United States Patent

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[54] **CARTON-HANDLING DEVICE**
11 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** ..... **93/53 SD**
[51] **Int. Cl.** **B31b 1/76**
[50] **Field of Search** ..... 93/53 SD, 53 M, 53 R

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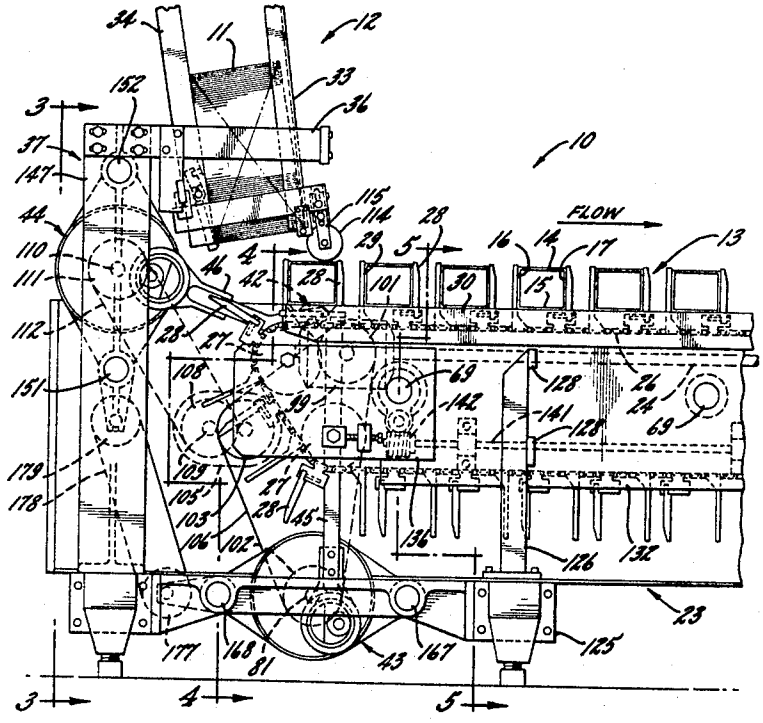
ABSTRACT: A device for drawing successive flattened cartons downwardly and outwardly from a magazine and placing each carton on a conveyor between two successive, spaced holders on the conveyor in timed relation with the speed at which the holders are moved. As an incident to being drawn from the magazine, each carton is erected and thus is placed on the conveyor in an erected position to be filled with a product. A transfer device for gripping the cartons and delivering the latter from the magazine to the conveyor is moved along a triangular path by the action of two drive mechanisms acting in concert. One drive mechanism is operative to raise and lower the transfer device, and the second is operative to move the transfer device horizontally. To draw the carton out of the magazine and place it on the conveyor, both mechanisms work together thus moving the transfer device downwardly and outwardly toward the conveyor along one leg of the triangle. A dwell means is built into each drive mechanism so that, after the carton is placed on the conveyor, the first mechanism dwells and the second mechanism moves the transfer device in a generally horizontal direction from the conveyor to a position spaced beneath the magazine. Then the second mechanism dwells, and the first mechanism is operable to raise the transfer device into engagement with the terminal carton in the magazine.



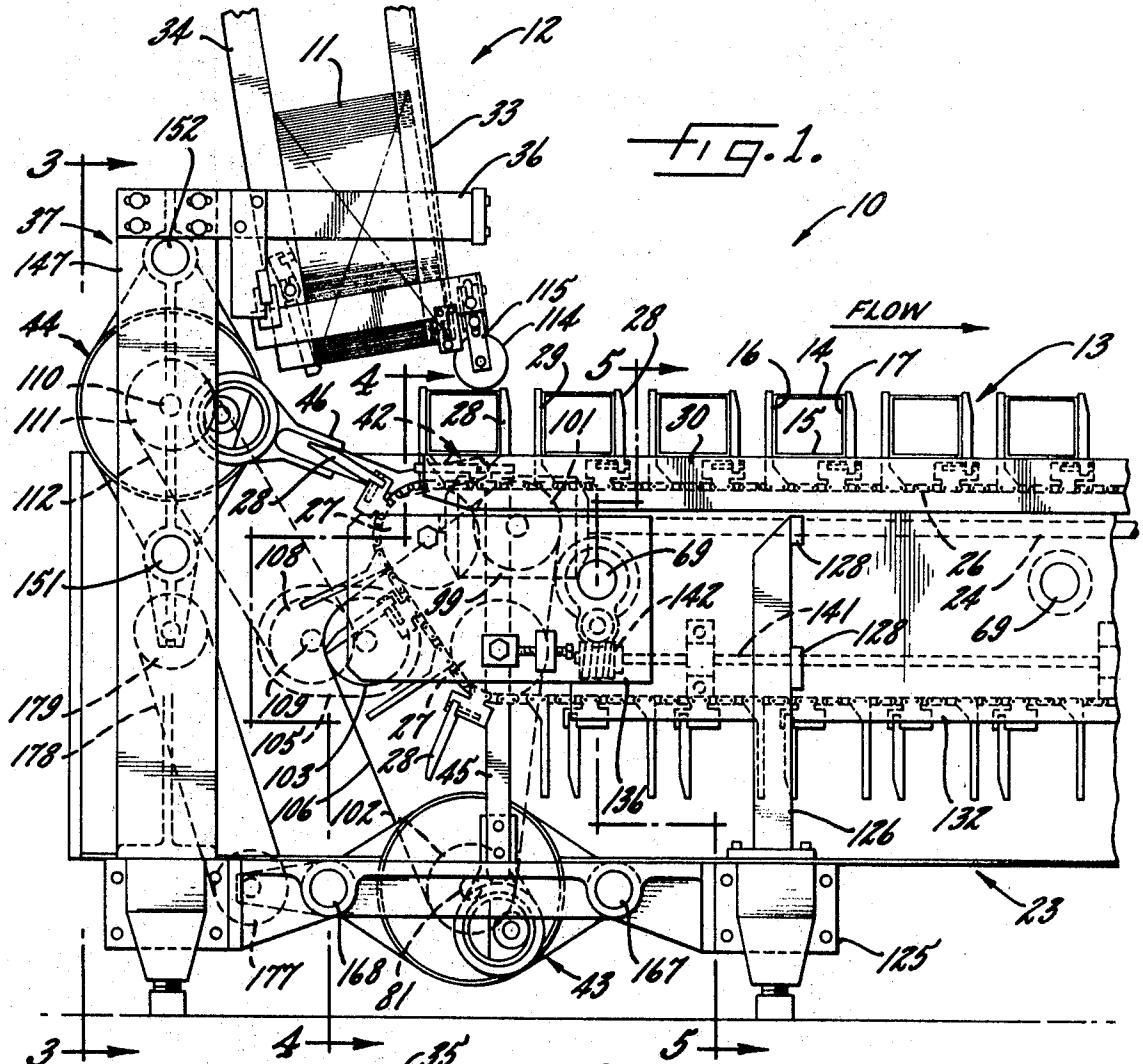


Fig. 1.

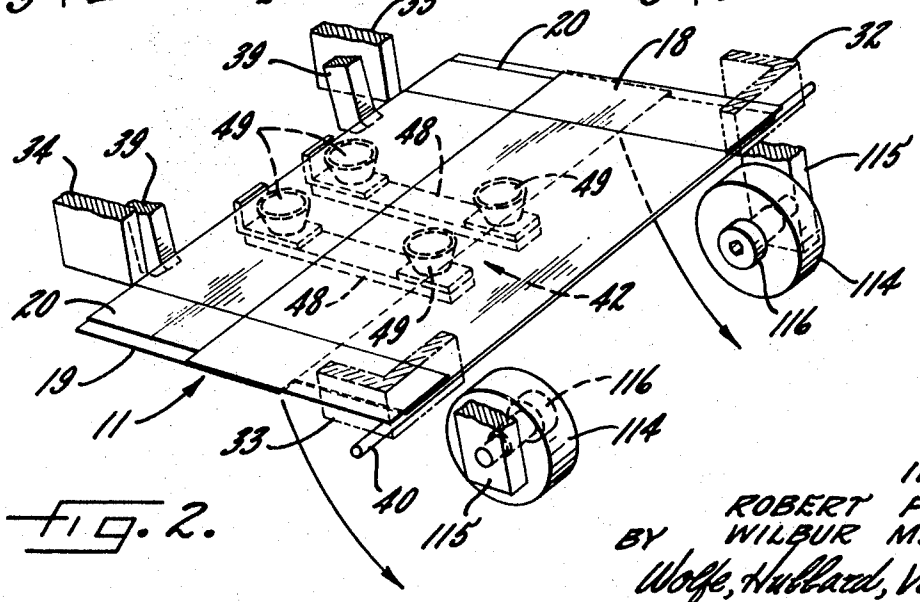


Fig. 2.

