

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
13 October 2005 (13.10.2005)

PCT

(10) International Publication Number  
**WO 2005/094471 A2**

(51) International Patent Classification: **Not classified**

(21) International Application Number:  
PCT/US2005/009544

(22) International Filing Date: 23 March 2005 (23.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/555,762 24 March 2004 (24.03.2004) US

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(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,  
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,  
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,  
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,  
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,  
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,  
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ,  
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA,  
ZM, ZW.

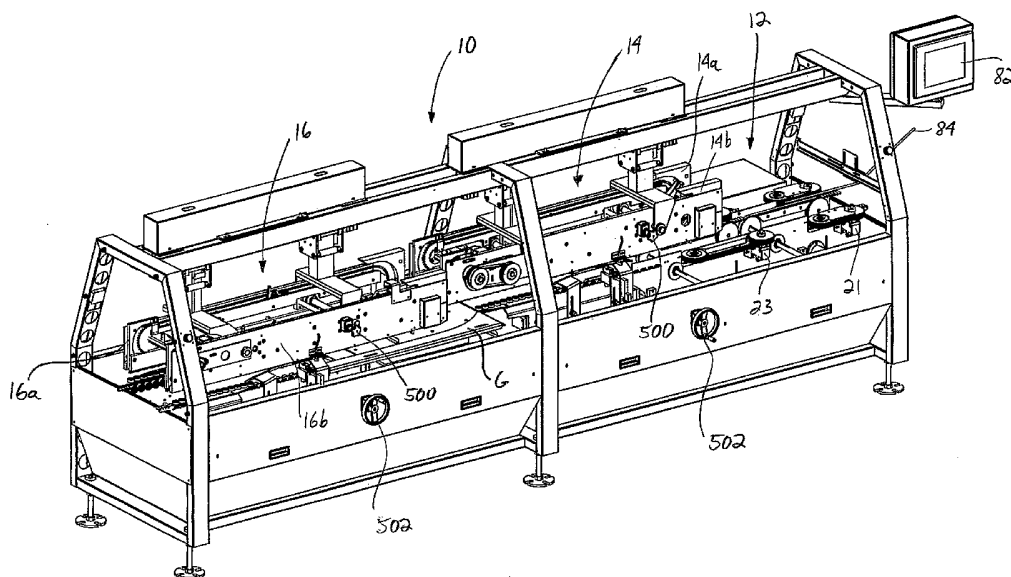
(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,  
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,  
FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,  
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,  
GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— without international search report and to be republished  
upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: IN-LINE CARTON FEEDING AND FORMING MACHINE AND RELATED METHODS



(57) Abstract: A machine feeds and completes a partially formed carton in a highly efficient and effective manner. In one embodiment, the machine includes an overhead conveyor with selectively actuated, depending lugs for engaging and conveying the carton while a first flap on a lid is folded and sealed. A turning mechanism includes a wheel with an outwardly projecting arm that effects turning of the carton about a vertical axis from a first orientation to a second orientation, such as through 90°. A takeaway conveyor conveys the reoriented carton while additional flaps on the lid are folded and sealed.

**IN-LINE CARTON FEEDING AND FORMING  
MACHINE AND RELATED METHODS**

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/555,762, the disclosure of which is incorporated herein by reference.

**Field of the Invention**

The present invention relates to carton handling and, more particularly, to a machine for feeding a partially formed and filled carton while closing one or more flaps to complete the carton.

**Background of the Invention**

Machines for feeding and completing partially formed and filled, top-loaded paperboard cartons are well known in the art. For many years, the most efficient approach for the high speed feeding and forming of such cartons, including closing the lid and sealing the corresponding flaps, was a continuous or in-line one. An early example of this approach is found in commonly owned U.S. Patent No. 3,267,637 to Baker, which is incorporated herein by reference.

The machine disclosed in the '637 patent uses fixedly mounted, upstanding lugs or "pushers" carried by spaced parallel chains to convey the carton. Specifically, after folding of the lid and pre-folding of the trailing end flap, the lugs push the carton along while folding and sealing of the front flap on the lid simultaneously occurs. Pushing from the trailing end of the carton advantageously helps to maintain the lid in the proper registration during folding and sealing of the front flap. To fold the opposite side flaps in an efficient manner, the carton with the folded and partially sealed lid is then turned about its vertical axis in a common or same plane while forward feeding continues. After turning, the carton is conveyed in-line by upstanding lugs of a downstream conveyor while the side flaps are sealed, thus completing the carton.

A more modern "lugless" example of the continuous carton forming approach is found in commonly assigned U.S. Patent No. 5,660,262 to Landrum et al., the disclosure of which is also incorporated herein by reference. In this approach, infeed belts frictionally engage the top and bottom surfaces of the carton for conveying while the front flap is sealed. This eliminates the need for pre-folding the trailing end flap to avoid damaging it, as is required when using upstanding lugs. After the front flap is sealed, the carton enters a zone including a plurality of spaced parallel belts running at different speeds that reorient it, such as with turning through 90° in the same plane. The turned carton is then received and conveyed by spaced belts while the opposite side flaps are folded

and sealed. The carton is thus formed in a continuous fashion without stopping or changing the conveying direction.

While these approaches enjoyed considerable commercial success, there are certain disadvantages. For instance, running plural spaced belts at different speeds to turn the carton during feeding increases the complexity of the machine. Coordinating fixed lugs among independent conveyors for moving the cartons along in the most efficient manner may also complicate the operation of the machine. Accordingly, a need exists for an improved carton feeding and forming machine that overcomes the foregoing limitations and others.

### **Summary of the Invention**

In accordance with one aspect of the invention, a machine for conveying a carton having a plurality of flaps along a path is disclosed. The machine comprises a first conveyor that conveys the carton in a first orientation along the path while a first flap is folded. At least one arm projecting into the path rotates to engage and positively turn the carton about a vertical axis to a second orientation. A second in-line conveyor receives and conveys the carton in the second orientation while a second flap is folded.

Preferably, the first and second conveyors are overhead conveyors, each having a pair of spaced chains carrying at least one selectively actuated pop-down lug for engaging and conveying the carton. The arm may be fixedly or pivotally mounted to an associated wheel mounted for rotation about the vertical axis. In the case of pivotal mounting, at least one, and preferably a pair of followers may be associated with the arm. Corresponding cam track(s) guide the follower(s) and thereby cause the arm to pivot and turn the carton from the first orientation to the second orientation as the wheel rotates. Preferably, the wheel rotates approximately  $120^\circ$  while the carton is engaged by the arm and reoriented approximately  $90^\circ$  in the same horizontal plane. At least one of the cam tracks is preferably arranged to cause the arm to withdraw from engagement with the carton upon reaching the second orientation.

In one embodiment, the arm associates with an epicyclic gear for engaging a stationary gear adjacent the wheel. The stationary gear includes a non-toothed region associated with a cam track for engaging a follower carried by the epicyclic gear. A single cam track causes the arm to engage and reorient the carton.

The machine may further include a variable speed drive or motive device for rotating the wheel at a continuous, but non-constant speed to accommodate variations in carton spacing. Preferably, the drive or motive device is a servomotor. In the usual case where the carton includes

three foldable flaps, a stationary plow adjacent the first conveyor folds the first flap, such as during conveyance. A stationary plow adjacent each side of the second conveyor then folds the second flap and a third flap. In both cases, the plows are preferably preceded by glue guns that apply an adhesive for sealing the corresponding flap once folded.

5 In accordance with another aspect of the invention, a turning mechanism for intended use in a machine for feeding a carton along a path is disclosed. The mechanism comprises a wheel rotatable about a vertical axis offset from the path and including at least one pivoting arm carrying at least one follower. A cam track adjacent the wheel is associated with the follower. As the wheel rotates, the cam and follower cause the arm to reorient the carton about the vertical axis.

10 In one embodiment, a pair of followers and a pair of associated cam tracks are provided adjacent the wheel for reorienting each arm. In another embodiment, a stationary gear adjacent the wheel engages an epicyclic gear associated with the arm along at least part of the rotation of the wheel. In such embodiment, the epicyclic gear carries the follower for engaging the cam track.

15 In accordance with still another aspect of the invention, a turning mechanism for intended use in a carton feeding and forming machine is disclosed. The mechanism comprises a rotatable wheel including at least one pivoting arm. A stationary gear adjacent the wheel engages an epicyclic gear along at least a portion thereof and causes the arm to engage and reorient the carton as the wheel rotates. Preferably, the epicyclic gear is associated with a gear assembly for causing the arm to pivot in a direction opposite the direction in which the wheel rotates during engagement with the stationary gear.

20 In accordance with still a further aspect of the invention, a machine for conveying a carton including a lid having a plurality of flaps along a path is disclosed. The machine comprises: (1) a first conveyor for conveying the carton in a first orientation along the path while a first flap is folded; (2) means for turning the carton to a second orientation; and (3) a second conveyor for conveying the carton in the second orientation while a second flap is folded.

25 In one embodiment, the turning means comprises a rotatable wheel including at least one arm for engaging and turning the carton to the second orientation. Preferably, the arm is associated with an epicyclic gear for engaging a stationary gear adjacent the rotatable wheel. The stationary gear may include a non-toothed region associated with a cam track for engaging a follower carried by the epicyclic gear. The engagement of the follower in the cam track causes the arm to engage and reorient the carton while the engagement between the stationary gear and the epicyclic gear causes the arm to withdraw from the carton in the second orientation and assume a position for engaging another carton in the first orientation.

In another embodiment, the arm is pivotally mounted and carries at least one follower. In such case, the turning means further includes a cam track adjacent the wheel for engaging the follower and causing the arm to engage and move the carton to the second orientation. More preferably, the arm carries a pair of followers, and the turning means further includes a pair of associated cam tracks adjacent the wheel, each for engaging one of the followers and causing the arm to engage and move the carton to the second orientation.

In accordance with yet a further aspect of the invention, a machine is disclosed for conveying a carton along a path. The machine comprises a first overhead conveyor for conveying the carton in a first orientation along the path. A turner turns the carton to a second orientation for conveyance by second overhead conveyor.

In one embodiment, each overhead conveyor includes a pair of spaced chains carrying at least one selectively actuated pop-down lug for engaging and conveying the carton. Stationary plows adjacent the conveyors fold one or more flaps associated with the carton during conveyance, while adjacent glue guns apply an adhesive for sealing these flap(s) once folded.

In accordance with still another aspect of the invention, a method of reorienting a carton along a conveying path is disclosed. The method comprises conveying the carton having a lid with at least three flaps in a first orientation along the path; folding and sealing a first flap of the carton; engaging the carton with at least one arm projecting outwardly from a rotatable turner for turning the carton about a vertical axis to a second orientation; conveying the carton in the second orientation; and folding and sealing a second flap of the carton. Preferably, the folding and sealing of the first flap is completed during conveying in the first orientation, and the folding and sealing of the second (and possibly third) flap is completed during conveying in the second orientation.

### **Brief Description of the Drawings**

Figure 1 is an overall perspective view of one embodiment of a carton forming and feeding machine forming one aspect of the invention;

Figure 2 is a rear view showing the main components of the machine of Figure 1;

Figure 3 is a side view of an overhead lug conveyor;

Figure 4a is a bottom perspective view of a pair of lugs for possible use with the conveyor of Figure 3;

Figure 4b is a partially schematic side view showing one possible manner of lug actuation;

Figure 4c is a side view similar to Figure 4b;

Figures 5a-5e are side views of a rotatable star wheel for assisting in folding a trailing edge

flap of a carton being conveyed by the machine;

Figure 5f shows the manner in which an actuated lug may be retracted;

Figures 6a-6e illustrate one exemplary embodiment of a carton turning or reorienting mechanism;

5        Figures 7a-7c illustrate another possible embodiment of a carton turning or reorienting mechanism;

Figures 8a-8c illustrate yet another possible embodiment of a carton turning or reorienting mechanism;

Figures 9a-9d show a possible mode of operation of the mechanism of Figures 8a-8c; and

10        Figure 10 shows still another possible embodiment of a carton turning or reorienting machine.

### **Description of the Invention**

15        Making reference now to Figure 1, an overall perspective view of an exemplary embodiment of the carton forming and feeding machine 10 forming one aspect of the present invention is shown. In the illustrated embodiment, and as perhaps best understood with combined reference to Figure 2, the machine 10 includes an infeed conveyor 12, a takeaway conveyor 16, and an intermediate conveyor 14 between the two conveyors 12, 16. These conveyors 12, 14, 16 are all "in-line" and thus together define a substantially horizontal conveying or flow path for objects being conveyed in  
20        a conveying direction.

25        The machine 10 of the present invention is particularly useful in a cartoning line for the top-loaded style of cartons C including at least two flaps. For example, the carton C may have a lid I or closure having a front flap  $F_1$  and generally opposed side flaps  $F_2$ ,  $F_3$  (see Figure 2) with hinges defined by score or fold lines K. A carton C of this type may be formed from a blank by an upstream forming apparatus (not shown, but see for example commonly assigned U.S. Patent No. 5,177,930 to Harston et al., the disclosure of which is incorporated herein by reference). In the typical arrangement, the carton C with the lid I in an open position is filled with product while traveling between the forming apparatus and the infeed conveyor 12 of the machine 10, which as outlined further below that completes the filled carton by folding and sealing the lid I.

30        As perhaps best shown in Figure 2, the infeed conveyor 12 in the illustrated embodiment includes a metering device at one end comprising one or more pairs of spaced belts 18. The preferable arrangement is to provide a pair of belts 18 along the side, as well as a pair of belts 18 along the bottom of the carton conveying path. These belts 18 may be independently supported by

first and second spaced frame members 19 of the machine 10, and serve to initially receive and engage the corresponding sides of the carton C. The belts 18 may be driven in an endless path over corresponding drive and idler pulleys (not numbered) by one or more variable speed drives (e.g., variable frequency drives (VFD) or motors 21.

5 In one anticipated arrangement, the feed of partially formed and filled cartons to the machine 10 is random. Belt conveyors 22 downstream of the infeed belts 18 then accelerate the randomly received cartons such that each travels at a known, substantially constant speed upon encountering the intermediate conveyor 14. As should be appreciated, this acceleration also helps to create a desirable minimum gap with the next-in-line carton (which gap may be made smaller than usual in  
10 the present machine 10, as will be understood from reviewing the remaining description). This set of belt conveyors 22 may be independently driven one or more motors 23 (which likewise may comprise a servomotor or variably frequency drive). The use of independent sets of motors 21, 23 of course allows for driving the belt conveyors 18, 22 at different speeds, as desired for a particular throughput or mode of operation. Regulation of the speed of the various motors and other aspects  
15 of the machine 10 may be effected by an onboard computer or like logic device programmed to serve as a controller.

With reference to Figure 3, one possible construction of the intermediate conveyor 14 for receiving the cartons from the infeed conveyor 12 and conveying them in or along a substantially horizontal path in a first direction is now described in detail. In the illustrated embodiment, the  
20 intermediate conveyor 14 is comprised of a pair of spaced, generally parallel lug conveyors 14a, 14b (front and rear when the machine 10 is in the orientation shown in Figure 1) that overlie and define a conveying path. As perhaps best shown in Figure 3, each lug conveyor 14a or 14b (only one conveyor 14a shown, but the other conveyor 14b may be substantially a mirror image of what is shown) includes a chain 30 driven in an endless path along a forward or lower run (action arrow L) and a return or upper run (action arrow U), with first and second transitions  $T_1$ ,  $T_2$  between the runs  
25 U, L. Each chain 30 carries a plurality of extensible lugs 32 that, as described in more detail below, may be selectively actuated from a retracted or normal position to a depending (or "pop-down") actuated position at a desired instant in time for engaging and conveying the partially folded and formed cartons received from the infeed conveyor 12.

30 More specifically describing the lug conveyors 14a, 14b, each includes a drive sprocket 34 for engaging and driving the corresponding chain 30 along an endless path defined by a guide track 36. Preferably, the sprocket 34 of each lug conveyor 14a, 14b is mounted on a common shaft 38 and gang-driven by a common motive device or third motor (not shown). Consequently, each chain 30

is moved along the endless path at substantially the same speed. The chains 30 may be conventional link chains, which may optionally include friction-reducing rollers.

With reference now to Figures 4a-4c, the manner in which selected lugs 32 associated with the chains 30 of the conveyors 14a, 14b are simultaneously pivoted or moved to the actuated or depending position (32') for engaging and conveying an object, such as a carton, is now described in detail. Turning first to the bottom perspective view of Figure 4a, each lug 32 is mounted to and carried by the chain 30 such that it is capable of pivoting movement. For example, a pair of pins 50a, 50b may extend transversely from the chain 30 at selected intervals. A first one of the pins 50a passes through a hole (not shown) formed at one end of the lug 32 and the second pin 50b passes through a generally arcuate slot 52 formed in the body of the lug 32. A removable locking retainer 54 holds a plate-like bearing 56 against the outer surface of the lug 32, and a corresponding elongated connector 58 is provided for interconnecting the links (not numbered) along the opposite side of the chain 30.

As a result of this arrangement of structures, each lug 32 may freely pivot or rotate about the pivot point P (clockwise in the view of Figure 4c; note action arrow Q) defined by the first pin 50a and travel along an arcuate path defined by the slot 52. Thus, a point on the surface of the lug 32 during pivoting is considered to follow an arcuate path. Preferably, when the lug 32 is in the retracted or "laid-back" position, as is the leading lug in Figure 4a, the pin 50a is at the lower end of the slot 52. In this position, a projecting pusher 60 of the lug 32 remains withdrawn from the adjacent path of conveyance (see Figure 3) such that it forms an acute angle with the horizontal plane. In contrast, when the lug 32 is in the actuated or depending position, like the trailing lug 32' in Figure 4a, the second pin 50b is at the opposite end of the slot 52. Consequently, the pusher 60 extends into the conveying path for engaging the carton, and is generally perpendicular to the horizontal plane.

In the illustrated embodiment, the lugs 32 are oriented such that, when the associated pusher 60 is in the actuated position, the generally planar engagement face 62 is presented for engaging and pushing the carton along a trailing end (which with the trailing end flap  $F_3$  in the folded condition is generally planar). However, as noted further in the description that follows, the lugs 32 could also be oriented such that the engagement face 62 of the pusher 60 contacts the carton along the leading end (and may thus be used to provide a squaring function as the carton is pushed along by either a belt conveyor or a bottom-running lug conveyor, or to hold the carton back while a pop-down lug is used to engage and fold an associated flap). A combination of the two approaches could also be used, either on the same conveyor in the case of lugs spaced far apart or different conveyors in the

case of overlapping lugs. In either case, the engagement face 62 is preferably perpendicular to the horizontal plane when the lug 32 is actuated.

