

[54] MAIL TRAY UNLOADING

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[73] Assignee: Recognition Equipment Incorporated, Irving, Tex.

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[51] Int. Cl. .... B65g 65/04

[58] Field of Search ..... 198/106; 214/312, 313, 214/314, 152

[56] References Cited  
UNITED STATES PATENTS

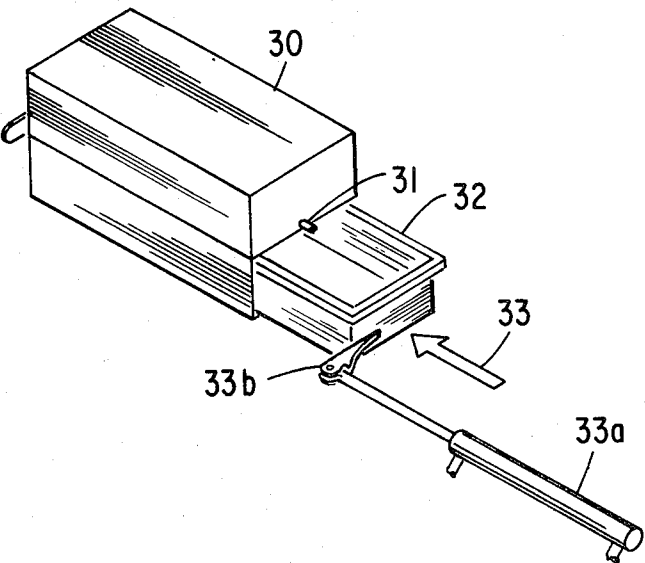
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Primary Examiner—Robert J. Spar  
Assistant Examiner—Lawrence J. Oresky  
Attorney, Agent, or Firm—Richards, Harris & Medlock

[57] ABSTRACT

A mail tray turnover box includes a load end, an unload end, and a bottom panel on which stacks of edge supported mail pieces are deposited from mail trays with the bottom panel having laterally spaced longitudinal slots extending through the unload end and a paddle movable through the box when each stack is placed on the bottom panel to move the stack in the direction of the unload end. The paddle has vertical slots open at the bottom paddle edge and aligned with the longitudinal slots in the bottom panel. A rank of upstanding aligned fingers mounted to follow a closed course having an upper traverse arranged so that the tip of the fingers pass upward through the longitudinal slots and through the vertical slots during movement through the unload end of the turnover box to push each stack from the paddle and out of the box.

