United States Patent [19]

Kuehn

[11] **3,904,190**

[45] **Sept. 9, 1975**

[54] **APPARATUS FOR FEEDING PAPERBOARD BLANKS**

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[73] Assignee: **Koppers Company, Inc.,** Pittsburgh, Pa.

[22] Filed: **Mar. 15, 1974**

[21] Appl. No.: **451,566**

[52] **U.S. Cl.** **271/99;** 271/108; 271/136; 417/305; 417/490

[51] **Int. Cl.²** **B65H 3/12**

[58] **Field of Search** ..... 271/99, 102, 108, 90, 132, 271/136; 214/8.5 D; 417/490, 305

[56] **References Cited**

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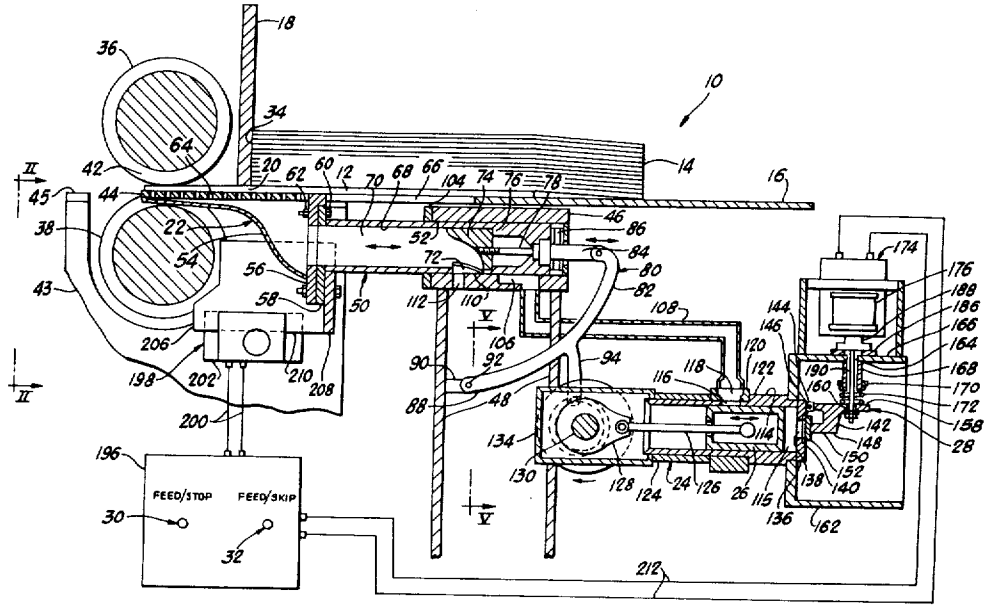
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Assistant Examiner—Bruce H. Stoner, Jr.
Attorney, Agent, or Firm—Boyce C. Dent; Oscar B. Brumback

[57] **ABSTRACT**

An improved blank feeding machine for feeding successive bottom blanks from a stack of blanks into adjacent processing machinery comprises a support table for supporting the stack of blanks thereon and defines with a gate an opening therebetween through which the bottom blanks are successively advanced into the adjacent machinery; a suction box reciprocating beneath the blanks applies suction pressure to the bottom blanks from the beginning of the feed stroke of the suction box throughout substantially the first half of the feed stroke and thereafter vents the suction pressure to atmosphere until the beginning of the next successive feed stroke. A suction pump delivers suction pressure to the suction box during the forward stroke of a piston within the suction pump; the suction pump includes a valve operable upon command to prevent delivery of the suction pressure to the suction box. A selectively operable first command system operates the valve to prevent delivery of suction pressure during each forward stroke of the piston to prevent advancement of the blanks during a "stop-feed" mode; a selectively operable second command system operates the valve to prevent delivery of suction pressure during alternate forward strokes of the piston to prevent advancement of the blanks during alternate feed strokes of the suction box during a "skip-feed" mode of operation.

