Oct. 11, 1966 J. K. BRUCE 3,278,048

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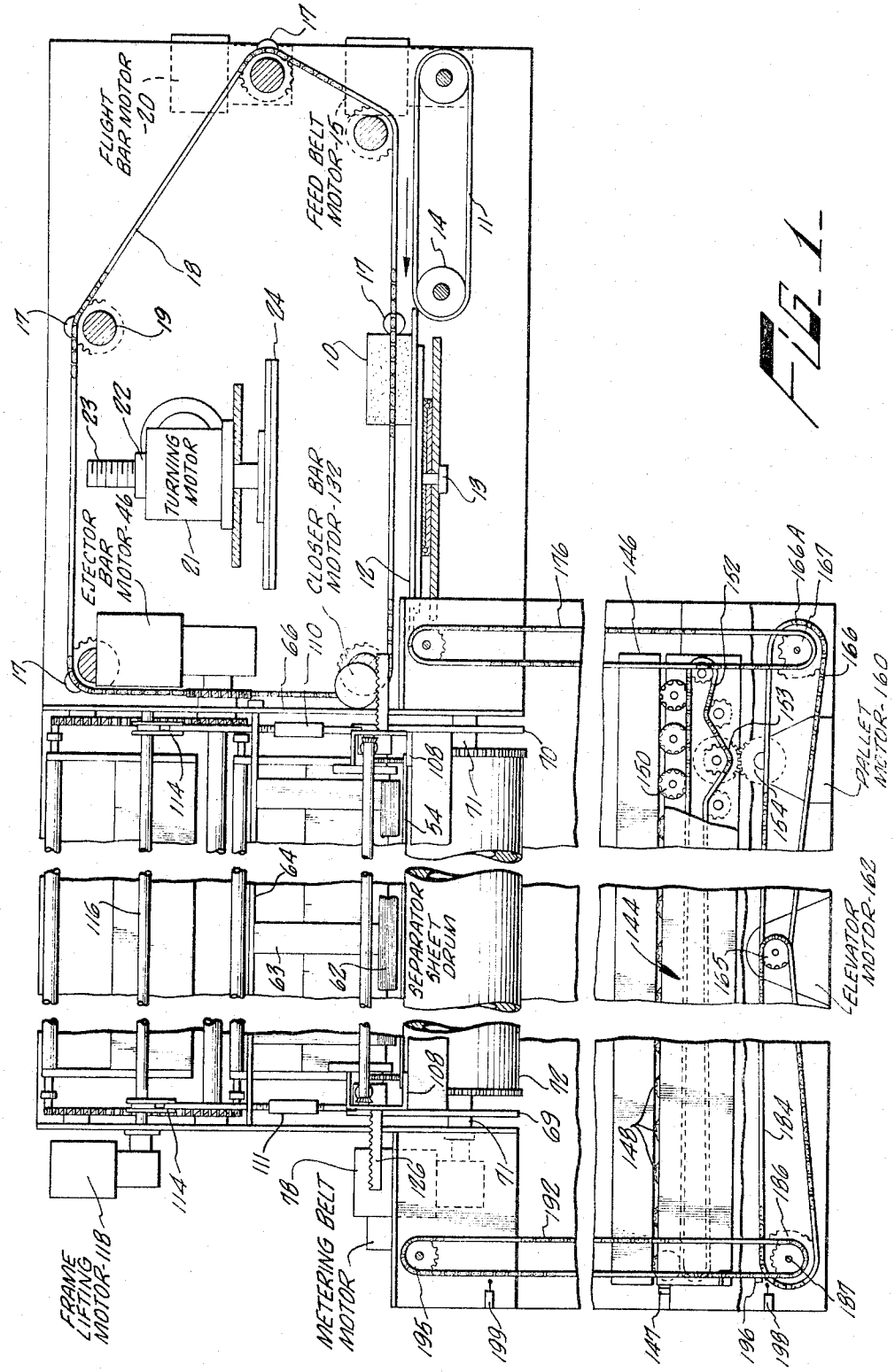