11 Claims, 20 Drawing Figures



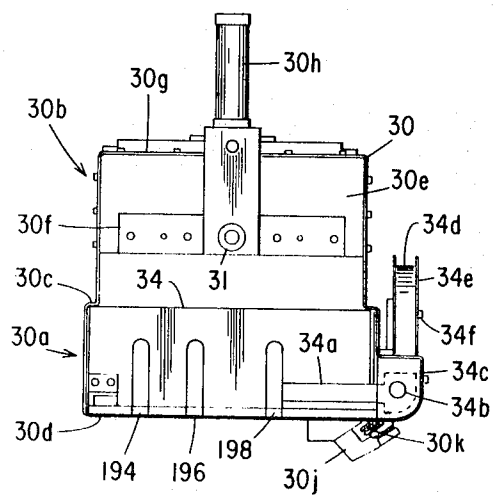


FIG. 7

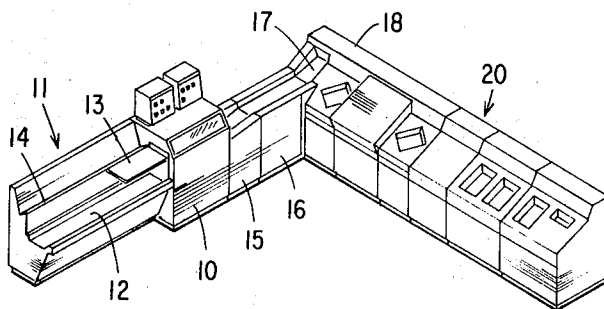


FIG. 1

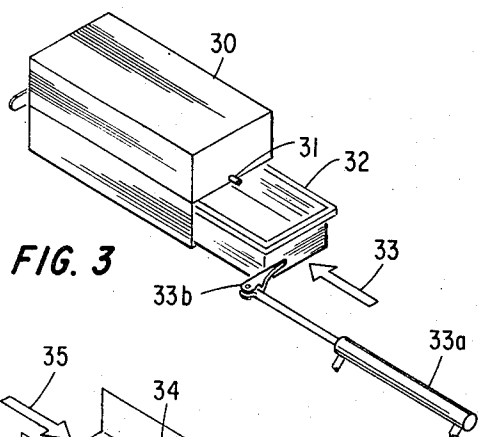


FIG. 3

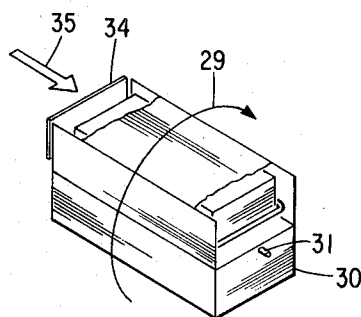


FIG. 4

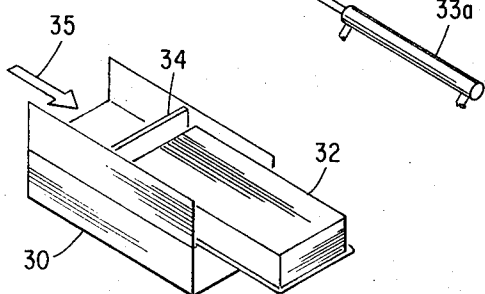


FIG. 5

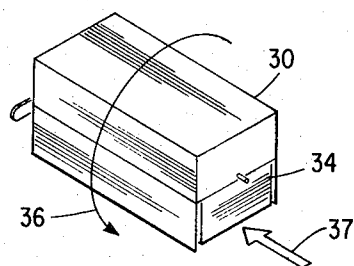


FIG. 6

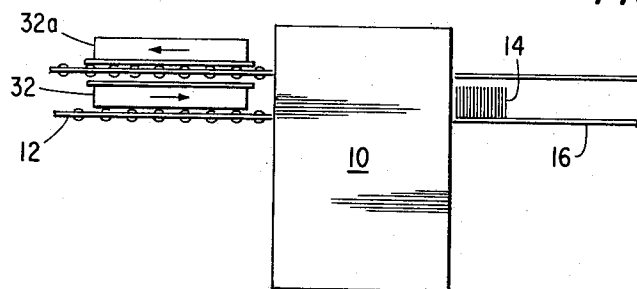


