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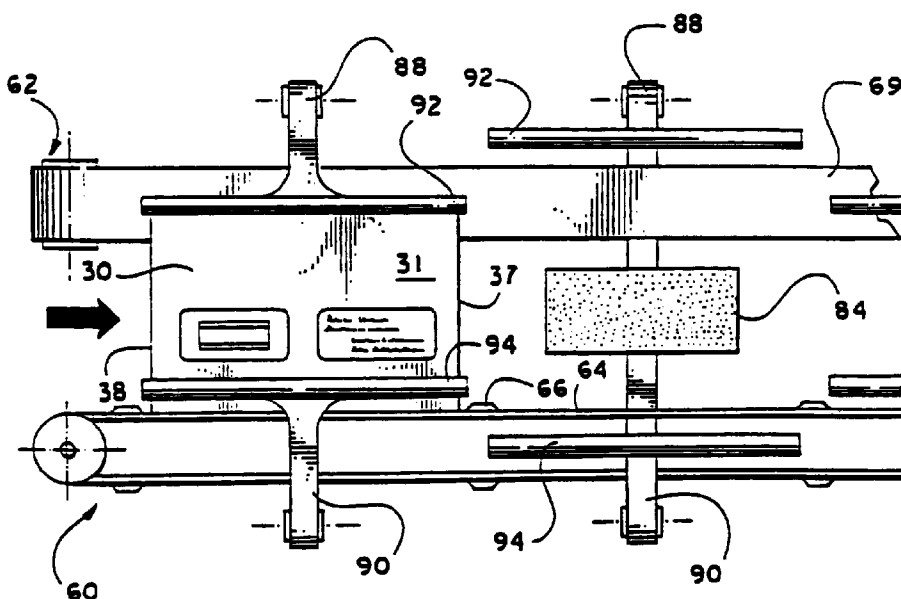
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(54) Apparatus and method of feeding and sorting objects

(57) An apparatus for automatically feeding objects
such as packages or letters at a high speed onto a sort-
ing line. The apparatus utilizes intermittent vacuum
source or other graspers to grasp and move the item

from a feeder line to a sorting line. The grasper may be
located on a continuous loop that extends adjacent to
the feeder line and the sorting line.



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Description

Technical Field of the Invention

This invention relates to an apparatus for automatically feeding objects such as packages or letters at a high speed onto a sorting line.

Background of the Invention

The use of sorting machines to separate packages along an automated system is known. Such systems are useful in sorting a large number of packages for delivery to a number of different regions, such as zip code areas. Under the control of a computer or programmed logic controller, the packages are identified or coded as they enter the system, and may then be tracked for output at a chute or bin corresponding to the coded information.

Many deliveries are made in standardized letters of a specified size (such as 9 1/2 x 12 1/2 inches). These envelopes are often called "flats" or "flat letters" in the shipping industry. The size and construction of the flat letters is standardized so that they may be handled and sorted quickly. Because coded data is imprinted on the sides of these envelopes concerning their destination, it is preferable that the envelopes be sorted such that the information on the flats may be read by a scanner as the flat letters move along a sorting line.

U.S. Patent No. 4,838,435 to *Alexandre* and U.S. Patent No. 3,757,942 to *Gunn* each disclose envelope sorters which allow sorting in a generally upright position so that coded information may be read on the envelopes as they proceed along a line. The patent to *Alexandre* discloses a conveyor assembly for processing photograph envelopes. The assembly includes a lower, horizontal conveyor belt for moving the envelopes along the line and two guide rails which extend above and beside the lower conveyor for preventing the envelopes from falling. In this manner, the envelopes are delivered in a substantially vertical orientation. A variety of different sorting modules are provided along the conveyor for separating out packages which are too long, too thick, or unmarked. Each of these sorting modules includes an opening in one guide rail and a flap built in as part of the other guide rail. When a reject envelope approaches the sorting module, the flap is operated to reroute the envelope out through the opening in the other guide rail.

The manner of feeding the letters into the sorting system, known as the feeding mechanism, of *Alexandre*, dumps envelopes, standing up or lying down, on a receiving belt consisting of a horizontal endless belt. At the output of this receiving belt, the envelopes are suctioned onto a vertical, air-permeable conveyor belt by a vacuum which is located on the other side of the vertical belt. The envelopes are then fed into the horizontal conveyor belt between the two guide rails

so that the envelope is maintained in the substantially vertical orientation.

Gunn discloses an envelope sorter having a lower, horizontal conveyor belt for supporting the bottom of the envelope and an upper, substantially vertical conveyor belt supporting the top of the envelope. The system relies solely on gravity for keeping the envelopes on the conveyors, and therefore the envelopes are transported down the line in an orientation which is substantially vertical, but slightly tilted from vertical. A movable sorting bin at the end of the conveyor belt moves responsive to a bar code reading on the envelopes so that the envelopes may fall from the end of the belts into a proper chute. The feeding mechanism of *Gunn* provides envelopes in a slanted orientation, approximately 45° to vertical, down to a roller. The roller then feeds the envelopes, one at a time, onto the two conveyor belts.

Several problems exist with these prior art feeding mechanisms. The large number of the stiffened cardboard flats that are used in the industry today, along with the need for nationwide or even worldwide shipping in one night, requires that the sorting mechanism, and therefore the feeding mechanism, work at extremely high speeds. The prior art designs are not developed so as to work at this high volume of output with the semi-rigid flats.

The feeding mechanism of *Gunn* is designed for flexible envelopes which can be easily turned and rolled onto the conveyor by the roller of that system. The roller could be inadequate for feeding stiffened cardboard flats. Moreover, the feeding mechanism of *Gunn* does not insure exact positioning of the envelopes on the conveyor belt, but instead drops envelopes on the conveyor belt as the roller reaches the end of the envelope. If envelopes are not positioned exactly the same in the slanted feeding trough of *Gunn*, the envelopes could not be fed into the conveyor system in a consistent manner. The feeding mechanism of *Alexandre*, on the other hand, has its own problems. The suction conveyor of that system may drop an envelope in any orientation onto the horizontal conveyor. There is also no provision in *Alexandre* for timed entry of the envelopes into the sorting system. Instead, the feeding mechanism just drops the envelopes randomly into the conveying system.

There is a need in the art for a feeding mechanism which can more efficiently deposit a large number of packages on a high-speed sorting system. This feeding mechanism preferably would have a more timely and accurate manner of depositing the packages than the systems currently offered.

Summary of the Invention

The present invention solves the above problems by providing a feeding mechanism which accurately and quickly deposits packages onto a sorting line. The feeding system uses selective vacuuming to grasp the items

from a feeding line and place them on the sorting line.

More particularly described, the present invention provides a feeding mechanism for depositing items on a sorting line. The feeding mechanism includes a feeder line and a suction port selectively positionable from the feeder line to the sorting line. A supply of vacuum is included which leads to the suction port, the supply being selectively operable to (1) supply adequate vacuum to the suction port such that the suction port may grasp an item and (2) cut off an adequate supply of the vacuum such that the suction port may release the item. The selective positioning of the suction port from the feeder line to the suction line is timed with the grasping and releasing of the items such that the suction port grasps the item at the feeder line and continues to grasp the item until the item substantially reaches the sorting line, where the suction port releases the item.

Preferably, the suction port is located on a continuous loop and the loop extends adjacent to the feeder line and the sorting line. It is preferred that the suction port grasp the item substantially simultaneous with arriving at the feeding line and the suction port release the item substantially simultaneous to arriving at the sorting line.

A plurality of the suction ports may be provided. Preferably, conduits extend from each respective suction port and are configured to selectively engage a vacuum timing port, the vacuum timing port being connected to the supply of vacuum. The conduits and the suction ports are configured for simultaneous rotating motion such that each of the conduits engages the vacuum port on each rotation.

The present invention further provides a feeding mechanism for depositing items on a sorting line, the feeding mechanism including a feeding line and a grasper selectively positionable from the feeding line to the sorting line and selectively operable to grasp and release the items, the grasper being located on a continuous loop which extends adjacent to the feeding line and the sorting line. The selective positioning of the grasper from the feeding line to the sorting line is timed with the grasping and releasing of the item such that the grasper grasps the item at the feeding line and continues to grasp the item until the item and the grasper substantially reach the sorting line, where the grasper releases the item.

Another embodiment of a feeding mechanism for depositing flat packages in an upright position includes a first conveyor with cleats and a second conveyor with cleats. The second conveyor extends substantially parallel to the first conveyor and is set for substantially synchronous operation with the first conveyor. The cleats on the first and second conveyors are spaced equidistantly along the conveyors and relative to one another so that the packages may extend between corresponding cleats on the first and second conveyors. Air injectors may be included along the line which supply surges of air for blowing the flat packages off the first and sec-

ond conveyors as the flat packages reach the end of the conveyors.

Therefore, it is an object of the present invention to provide an improved apparatus and method of sorting objects.