With reference again to Figure 4a, each lug 32 includes a transversely extending projection or tab 66. Preferably, each tab 66 is specially contoured to include a first sloping or inclined leading face 66a for engaging a first surface of a diverter, such as a pivotally mounted finger 68. In the illustrated embodiment, the finger 68 is tapered and elongated in the conveying direction. The finger 68 may project from an elongated support structure 70 positioned adjacent to the conveyor 14a and, more particularly, along the lower run L thereof.

When in the home position as shown in Figure 4b, a first side of the finger 68 may engage the leading face 66a of the tab 66 extending from each lug 32. This guides it into engagement with a first surface 72a of a guide structure 72 supported by the support member 70 and also forming part of the diverter. As a result, the corresponding lug 32 is maintained in the retracted position as it travels along with the chain 30. In this position, the elongated pusher 60 is incapable of engaging a carton in the conveying path by virtue of the captured nature of the corresponding tab 66.

When actuation of a particular lug 32 is desired, such as for engaging a portion of a stationary or fleeting carton adjacent to the conveyor(s) 14a, 14b, the finger 68 is pivoted (counterclockwise in Figures 4b and 4c to position 68") to engage an different surface 66b of the corresponding tab 66. The pivoting movement may be provided by a corresponding motive device, such as a rotary solenoid 76, the actuation of which is controlled by the controller. Preferably, the pivoting is momentary and through a small angular range (e.g., a few degrees in the counterclockwise direction). As a result, only the transverse tab 66 of a single selected lug 32 is engaged but the projection of the next-in-line lug is not (even when the chains 30 are moving at high speeds; e.g., greater than 1 ft/s).

Initially, the engagement with the finger 68 in the actuated position causes the selected lug 32 to begin the pivoting sequence, such as by moving from a retracted position to approximately 10° pivoted (that is, the second pin 50b travels approximately 10° along the arc defined by the slot 52). The finger 68 when actuated guides the tab 66a into engagement with a second, adjacent engagement surface 72b at the upstream end of the guide structure 72, which is also considered to be located in or along the transition T<sub>1</sub> from the return run to the forward run. The portion of the engagement surface 72b at the upstream end of the guide structure 72 by the transition T<sub>1</sub> is curved or specially contoured such that the partially pivoted lug 32 moves to a more fully pivoted position (note phantom position 32" in Figure 4c) and ultimately to a fully pivoted position (position 32' in Figures 4b and 4c), with the elongated pusher 60 now fully depending and ready to engage a portion of a carton or other object on an adjacent support surface (such as a dead plate, a conveyor, a pair of

spaced guide rails, etc.). With the partial pivoting created by the engagement with the finger 68, the total range of movement of the lug 32 in the preferred embodiment is about  $60^\circ$  (which means that the slot 52 defines an arc of about the same angle). This actuation sequence performed along the transition  $T_1$  helps to reduce the amount of gap required between successive cartons. Positive engagement with the continuous guide surface 72b also ensures that the actuated lug 32' remains in position and prevents inadvertent retraction.

An optional guide structure 69 with a curved engagement face may also extend at least partially along the transition  $T_1$  from the return or upper run U to the forward or lower run L. The engagement between the tip of the pusher 60 and the curved face of this guide structure 69 helps to resist the centrifugal and gravitational forces that tend to rotate each lug 32 toward the infeed end as it moves through the transition  $T_1$ . This in turn helps to ensure that the transverse tab 66 remains in the desired position for engaging the corresponding surface of the finger 68 such that it reaches the desired surface 72a, 72b of the guide structure 72.

With reference back to Figure 3, the lug conveyors 14a or 14b used in the preferred embodiment of the machine 10 include closely spaced lugs 32. In the most preferred embodiment, the distance D from a point on any leading lug, such as the center, to the corresponding point on the next-adjacent trailing lug in the retracted or normal position (commonly referred to as the "pitch") is about 2.5 inches. In this embodiment, this distance D is less than the width of each lug in the conveying direction (such that about 4.8 lugs in the normal position are provided for each foot of chain 30). Consequently, the leading and trailing lugs 32 fully overlap with one another, even in the retracted normal condition. Preferably, the overlap occurs in the conveying direction (parallel to action arrow L in Figure 3) or a direction generally transverse to the conveying direction and the vertical direction (e.g., perpendicular to action arrow L and in the same horizontal plane), depending on the orientation of the lugs 32. In other words, a trailing part of each leading lug (such as the pusher 60) at least partially covers a leading part of each trailing lug, both along the upper and lower runs U, L.

This close spacing provides the lug conveyors 14a, 14b with the ability to vary the pitch of the actuated lugs 32'. Consequently, when the chains 30 move at high rates of speed, the lugs 32 are essentially infinitely actuatable at a desired instant in time at any location along the endless path where the diverter (finger 68) is positioned. By positioning the diverter at the transition  $T_1$  to the forward run, an adjacent carton may be engaged and conveyed at the point of introduction without the need for precisely timing the infeed to ensure that a smooth, uninterrupted operation is maintained. Even in the situation where the cartons are randomly fed, the ability to selectively

actuate the lugs (and thus vary the pitch of the actuated lugs on the chain 30) reduces the time between the carton reaching the position for conveyance and the actual engagement event. A significant increase in throughput is therefore possible with enhanced reliability. Advantageously, the use of pusher lugs 32 also avoids the possible skewing created when the carton is conveyed via frictional engagement with top and bottom-running belts.

One possible mode of operation of the machine 10 is to deliver the partially formed cartons to a stable support surface, such as a pair of spaced, elongated support rails (not shown) or closely spaced rollers 78 (see Figure 2), positioned adjacent to the intermediate conveyor 14 and along the conveying path. The carton may be introduced at a constant speed using the belts 22, with the leading end detected by adjacent position sensor (but which may comprise a photo-electric, through-beam type sensor with an opposed transmitter and receiver). Based on the known dimensions of the carton (which may be inputted by the operator to the controller via an interface such as a touch screen 82; see Figure 1), the known position of the leading end (as determined by sensor, which may generate a corresponding output signal), and the known speed of travel of the carton (as determined by the belts 22, and adjustable depending on the desired throughput), the finger 68 may be actuated at the desired instant in time such that a single lug 32 of each conveyor 14a, 14b assumes the actuated or depending position to engage and convey the carton. The selective actuation of the lugs by the finger 68 along the transition  $T_1$  ensures that only the selected lug is engaged just in time for engaging the carton (which is spaced from the next-in-line carton by the metering belts 18 and 22) in the desired fashion. The operation is thus smooth and efficient, which allows for an increase in throughput without a concomitant increase in downtime to clear deleterious jams.

In the typical arrangement, the partially formed and filled carton C is introduced to the machine 10 with the lid I or closure in an open state and the flaps unfolded, as shown in Figure 2. Consequently, as the carton enters the machine 10, the lid I must be moved toward the closed position in order to allow for the folding and sealing of the associated flaps. In one possible embodiment, and as perhaps best shown in Figure 1, the closing is accomplished by a static plow 84 for engaging the generally vertically oriented lid and automatically folding it as the carton approaches the intermediate conveyor 14. When the lid I is closed, a first side flap  $F_2$  of the carton remains unfolded along the leading end and the second side flap  $F_3$  remains unfolded along the trailing end. In this orientation, the front side flap  $F_1$  faces the front of the machine 10 as it appears in Figure 2. This is known as a "narrow end" leading configuration (that is, the narrower lateral side of the rectangular carton is the leading or front edge). However, it should be appreciated that the converse configuration may also be used in cartons where the side flaps are on the elongated sides

of the carton (although an adjustment in the spacing of the lug conveyors 14a, 14b may be necessary).

Engaging the carton with the trailing end flap  $F_3$  in the unfolded or open condition using lugs 32 is undesirable in most instances, since damage may result. To avoid this situation, the trailing end flap  $F_3$  of each carton introduced to the machine 10 may be at least partially pre-folded before being engaged by the lugs 32. In the illustrated embodiment, the pre-folding or partial closing of this flap  $F_3$  is accomplished using at least one rotatable "pre-folding" wheel 86 including one or more radially extending projections. The projections thus form fingers or paddles 88 adapted for engaging the trailing end flap  $F_3$  (Figures 5a-5e). The wheel 86 is preferably positioned between the lug conveyors 14a, 14b such that when it is rotated, a paddle 88 moves into engagement with the trailing end flap  $F_3$  to at least partially fold and close it prior to engagement with the selected lugs 32 in the actuated position. In the illustrated embodiment, the wheel 86 includes four paddles 88 (each with an optional transversely extending foot), and is thus intermittently rotated one quarter turn to cause the corresponding paddle 88a to advance into engagement with the trailing end flap  $F_3$ . The rotation may be effected by an onboard motive device, such as a motor. Suitable gearing (not shown) may also be used to ensure that a full or partial turn of the output shaft of the motor effects the desired amount of rotation in the wheel 86 for both folding the trailing end flap  $F_3$  and retracting the corresponding paddle 88a from the conveying path.

Thus, in another, more preferred mode of operation, as shown in the progressive views of Figures 5b-5e, the carton C is introduced to the intermediate conveyor 14 traveling at a generally constant and predictable speed as the result of the belts 22 (which as perhaps best shown in Figure 5a may extend at least partially beneath the adjacent overhead conveyor 14). As the carton C is conveyed along by the belts 22, the position of the leading end adjacent to the side flap  $F_2$  is detected using sensors, and the length in the conveying direction is known from the operator input. Consequently, the moment in time when the trailing end flap  $F_3$  is adjacent to the corresponding paddle 88a may be determined by the controller (which receives the output signal from the sensor used to actuate the wheel 86). Preceding or at that instant, the wheel 86 is rotated (note counterclockwise action arrow W) such that the next-in-line paddle 88a sweeps into the conveying path (Figure 5b) to engage and at least partially fold the trailing end flap  $F_3$  (Figure 5c).

At about the same instant in time, corresponding lugs 32 associated with the lug conveyors 14a, 14b are also selected for actuation by momentarily pivoting the fingers 68 associated with the lug conveyors 14a, 14b. The lugs 32 selected for actuation thus move into the conveying path slightly behind the at least partially folded trailing end flap  $F_3$  (Figure 5b). Preferably, the timing is

such that the lugs 32 catch up with the carton C to engage and convey it just as the trailing end flap  $F_3$  is partially folded (at which point the conveying influence of the belts 22 is no longer necessary). The lugs 32 may then, and possibly for only a brief instant in time, simultaneously engage the at least partially folded flap  $F_3$  with the paddle 88a and convey the carton along (and possibly complete the folding, depending on the timing). Eventually, the carton C advances to a point where the paddle 88a disengages from the trailing end flap  $F_3$  (Figure 5d).

Continued rotation of the pre-folding wheel 86 retracts or withdraws the paddle 88a from the conveying path to a position between the lug conveyors 14a, 14b (Figure 5e). Simultaneously, the next-in-line paddle 88b moves to a ready position for engaging the trailing end flap  $F_3$  on a next-in-line carton. In this particularly preferred embodiment, the combined use of the pre-folding wheel 86 and the selectively actuated, small pitch (overlapping) lugs 32 with the corresponding diverter (finger 68) positioned at the transition  $T_1$  advantageously provide for smooth, efficient, and reliable operation, even at high throughput speeds (e.g., 200-300 cartons per minute).

Turning back to Figure 2, as the carton is conveyed along by the depending lugs 32, the front or "broad" side flap  $F_1$  is folded and sealed. In the illustrated embodiment, an adhesive is applied to the sidewall of the carton using a gun 90 or like device positioned adjacent to the conveying path. A stationary plow 92 adjacent to and preferably protruding into the conveying path may engage the underside of this broad side flap  $F_1$  as the carton moves along. Next, a series of downstream compression discs or wheels 96 receive the folded flap  $F_1$  and apply gentle pressure. This helps to ensure that the adhesive sets such that a proper seal is formed and the lid is correctly registered. It should further be appreciated that, during this folding sequence, the engagement between the pushers 60 of the actuated lugs 32' and the trailing end of the carton C (see Figure 5f) helps to ensure that the lid I or closure remains properly registered. The positions of the adhesive gun 90, plow 92, and compression wheels 96 relative to the conveying path are preferably each vertically adjustable to accommodate cartons having different heights.

After the broad side flap  $F_1$  is folded and sealed, the depending or "pop-down" lugs 32 continue to push the carton along the guide rails or rollers 78 and eventually eject it from a discharge end of the intermediate conveyor 14 opposite the end associated with the infeed conveyor 12 (see Figure 5f). As disengagement occurs, the actuated lugs 32' may be automatically drawn out of the conveying path in a generally vertical direction as a result of the movement of the corresponding chain in the guide track 36 and the contour of the guide surface 72b at the opposite end of the support member 70. This disengagement allows the trailing end flap  $F_3$  to return to at least a partially unfolded position (which occurs naturally, since the carton was initially formed from a

generally planar blank including this flap).

More specifically describing the movement of the actuated lugs 32' at the discharge end of the intermediate conveyor 14, and with reference to Figure 5f, the guide structure 72 initially may continue to engage the transverse tab 66 of each lug 32. Toward the downstream end where the transition  $T_2$  to the return or upper run U begins, the guide structure 72 also includes a curved or contoured surface 72b for engaging the tab 66. The contour of this surface 72b and the contour of the guide track 36 for the chain 30 are such that the movement to the retracted position is made in a gradual fashion. Consequently, the pusher 60 of the actuated lug 32' remains in a ready position until withdrawn from the conveying path and does not interfere with the orientation of the squared carton (note phantom positions 33 and 33'). In other words, the pusher 60 is withdrawn from the actuated or operative position (corresponding to lug position 32') in a generally vertical direction, at least until it is away from the path of the squared carton.

Also noteworthy is the fact that the withdrawal of the lugs 32 and return to the retracted position are also accomplished in a passive manner. This avoids the need for pivot blocks or like structures that actively engage and "kick back" the actuated lugs. The potential for breakage is thus reduced and the service life increased.

The guide structure 72 ultimately terminates, which allows the corresponding actuated lug 32 to rotate toward the retracted or home position slightly (note position 33"), such that pin 50b engages the upper end of the slot 52. However, as the corresponding chain 30 is driven forward over the sprocket 34 and toward the return/upper run U, the lug 32 is then rotated or pivoted in the opposite direction as the result of the combined centrifugal and gravitational forces acting on it (see Figure 3). In terms of pivoting movement, the lug 32 ultimately comes to rest in the generally retracted or normal position, and remains in this position as the chain 30 is driven in an endless fashion until it is again selectively actuated by the diverter (e.g., finger 68).

Referring now back to Figure 2, upon being ejected from the intermediate conveyor 14 encounters a means or mechanism for reorienting or turning the carton about a generally vertical axis in the same or a common plane so that the other side flaps may be folded and sealed. The arrangement shown in Figure 2 comprises the carton reorienting and turning mechanism 300 illustrated in greater detail in Figures 8a-9d. However, the various embodiments outlined in the following description and shown in the accompanying figures could be substituted for mechanism 300. In each embodiment, support for the carton during reorientation may be provided by a stable support surface 99 adjacent to the mechanism, which may be passive or alternatively at least partially active (e.g., a powered roller bed or belt) to facilitate carton reorientation.

Turning first to the progressive plan views Figures 6a-6e, which are schematic in nature, one possible embodiment of a turning mechanism 100 for reorienting a carton is shown. This mechanism 100 also includes a rotating "turner" including a wheel 102 mounted offset from the conveying path and including at least one and preferably a plurality of arms 104a, 104b, 104c. These arms 104a, 104b, 104c are pivotally or rotatably mounted to the wheel 102, which in the illustrated embodiment comprises a ring-shaped periphery 102a attached to a Y-shaped hub 102b (but could also comprise a continuous disc-shaped structure or just a Y-shaped structure). The spatial orientation of this wheel 102 is generally the same as described above, with rotation in a generally horizontal plane (which may be aligned with the conveying plane) about a generally vertical axis. Again, the variable speed motive device or drive for effecting rotation is not shown, but may be in the form of a conventional servomotor, VFD, or the like. From this top plan view, the rotation is clockwise, as indicated by action arrow  $W_1$  and the carton flow is from right to left.

Optionally, each arm 104a, 104b, 104c may be generally L-shaped, with one end including a projection, such as a finger 106, and the other end including at least one follower 108. The follower 108 is positioned in and tracks an associated cam track 110, which may be formed in a plate or like structure positioned above the wheel 102. This generally ovate or elliptical, but somewhat irregular track 110 is offset or non-concentric relative to the axis of rotation of the wheel 102 and otherwise arranged such that, when a carton  $C_1$  reaches the phantom position  $P_1$  shown in Figures 6a and 6b, the leading or engagement face of the corresponding arm 104a, 104b, 104c is substantially aligned or "squared" with the backside face of a carton with the finger 106 positioned slightly behind the trailing end thereof. As will be understood upon reviewing the description that follows, this embodiment with one follower 108 associated with each arm 104a, 104b, 104c is less preferred because of the possibility of experiencing uncontrolled counter-rotation at two points along the corresponding track 110.

Continued rotation of the wheel 102 and the movement of the follower 108 in the track 110 typically causes the corresponding arm 104a to move into the conveying path while engaging the carton  $C_1$  at position  $P_1$  (which corresponds to the first orientation, which is with the "narrow" end or side leading) and begin turning or rotating it in a direction corresponding to a forward conveying direction. Ultimately, the carton  $C_1$  upon reaching the other position  $P_2$  is turned to a second, different orientation (which may be "broadside leading"). In this orientation, the opposed "narrow" sides of the carton  $C_1$  extend generally parallel to the conveying direction with the corresponding side flaps  $F_2$ ,  $F_3$  ready for folding and sealing (see Figure 2).

As can be appreciated from viewing Figures 6c, 6d, and 6e together, the arrangement is such

that from a time just before the arm 104a engages the carton  $C_1$  at position  $P_1$  to the time the reorientation is substantially complete, a substantially constant angle  $\alpha$  is maintained between a line  $L_1$  tangent to the pivot point of the arm 104a (which is orthogonal to a radial line  $L_3$ ) and a corresponding line  $L_2$  drawn generally parallel to the arm 104a itself. This angle  $\alpha$  (which in the illustrated embodiment is approximately  $40^\circ$ - $45^\circ$ ) helps to ensure that the reorientation is achieved in a highly efficient and effective manner (with the carton being reoriented in the same plane as the result of the wheel 102 turning through  $120^\circ$ ). The fixed nature of the angle  $\alpha$  also helps to ensure that the given starting point and ending point for the trailing corner of the carton  $C_1$  remains substantially the same, regardless of the carton length and width (as indicated by the smaller phantom depictions  $P_1'$  and  $P_2'$ ). This helps to eliminate the need for gross or significant operational adjustments to allow this machine 10 to accommodate cartons of different sizes.