FIG. 2

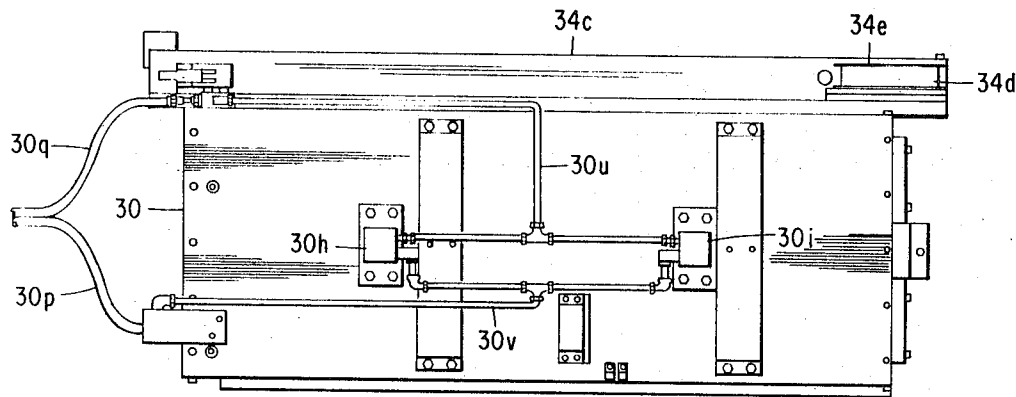


FIG. 8

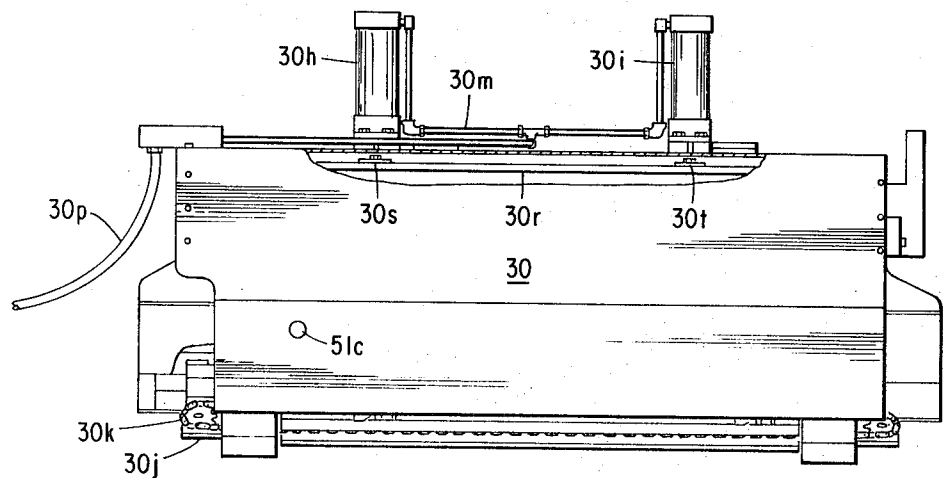


FIG. 9

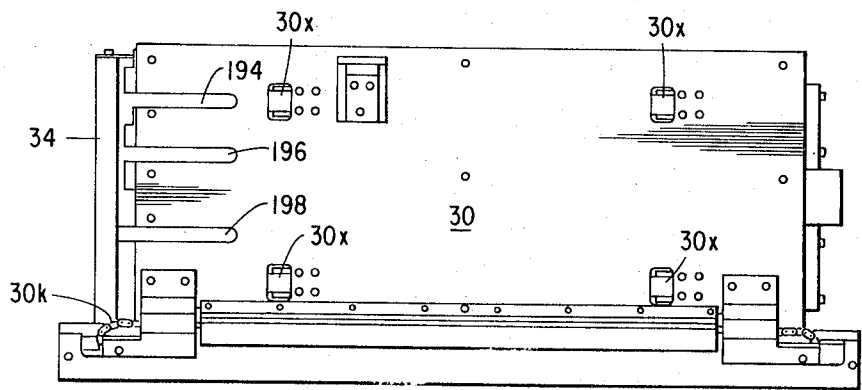


FIG. 10

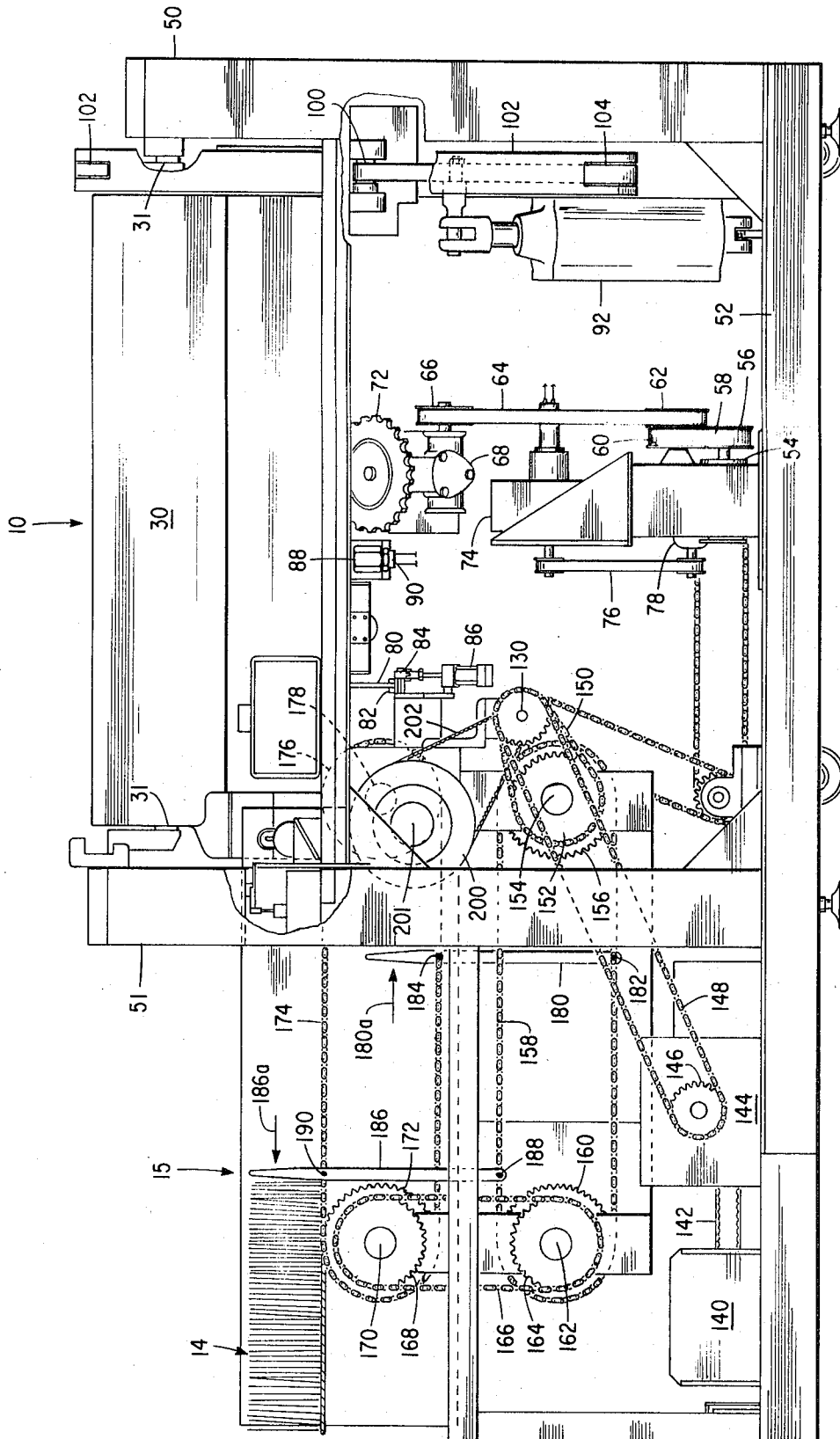


FIG. 11

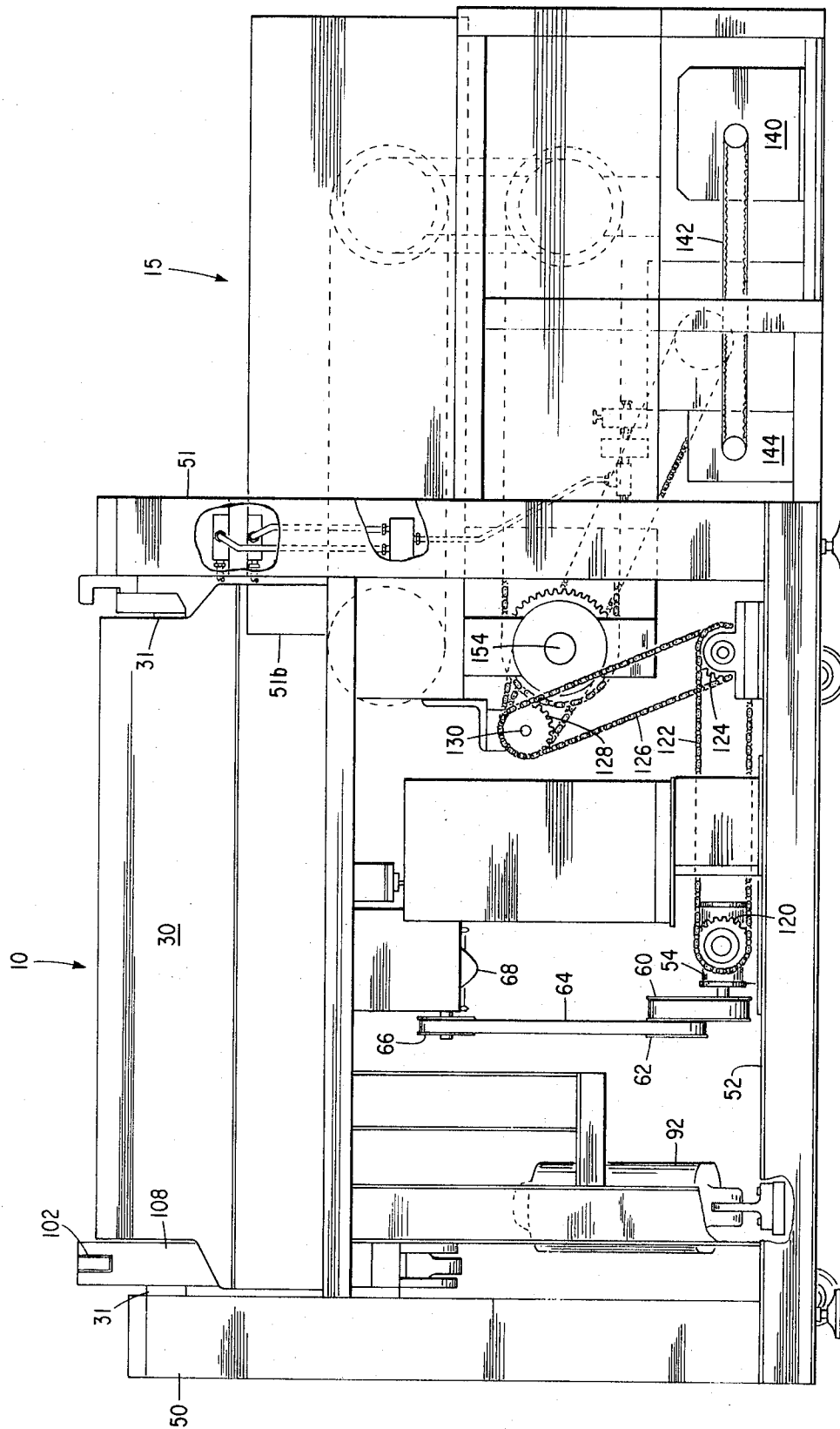
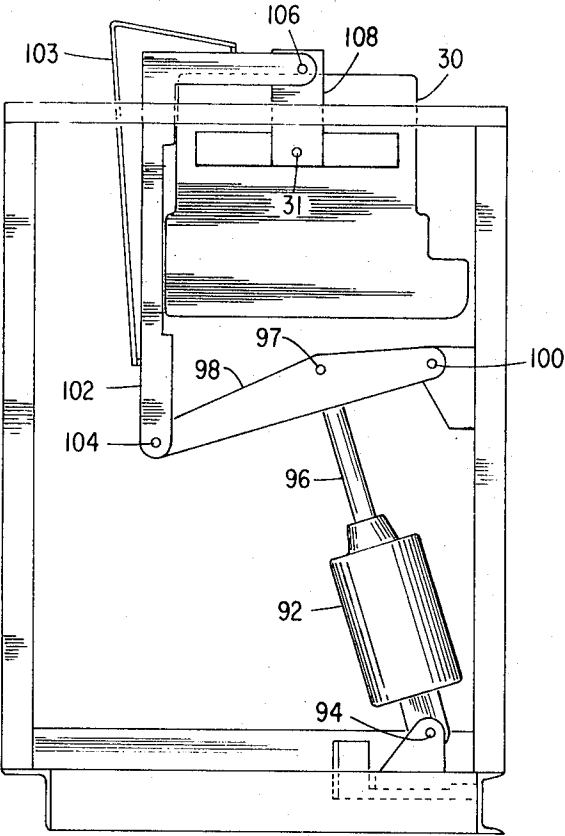
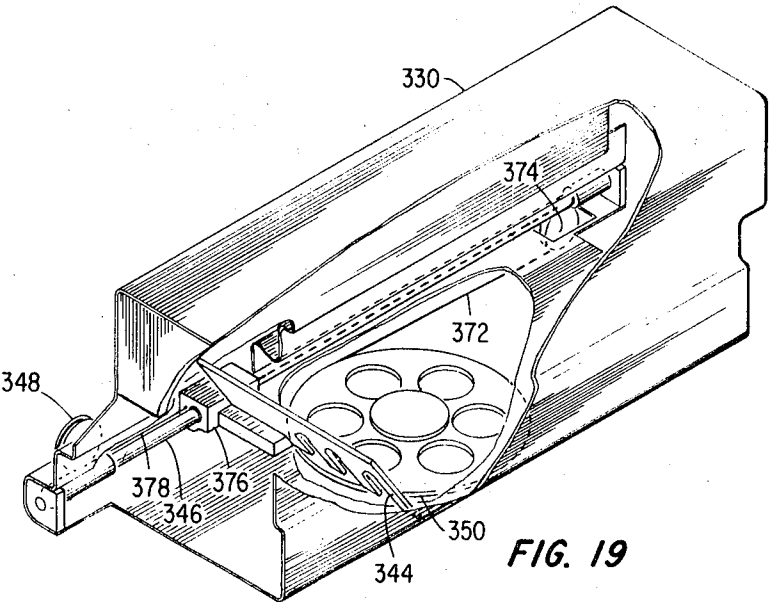
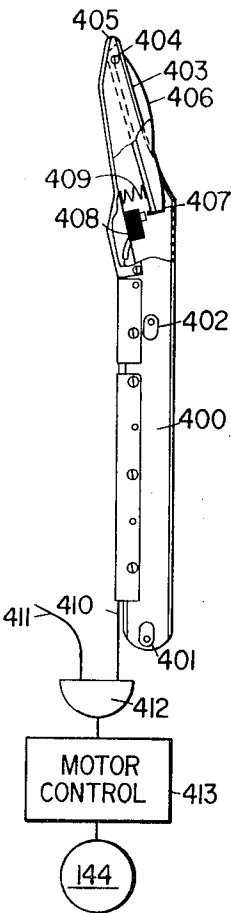