7 Claims, 9 Drawing Figures



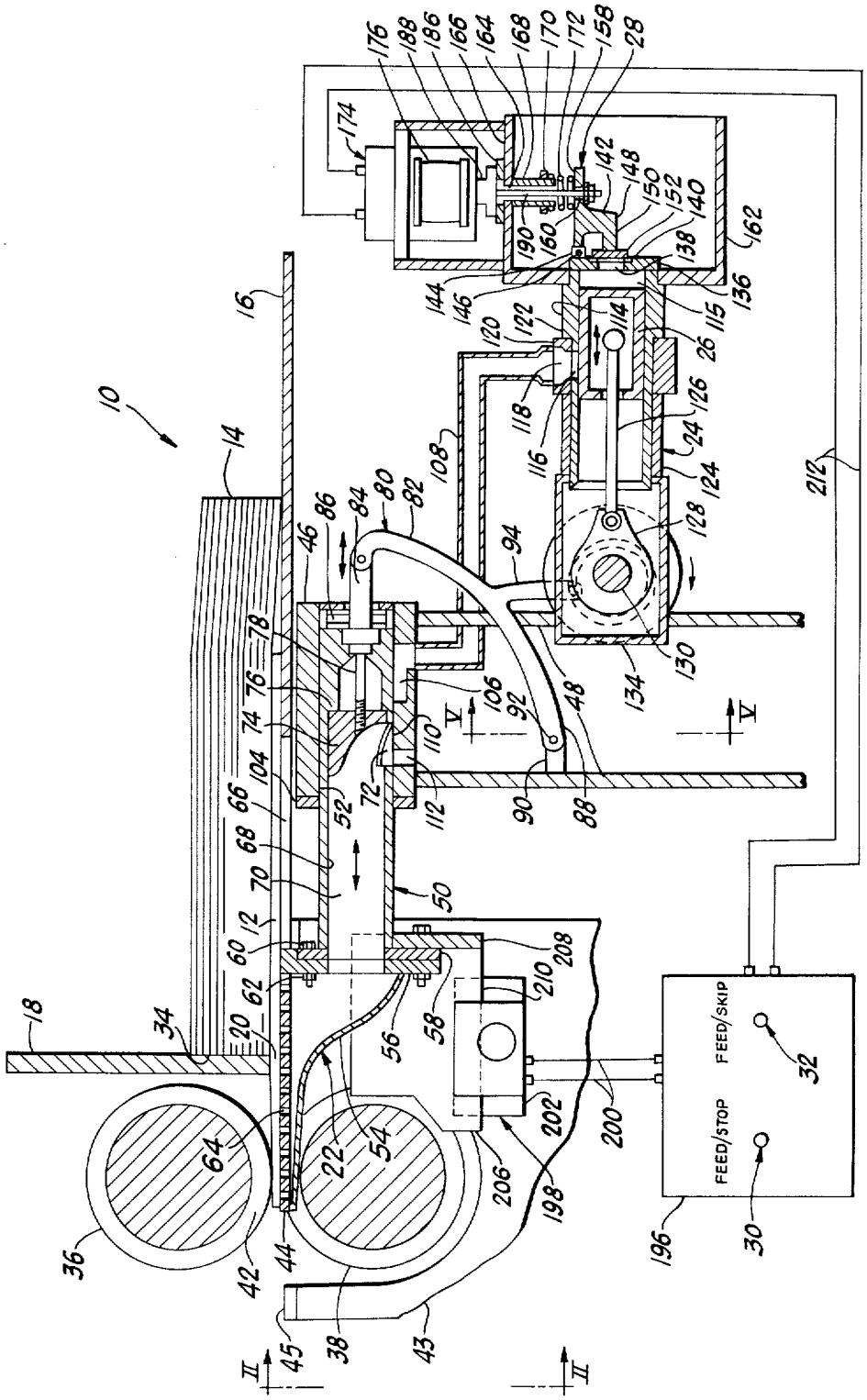


FIG. 1

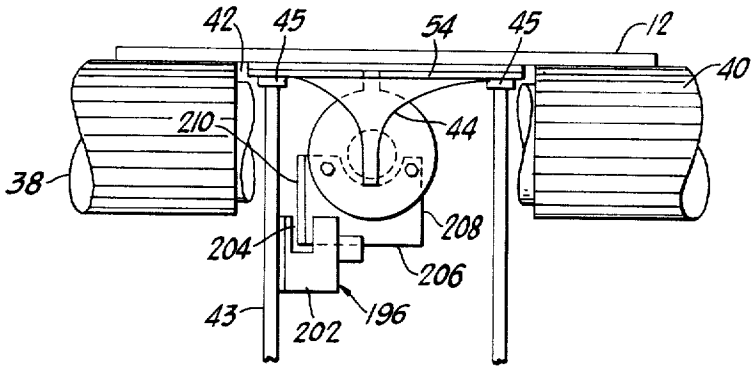


FIG. 2

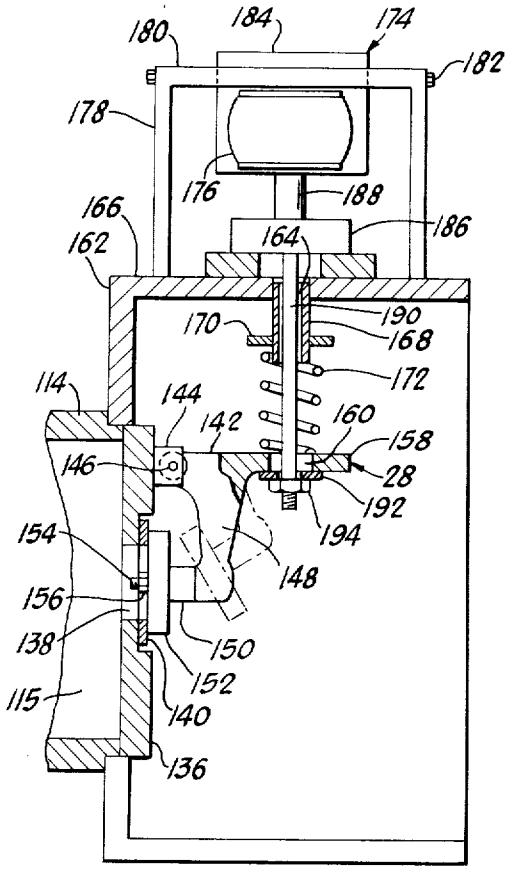


FIG. 3

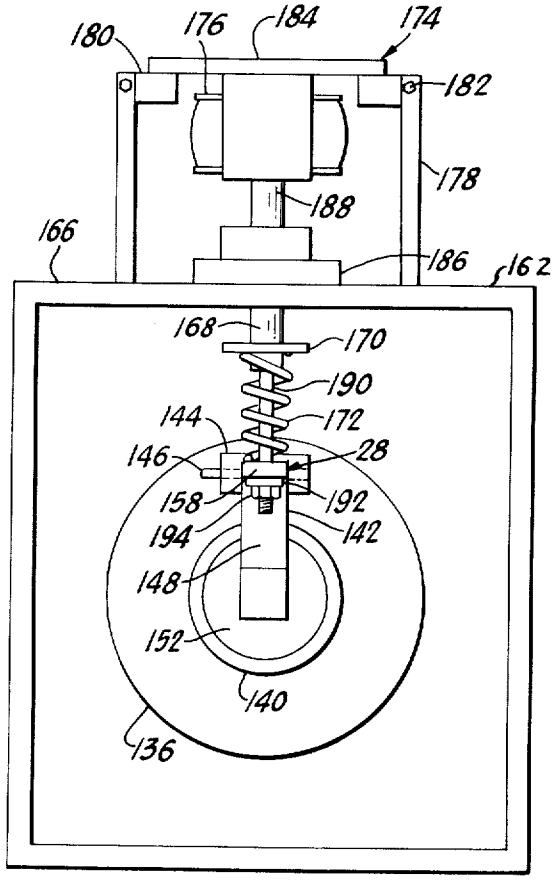


FIG. 4

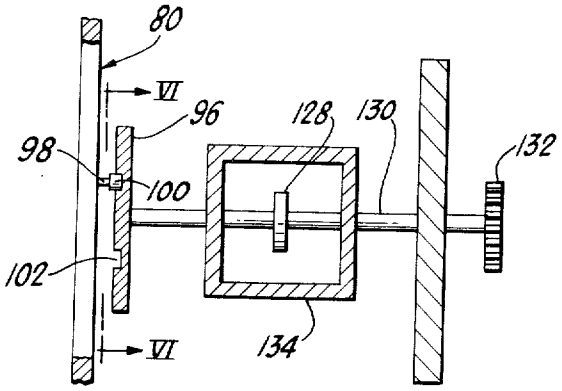


FIG. 5

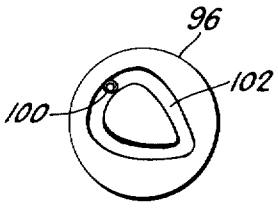


FIG. 6

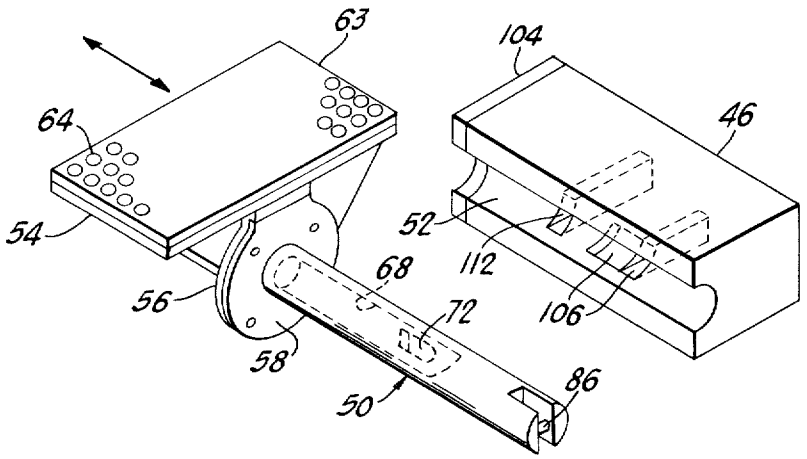


FIG. 7

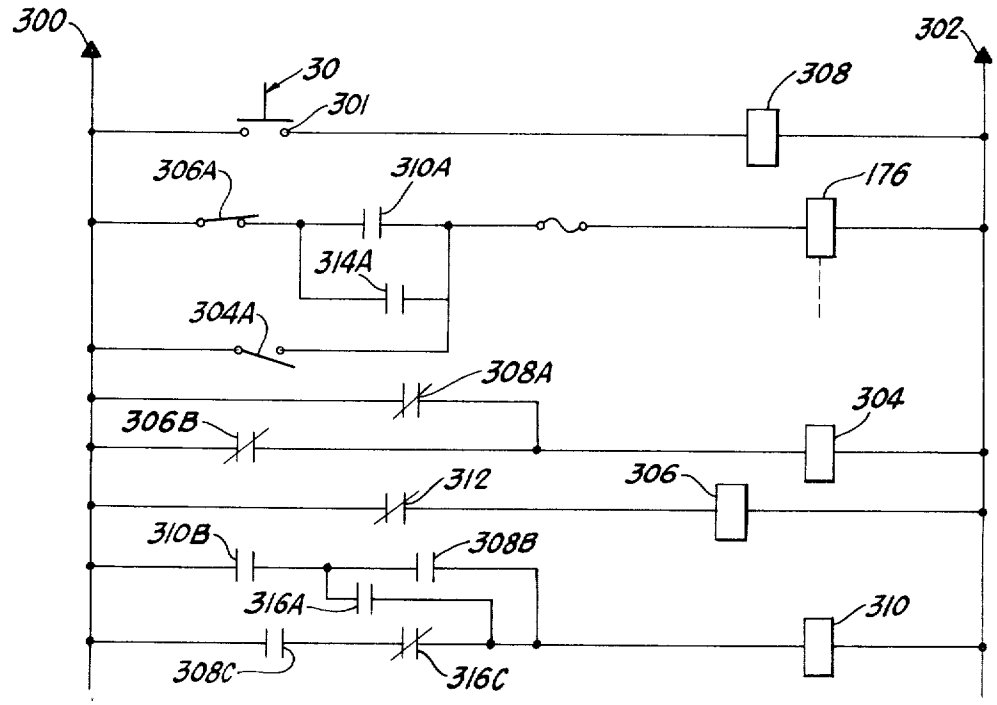

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316C

FIG. 8

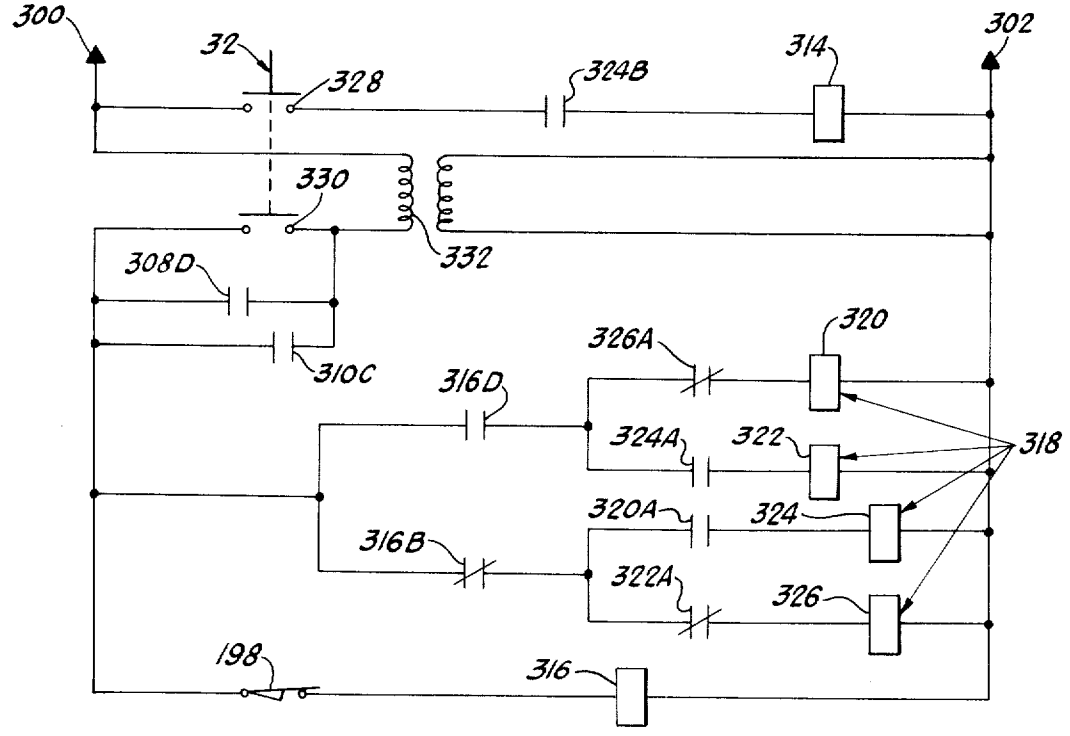

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FIG. 9

APPARATUS FOR FEEDING PAPERBOARD BLANKS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to sheet feeding or delivering apparatus having a pneumatic bottom feed mechanism for feeding the bottom-most blank of a stack of paperboard blanks into a processing mechanism.

2. Description of Prior Art

Suction feeders for feeding the bottom blank from a stack of paperboard blanks are well known in the art and are used for feeding the blanks into an adjacent processing apparatus.

One type of suction feeder utilizes a stationary suction chamber such as shown in Ward, et al. U.S. Pat. No. 3,588,095 and Thayer U.S. Pat. No. 3,754,752. Such suction feeders are designed to hold the bottom blank against the support table. A reciprocating feed bar engages the trailing edge of the bottom blank and moves it through a gate mechanism into a processing apparatus. These suction feeders utilize the reciprocating feed bar to move the bottom blank through the gate mechanism and were developed to eliminate the problem of feeding warped blanks which prevent them from passing through the gate mechanism. These suction feeders generally do their job very well. The suction chamber pulls the warped bottom blank against the support table and the suction pressure is strong enough to flatten the warped blank and allow the feeder bar to engage the trailing edge of the blank and move it through the gap in the gate mechanism.

Although the reciprocating feed bar type suction feeder has the above-mentioned advantage, it does have a number of disadvantages. First, the suction pressure in the suction chamber must be continuously applied so that the warped blank will stay flat during movement through the gate mechanism. This continuous suction pressure creates friction between the blank and support table which the feeder bar must overcome to advance the blank. The feeder bar pushes the trailing edge of the blank and tends to bend and deform the trailing edge thus damaging the product.

A second disadvantage is that the feeder bar moves rapidly in the area where the machine operator stands at the rear of the stack. As he loads the stack on the support table, his hands are in close proximity to the feeder bar. Should the operator be careless or make a mistake, his hand may contact the moving feeder bar and injure his hands.

Another example of a suction feeder is shown in E.L. Bishop U.S. Pat. No. 2,331,533 and T.D. Bishop U.S. Pat. No. 3,226,108, which is an improvement over the E.L. Bishop Patent. In this type of suction feeder, the suction box itself reciprocates along the plane of the feed table eliminating the need for a feeder bar and consequently, the disadvantages associated with a feeder bar. Suction in the box draws the bottom blank downward into flat contact with the top of suction box. The suction box moves the blank forward until its leading edge is gripped by a pair of pull rollers beyond the gate which pull the blank into the processing machine. When the pull rolls grip the blank, the vacuum in the suction box is released to the atmosphere which releases the blank from the suction box and allows easy pulling of the blank by the pull rollers. The suction box

then moves rearward until it is below the next bottom blank at which time vacuum is reapplied to the suction box to feed the next blank.