Now describing one possible mode of operation, it should be appreciated that the three arms 104a, 104b, 104c are mounted approximately  $120^\circ$  apart along the ring-shaped periphery 102a. Thus, as perhaps best understood with reference to Figure 6d, when the first arm 104a associated with a first carton  $C_1$  is performing as described above, the second arm 104b is approaching or engaging the next-in-line or second carton  $C_2$  at position  $P_1$  to effect reorientation in the foregoing manner. Although not illustrated, while the second carton  $C_2$  is turning as a result of the engagement with the second arm 104b, it can be appreciated that the engagement between the follower 108 and the track 110 is such that the first arm 104a is being returned to a "squared" position for engaging a succeeding carton upon exiting the intermediate conveyor 14 and reaching position  $P_1$  (which occurs while the third arm 104c engaging and sweeping the preceding carton). The turning operation is then completed substantially as outlined in the foregoing description for this and each succeeding carton  $C_n$ .

As mentioned above, once turning is complete, it is desirable for the carton and the arm 104a, 104b, 104c to separate in order to prevent any damage or skewing from occurring as rotation of the wheel 102 continues. Rather than rapidly advancing the now-turned carton to the downstream conveyor (such as using a takeaway conveyor 16), the arrangement may be such that the engagement between the cam track 110 and the follower 108 of the associated arm 104a, 104b, 104c causes it to retract or withdraw from the backside face of the carton when at position  $P_2$  through continued rotation of the wheel 102 (note position of arm 104c in Figure 6c). This withdrawal lessens or eliminates the chance of further engagement between the now-turned, substantially squared carton and the associated arm 104a, 104b, 104c, even as rotation of the wheel 102 continues (such as for reorienting a succeeding carton  $C_2$ ; see below). Once separated from the arm 104a, 104b, 104c, the

turned carton is simply advanced downstream by or to the takeaway conveyor 16 (which as explained below may be an overhead conveyor with selectively actuated pop-down lugs) for further processing (e.g., closing of the opposed side flaps  $F_2$ ,  $F_3$ ).

Turning back to Figures 6b and 6d, when the cartons  $C_1$ ,  $C_2$  are regularly spaced (note spacing  $S_1$  and  $S_2$ , which may occur naturally or may be caused by the upstream conveyors 12, 14 or any other interposed speed control mechanism), the wheel 102 may rotate at a substantially constant angular velocity. In that situation, the operational sequence is substantially as described above and shown in Figures 6a-6e. However, a more likely situation is one in which a succeeding carton is not regularly spaced from the preceding carton, such as may result when the feed is random. To accommodate this situation (which may be detected using known types of position sensors or as the result of a prediction made based on the speed of the upstream conveyors), the angular velocity of the wheel 102 may be adjusted (but it usually never stopped and is thus continuous). In particular, when the trailing to leading edge spacing of cartons approaching the turning mechanism 100 is reduced, the angular velocity of the wheel 102 is increased, such as by increasing the speed of the associated variable speed drive or motive device.

This acceleration may cause the previous carton to reach position  $P_2$  earlier than in a mode of operation where the carton-to-carton spacing is substantially constant. Although this places the succeeding carton closer to the preceding carton, this may not be a concern in the illustrated embodiment because of the nature of the takeaway conveyor 16 (which as discussed below is overhead with closely spaced, selectively actuated, pop-down lugs). If it does present a problem, an adjustment can easily be made during the subsequent or downstream conveying operation to achieve any spacing desired or necessary for a downstream operation, such as closing of the side flaps, labeling, printing, sealing, packaging, etc., or by using powered rollers, acceleration belts, or the like to augment the separation distance.

If the next-in-line carton is spaced differently from the preceding one, the angular velocity of the wheel 102 may again be adjusted as necessary to ensure the most efficient and effective operational sequence results. As should be appreciated, continuous adjustments may be necessary, such as if the carton feed is random. Likewise, the operation may approach or achieve a steady state in the event the sequential feed of cartons is regularly spaced.

Another embodiment of a carton reorienting or turning mechanism 200 is shown in Figures 7a-7c. Generally speaking, this mechanism 200 functions in a manner similar to the one described above, with a turner including a rotating wheel 202 mounted offset from the conveying path with one or more, and preferably three pivotally mounted arms 204a, 204b, 204c. However, this embodiment

is preferred and offers more reliable operation, since each arm 204a, 204b, 204c associates with a pair of followers 208a, 208b (shown for the first arm 204a only). In particular, the first follower 208a lies at one end of the first arm 204a, substantially as described above, while the second follower 208b lies on an extension of this arm in a different horizontal plane (see Figure 7b). Each arm 204a, 204b, 204c may include a finger (not shown) for preventing the associated carton from moving in the radial direction during reorientation, or alternatively, an adjacent guide structure may be used (not shown, but see Figures 9a-9d).

Still referring to the first arm 204a, the associated first follower 208a associates with a first cam track 210a and the second follower 208b associates with a second cam track 210b. Both tracks 210a, 210b are generally elliptical or oblong, but irregular in shape and optionally segmented, as illustrated. In the embodiment illustrated in Figures 7b and 7c, one track 210a exists in a first structure, such as a plate 212a, positioned along one side face of the wheel 202, and the other track 210b, exists in a second, different structure, such as a plate 212b, positioned along the other side face of the wheel 202. These plates 212a, 212b are above and below the wheel 202, respectively, when it is oriented with the axis of rotation Z generally perpendicular to a horizontal plane or the plane of the conveying path (which may coincide) corresponding to orthogonal axes X, Y.

As the wheel 202 is thus rotated by a motor M, which again may be a variable speed drive or like motive device, each arm 204a, 204b, 204c essentially moves through a similar sequence of positions as the arm 104 in the above-described mechanism 100. For example, starting with the position shown in Figure 7a, the first arm 204a as a result of the movement of follower 208b in cam track 210b aligns with the backside face of the carton for engaging it upon delivery from an upstream conveyor, typically in a narrow-end leading configuration after having the front broadside flap folded and sealed upstream. As the associated wheel 202 rotates, the second follower 208a eventually engages the upper track 210a between the first two nodes  $N_1$ ,  $N_2$  and causes this arm 204a to engage and turn the carton through  $90^\circ$ , with the follower 208b essentially uncaptured between the corresponding nodes  $N_1$ ,  $N_2$ . This portion of the upper track 210a thus "controls" the movement or pivoting of the arm 204a during this portion of the rotation of wheel 202.

Approaching the second node  $N_2$ , the upper track 210a through engagement with the first follower 208a and continued rotation of the wheel 202, causes the arm 204a to withdraw from the carton once it squarely reaches the reoriented release position so as to avoid creating interference. The first follower 208a is then released when the second node  $N_2$  is reached, and the other follower 208b simply follows the corresponding track 210b between nodes  $N_2$  and  $N_3$ .

At the third node  $N_3$ , the upper track 210a again takes precedence and, through engagement

with the first follower 208a, causes the arm 204a to commence repositioning itself for starting over again. The other follower 208b may simply ride along with the arm 204a between nodes  $N_3$  and  $N_4$ .

Finally, in moving from the fourth node  $N_4$  back to the first node  $N_1$ , the second follower 208b primarily engages the second track 210b. The contour or shape of this portion of the second track 210b causes the arm 204a to assume the orientation shown in Figure 7a. In this position, the arm 204a is thus ready for engaging the backside face of the carton to effect turning through  $90^\circ$ .

Yet another embodiment of a turning mechanism 300 is shown in Figures 2 and 8a-8b. This embodiment 300 includes the common features of a rotating wheel 302 mounted for rotation about an axis Z generally perpendicular to the horizontal plane and offset from the conveying path. The wheel 302 carries one or more arms 304 (preferably three arms 304a, 304b, 304c) capable of moving or pivoting to and fro in a plane corresponding to the path of carton conveyance as the wheel rotates (e.g., the horizontal plane). A motor M associated with the wheel 302 effects rotation thereof at a variable speed and preferably in a clockwise direction (note arrow  $W_1$ ).

As the associated turner wheel 302 rotates, relative movement of each arm 304 is controlled in this embodiment using a series of gears forming an actuating means. In the illustrated embodiment, this actuating means includes a stationary "sun" gear 308 about which the wheel 302 rotates and an associated gear assembly 310. The stationary gear 308 is fixed against rotation, or stationary, and includes a "non-spurred" region 308a that lacks teeth or like engagement structures.

The wheel 302 carries the gear assembly 310 associated with each arm 304, which includes a first epicyclic planetary gear 310a. This gear 310a engages the stationary sun gear 308 along the toothed region during rotation of the wheel 302. This first gear 310a is gang-mounted on a rotatable shaft 312 with a second gear 310b. In turn, the second gear 310b meshes with a third gear 310c associated with a shaft 314 to which the arm 304 is fixedly mounted (such as by a clamp or like fastener). Both shafts 312, 314 may be rotatably supported by the wheel 302, with one being positioned radially inwardly relative to the other in the illustrated embodiment. A top bearing plate 315 may also be provided, through which the ends of the shafts 312, 314 may be journaled (in which case, each arm 304a, 304b, 304c may include a corresponding notch 305 to accommodate the projecting end of shaft 312).

In this embodiment, the first gear 310a is adjacent the backside of the wheel 302 and is sandwiched between it and a corresponding structure such as a backplate 316. This backplate 316 includes a cam track 318 associated with a follower 320 (see Figures 8b and 8c) carried by the first gear 310a. The cam track 318 is generally C-shaped in plan view, but irregular in shape. The plate 316 and cam track 318 are generally positioned adjacent to the non-toothed region 308a.

Referring now to the progressive top plan views of Figures 9a-9d, operation of the turning mechanism 300 of this embodiment is now described. In this embodiment, the wheel 302 (which includes an optional Y-shaped hub and ring-shaped periphery, as can be seen with the bearing plate 315 removed) includes three pivoting arms 304a, 304b, and 304c, each mounted approximately 120° from the other and rotatably mounted along the periphery. Taking arm 304a as a first reference point, it approaches carton  $C_1$  introduced from an upstream conveyor, such as intermediate lug conveyor 14 in a narrow-end leading configuration. In this position, the associated first gear 310a disengages from the toothed portion of gear 308 and is thus adjacent to the non-toothed region 308a.

As perhaps best understood with reference to Figure 9b, the follower 320 is adjacent the entrance of the cam track 318, which is initially designed or contoured such that the first gear 310a rotates clockwise slightly (i.e., in the direction of action arrow  $W_2$  in Figure 9a). This causes the associated gang-mounted second gear 310b to rotate in a similar fashion, which in turn causes the third gear 310c to rotate counterclockwise (i.e., in the direction of action arrow  $W_3$ ). As a result of the relative positioning of the arm 304a, the face thereof becomes aligned or squared with the backside vertical face of the corresponding carton  $C_1$  (compare Figures 9a and 9b).

Figure 9b illustrates the continued movement of the follower 320 through the track 318 in a manner such that the relative angle  $\alpha$  between a line  $L_1$  drawn tangent to an imaginary circular path of travel corresponding to the shaft 314 and a line  $L_2$  parallel to the axis of elongation of the arm 304a remains substantially constant (at about 90°) as rotation of the wheel 302 continues. Eventually, this rotation of the wheel 302 causes the arm 304a to rotate about the axis Z. However, the first gear 310a does not substantially rotate (which means that the shaft 312 does not substantially rotate, either). This combined movement not only moves the carton from the infeed position  $P_1$  to the outfeed position  $P_2$ , but also rotates it through 90° as the wheel 302 turns. The cam track 318 thus essentially limits or controls the ability of the epicyclic first gear 310a to rotate about its own axis while fixing the relative position of the corresponding arm 304a, at least until a certain point along the path of travel is reached.

During the reorientation of the carton  $C_1$ , an adjacent guide structure G may be provided as part of the reorienting means of this or the other embodiments (specifically if the arm lack fingers or the like). As should be appreciated, this guide structure G is specially contoured or designed to maintain the carton  $C_1$  in position and prevent it from moving radially to any significant degree during reorientation. Once turned, the guide structure G also helps to keep each carton square as it is taken away, such as by overhead conveyor 16. Preferably, the guide structure G is positioned relatively close to the support surface 99 so as to engage the carton C but not engage or interfere with

the trailing edge flap during reorientation.

As the follower 320 exits the track 318, and as perhaps best understood with reference Figures 9b and 9c and the second arm 304b associated with an upstream carton  $C_2$ , the wheel 302 continues to rotate. Consequently, the arm 304b is withdrawn in a direction generally perpendicular to the conveying direction. At the same time or slightly later, the first gear 310a engages or meshes with the teeth on the stationary gear 308, which causes it to rotate clockwise in a continuous fashion. Consequently, the associated third gear 310c rotates in the opposite, or counterclockwise, direction such that the arm (see arm 304b) continues to be moved away from the carton  $C_2$  as rotation of the wheel 302 continues.

As a result of this continuous rotation, the follower 320 ultimately reaches the entrance of the track 318 with the arm 304a substantially in position for engaging the backside vertical face of a next-in-line carton, substantially as is shown in Figure 9a. At or near that point, the first gear 310a moves out of contact with the teeth on the stationary gear 308 and adjacent to the non-toothed region 308a such that the "attack" angle of the arm 304a is fixed while rotation of the wheel 302 continues. The same sequence of events occurs with respect to the other arms 304b, 304c as well, with each 120° of rotation of the wheel 302 turning a single carton through 90° and thus provides the desired reorientation in the same plane.

As with the embodiments described above, this one is also well-suited for accommodating a sequential feed of regularly or randomly spaced cartons. In particular, the wheel 302 may be rotated by a variable speed drive that may accelerate or decelerate as necessary for the next-in-line arm 304a, 304b, 304c to reach a corresponding carton at the infeed position (which may be sensed or detected) without the need for delays or for retarding or accelerating the infeed. When used in such a manner, the past requirement of precisely timing the carton feed to ensure efficient operation of the cartoning machine may be eliminated.

With reference back to Figure 2, it is also noted that in the illustrated embodiment, the bearing plate 315 also forms part of the carton conveying surface 99. Thus, as the wheel 302 rotates, this surface helps in supporting the carton as the desired reorientation is achieved. Although entirely optional, this feature may thus also be considered to form part of yet another carton turning means.

The final and perhaps simplest example of a turning mechanism for possible use in combination with a carton feeding and forming machine 10 is the one shown in Figure 10 and identified by reference numeral 400. This mechanism 400 includes a "star" turner wheel 402 having one or more fixed, radially extending projections or arms 404 spaced 90° from each other. Each arm 404 may include a circumferentially extending projection or finger 406, or alternatively an adjacent

guide structure may be used to constrain carton movement in the radial direction. The wheel 402 is oriented with its axis of rotation generally perpendicular to a horizontal plane or the plane of a roller bed forming the support surface 99, and is associated with a variable speed motive device or drive, such as a servo motor (not shown).

5 In operation, the wheel 402 is thus rotated such that one of the arms 404 engages a backside face of the carton C and moves it from a first orientation to a second orientation, such as by turning it 90° in the same plane about a vertical axis. In particular, when the feed of the cartons C is timed, the wheel 402 is turned at a substantially constant angular speed such that the next-in-line arm 404 engages the next carton exiting the intermediate conveyor 14 (with its front flap F<sub>1</sub> sealed as the  
10 result of upstream processing) onto the roller bed forming the support surface 99. The finger 406 engages the narrow side of the carton C formerly qualifying as the trailing side during upstream conveyance with the unfolded trailing end side flap F<sub>3</sub> (which usually pops-up to an unfolded condition upon separating from the lugs 32 of conveyors 14a, 14b). This engagement helps to prevent the carton C from escaping in the radial direction as it is turned, but an adjacent guard  
15 structure (not shown) may be used instead.

In any of the foregoing embodiments, once the carton is reoriented, it is preferably actively separated from the associated arm 104, 204, 304, 404. This active separation may be achieved using conveying means, such as the takeaway conveyor 16 (which as described below may be overhead and include pop-down lugs for engaging the carton and conveying it forward to achieve this desired  
20 separation). Preferably, the advancement is to a downstream position such that the arm 404 then continues to sweep over the adjacent support surface without engaging the carton (e.g., carton C' in Figure 2) and potentially causing skewing or damage.

Downstream of the selected embodiment of the turning mechanism 100, 200, 300, 400 the takeaway conveyor 16 is generally oriented in-line with the intermediate conveyor 14. In one  
25 embodiment, the takeaway conveyor comprises a pair of spaced, generally parallel overhead conveyors 16a, 16b (see Figure 2). Similar to the lug conveyors 14a, 14b of the intermediate conveyor 14, each lug conveyor 16a, 16b may include an endless chain driven along a guide track by a sprocket associated with motor. The chain of each conveyor carries a plurality of closely-spaced selectively actuatable lugs, which may be essentially identical to the lugs 32 used in the intermediate  
30 conveyor 14 and thus are pivotally connected to the chain and selectively actuated for engaging and conveying the squared carton away from position P<sub>2</sub> (or a downstream position resulting from the advancement of the carton from this position using a bottom-running conveyor (e.g., driven rollers)). Preferably, the actuation is simultaneous such that the lugs 32 keep the carton squared (that is, with

the narrow sides generally parallel to the conveying direction).

During conveyance along the takeaway conveyor 16 by the lugs when actuated (with support for the carton in the illustrated embodiment being provided by rollers 78 as the support surface, which is in turn supported by frame members 19), the side flaps are folded and sealed. As perhaps  
5 best understood with reference in Figure 2, an adhesive may be simultaneously applied to each side of the carton by a pair of spaced guns 190, and the narrow side flaps  $F_2$ ,  $F_3$  then pass a stationary plow 192. The folded side flaps  $F_2$ ,  $F_3$  are each engaged by serially arranged discs 194 positioned adjacent to the conveying path. These discs 194 provide a slight compressive force and ensure a proper seal is formed as the adhesive sets. The glue gun 190, plow 192, and discs 194 may be  
10 supported by mounts including quick-release handles to facilitate manual height adjustment.