It is a further object of the present invention to provide an improved method of depositing items into a moving conveyor system.

A further object of the present invention is to provide a feeding mechanism which can selectively deposit substantially planar individual items.

Another object of the present invention is to provide a high speed, accurate feed system for a sorting system.

Other objects, features, and advantages of the present invention will become apparent upon consideration of the following detailed description of the invention when taken in conjunction with the drawing and the appended claims.

Brief Description of the Drawings

Fig. 1 is a schematic of two automatic sorter systems embodying the invention.

Fig. 2 is a typical flat letter, known in the industry, which may be sorted by the automatic flat sorters of Fig. 1.

Fig. 3 is a side view of a feeding mechanism embodying the invention.

Fig. 4 is a top view of the feeding mechanism of Fig. 3, with parts broken away to show interior detail.

Fig. 5 is a top view of an alternative embodiment of a feeding mechanism embodying the invention.

Fig. 6 is a side view of an ejection module for use in the automatic sorting system of the invention, with the ejection module in a closed, or travel, position.

Fig. 7 is a side view of the ejection module of Fig. 6, with the ejection module in an opened, or ejection, position.

Fig. 8 is a front view of two ejection modules such as are shown in Figs. 6 and 7, with one of the ejection modules opened, and the other closed.

Fig. 9 is a side view of an alternate embodiment of an ejection module embodying the invention, with the ejection module in a closed, or travel, position.

Fig. 10 is a side view of the ejection module of Fig. 9, with the ejection module in an open, or ejection, position.

Fig. 11 is a side view of an alternate embodiment of a feeding mechanism embodying the invention.

Fig. 12 is a rear view of the feeding mechanism of Fig. 11, with parts removed for detail.

Fig. 13 is a front view of the vacuum port for use with the feeding mechanism of Fig. 11.

Detailed Description of the Embodiment

Referring now in more detail to the drawing, in

which like numerals represent like parts throughout the several views, Fig. 1 shows two automatic sorting systems 10. The two sorting systems 10 are similar in configuration and each include a path 12, the two paths being placed in substantially parallel, back-to-back relationship in the figure. The paths 12 each include feed stations 16 for depositing individual items or objects to be sorted in the system 10. A data scanner 18 is located just past the feed stations 16 on each of the paths 12 and a plurality of ejection modules 20 are located past the scanners at spaced intervals along each of the paths 12. Discharge chutes 22 extend outwardly and downwardly from each of the ejection modules 20 to guide ejected objects to separate bins 24. Briefly described, objects fed from the feed stations travel down the path 12 while data are scanned by the scanner 18, and finally are ejected at one of the ejection modules 20 into a chute 24, the particular ejection module determined by the scanned data. For ease of description, hereinafter the design and operation of only one system 10 will be described.

Each system 10 disclosed in the drawings is designed to sort typical flat letters in the shipping industry. Such a flat letter 30 is shown in Fig. 2. The flat letter 30 is typically made at least partially of cardboard, and is designed to receive a specified thickness or weight of paper therein while maintaining a semi-rigid formation. The flat letters 30 define two opposing primary planar surfaces 31, 32. One planar surface 31 includes a destination code 33, such as a bar or other code, which is encoded and may be placed on the flat letter by delivery and service personnel. Adjacent to the destination code 33 is an address label 34, which may be applied by the customer. The letters have a typical size of 9 1/2 inches height (designated by the letter A in Fig. 2) by 12 1/2 inches length (designated by the letter B in Fig. 2). The flat letter defines an upper edge 35, a lower edge 36, a leading edge 37, and a trailing edge 38.

Fig. 3 discloses a side view of a feeding mechanism 40 such as is located at each of the feed stations 16 along each automatic sorting system 10. The feeding mechanism 40 is used to deposit the flat letters 30 on the path 12 such that their primary planar surfaces 31, 32 are substantially vertical. With reference to Fig. 3, the feeding mechanism 40 includes an upper conveyor 42 and a lower conveyor 44. The conveyors 42, 44 are synchronized and include separating cleats 46 along their length.

The upper and lower conveyors 42, 44 work together to contain the upper and lower edges 35, 36 of the flat letters 30. Air injectors 48 (see Fig. 4) are included at the discharge end of the conveyors 42, 44, for blowing the flat letters 30 off the end of the feeding mechanism 40 onto the path 12. A feeding slot 50 is included at the leading end of the feeding mechanism 40 for depositing the fiat letters 30 into the feeding mechanism 40.

An alternate embodiment of a feeding mechanism

140 is shown in Fig. 5. In this embodiment, conveyors 142, 144 extend substantially vertical and the flat letters 30 are positioned therebetween in a substantially vertical orientation. Air injectors 48 (not shown) are preferably used on this embodiment as well, and are located above and below the letters 30. In operation, the conveyors 142, 144 contain the leading and trailing edges 37, 38 of the flat letters 30.

Referring back also to Fig. 3, to properly understand the function of the feeding mechanism 40, the movement along the path 12 downstream of the feeding mechanism must first be explained. The path 12 includes a lower path conveyor 60 and an upper path conveyor 62. The lower path conveyor 60 defines a substantially horizontal support surface in the form of a belt 64. In addition, the lower conveyor belt 64 preferably includes transverse cleats 66 which separate positions 68 on the lower conveyor belt 64 for receiving individual flat letters 30. The upper conveyor 62 defines a substantially vertical support surface in the form of a belt 69. The upper and lower conveyors 62, 60 together define the substantially straight path 12 along which the flat letters 30 travel prior to being ejected from the path. As can be seen in Fig. 3, the lower conveyor belt 64 supports the lower edge 36 of the flat letters 30, while the upper edge 35 leans against the upper conveyor belt 69.

Operation of the feeding mechanism 40 may be described as follows. The flat letters 30 are fed through the feeding slot 50 into the feeding mechanism 40. The flat letters 30 preferably are fed with the destination code 33 in an orientation such that when the flat letters are placed in the path, the code is accessible to the scanners 18 when the flat letter 30 moves down the path 12. Thus, as Fig. 4 is viewed, the flat letters 30 are fed with the planar surface 31 facing the right. The upper and lower feeding conveyors 42, 44 are driven by a high speed stepping motor (not shown), such as is known in the industry. After the flat letters 30 are fed into the slot, the letters are caught between a corresponding pair of cleats 46 on the upper and lower feeding conveyors 42, 44 of the feeding mechanism 40. The upper and lower feeding conveyors 42, 44 move forward in synchronicity with one another.

When the feeding conveyors 42, 44 have moved a flat letter 30 into a position to be inserted into the line, the two feed conveyors 42, 44 move rapidly forward to release the flat letter 30 and then stop. Substantially simultaneously to this stopping, a series of two or more air jets from the air injectors 48 apply air pressure to the flat letter 30 so that the letter may rapidly enter the stream of the moving path 12 between two cleats 66 of the lower conveyor belt 64. If a letter is already in the location 68 on the lower conveyor belt 64, a presence photocell 70 will detect its presence and will inhibit the feeding mechanism 40 from operating until a space is available. Multiple feeding mechanisms 40 may be employed to match the capacity of the automatic sorting

system 10.

It should also be understood that a mechanical "picking" device such as is known in the art could be used in combination with or in replacement of the air blasts to facilitate transfer of letters from the feeding conveyors into the sorting path.

Alternative Embodiment of the Feeding Mechanism

An alternative embodiment of a feeding mechanism 240 is set forth in Figs. 11-13. Briefly, the feeding mechanism 240 indexes a number of flats 30 down a flat feeding line 242, where the flats are individually grabbed by a grasping mechanism 244 and placed on a flat sorting line, such as on the lower conveyor 60 of the path 12. The grasping mechanism 244 uses suction ports in the form of vacuum cups 246 to selectively take hold of the flats and move the flats from the feeding line 240 to the path 12 where they are released between two cleats 66 on the lower conveyor 60.

The feeding line 242 includes a slipping surface 248 for receiving a number of flats 30 aligned in a vertical direction. The slipping surface 248 ends sharply so as to form a substantially vertical chute 249 extending downward from the slipping surface 248. Preferably, the chute 249 extends in the direction of and ends near the lower conveyor 60. The upper conveyor 64 may be located on the chute 249, or may be located downstream of the chute on the same side of the path 12.

A pusher carriage 250 is configured to bias the flats 30 in the direction of the chute 249 and to maintain the flats in the vertical orientation. The pusher carriage 250 is biased by a spring 252 such that the carriage maintains a constant pressure against the flats 30, continually pushing them to the left in Fig. 11. A retaining idler roller 254 is positioned against the end of the row of flats 30 in a position just beyond the edge of the slipping surface 248.