It is desirable at times to stop the feeding of the blanks into the processing apparatus without having to shut down the machinery or to feed a blank on every other stroke of the suction box. To stop the feeding of the blanks in the foregoing feeder, vacuum is not applied to the suction box when the suction box is at the beginning of its feed stroke, thus, the suction box will not pick up the blank as it moves forward on each stroke. This is referred to as "stop-feed." To feed a blank on every other forward stroke of the suction box, vacuum is only applied to the suction box at the beginning of every other forward stroke, thus moving a blank only on every other stroke. This is referred to as "skip-feed."

To produce the stop-feed and skip-feed functions in suction feeders utilizing a reciprocating suction box, the vacuum supply to the suction box must be cut off at the appropriate time. Normally, a conventional suction pump is used in which a piston therein reciprocates in timed sequence with the suction box to provide suction pressure during a suction stroke of the piston. It is arranged to shut off the vacuum to the suction box altogether in the stop-feed mode or system of operation and shut off the vacuum to the suction box on every other forward stroke in the skip-feed mode of operation. In the past, this has been accomplished by mechanically controlling a valve mechanism on the suction pump. In the stop-feed mode, the valve is left open so that when the piston moves forward on its suction stroke, the piston chamber is vented to atmosphere and thus no vacuum or suction is created. In the skip-feed mode, the valve is mechanically opened on every other forward suction stroke of the piston and closed on the remaining alternate forward strokes; thus, vacuum is only created on the forward stroke of the piston when the valve is closed.

To open and close the valve, it has been the practice to use a complex mechanical lever and dual cam arrangement which is connected to the valve to open and close it. To select the stop-feed mode, the operator moves a lever to the stop-feed position. This rotates a cam shaft carrying a lobed disc cam which contacts the valve upon rotation of the camshaft to maintain the valve in an open position as long as the cam engages the valve.

To select the skip-feed mode, the operator moves the lever to a skip-feed position and a second lobed disc cam, carried on a camshaft rotating in timed rotation to the suction pump piston, contacts the valve to open it on the first forward stroke of the piston. Opening the valve, vents the suction pump cylinder so the piston cannot create vacuum during its forward stroke.

On the rearward stroke of the piston, the camshaft rotates the high lobed of the cam past the valve permitting it to close. The configuration of the cam is arranged to keep the valve closed on the next forward stroke of the piston; thus, the piston can create a vacuum in the suction box. On the second rearward stroke, the camshaft again rotates the cam to open the valve and keeps it open on the next forward stroke of the piston, thus not supplying vacuum to the suction box. This is continued as long as the skip-feed operation is desired.

Although this mechanical lever and cam arrangement produces the desired stop-feed and skip-feed functions, it does have a number of disadvantages. One disadvantage is the high cost of the mechanical cam arrangement. The materials and maintenance costs are extremely high and these costs are reflected in the purchase price of the entire suction feeder machine.

A second disadvantage is that the mechanical lever and cam mechanism has a large number of rotating parts subject to wear which require lubrication and maintenance from time to time which means the suction feeder apparatus must be shut down which results in loss of production time. In addition, because a large number of parts are involved, the reliability of the system is poor since mechanical parts tend to wear and break, thus necessitating the taking of the machine out of production for repairs.