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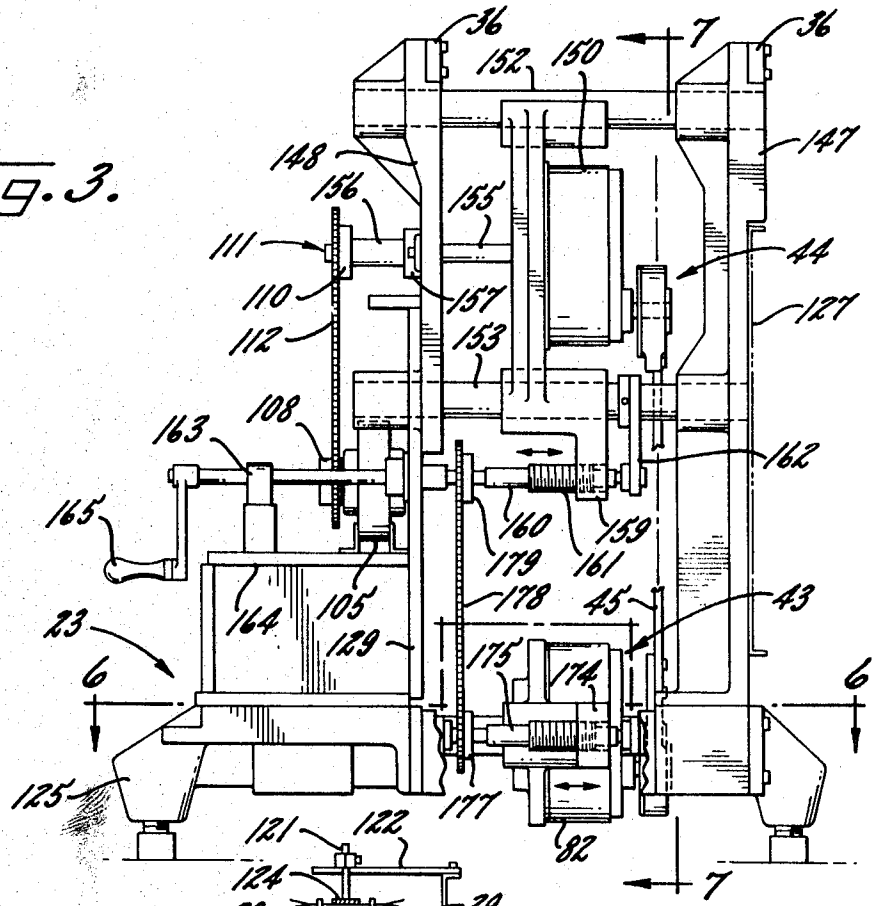
Fig. 3.



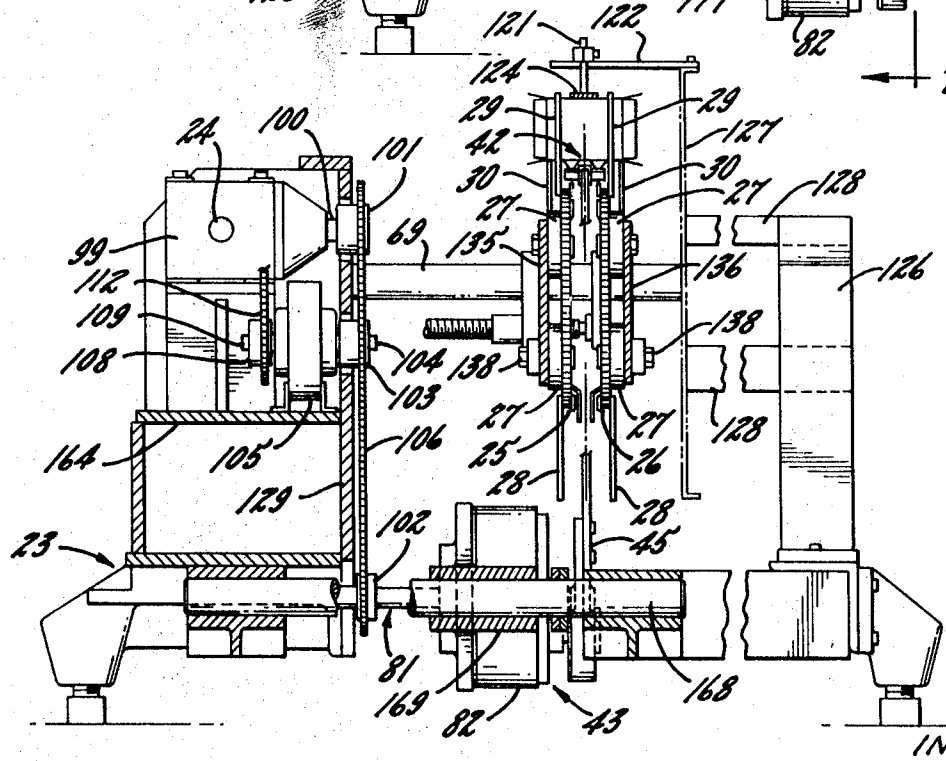


Fig. 4.

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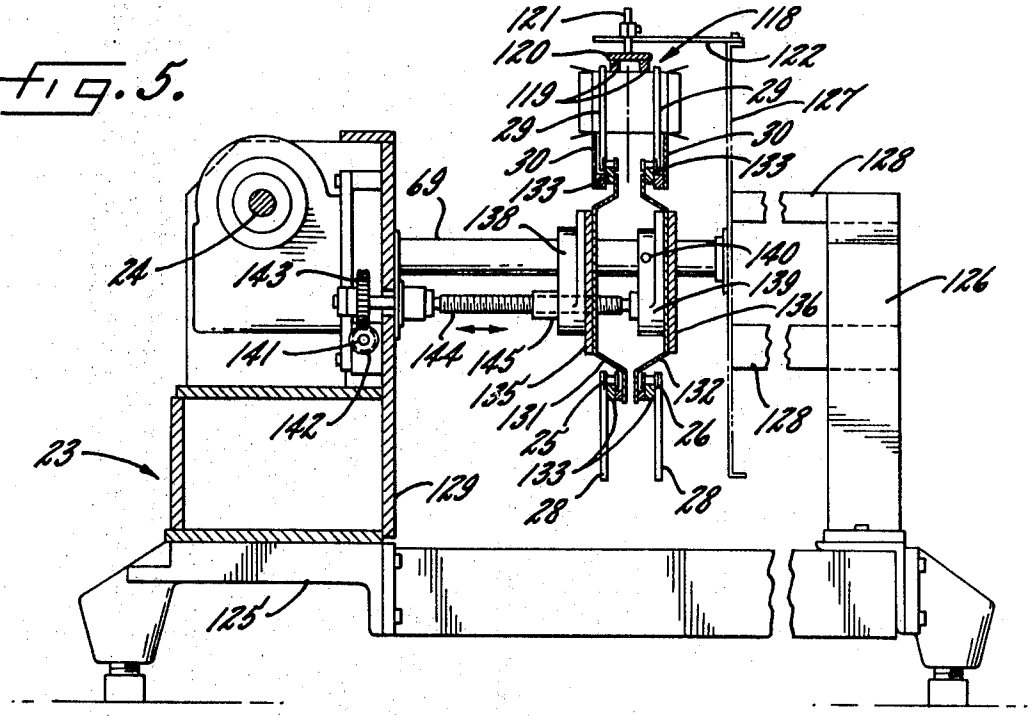
Fig. 5.



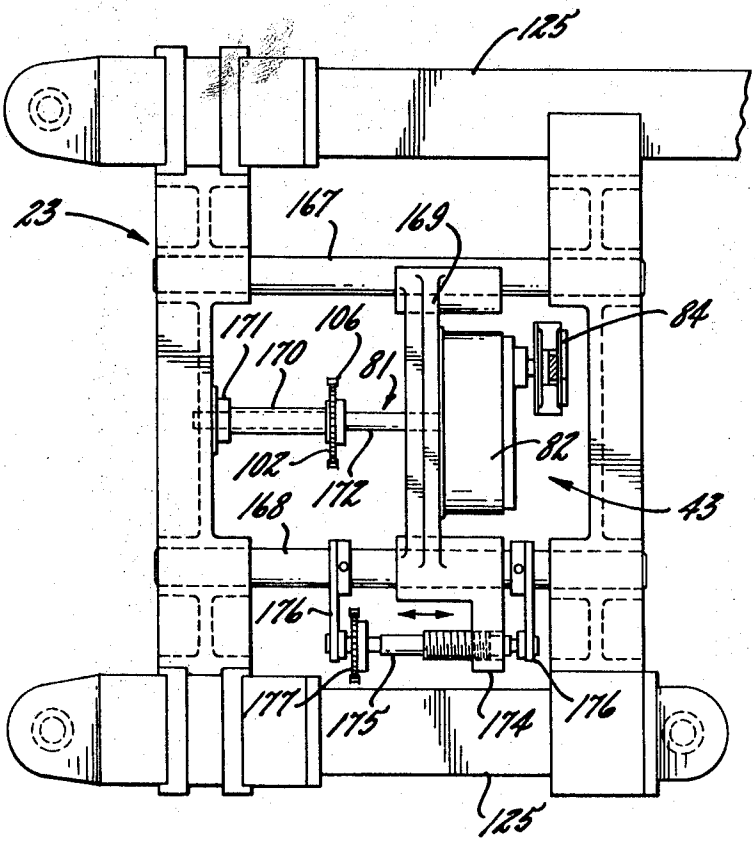


Fig. 6.