FIG. 1

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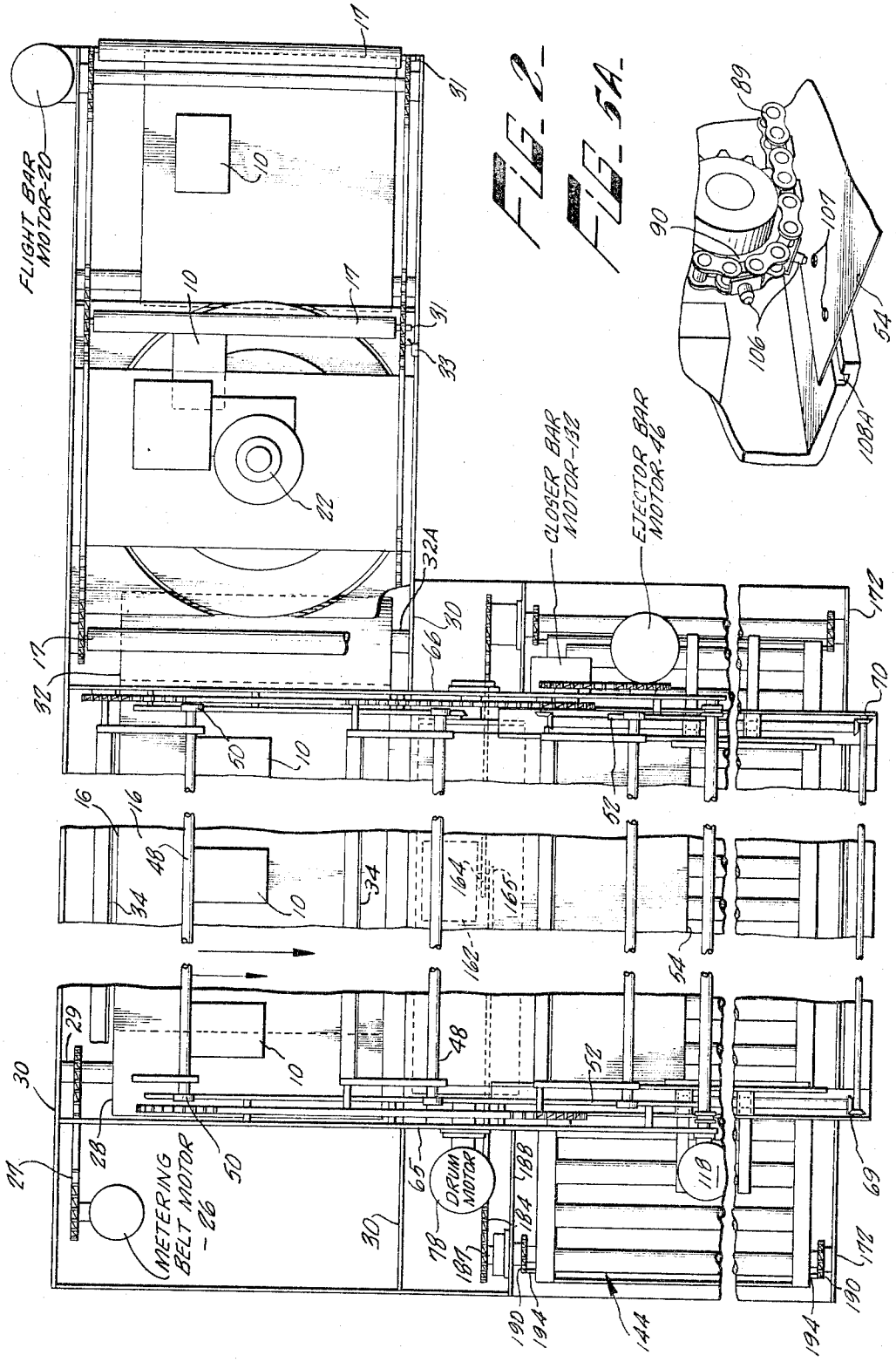