Fig. 11 discloses a side view of the grasping mechanism 244, which is used to move the flats 30 from the feeding line 242 to the path 12. In the embodiment shown, the grasping mechanism 244 includes a vacuum timing belt (such as a cog belt) 260 set to rotate about a rotatably supported drive pulley 262 and two rotatably supported idler pulleys 264, 266. As can best be seen in Fig. 12, three sets of two vacuum cups 246 are located transversely across the timing belt 260, and spaced equidistantly around the belt 260. The vacuum timing belt 260 is driven by the drive pulley 262, which is rotated by a drive motor 270 via a vacuum timing belt 272.

The vacuum cups 246 are supplied with intermittent suction by a rotating port and suction system 278. The rotating port and suction system 278 includes a constant source of vacuum 280 leading from a stationary port 282. The stationary port 282 includes a vacuum timing port 284, consisting of a hole which extends through the stationary port 282 and forms a manifold

283 along the face of the stationary port, as can best be seen by Fig. 13. Preferably, the manifold 283 of the vacuum timing port 284 extends approximately one third around the face of the stationary port 282.

A rotating disc 286 is mounted for revolving motion relative to the face of the stationary port 282, as can best be seen in Fig. 12. The rotating disc 286 includes three rotating ports 288. Flexible hoses 290 extend from the rotating ports 288 to the three pairs of vacuum cups 246 on the vacuum timing belt 260. The rotating disc 286 is driven by a motor 294 via a vacuum timing belt 292 and is rotatably supported by a bearing surface as known in the art. The operation of the motor 294 and the motor 270 for the vacuum timing belt 260 is synchronized such that the vacuum timing belt 260 and the rotating disc 286 rotate on the same cycle. The significance of this arrangement is described in detail below.

The operation of the feeding mechanism 240 can be best understood from the foregoing description and by reference to the drawing. Briefly, the feeding mechanism 240 indexes a number of flats 30 down the feeding line 242, where the flats are individually grabbed by a grasping mechanism 244 and placed on the lower conveyor 60 of the path 12. The grasping mechanism 244 uses the vacuum cups 246 to selectively take hold of the flats 30 and move the flats from the feeding line 240 to the path 12 where they are released between cleats 66 on the lower conveyor 60.

The operation of the feeding line 242 can best be understood with reference to Fig. 11. The feeding line 242 is fed a number of flats 30 by hand or machine onto the slipping surface 248. Preferably, the slipping surface 248 is substantially horizontal and the primary planar surfaces 31, 32 of the flat letters 30 are substantially vertical. It is preferred that the destination code 33 faces to the left in the diagram and the outer edges 37, 38 are kept even. Guides (not shown) may be used to keep the edges 37, 38 of the flats 30 even.

As can best be understood with reference to Fig. 11, the spring 252 and pusher carriage 250 put adequate pressure on the flats 30 such that the flats are indexed against the retaining idler roller 254 as each flat 30 is removed, but the pressure of the carriage 250 is preferably not too much that the flat to be removed will not slide against the adjacent flat, or the retaining idler roller cannot spin when the flat is pulled from the feeding line 242. Preferably, the slipping surface 248 ends and the chute 249 begins such that only one flat 30a extends over the edge of the chute as the flats await the next pair of vacuum cups 246. This positioning allows the passage of only one flat 30 when the flat is grasped and then moved by the grasping mechanism 244.

Turning now to the operation of the grasping mechanism 244, the vacuum timing belt 260 is set to rotate clockwise in Fig. 11 at very high speeds, drawing the vacuum cups 246 from the feeding line 242 to the sorting line and back around the loop to repeat the action over again. As discussed earlier, the drive motor 294 for

the rotating disc 286 is synchronized with the motor 270 for the vacuum belt 260, such that the disc 286 and the vacuum timing belt 260 turn in unison. That is, the disc 286 and vacuum timing belt 260 turn a complete cycle in the same amount of time. In fact, one motor could replace the two motors 270, 294 and turn each of the belts 272, 292 by use of a common axle (not shown). By having the disc 286 and vacuum belt 260 rotate on the same cycle, the disc and vacuum belt rotate as one unit.

As the disc 286 is rotated, the ports 288 are selectively positioned against the manifold 283 of the vacuum timing port 284 such that each of the rotating ports intermittently receives suction from the vacuum system 278 via the constant source of vacuum 280. When a port 288 is not positioned against the manifold 283, but instead is against the face of the stationary port 282, the flexible hose 290, and therefore the vacuum cups 246 corresponding with the specific rotating port 288, receive no vacuum from the constant source of vacuum 280.

The intermittent vacuum through the hoses 290 causes corresponding intermittent suction through the vacuum cups 246. By arranging the rotating port and suction system 278 so that suction first occurs as the vacuum cups 246 reach the feeding line 242, the first flat 30a, corresponding to the flat which is farthest left on the feeding line in Fig. 11, is "grasped" by the vacuum going through the pair of cups 246 engaging the flat. As the vacuum timing belt 260 rotates about its path, the cups 246 maintain their grasp and pull the flat from the feeding line 242.

The flat 30a grasped by the vacuum cups 246 is carried to the path 12 and then released at the position of the flat 30b on the lower conveyor 60. The flat 30b may be released by the vacuum cups 246 at any point along the path between the feeding line 242 and the lower conveyor 60 so as to allow the flat 30b to fall freely to the lower conveyor 60, but preferably the flat is placed on the lower conveyor 60 precisely between two cleats 66.

The vacuum timing port 284 may extend around the face of the stationary port 282 such that two flats may be grasped at the same time. In such an arrangement, the second flat 30a is picked up or grasped before the leading flat 30b is dropped on the lower conveyor 60.

The unique grasping feature of the grasping mechanism 244 allows flats 30 to be moved from the feeding line 242 to the path 12 faster and more precisely than gravity working alone. Also, the grasping feature does not actually require downward movement from the feeding line 242 to the path 12. Because the flats 30 are actually grasped, the movement between the two lines could be sideways or even upward. However, the arrangement set forth in the drawing is preferred because of the vertical arrangement of the flats 30.

The grasping mechanism 242 in the present invention could be replaced by any system which allows firm contact with the flats 30 and an unmoving engagement

between the flats and the grasper. For example, a frictional engagement with pressure placed upon the flats could be used. In such an embodiment the flats would have to be pressed against the side of the chute 249, or some other surface. Such a system, however, does not offer the advantages of the present system in that the present system uses vacuum cups which only require contact with one side of the flats 30. A system utilizing pressurized engagement with the flats 30 could also damage the flats when delivering them to the path 12.

Although the preferred embodiment shown in the drawings is designed for use of flats, it is to be understood that the general concepts of the apparatus and the method of sorting described may be used for any type of item which is to be sorted. In such a set up, the feeding line 242 could be of any design which presents an item such that the item may be individually released from the feeding line and drawn toward or taken to the path 12 by the grasping mechanism 244.

The automatic feed system 240 can operate at a much higher speed than prior feeding mechanisms and thereby improves the productivity of the entire line 10. Designs similar to the one described have been found to feed flats 30 at the rate of 200 milliseconds per unit, or five flats per second. At that rate, the entire automatic sorting system 10 can sort flats 30 at a maximum rate of 18,000 flats per hour while using only one feeding mechanism 240.

As discussed in further detail below, after the flat letters are deposited into the sorting path 12, the letters pass a code scanner 18, and then pass a presence photocell (not shown) immediately downstream of the data scanner. The letters then pass through a series of side-by-side ejection modules 24, which, depending on their mode of operation, can allow letters to pass through to the next module 24, or to be ejected from the path.

An ejection module 20 for use in the present invention is pictured in Fig. 6. As can be seen from that drawing, the module 20 includes a pusher 80 having a push rod 82 and a push pad 84. In one embodiment, the push pad 84 extends further out at its base than its top, the advantage of which will be described below.

The push rod 82 of the ejection module 20 extends into a high speed electric linear actuator 86. The actuator 86 may alternatively be substituted with a solenoid or pressurized air. An upper linkage 88 and a lower linkage 90 are attached at a central pin 96 at slots 89, 91 to the rod 92 at a location forward of the high speed electric actuator 86. The upper linkage 88 includes an upper guide rod 92 which extends a fixed distance from and substantially parallel to the upper conveyor 62 when the ejection module 20 is in the closed, or "travel", position, such as is shown in Fig. 6. Likewise, the lower linkage 90 includes a lower guide rod 94 which extends just above and just to the right of the lower conveyor 60. The upper and lower linkages 88, 90 are positioned to pivot about a stationary upper pivot point 98, and a stationary lower pivot point 100, respectively. A return spring 102

is preferably attached at one end to either the upper or lower linkage and attached at the other end to a fixed position.