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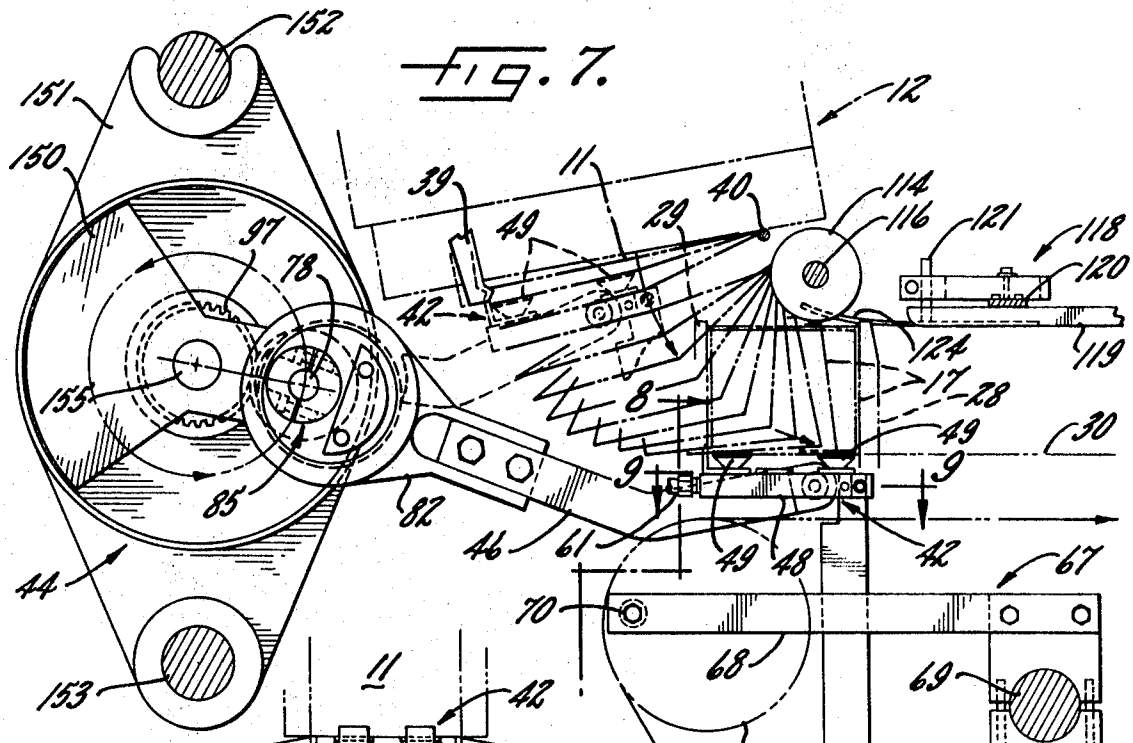
Fig. 7.



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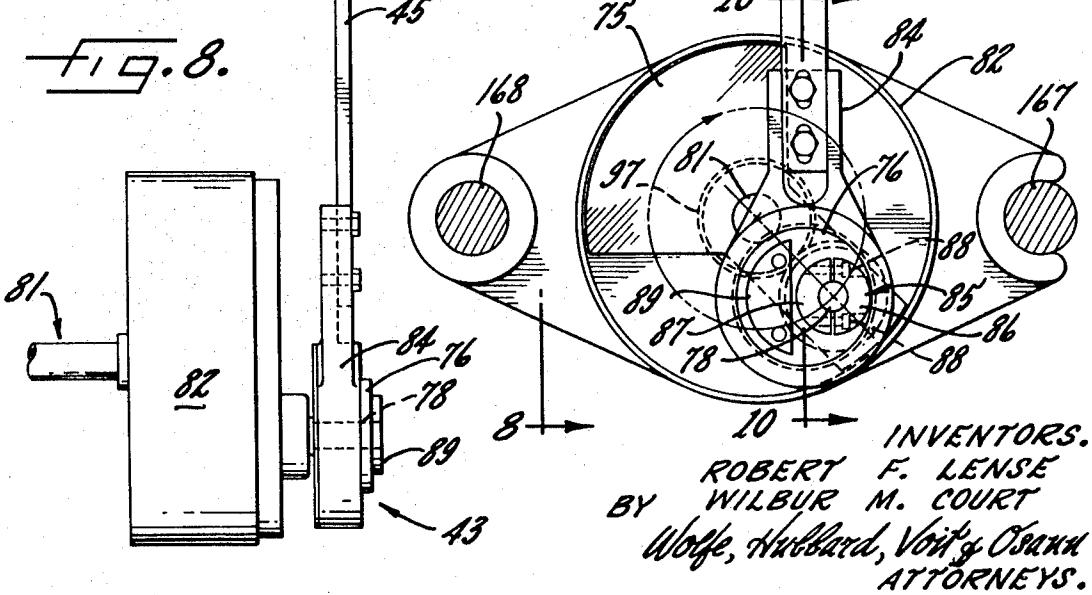

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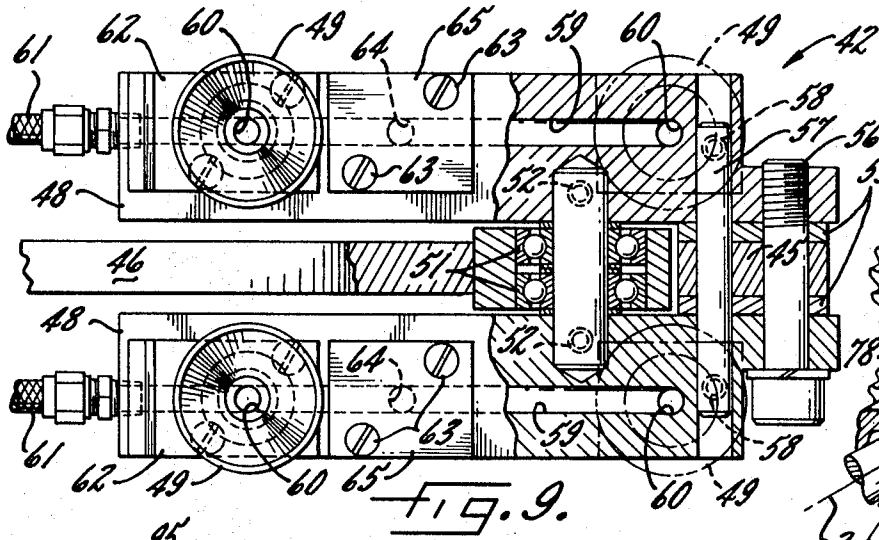

Fig. 9.

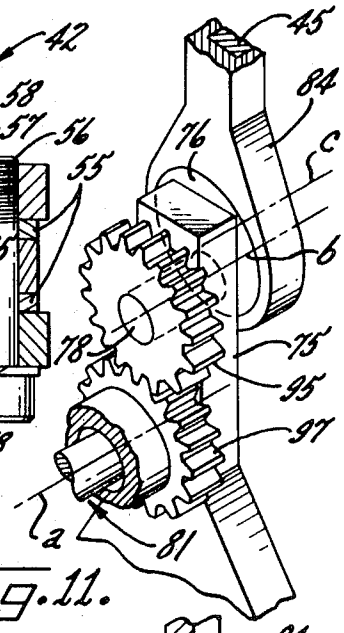

Fig. 11.

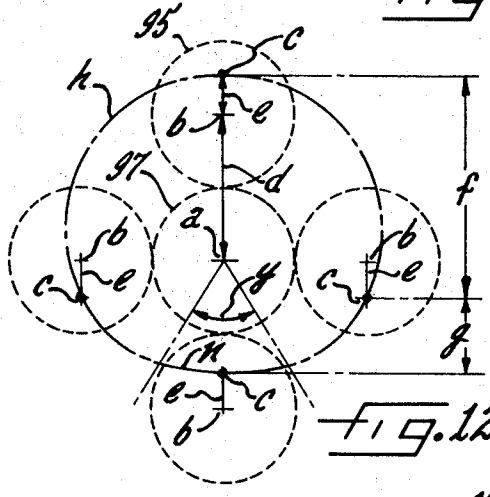

Fig. 12.

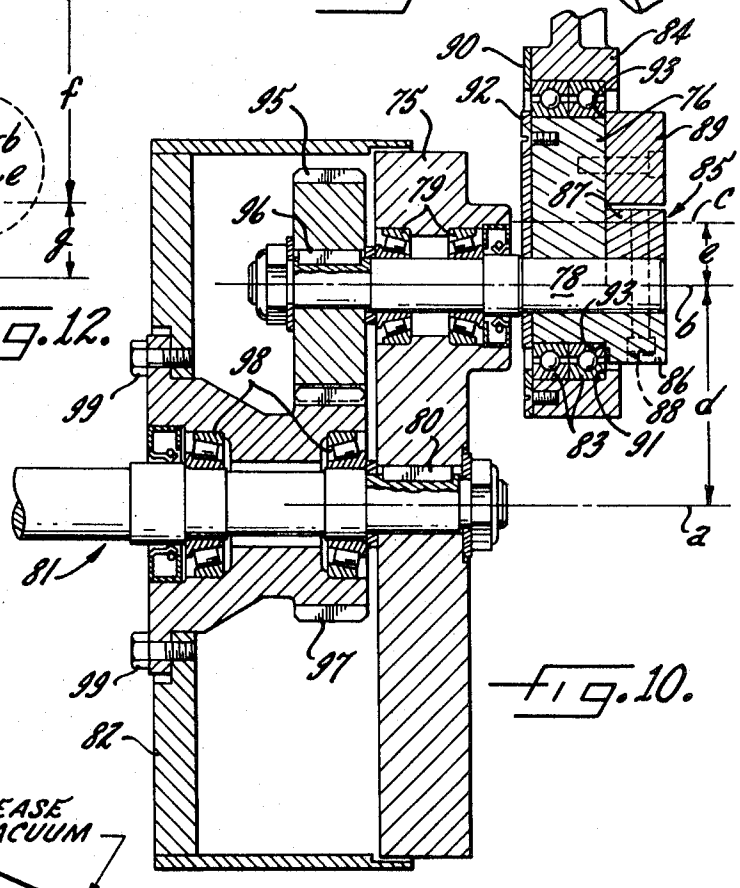

Fig. 10.