FIG. 2

FIG. 5A

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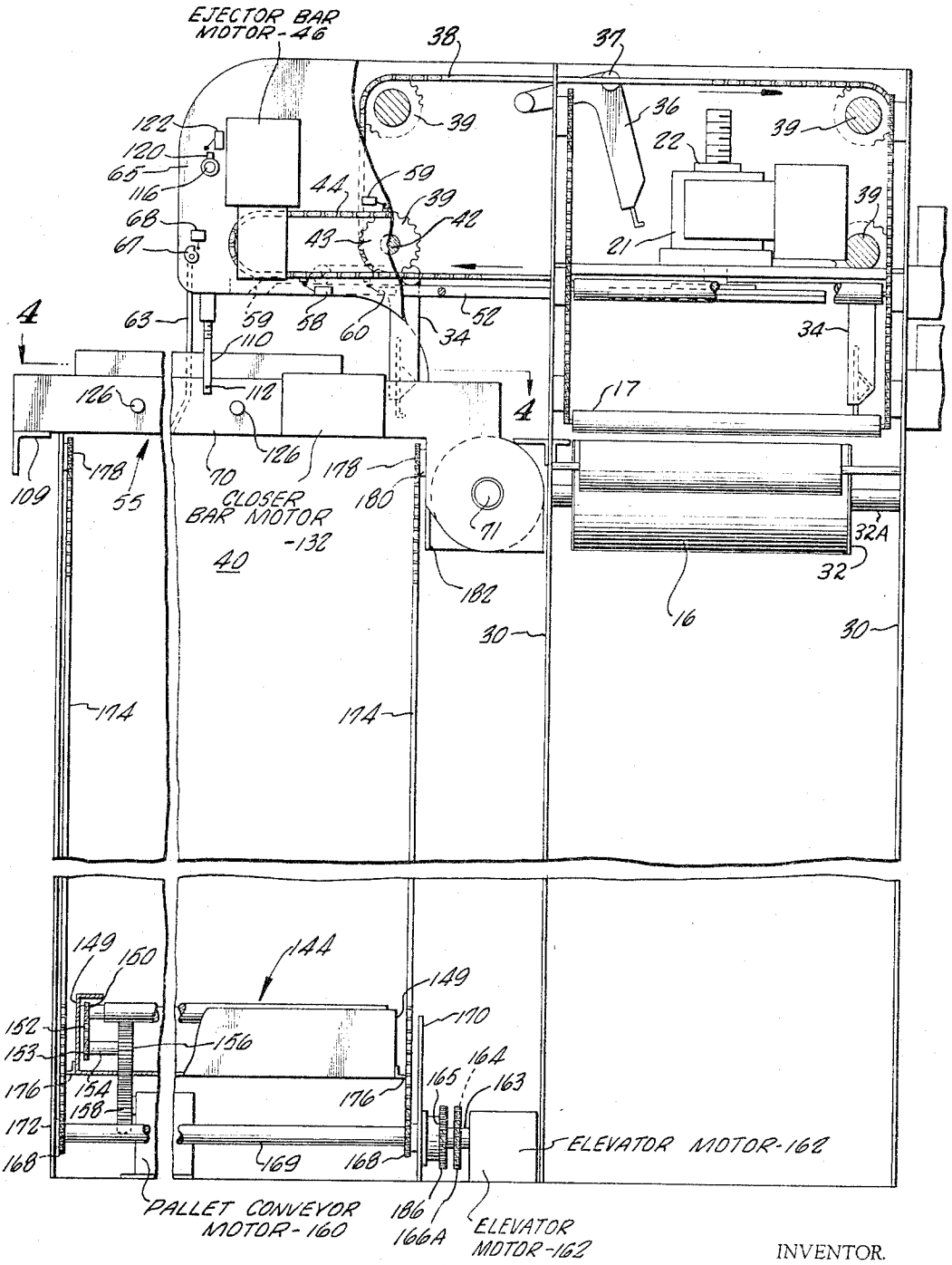


