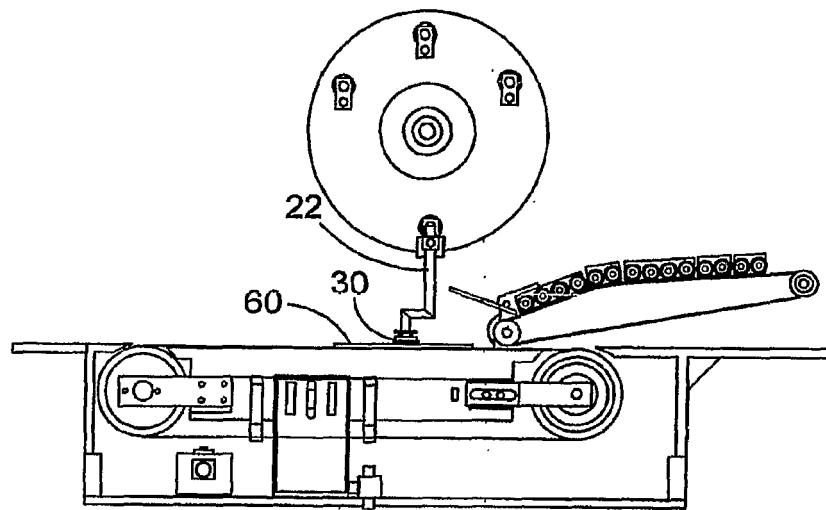


FIGURE 2

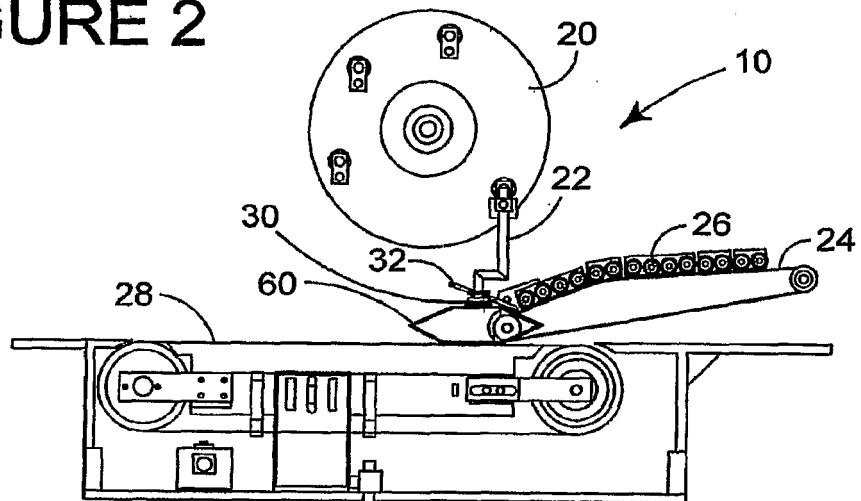


FIGURE 3

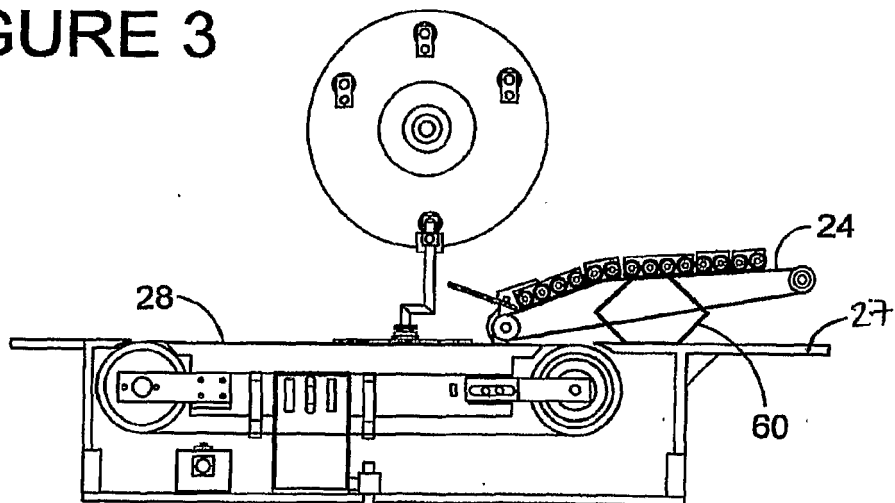


FIGURE 4

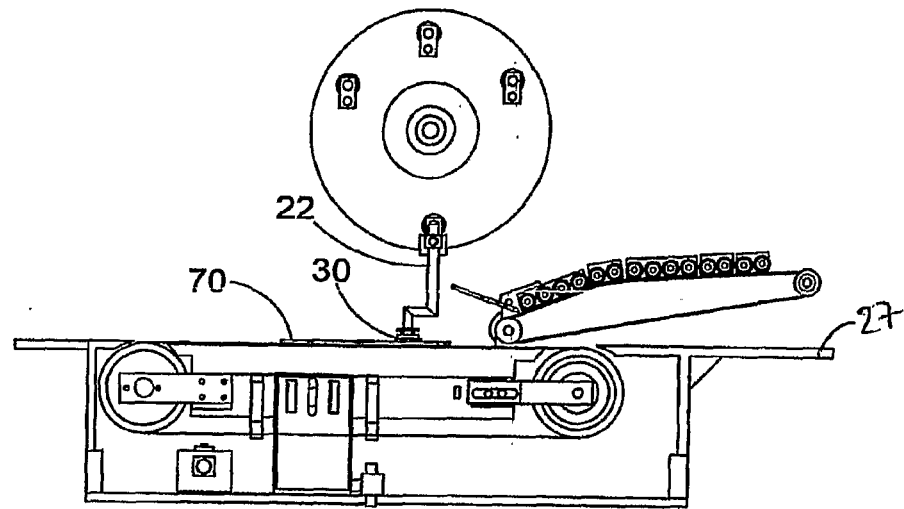


FIGURE 5

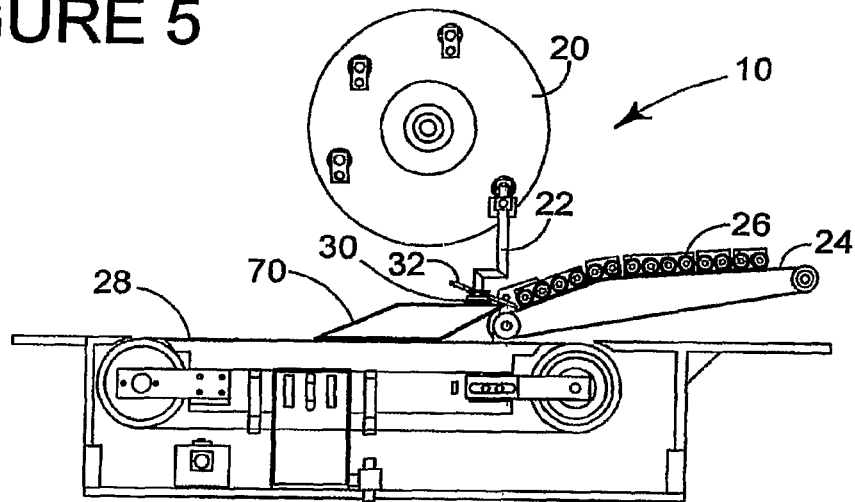


FIGURE 6

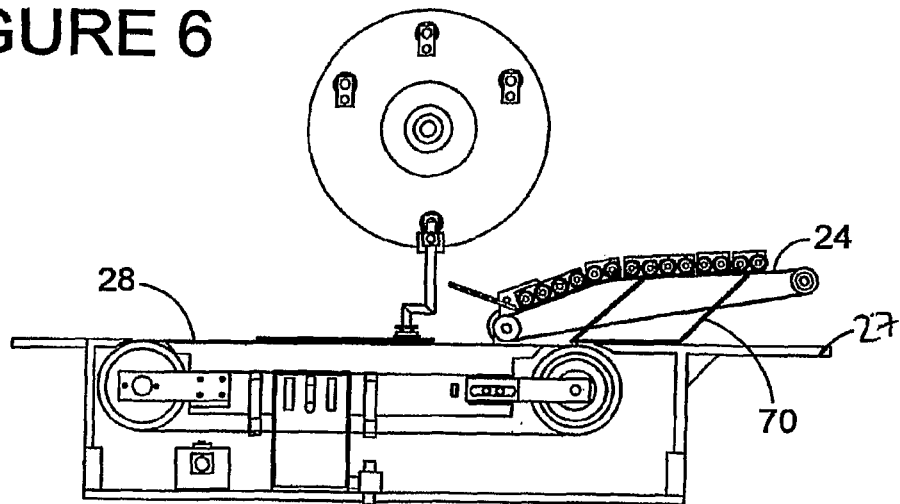
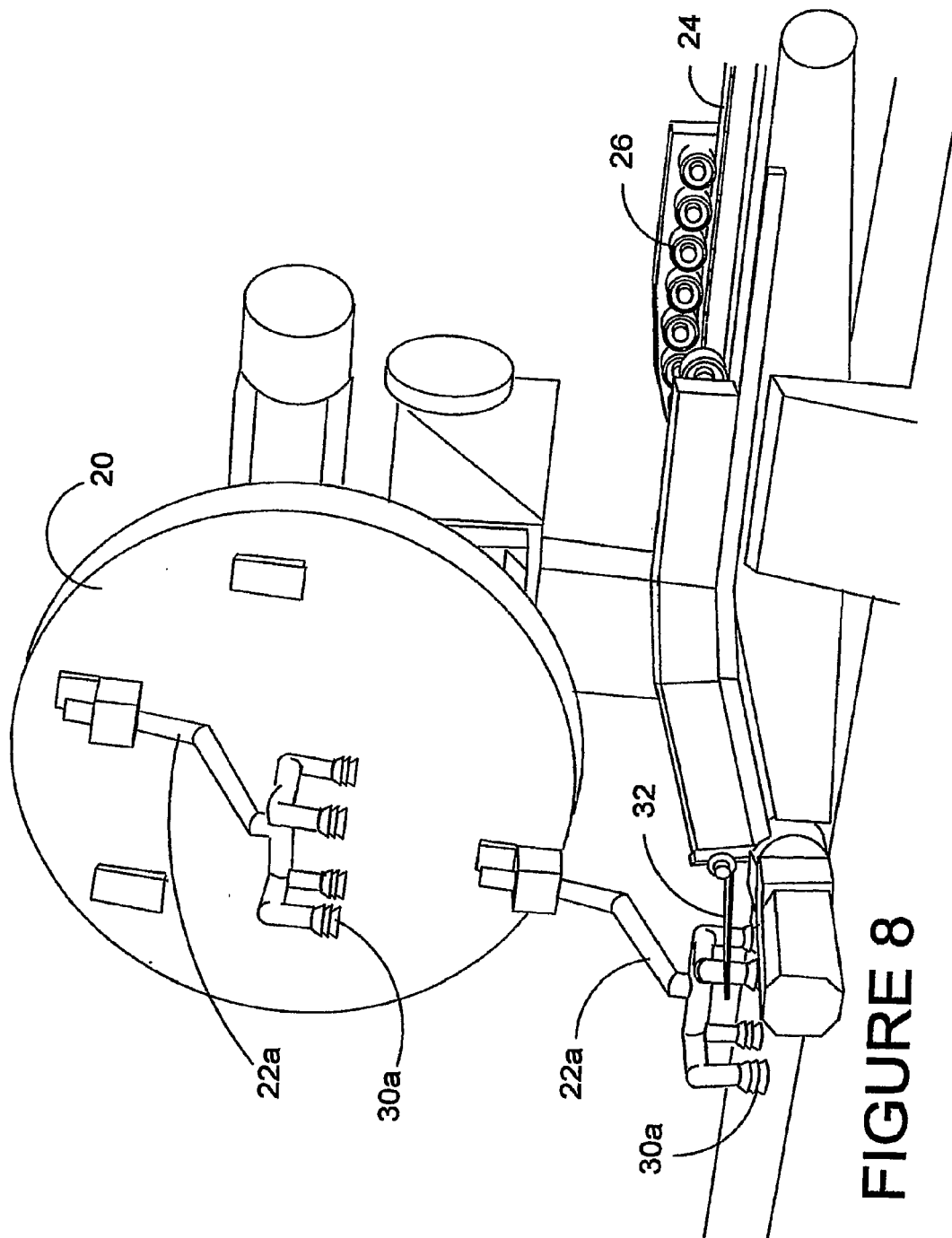