FIG. 12



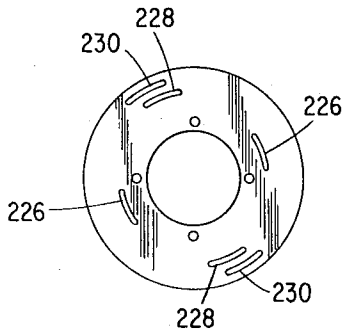


FIG. 16

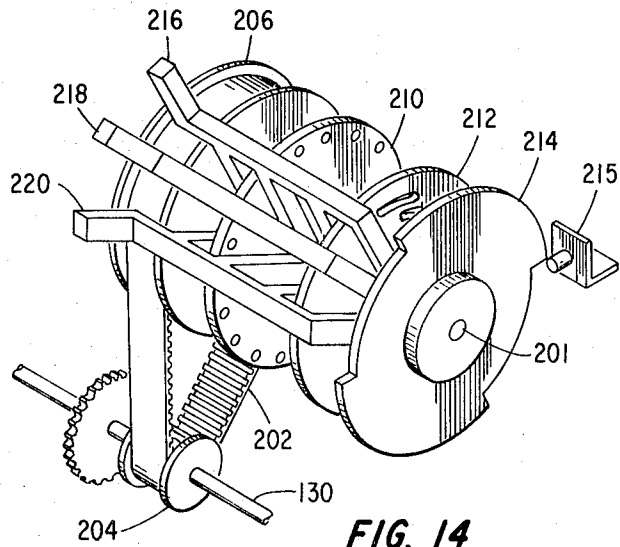


FIG. 14

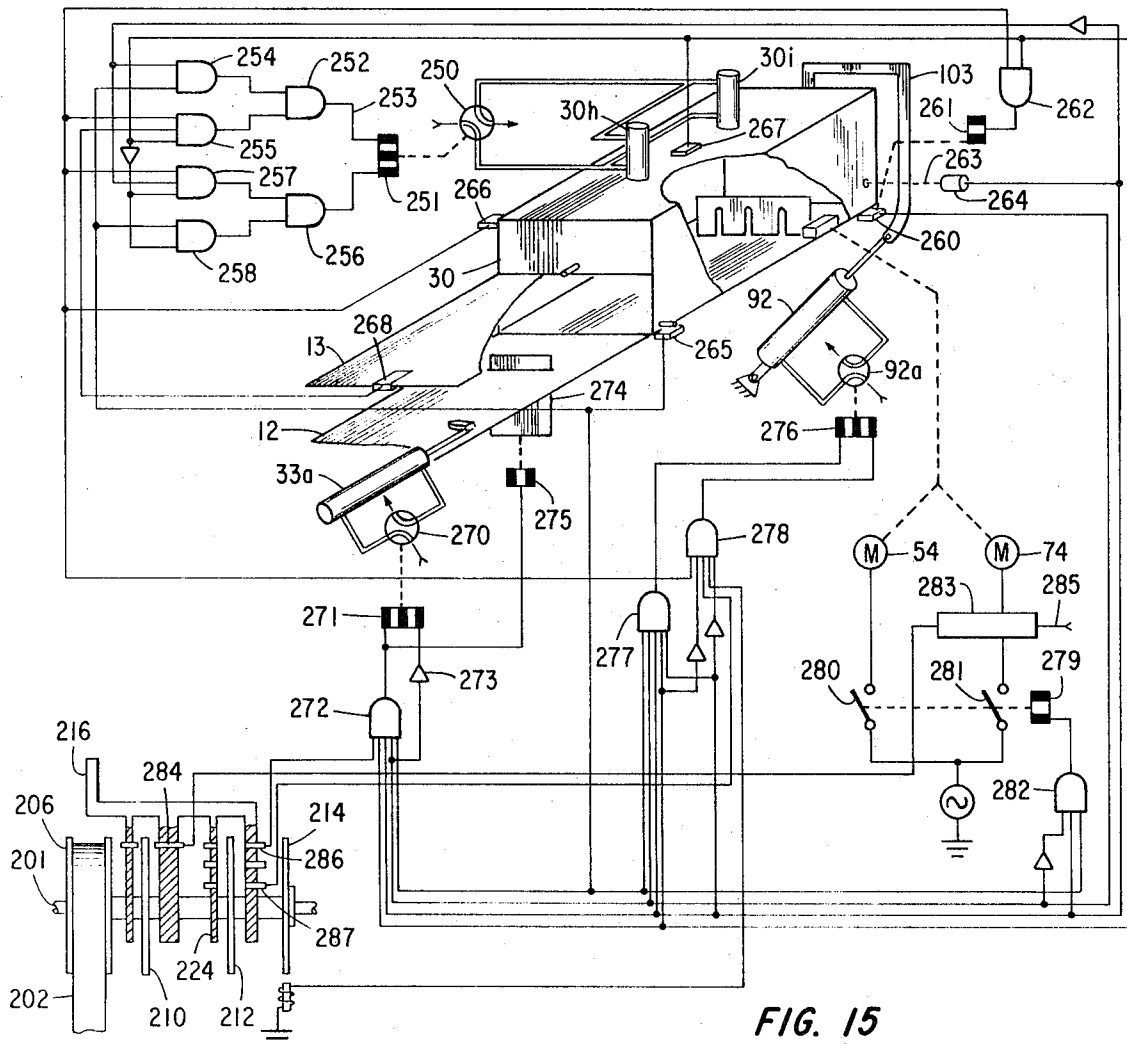


FIG. 15

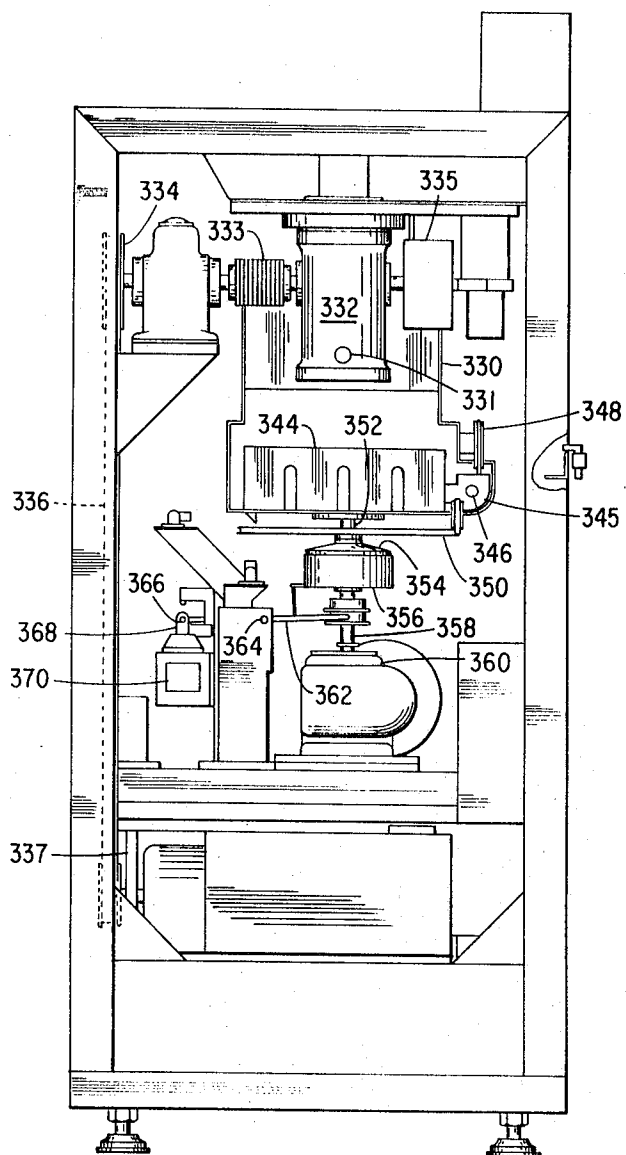


FIG. 17

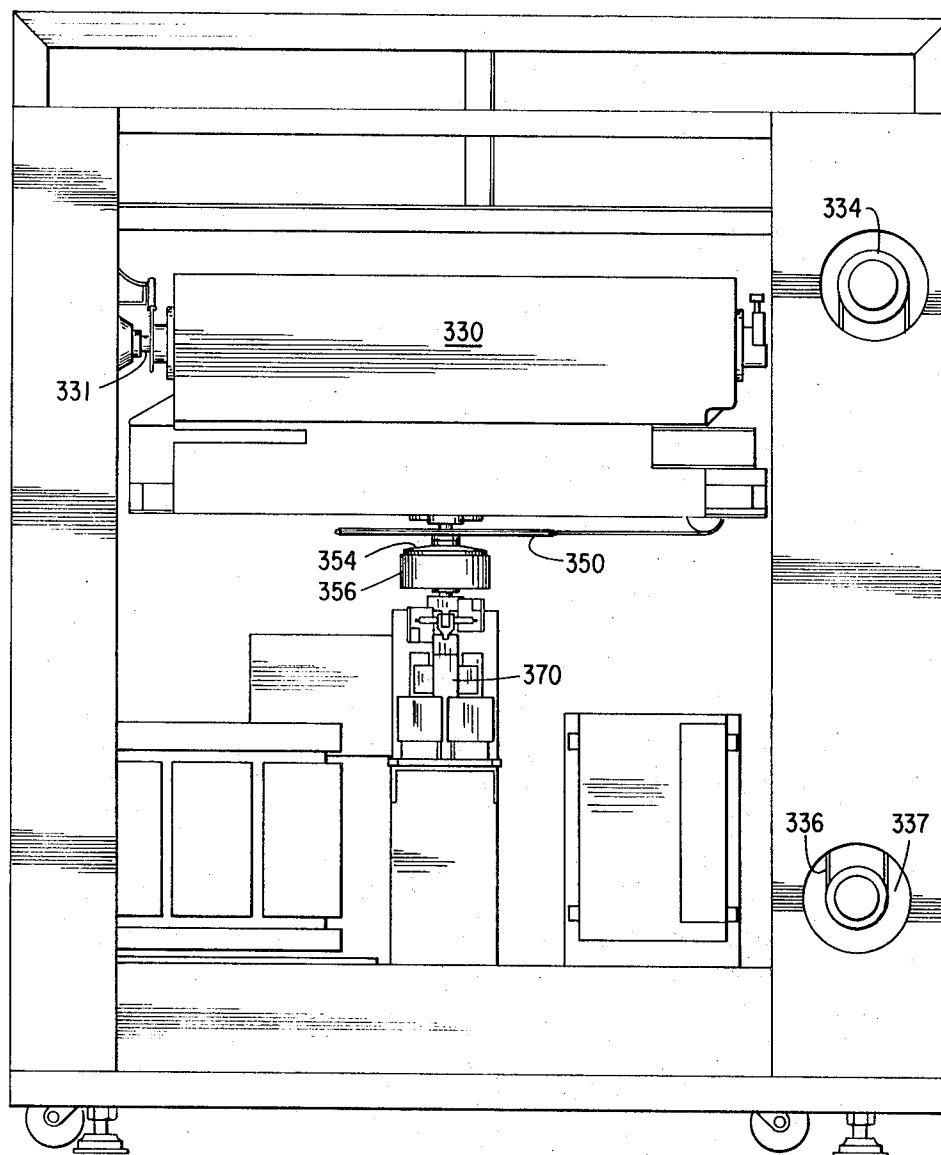


FIG. 18

## MAIL TRAY UNLOADING

This invention relates to an automatic mail tray unloader, and more particularly to a method and system for unloading trays loaded with mail pieces in an ordered stack while preventing reordering thereof.

In automatic mail handling systems, procedures adopted in the U.S. postal system includes canceling the stamp on each mail piece, facing all mail pieces in the same direction in a stack whereby the faced and canceled mail pieces may be sorted. Normally the stack of mail pieces is placed in a tray having a bottom and four upstanding sides. The documents are stacked as to be supported along the bottom edges thereof as they rest on the bottom of the tray.

Heretofore it has been proposed that documents be automatically unloaded from trays by inserting a pair of paddles into the ends of the tray, then drawing the paddles together to compress the stack of documents sufficient to permit them to be lifted out as a body. Mail pieces generally are of assorted sizes and thicknesses and varying quality of paper and thus are not readily amenable to such handling operations.

In contrast to prior proposals and in accordance with the present invention, there is provided a method of unloading a tray containing an ordered stack of edge supported documents. Initially, the tray with the stack of documents therein is rotated to an inverted position on an axis perpendicular to the face of the documents while restraining the stack from leaving the tray. Upon cessation of rotation, the stack is permitted to respond to gravity to transfer the stack as a body to a rest position supported by the top edges of the documents but outside of and beneath the tray. The inverted tray is then moved from its position above the stack. The stack is then rotated about the same axis while restraining the stack in a substantially fixed relation to the axis. Upon cessation of rotation, the stack is permitted to respond to gravity to transfer the stack to a rest position substantially the same as was initially occupied when in the tray, but now outside the tray.