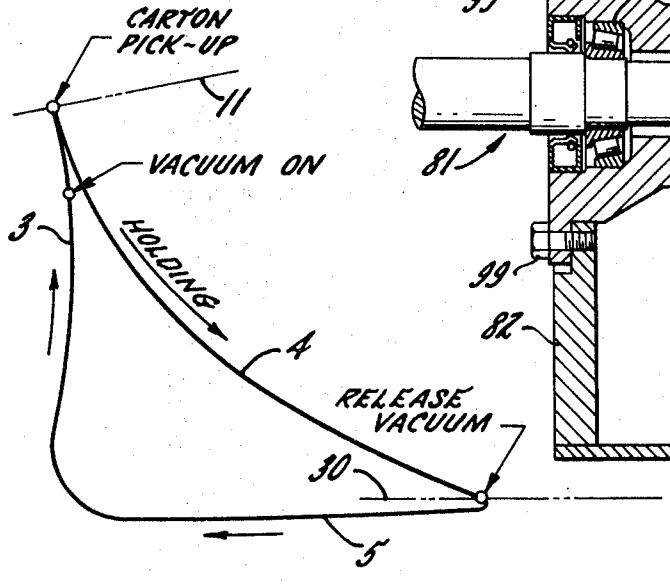

Fig. 13.

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CARTON-HANDLING DEVICE

BACKGROUND OF THE INVENTION

This invention relates to a machine for erecting collapsed cartons while transferring the cartons from a stack in a magazine to a conveyor spaced below and laterally from the magazine. Such cartons usually are rectangular when erected and comprise a sheet of paperboard folded and glued to form a first pair of opposing panels connected by a second pair of opposing panels, the panels being hingedly joined together along fold lines which are weakened as by scoring the paperboard. The cartons are stored in a flattened condition in the magazine and are removed one at a time from one end of the magazine by a transfer device which grips one exposed panel of the terminal carton in the stack and pulls the carton from the magazine for delivery to the conveyor in a substantially erected position for filling with a product to be cartoned.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide a new and improved machine of the above character which is operable to deliver cartons one at a time to the conveyor more rapidly and consistently and with less possibility of machine malfunction than has been possible with similar machines heretofore available.

It is another object to provide a machine which is operable to move the transfer device and thus a carton directly and in an uninterrupted motion from the magazine to the conveyor in timed relation with the speed of the conveyor to deliver the carton between two successive holders on the conveyor at a speed generally equal to the speed of the holders.

It is a more detailed object to provide a unique drive unit which is operable not only to draw a carton downwardly out of the magazine but also move it laterally to the conveyor in one continuous motion, and, as an incident to such movement, to erect the carton.

The invention also resides in the novel provision of a drive unit having two relatively simple drive mechanisms, one for moving the transfer device vertically and one for moving it horizontally, which are operable in concert to move the transfer device about a triangular path in timed relation with the speed of the conveyor to move the cartons to the conveyor.

It is still another object to provide a novel adjusting mechanism which is operable to simultaneously move both dive mechanisms laterally of the path the cartons follow so that, if the lateral length of the cartons is changed from run to run, the drive mechanisms and the transfer device may be centered on the cartons.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary side elevational view of a new and improved machine embodying the novel features of the present invention.

FIG. 2 is a fragmentary, perspective view of a flattened carton and parts of the magazine and of a roller for erecting the cartons.

FIG. 3 is a cross section taken substantially along the line 3—3 in FIG. 1 with parts broken away for purposes of clarity.

FIG. 4 is a cross section taken substantially along the line 4—4 in FIG. 1 with parts broken away for purposes of clarity.

FIG. 5 is a cross section taken substantially along the line 5—5 in FIG. 1 with parts broken away for purposes of clarity.

FIG. 6 is a fragmentary cross section taken substantially along the line 6—6 in FIG. 3.

FIG. 7 is an enlarged, fragmentary cross section taken substantially along the line 7—7 in FIG. 3.

FIG. 8 is a fragmentary cross section taken substantially along line 8—8 in FIG. 7.

FIG. 9 is an enlarged, fragmentary cross section taken substantially along the line 9—9 in FIG. 7.

FIG. 10 is a fragmentary cross section taken along the line 10—10 of FIG. 7 but showing certain parts in moved positions.

FIG. 11 is a fragmentary, perspective view of parts shown in FIG. 10.

FIG. 12 is a diagrammatic illustration of the principles of operation of one drive mechanism.

FIG. 13 is a diagram illustrating the triangular path taken by the transfer device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the invention is embodied in a packaging machine **10** (FIG. 1) in which cartons **11** stored in a flattened condition in a magazine **12** are removed one at a time from the magazine an transferred to a continuously moving carrier or conveyor **13**, the cartons being opened during this transfer to receive a product to be packaged in the cartons. On the conveyor, the cartons pass through successive stations to be filled, glued, and closed in a manner well known to those of ordinary skill in the art.

Each of the cartons **11** shown herein comprises rectangular top and bottom panels **14** and **15** (FIG. 1) hingedly connected along opposite side margins by two narrow rectangular side panels **16** and **17**. To close the open ends of the carton, top and bottom flaps **18** and **19** (FIG. 2) and side flaps **20** projecting outwardly at each end of the panels are folded across the open ends. Usually, such cartons are made of a single folded sheet of suitable material such as paperboard which is slit on opposite sides to form the flaps and is scored or otherwise weakened along the fold lines. The free ends of the sheet are glued together along a seam (not shown).

Preferably, the various mechanisms for opening, advancing, filling, and closing the cartons **11** are mounted on an elongated horizontal frame **23** (FIG. 1) and are operated in timed relation with each other by a single, continuously rotating horizontal cycle shaft **24** (FIGS. 1, 4 and 5) journaled on the frame and generally paralleling the path of the opened cartons. The conveyor **13** is in the form of two endless chains **25** and **26** (FIG. 4) disposed in parallel vertical planes and wound around two horizontally spaced pairs of sprocket wheels **27** (FIGS. 1 and 4) with the upper horizontal runs of the chains defining the path of the cartons. Spaced apart along and secured to the chains are sets of leading holders or arms **28** (FIG. 1) and trailing holders or arms **29** arranged in pairs and projecting upwardly between two carton-supporting rails **30** (FIGS. 1 and 5) when on the upper horizontal runs thereby to form the leading and trailing walls of a plurality of pockets along the conveyor. The distance between the leading and trailing pairs of arms in a set is substantially equal to the width of the cartons. Thus, each carton is held in a pocket between the trailing sides of the leading pair of arms and the leading sides of the trailing pair. Each trailing pair of arms is fixed relative to the chains and evenly spaced along the chains, but each leading pair is mounted on the chains for selective adjustment toward and away from the trailing pair of arms so that the size of the pockets can be changed when cartons of a different width are run on the machine. With the trailing pairs of arms being fixed in position and evenly spaced along the chains, the arms slide the cartons along the rails and through the machine **10** while holding them evenly spaced to position each of the cartons properly at the various operating stations.

Preparatory to being transferred to the conveyor **13**, the cartons **11** are stored in a stack in the magazine **12** in a flattened or collapsed condition, that is, with the top and bottom panels **14** and **15** lying side by side (see FIG. 2) and offset laterally from each other by the width of one of the side panels and with the side panels **16** and **17** lying flat against the top and bottom panels, respectively. As shown in FIG. 1, the magazine is positioned above and somewhat to the left of the beginning of the upper horizontal runs of the conveyor. In the present instance, the magazine **12** comprises an upright open frame including two bars **32** and **33** (FIG. 2) of right-angle cross section opening inwardly and spaced apart to receive the

corners of the stack on one side, the right side as viewed in FIGS. 1 and 2, and with two, upwardly extending, spaced-apart, inclined plates 34 and 35 disposed on the opposite side of the stack with their inner surfaces positioned to bear against the left-hand side of the stack. The bars and the plates are supported by a boxlike framework 36 (FIG. 1) connected to a standard 37 projecting upwardly from the frame 23 and are adjustable relative to one another to enable changing over of the magazine to accommodate cartons of different sizes.

The cartons 11 are supported releasably in the magazine 12 by suitable means which herein comprises two fingers 39 (FIG. 2) and a rod 40 mounted at the lower end of the magazine and projecting a short distance inwardly under the bottom carton in the stack. The two fingers are pivotally supported on the lower end portions of the plates 34, 35 and are spring biased to press against the lower left-hand portion of the stack to push the latter against the bars 32 while projecting under the bottom or terminal carton in the stack. During removal, the cartons are pulled one by one from the stack through the open bottom of the magazine, and each carton bends a slight amount during removal to pass around the rod, the fingers swinging clockwise (FIG. 1) to let the carton pass and then springing back to prevent the next carton from falling through the open bottom.