FIG. 3

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FIG. 4

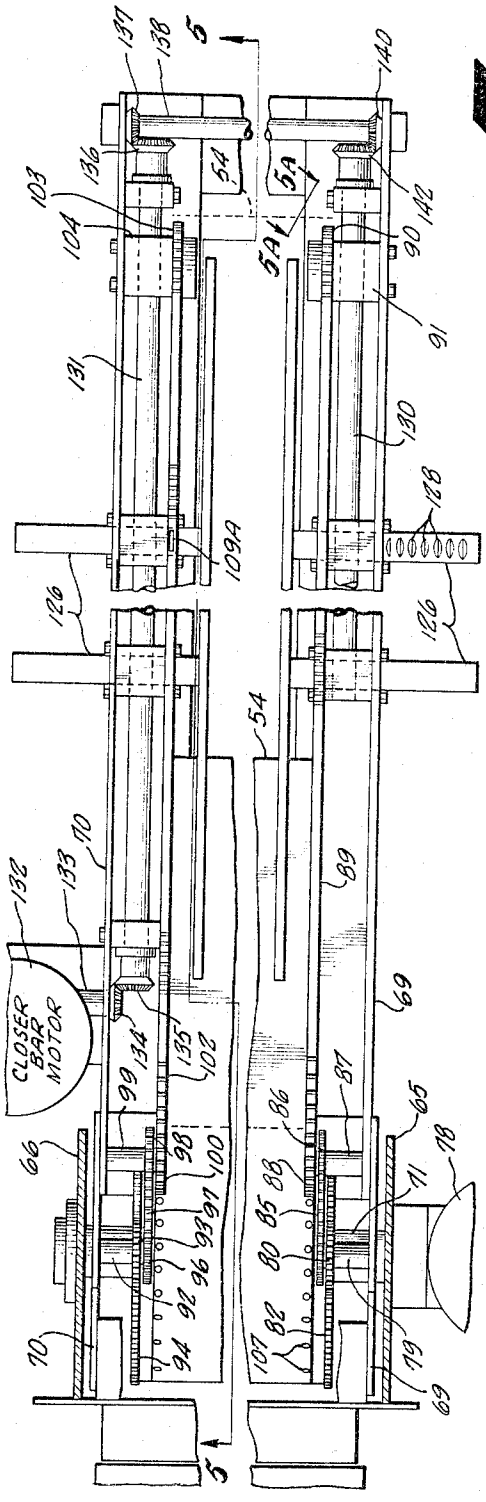
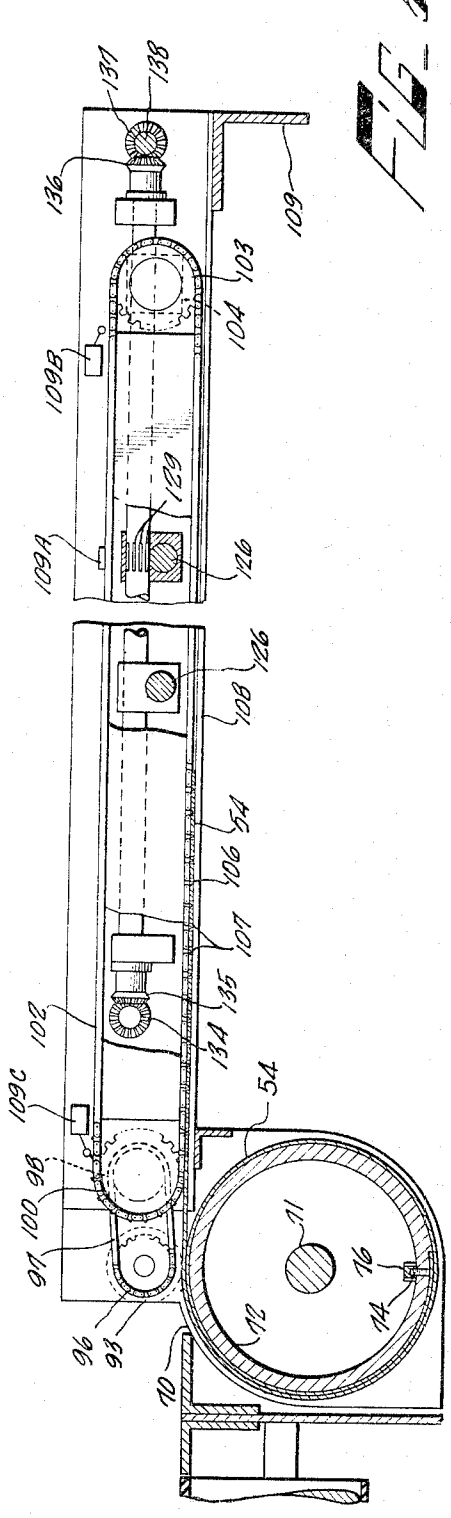