In one mode, the restraint applied to the stack during rotation is provided by moving an auxiliary pan toward and away from the plane of the top of the tray in correlation with rotation of the stack.

In accordance with another mode, the restraint applied during rotation is provided by controlled centrifugal forces created by rotation of the tray in accordance with a predetermined rotational velocity profile.

In accordance with another aspect of the invention, a method is provided for supplying a continuous flow of mail from batches of mail dumped from trays in a dump zone. A first stack of edge supported mail pieces is moved from the dump zone toward a transport which removes mail pieces one at a time from the front of the stack. Exit of the rear of the stack from the dump zone is sensed and a second mail stack is introduced. The second stack is propelled toward the transport until the front thereof catches up with the rear of the first mail stack. Movement of the second mail stack is moderated to maintain continuity between the first and second mail stacks.

For a more complete understanding of the invention, reference may now be had to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a mail handling system in which the tray unloader of the present invention forms a part;

FIG. 2 illustrates the supply and ejection of mail trays from the unloader of FIG. 1;

FIGS. 3-6 illustrate the sequence of steps embodying the present invention in unloading mail trays automatically;

FIG. 7 is an end view of the turnover box of FIGS. 3-6;

FIG. 8 is a top view of the box of FIG. 7;

FIG. 9 is a side view of the box of FIG. 7;

FIG. 10 is a bottom view of the box of FIGS. 7-9;

FIG. 11 is a front view of an unloader mechanism including the box of FIGS. 7-10;

FIG. 12 is a rear view of the unit of FIG. 10;

FIG. 13 is a diagrammatic end view of a portion of the system of FIGS. 10 and 11;

FIG. 14 is a diagrammatic view of a form of control system for the unit of FIGS. 1-12;

FIG. 15 is an isometric view of a sensor disk assembly of FIG. 14;

FIG. 16 is a view of one of the disks of the unit of FIGS. 14 and 15;

FIG. 17 is an isometric drawing of a modified form of the tray unloader box illustrating a preferred embodiment thereof;

FIG. 18 is an end view of an unloader system for incorporating the box of FIG. 12;

FIG. 19 is a side view of the unit of FIG. 13; and

FIG. 20 illustrates a preferred form of an unloader finger and motor control.

Referring to FIG. 1, a system embodying the present invention has been illustrated in block form. A tray unloader 10 primarily involved in the present invention is shown in association with a tray conveyor section 11. Section 11 includes a trough conveyor 12 into which trays loaded with mail are placed. The mail normally is edge supported with the stamp up. In the system illustrated, the stamps face away from the unloader 10. Also included is an empty tray return structure which includes a platform 13 on which the empty trays are received when ejected from the unloader. The empty trays are then flipped on edge into a channel 14 to be again filled with mail and placed on conveyor 12.

As will later be described, unloader 10 serves to receive the trays top up and loaded with an ordered stack of mail pieces, invert the tray and the stack to dump the stack, and deliver the empty tray to platform 13. The stack then is inverted to its upright position and delivered by way of a transition section 15 and an edger module 16 to a feeder 17. Feeder 17 serves as the input to the document transport unit 18 along which the mail pieces travel piece by piece in tandem during which travel each piece is read, indexed and handled by a sorter-stacker system 20.

The present invention relates to the unloading of trays delivered by conveyor 12 in such a manner that the mail pieces having been faced and canceled will be received with the stamp up and will be maintained in the order that they are placed in the tray. The mail pieces then will be entered batch-wise into a continuous stream of documents delivered from the edger module 16 to the feeder 17.

Mail pieces delivered to the feeder 17 move from the feeder 17 in a continuous stream. One capability of the present invention is to supply mail pieces in batches, as they necessarily are arranged in trays delivered to the

unloader, and then supply mail pieces in the same order to the tail end of the stream leading to the feeder 17.

The operational sequence is shown by FIGS. 2-6.

In FIG. 2, the tray unloader 10 is shown with tray 32 approaching the unloader 10 on a conveyor 12 with an unloaded tray 32a being delivered onto platform 13. The mail pieces, maintained in the same order as they appeared in tray 32, may then be conveyed by edger module 16.

FIG. 3 illustrates a turnover box 30 used in unit 10. Box 30 is a rectangular polyhedron having the lower half of both ends open. The box 30 is to be mounted for rotation about a longitudinal axis represented by the stub shaft 31. Trays, such as tray 32, are delivered intermittently into box 30 in the direction of arrow 33.

In FIG. 4, after tray 32 is completely nested, box 30 is rotated in the direction of arrow 29 on shaft 31 so that the mail pieces, stacked in the tray 32, drop out of the tray. The bottom panel of box 30 is partially shown so that inverted tray 32 is seen in relation to a paddle 34.

In FIG. 5, after the documents leave tray 32, paddle 34 is actuated to move in the direction of arrow 35 to eject inverted tray 32 from box 30. After tray 32 has been ejected in the inverted position, box 30 is rotated in the direction of arrow 36 to the original upright position. Paddle 34 rotates with box 30 so that the stack of mail that was in the top half of the box 30 is returned to the bottom panel. Paddle 34 may then be actuated in the direction of the arrow 37 to sweep the documents out of the box 30 as shown in FIG. 6.

It is highly desirable that documents comprising stack 14, FIG. 2, maintain the same orientation or order when leaving box 30 as when placed in tray 32. In emptying tray 32, it has been found necessary to prevent the documents from falling at random from inverted tray 32. To this end two modes of operation are employed and will be described herein for maintaining the document order.

The first mode involves the use of a turnover box 30 in the form generally illustrated in FIGS. 7-9 and embodied in the system of FIGS. 10-12. The second and preferred mode is illustrated in FIGS. 13-15.

In FIGS. 7-9 a pan is lowered to closely adjacent the top of tray 32 preparatory to rotating the box 30. The pan-tray relationship is maintained until the box has been inverted. The documents then rest on the pan. The pan is then lowered to a point adjacent the top of the turnover box which is in an inverted position. The inverted tray may then be ejected from the box. The pan is then raised to position the documents closely adjacent the inverted bottom box 30. The box is again rotated to its upright position so that the documents rest on the bottom of box 30. The pan is then elevated and paddle 34 is actuated to move the documents from the box.

In the second mode, the box is rotated at a controlled velocity profile to restrain the documents during both cycles of rotation of the box so that they fall from tray to top and from top to bottom as a body, not randomly.

FIG. 7 is an end view of box 30 adapted for rotation on shaft 31. The bottom half 30a is wider than the top portion 30b. A shoulder 30c defines the transition between bottom 30a and top 30b.

The lower half of the ends of box 30 is open, i.e., the portions between shoulder 30c and the bottom plate 30d. The top half of each end is closed by a plate such

as plate 30e which extends from boundary 30f to the top plate 30g. Paddle 34 extends laterally across the bottom of the box 30. Paddle 34 is mounted by means of a bar 34a onto a longitudinal shaft 34b. Shaft 34b is mounted in a longitudinal chamber 34c. The paddle 34 is connected to a steel band 34d which is wound onto a spring wheel 34e. Spring wheel 34e is mounted on a shaft 34f and is biased by a spring (not shown) normally to urge paddle 34 to the input end of box 30.

Mounted on top of box 30 is a pair of vertically oriented air cylinders 30h and 30i. Only the cylinder 30h is shown in FIG. 7.

A sprocket chain 30k is supported by sprocket wheels mounted on a block 30j adjacent to the lower right hand corner of box 30. Chain 30k is connected to bar 34a. A sprocket wheel, as will later be described, is operative when box 30 is in the upright position shown in FIG. 7, to mesh with chain 30k to drive paddle 34 to the output end of box 30, opposing the force applied by the spring wheel 34e and storing energy in wheel 34e. The paddle 34 is latched at the output end of box 30. As the paddle 34 becomes latched, conveyor 12 is signaled to deliver a loaded tray into the box 30.

Thereafter, when box 30 is inverted, paddle 34 is released. The energy stored in the spring wheel 34e is then utilized to propel the paddle to the input end of box 30, thereby ejecting the inverted tray. Paddle 34 then remains in the input end until box 30 is rotated to its upright position in which position paddle 34 is located behind the stack of documents. Sprocket chain 30k, engaged by a sprocket wheel, drives paddle 34 to the output end of the box 30, pushing the stack of documents from box 30.

In the top view, FIG. 8, the chamber 34c is shown extending the length of box 30 on the same side as the spring wheel 34e. The periphery of spring wheel 34e extends into the top of box 34c so that the spring can be drawn the length of chamber 34c beneath the top panel thereof. Piping is shown in FIG. 8 and is provided to actuate the cylinders 30h and 30i with compressed air by way of flexible lines 30p and 30q.