FIGURE 7



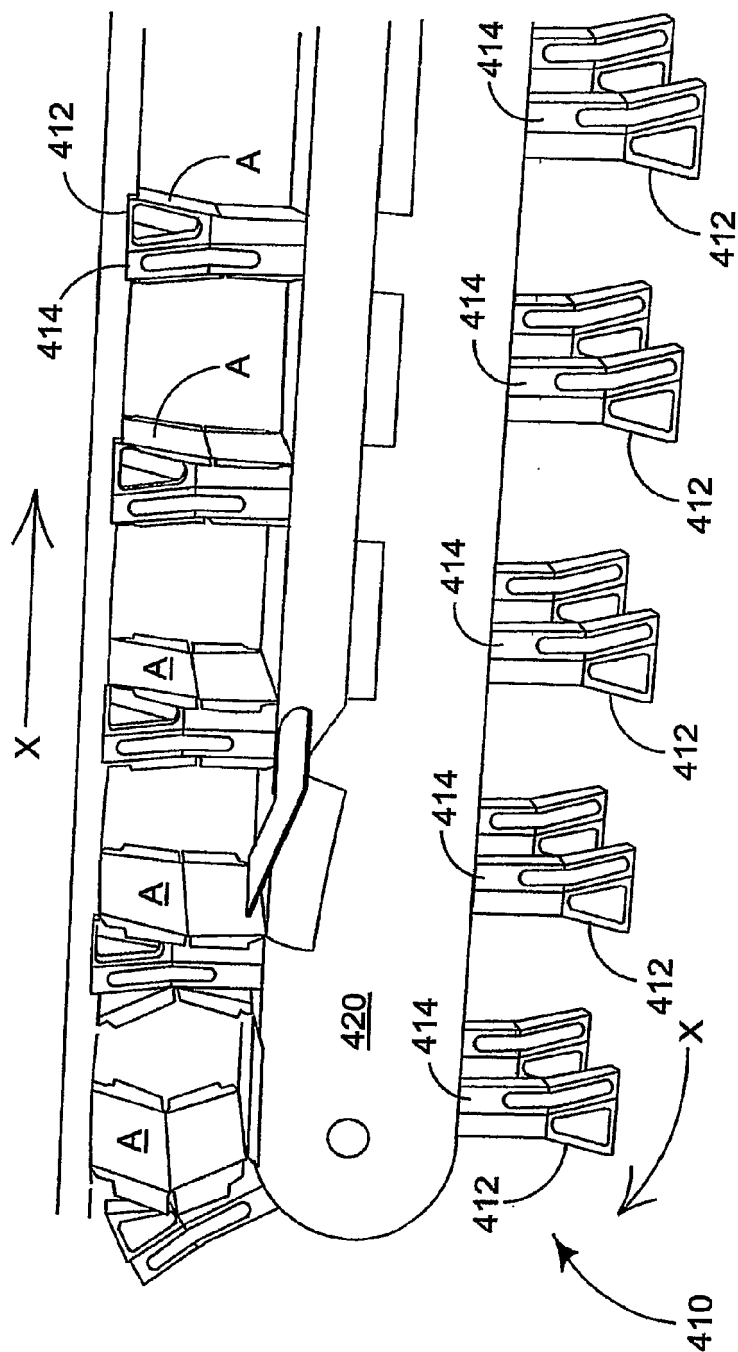


FIGURE 9

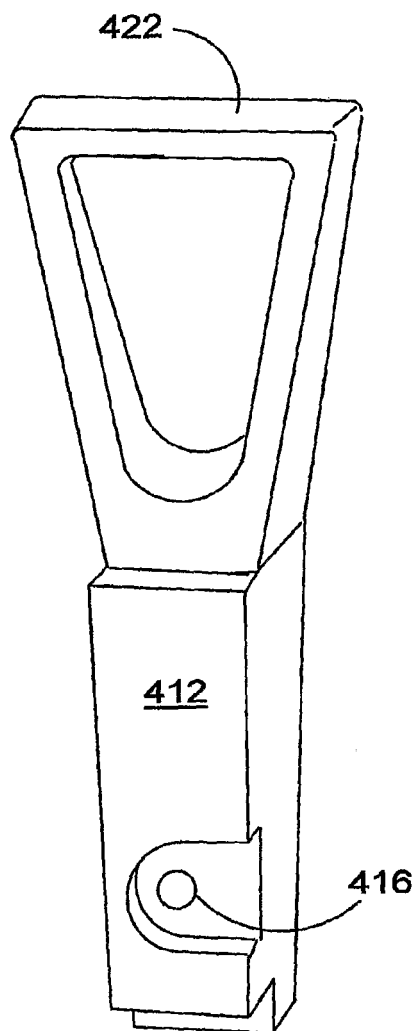


FIGURE 10A

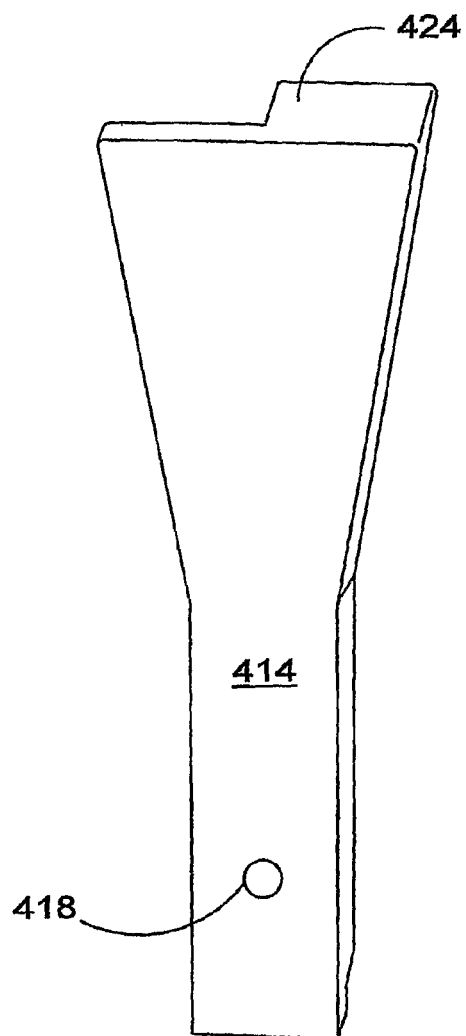


FIGURE 10B

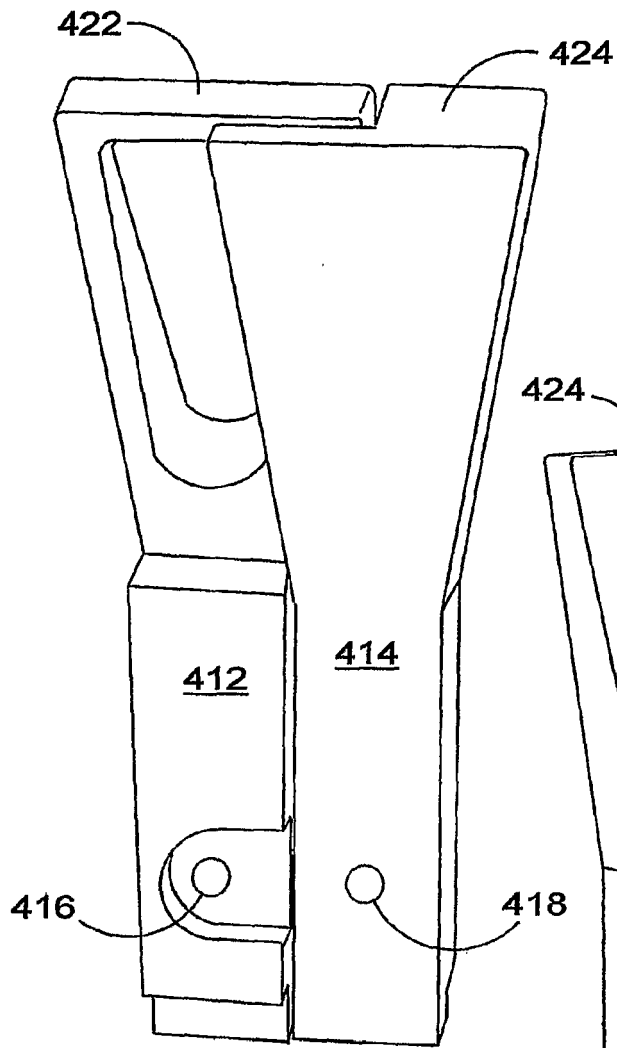