FIG. 5



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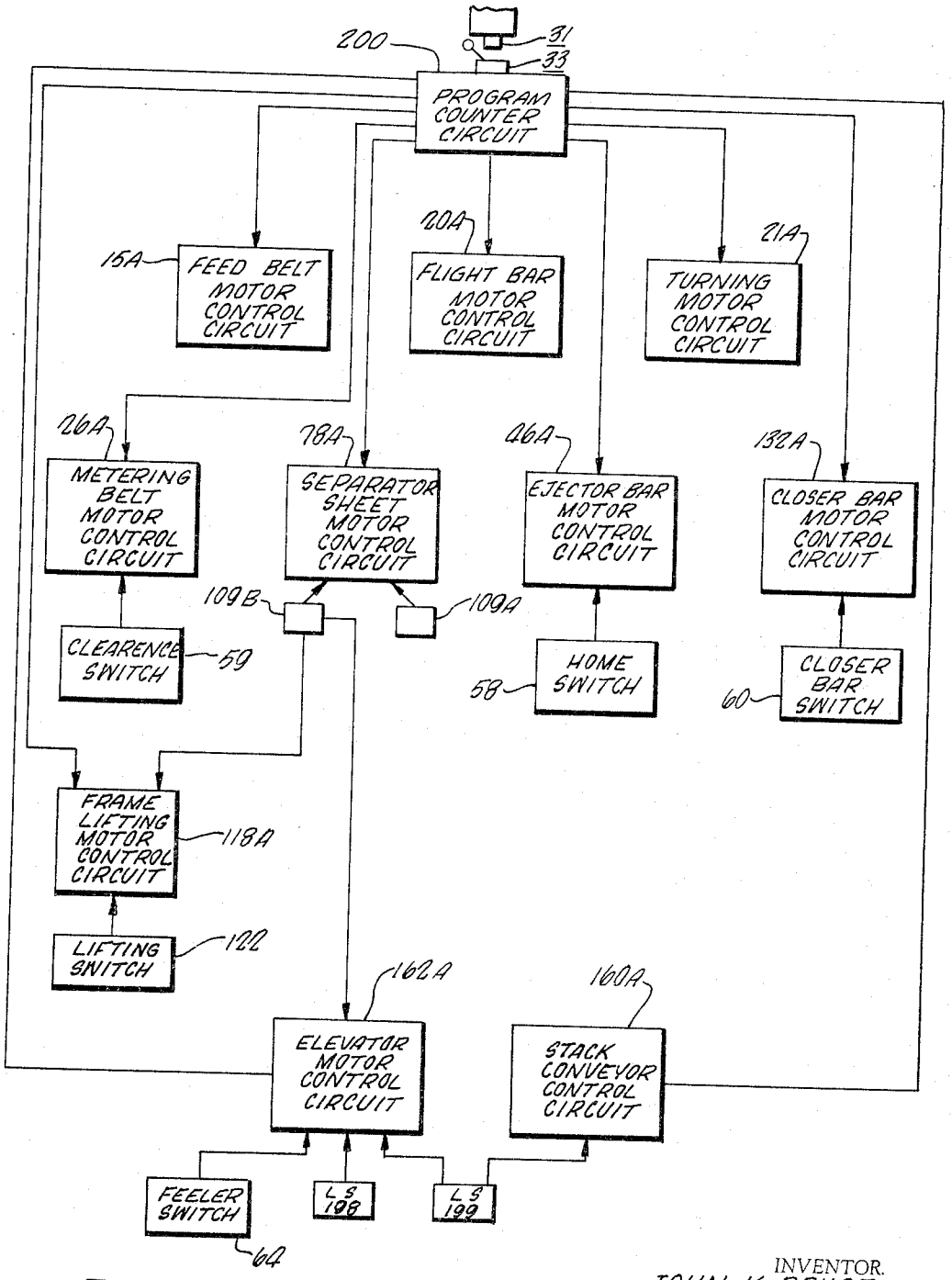