The ejection module 20, in one operational mode, contains flat letters 30 traveling on the path 12 to guide and prevents falling of the letters. The flat letters 30 travel along the upper and lower path conveyor belts 64, 69 at a high speed and are kept from falling over by the guiding effect of the upper and lower rods 92, 94. The arrangement of the upper rod 92 prevents the upper edges 35 of the flat letters 30 from falling too far away from the upper conveyor belt 69, and the lower rod 94 serves to position the lower end 36 of the letter in the center of the lower conveyor belt 64. Thus, the upper linkage 88, along with the guide rod 92, serves as a jaw which extends over and around the top edge 35 of the flat letters 30 as they travel down the path 12. Likewise, the lower linkage 90, along with the lower guide rod 94, serves as a jaw which extends under and around the flat letters 30 as they travel down the path 12. This allows the flat letter 30 to be delivered in a substantially upright position at a high speed, with some degree of "slack" provided between the upper rod 92 and the upper conveyor belt to compensate for thick or deformed flats.

The ejection module 20 also serves to remove a flat letter 30 from the path 12 when the flat letter reaches the ejection module 20 which matches its destination code 33. The feed station 16 and ejection modules 20 work together with the path 12 so that flat letters 30 may be sorted at a high speed and a large number of destinations by automation. Once the flat letters 30 are placed on the path 12 by the feeding mechanism 40, the letters 30 proceed down the path 12 and are tracked in accordance with prior art methods. The scanner 18 reads the destination code 33 on the flat letter 30 and a programmable logic controller (not shown) selects a destination, or certain ejection module 20, for the flat letter 30. A tracking photocell (not shown), just downstream of the code scanner 18, identifies the actual presence of the letter and matches this with its destination and starts the count on a shaft encoder (not shown).

When the shaft encoder registers the correct number of pulses for the specific destination, a signal is sent to the programmable logic controller which causes the high speed electric actuator 86 to activate, forcing the push rod 82 to extend rapidly outward as the matching flat letter 30 reaches a position immediately in front of the pusher pad 84. The movement of the push rod 82 forward causes the upper and lower linkages 88, 90 to pivot about the stationary pivot points 98, 100 and the slots 89, 91 to travel along the central pin 96 such that the upper and lower linkages are moved to the position shown in Fig. 7. This arrangement of the upper and lower linkages 88, 90 moves the upper and lower guide rods 92, 94 out of the way so that the flat letter 30 may be ejected from the path of the automatic sorting system 10. Thus, the jaws open and allow the flat letters 30

to be ejected. Because the push pad 84 extends further outward at its lower end, it ejects the lower edge 36 of the flat letter 30 out further than the upper edge 35 so that the flat letter lands on the chute 22 and slides into the bin 24 with the destination code 33 and address label 34 facing upward. Moreover, the orientation of the push pad 84 relative to the letter 30 causes the letter to be ejected upwardly and outwardly so that it will not get hung up on the lower conveyor belt 64 as it is ejected from the path 12 into one of the bins.

Once the bins 24 are full, they are ready to be carried to other sorting machines 10, or directly to a carrier. A letter 30 that is not sorted for any reason will simply exit the automatic sorting system 10 at its end and fall into a reject bin (not shown).

An alternative embodiment of an ejection module 120 is shown in Fig. 9. As can be seen in that figure, the ejection module 120 includes a high speed actuator 186 and push rod 182 which are similar to the actuator 86 and push rod 82 of the first embodiment. However, this embodiment includes only one linkage 188 which pivots from a stationary upper pivot point 198 and is attached to a return spring 202. This linkage 188 has at one end an upper guide rod 192 and at the other end a pusher pad 184.

As with the first embodiment, the upper guide rod 192 serves to prevent the flat letter 30 from falling too far forward when the ejection module 120 is in the travel position. As in the previously-discussed embodiment, the spaced-apart relative positioning of the upper guide rod 192 and the upper conveyor 62 allows for some "slack" therebetween to facilitate handling of thick or deformed flats or packages. To maintain the lower edge 36 of the flat letter 30 on the lower conveyor belt 64, the lower conveyor belt 64 in this embodiment includes one beveled side 166 and a sloped side 168. The beveled side 166 serves to prevent the flat letter 30 from extending too far left in Fig. 9 and the sloped side 168 serves to hold the flat letter 30 in a central position on the belt 164 until it is ejected.

As can be seen by Fig. 10, the ejection module 120 is designed such that when the high speed electric actuator 186 is activated, the push rod 182 extends outward and the upper guide rod 192 moves out of the way. As this upper guide rod 192 is moving, the pusher pad 184 contacts the bottom half of the flat letter 30 and presses it in the direction of the chute 22. Because the pusher pad 184 presses the bottom portion of the flat letter 30 upward and outward as the push rod 182 extends, the flat letter lands on the chute with the destination code 33 and address label 34 exposed. This upward and outward movement also pushes the bottom edge of the flat letter 30 up and over the sloped surface 168.

It may be understood that one of the distinct advantages provided by the present invention is that of "positive displacement" of the flats from the sorting path out of the sorting path by the use of mechanical plungers. As may be understood, flats, packages, or any objects

being moved high speed may tend to jam, and a jam of one letter can quickly become a jam of a multitude of letters. The present invention, when using a mechanical plunger, provides a lesser chance of risk by positively displacing the entire letter from the path with a plunging action, which is believed to be an improvement over "gated" types of sorters which tend to provide jam points due to the potential of letters becoming pinched when the gates close.

It should be understood that there are several alternative sorting configurations which could be used without departing from the spirit and scope of the present invention. For example, data scanners could be used on both sides of the sorting path in order to read data on either side of the path, such as would be the case if the flats were not fed into the path with data consistently positioned on one side. In such a situation where the flats are introduced into the path in more "random" fashion, the ejection modules could, if desired, be modified to include two plungers or pusher pads, with a lower pusher pad used to provide the action described above, and a second, "higher" pad actuated when the data is recognized to be on the other side of the flat. In such a system, the flats would be turned in a manner such that the encoded data would be consistently oriented (e.g. facing upwardly) regardless of the orientation of the data when the flats are in the sorting path.

It should also be understood that an air blast could be used in place of the plungers, although this would not provide the "positive displacement" feature discussed above.

As can be understood from the foregoing, the sorting system 10 of the present invention overcomes many problems in the prior art. The feeding mechanism 40 inputs objects to be sorted in a systematic order. The ejection module 20 offers not only a supported guiding system, but also an efficient ejection system which may be used to sort a large number of packages to a large number of destinations. Although the automatic sorting system 10 described in the specification is developed to specifically sort flat letters 30, it is to be understood that the principles of the sorting system 10 could be employed for any size or shape of items to be sorted.

While the present invention and its various aspects has been described in detail with regard to preferred embodiments thereof, it should be understood that variations, modifications and enhancements can be made to the disclosed apparatus and procedures without departing from the spirit and scope of the present invention as defined in the appended claims.

Claims

1. An apparatus (10) for transporting and sorting substantially planar individual items along an item travel path, said items having opposing upper and lower edges (35, 36), said apparatus comprising:

a lower conveyor (60) traveling at least partially parallel to and adjacent to said travel path and for supporting said lower edge of each of said items;

an upper conveyor (62) traveling at least partially parallel to and adjacent to said travel path, said upper conveyor for supporting said upper edge of each of said items, said upper and lower conveyors combining to urge said items along a travel path; and

a plunger (84, 184) separate and distinct from said upper and lower conveyors and having a travel path intersecting said item travel path, said plunger located intermediate said lower and upper conveyors, said plunger configured for ejecting an item from said path by a pushing action.

2. The apparatus of Claim 1, wherein data (33, 34) is encoded on said items and further comprising a scanner (18) located adjacent to said path for reading said data as an item moves along said path, wherein each individual item is ejected by said plunger responsive to said data on said item.
3. The apparatus of Claim 1, further comprising an upper guide rail (92, 192) extending substantially parallel to and a fixed distance from said upper conveyor, said upper guide rail for preventing said items from falling away from said upper conveyor out of said travel path.
4. The apparatus of Claim 3, further having a plurality of said plungers (84, 184), wherein said upper guide rail is movable in segments (92), each of said segments corresponding to one of said plungers and being linked to said one of said plungers such that said segment moves out of the way of said item as said one of said plungers ejects said item from said path.
5. The apparatus of Claim 4, further comprising a lower guide rail (94), said lower guide rail extending substantially parallel to and a fixed distance from said lower conveyor, said lower guide rail acting to prevent a lower portion of each of said items from falling from said lower conveyor.
6. The apparatus of Claim 5, wherein said lower guide rail (94) is movable in segments, each of said segments corresponding to one of said plungers and being linked to said one of said plungers such that said segment moves out of said way of said item as said one of said plungers ejects said object from said path.
7. The apparatus of Claim 3, further comprising a lower guide rail (94), said lower guide rail extending

substantially parallel to and a fixed distance from said lower conveyor, said lower guide rail acting to prevent a lower portion of each of said items from falling from said lower conveyor.

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8. The apparatus of Claim 7, further having a plurality of plungers (84, 184).

9. The apparatus of Claim 1, wherein said plunger is designed such that said plunger presses said lower edge (36) of said items upward and outward as it ejects said items from said path.

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10. The apparatus of Claim 1, wherein said plunger (84) is configured such that said lower portion of said plunger extends further outward than said upper portion of said plunger such that outward movement of said plunger causes upward and outward ejection of said lower edge of said item.