FIGURE 10C

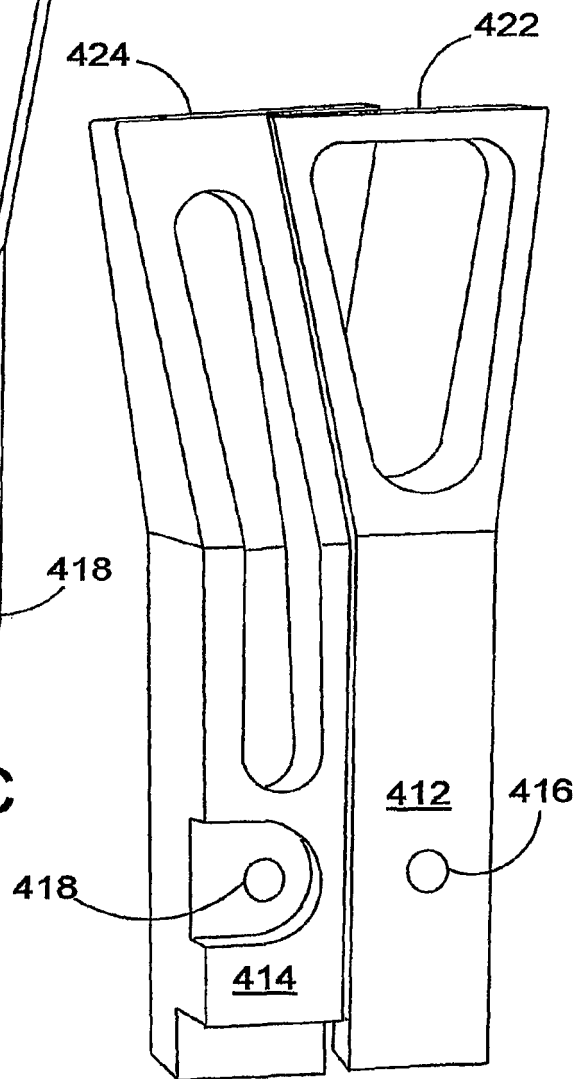


FIGURE 10D

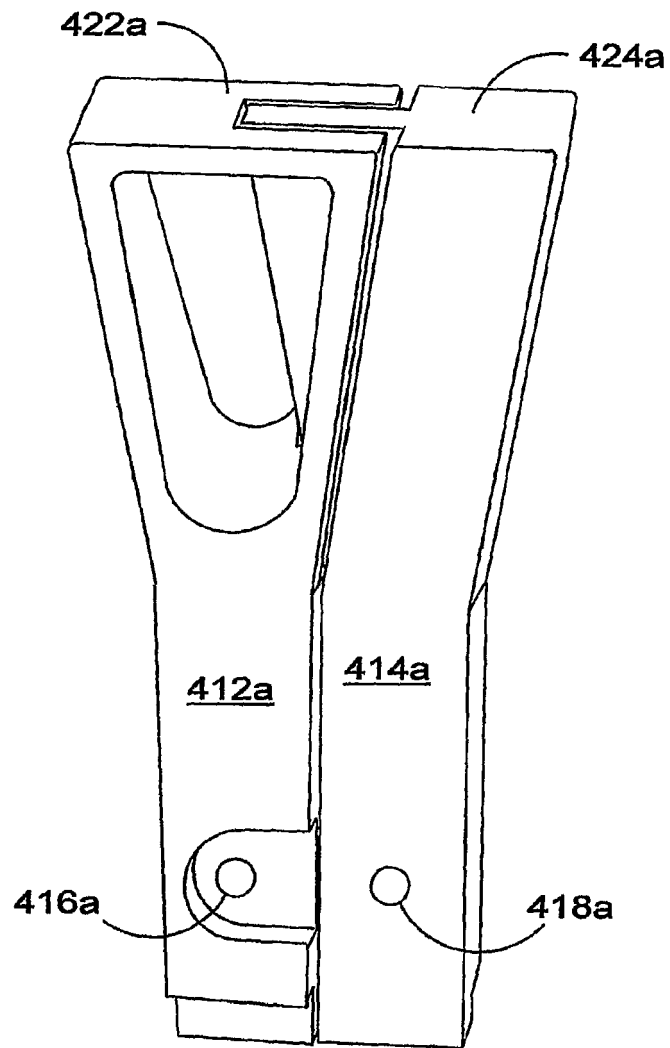
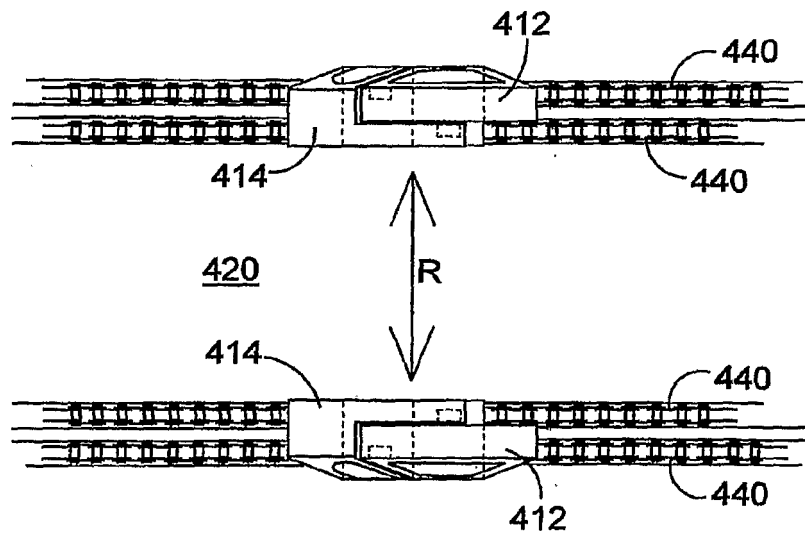
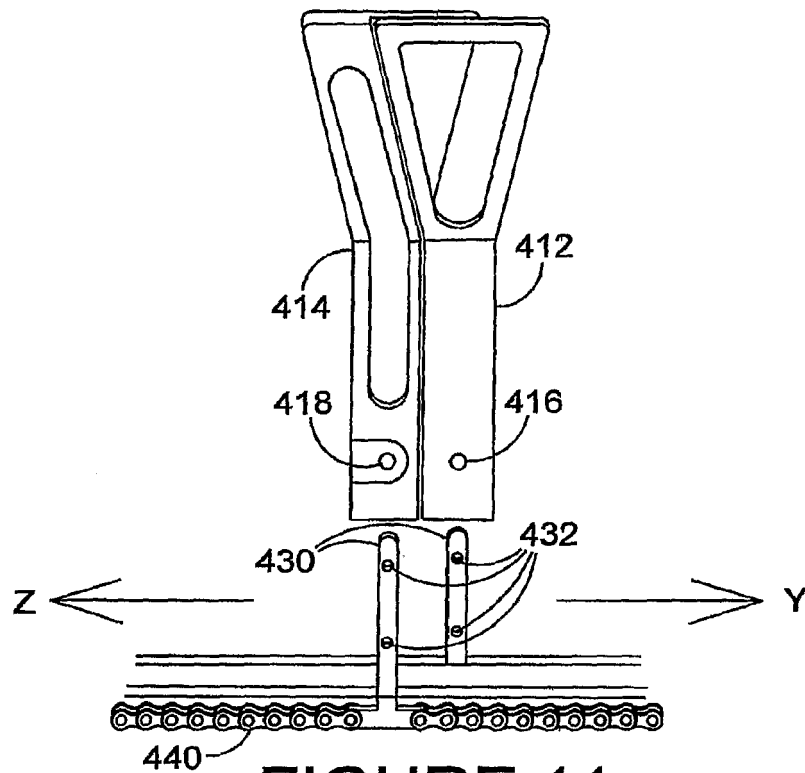