In a preferred embodiment, the lugs of the takeaway conveyor 16 are withdrawn from the conveying path in the vertical direction while the carton is engaged by the discs 194. As a result, the carton is not actively ejected from the takeaway conveyor 16 by the lugs. Instead, the engagement with the next-in-line completed carton serves to engage and eject the previously completed carton  
15 from the takeaway conveyor 16 (such as onto another conveyor; not shown). This vertical withdrawal prevents the lugs from inadvertently damaging the cartons, which are merely ejected as a result of the slight push forward provided by the engagement by the next-in-line completed carton. As should be appreciated, the use of selectively actuated lugs allows for the machine 10 in the preferred embodiment to be readily adapted for use with cartons having different lengths in the conveying direction. In the preferred embodiment, the infeed conveyor 12, intermediate conveyor  
20 14, and takeaway conveyors 16 are each independently adjustable to accommodate cartons of varying widths. For example, the intermediate 14 and takeaway conveyors 16 may be provided with means 500 for adjusting the spacing of the associated lug conveyors, such as conveyors 14a, 14b. To avoid the need for adjusting the position of the corresponding motors, the output shafts may be telescopingly connected to the drive shafts associated with the corresponding sprockets via splined  
25 interface. Instead of manually operated jack screws, automated linear actuators or ball screws may also be used for adjusting the spacing of the lug conveyors 14a, 14b to accommodate the cartons (in which case the adjustments could also be made automatically based on operator input via touch screen 82). Means, such as handwheels 502 associated with jackscrews, may also be provided for  
30 adjusting one or both of the frame members 19 to vary the width of the conveying path.

It is also possible to provide a similar motive device (e.g., linear actuator or jack screw) for adjusting the vertical position of the overhead lug conveyors 14a, 14b relative to the support surface, such as guide rails or rollers 78, to accommodate cartons having increased heights. The range of

adjustment in the machine of the preferred embodiment may be limited by the fact that the lugs 32 are of fixed length. To avoid this, it may be possible to use lugs that, in the extended condition, extend through the space provided between the guide rails or rollers 78. A significant height adjustment to the conveyor 14 could then be made.

5           The foregoing description has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Although the use of static folding structures (e.g., plows and wheels) is preferred for sake of simplicity, the use of other means for folding/sealing is possible. For example, movable devices (e.g., extensible fingers) could be used for folding the side flaps  $F_1$ ,  $F_2$ ,  $F_3$  as the carton is conveyed along. Instead  
10 of using a glue gun, cartons with pre-applied, heat-activated adhesives or coatings could also be used (in which case the "gun" would instead supply focused, heated air to activate the adhesive or coating in advance of the folding of the corresponding flap). Also, instead of using lug conveyors, belt conveyors could be used to deliver the cartons to the turner mechanism, as well as to take the cartons away once turning is complete (see, e.g., U.S. Patent No. 5,660,262); provided, any resulting mis-  
15 registration of the flaps during folding and sealing is acceptable or otherwise kept in check. Instead of providing three arms mounted  $120^\circ$  apart, the turning mechanism could include only one arm or two arms (which may be spaced apart any distance as long as they do not interfere with each other). Also, more than three arms could be provided (e.g., four arms spaced  $90^\circ$  apart), again with any spacing as long as no interference results. The embodiments described to provide an illustration of  
20 the inventive principles and the practical application thereof sufficient to enable one of ordinary skill in the art to utilize them in various other embodiments and with various modifications, as are suited to the particular use contemplated.

**In the Claims**

1. A machine for conveying a carton having a plurality of flaps along a path, comprising:  
a first conveyor for conveying the carton in a first orientation along the path while  
a first flap is folded and sealed;  
a rotatable arm projecting into the path for engaging and positively turning the carton  
5 about a vertical axis to a second orientation; and  
a second in-line conveyor for receiving and conveying the carton in the second  
orientation along the path while a second flap is folded and sealed.
2. The machine according to claim 1, wherein the first and second conveyors are  
overhead conveyors, each including a pair of spaced chains carrying at least one selectively actuated  
pop-down lug for engaging and conveying the carton.
3. The machine according to claim 1, further including a wheel to which the arm is  
fixedly mounted.
4. The machine according to claim 1, further including a wheel to which the arm is  
pivotally mounted.
5. The machine according to claim 4, further including at least one follower associated  
with the arm and a corresponding cam track for guiding the follower and causing the arm to pivot  
and turn the carton from the first orientation to the second orientation as the wheel rotates.
6. The machine according to claim 5, wherein the wheel rotates approximately 120°  
while the carton is engaged by the arm and reoriented approximately 90°.
7. The machine according to claim 4, further including a pair of followers associated  
with the arm and a pair of corresponding cam tracks for guiding the followers and causing the arm  
to pivot.
8. The machine according to claim 5, wherein the at least one cam track is arranged to  
cause the arm to withdraw from engagement with the carton upon or after reaching the second  
orientation.

9. The machine according to claim 4, wherein the arm associates with an epicyclic gear for engaging a stationary gear adjacent the wheel.

10. The machine according to claim 9, wherein the stationary gear includes a non-toothed region associated with a cam track for engaging a follower carried by the epicyclic gear, wherein the cam track causes the arm to engage and reorient the carton.

11. The machine according to claim 1, wherein the arm includes a finger for engaging a narrow side of the carton during reorientation.

12. The machine according to claim 1, further including three arms mounted approximately 120° apart.

13. The machine according to claim 4, wherein the wheel includes a surface forming part of the conveying path for the carton.

14. The machine according to claim 1, further including a variable speed drive or motive device for rotating the arm at a continuous, but non-constant speed to accommodate variations in carton spacing.

15. The machine according to claim 14, wherein the drive or motive device is a servomotor.

16. The machine according to claim 1, further including a stationary plow adjacent the first conveyor for folding the first flap.

17. The machine according to claim 1, further including a stationary plow adjacent each side of the second conveyor for folding the second flap and a third flap.

18. The machine according to claim 1, further including a first glue gun positioned adjacent to the first conveyor for applying an adhesive for sealing the first flap.

19. The machine according to claim 1, further including a glue gun positioned adjacent

each side of the second conveyor for applying an adhesive for sealing the second and a third flap.

20. A turning mechanism for intended use in a machine for feeding a carton along a path, comprising:

a wheel rotatable about a vertical axis offset from the path and including at least one pivoting arm carrying at least one follower; and

5 a cam track adjacent the wheel and associated with the follower for causing the arm to reorient the carton about the vertical axis as the wheel rotates.

21. The mechanism according to claim 20, further including a pair of followers and a pair of associated cam tracks adjacent the wheel.

22. The mechanism according to claim 20, further including a stationary gear adjacent the wheel and an epicyclic gear associated with the arm and mounted for engaging the stationary gear along at least part of the rotation of the wheel, wherein the epicyclic gear carries the follower for engaging the cam track. and associates with a gear assembly for causing the arm to pivot in a  
5 direction opposite the direction in which the wheel rotates during engagement with the stationary gear.

23. A turning mechanism for intended use in a carton feeding and forming machine, comprising:

a rotatable wheel including at least one pivoting arm;

a stationary gear adjacent the wheel; and

5 an epicyclic gear for engaging the stationary gear along at least a portion thereof and causing the arm to engage and reorient the carton as the wheel rotates.

24. The mechanism according to claim 23, wherein the stationary gear includes a non-toothed region associated with a cam track adjacent thereto for engaging a follower carried by the epicyclic gear.

25. The mechanism according to claim 23, wherein the epicyclic gear is associated with a gear assembly for causing the arm to pivot in a direction opposite the direction in which the wheel rotates during engagement with the stationary gear.

26. A machine for conveying a carton including a lid having a plurality of flaps along a path, comprising:

a first conveyor for conveying the carton in a first orientation along the path while a first flap is folded;

5 means for turning the carton to a second orientation; and

a second conveyor for conveying the carton in the second orientation while a second flap is folded.

27. The machine according to claim 26, wherein the turning means comprises a rotatable wheel including at least one arm for engaging and turning the carton to the second orientation.

28. The machine according to claim 27, wherein the arm is associated with an epicyclic gear for engaging a stationary gear adjacent the rotatable wheel.

29. The machine according to claim 28, wherein the stationary gear includes a non-toothed region associated with a cam track for engaging a follower carried by the epicyclic gear, wherein the engagement of the follower in the cam track causes the arm to engage and reorient the carton while the engagement between the stationary gear and the epicyclic gear causes the arm to  
5 withdraw from the carton in the second orientation and assume a position for engaging another carton in the first orientation.

30. The machine according to claim 29, wherein the epicyclic gear is associated with a gear assembly for causing withdrawal of the arm from the carton, including by pivoting in a direction opposite the direction in which the wheel rotates during engagement with the stationary gear.

31. The machine according to claim 27, wherein the arm is pivotally mounted and carries a pair of followers, and the turning means further includes a pair of associated cam tracks adjacent the wheel, each for engaging one of the followers and causing the arm to engage and move the carton to the second orientation.

32. The machine according to claim 27, wherein the wheel includes a plurality of pivotally mounted arms.

33. The machine according to claim 27, wherein the wheel includes a surface forming part of the conveying path for the carton.

34. A machine for conveying a carton along a path, comprising:  
a first overhead conveyor for conveying the carton in a first orientation along the path;  
a turner for turning the carton to a second orientation; and  
a second overhead conveyor for conveying the carton in the second orientation.

35. The machine according to claim 34, wherein each overhead conveyor includes a pair of spaced chains carrying at least one selectively actuated pop-down lug for engaging and conveying the carton.

36. The machine according to claim 35, further including a stationary plow adjacent the first conveyor for folding a first flap associated with a lid of the carton.

37. The machine according to claim 35, further including a stationary plow adjacent each side of the second conveyor for folding second and third flaps associated with a lid of the carton.

38. The machine according to claim 36, further including a first glue gun positioned adjacent to the first conveyor for applying an adhesive for sealing the first flap once folded.

39. The machine according to claim 37, further including a glue gun positioned adjacent each side of the second conveyor for applying an adhesive for sealing the second and third flaps once folded.

40. A method of reorienting a carton having a plurality of flaps along a conveying path, comprising:

conveying the carton in a first orientation along the path;

folding and sealing a first flap of the carton;

engaging the carton with at least one arm projecting into the path for turning the

carton about a vertical axis to a second orientation;  
conveying the carton in the second orientation; and  
folding and sealing a second flap of the carton.

41. The method of claim 40, wherein the step of folding and sealing the first flap on the carton occurs during the conveying in the first orientation.

42. The method of claim 40, wherein the step of folding and sealing the second flap on the carton occurs during the conveying in the second orientation.

43. The method of claim 40, further including the step of folding and sealing a third flap during the conveying in the second orientation.

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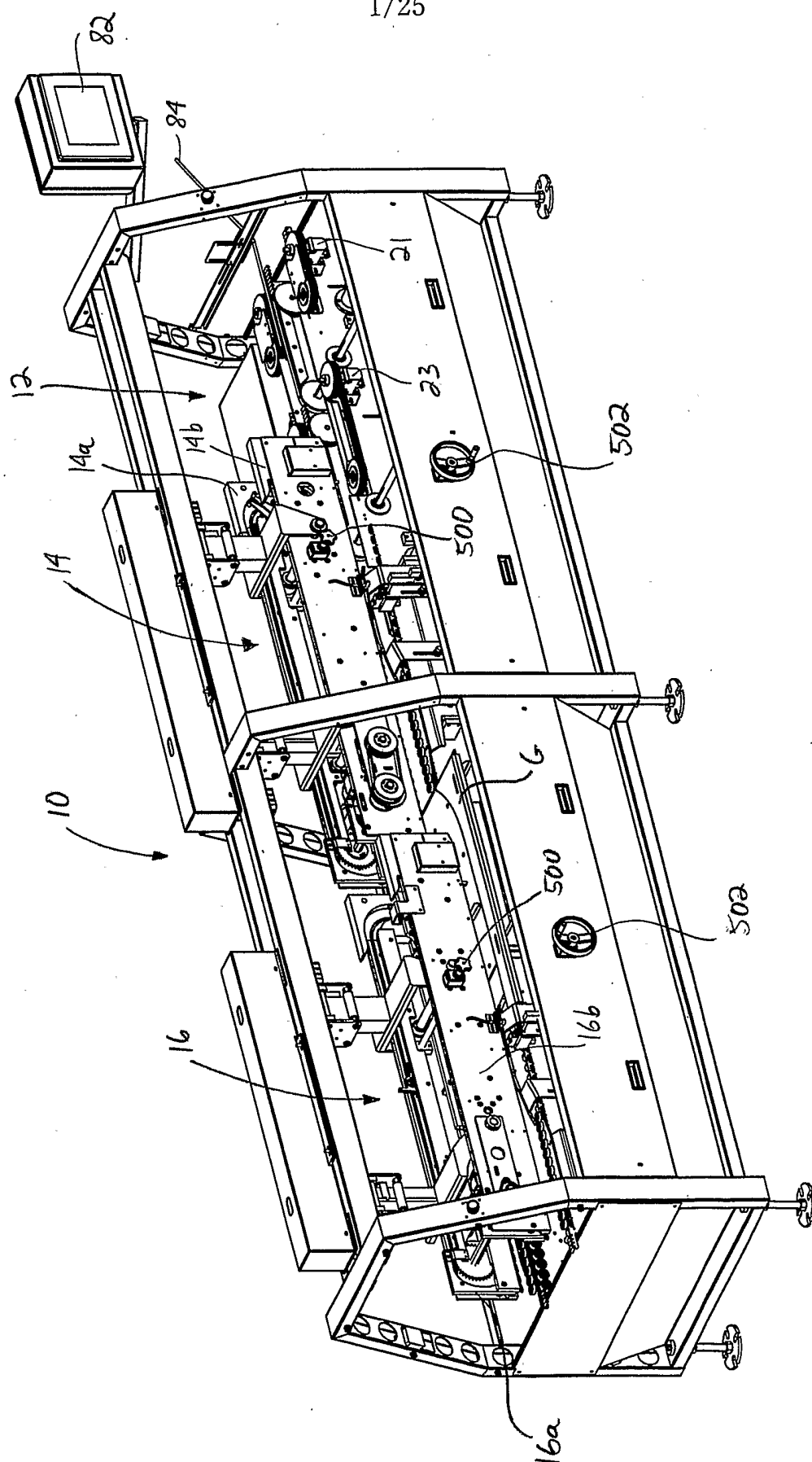


**Fig. 1**

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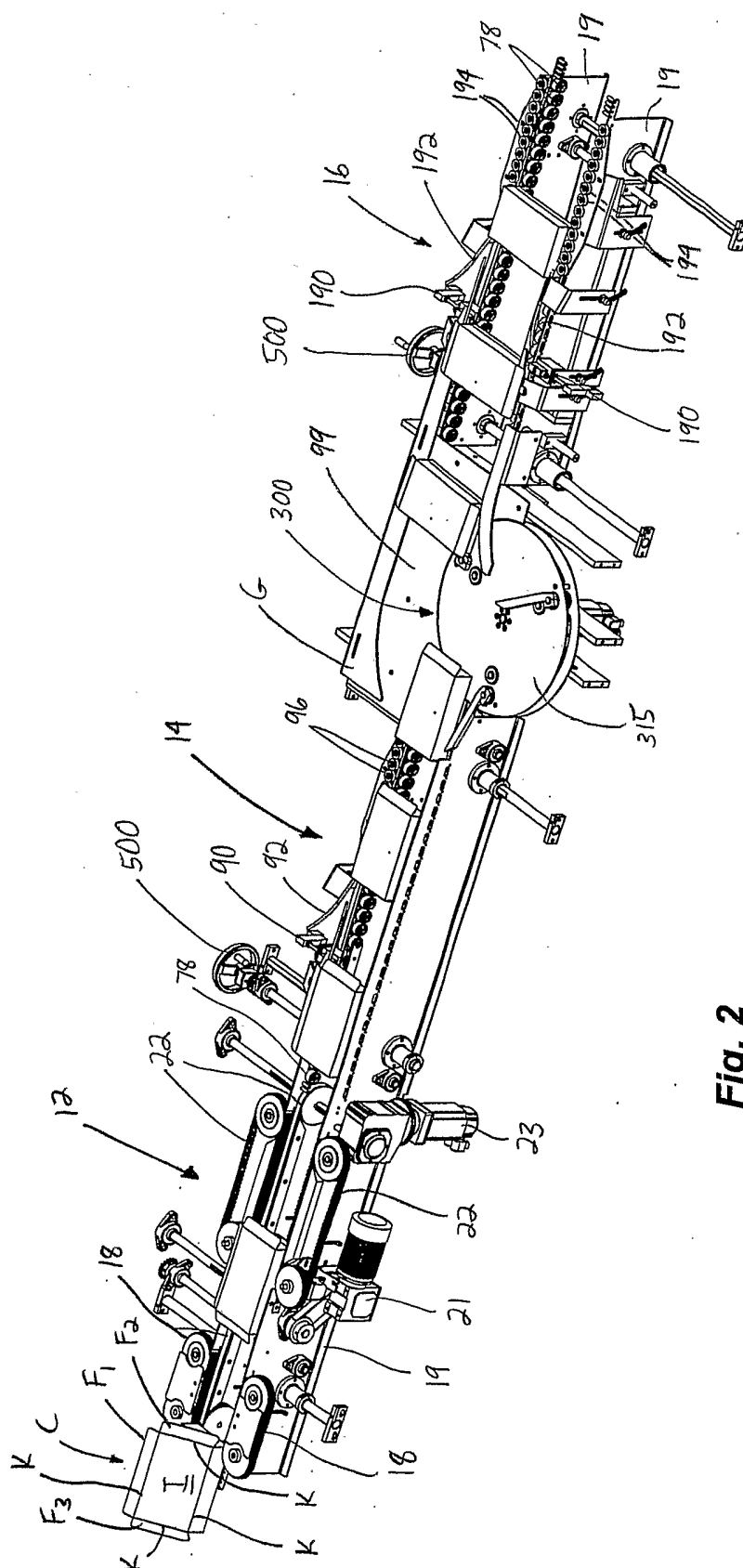