FIG. 6

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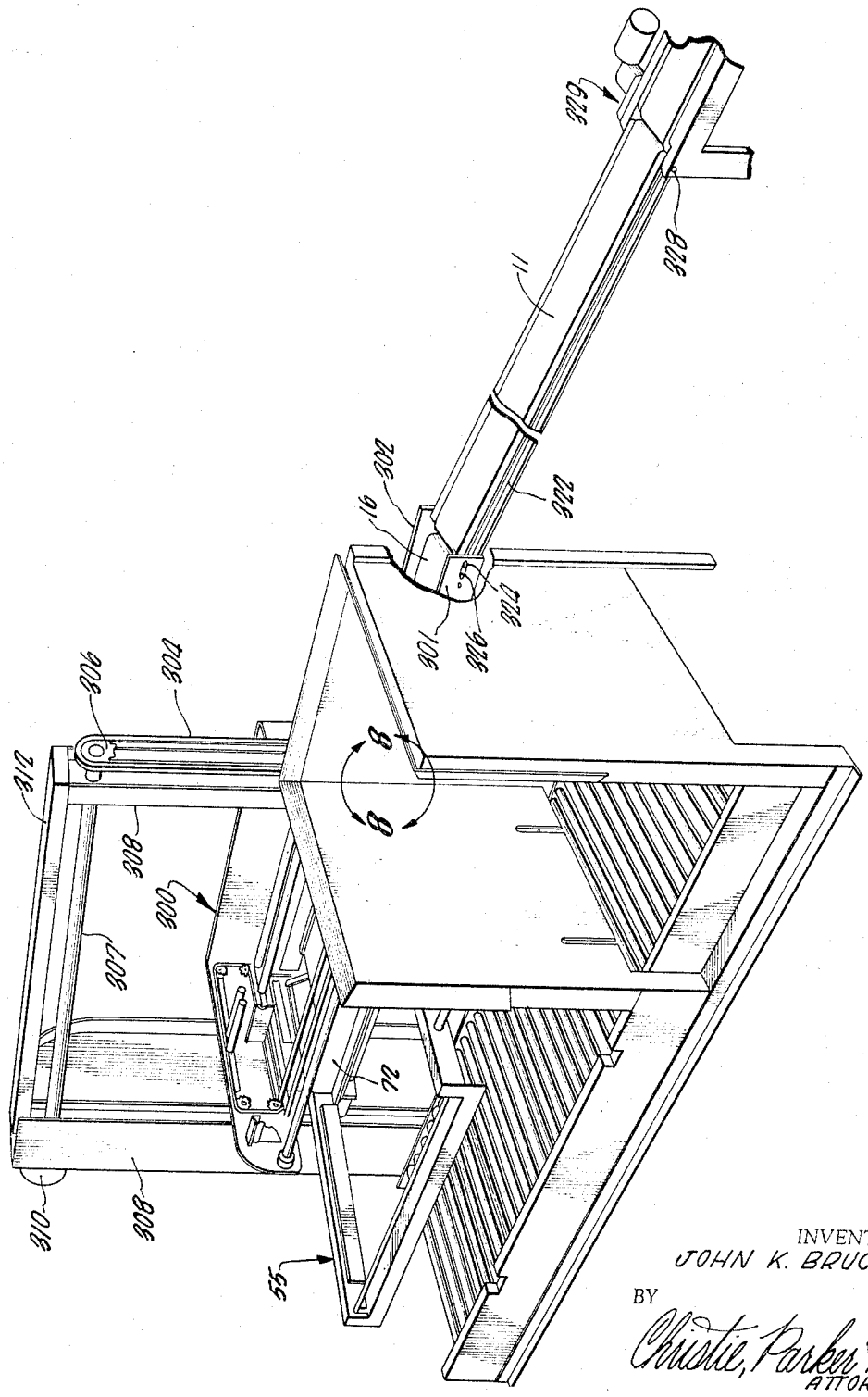