A third disadvantage is that suction feeder machines are inherently noisy. One source of noise is the lever and cam mechanism on the suction feeder. The box making industry is continuously seeking ways to reduce noise. In addition, the Occupational Safety and Health Administration has set forth standards governing maximum noise levels in box plants; industry is required to meet these OSHA standards. As mentioned above, the mechanical lever and cam mechanism has been found to be the source of a great amount of noise resulting from the large number of movable and continuously contacting parts.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an improved blank feeding machine that will overcome the aforementioned disadvantages and others. Thus, this invention provides a blank feeding apparatus of the reciprocating suction box type that effectively reduces the noise output of the blank feeding machine by utilizing an automatic, non-mechanical system for providing a skip-feed mode of operation and a stop-feed mode of operation.

This is generally accomplished by providing a blank feeding machine used for feeding successive bottom blanks from a stack of blanks into adjacent processing machinery with a support means for supporting the stack of blanks thereon and defining with a gate means an opening therebetween through which the bottom blanks are successively advanced into the adjacent machinery. An advancing means reciprocates beneath the bottom blank along the support plane of the support means and applies suction pressure to the bottom blanks from the beginning of its feed stroke and continues substantially through the first half of the feed stroke. Thereafter, suction pressure is vented to atmosphere until the beginning of the next successive feed stroke. A suction pump means delivers suction pressure to the advancing means during the forward stroke of a piston means within a suction pump means; the suction pump means includes a valve means operable upon command for preventing delivery of the suction pressure to the advancing means. A selectively operable first command means controls operation of the valve means to prevent delivery of suction pressure during each forward stroke of the piston means to prevent advancement of the blanks during the stop-feed mode of operation. A selectively operable second command means controls operation of the valve means to prevent delivery of suction pressure during alternate forward strokes of the piston means to prevent advancement of the blanks during alternate feed strokes of the advancing means during the skip-feed mode of operation.

The above and further objects and novel features of the invention will appear more fully from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are not intended as a definition of the invention but are for the purpose of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like parts are marked alike.

FIG. **1** is a schematic illustration in side elevation of the present invention showing the feeder generally and including the reciprocating suction box, the suction pump, and the valve mechanism for regulating the vacuum applied to the suction box;

FIG. **2** is a cross-sectional view of the blank feeding machine of FIG. **1** taken along the line II—II showing the lower pull rolls, suction box, and a vane switch arrangement;

FIG. **3** is an enlarged cross-sectional view of the valve assembly of FIG. **1** showing a pivotable plate mechanism and solenoid-activated plunger for pivoting the plate mechanism;

FIG. **4** is an end view of FIG. **3**;

FIG. **5** is a cross-sectional view of the blank feeding machine of FIG. **1** taken along the line V—V showing a cam arrangement for reciprocating the suction box of FIG. **1**;

FIG. **6** is a side view of the cam arrangement of FIG. **5** taken along the lines of VI—VI showing a cam track and cam follower;

FIG. **7** is a perspective view of the suction box of FIG. **1** showing a suction inlet and exhaust port arrangement;

FIG. **8** is an electrical schematic diagram showing the electrical arrangement for activating the valve mechanism of FIG. **1** in the STOP-FEED mode of operation; and

FIG. **9** is an electrical schematic diagram showing the electrical arrangement for activating the valve mechanism of FIG. **1** in the SKIP-FEED mode of operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the invention generally comprises a blank feeding machine, denoted generally by numeral **10**, for feeding successive bottom blanks **12** from a stack of blanks **14** into adjacent processing machinery, not shown. For illustration purposes, the present invention is shown as it is used in the corrugated box making industry, that is, the stack of blanks **14** of corrugated paperboard is fed by blank feeding machine **10** into adjacent corrugated paperboard processing machinery such as, for example, scoring and slotting apparatus, printing apparatus, and box making apparatus. It should be understood, however, that the present invention can be used in other type applications such as, for example, cardboard processing, laminated board processing, or any other industry that feeds sheets of material from a stack of sheets.

Blank feeding machine **10** generally comprises a support table **16** for supporting the stack of blanks **14** thereon and defining with a conventional gate assembly **18** an opening **20** therebetween through which bottom

blanks 12 are successively advanced into the adjacent machinery. A suction box, denoted generally by numeral 22, is reciprocable beneath stack 14 in a plane level with the top of table 16 and applies suction pressure to bottom blanks 12 from the beginning of the feed stroke of suction box 22 and continuing substantially through the first half of the feed stroke. Thereafter the suction pressure is vented to atmosphere until the beginning of the next successive feed stroke. A suction pump, denoted generally by numeral 24, is used for delivering suction pressure to suction box 22 during the forward stroke of a piston 26 within suction pump 24. Suction pump 24 includes a valve, denoted generally by numeral 28, operable upon command for preventing delivery of the suction pressure to suction box 22. A selectively operable first command system switch, denoted generally by numeral 30, is used to operate valve 28 to prevent delivery of the suction pressure during each forward stroke of piston 26 to prevent advancement of bottom blanks 12. A selectively operable second command system switch, denoted generally by numeral 32, is used for operating valve 28 to prevent delivery of the suction pressure during alternate forward strokes of piston 26 to prevent advancement of bottom blanks 12 during alternate feed strokes of suction box 22.

For illustration purposes, it should be understood that when reference is made to the feed stroke of suction box 22 and the forward stroke of piston 26, it is meant that suction box 22 and piston 26 are moving from right to left as depicted in FIG. 1. Likewise it is to be understood that the return stroke of suction box 22 and the rearward stroke of piston 26 will be considered as the movement from left to right. In addition, it is to be expressly understood that the term command means used in the specification and claims refers to an electrical, pneumatic, or hydraulic system as later explained and does not refer to any mechanical system as previously explained.

More specifically, and referring to FIG. 1, the blank feeding machine 10 consists of a support table 16 which supports a stack of corrugated paperboard blanks 14. At the front of table 16, a gate assembly 18 is spaced above table 16 an amount substantially equal to the thickness of bottom blank 12. The stack of blanks 14 are placed upon table 16 so their leading edges 34 abut gate 18 and bottom blank 12 lies adjacent to space 20 between gate 18 and table 16, so that suction box 22 can engage blank 12 and, on the feed stroke of suction box 22, blank 12 is fed through space 20 to be picked up by a pair of feed rollers 36 and 38 which are adjacent space 20 and which are rotated by a drive system, not shown, in blank feeding machine 10. Upper feed roller 36 may be covered with rubber or a synthetic covering which gives a high co-efficient of friction so that when roller 36 grips blank 12, it will pull the blank through rollers 36 and 38 for feeding into adjacent processing machinery. Lower roller 38 may be made similar to upper roller 36 except it is preferably made of steel with longitudinal grooves 40, FIG. 2, for gripping the underside of blank 12. The central portion of rollers 36 and 38 are gapped at 42, FIG. 1 and 2, so that the front nose 44 of suction box 22 can pass between rollers 36 and 38 so that blank 12, which is usually considerably wider than suction box 22, can be gripped by rollers 36 and 38.

Referring to FIGS. 1 and 2, a suction box support frame 43 surrounds lower roller 38 and is rigidly attached to a support frame, not shown, of blank feeding machine 10. The top 45 of support frame 43 is in horizontal alignment with suction chamber 54 of suction box 22 and provides a surface on which suction chamber 54 is supported when suction box 22 is advanced on its feeding stroke into gap 42 between rollers 36 and 38.

Generally, a suction pump 24 is utilized to create a vacuum within suction box 22. The suction pressure within suction box 22 seizes the bottom blank 12 when suction box 22 is at the end of its return stroke, that is when the top of suction box 22 is completely beneath blank 12. The suction box is advanced through space 20 at a gradually increasing speed. Its maximum velocity is arranged to coincide with the peripheral velocity of rollers 36 and 38. When blank 12 is brought into engagement with rollers 36 and 38, this velocity is maintained for a substantially short distance to allow time for the vacuum in box 22 to be vented to atmosphere which returns suction box 22 to atmospheric pressure to release blank 12. The vacuum is maintained in suction box 22 during the feed stroke toward feed rollers 36 and 38, but once the leading edge 34 of blank 12 has been successfully engaged by feed rollers 36 and 38, the vacuum in suction box 22 is cut off and brought to atmospheric pressure as quickly as possible so that suction box 22 does not hold blank 12 for any more time then is required for rollers 36 and 38 to grip blank 12. This is generally accomplished by cutting off the vacuum to suction box 22 and then venting it to atmosphere as will be later described.