Fig. 2

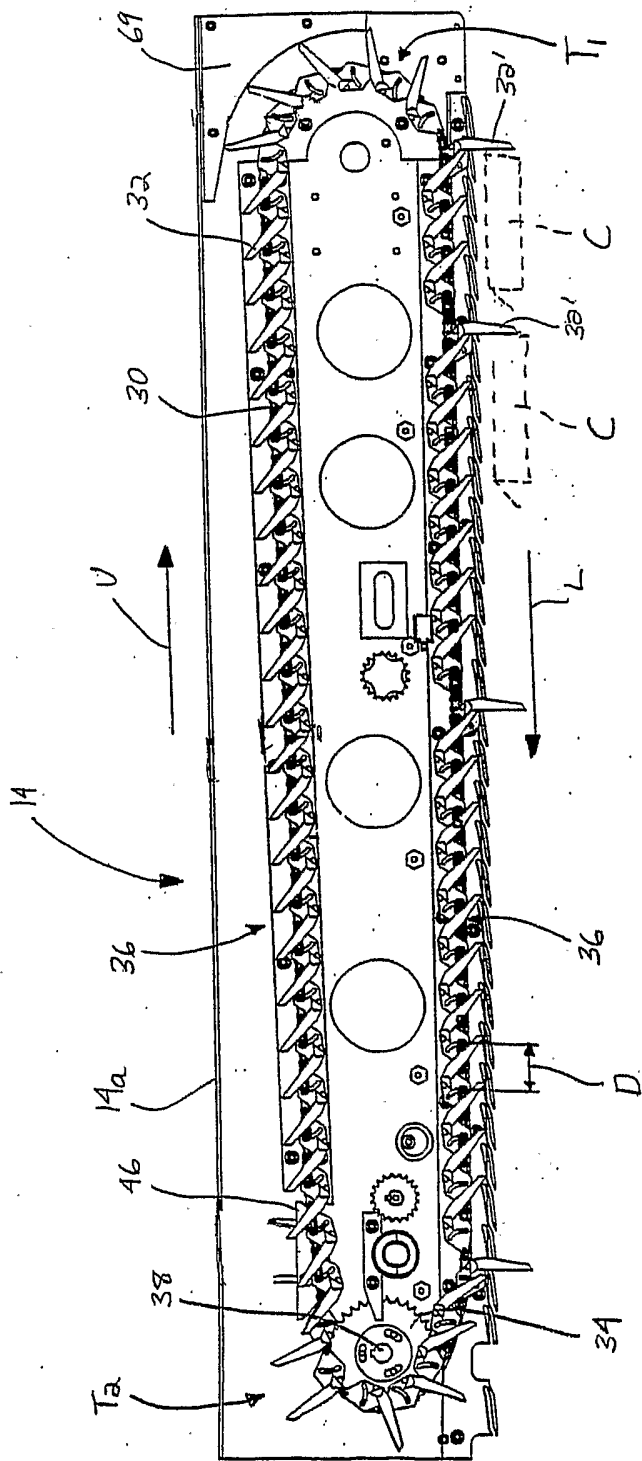


Fig. 3

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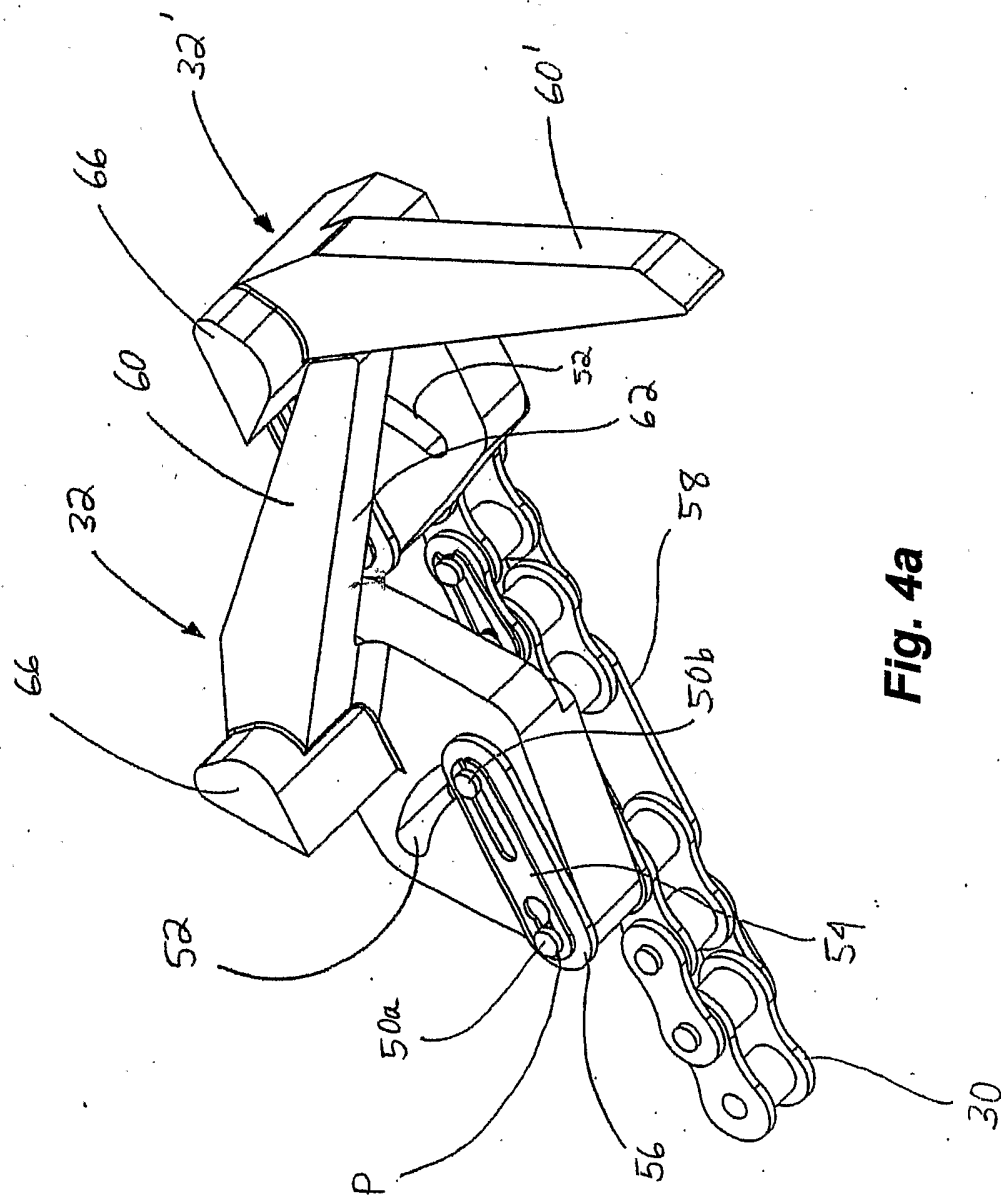


**Fig. 4a**

5/25

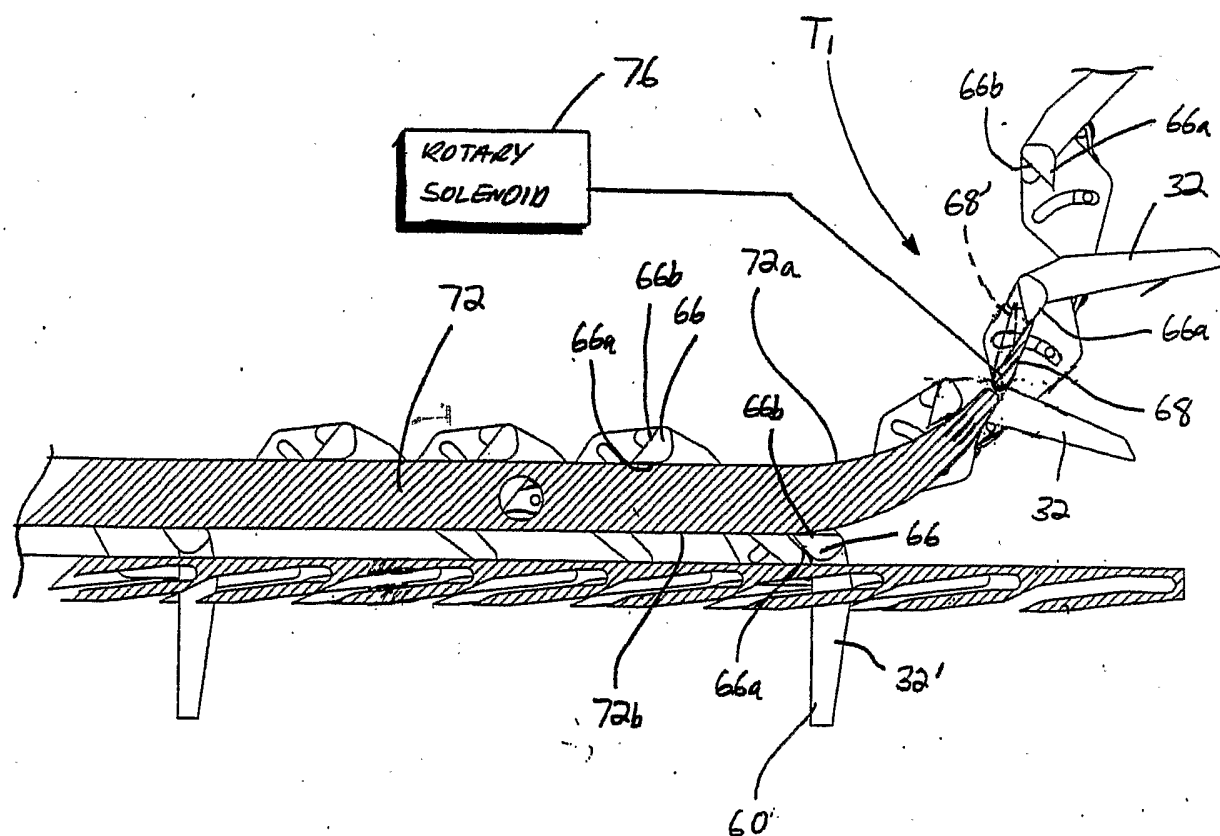


**Fig. 4b**

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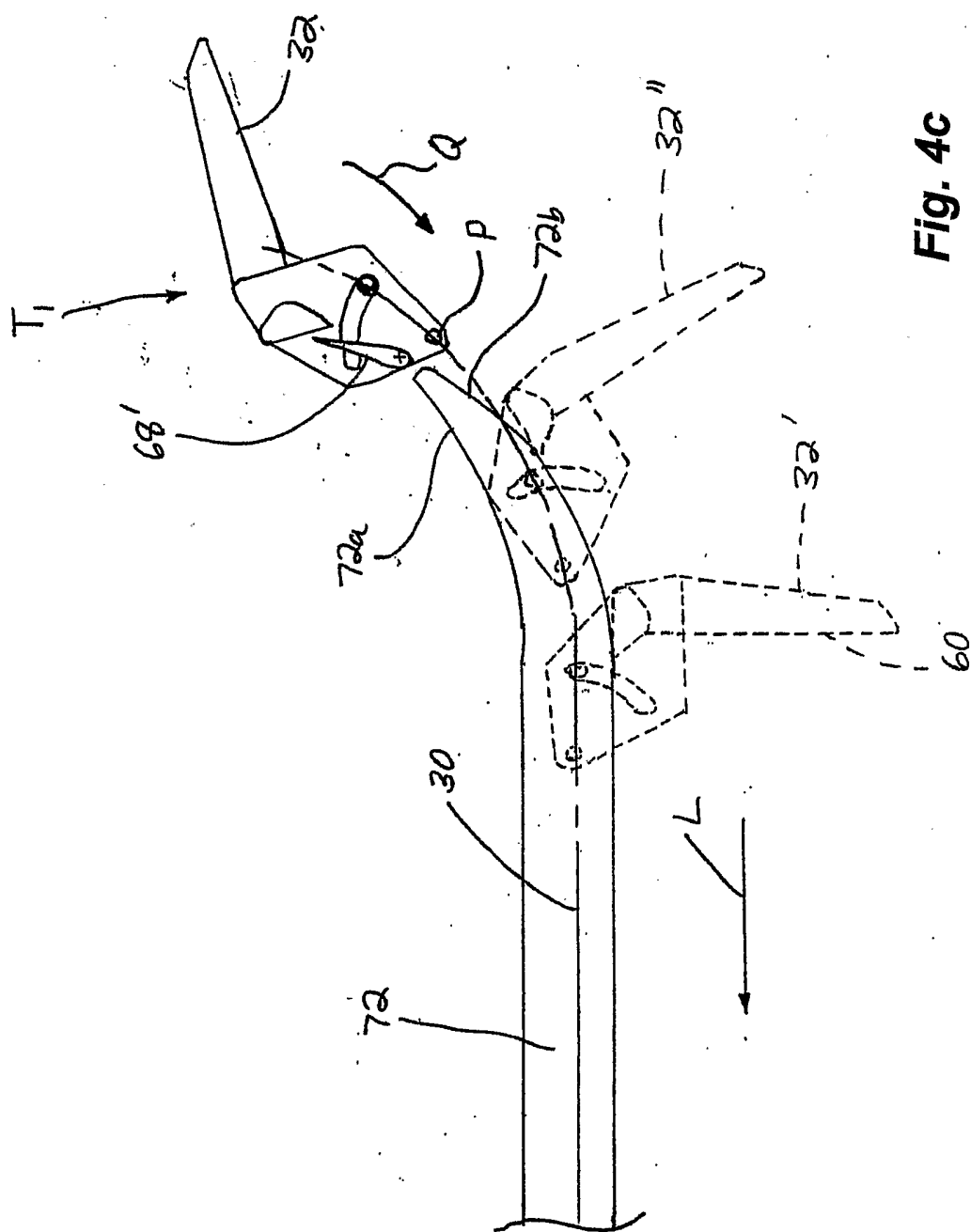