In accordance with the primary aspect of the present invention, successive cartons 11 are drawn in one continuous motion downwardly and outwardly from the magazine 12 and placed, in timed relation with the speed of the arms 28 and 29 of the conveyor 13, into a pocket between one set of paired leading and trailing arms thereby to effect a rapid and very smooth transfer of the cartons from the magazine to the conveyor. For this purpose, a transfer device 42 (FIGS. 7, 8 and 9) which is operable to engage and grip the cartons one at a time is moved by a vertical drive mechanism 43 (FIG. 1) and a horizontal drive mechanism 44 along a generally triangular path. THe transfer device first is moved generally upwardly along one leg 3 (see FIG. 13) of the path to engage and grip one exposed panel 15 of the terminal carton 11 in the magazine, then is moved downwardly and outwardly along a second leg 4 of the triangle to deliver the carton to the rails 30 while synchronizing the speed and location of the carton with that of the pairs of arms 28 and 29, and finally is moved empty along a generally horizontal third leg 5 of the triangle to clear the conveyor and place the device beneath the magazine to begin a new cycle of operation. As an incident to transfer of the carton, the latter is erected. With this arrangement, the cartons are delivered to the conveyor 13 more rapidly than has been possible with prior machines of the same general type and also are delivered in a smoother manner with a continuous and uninterrupted motion.

As shown in FIG. 7, the vertical drive mechanism 43 is positioned below the transfer device 42 and is connected to the latter by a relatively long straight arm 45. Positioned to the left (FIG. 7) of the transfer device and at an elevation between the conveyor 13 and the magazine 12, the horizontal drive mechanism 44 is connected to the transfer device by a relatively short, slightly bent arm 46. Herein, the transfer device is a platform formed by two spaced-apart parallel sections 48 (FIG. 2). Two suction cups 49 for gripping the cartons 11 are supported on the upper surface of each section. For purposes explained hereafter, the short arm 46 is pivotally connected to the sections while the long arm 45 is rigidly connected to such sections. To connect the short arm pivotally to the sections, the arm extends into the space between the sections, and a pin 50 (FIG. 9) extends through a bearing 51 in the end portion of the arm 46 and into both sections where setscrews 52 lock the pin to the sections. FOrwardly of the connection of the short arm to the sections, the long arm is connected rigidly and perpendicularly to the sections. As shown in FIG. 9, the upper end portion of the long arm 45 extends into the space between the sections and spacers 55 which are placed on each side of the arm to establish the spacing of the sections. A capscrew 56 extends through one of the sections and the arm 45 and is tightly threaded into the other section to clamp the two sections to the arm. FOr further rigidity a pin 57 extends through the two sections and the arm and is locked to the sections by setscrews 58.

To enable the section cups 49 to grip and release the cartons 11, a source of vacuum (not shown) is connected to each suction cup. Vacuum is applied to the suction cups just prior to the cups being moved into engagement with the terminal carton in the magazine 12 and is cut off as the carton is placed on the rails 30. For this purpose, a horizontal, main passageway 59 is formed from the rear (left in FIG. 9) of each section 48 forwardly almost to the front of each section. Vertical passageways 60 connect each section cup to a main passageway, and flexible lines 61 connect the rear end of each main passageway with the vacuum source. To enable the section cups to be moved on the sections to accommodate a change in carton size, each cup is mounted on a plate 62 which covers one vertical passageway in each section and which is removably mounted onto such section by screws 63. Extra vertical passageways 64 are formed in the sections, and the passageways not connected to a suction cup are covered by a dummy plate 65. Each suction cup thus is positionable over any selected vertical passageway by changing a dummy plate 65 for a cover plate 62 and suction cup 49.

In order to move the transfer device 42 between the magazine 12 and the conveyor 13, the vertical drive mechanism 43 moves the long arm 45 through up and down strokes, and the horizontal drive mechanism 44 moves the short arm 46 laterally through back and forth strokes. Each arm is connected to its respective drive mechanism in such a manner that the arm can swing about its connection to the drive mechanism, the short arm being able to swing up and down and the long arm being able to swing from side to side. As each mechanism moves its associated arm through one cycle of stokes, the mechanism causes a swell period in the stroke movement of its associated arm. That is, the long arm ceases to move up and down and the short arm ceases to move back and forth. THe driving action and dwell periods caused by the mechanisms are coordinated such that the arms act in concert to move the transfer device along the triangular path shown in FIG. 13.

To follow through a complete cycle of operation, assume that the transfer device 42 is positioned empty at the lower left-hand corner of the triangle (FIG. 13) that is, vertically beneath the magazine 12 and generally on a level with the upper runs of the chains 25 and 26. The vertical drive mechanism 43 moves the long arm 45 through an upstroke along the leg 3 to raise the suction cups 49 into engagement with the terminal carton 11 in the magazine 12, the vacuum being turned on just prior to the cup's engaging the carton. As the long arm moves through its upstroke, the horizontal drive mechanism 44 causes a dwell in the stroke movement of the short arm 46 so that the latter simply swings about its connection to its drive mechanism without positively moving the section cups horizontally, the dwell in stroke movement of the short arm occurring as the short arm is at the left end (FIG. 7) of its stroke. Because the arm 46 is relatively short, the swinging of the short arm causes the upward path along the first leg 3 of the triangle to be somewhat arcuate (FIG. 13). With the sections 48 being rigidly secured perpendicular to the long arm, the section cups are inclined at an angle of about 10° to the horizontal at the top of the first leg of the triangle. Accordingly, the magazine is tilted at a 10° angle with the horizontal thus insuring solid gripping of the cartons by the suction cups as shown by dotted lines in FIG. 7. After the cups have gripped the lower carton, the two mechanisms work in unison to move the carton to the rails 30. The horizontal drive mechanism ends the dwell of the short arm when the carton is engaged and moves the short arm outwardly to move the cups laterally toward the rails. At the same time, the vertical drive mechanism moves the long arm downwardly to move the cups downwardly. THe result of these simultaneous actions is to move the cups downwardly and outwardly from the magazine

along the second leg 4 or hypotenuse of the triangular path to the rails. As the carton reaches the rails, the vacuum is cut off to release the carton onto the rails. Finally, the vertical drive mechanism causes a dwell in the stroke movement of the long arm at the bottom of its stroke, and the horizontal drive mechanism retracts the short arm to move the cups, now empty, along the third leg 5 of the triangular path to return the cups to the starting point and complete an operational cycle. Because of the length of the long arm, the third leg is nearly a flat horizontal line.

The movement of the cups 49 along the second leg 4 of the triangular path is coordinated in speed with the speed of the paired arms 28 and 29 of the conveyor 13 and is timed such that the carton 11 will be deposited into one of the pockets formed by the arms. From FIG. 1, it will be observed that the pairs of arms of each set are spaced further apart at their free ends than at their attached ends as they pass around the upper sprockets 27 to begin moving along the upper horizontal runs, this being due to the arms' passing around circular paths defined by the sprockets. FIrst, the leading pair of arms 28 moves into a vertical position, and then the trailing pair of arms 29 passes around the upper sprockets and swings into a vertical position parallel to the leading pair. The carton is delivered in such a manner that the leading panel 17 of the carton abuts against the leading pair of arms, and the trailing pair of arms then swings into a vertical position to hold the carton, the nonvertical position of the trailing pair of arms coming around the sprockets providing an open pathway along which the carton may be delivered onto the rails 30. To deliver the cartons, the long arm 45 is adapted to pass between the chains 25 and 26 to position the suction cups 49 between the rails 30 (FIG. 8). The vertical drive mechanism 43 is positioned beneath the transfer location or station on the conveyor 13 where the carton is transferred to the rails 30. With the long arm being perpendicular to and rigidly connected to the sections 48, the sections and thus the carton 11 are horizontal during the transfer of the carton. Because the long arm is rigidly attached to the sections, the short arm must be pivotally attached to allow the necessary relative movement between the long and short arms to enable the cups to be moved about the triangular path.

With the arm 45 being relatively long, a guide 67 (FIGS. 7 and 8) is positioned to prevent lateral wobbling of the arm as it shifts to move the suction cups 49. To form the guide, two spaced-apart, horizontal strips 68 straddle the long arm and are each connected at one end portion to a laterally extending support member 69 of the frame 23 and at the other end portion to one another by a bolt 70. In this instance, the frame member 69 is cylindrical and the straps are bolted to the upper portion of a split clamp 71 which is clamped around the cylindrical frame member.

Since both drive mechanisms 43 and 44 are constructed essentially the same, only the vertical drive mechanism 43 will be described in detail. It will be appreciated that the drive mechanisms are oriented on the frame 23 approximately at right angles to one another so that the vertical drive mechanism 43 imparts vertical motion to the long arm 45 while the horizontal drive mechanism 44 imparts horizontal motion to the short arm 46. Also, the drive mechanisms are operated out of phase with one another so that the dwell periods occur alternately rather than simultaneously.

The vertical drive mechanism 43 is a form of a planetary differential having two input elements 75 and 76 (FIGS. 7, 10 and 11) driving an output element, herein the long arm 45 which is connected to the section cups 42. The arm and the cups are moved in accordance with the resultant motion of the two input elements. THe input element 75 comprises a rotatable crank coupled to the arm. The harmonic or sinusoidal motion normally produced by the crank is modified, however, by the input element 76 in such a manner that the arm dwells or substantially dwells at a fixed elevation at the end of its downward stroke for a considerably longer interval than would occur with pure harmonic motion, the interval being sufficiently long to delay the upward return of the arm until the horizontal drive mechanism 44 has moved the cups along the third or horizontal leg 5 of the triangular path.