Referring now to FIGS. 1 and 7, suction box 22 consists of a box-like body 46 which is mounted beneath table 16 on support members 48 which are secured to the frame, not shown, of blank feeding machine 10. A hollow tube, denoted generally by numeral 50, is slidably mounted within a bore 52 of body 46. The forward part of tube 50 is secured to a suction chamber 54 such as by bolting a flange 56 on suction chamber 54 to a flange 58 on tube 50 by bolts 60 and 62. Suction chamber 54 has a top member 63 which is substantially rectangular in shape and is secured to a top portion of suction box 54 such as by bolts, not shown. Top member 63 has a plurality of openings 64 which extend into suction chamber 54 so that suction pressure may be applied to blank 12. Suction chamber 54 is positioned within a slot 66 centrally located in table 16 so that suction chamber 54 will be able to grip the central forward portion of blank 12.

Tube 50 consists of a hollow tubular member 68 which is attached to suction chamber 54 by flange 58 as previously described. A hollow central portion 70 is open to suction chamber 54 as shown in FIG. 1. Tubular member 68 includes an opening 72 with a sealing member 74 inserted at the rearward portion of opening 72 and completely contacting the inner periphery of central portion 70 and abutting a shoulder portion 76. Sealing member 74 is held against shoulder portion 76 by bolt 78 thus sealing the rear portion of tube 50 from the front part of tube 50.

Referring to FIGS. 1, 5 and 6, tube 50 is reciprocated forwardly and rearwardly within bore 52 of body 46 by a lever, denoted generally by numeral 80. Lever 80 includes three legs of which one leg 82 is connected to the rearward portion of tube 50 by a linking bar 84

which is connected to tube 50 by pin 86. A second leg 88 is pivotably connected to frame support 48 by bracket 90. Legs 82 and 88 are allowed to pivot about bar 84 and bracket 90 by pivot pins 92. A third leg 94 is connected to a cam mechanism 96 by a pin 98 and a cam follower 100 which rides in a cam track 102 in cam mechanism 96. The cam mechanism 96 propells lever 80 forwardly and rearwardly at the correct speed and positive movement required for proper feeding of blank 12 by suction box 22.

Referring to FIGS. 1 and 7, box like body 46 includes a forward sealing element 104 which is secured to a forward part of body 46 such as by bolts, not shown, in order to prevent dust and other foreign particles from getting between tube 50 and body 46 when tube 50 moves into and out of body 46. Body 46 has a port 106 extending through body 46 and when tube 50 is at its rearward most position, opening 72 registers with port 106. Port 106 connects with suction pump 24 by a flexible conduit 108 so that suction chamber 54 can be subjected to vacuum. When tube 50 moves forward, opening 72 remains in contact with port 106 for a predetermined interval. Opening 72 is then completely disconnected from port 106 when opening 72 passes through region 110 of body 46 which has no port. The forward speed of suction chamber 54 is increased until it reaches the peripheral speed of rollers 36 and 38, then opening 72 registers with a second port 112 in body 46 which is connected to atmosphere. When opening 72 registers with second port 112, suction chamber 54 is rapidly vented to atmosphere thereby releasing blank 12 for continuing advancement by feed rollers 36 and 38.

For ease of illustration, port 72 in tube 50 and ports 106 and 112 in body 46 have been shown in a vertical position. Although the ports 72, 106, and 112 may be positioned anywhere that is desired, the preferred position is the horizontal setting as shown in FIG. 7.

Referring now to FIGS. 1, 2, 3, 4, and 5, suction pump 24 consists of a cylinder 114 having a port 116 that opens into an opening 118 in a sleeve 120 that fits around cylinder 114 and abuts a shoulder 122 on cylinder 114. A second sleeve 124 surrounds cylinder 114 abutting sleeve 120 and holding sleeve 120 in its correct position on cylinder 114. Flexible conduit 108 is connected to port 118. A piston 26 is reciprocally slideable within cylinder 114. A connecting rod 126 is pivotally connected at one end to piston 26 and extends through an opening in the forward portion of piston 26 and through an opening in the forward end of cylinder 114 where connecting rod 126 pivotably connects with a rotatable plate 128. A drive shaft 130 extending perpendicular to the travel of connecting rod 126 passes through the center of plate 128 and is rigidly connected thereto. One end of shaft 130 is connected to cam mechanism 96 and the other end is connected to the drive system, not shown, for feeding machine 10 such as by gear 132. A housing 134 surrounds plate 128 and part of shaft 130. One end of housing 134 is slideably engageable with the forward end of cylinder 114 in order to maintain the interior portions of pump 24 free from foreign matter and to maintain lubricants therein. As previously mentioned, shaft 130 connects with piston 26 and cam mechanism 96. Cam track 102 is profiled so that when shaft 130 rotates in the direction to make piston 26 move in the forward direction, lever 80 will, at a predetermined time, propel suction box 22 on its feed stroke and when piston 26 moves rearwardly, suction box 22 moves on its return stroke. Cam track 102 is additionally profiled to increase the speed of suction box 22 in its feed stroke until suction box 22 reaches its maximum forward velocity just before it reaches its maximum forward position at which time its forward velocity is substantially the same as the peripheral velocity of rollers 36 and 38 so that there is a smooth transition of blank 12 from suction box 22 to rollers 36 and 38.

At the rearward end of cylinder 114 is valve mechanism 28 which consists of a plate 136, FIGS. 1, 3, and 4, which is secured to the end of cylinder 114 such as by bolts, not shown. Plate 136 has an opening 138 extending into cylinder 114. Surrounding opening 138 is a washer 140 which is secured to plate 136 such as by screws, not shown. Washer 140 is preferably made from a resilient material such as, for example, rubber or the like. An arm mechanism 142 is pivotally connected to plate 136 by bracket 144 and pin 146. One arm 148 of arm mechanism 142 extends vertically parallel to opening 138. At the end of arm 148 is a perpendicularly extending protrusion 150. Protrusion 150 extends toward opening 138. A circular plate 152 having an outer diameter greater than the diameter of opening 138 is connected to protrusion 150 at substantially its center by bolt 154 and nut 156. Arm 148 is so positioned that when arm mechanism 142 pivots downward, plate 152 contacts washer 140, thereby closing opening 138. A second arm 158 extends perpendicular to arm 148 and has an opening 160 extending therethrough. Surrounding valve 28 is a housing 162 which is secured to cylinder 114 such as by welding. An opening 164 in top 166 of housing 162 is in vertical alignment with opening 160 in arm 158. A hollow sleeve 168 is secured in opening 164 such as by threading. A collar 170 surrounds sleeve 168 so that a portion of sleeve 168 extends below collar 170. Collar 170 is secured to sleeve 168 such as by welding. A biasing member such as a coil spring 172 is positioned around the bottom portion of sleeve 168 so that its end abuts collar 170. The other end of spring 172 is positioned over opening 160 in arm 158. If desired, a recess may be formed around opening 160 and spring 172 placed therein so that spring 172 will not slide on arm 158. Spring 172 is positioned so it is in partial compression so spring 172 will pivot arm mechanism 142 to place plate 152 in contact with washer 140 when no other forces are acting on arm mechanism 142.

An actuator mechanism, denoted generally by numeral 174, is positioned on top 166 of housing 162 in vertical alignment with opening 164. FIGS. 1, 3 and 4 illustrate actuator 174 as an electrically activated solenoid 176 and plunger mechanism. Although the preferred actuator is shown as a solenoid 176, other actuators such as, for example, a pneumatically operated piston and cylinder system or a hydraulically operated piston and cylinder system may be utilized.

Actuator mechanism 174 comprises a plurality of spaced vertically extending support members 178 secured to top 166 such as by welding. A pair of cross members 180 span the distance between adjacent support members 178 and are secured thereto by bolts 182. Solenoid 176 is supported by support plate 184 and is secured to cross members 180 such as by bolts, not shown.