Fig. 4c

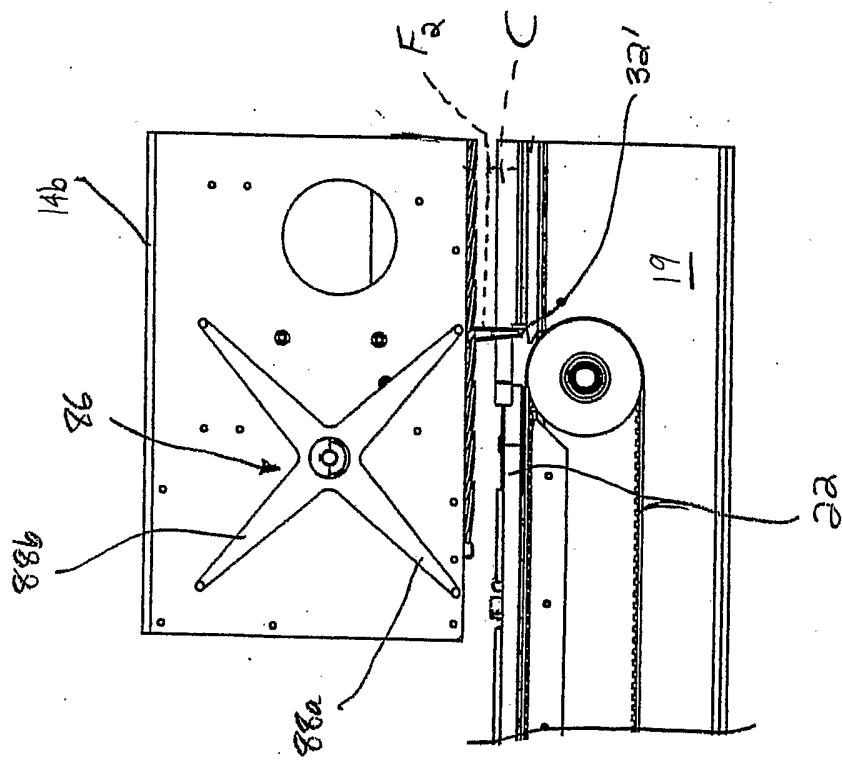


Fig. 5a

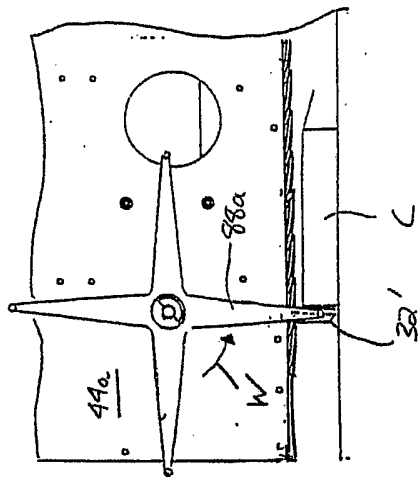


Fig. 5c

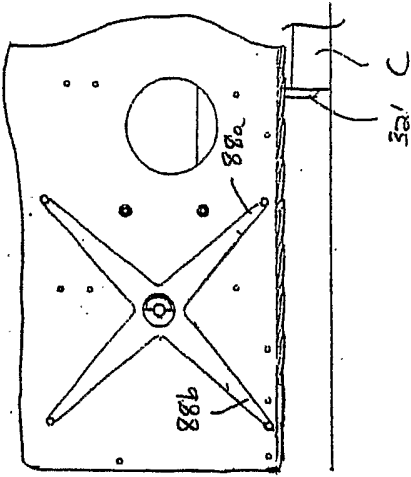


Fig. 5e

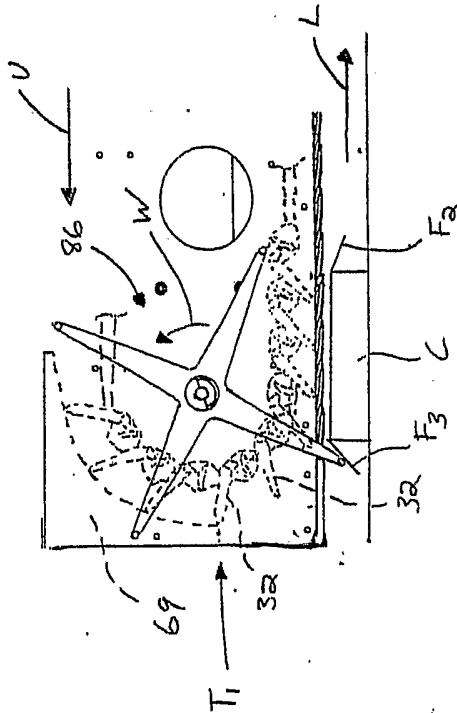


Fig. 5b

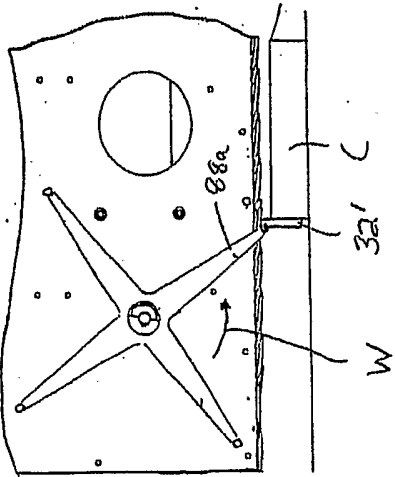
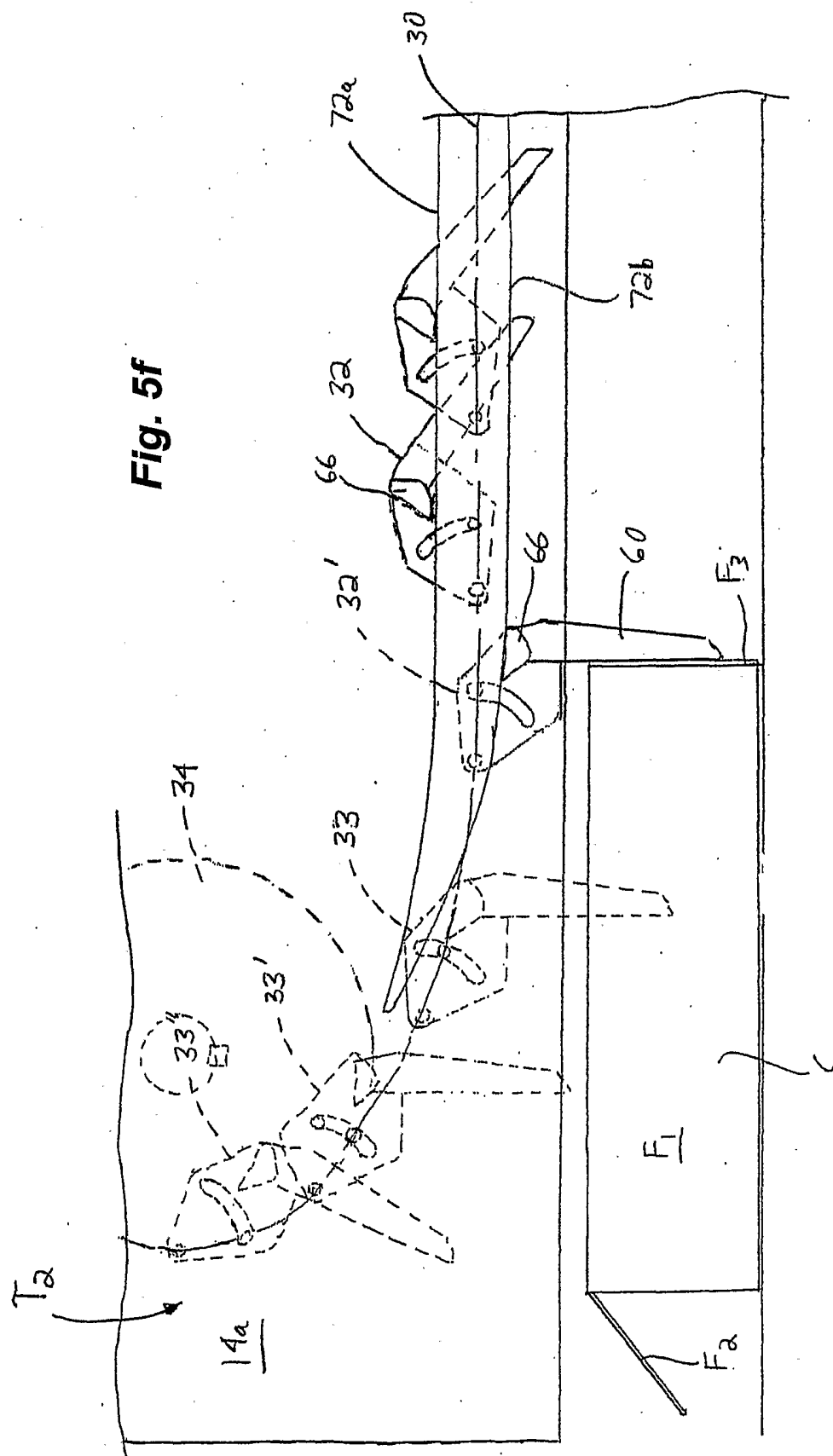


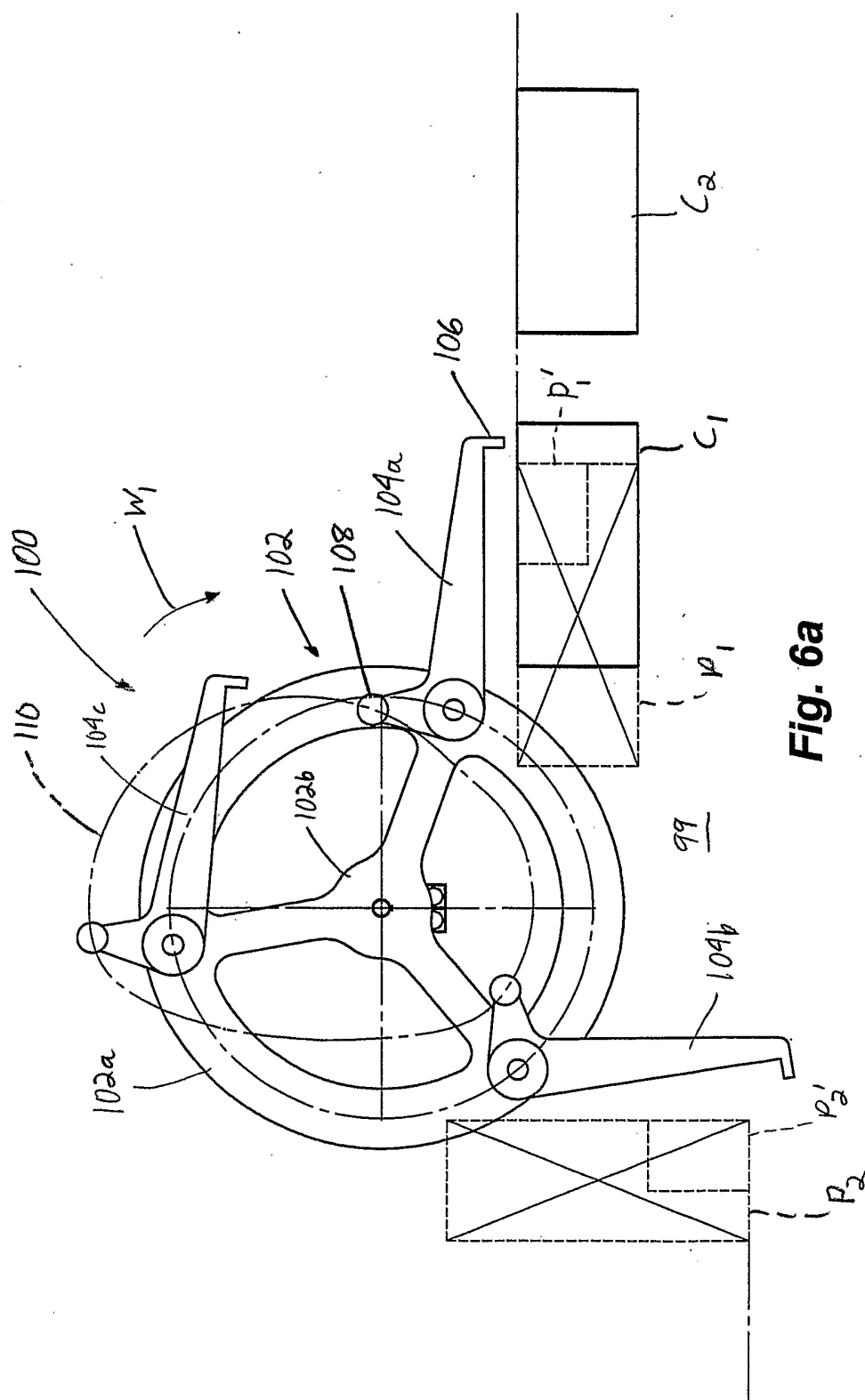
Fig. 5d

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**Fig. 5f**



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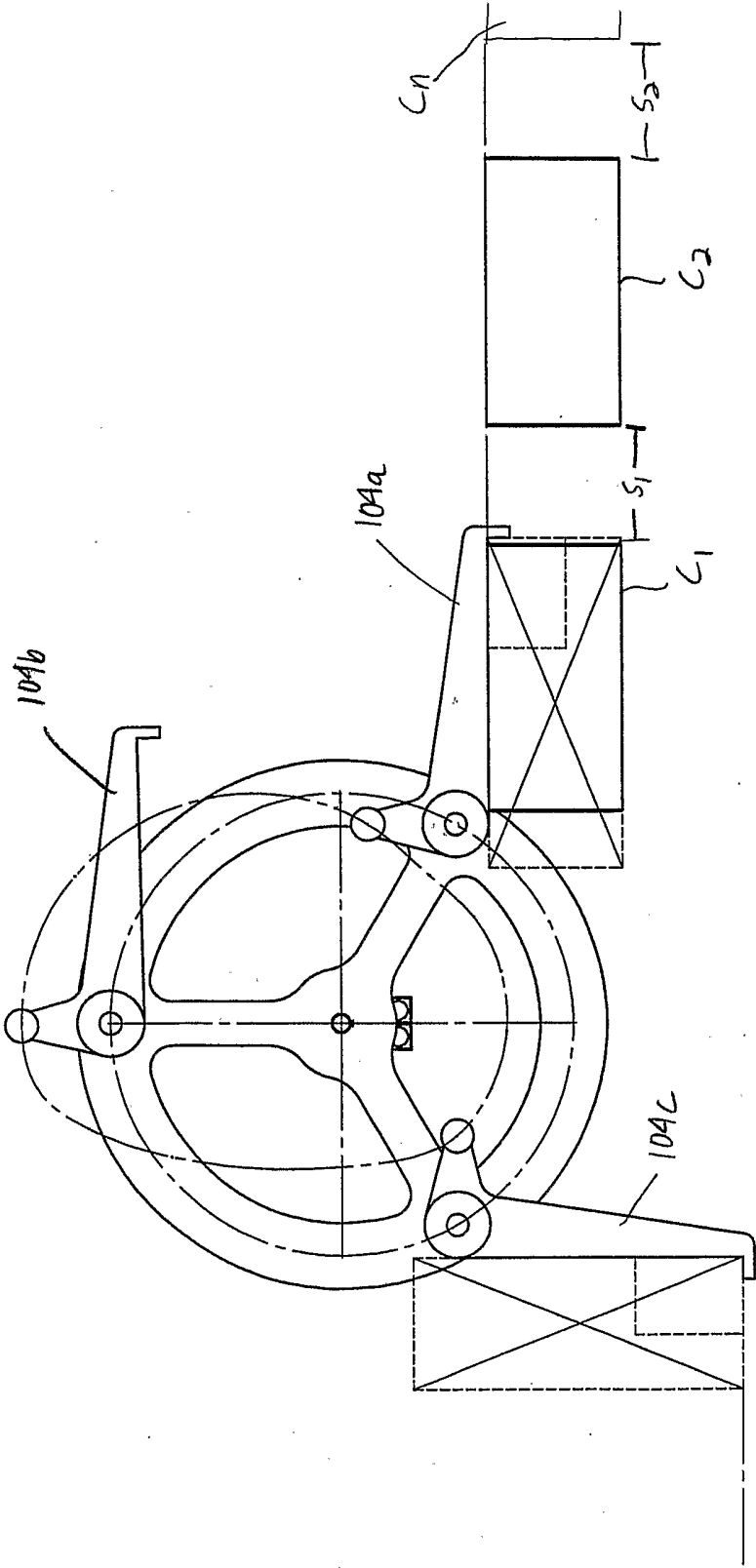
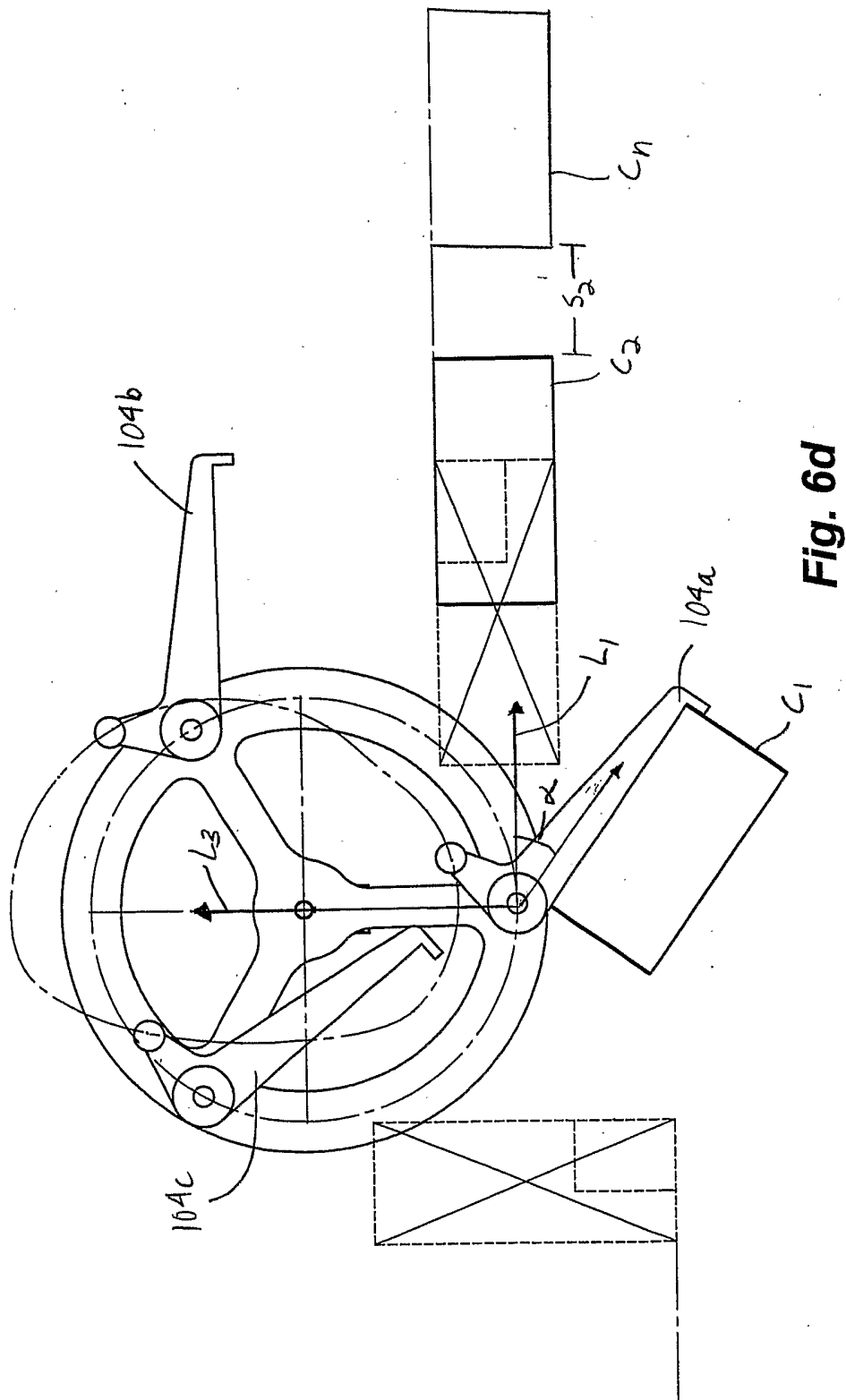