FIGURE 10E



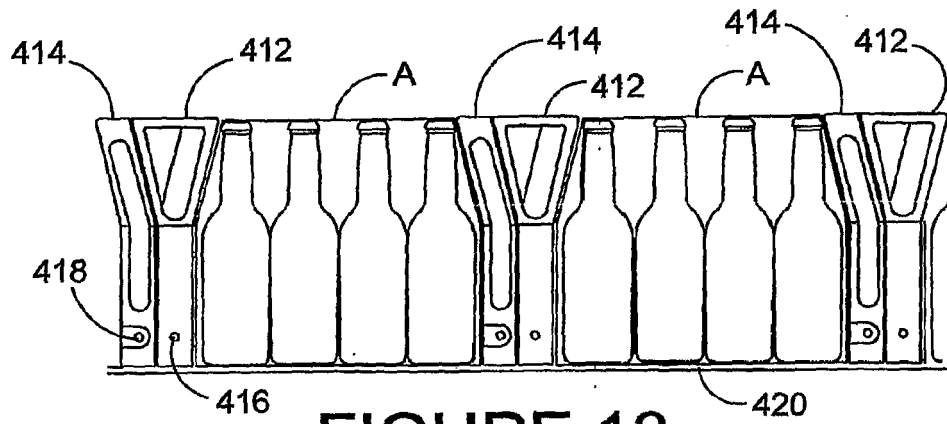


FIGURE 13

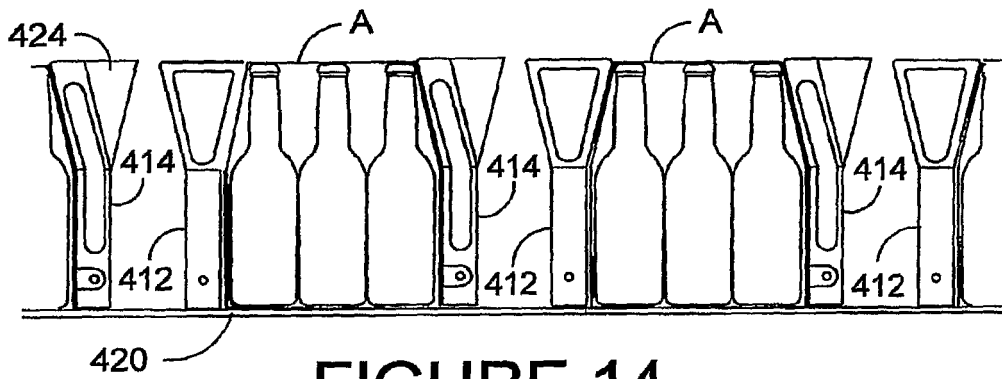


FIGURE 14

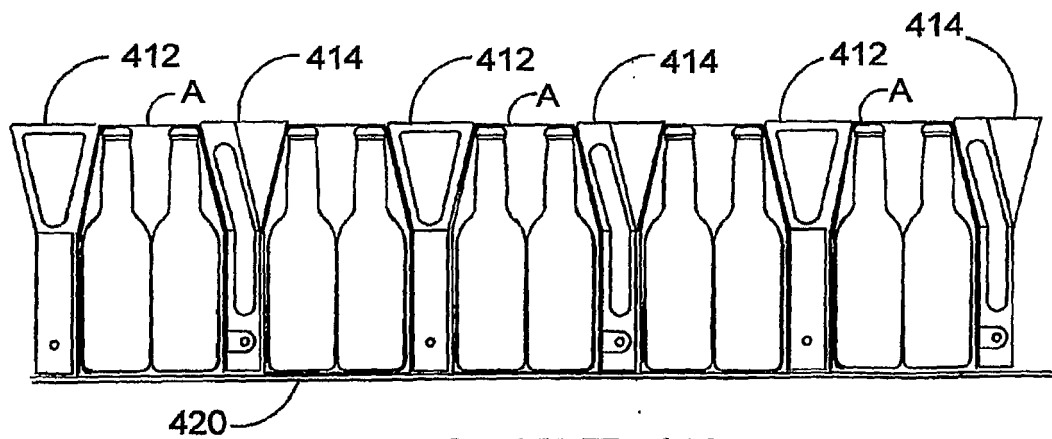


FIGURE 15

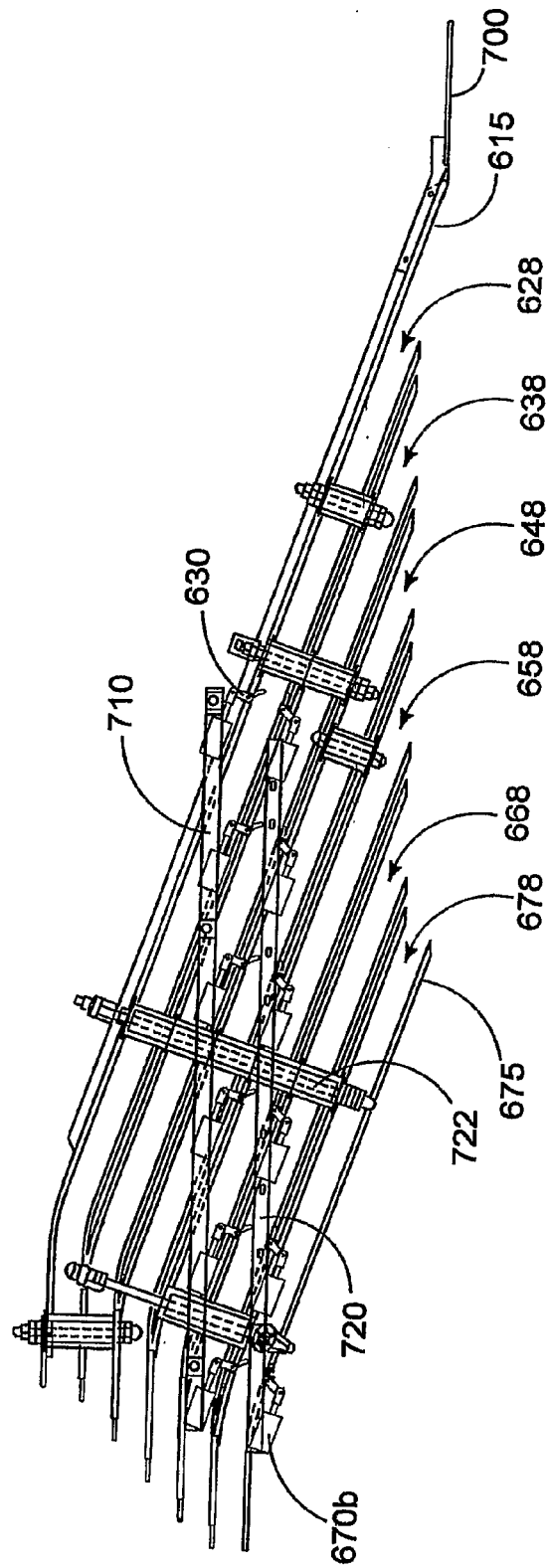


FIGURE 16

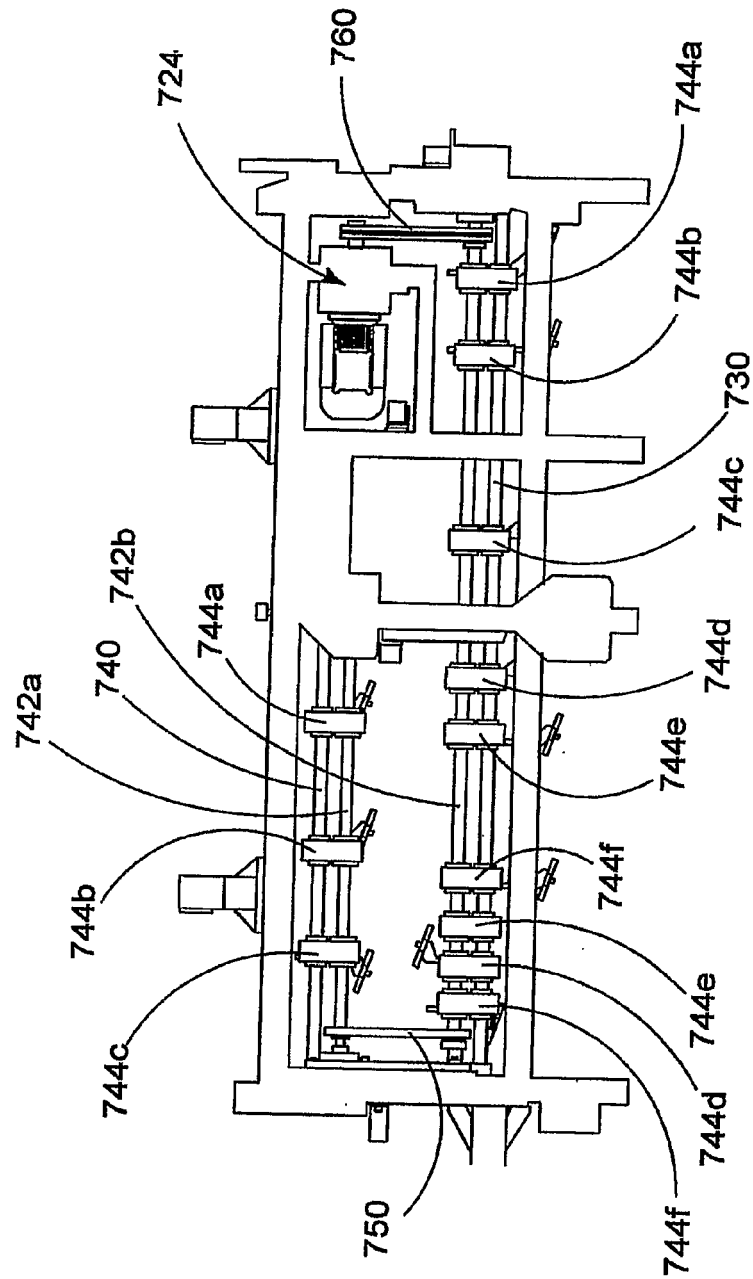