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11. The apparatus of Claim 1, wherein said lower conveyor (64) is cupped so that said lower end of said items have a tendency to remain in said center of said lower conveyor.

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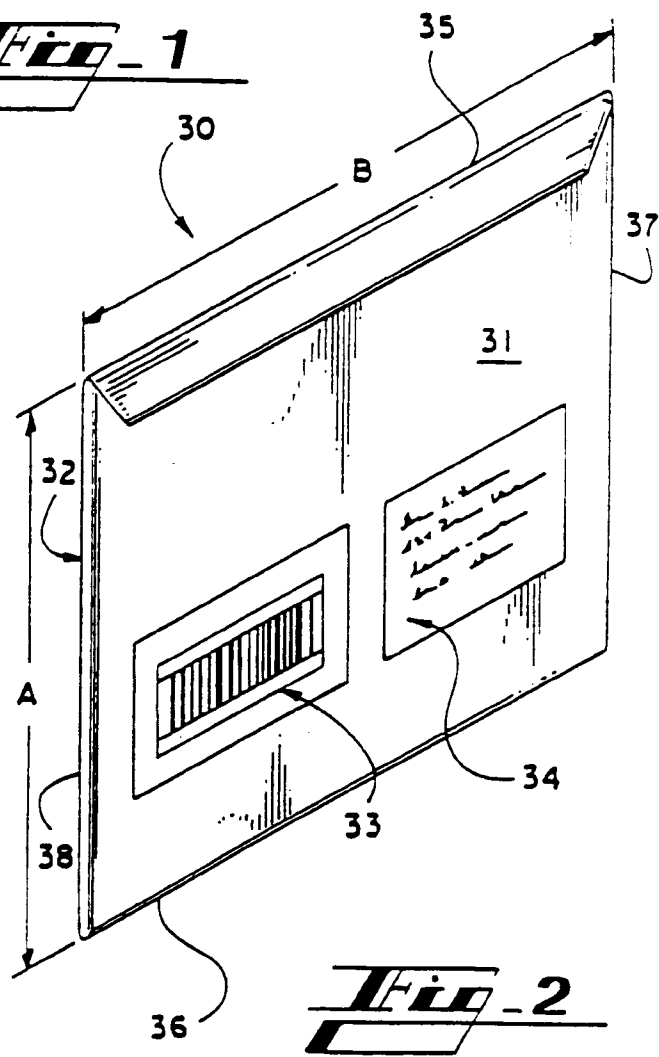
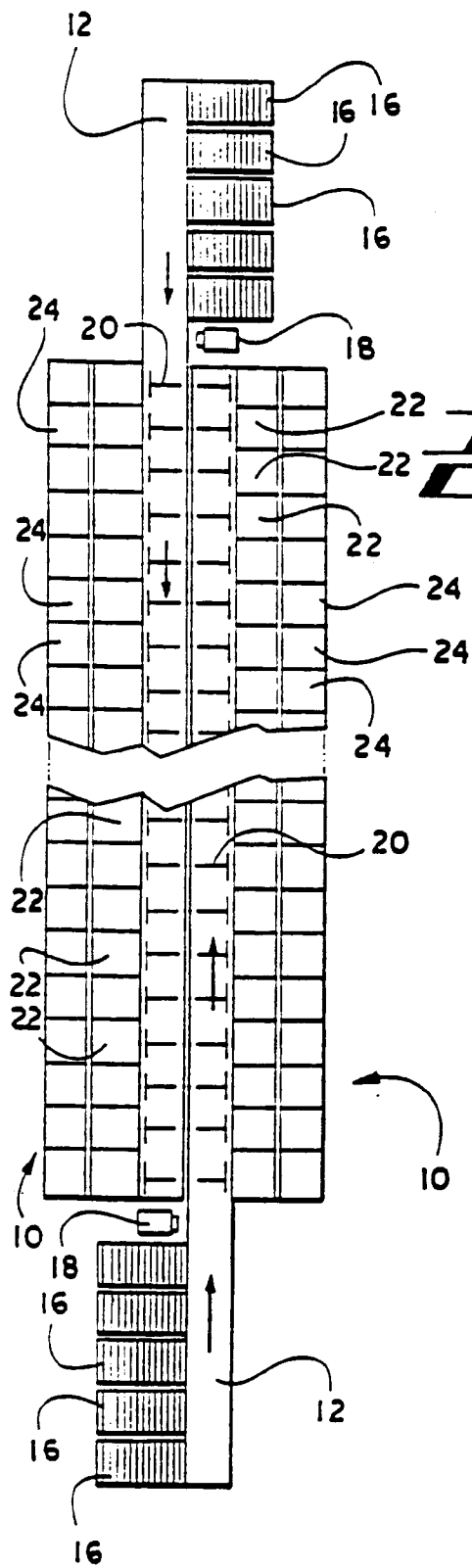
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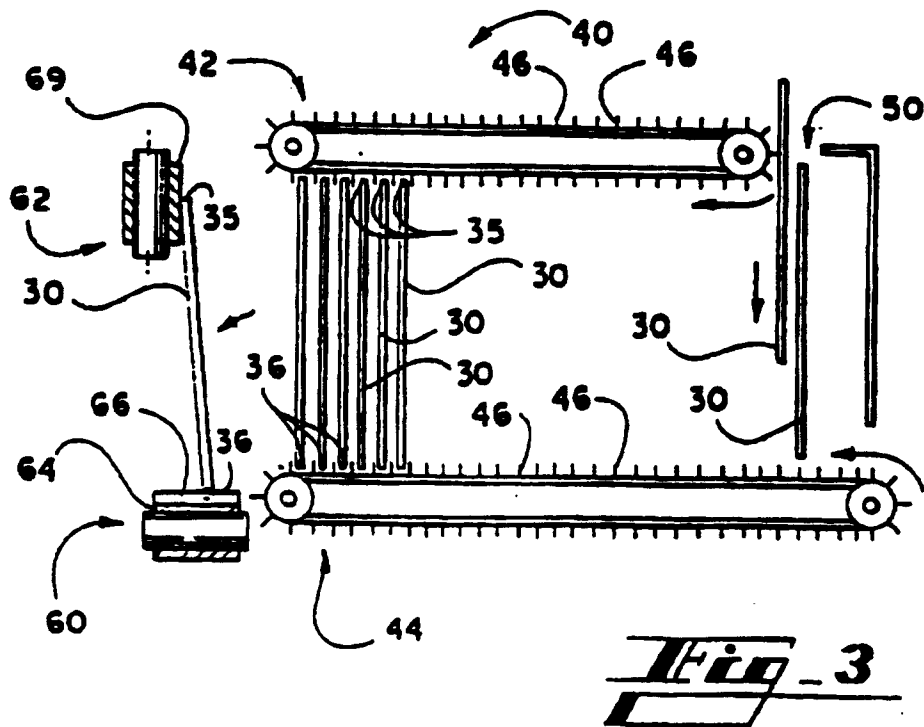
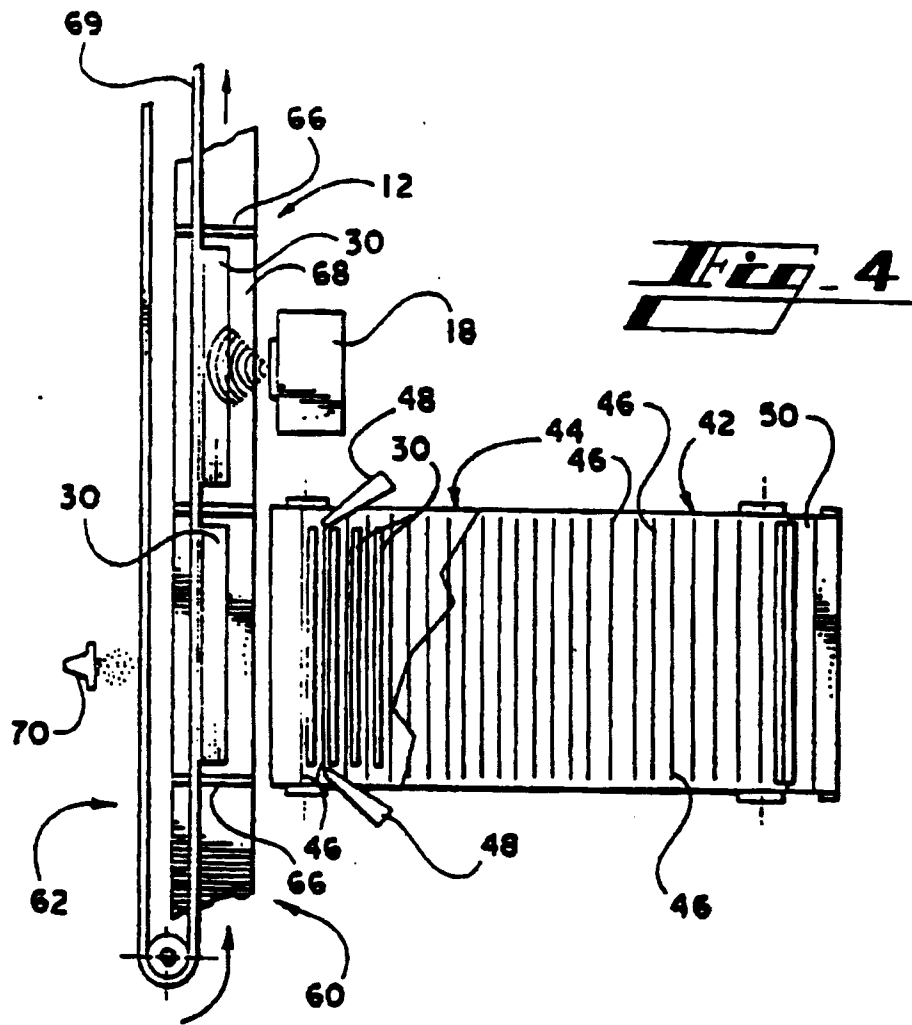