In FIG. 7, it will be noted that the axis of the sprocket on which chain 30k is mounted is tilted to about 60° from the horizontal. As further shown in FIG. 9, the box 30 is viewed from the back with the chain 30k extending the length of the box 30 and exposed for substantially the entire length of the box 30.

Also shown in FIG. 9 is a mail pan 30r. Pan 30r is mounted on piston rods extending from cylinders 30i and 30h and secured to pan 30r by transverse bars 30s and 30t. Pan 30r is inverted and is three sided, having only a bottom panel and two end panels. Compressed air from line 30q, FIG. 8, is fed by way of line 30u to cylinders 30i and 30h to drive pan 30r downward to insert the end panels of pan 30r into a mail tray. With pan 30r thus positioned, the box 30 may be inverted permitting the documents to fall from the bottom of the mail tray onto the pan 30r. Thereafter, compressed air from line 30p supplied by way of line 30v will actuate cylinders 30i and 30h to move pan 30r toward the now inverted top of the box 30. By this means the mail pieces are lowered in a controlled manner out of the inverted tray. When the mail pieces are clear of the mail tray, the mail tray is ejected. Thereafter, compressed air from line 30u raises pan 30r with the mail resting thereon until it is adjacent the now inverted bottom of box 30. Box 30 is then rotated back to its original posi-

tion. In this position the mail pieces rest on the bottom of box 30. Air from line 30v actuates cylinders 30i and 30h to elevate pan 30r so that the paddle 34 may sweep the documents out of the box 30 toward the rear of the column of documents being handled by feeder 17, FIG. 1.

In FIG. 10 the bottom of box 30 is characterized by four clutched rollers 30x over which the mail tray is to roll. Rollers 30x permit the tray to roll forward freely but will not roll in the opposite direction. Further, three slots 194, 196 and 198 are formed in the bottom plate of box 30, extending to the front lip of the bottom plate.

Now that certain of the details of box 30 have been described, reference should be had to FIGS. 11-13 wherein the box 30 is incorporated in an actuating mechanism comprising unloader 10 which is shown in conjunction with the transition section 15.

In FIG. 11 box 30 is rotatably supported on axis 31 from standards 50 and 51. Standards 50 and 51 are supported from a base 52. Beneath box 32 and supported by base 52 are controls and drive means for actuation of the system. A motor 54 mounted on base 52 drives a pulley 56 which is coupled by a belt 58 to a pulley 60. Pulley 60 is mounted on the same shaft with a pulley 62 which is connected by way of belt 64 to the input pulley 66 on an angle gear drive 68. The output shaft of drive 68 supports a sprocket 72 which meshes with chain 30k, FIG. 7, when the box 30 is in the upright position.

A servo control motor 74 is mounted immediately above motor 54 and is coupled by way of a belt 76 to the input of a gear box 78. Pulleys 60 and 62 are mounted on the output shaft of the gear box 78.

Motor 54 serves to drive sprocket 72 at a high speed preparatory to insertion of a mail tray into box 30 and to permit a new stack of documents in box 30 to catch up with the trailing end of the preceding stack. Servo control motor 74, actuated after motor 54 is deactuated, drives sprocket 72 at a low speed determined by the rate at which a stack of documents is assimilated by feeder 17, FIG. 1, as will later be explained.

A bracket 80 is secured to the bottom of box 40 and extends downwardly therefrom supporting a roller 82 at the lower end thereof. Roller 82 engages a latch arm 84 which is under the control of a latching solenoid 86. When the solenoid 86 is energized, roller 82 is in a notch in arm 84 thereby preventing rotation of the box 30 and thus assuring maintenance of registration between the sprocket 72 and the chain carried by the box 30.

A paddle position sensor 88 is actuated by the chain in box 30 to provide an output on conductors 90 which indicates at all times the location of paddle 34 in box 30.

Box 30 is rotated by actuation of a pneumatic cylinder 92 and a four bar linkage. This linkage is best illustrated in the fragmentary view shown in FIG. 13 wherein the lower end of the cylinder 92 is attached to the frame by a pin 94 to permit pivotal movement of the cylinder 92. A piston rod 96 is connected to a midpoint on an arm 98 by pin 97. One end of arm 98 is coupled to the frame by a pin 100. The other end is connected to an L-shaped bar 102 by a pin 104. Bar 102 is provided with a stiffening plate 103. The other end of bar 102 is connected by way of a pin 106 to an upstanding arm 108 which is fastened to box 30.

When cylinder 92 is actuated to retract piston rod 96 into cylinder 92, box 30 is rotated counterclockwise to an inverted position. When the piston rod 96 is driven upward, the box 30 is again rotated in clockwise direction to its original position.

FIG. 12 is a back side view of the unit which, in FIG. 11 is shown from the front or operator's side. As seen in FIG. 12, motor 54 also drives a sprocket 120 through an angle gear arrangement (not shown). Sprocket 120 is coupled by way of chain 122 to a sprocket 124 which drives a chain 126 leading to a sprocket 128 on a shaft 130. Shaft 130 is an input drive shaft for a transfer mechanism in the transition unit 15.

In transition unit 15 a motor 140 is connected by way of a timing belt 142 to a gear box 144. As best seen in FIG. 11, gear box 144 has an output sprocket 146 which is coupled by way of a chain 148 to shaft 130. Thus, both motors 54 and 140 may drive the shaft 130.

Shaft 130 is coupled by a sprocket chain 150 to a sprocket 152 which is mounted for rotation on axis 154. A set of six sprockets of diameter larger than sprocket 152 is also mounted on pivots whose axes are aligned with axis 154. One such sprocket, the sprocket 156, may be seen in FIG. 10. Five like sprockets are also provided. A sprocket chain 158 is connected from sprocket 156 to a sprocket 160. Sprocket 160 is one of six sprockets mounted in alignment on an axis 162. A smaller sprocket 164 on axis 162 is connected by chain 166 to a like sprocket 168, mounted on axis 170. A total of six large and six small sprockets are mounted on axis 170, only one of which, sprocket 172, may be seen. A chain 174 is connected to sprocket 176 which is one of a set of six sprockets mounted on axis 178.

The large sprockets mounted on axes 154, 162, 170 and 178 all carry chains such as chains 158 and 174, which chains each carry two unloader fingers.

More particularly, as shown in FIG. 11, an unloader finger 186 is connected at its lower end to chain 158 by pin 188. It is also connected at a point below the top thereof to chain 174 by pin 190 so that the tip of the finger 186 extends above the plane of the bottom of box 30 when moving in the direction of arrow 186a. There are three such fingers mounted in alignment with finger 186 to form a rank of fingers, which rank moves in the direction of arrow 186a. The fingers serve to push on the rear of a stack of mail which has been moved to the front end of box 30 by paddle 34.

Finger 180 is connected at point 182 to a second chain which is positioned behind chain 158 and to a second chain at point 184 which is positioned behind chain 174. There are two additional fingers similarly mounted on chains and in alignment with finger 180 to move as a rank in the return direction indicated by arrow 180a. It will be noted that the tip of finger 180 travels below the plane of the bed of the box 30. Thus, during the return trip the fingers do not interfere with mail being moved forward by the rank which includes finger 186. It will now be clear that the chains mounted on the sprockets which rotate on axes 154 and 162 support the lower extremities of the six fingers while the chains on sprockets which rotate on axes 170 and 178 support the six fingers at the midpoints thereof. The fingers are divided into two ranks of three fingers per rank. The two ranks are spaced apart along the chain by distance equal to one-half of the chain length.

Fingers 180 and 186 extend above the plane of the floor of box 30 during each orbit. Because shaft 178 is

located under box 30, the fingers 180 and 186 must pass up through the bottom of box 30. In order to accommodate movement of fingers 180 and 186, the bottom of the box 30 is slotted at the front end. Paddle 34 and the bed of transition section 15 also are slotted so that fingers 180 and 186 may pass therethrough. As shown in FIGS. 7 and 10, the bottom plate 30d of box 30 has three slots 194, 196 and 198 extending to the front edge from a point beyond the periphery of sprocket 176 as viewed in FIG. 11.

Unit 10, FIG. 11, includes a control system including a sensor disk assembly 200 mounted for rotation on axis 201. Assembly 200 is shown in FIGS. 14-16. More particularly in FIG. 14, shaft 130, also seen in FIG. 11, also serves to drive a timing belt 202 from a timing pulley 204. Belt 202 drives a pulley 206 which is mounted on a shaft 208. Shaft 208 also carries two code disks 210 and 212 and a proximity switch cam 214. A guard band sensor bar 216 has fingers which extend over code disks 210 and 212. A paddle motor sensor bar 218 has similar fingers. A speed sensor bar 220 also has similar fingers encompassing the code disks 210 and 212.

FIG. 15 shows sensor arm 216 as a typical arm viewed from the front. Sensor arm 216 has one bar 222 in which three lamps are mounted at three radii. A second bar 224 supports three light sensors.