A resilient cushion **186** having an opening in alignment with opening **164** surrounds opening **164** and is secured to top **166.**

Solenoid **176** contains a plunger **188** that moves upward in the vertical plane into solenoid **176** when solenoid **176** is energized. When not energized, plunger **188** seats upon cushion **186.** A rod **190** is connected to the base of plunger **188** and extends through opening **164,** sleeve **168,** spring **172,** and opening **160** in arm **158.** A collar **192** of larger diameter than opening **160** surrounds rod **190** and abuts the underside of arm **158.** The bottom of rod **190** is threaded and collar **192** is held in place by threading a nut **194** on the end of rod **192.** Nut **194** is only threaded on rod **190** to a point just before arm mechanism **142** begins to pivot upward. This is to insure that plate **152** will remain in contact with washer **140** as long as solenoid **176** is de-energized.

When piston **26** moves in its forward stroke, valve **28** is in the closed position, that is, plate **152** is in contact with washer **140** closing opening **138,** thus as piston **26** moves forward a vacuum is created in a space **115** in cylinder **114.** The vacuum continues to build up in space **115** until piston **26** passes and opens port **116** which substantially instantaniously creates a vacuum within suction chamber **54** since opening **72** in tube **50** is over port **106** in body **46.** At this time suction box **22** grips blank **12** by suction pressure and suction box **22** moves on its feed stroke while piston **26** continues its forward stroke. After suction box **22** releases blank **12** as previously described, suction box **22** moves on its return stroke and piston **26** moves rearwardly. As piston **26** covers port **116** and moves toward plate **136,** pressure is built up in space **115** since the volume of space **115** is decreasing. This pressure pushes on plate **152** pivoting arm mechanism **142** and compressing spring **172.** As arm mechanism **142** pivots, plate **152** moves away from washer **140** allowing the air under pressure in space **115** in cylinder **114** to escape through opening **138.** When piston **26** reaches its maximum rearward position the pressure build-up ceases and spring **172** pivots arm mechanism **142** so that plate **152** again contacts washer **140** and closes opening **138.**

In the continuous feeding mode of operation of feeding mechanism **10,** the above-described arrangement is all that is needed. On every feed stroke of suction box **22,** vacuum is applied by suction pump **24** to suction box **22** which feeds blank **12** and when suction box **22** reaches its maximum velocity, the vacuum is vented to atmosphere which releases blank **12** to the control of rolls **36** and **38.** Suction box **22** then returns to its starting position while piston **26** in suction pump **24** moves rearwardly until it is ready to reapply the vacuum to suction box **22** on the next feed stroke.

As previously described, it is desirable in many instances to stop feeding blanks at any given time without shutting down the equipment or to feed blanks only on every other feed stroke of the suction box. It is therefore desirable to allow the machine operator to command the blank feeding machine to stop feeding blanks in response to malfunctions or other reasons or to feed blanks only on alternate feed strokes to permit feeding of blanks of extra length as will be understood by those skilled in the art.

The preferred type of command system is of the electrical type as shown in FIGS. **1, 2, 8,** and **9.** Although the electrical command system is preferred, other systems such as pneumatic or hydraulic may be used if desired by substantially substituting the proper pneumatic or hydraulic components for the electrical components shown in FIGS. **8** and **9.**

Referring to FIGS. **1** and **2,** the electrical command system includes a control panel **196** with a first command system switch **30,** marked FEED/STOP in FIG. **1,** which, when depressed, signals blank feeding machine **10** to stop feeding blanks and a second command system switch **32,** marked FEED/SKIP in FIG. **1,** which, when depressed, signals blank feeding machine **10** to feed blanks on alternate feed strokes of suction box **22.**

An electrical switch, denoted generally by numeral **198,** FIGS. **1** and **2** is connected electrically to control panel **196** by wires **200.** As shown in FIGS. **1** and **2,** switch **198** is preferably of a conventional magnetic vane type limit switch; however, other types of switches may also be used. A conventional 115 volt alternating current vane type limit switch may be purchased from the General Electric Corporation under model number CR115A12. Vane type switch **198** consists of a contact assembly **202** having a slot **204** extending through the body. Contact assembly **202** also contains a pair of contacts, not shown, in which one of the contacts is moveable and magnetized. Contact assembly **202** is preferrably mounted on support frame **43** such as by bolts, not shown, in a position substantially below and substantially rearward of lower roller **38** as shown in FIG. **1.** Slot **204** extends parallel to the direction of motion on suction box **22.** A vane member **206** constructed from metal such as iron or steel is secured to suction box **22.** Vane **206** is constructed in the shape of an L so that one leg **208** is secured to flange **58** of tube **50** by bolts **60** and nut **62.** The other leg **210** extends perpendicular to leg **208** and in alignment with slot **204** in contact assembly **202.** Arm **210** is made of sufficient length so that when suction box **22** moves forward on its feed stroke, arm **210** will pass through slot **204** as suction box **22** reaches its maximum forward position. When arm **210** enters slot **204,** the magnetized contact is attracted to arm **210** but remains stationary in a normally closed position. As arm **210** moves rearward when suction box **22** is on its return stroke, the magnetized contact also moves rearward opening the normally closed contacts.

Although the above is the preferred arrangement for switch **198,** switch **198** may be positioned anywhere there are parts moving in timed sequence with the suction box **22.** For example, contact assembly **202** may be positioned near arm **82** of lever **80** and vane **206** may be mounted on arm **82** so that when arm **82** reciprocates, vane **206** passes through slot **204.**

Control panel **196** is electrically connected to solenoid **176** by wires **212** (FIG. **1**) so that upon command and when piston **26** is on its rearward stroke, solenoid **176** is energized which causes plunger **188** to raise rod **190** and since rod **190** is prevented from passing through opening **160** in arm **158** by collar **192** and nut **194,** arm mechanism **142** pivots around pivot pin **146** to the position shown by the dotted lines in FIG. **3.** Solenoid **176** is only activated on the rearward or exhaust stroke of piston **26** because if solenoid **176** is activated on the forward stroke of piston **26,** that is the vacuum stroke, the solenoid would have to overcome the vacuum pressure to pivot arm mechanism **142** which may cause damage to solenoid **176.** When arm mechanism

142 is pivoted, plate 152 no longer contacts washer 140 and cylinder 114 is thereby vented to atmosphere. Arm mechanism 142 will remain pivoted and thus valve mechanism 28 will be in the open position as long as solenoid 176 remains energized. When solenoid 176 is de-energized on command, plunger 188 drops on resilient cushion 186 and spring 172, being in compression, pivots arm mechanism 142 until plate 152 contacts washer 140, thus closing opening 138.

FIGS. 8 and 9 illustrate the electrical schematic for energizing solenoid 176 in both the first and second command systems respectively. The operations shown in FIGS. 8 and 9 will be described in detail during the explanation of the operation of blank feeding machine 10.

OPERATION

Referring first to the mode of operation wherein a bottom blank 12 is fed into adjacent processing machinery on each forward or feed stroke of suction box 22, the machine operator obtains a stack of corrugated box blanks 14 and places them on table 16 so that the leading edges 34 of the blanks in stack 14 abut gate 18. The bottom blank 12 is adjacent to and in alignment with space 20 between table 16 and gate 18. The machine operator pulls out switches 30 and 32 on control panel 196 which starts blank feeding machine 10 in operation, that is, it starts rollers 36 and 38 rotating and starts drive shaft 130 rotating.

For illustration purposes, it will be assumed that at the start of operations, piston 26 is at its most rearward position and suction box 22 is at the end of its return stroke so that suction chamber 54 is directly beneath bottom blank 12; however, it should be understood that piston 26 and suction box 22 may be in any position when starting blank feeding machine 10 in operation. As drive shaft 130 rotates clockwise, plate 128 is also rotated clockwise and since connecting rod 126 is connected to plate 128 and piston 26, piston 26 begins its forward stroke. Since plate 152 of arm mechanism 28 is in contact with washer 140 and covering opening 138 in cylinder 114, the forward stroke of piston 26 creates a vacuum within space 115 in cylinder 114. As piston 26 moves forward, drive shaft 130 also rotates cam mechanism 96, but because of the profile of cam track 102, lever 80 does not move and cam track 102 just moves around cam follower 100. As piston 26 continues on its forward stroke it uncovers port 116 in cylinder 114. When port 116 is uncovered the high vacuum in space 115 in cylinder 114 causes a vacuum to be substantially instantaneously created in suction chamber 54 since there is, at this moment, an open path from space 115 through port 116, port 118, flexible conduit 108, port 106 in body 46, port 72 in ram 50, hollow space 70 in tube 50, and the opening between tube 50 and suction chamber 54 to openings 64 in plate 63. The vacuum in suction chamber 54 causes bottom blank 12 to be held on top of plate 63 by the suction pressure.