Fig. 6b





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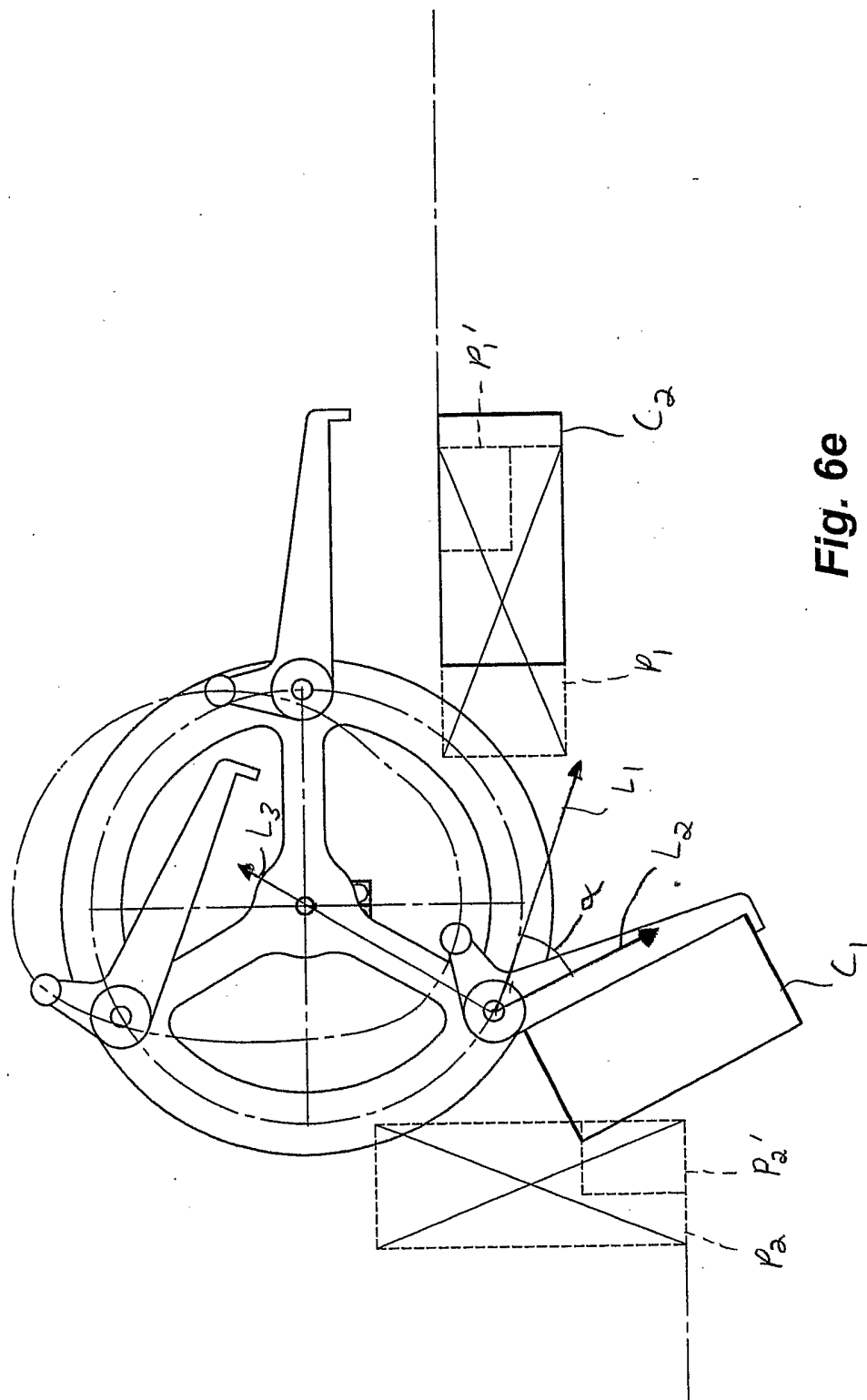
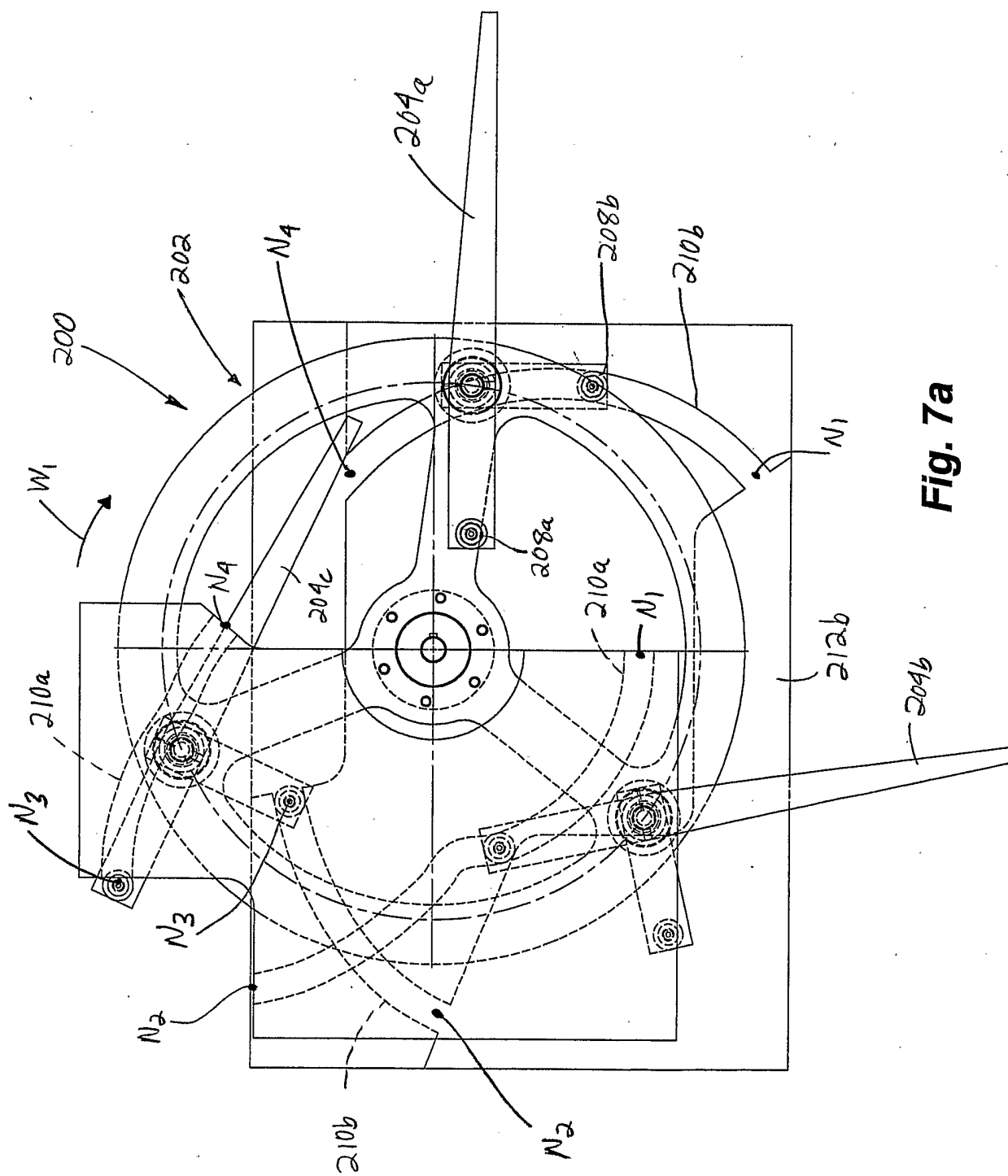


Fig. 6e



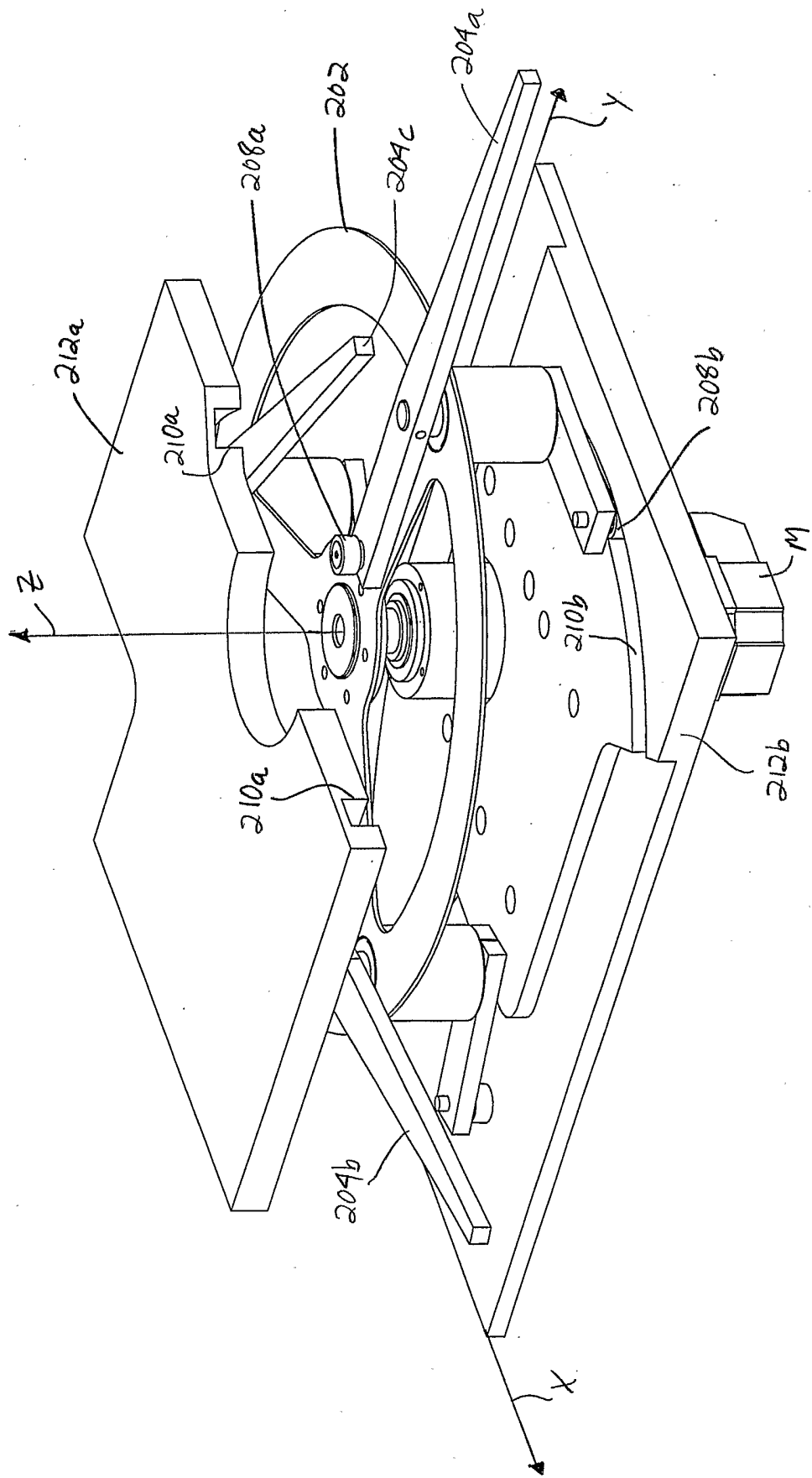


Fig. 7b

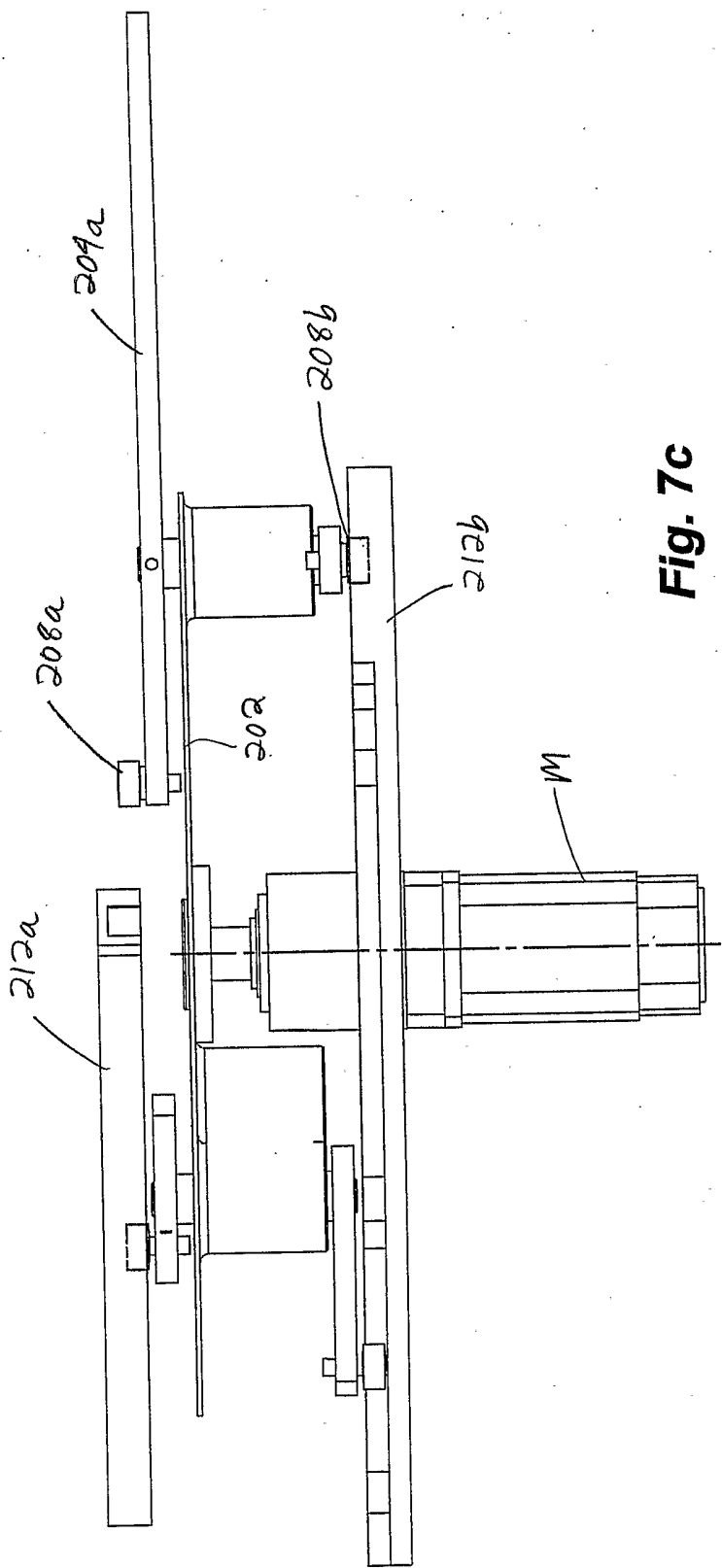
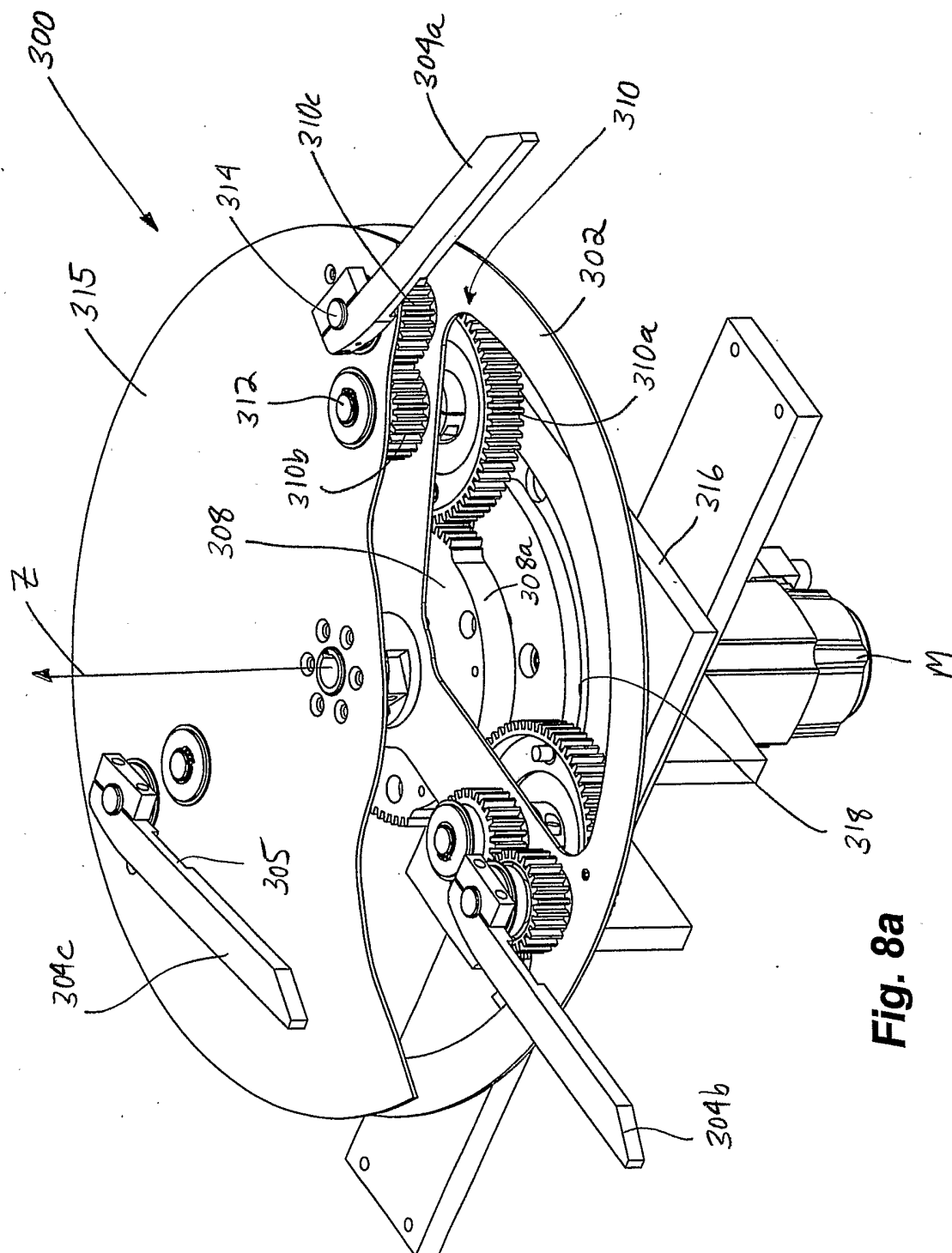