Disk 210 shown in FIG. 16 has six arcuate slots therein. Slots 226 are on a small radius located diametrically opposite each other and extend approximately 30°. Slots 228 are on an intermediate diameter and are slightly offset from quadrature relation with respect to slots 226. Slots 230 are on a larger diameter and are oriented in quadrature relation to slots 226. Slots 230 pass light from a lamp on arm 222 to a sensor on arm 224 to initiate movement of the paddle 34. Light passing through slots 228 similarly is sensed to indicate the speed at which the fingers 180 and 186 are propelled. Light passing through slots 226 is sensed to prevent rotation of box 30 when either finger 180 or finger 186 is positioned in any one of slots 194-198.

In operation, trays may be loaded into box 30 by hand. Preferably they will be loaded automatically. Two basic assemblies are employed. These assemblies are a load cylinder 33a, FIG. 15, and a gate. Load cylinder 33a is mounted on the frame mount 14. It is air operated and solenoid valve controlled. As the cylinder rod extends, eccentric, spring-loaded ram 33b pushes the tray completely into box 30. As the ram returns to its initial position, it is pushed out of the path by any following mail tray.

The request command is a function of (1) the box paddle being in the forward position, (2) a tray-in-box photocell path being unobstructed, (3) the guardband sensor of unit 200 being properly positioned, (4) the mail pan 30r raised and (5) the box 30 being stationary.

Each command to release and load a tray into the box 30 is initiated by the sensor unit 200. The command to release and load comes only after the transition fingers 180 or 186 have cleared the slots in the front of box 30, thereby clearing the last of the mail items dumped during the previous cycle. The front end of the tray must be loaded all the way to the forward end of the box. In FIG. 11, a photocell sensor 51a mounted adjacent standard 51 detects tray presence. Sensor 51a is located near the forward end of box 30 at the operator side of unit 10. A light source 51b, FIG. 12, is mounted in alignment with holes 51c, FIG. 9, as

is sensor 51a. When a tray is fully inserted in box 30, the light beam is interrupted and sensor 51a then responds, indicating a tray is present. The mail pin 30r lowers to trap the mail in the tray and box 30 rotates 180° counterclockwise (as observed from the rear end) in approximately 0.7 seconds. The mail pieces are then lowered from the tray on the mail pan 30r into what is now the bottom of the box. The tray is then ejected from what is now the top of the box where it is sent to be reloaded. The ejection is accomplished by means of paddle 34. When a tray is completely clear of the box 30 and comes to rest upside down in the horizontal position directly above the conveyor that loaded it into box 30, a microswitch detects tray presence and position. When this sensor responds, it initiates a command which sends the mail pan to the now up position, entrapping the mail pieces. Then the box rotates back 180° in the clockwise direction, thus positioning the mail into the bottom of the box in the same order and orientation in which it entered. The pan is raised above the mail, leaving it on the box waiting for transfer.

Paddle 34 is now in back of the mail ready to push it out of the box to the transition unit 15. The signal to drive the paddle forward and unload the mail from the box comes from the sensor on bar 218. The sensor initiates this command when the transition fingers 180, 186 are out of the guardband or finger protect region. The forward end of the stack of mail pieces overtakes the transition fingers and is set in the upright position. A switch in the center finger senses the mail and deenergizes the high speed paddle drive to keep the mail from being pushed over the top of the fingers. The paddle continues to discharge the mail in response to servo motor 74 to the transition unit until it reaches the end of its travel. The continued feeding of the mail through the transition unit is then taken over by the next set of fingers.

As soon as the fingers are clear of box 30, the complete cycle is repeated. The rate at which the transition fingers feed the mail is a function of a signal generated by the feeder module of FIG. 1. The signal is initiated on a demand basis as required by the feeder.

The control unit of FIG. 14 is diagrammatically shown in FIG. 15 as a part of one embodiment of a control system. In FIG. 15, box 30 is turned over by actuation of cylinder 92 acting through arm 103. Cylinder 92 is controlled by a valve 92a which in turn is actuated by a solenoid 276. Solenoid 276 is actuated to turn box 30 over in response to the output of an AND gate 277. The box 230 is erected upright in response to the output of an AND gate 278.

Cylinders 30h and 30i are actuated under the control of a valve 250. Valve 250 is actuated by a solenoid 251. An OR gate 252 enables line 253 to cause cylinders 30h and 30i to lower pan 30r. One input of OR gate 252 is supplied by an AND gate 254. An AND gate 255 also is connected at its output to AND gate 252. Similarly, an AND gate 256 is provided at the second input of relay 251 and is controlled by AND gates 257 and 258.

A latch unit 260 is connected to box 30 and serves to latch the paddle 34 when it is moved to the front of the box 30. The latch is adapted to be released by a solenoid 261 which is operated under the control of an AND gate 262.

A light beam 263 passes through box 30 when upright and when a tray is not present. The light beam is sensed by a photocell unit 264.

A switch 265 is provided adjacent box 30 and is actuated or closed to enable its output line when box 30 is in the upright position. A switch 266 is provided at the opposite corner of the box and is adapted to be closed to enable its output line when box 30 is rotated to its inverted position.

A switch 267 is mounted on the top of box 30 between cylinders 30h and 30i and is closed when the pan 30r is in its raised position. A switch 268 is mounted in plate 13 and is adapted to be closed to enable its output line when an inverted tray is ejected from box 30 onto the plate 13. Cylinder 33a is controlled by a valve 270 which is actuated under the control of a solenoid 271. Solenoid 271 is controlled at one input by an AND gate 272 and at the other input by an inverter 273. A gate 274 is solenoid operated as by solenoid 275. When solenoid 275 is energized, the gate 274 is retracted downward so that a loaded tray resting on the unit 12 may be forced into the box 30 by actuation of the cylinder 33a.

Motors 54 and 57 are alternately energized under control of a solenoid 279 to actuate switches 280 and 281. Solenoid 279 is energized in response to an AND gate 282. A controller 283 serves to control the speed of motor 274 in response to an output of a photocell 284 and to an input on line 285 which lead from feeder 17 as a demand signal.

The system of FIG. 15 may operate to assure the following sequence:

A. A tray 34 may be loaded into box 30 under the following conditions:

1. Box 30 is upright, switch 265 closed
2. No fingers are extending through the bottom of box 30, photocell 286 is illuminated
3. Paddle 34 is latched, switch 260 closed
4. Pan 30r is up, switch 267 closed
5. Beam 260 is not interrupted, photocell 264 illuminated

B. Pan 34 then lowers under the following conditions:

1. Beam 260 is interrupted by a tray present, photocell 264 dark

2. Box 30 upright, switch 265 closed

C. Box 30 may then turn over under the following conditions:

1. Paddle 34 latched, switch 260 closed
2. Box 30 upright, switch 265 closed
3. No fingers extend through the bottom of box 30, photocell 286 illuminated
4. Beam 360 interrupted by tray, photocell 261 dark
5. The pan 30r lowered, switch 267 open

D. Pan 34 is raised under the following conditions:

1. Box 30 is inverted, switch 266 closed
2. Pan 34 is lowered, switch 267 is open
3. Photocell 264 is dark

E. An inverted tray may be ejected under the following conditions:

1. Box 30 inverted, switch 266 closed
2. Pan 30r raised, switch 267 closed

F. 30r may be lowered under the following conditions:

1. Box 30 inverted, switch 265 closed
2. Tray ejected onto plate 13, switch 268 closed
3. Switch 267 closed

G. Box 30 may be erected under the following conditions:

1. Box 30 inverted, switch 266 closed
2. Pan 30r lowered, switch 267 open
3. No fingers in box 30, photocell 286 illuminated

H. Pan 30r may be raised under the following conditions:

1. Box 30 upright, switch 265 closed
2. Pan lowered, switch 267 open
3. Beam 260 interrupted by a stack of mail, photocell 261 dark

I. Fast drive motor 54 may be energized to move paddle 34 under the following conditions:

1. Box 30 upright, switch 265 closed
2. Tray 32 is out of box 30, photocell 261 is illuminated
3. Paddle 34 is not latched, switch 260 open

J. Slow motor 74 may be energized under the following conditions:

1. Requirement signal from feeder unit
2. Back pressure off of finger
3. Photocell 287 illuminated

When paddle 34 is latched and the fingers are clear of box 30, another loaded tray may be inserted into box 30 and the cycle is repeated.

Referring now to FIGS. 17 and 18, a modified form of the turning system has been shown. In this embodiment, box 330 is mounted as to be pivoted on shaft 331, which shaft is part of the clutch 333 from pulley 334. The unit 332 provides for controlled rotation of shaft 331 with a predetermined velocity profile.

In one embodiment, unit 332 was a roller gear indexing drive of the type manufactured and sold by Ferguson Machine Co. of St. Louis, Mo. and identified by part number MH2-2300.