FIG 7

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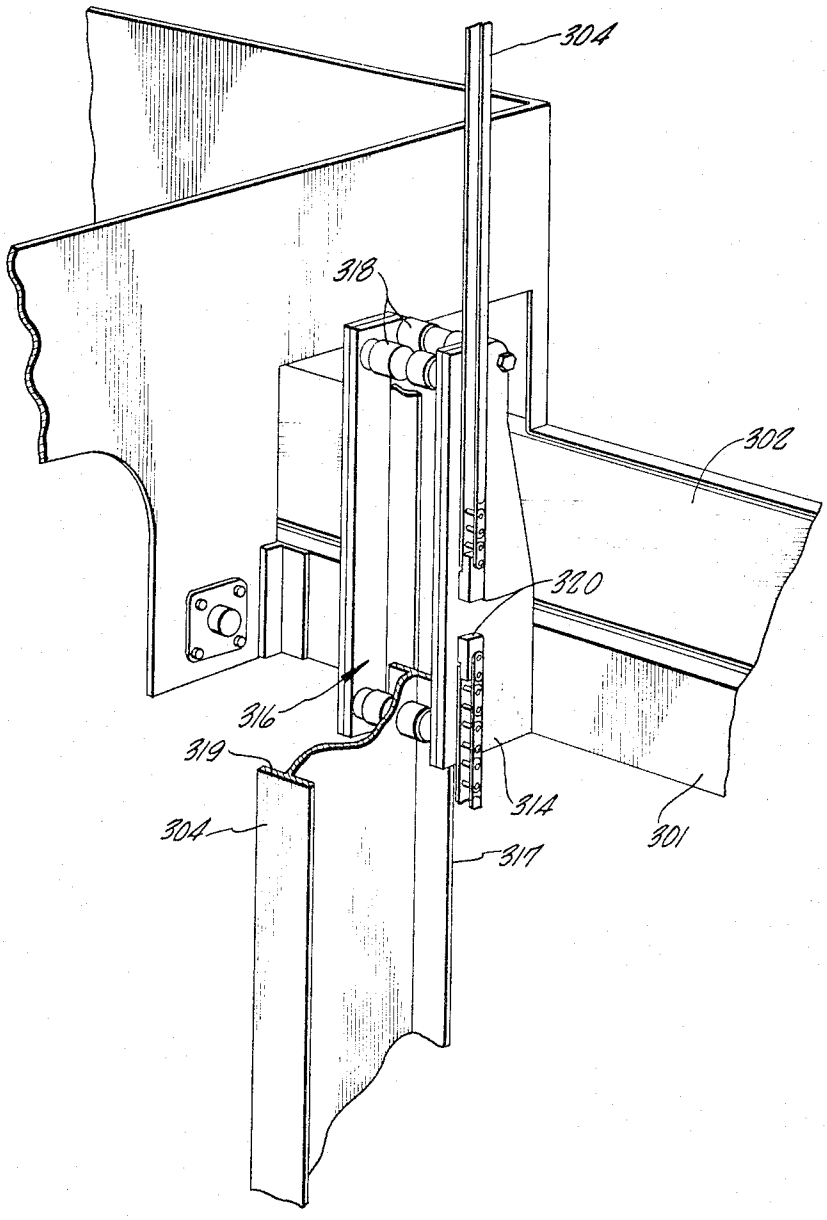


FIG. 8.

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3,278,048

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John K. Bruce, La Verne, Calif., assignor of one-half to United California Bank, a corporation of California

Filed July 22, 1963, Ser. No. 296,696
7 Claims. (Cl. 214—6)

This invention relates to apparatus and methods for stacking articles in layers.

Although it may be used for many different kinds of stacking applications, the invention is particularly well suited for automatically loading articles on pallets for shipment or storage. When so used, such equipment is generally referred to in the industry as palletizers. Presently available palletizers are large complex machines which are sometimes so expensive as to preclude their wide use throughout many industries in need of equipment for automatically handling and stacking articles such as cardboard cartons, sacks, cans, bricks, concrete blocks, and the like. Moreover, many of the present machines handle the articles so roughly that the articles are damaged, or cannot be stacked at all.

This invention provides a relatively simple automatic machine for handling and stacking various types of material, so as to avoid rough handling of the articles, and to require less floor space than that previously required by prior machines.

In accordance with the method of this invention, articles are stacked in a stacking area by forming a first layer of articles in the area, and disposing a thin flexible sheet on the articles in the first layer. Additional articles are moved onto the sheet to form a second layer so the sheet and second layer rest on the articles in the first layer. The articles in the second layer are restrained from moving, and the sheet is withdrawn from between the two layers so the second layer rests directly on the first.

In the preferred method, the sheet is withdrawn from between the two layers by rolling it around a rotatable drum, and is disposed over the first layer by unrolling it from the drum.

In the apparatus of this invention, a frame is disposed around an area in which articles are to be stacked in layers. A rotatable drum is mounted adjacent the frame, and a flexible sheet is mounted to be wrapped and unwrapped from around the drum. The sheet may be of any suitable material, but preferably it is tough and durable, such as a thin sheet of flexible stainless steel. Guide means on the frame receive the sheet, and guide it over the stacking area as the drum is rotated, first in one direction, and then in another, to wrap and unwrap the sheet. Means are provided for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area. Means are also provided for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from the stacking area.

Thus, with the apparatus of this invention, the thin sheet is disposed on a pallet or other suitable support while articles to be stacked are moved onto the sheet to form a first layer. The first layer is restrained from moving from the stacking area as the drum is rotated to withdraw the sheet from under the first layer. Thereafter, either the frame is raised, or the first layer is lowered, by a distance equal to the height of the first layer. The sheet is then unwrapped from the drum and extended into the frame to cover the first layer of articles in the stacking area, and the sheet is disposed to rest on the first layer. A second layer of articles is then moved onto the sheet, and the foregoing process repeated, until as many layers as desired are built up in the stacking area. Then

the stacked material is moved from the stacking area, and a new stack is formed in a similar fashion.