FIGURE 17

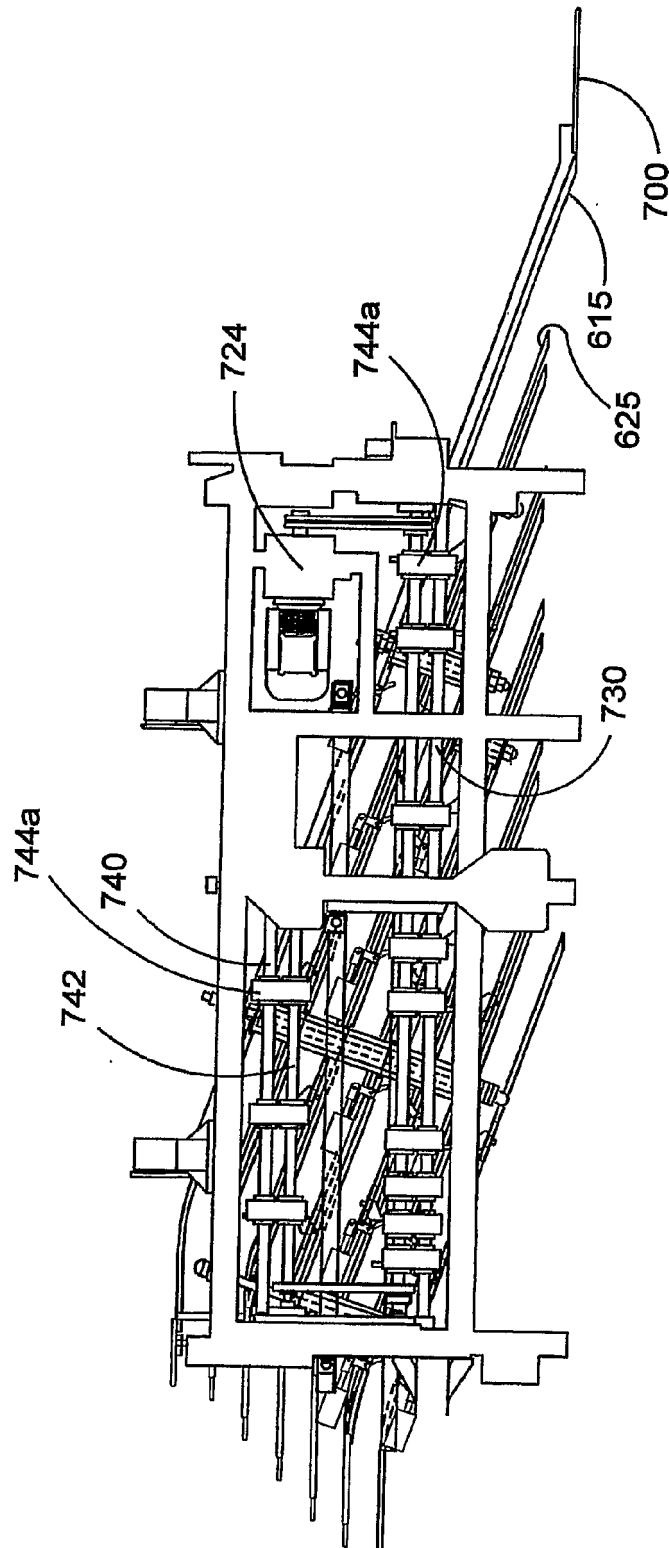


FIGURE 18

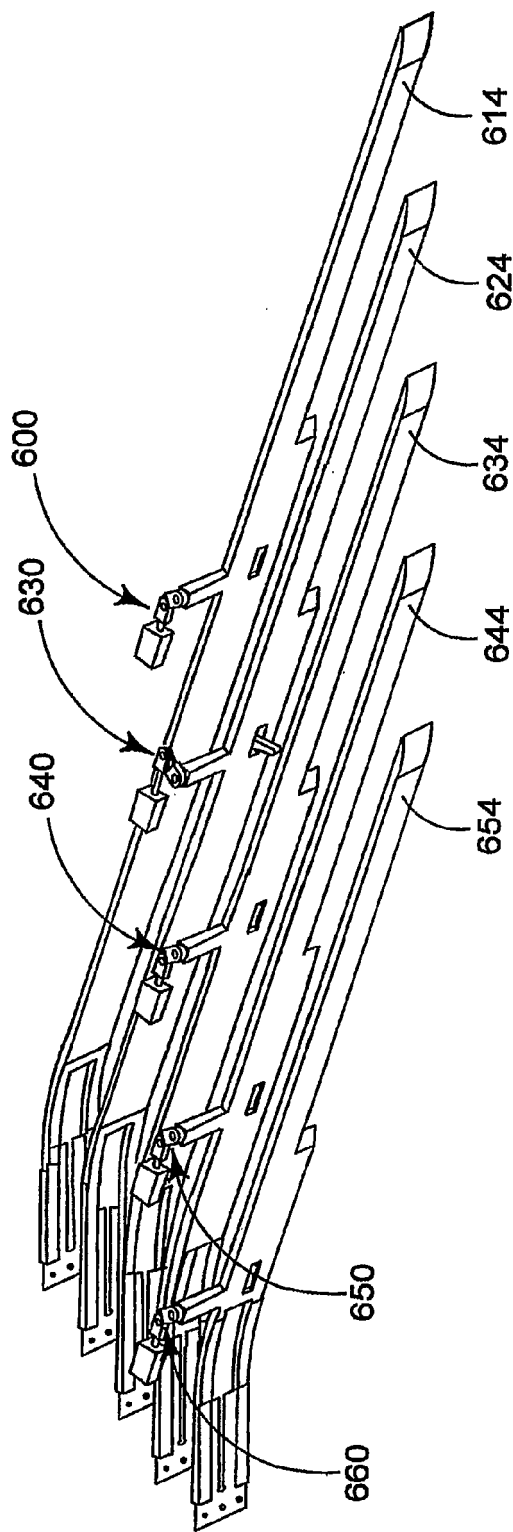


FIGURE 19

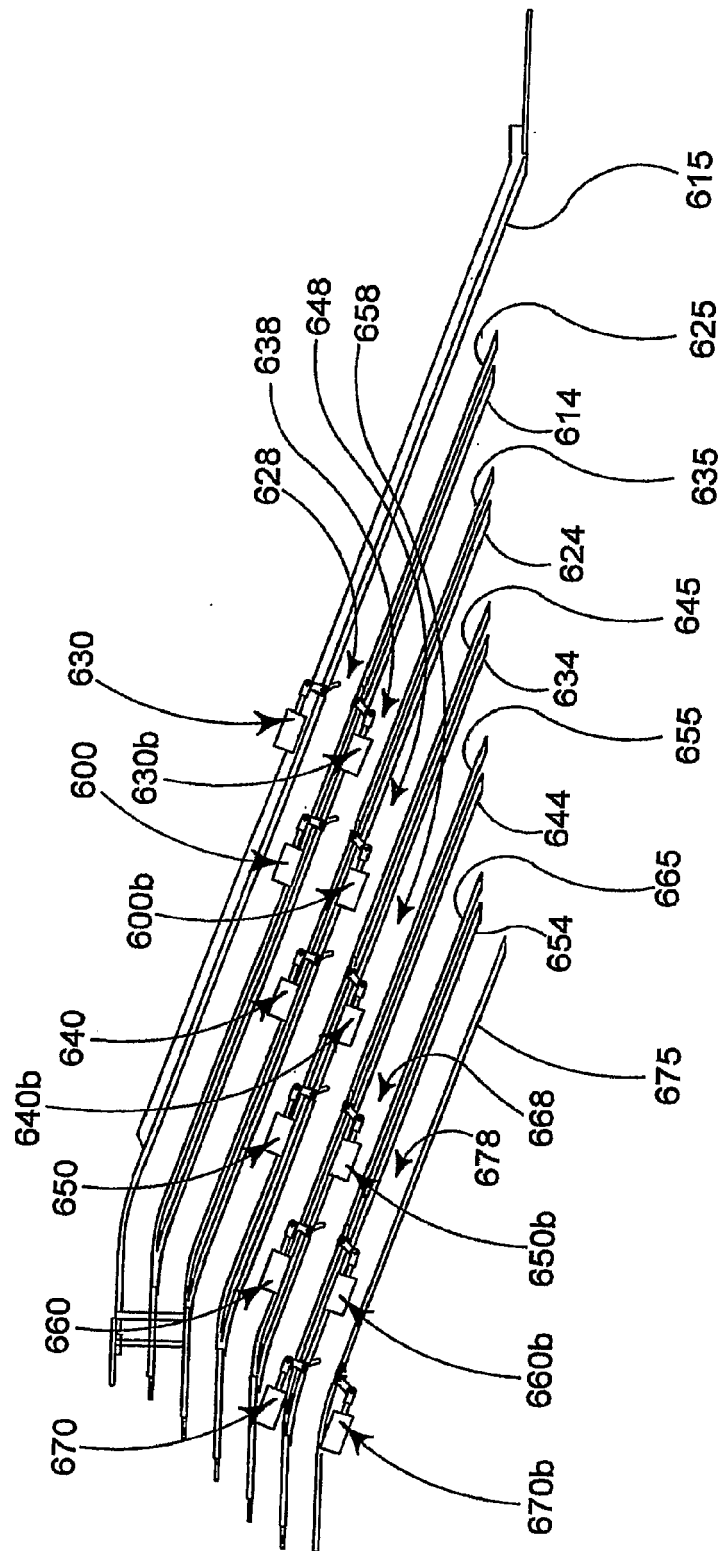


FIGURE 20

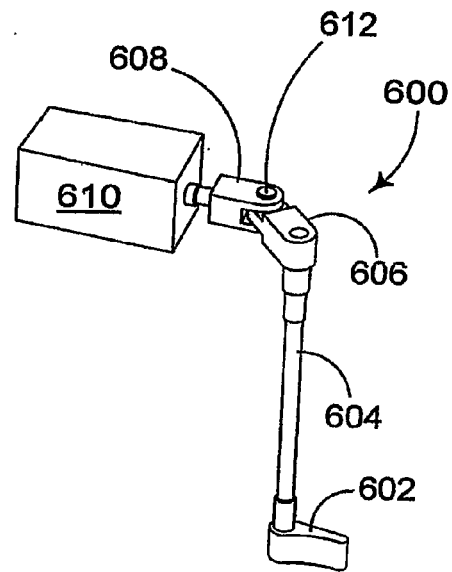


FIGURE 21

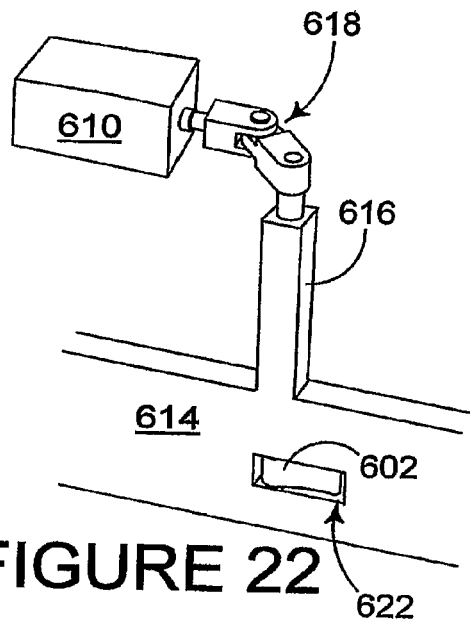