When bottom blank 12 is held by the suction pressure, the cam track 102 profile is such that upon further rotation of drive shaft 130 and cam mechanism 96, lever 80 propels tube 50 forward and consequently propels suction chamber 54 on its feed stroke at an ever increasing velocity. At the same time, piston 26 continues on its forward stroke. As tube 50 moves forward, suction pressure continues to be applied to blank 12 as long as opening 72 is in alignment with opening 106. As opening 72 passes over region 110 on body 46, vacuum is discontinued since opening 72 is no longer in alignment with opening 106. At this moment in time, nose 44 of suction chamber 54 enters gap 42 between rollers 36 and 38 and suction box 22 is moving forward at substantially the same velocity as the peripheral velocity of rollers 36 and 38. Suction chamber 54 continues forward for a substantially short distance until rollers 36 and 38 have gripped blank 12. At this moment in time, opening 72 becomes aligned with opening 112 in body 46 which is vented to atmosphere and the vacuum still remaining in suction chamber 54 is also vented to atmosphere releasing the suction pressure on blank 12 thus releasing the grip that suction chamber 54 had on blank 12. At this moment, the profile of cam track 102 is such that piston 26 is at its maximum forward position. Upon further clockwise rotation of drive shaft 130, piston 26 moves rearwardly and lever 80 changes direction and pulls tube 50 and suction chamber 54 on their return stroke. Rollers 36 and 38 are now free to feed blank 12 into adjacent processing machinery without any retarding forces by suction box 22.

As tube 50 and suction chamber 54 move on their return stroke, piston 26 also moves rearwardly and covers opening 116 in cylinder 114. As piston 26 continues to move rearwardly, the air within space 115 in cylinder 114 is compressed since the volume within space 115 is continuously decreasing, causing pressure to build up. The pressure acts upon plate 152 of arm mechanism 142, and when the pressure is strong enough to overcome the biasing force of spring 172, arm mechanism 142 is pivoted about pin 146 so that plate 152 no longer contacts washer 140 and allows opening 138 to be open to atmosphere. The air pressure in space 115 is then allowed to escape through opening 138 and piston 26 can continue on its rearward stroke without any pressure build-up. Once piston 26 reaches its most rearward position, the pressure created by piston 26 rearward movement ceases and spring 172 pivots arm mechanism 142 downward until plate 152 contacts washer 140 and closes opening 138. When piston 26 reaches its most rearward position, tube 50 and suction chamber 54 are at the end of their return stroke so suction chamber 54 is beneath the next bottom blank 12.

The next feed stroke of suction box 22 is ready to begin in the same manner as described above. The blank feeding machine 10 continues to feed blanks 12 on each feed stroke in the manner described until the operator desires to command blank feeding machine 10 to stop feeding bottom blanks 12 altogether or to command blank feeding machine 10 to only feed blanks 12 on every other feed stroke of suction box 22.

FIGS. 8 and 9 show the preferred electrical system to command blank feeding machine 10 to stop feeding bottom blanks 12 (FIG. 8) or to skip feed bottom blanks 12 (FIG. 9). FIGS. 8 and 9 illustrate the electrical configuration of the control circuits when blank feeding machine 10 is feeding a bottom blank 12 on every feed stroke of suction box 22. In this configuration FEED/STOP button 30 and FEED/SKIP button 32 are in the pulled out position and consequently solenoid 176 is de-energized. For ease of illustration, FIGS. 8 and 9 are shown separately but, in actual operation, leads 300 are connected to the same conventional power source and leads 302 are connected to ground.

Referring to FIGS. **8** and **9**, for the continuous feeding operation, relay **304** is energized and switch **314A** is open; relay **306** is energized and switch **306A** is closed and contact **306B** is closed; relay **308** is de-energized and contact **308A** is closed and contacts **308B**, **308C**, and **308D** are open; relay **310** is de-energized and contacts **310A**, **310B** and **310C** are open; main feeding machine **10** contact **312** is closed; relay **314** is de-energized and contact **314A** is open and relay **316** is de-energized and contacts **316A** and **316D** are open and contacts **316B** and **316C** are closed. The skip feed circuit also contains a flip-flop relay denoted generally by numeral **318**. Flip-flop relay **318** has a pair of input relays **320** and **322** and a pair of output relays **324** and **326**. Flip-flop relay **318** is de-energized and contact **320A** is open, contact **322A** is closed, contacts **324A** and **324B** are open, and contact **326A** is closed. Therefore the only electrical path that is complete for continuous feeding of blank **12** is through contacts **308A**, **306B**, and relay **304** and through main feeding machine **10** contact **312** and relay **306**, thus bypassing solenoid **176**.

When it is desired to stop feeding blanks **12** altogether the machine operator depresses FEED/STOP button **30** and makes contact at point **301**. For illustration purposes, it will be assumed that the machine operator depresses the stop button when suction box **22** is on its feed stroke so that the contacts in vane switch **198** are closed. Relay **308** is energized which opens contact **308A** and closes contacts **308B**, **308C**, and **308D**. The closing of contact **308D** creates a path through transformer **332** to vane switch **198** and energizes relay **316** through the closed contacts in vane switch **198** which opens contact **316C** and closes contact **316A**. The energizing of relay **316** allows the suction box **22** to continue its feed stroke until blank **12** is picked up by rollers **36** and **38**, and delays activation of solenoid **176** until the return stroke of suction box **22** and piston **26** so that solenoid **176** is not energized to pivot arm mechanism **142** during the vacuum stroke. When suction box **22** is on its return stroke, vane limit switch **198** opens, due to the vane on suction box **22** pulling the movable magnetized contact away from the stationary contact. Although the time when the contacts in vane switch **198** open can be at any time during the return strokes of suction box **22** and piston **26**, the preferred time is substantially between 10° and 25° after piston **26** starts its rearward stroke in order to insure that solenoid **176** is not energized while piston **26** is on its vacuum creating stroke. This de-energizes relay **316** and opens contact **316A** and closes contact **316C**. Since contact **308C** and **316C** are both closed, relay **310** is energized closing contacts **310A**, **310B**, and **310C**. This provides a path through contacts **310B** and **308B** to maintain relay **310** energized and since relay **310** is now continuously energized, there is a path through switch **306A** and contact **310A** to solenoid **176**.

When contact **310A** closes, solenoid **176** is energized which pulls plunger **188** (FIGS. **1**, **3**, and **4**) up into solenoid **176**. This pulls up rod **190** which pivots arm mechanism **142** to the position shown by the dotted lines in FIG. **3**. The arm mechanism **142** will remain pivoted and opening **138** will remain uncovered as long as solenoid **176** remains energized. Therefore, on the forward stroke of piston **26**, opening **138** remains open and no vacuum is created in space **115**. When opening **116** is uncovered, no vacuum will be applied to suction chamber **54** and suction chamber **54** will not pick up bottom blank **12**. Thus, suction box **22** will move on its feed stroke without moving blank **12** and this operation will continue as long as FEED/STOP button **30** is depressed. Solenoid **176** will remain energized even though the contacts in vane switch **198** are continuing to close and open thereby energizing and de-energizing relay **316** which in turn keeps opening and closing contacts **316A** and **316C** because there remains a complete current path to keep relay **310** energized through contacts **310B** and **308B**, thus insuring that contact **310A** remains closed.

When continuous feeding of blank **12** is again desired the machine operator pulls out FEED/STOP button **30** which breaks the contact at point **301**. This de-energizes relay **308** and opens contacts **308B**, **308C**, and **308D** and closes contact **308A**. When contact **308B** opens, it breaks the current path to relay **310** by way of contacts **310B** and **308B** and when contact **308C** opens it breaks the path to relay **310** by way of contacts **308C** and **316C** when relay **316** is energized, but because it is undesirable to de-energize solenoid **176** when suction box **22** and piston **26** are on their forward strokes, there is still a path to relay **310** by way of contacts **310B** and **316A** when vane switch **198** contacts are closed. When suction box **22** is on its return stroke, the contacts in vane switch **198** open, de-energizing relay **316** and opening contact **316A** and closing contact **316C**. This breaks the last remaining path to relay **310**, thus de-energizing relay **310** and opening contacts **310A**, **310B** and **310C**.