More specifically, the lower end of the long arm 45 is connected to the crank 75 by a rotatable shaft 78 (FIG. 10) which is journaled intermediate its ends by bearings 79 located in one end portion of the crank. A key 80 fastens the crank for rotation with a horizontal drive shaft 81 which is journaled to turn about its own axis *a* by a housing 82 connected to the frame 13. Power for rotating the crank is transmitted to the shaft 81 from the cycle shaft 24 as will be explained subsequently.

The harmonic motion which normally would be undertaken by the upper end of the long arm 45 as a result of being driven by the crank 75 is modified in order to cause the arm to dwell at a substantially fixed elevation for a relatively long interval at the end of its downstroke, such modification of the motion being effected by the second input element 76 of the drive mechanism 43. FOr this purpose, the second input element 76 comprises a second crank in the form of a rotatable eccentric connected to the arm and operable to cancel out the motion transmitted to the arm by the crank 75 during the time the latter approaches, crosses and leaves its bottom dead center position. As shown most clearly in FIGS. 10 and 11, the eccentric 76 is simply a circular disc which is journaled rotatably by bearings 83 within a round opening formed in a collar 84 to which the lower end of the arm 45 is fastened. The eccentric is mounted on one end portion of the shaft 78 and is coupled for rotation with the shaft, the axis *b* of the shaft 78 being offset radially from the geometric axis or true center *c* of the eccentric. Herein, the shaft 78 is coupled to the eccentric by a split clamp 85. As shown in FIGS. 7 and 10, one-half 86 of the clamp is formed integrally with the eccentric, and the other half 87 is formed as an independent unit and is connected to the first half by two screws 88, tightening of the screws clamping the shaft 78 between the two halves. To balance the effect of the clamp during rotation of the eccentric, a counterweight 89 is mounted on the eccentric. Movement of the collar 84 axially of the eccentric 76 is prevented by a retaining plate 90 and a shoulder 91 on the collar engaging the outer race of the bearings 83. Also, such movement is prevented by a retaining plate 92 and shoulders 93 on the clamp and counterweight engaging the inner race of the bearings.

To rotate the eccentric 76, a planet gear 95 (FIGS. 10 and 11) is carried on the end portion of the shaft 78 opposite the eccentric and is coupled to turn the latter through a key 96. The planet gear meshes with a one-to-one ratio with a stationary sun gear 97 which rotatably journals the shaft 81 by means of bearings 98 and which is anchored to the housing 82 by screws 99 extending through the sun gear and threaded into the housing. As the crank 75 is rotated, the planet gear walks around the sun gear about the axis *a* of the shaft 81 and, at the same time, revolves about its own axis *b* to cause turning of the shaft 78 and the eccentric 76 through one full revolution for each one-half revolution of the crank.

As shown in FIGS. 10 and 11 and diagrammatically in FIG. 12, the eccentric 76 is positioned at top dead center within the collar 84 at the same time the crank 75 is positioned at its top dead center. At this time, the long arm 45 is at the uppermost point in its stroke and thus places the suction cups 49 in engagement with the lower carton 11 in the magazine 12. As the crank is rotated clockwise by the shaft 81 from the position shown in FIG. 10, the arm 45 starts moving downwardly. In turning through each one-fourth revolution, the crank, acting alone and without the eccentric, would cause shifting of the arm through a stroke *d*(FIG. 10) equal in length to the distance between the axes *a* and *b* of the shafts 78 and 81. During the first one-fourth revolution of the crank from top dead center, however, the eccentric 76 is turned clockwise through one-half revolution from top dead center to bottom dead center as a result of the planet gear 95 rolling around the sun gear 97 about the axis *a* and revolving about its own axis *b*. The eccentric itself thus acts to move the arm downwardly

through a stroke equal in length to twice the distance *e* between the axis *b* and the center *c* of the eccentric. Accordingly, the motions of the crank and the eccentric are added or combined during the first one-fourth revolution of the crank thereby shifting the arm downwardly through a longer stroke *f* (equal in length to the distances $d+2e$) and with greater velocity than would result from the crank acting alone with pure harmonic motion. THe motions undertaken by the driving elements during rotation of the crank are illustrated diagrammatically in FIG. **12** with the curve *h* indicating the path followed by the center *c* of the eccentric.

As soon as the crank **75** has rotated through its first one-fourth revolution, the eccentric **76** reaches its bottom dead center. Then, as the crank turns through another one-fourth revolution and approaches its bottom dead center position (see FIG. **12**), the eccentric turns through one-half revolution from its bottom dead center toward its top dead center. In so turning, the eccentric tends to shift the long arm **45** upwardly through a stroke of length $2e$ thereby subtracting from the downward motion produced by the crank and causing a resultant downward displacement of the arm through a relatively short stroke *g* (equal to the distance $d-2e$) as the crank moves through its second one-fourth revolution. Thus, the arm moves downwardly at a slower velocity to move the suction cups **49** downwardly at a slower velocity as they approach the support rails **30**.

Upon passing bottom dead center and completing one-half revolution, the crank **75** starts shifting the suction cups **49** upwardly. THe eccentric **76**, however, again starts turning from its top dead center toward its bottom dead center and tends to shift the cups downwardly thereby again subtracting from the motion of the crank and retarding the upward motion of the cups during the third one-fourth revolution of the crank. As the crank starts through its final one-fourth revolution, the eccentric once again turns from its bottom dead center toward its top dead center to add to the upward motion produced by the crank and to cause the major portion of the upstroke of the cups to occur during the final one-fourth revolution of the crank.

Because the eccentric **76** subtracts from the motion of the crank **75** as the latter approaches, crosses and leaves its bottom dead center position, very little motion is transmitted to the long arm **45** as it completes its downstroke and begins its upstroke. As shown in FIG. **12**, the arm and the center *c* of the eccentric move along a substantially flat path *n* as the crank turns through its lowermost angle *y* of about 70 cycle shaft degrees. As the crank turns through this angle, the arm is displaced vertically only about 1/200 of *d* in each direction. Thus, the arm, for all practical purposes, dwells at a substantially fixed elevation (it swings about the eccentric) from the time a carton **11** is placed on the rails **30** until after the horizontal drive mechanism **44** moves the suction cups **49** along the third leg **5** of the triangular path.

Like the vertical drive mechanism **43**, the horizontal drive mechanism **44** includes a first crank, an eccentric, a planet gear and a sun gear with the proper shafts so that the horizontal drive mechanism is able to cause a dwell period in the stroke of the short arm **46**. As most clearly shown in FIG. **7**, the horizontal drive mechanism is positioned to move the short arm through generally horizontal strokes from right to left and return with the horizontal drive mechanism causing the short arm to dwell when the arm is at its leftmost position.

To move the suction cups **49** about the triangular path, the two drive mechanisms **43** and **44** act to move the long arm **45** and short arm **46** in concert. When the vertical drive mechanism completes turning through the 70 cycle shaft degrees, which represent the stroke dwell period of the long arm, the short arm is positioned near the left end of its stroke and the horizontal drive mechanism is within a few cycle shaft degrees of causing the stroke dwell of the short arm. At this moment, the suction cups **49** are empty and positioned below the magazine **12**. Next, the long arm is moved upwardly toward the terminal carton **11** in the magazine **12** while the short arm enters its stroke dwell period and swings vertically about the eccentric of the horizontal drive mechanism. Thus, the suction cups are raised along the leg **3** into contact with the terminal carton, such contact being made as the dwell period of the short arm ends and at the end of the upstroke of the long arm, as indicated by the dotted lines in FIG. **7**.

After the suction cups **49** engage the terminal carton **11**, the short arm **46** is moved to the right through an outstroke while the long arm is pulled downwardly through a downstroke. Since both arms are connected to the suction cups, the latter are moved, along with the carton being gripped, diagonally downwardly and outwardly (to the right in FIG. **7**) along the second leg **4** to deliver the carton to the rails **30**. When the suction cups deliver the carton, the short arm is at the end of its outstroke and the long arm is about to enter its stroke dwell period, as indicated by the full lines. Finally, the suction cups are moved horizontally along the third leg **5** to the starting position. To accomplish this movement, the short arm is pulled through a return stroke as the long arm passes through its stroke dwell period and swings about the eccentric **76**. Thus, it will be appreciated that the two drive mechanisms work in unison to move the suction cups about the triangular path.

As explained in detail hereinafter, both drive mechanisms are driven by the cycle shaft **24** and thus the phase relation between the drive mechanisms can best be described in terms of cycle shaft degrees. In this instance, the mechanism are timed such that when the short arm is at the end of its stroke to the right or, in other words, 180 cycle shaft degrees from the center of its stroke dwell period, the long arm is just entering its stroke dwell period. Thus, the vertical drive mechanism may be said to be leading the horizontal drive mechanism by 145 cycle shaft degrees. The phase relation between the drive mechanisms can be changed, if necessary, by changing the angular position of the entire drive mechanism with respect to its input shaft **81**.