FIGURE 22

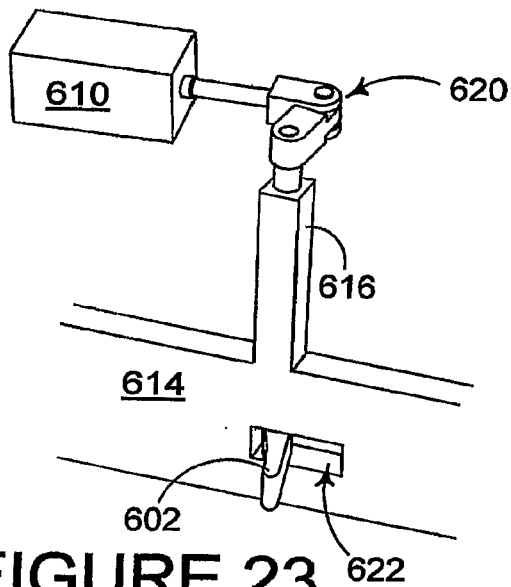


FIGURE 23

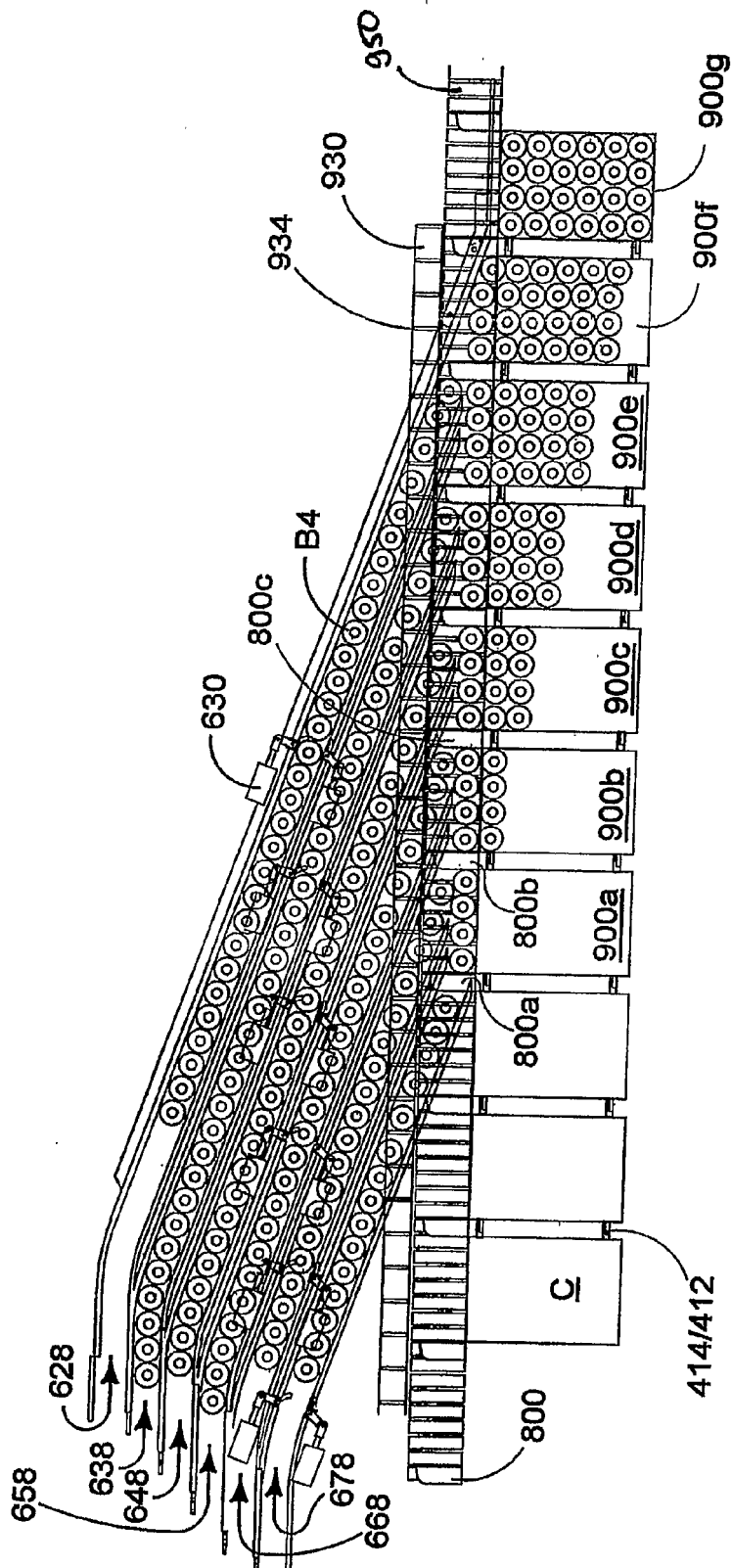


FIGURE 24

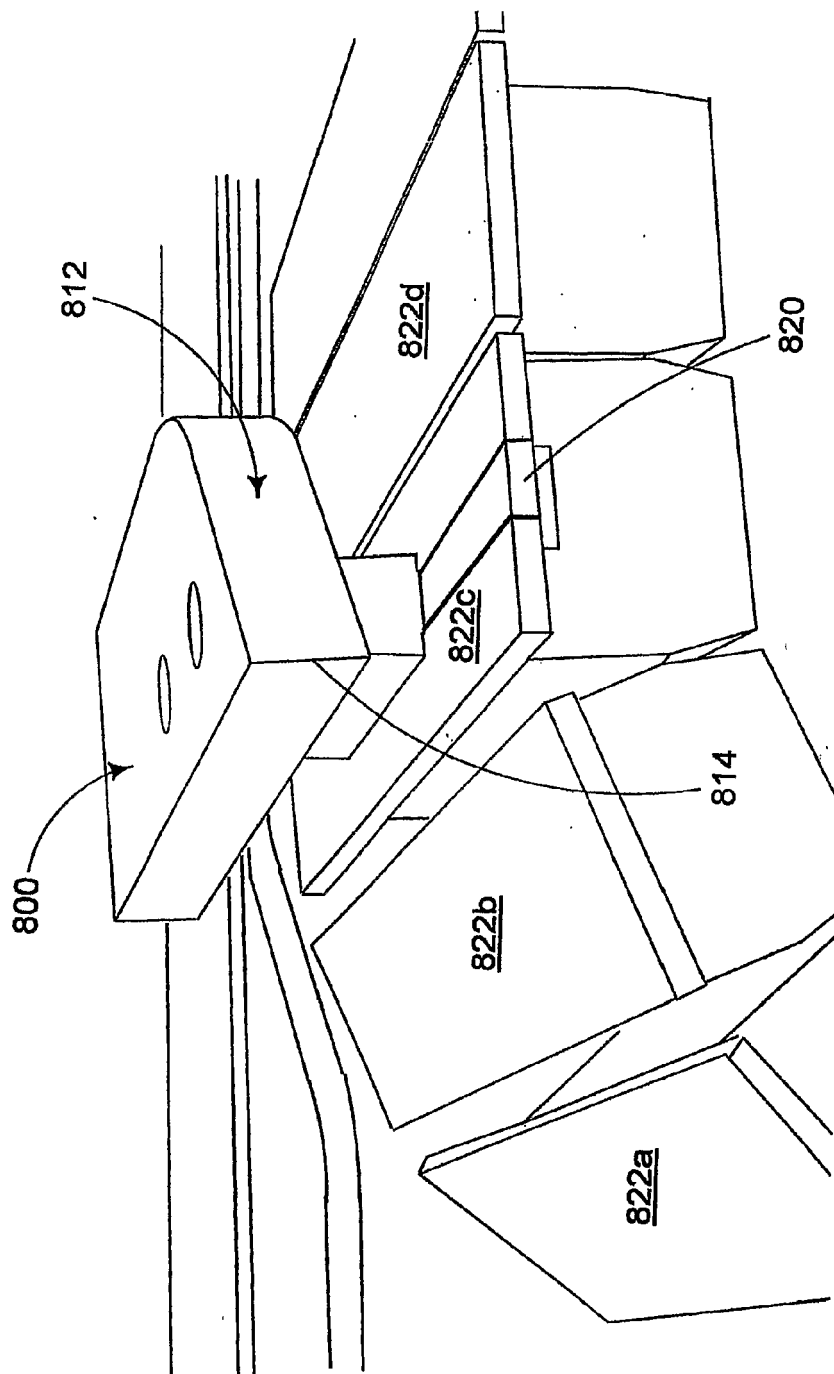


FIGURE 25

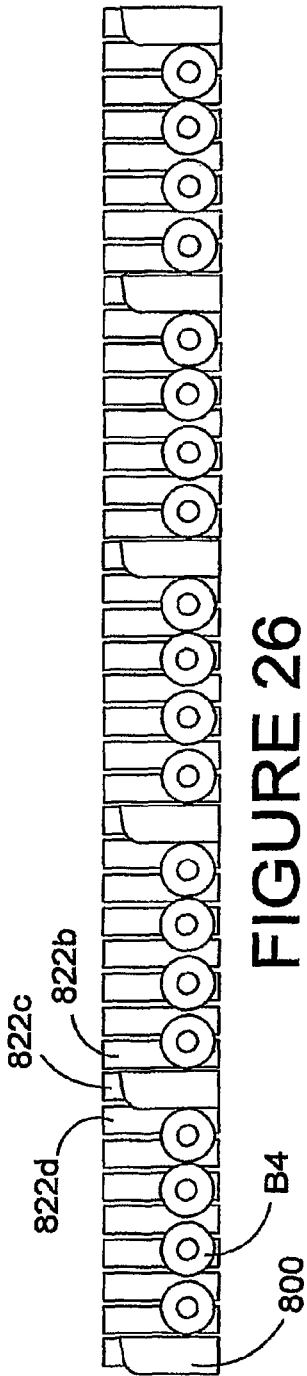


FIGURE 26

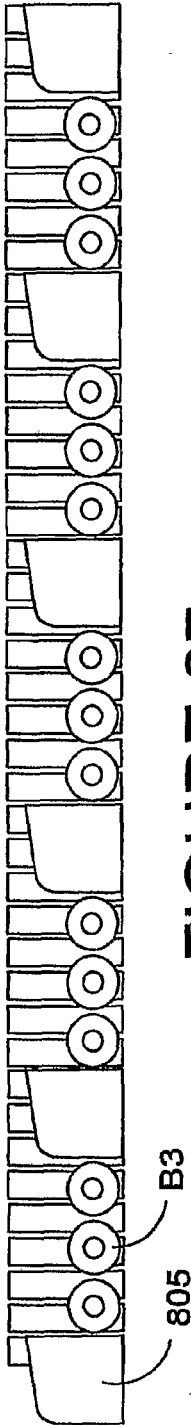