Fig. 7c

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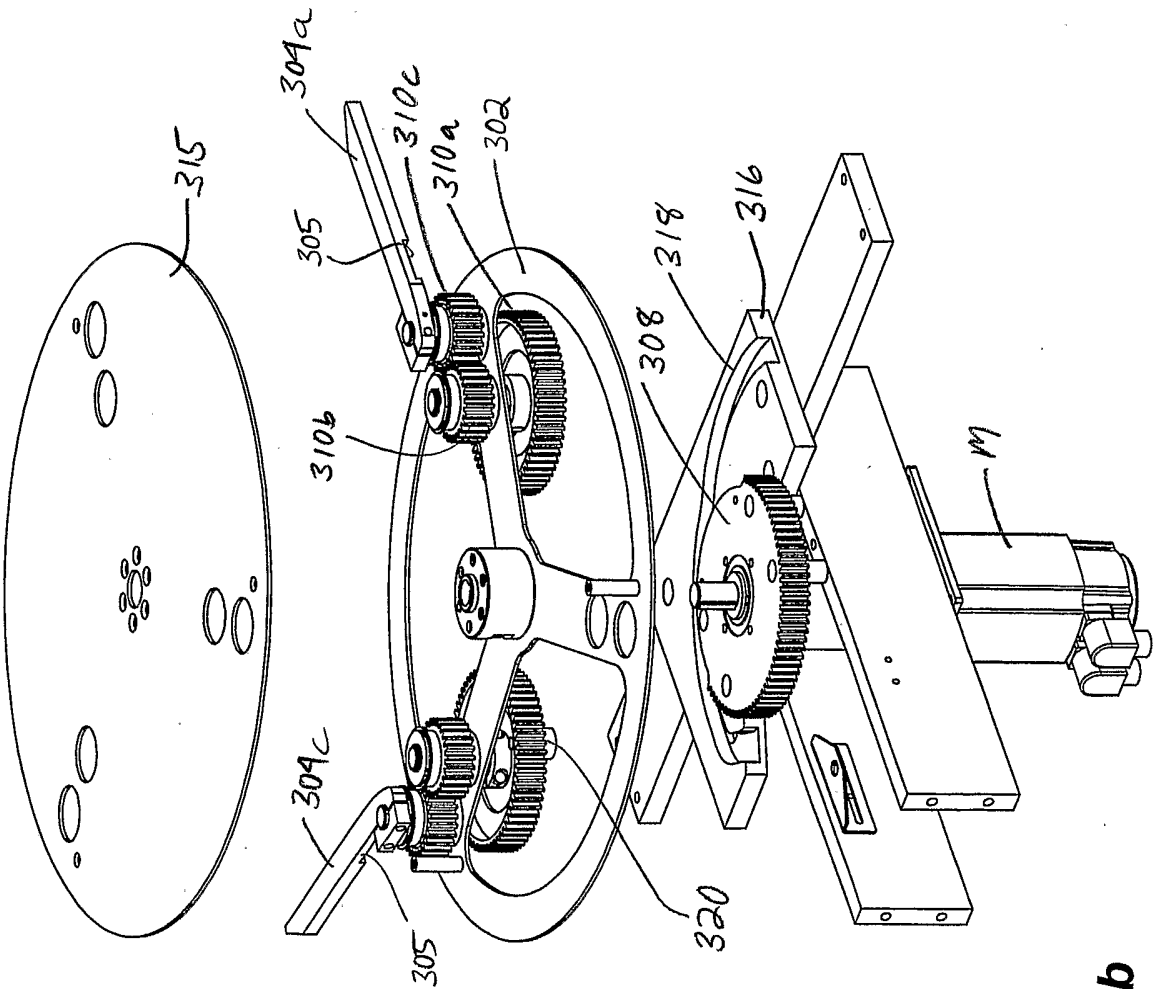
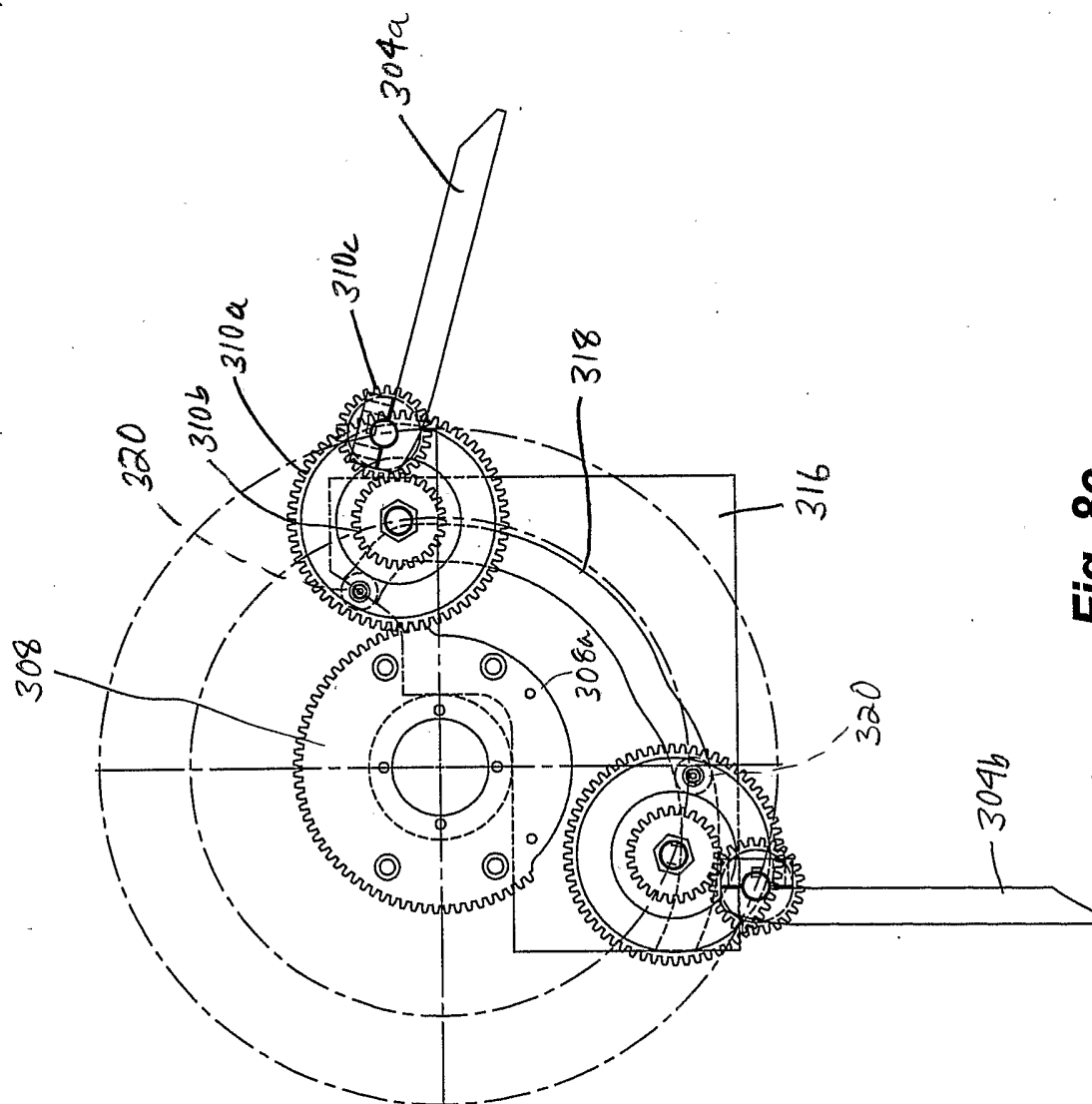


Fig. 8b

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**Fig. 8c**

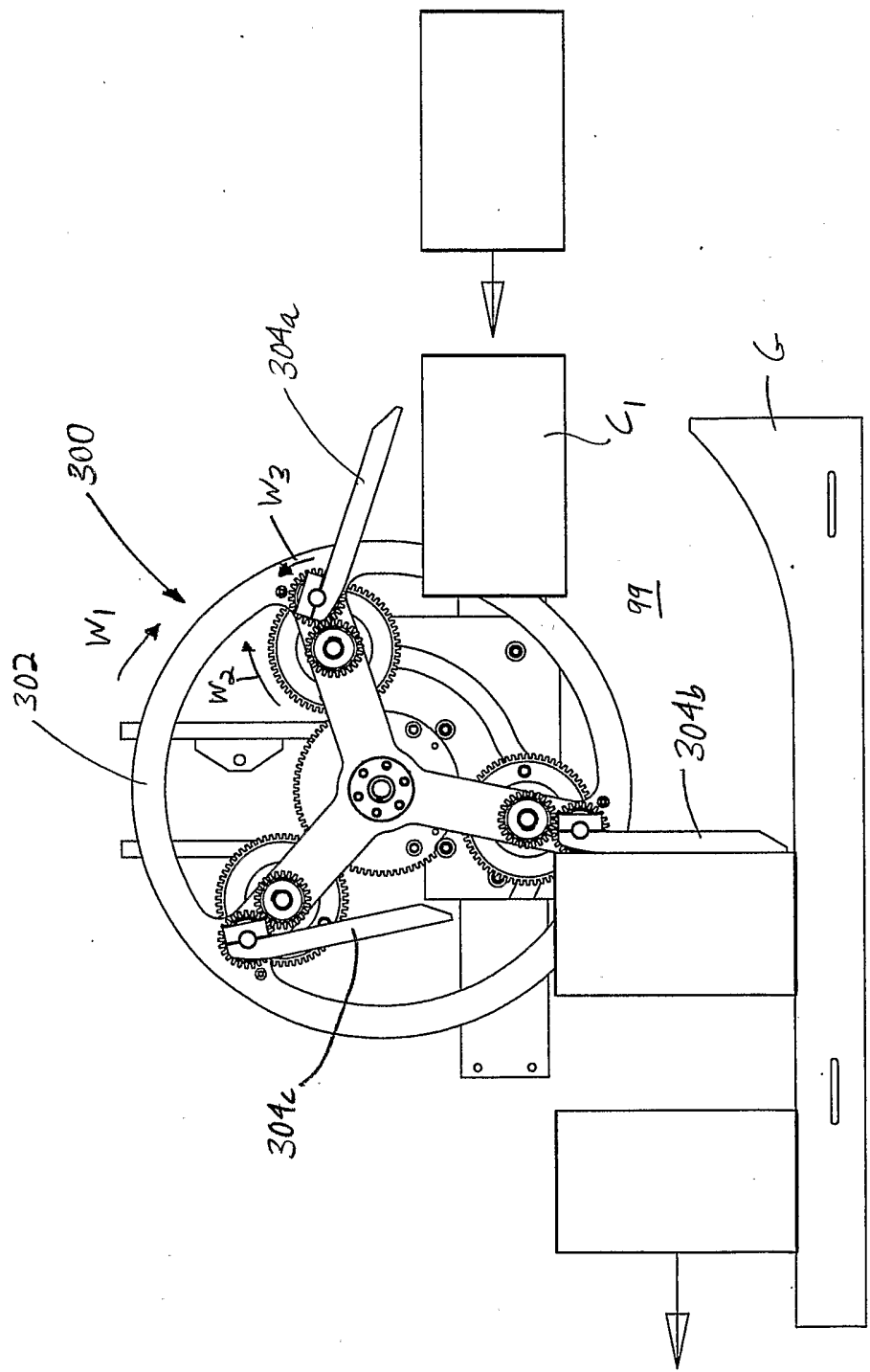


Fig. 9a

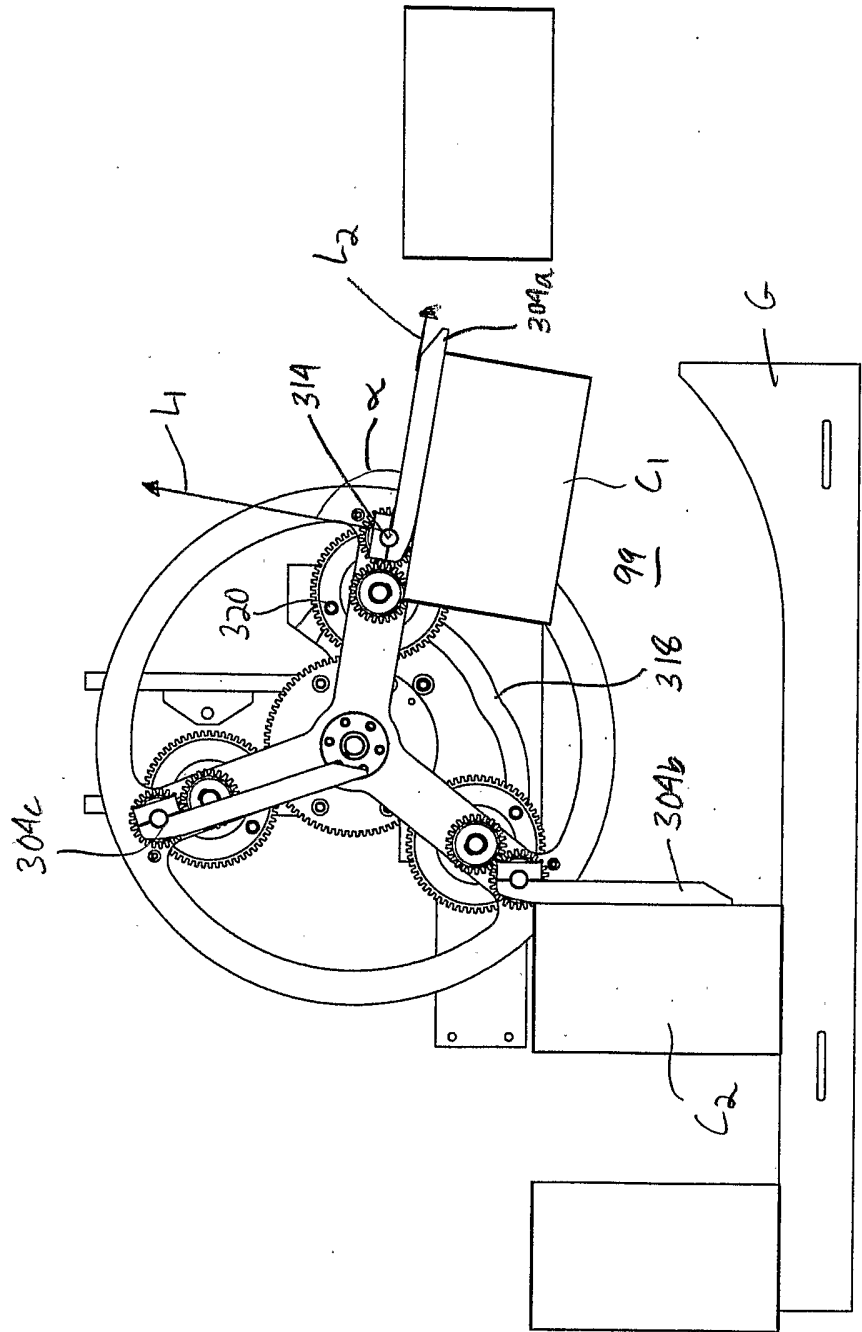


Fig. 9b

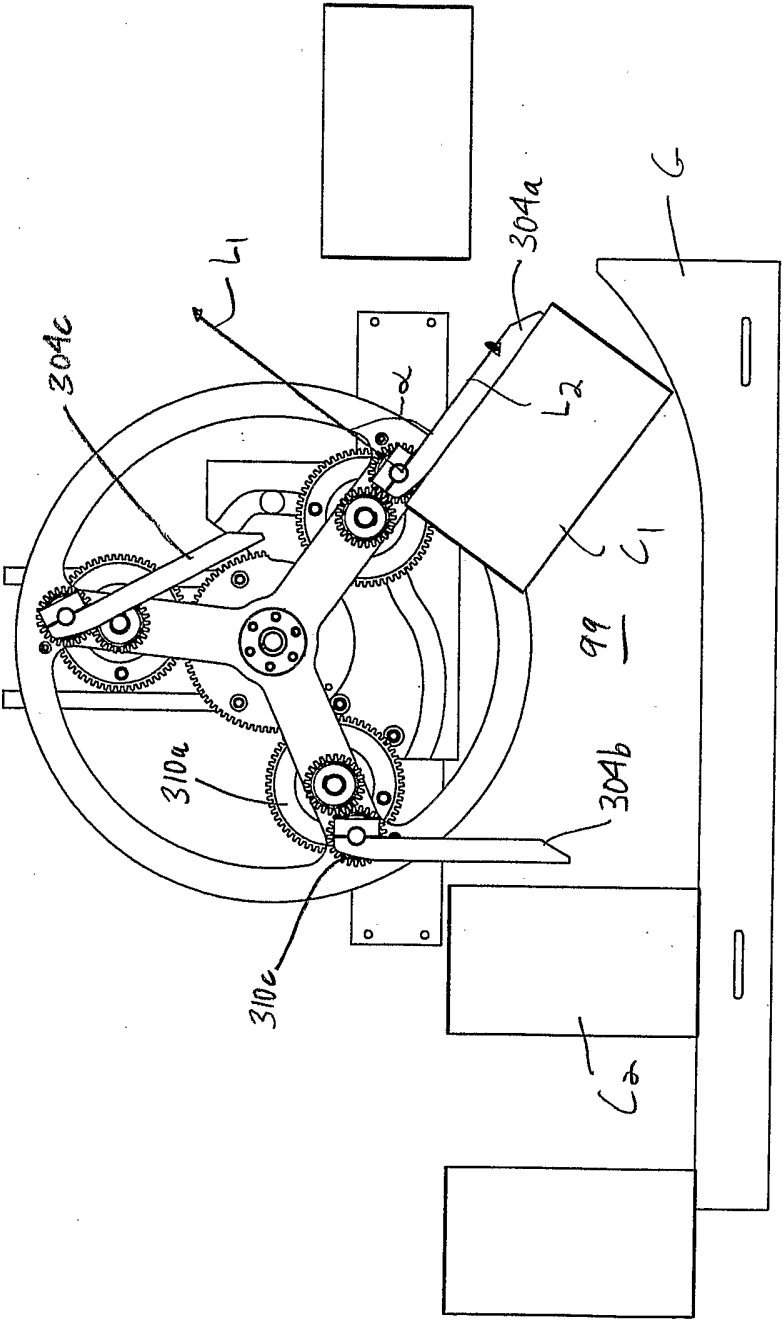


Fig. 9c

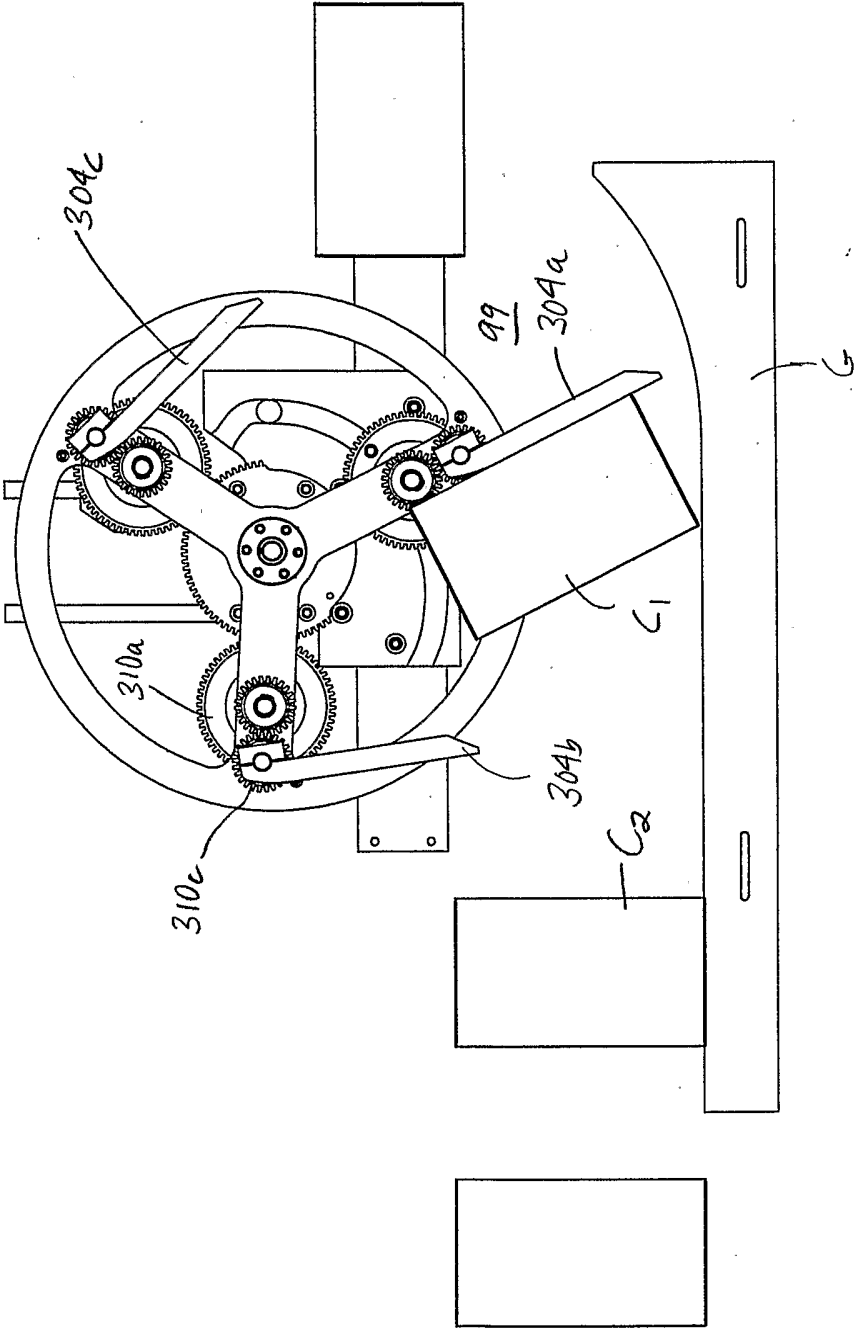


Fig. 9d

Fig. 10