Both the horizontal drive mechanism **44** and the vertical drive mechanism **43** are driven from a single power takeoff unit **99** (FIGS. **1** and **4**) which takes power from the cycle shaft **24**. Through the power takeoff unit, the cycle shaft rotates a drive shaft **100** (FIG. **4**) with a sprocket **101** fixed on the free end portion thereof for rotation with the shaft. A second sprocket **102** is rigidly mounted on the shaft **81** of the vertical drive mechanism and a third sprocket **103** is fixed to one shaft **104** (FIG. **1**) of a parallel gearbox **105**. Power is transmitted from the first sprocket **101** to the second and third sprockets **102** and **103** by a chain **106** which is trained around the three sprockets. A fourth sprocket **108** is mounted on a second shaft **109** in the parallel gearbox (FIGS. **3** and **4**), the second shaft being driven by the power delivered to the third sprocket **103** and driven at a speed equal to that of the shaft **104**. To drive the horizontal drive mechanism, a fifth sprocket **110** is rigidly affixed to a shaft **111** corresponding to the shaft **81** of the vertical drive mechanism, and a chain **112** is trained around the fourth and fifth sprockets thus transmitting power from the fourth to the fifth sprocket to rotate the shaft **111**. The third and fourth sprockets are the same size so that the shaft **111** and the shaft **81** are rotated at the same speed thus synchronizing the speeds of the two drive mechanisms.

Advantageously, two cylindrical rollers **114** (FIGS. **1**, **2** and **7**) extend into the path of the cartons **11** as they are transferred from the magazine **12** to the rails **30** by the suction cups **49** as the latter move along the second leg **4** of the triangular path. The rollers are operable to erect each carton as it is transferred so that a fully erect carton is positioned in the pocket between the paired arms **28** and **29**. For this purpose, the two rollers are suspended from the magazine and are journaled to turn about a common axis which extends transversely of the magazine and the path of the cartons. As shown in FIG. **1**, each roller is journaled on the lower end portion of a support strap **115** whose upper end portion is mounted on the magazine for vertical adjustment, the roller being journaled by a shouldered capscrew **116** (FIG. **2**) extending through the

roller and threaded into the strap. The rollers are spaced above the rails **30** in the transfer station a distance slightly greater than the height of the side panels **16** and **17** of the cartons, and the axis of the rollers is spaced just forwardly (right in FIG. **1**) of the rod **40**.

The suction cups **49** are positioned on the sections **48** such that the cups engage and grip only the bottom panel **15** of the terminal carton **11** in the magazine **12**. As the carton is pulled from the magazine, the effect of passing around rod **40** starts the panels bending along the hinge lines so that the carton begins to open, as indicated by the dot-dash lines in FIG. **7**. The rollers **114** are positioned so that they engage the leading edge portion of the leading side panel **17** as the carton is moved toward the rails **30**. This engagement retards the forward motion of that edge portion and thus causes the carton to swing into an erected position as the bottom panel continues to be moved toward the rails. Thus, an erected carton is placed on the rails and is held in an erected position by the leading and trailing paired arms **28** and **29**. While the cartons are erected in this instance by two rollers, a single roller could be used and, though less efficient, cylindrical members which do not rotate also could be employed.

Due to the memory of the material of the cartons **11**, each carton has a tendency to return to the collapsed position. To prevent the cartons from rising upwardly out of the pockets due to this tendency to collapse, a holddown **118** (FIG. **5**) extends above the cartons along the length of the rails **30** and is centered between the chains **25** and **26**. Herein, the holddown comprises two parallel members **119** which extend longitudinally along and above the rails. THese members are suspended from and spaced apart by a plurality of support plates **120** (one shown in FIGS. **5** and **7**) which in turn are connected to the lower ends of vertical rods **121**. To support the vertical rods, a plurality of horizontally positioned arms **122** (one shown in FIG. **5**) are connected at one end to a member of the frame **23** and extend cantilever fashion transversely over the rails. Each rod **121** is adjustably connected to one of the arms for both vertical adjustment and lateral sliding along the arm so that the position of the members can be changed if cartons of a different size are run through the machine **10**. As shown in FIG. **4**, the two members end short of the magazine and a single member **124** is connected to one of the rods **121**.

Advantageously, the machine **10** is constructed such that after cartons **11** of one length are run, adjustments may be made to the lateral positioning of one chain, the chain **25**, of the conveyor **13** and the drive mechanisms **43** and **44** to allow cartons of a different length to be run through the machine. In this instance, the length of the carton refers to the dimension of the carton from left to right in FIG. **5**. With the positions of the mechanisms being adjustable, the suction cups **49** may be positioned to engage the central area of each carton while maintaining one end of the carton (the right end in FIG. **5**) on a fixed reference line for standardized operations on the carton in the various stations along the conveyor. Additionally, with the chain **25** being laterally adjustable, clearance is provided for the long arm **45** to move between the chains, and the paired arms **28** and **29** will be spaced to engage the outer end portions of the cartons.

Herein, the frame **23** comprises a legged base **125** (FIGS. **1** and **5**) on which the drive mechanisms **43** and **44**, the magazine **12** and one end (the left in FIG. **1**) of the conveyor **13** are supported. To support the conveyor from one side (the right side in FIG. **5**), a post **126** is fixed to and extends upwardly from the base and supports a vertically disposed plate **127** which extends longitudinally of the conveyor, the plate being connected to the post by two arms **128**. On the left side, a longitudinally extending support wall **129** extends upwardly from the base. Support rods **69** positioned at spaced intervals extend between and are connected to the plate **127** and the support wall. Extending parallel to the plate **127** and mounted on the support rods are two support plates **131** and **132** with chain guides **133** mounted on the upper and lower edge portions of the support plates to guide the chains **25** and **26**, the rails **30** being fastened to and extending upwardly from the outer sides of the supper chain guides. To support the chains, secondary plates **135** and **136** (FIG. **4**) are rigidly connected to the left end portions (FIG. **1**) of the support plates **131** and **132** and mount the conveyor sprockets **27**. As shown in FIG. **4**, each of the conveyor sprockets is journaled onto its respective secondary support plate by a stub axle **138**.

So that the left-hand (FIG. **5**) chain **25** and rail **30** may be moved to adjust the spacing between the rails for cartons **11** of different length, the left-hand support plate **131** is slidably mounted on the rods **69** while the right-hand support plate **132** is fixedly mounted on the rods to maintain the right-hand edge of the cartons on the common reference line regardless of the carton length. For this purpose, supports **138** and **139** (FIG. **5**) are connected to the support plates and telescoped over the rods. All of the right-hand supports **139** are locked to the rods by setscrews **140** (one shown in FIG. **5**) while the left-hand supports are slidably mounted on the rods. Herein, when adjustment of the left-hand rail is required, the left-hand supports are moved along the rods by an adjusting mechanism. In furtherance of this as shown in FIG. **1**, the mechanism comprises a shaft **141** extends horizontally along and is journaled on the support wall **129**, and worm gears **142** (one shown) are mounted on the shaft adjacent selected rods **169**. Each worm gear drives a worm wheel **143** (FIG. **5**) fast on one end of a threaded shaft **144** extending through the wall **129**, through the lower end portion of the left-hand support **138**, and journaled in the lower end portion of the right-hand support **139**. A nut **145** is fixed to the left-hand support and is threaded on the threaded rod. Thus, when the shaft **144** is rotated, all the left-hand supports are forced to travel on the rods **169** thus changing the positions of the rail **30** and chain **25** with its associated arms **28** and **29**, such position changes being performed when the carton length is changed.

To support the magazine **12** and the horizontal drive mechanism **44**, the standard **37** comprises a post **147** (FIG. **3**) which extends upwardly from the rear or left-hand (FIG. **1**) end portion of the base **125** and a post **148** which extends upwardly from the support wall **129**. As shown in FIG. **1**, the collar **36** supporting the magazine is bolted to the upper end portion of the posts. When the carton length is changed, the magazine is expanded to the left (FIG. **3**) to maintain the fixed reference line along the right-hand side of the machine **10**. While not shown in detail, adjustable magazines are well known. As shown most clearly in FIG. **3**, the horizontal drive mechanism housing **150** which corresponds to the housing **82** of the vertical drive mechanism **43** is mounted on a carrier **151** which is mounted for sliding movement on two vertically spaced, horizontal rods **152** and **153** that extend between the posts **147** and **148**. For this purpose, the lower end portion of the carrier is slidably telescoped over the lower rod **153**, and the upper end portion of the carrier, formed as a yoke, cradles the lower half of the upper rod **152**. To allow the horizontal drive mechanism to move horizontally while still maintaining a driving connection between the mechanism and the sprocket **110**, the shaft **111** is formed by a first shaft **155** and a sleeve **156** telescoped over the shaft **155**, the shaft **155** being connected at one end to a sun gear (not shown but corresponding to sun gear **97**) and being slidably telescoped at its other end portion in the sleeve which is rotatably mounted by a flanged bearing block **157** on the post **148**. The fifth sprocket **110** is mounted on the free end of the sleeve, and the shaft **155** is keyed to the sleeve so that power is transmitted from the sleeve to the shaft while still allowing the shaft to telescopingly slide in the sleeve.

Horizontal movement of the horizontal drive mechanism **44** along the rods **152** and **153** is obtained by utilizing an adjusting mechanism. FOr this purpose, a nut **159** depends from and is rigidly fixed to the lower end portion of the carrier **151**, and a rod **160** threaded along one portion **161** is threaded through the nut, the rod being journaled at one end in a support **162** depending from the rod **153** and near the other end by a sup-

port 163 projecting upwardly from a frame member 164 on the base 125. For turning the rod 160, a crank 165 is connected to the left end portion (FIG. 3) of the rod, and rotation of the rod causes the nut to travel along the threaded portion of the rod thus moving the carrier and horizontal drive mechanism, the direction of movement being determined by the direction of rotation of the rod 160.