The opening of contact **310C** breaks the path to vane switch **198** which keeps relay **316** de-energized; opening of contact **310B** breaks the path to relay **310**; and the opening of contact **310A** breaks the path to solenoid **176**. This de-energizes solenoid **176** which allows plunger **188** to drop onto cushion **186** and drop rod **190** downward which allows spring **172** to pivot arm mechanism **142** so that plate **152** covers opening **138** and on the next forward stroke of piston **26** vacuum will be created in space **115** so vacuum can be applied to suction chamber **54** for subsequent feeding of bottom blank **12**.

When it is desired to skip feed blank **12**, that is, feed blanks **12** on every other feed stroke of suction box **22**, the machine operator depresses FEED/SKIP botton **32** which makes contact at points **328** and **330**. This provides a current path through transformer **332** to vane switch **198**. For illustration purposes, it will be assumed that suction box **22** has just started its feed stroke for feeding blank **12** when the operator depresses the FEED/SKIP button **32**. Since the contacts in vane switch **198** are closed, relay **316** is energized thereby closing contact **316D** and opening contact **316B**. The closing of contact **316D** energizes relay **320** through closed contact **326A**. When relay **320** is energized, contact **320A** is closed and contact **322** A is opened. After suction box **22** feeds blank **12** into rollers **36** and **38** it starts its return stroke. Substantially **10** to **25** degrees after piston **26** has started its return stroke, vane **210** passing through slot **204** in contact assembly **202** opens the contacts in vane switch **198** and de-energizes relay **316**. This opens contact **316D** and closes contact **316B**. Since contact **320A** is closed, relay **324** is energized which opens contact **326A** and closes contacts **324A** and **324B**. As vane **210** leaves slot **204** in contact

assembly **202** on the return stroke of suction box **22**, the contacts in vane switch **198** close thereby energizing relay **316** which closes contact **316D** and opens contact **316B**. There is now a current path through contacts **316D** and **324A** to relay **322**. This energizes relay **322** which opens contact **320A** and closes contact **322A**. There is a second path through contact **324B** to relay **314**. This energizes relay **314** which closes contact **314A** thereby creating a path to energize solenoid **176**. Since suction box **22** is on its return stroke, solenoid **176**, being energized, pivots arm mechanism **142** and opens opening **138**. When suction box **22** starts its next feed stroke and piston **26** starts its next forward stroke, opening **138** remains opened since solenoid **176** is still energized and piston **26** does not create a vacuum and thus no vacuum is applied to suction chamber **54** and the bottom blank **12** is not gripped by suction chamber **54** and no blank is fed on the forward stroke. As suction box **22** starts its return stroke, the contacts in vane switch **198** open, de-energizing relay **316** which opens contact **316D** and closes contact **316B**. This energizes relay **326** which opens contacts **324A** and **324B** and closes contact **326A**. The opening of contact **324B**, de-energizes relay **314** which opens contact **314A**. The opening of contact **314A** de-energizes solenoid **176**, releasing plunger **188**, and rod **190** so that spring **172** can pivot arm mechanism **142** when piston **26** has reached its maximum return stroke. As vane **210** leaves slot **204** on the return stroke of suction box **22**, the contacts in vane switch **198** close thereby energizing relay **316** which closes contact **316D** and opens contact **316B**. Since solenoid **176** is not energized, piston **26** will create a vacuum within space **115** which will apply a vacuum to suction chamber **54** so that on this feed stroke, bottom blank **12** will be gripped by suction pressure and fed to rollers **36** and **38** by suction box **22**. The above-described cycle will continue to repeat as long as the FEED/SKIP button **32** is depressed and will continue to feed blanks **12** only on alternate feed strokes of suction box **22**.

When the machine operator desires to stop the skip feed operation and return to the regular feed operation, he pulls out FEED/SKIP button **32** which breaks contact at points **328** and **330**. This breaks the path to vane switch **198** and to relay **314**. Since relay **314** can no longer be energized, contact **314A** cannot be closed and thus solenoid **176** cannot be energized.

The foregoing has presented a novel blank feeding machine. The problem and danger of having a reciprocating feed bar to feed each bottom blank has been eliminated by having a reciprocating suction box apply suction pressure to the bottom blank on the suction box's feed stroke. In addition, by having a reciprocating suction box feed each blank and then release the blank by venting the suction to atmosphere, no friction must be overcome when rolls **36** and **38** pull the blank from the suction box.

The problems associated with mechanically operating a valve mechanism to allow the blank feeding machine to stop feeding blanks or to feed blanks only on every other feed stroke of the suction box have been eliminated by using and electrically operable command system for actuating the valve mechanism.

Accordingly, the invention having been described in its best embodiment and mode of operation, that which is desired to be claimed by Letters Patent is:

1. An improved blank feeding machine for feeding successive bottom blanks from a stack of blanks into adjacent processing machinery comprising in combination:

support means for supporting said stack of blanks thereon and defining with a gate means an opening therebetween through which said bottom blanks are successively advanced into said adjacent machinery;

advancing means reciprocable beneath said stack for applying suction pressure to said bottom blanks from the beginning of the feed stroke of said advancing means and continuing substantially through the first half of said feed stroke and thereafter for venting said suction pressure to atmosphere until the beginning of the next successive feed stroke;

suction pump means for delivering suction pressure to said advancing means during the forward stroke of a piston means within said suction pump means, said suction pump means including valve means electrically operable upon command for preventing delivery of said suction pressure to said advancing means;

selectively operable first command means for electrically operating said valve means to prevent delivery of said suction pressure during each forward stroke of said piston means to prevent advancement of said blanks; and

selectively operable second command means for electrically operating said valve means to prevent delivery of said suction pressure during alternate forward strokes of said piston means to prevent advancement of said blanks during alternate feed strokes of said advancing means.

2. The blank feeding machine of claim **1** wherein said valve means opens automatically in response to an increase in air pressure ahead of said piston means during the return stroke thereof for venting said suction pump means and closes automatically in response to a biasing means connected thereto during the forward stroke of said piston means.

3. An improved suction pump means for a blank feeder comprising in combination:

a cylinder means;

a piston means reciprocable within said cylinder means for creating suction pressure within said cylinder means on the forward stroke of said piston means;

drive means connecting said piston means and said blank feeder for reciprocating said piston means in timed relation thereto;

conduit means connected between said cylinder means and a reciprocable blank advancing means on said blank feeder adapted to deliver suction pressure of predetermined magnitude from said cylinder means substantially instantaneously to said advancing means at the beginning of the feed stroke of said advancing means; and

a valve means for automatically venting said cylinder means during the return stroke of said piston means, said valve means being electrically operable in response to a first command means to continuously vent said cylinder means to atmosphere on each forward stroke of said piston means and electrically operable in response to a second command means to vent said cylinder means to atmosphere

on alternate forward strokes of said piston means.

4. The suction pump means of claim 3 wherein said electrically operable valve means comprises:

a valve plate means on said cylinder means pivotable into closing engagement with a vent means in said cylinder means;

resilient biasing means for pivoting said valve plate means into closing engagement during forward strokes of said piston means, said valve plate means being pivotable out of closing engagement with said vent means during return strokes of said piston means for venting said cylinder means to atmosphere; and

actuator means for pivoting said valve plate means out of closing engagement in opposition to said biasing means during forward strokes of said piston means in response to signals from said first and second command means.

5. The suction pump means of claim 4 wherein said actuator means comprises an electrically energized solenoid means mounted to said cylinder means for pivoting said valve plate means out of closing engagement in response to electrical signals from said first and second command means.

6. The suction pump means of claim 3 wherein:

said first and second command means include first electrical switch means energized by said blank feeder for producing an electrical signal in timed relation thereto;

said first command means further includes a second switch means for activating said valve means in response to said electrical signals to pivot said valve means to an open position on the rearward strokes of said piston means and to maintain said valve means in said open position during subsequent forward strokes of said piston means; and

said second command means further includes a second switch means for activating said valve means in response to said electrical signals to pivot said valve means to said open position on alternate rearward strokes of said piston means and to maintain said valve means in said open position on said alternate forward strokes of said piston means.

7. The suction pump means of claim 6 wherein: said second switch means of both of said first and second command means includes an electrical switching means for activating said valve means.

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