Fig. 5

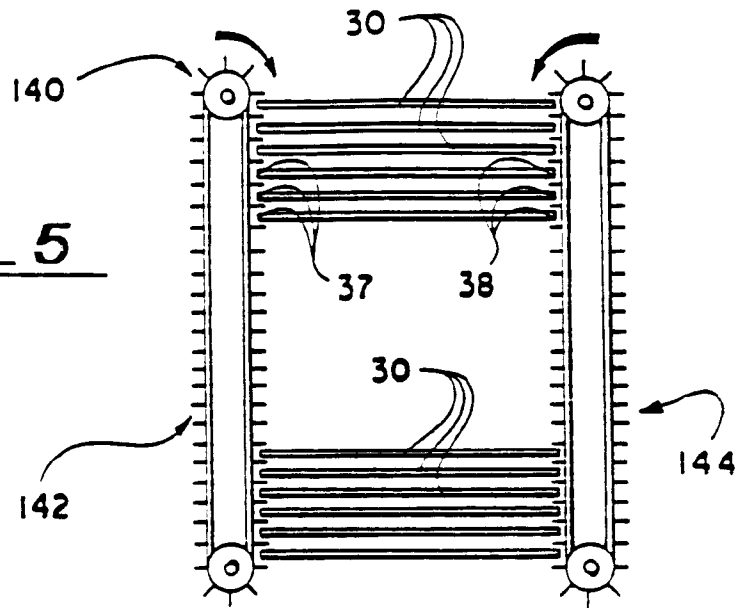
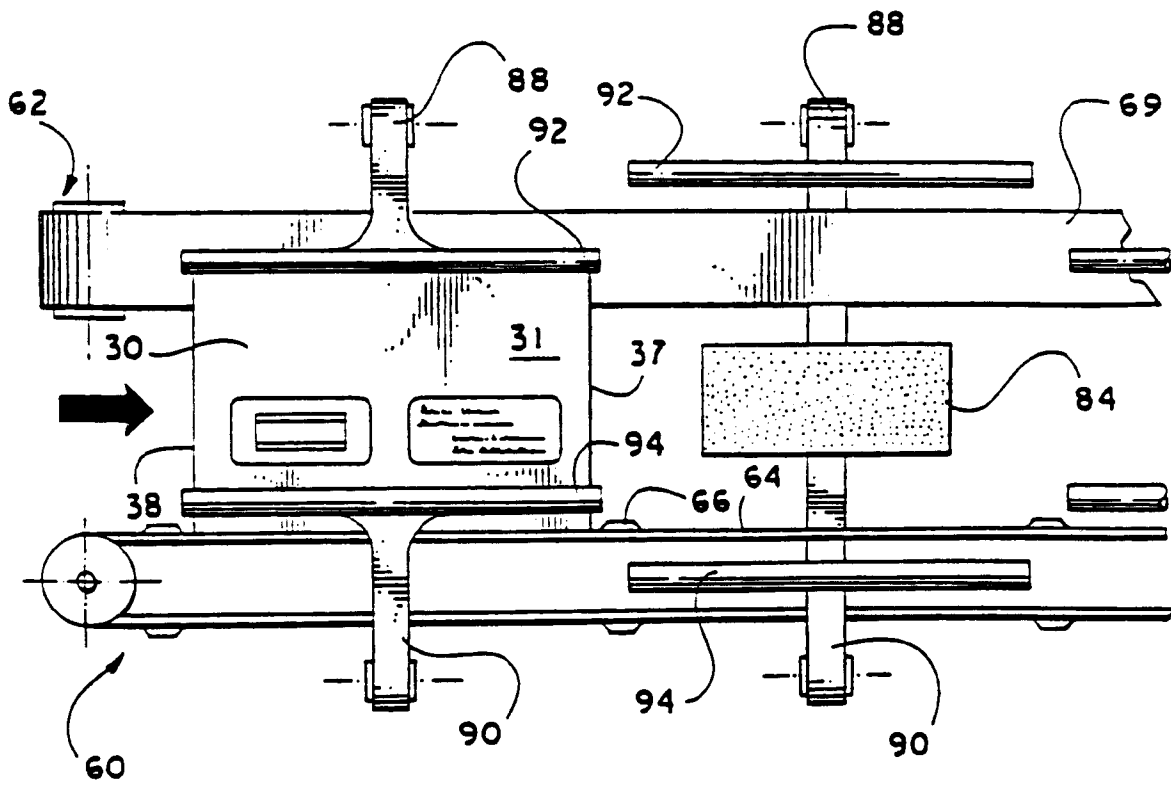