A brake 335 is mounted on the shaft leading from clutch 333. The unit 332 therefore replaces the four bar linkage of FIG. 13. Belt 336 drives pulley 334 from a drive motor 337.

Paddle 344 is mounted on a bracket 345 which travels along shaft 346. In this embodiment of the invention, spring wheel 338 serves to drive paddle 344 in a direction to eject a mail tray from box 330. However, the return of the paddle 344 is achieved by a cable which is tethered at one end to the block 345 and at the other end to the periphery of a large wheel 350. Wheel 350 is mounted on a shaft 352 extending downwardly from the bottom of box 330. Immediately below wheel 350 is a clutch face 354. The clutch face 354 mates with a clutch actuator 356 which is mounted on a shaft 358 of a motor 360. The clutch actuator 356 slides on shaft 358 under control of a lever 362 which is pivoted on pin 364. The end of lever 362 opposite shaft 358 is connected by pin 366 to the armature 368 of a solenoid 370. When solenoid 370 is energized, armature 368 moves down which elevates the clutch actuator 356 to bring it into contact with the bottom face of member 354 thereby applying power from motor 360 to the wheel 350.

As best shown in FIG. 19, box 330 has paddle 344 mounted therein in a sliding relation relative to shaft 346. Cable 372 encircles the periphery of wheel 350 and passes over a pulley 374 and then extends parallel to shaft 346 to an anchor on paddle support block 376. Spring wheel 348 also has a cable 378 which is anchored to block 376. Motor 360, FIG. 17, drives wheel 350 in a counterclockwise direction as viewed from the

top in FIG. 18 to pull paddle 344 from the back to the front of box 330 thereby to deliver mail pieces from box 330 to transition unit 15. In so doing, energy is stored in the spring wheel 348 adequate to pull paddle 344 back to the rear end of box 330 when the paddle is unlatched and the wheel 350 is disconnected by clutch 354-356 from motor 360.

In FIG. 19, the wheel 350 mounted on the bottom of box 330 has been shown with the clutch in engaged condition. When disengaged, box 330 may be rotated by forces applied through gear unit 332.

In FIG. 11 fingers 180 and 186 are mounted on chains 158 and 174. The tips of the fingers pass upward through slots in the bottom of box 30 contacting the mail pieces 14 to move the mail out of box 30 and into a transition section 15, FIG. 1. The system serves to translate a batch of mail collected in trays delivered to box 30 into a continuous flow of mail into edger 16, FIG. 1. If the pressure applied by finger 186, FIG. 11, is too great, the stack of mail ahead of finger 186, FIG. 11, will be compressed and cause the stack to buckle upward and be ejected from the transition section 15 or otherwise disabled from processing. Such disabling action is forestalled by use of controls which include fingers of the type illustrated in FIG. 20. In FIG. 20, the finger body 400 is provided with holes 401 and 402 to journal pivot pins, such as pins 188 and 190 of FIG. 11. The face 403 of the tip of finger 400 is positioned to contact the back of a stack of mail. The face is concave and finger body 400 is hollow. A pin 404 near the top 405 pivots a lever 406 which is convex and extends out beyond the concave boundary 403. The end 407 of lever 406 serves to actuate a microswitch 408 which is mounted in the finger 400. A spring 409 serves to determine the pressure from lever 406 to actuate switch 408. Switch 408 is then connected by way of cable 410 to control motor 144, FIG. 11, which drives chains 158 and 174. The control is such that when lever 406 actuates switch 408 at a predetermined pressure determined by spring 409, the drive applied to finger 400 will be terminated so that the pressure on the stack 14, FIG. 11, will not exceed a limit determined by spring 409. The circuit to which cable 409 leads is such that when the lever in any of the fingers mounted on chains 158 and 174 applies a predetermined pressure on the mail being pushed ahead of it, drive motor 144 will stop.

Thus, the fingers 180 and 186 of FIG. 11 preferably will be constructed in accordance with the details illustrated in FIG. 20. Two such fingers may be connected through AND logic circuit to the controls for motor 144 as indicated schematically in FIG. 20 where cables 410 and 411 lead to an AND gate 412. The output of AND gate 412 leads to the control 413 for motor 144.

The present application is directed to a method and system for unloading a mail tray by inserting it in a turnover box while maintaining a stack of mail in an ordered array.

The system in which fingers, such as fingers 180 and 186, cooperate with the mail turnover box and the paddle in the turnover box so that the fingers can pass upwards through slots in the box and push the stack away from the paddle and out of the box is also described and is claimed in pending U.S. application Ser. No. 385,295, filed Aug. 3, 1973 by Donald F. Renfrow, entitled "Batch to Continuous Flow Mail Handling," assigned to the assignee of the present invention.

The aspects of the system disclosed herein relating to the control of movement of fingers 180 and 186 in response to pressure from a trailing stack is also described and is claimed in copending U.S. application Ser. No. 389,352, filed Aug. 17, 1973 by John E. Blair for "Mail Stack Feed Control," said application being assigned to the assignee of the present application.

Having described the invention in connection with certain specific embodiments thereof, it is to be understood that further modifications may now suggest themselves to those skilled in the art and it is intended to cover such modifications as fall within the scope of the appended claims.

What is claimed is:

1. A mail tray unloader which comprises

a box having the bottom half of both ends open for entry at one end onto the bottom of said box of a tray filled with an ordered stack of edge supported mail pieces and delivery of said stack from the other end,

means to rotate said box about a longitudinal axis to drop said stack from said tray,

means to prevent reordering of said stack during said drop,

means to eject the inverted tray from said box,

means to rotate said box to its upright position to deposit said stack onto said bottom of said box,

means to prevent reordering of said stack during said deposit, and

means to sweep said stack from said box through said other end.

2. A mail tray unloader which comprises:

a. a box having open ends to admit at the load end thereof a tray filled with an ordered stack of edge supported mail pieces and for movement of said stack from the unload end thereof,

b. a paddle extending transversely across said box and mounted for movement longitudinally of said box,

c. means to latch said paddle at said unload end,

d. means to rotate said box about a longitudinal axis to unload said stack from said tray,

e. means to release said paddle and eject the inverted tray from said box,

f. means to rotate said box to its upright position to deposit said stack on the bottom of said box, and

g. means to actuate said paddle to sweep said stack from said box to said unload end and to relatch said paddle.

3. The combination set forth in claim 2 in which said paddle is resiliently biased toward said load end automatically to eject said inverted tray when released.

4. The combination set forth in claim 2 in which control means including sensor means prevent rotation from an inverted position back to its upright position so long as said tray has not been ejected.

5. The combination set forth in claim 2 in which a planar mail pan with downturned ends is mounted in the top of said box for controlled movement toward and away from the bottom of said box and in which control means moves said mail pan toward said bottom before said box is inverted to support said stack of mail and prevent random fall thereof from said tray when inverted.

6. The combination set forth in claim 5 in which pneumatic cylinders mounted on top of said box are

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coupled to said mail pan for control of movement thereof.

7. The combination set forth in claim 2 in which a spring biased tape is mounted outside said box adjacent said load end and extends to the mounting means for said paddle to urge said paddle towards said load end.

8. A system for unloading a tray containing an ordered stack of edge supported documents which comprises:

means for rotating said tray with said stack therein about an axis above said tray to an inverted position while restraining said stack from falling out of said tray,

means operable upon cessation of rotation to permit said stack to respond to gravity to transfer said stack as a body to a rest position supported by the top edges of said documents outside of and beneath said tray,

means to remove said tray from above said stack, means for rotating said stack about said axis to its upright position while restraining said stack in a substantially fixed relation to said axis, and

means permitting said stack to respond to gravity to transfer said stack to a rest position substantially the same as initially occupied when in said tray.

9. The system of claim 8 wherein a planar support restrains said stack during rotation by moving toward and away from the plane of the top of said tray in synchronism with rotation of said stack.

10. The system of claim 8 wherein rotational means

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generates a controlled centrifugal force to restrain said stack by rotation of said tray about a longitudinal axis in the region of the top of said tray.

11. An unloader unit for a mail tray loaded with mail which comprises:

a. a rectangular polyhedron box having six sides closed except for load and unload ends with ribbed side walls dimensioned to receive and restrain a mail tray in the bottom half thereof,

b. a bar extending the length of said box adjacent a bottom corner,

c. a transverse paddle mounted on said bar to move the length of said box,

d. means to resiliently bias said paddle normally to obstruct said load end,

e. clutch means to move said paddle to said unload end preparatory to insertion of a tray into said box,

f. means to latch said paddle at said unload end,

g. drive means for rotation of said box and any tray therein about an axis passing through said ends,

h. means operable when said box is rotated to an inverted position to unlatch said paddle to drive said tray out of said box, and

i. means operable upon removal of said tray from said box to rotate said box back to its upright position whereupon movement of said paddle to its latched position will drive said mail through said unload end.

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