FIGURE 27

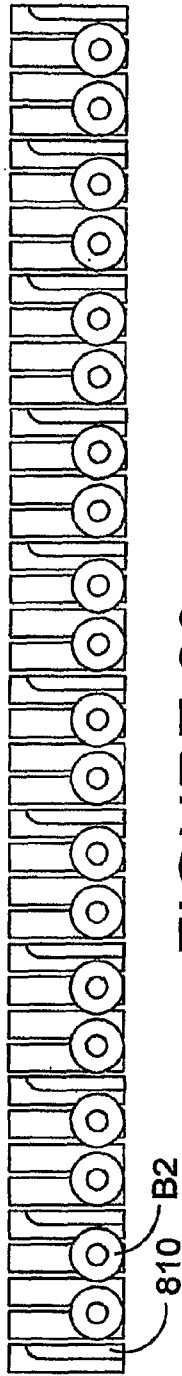


FIGURE 28

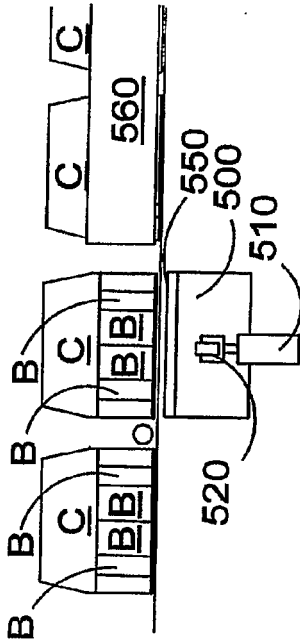


FIGURE 29A

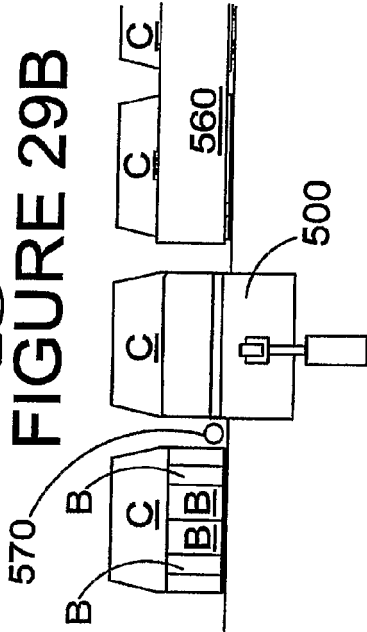


FIGURE 29B

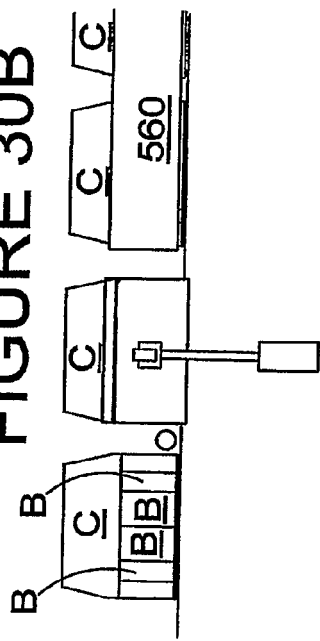


FIGURE 30A

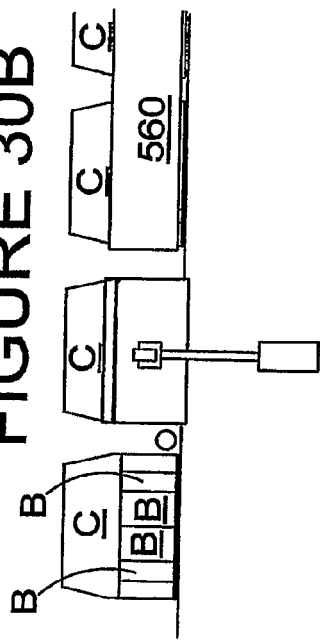