Fig. 8



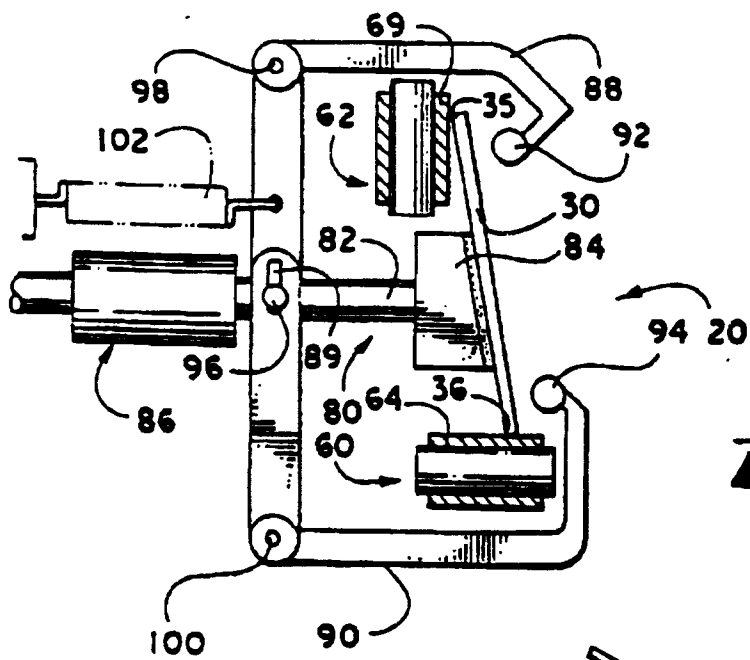


Fig. 6

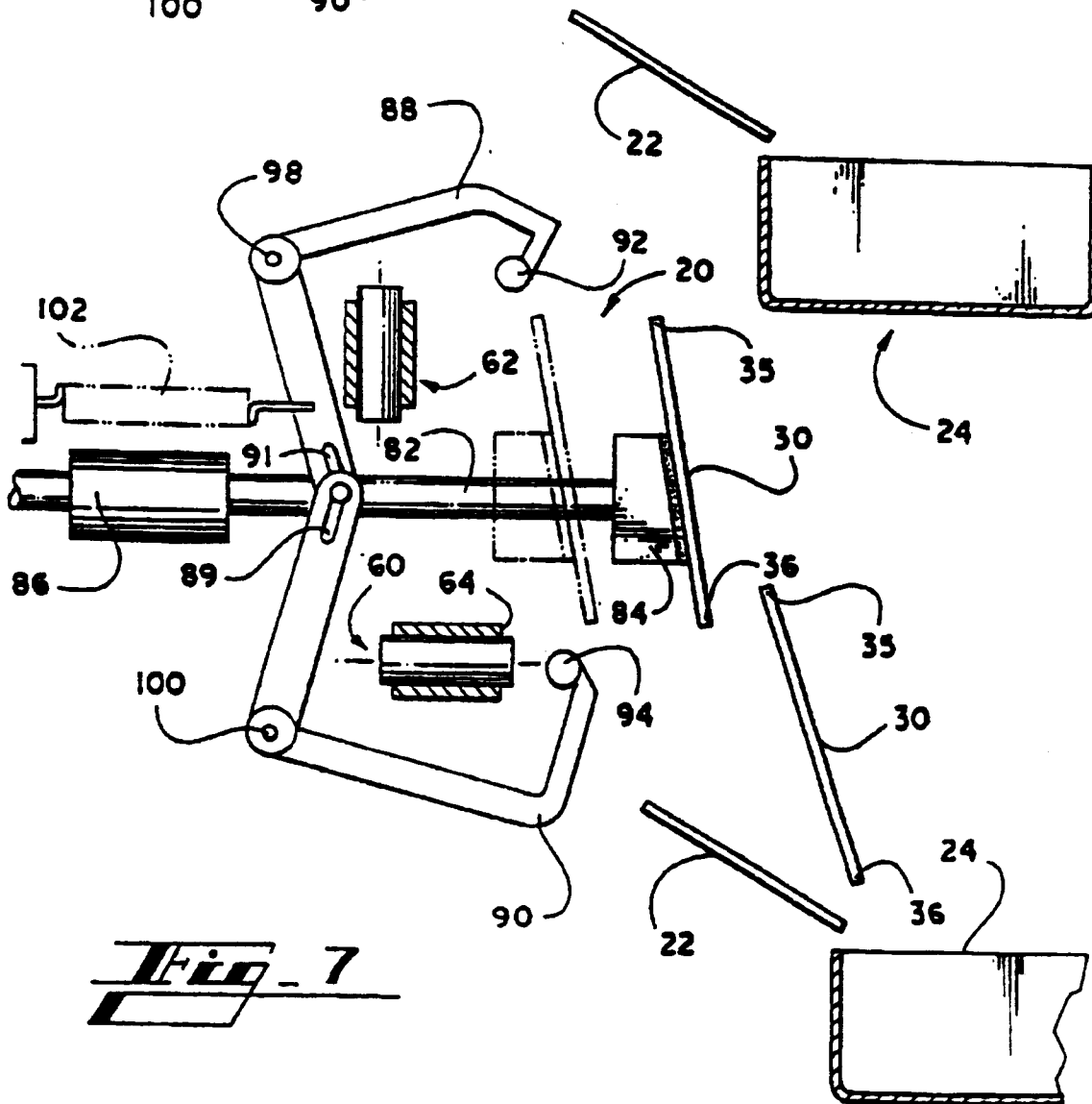
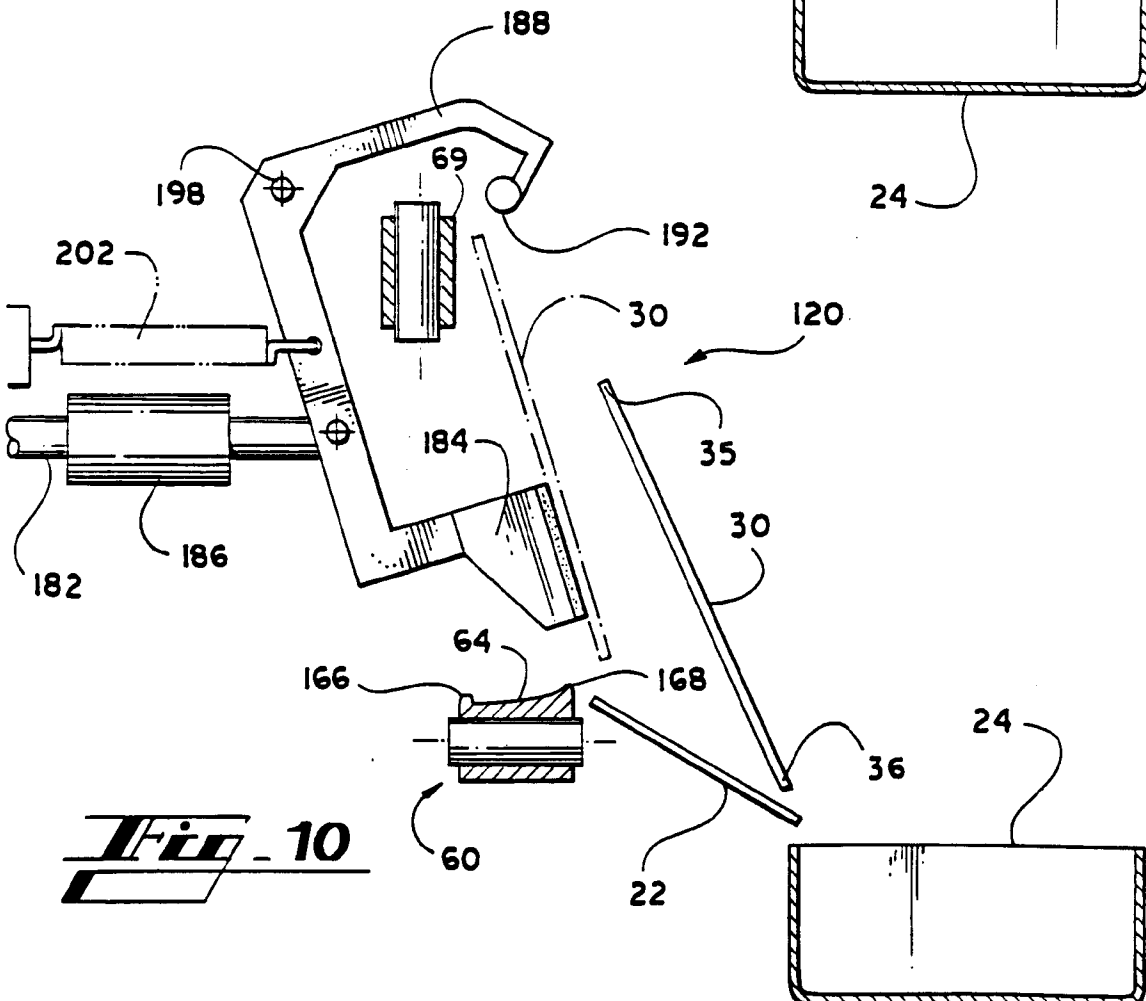
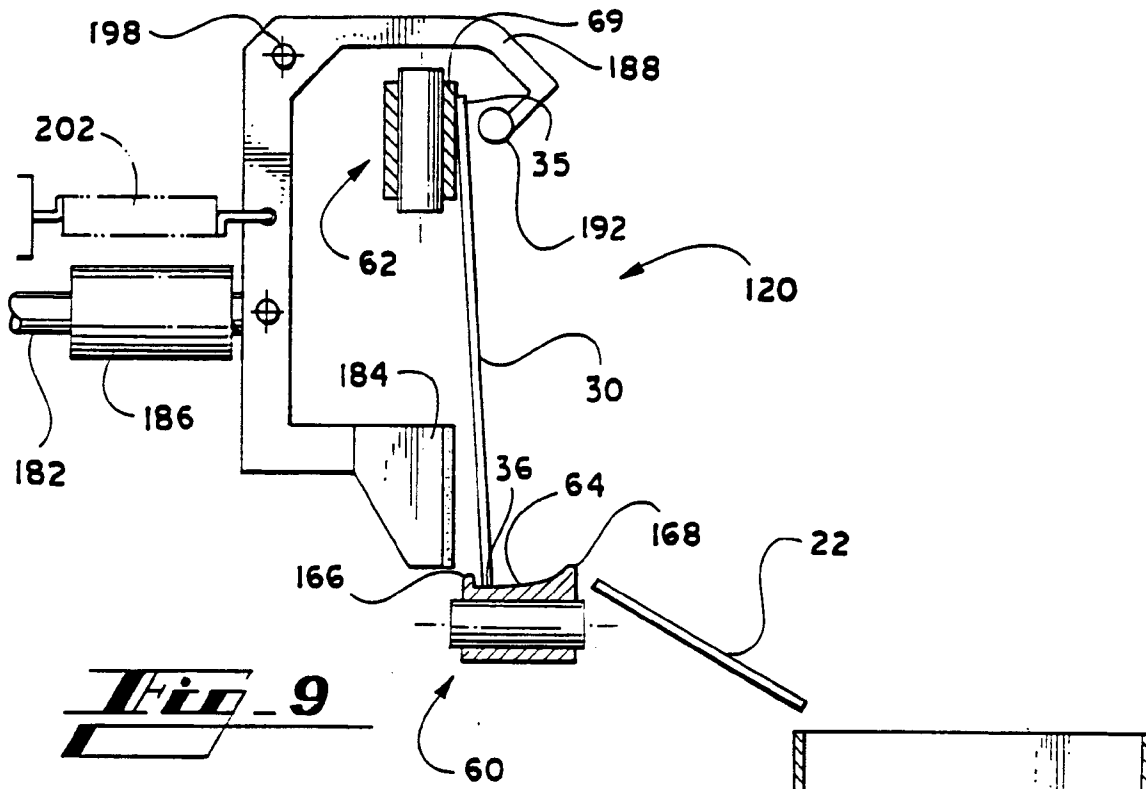
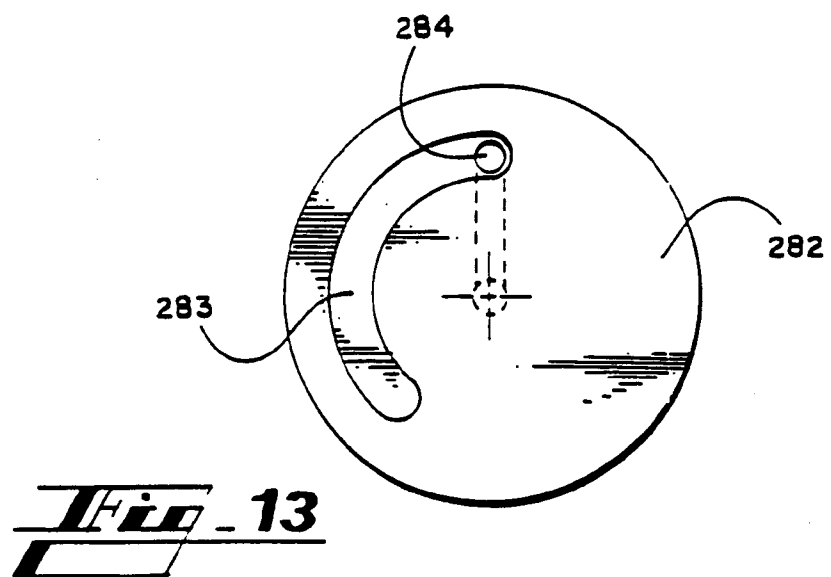
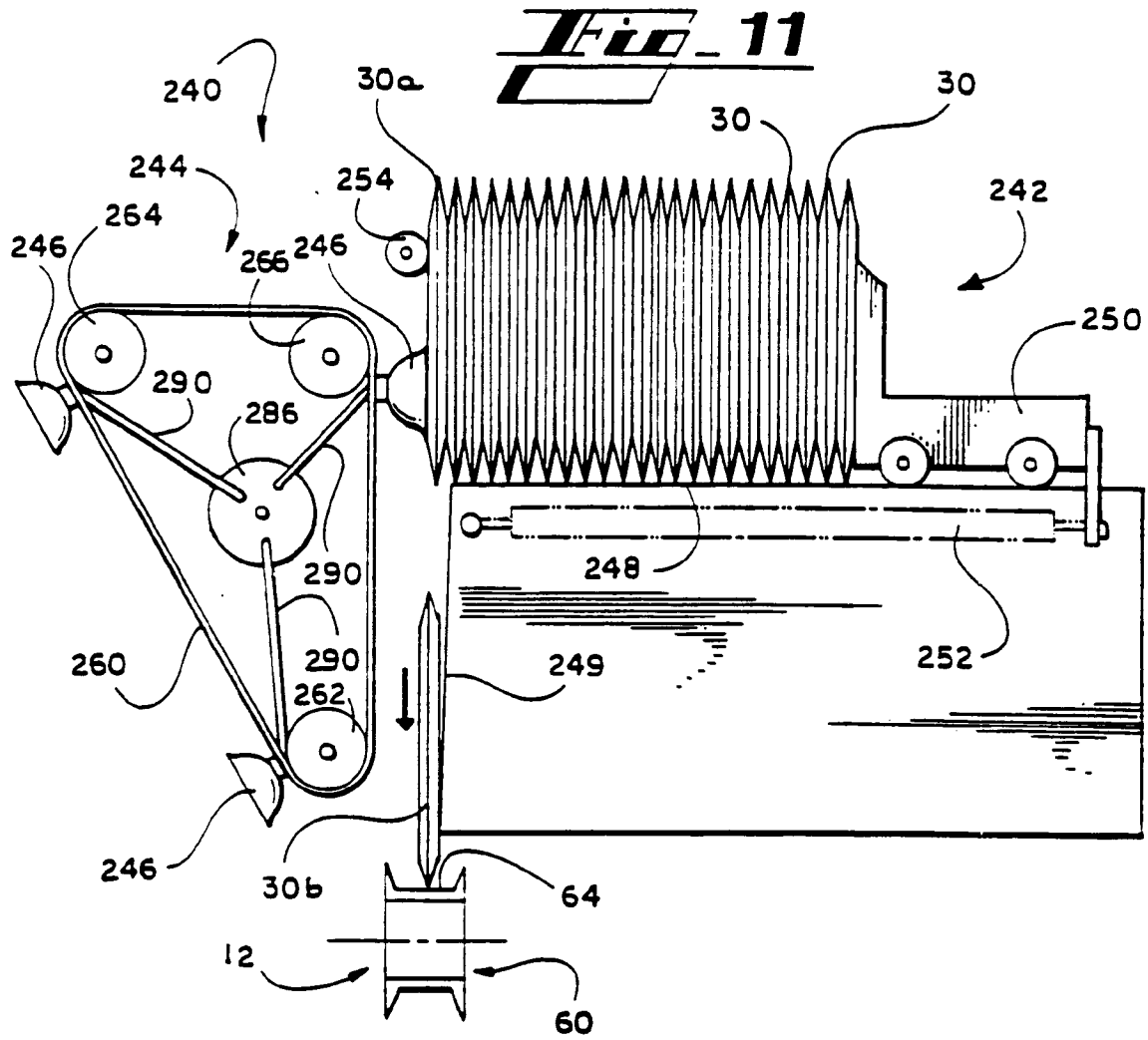