As shown in FIG. 6, the vertical drive mechanism 43 is mounted for movement in a manner similar to the mounting of the horizontal drive mechanism 44. In this instance, two horizontal and parallel rods 167 and 168 are supported by the base 125, and the housing 82 for the vertical drive mechanism is mounted on a carrier 169 corresponding to the carrier 151 and slidably mounted on the rods 167 and 168. Like the shaft 111, the shaft 81 is formed by a sleeve 180 rotatably mounted on the base 125 by a flanged bearing block 171 and a shaft 172 slidably telescoped in and keyed to the sleeve. The sprocket 102 is mounted on the sleeve, and power is transmitted from the sleeve to the shaft.

Advantageously, the rod 160 (FIG. 3) is used to adjust the positions of both drive mechanisms 43 and 44 simultaneously and through the same distance. For this purpose, an adjusting mechanism is used to move the vertical drive mechanism 43, and the operation of the adjusting mechanism is controlled by the rotation of the rod 160. Herein, a nut 174 (FIG. 6) is rigidly fixed to one end of the carrier 169. A rod 175 threaded along one portion and journaled at opposite ends in supports 176 extending outwardly from the rod 168 is threaded into the nut. A sprocket 177 is mounted on the rod 175, and a chain 178 (FIG. 3) is trained around the sprocket and around a similar sprocket 179 on the rod 160 so that, as the rod 160 is turned, the rod 175 is turned an equal amount in the same angular direction thus forcing the nut 174 to travel a distance equal to the travel of the nut 159 to move the vertical drive mechanism 43 through the same distance as the horizontal drive mechanism 44.

It will be observed from the above that the provision of the vertical drive mechanism 43 and the horizontal drive mechanism 44 which work in unison to move the suction cups 49 along a generally triangular path is particularly advantageous. With this arrangement, cartons 11 may be pulled from the magazine 12 and delivered directly onto the rails 30 into a pocket between paired leading and trailing arms 28 and 29 in timed relation with the speed of the arms. Thus, cartons may be delivered to the rails more rapidly and in a more continuous fashion than has been possible heretofore. Additionally, the two rollers 114 provide an extremely simple and efficient means for erecting the cartons as the latter are being delivered directly to the rails.

We claim:

1. In a machine for handling collapsible cartons, the combination of, a frame, a magazine having an open end and mounted on said frame for releasably holding a stack of flattened cartons, a transfer station, a conveyor spaced from said magazine and having spaced-apart holders, said conveyor being adapted to move said holders continuously at a predetermined speed along a predetermined path through said transfer station, a transfer device supported on said frame for engaging a carton, and means for moving said transfer device continuously along a generally triangular path in which said transfer device is moved along one leg of the triangle toward said magazine to engage and grip the exposed side of the terminal carton in the magazine, then is moved along a second leg of the triangle in timed relation with the speed of the holders to draw the terminal carton from the magazine while synchronizing the speed and location of the carton with the holders and placing the carton between two successive holders, and then is moved empty along a third leg of the triangle to clear the conveyor whereby cartons are delivered quickly and continuously from said magazine to said conveyor.

2. In a machine for handling collapsible cartons, the combination of, a frame, a magazine having an open end and mounted on said frame for releasably holding a stack of flattened cartons, a transfer station, a conveyor spaced downwardly and outwardly from said magazine, said conveyor having spaced-apart holders extending outwardly therefrom and being operable to move said holders continuously at a predetermined speed along a predetermined path through said transfer station, a transfer device supported on said frame and including means for gripping cartons one at a time, first and second drive mechanisms mounted on said frame, said mechanisms being connected to said transfer device and operable in concert to move said transfer device continuously along a generally triangular path in which said transfer device is moved generally vertically along one leg of the triangle toward said magazine to engage and grip the exposed side of the terminal carton in the magazine and then is moved along a second leg of the triangle downwardly and outwardly from the magazine in timed relation with the speed of the holders to draw the terminal carton from the magazine while synchronizing the speed and location of the carton with the holders in the transfer station and lowering the carton onto the conveyor between two successive holders, said gripping means being operable to release the cartons from the transfer device as the carton is lowered onto the conveyor, said drive mechanisms thereafter being operable to move the empty transfer device reversely in a generally horizontal direction along the third leg of the triangle and toward said magazine to clear the conveyor and place the transfer device beneath the magazine in vertical alignment therewith whereby cartons are delivered quickly and continuously from said magazine to said conveyor.

3. The machine of claim 2 further including erector means mounted on said frame and operable as an incident to movement of said transfer device along the second leg of the triangle to erect the flattened carton gripped by said gripping means so that the carton is delivered to the conveyor in an erected condition.

4. The machine of claim 3 in which the cartons are formed by top and bottom panels and front and rear side panels hingedly joined together at their edges and are stored in the magazine in a flattened condition with the top and front panels being side by side and overlying the other two panels and with the hinged edges of the panels extending transversely of the path followed by the conveyor through the transfer station, said erector means comprising a roller journaled on said frame to turn about an axis extending transversely of said last-mentioned path and being positioned to engage the forward edge of the carton as the latter is moved along the second leg of the triangle thus retarding the movement of the forward edge to cause the panels to swing about their hinged edges thus erecting the carton.

5. The machine of claim 2 in which the transfer device may be centered on the cartons in the magazine when the length of the cartons extending laterally of said predetermined path is varied from run to run, adjusting means on said frame mounting said drive mechanisms for movement laterally of said predetermined path so that the positions of said mechanisms may be adjusted when the length of the cartons is changed thereby to enable adjustment of the position of the transfer device to keep the latter centered on the cartons, said adjusting means comprising first and second threaded rods journaled on said frame and extending laterally of said predetermined path, means connected between said rods for rotating one of said rods when the other is rotated, a nut fixed to each of said drive mechanisms with said rods each threadably engaging a respective one of said nuts, and means for rotating one of said rods whereby rotation of one rod rotates the other rod to force each nut to travel along its respective rod to shift its respective drive mechanism laterally of said predetermined path thus adjusting the positions of the mechanisms.

6. The machine of claim 2 in which said first drive mechanism is operable to advance said transfer device vertically and said second drive mechanism is operable to advance said transfer device horizontally, said first mechanism including a first dwell means for causing the vertical movement of said first mechanism to dwell as said second mechanism ad-

vances said transfer device horizontally along the third leg of the triangle, said second mechanism including second dwell means for causing the horizontal movement of said second mechanism to dwell as said first mechanism moves said transfer device upwardly along the first leg of the triangle, the mechanisms being operable in concert to advance the transfer device downwardly and outwardly from the magazine along the second leg of the triangle to deliver the carton to the conveyor.

7. The machine of claim 6 in which said first drive mechanism and said first dwell means include a first differential having first and second driven input elements and having a first output element driven in accordance with the resultant motion of said input elements and connected to said transfer device, said first input element being connected to said output element to move the transfer device in a generally vertical direction, and said second input element being connected to said output element to subtract from the motion normally imparted to the transfer device by said first input element to cause the vertical movement of said first mechanism to dwell so that the transfer device is moved generally horizontally along the third leg of the triangle by the motion imparted to the transfer device by the second drive mechanism.

8. The machine of claim 7 in which said second drive mechanism and said second dwell means include a second differential having third and fourth driven input elements and having a second output element driven in accordance with the resultant motion of said third and fourth input elements and connected to said transfer deice, said third input element being connected to said second output element to move the transfer device in a generally horizontal direction, and said fourth input element being connected to said second output element to subtract from the motion normally imparted to the transfer device by said third input element to cause the horizontal movement of said second mechanism to dwell so that the transfer device is moved in a generally vertical direction along the first leg of the triangle by the motion imparted to the transfer device by the first mechanism.

9. The machine of claim 6 in which said first drive mechanism is positioned below said transfer station, said transfer device including a platform, said second drive mechanism including a second output element pivotally connected to said platform, and said first mechanism being positioned below said transfer station and including a first output element positioned generally perpendicular to and connected rigidly to said platform thereby to position said platform generally horizontally when said platform is in said transfer station.

10. The machine of claim 6 in which each of said drive mechanism and dwell means comprise (a) a power-rotated shaft, (b) a first crank connected to and rotatable with said shaft and movable from a first dead center position to a second and opposite dead center position as the shaft is turned through one-half revolution, (c) a second crank rotatable both with and on said first crank and movable from a first dead center position to a second and opposite dead center position, (d) an arm connecting said second crank to said transfer device to move the latter toward and away from the magazine, and (e) first gearing responsive to rotation of said shaft and connected to turn said second crank through one revolution for each one-half revolution of said first crank so that said second crank is disposed in its first dead center position when said first crank is turned to its second dead center position, each of the cranks of the first drive mechanism being in corresponding first dead center positions when said transfer device engages the terminal carton in said magazine, and each of the cranks of the second drive mechanisms being in corresponding first dead center positions when said transfer device is in said transfer station.

11. The machine of claim 10 in which each of said drive mechanisms includes a third shaft journaled by the free end portion of said first crank and paralleling said first shaft, said second crank being rotatable with said third shaft, said first gearing comprising a first stationary sun gear rotatable relative to said first shaft, and each of said drive mechanisms including a planet gear coupled for rotation with said third shaft and meshing with and orbiting said first sun gear to revolve said second crank in response to rotation of said first crank, said second crank comprising a circular disc eccentrically mounted on and rotatable with said third shaft and engageable with said arm.