FIGURE 30B

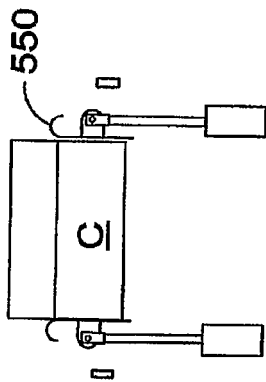
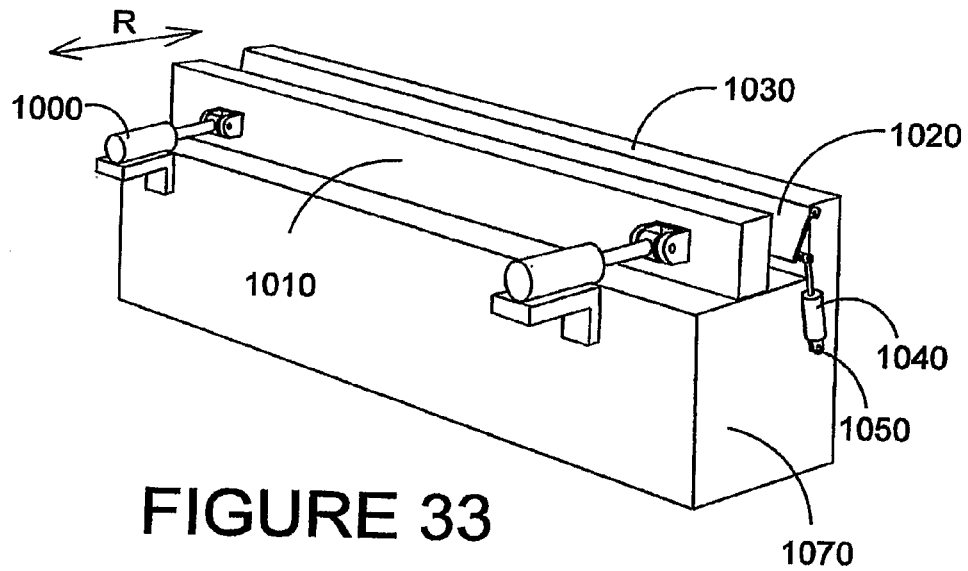
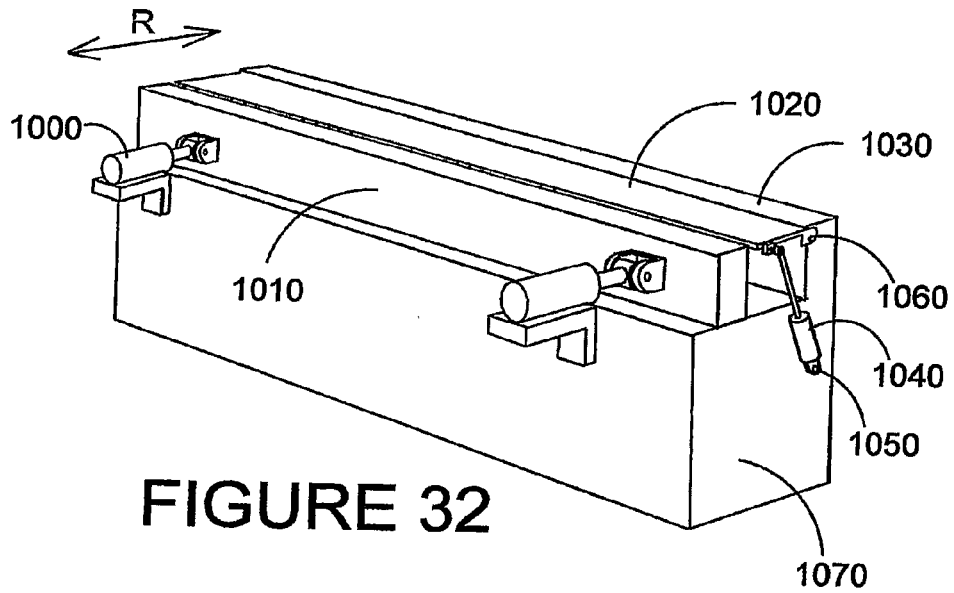


FIGURE 31A

FIGURE 31B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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