Fig. 7





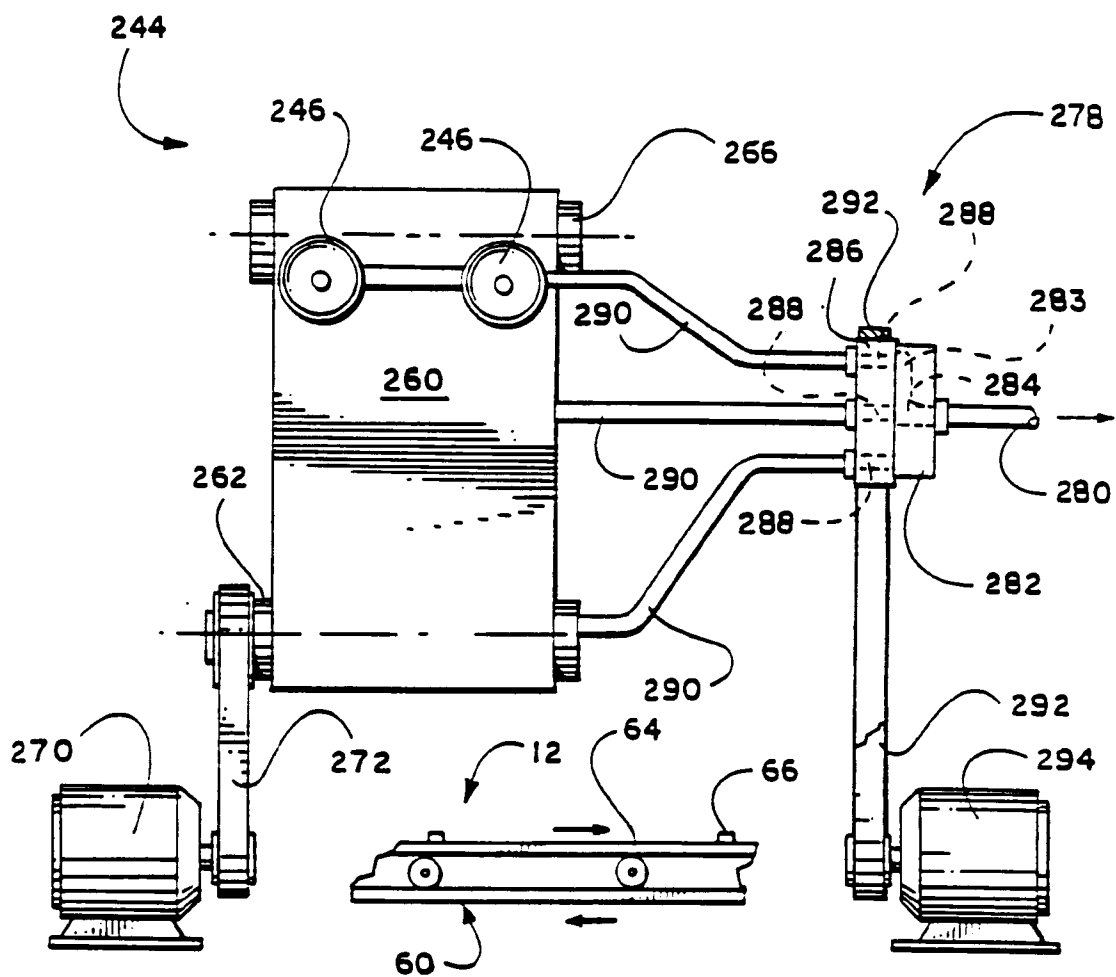


Fig. 12