In one form of the invention, the sheet and frame are movable up and down to provide for forming layers of stacked articles at different elevations, or to provide clearance as the sheet is extended out over a previously formed layer. In the preferred form, the frame pivots up and down about the axis of the drum to which the sheet is attached, so that the frame can be pivoted upwardly as the sheet is extended to insure clearing the top surface of the previously formed layer.

The preferred form of the invention also includes a pair of closer bars arranged on opposite sides of the frame to move toward and away from each other in a direction transverse to the movement of the sheet so that a layer disposed on the sheet can be squeezed together and compacted by the closer bars.

The articles being stacked are preferably moved onto the sheet by one or more ejector bars carried by an endless conveyor disposed above the sheet so that an ejector bar is advanced by the conveyor at one elevation toward the stacking area, carried upwardly by the conveyor, and moved away from the stacking area at a higher elevation. In this way, articles can be moved continuously toward the stacking area, even while the ejector bar is being returned to a position to move articles onto the thin sheet disposed over the stacking area.

Preferably, a conveyor is disposed adjacent the frame to move material or articles toward and to one side of the stacking area and in a direction transverse to that traveled by the ejector bars. Preferably, the ejector bars are pivoted to hang downwardly from the ejector bar conveyor so that they can pivot rearwardly away from the pushed articles as the bars reach the end of their travel toward the stacking area and begin to move upwardly.

In one form of the invention, a support is provided for holding a stack of articles in the stacking area, and means are provided for moving the support up and down. A conveyor is mounted on the support for moving the stacked articles or pallet on which they rest from off of the support. Thus, the support is raised to an upper level to deposit the first layer of articles, and is intermittently lowered in increments equal to the thickness of each layer as each layer is formed and stacked over the support. When a stack of the desired height is formed, the support is at its lower level and the conveyor on it is activated to move the stack out of the stacking area.

In another form, the support is at a fixed or lower level, and the frame and conveyor adjacent the frame for moving articles toward the stacking area are mounted to be movable up and down together so that the frame and conveyor adjacent it can be moved upwardly in increments equal to the thickness of the stacked layers. Thus, the frame starts at a low level, and is raised as layers are deposited in the stacking area. After the stack of the desired height is formed, the stack is moved out of the stacking area, and the frame is returned to the lower level for forming a new stack.

These and other aspects of the invention will be more fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is a fragmentary side elevation, partly broken away and partly in cross section, of the presently preferred embodiment;

FIG. 2 is a fragmentary plan view, partly broken away, of the apparatus shown in FIG. 1;

FIG. 3 is a fragmentary end elevation, partly broken away, of the apparatus shown in FIG. 1;

FIG. 4 is a view taken on line 4—4 of FIG. 3;

FIG. 5 is a view taken on line 5—5 of FIG. 4;

FIG. 5A is an enlarged partial perspective view of an

idler sprocket driving a flexible horizontal separator sheet shown in FIGS. 4 and 5;

FIG. 6 is a block diagram of various control circuits for automatically controlling the apparatus shown in FIGS. 1 through 5;

FIG. 7 is a perspective view, partly broken away, of an embodiment of the apparatus in which the frame and adjacent conveyor are moved up and down to form a stack; and

FIG. 8 is a fragmentary perspective view taken in the area of line 8—8 of FIG. 6.

Referring to FIGS. 1, 2, and 3, articles **10**, such as cases, concrete blocks, and the like, are moved by an endless horizontal feed belt **11** toward a horizontal turn table **12** mounted to rotate on a vertical shaft **13**. The feed belt is disposed around a pair of horizontal feed belt drums **14** driven by a feed belt motor **15**, which is operated by a feed belt motor control circuit **15A**, as described below with reference to FIG. 6.

As an article leaves the feed belt and moves onto the turntable, it is pushed across the turntable toward a horizontal metering belt **16** by one of a plurality of horizontal transverse flight bars **17** which are each secured at their ends to a pair of laterally spaced flight bar chains **18** disposed around flight bar sprockets **19** driven by a flight bar motor **20**, which is operated by a flight bar motor control circuit **20A** (FIG. 6).

If an article is to be turned, a turning motor **21**, operated by a turning motor control circuit **21A** (FIG. 6), and located over the turntable is turned on to rotate an internally threaded collar **22** and causes a vertically threaded shaft **23** disposed within the collar to move downwardly. A turning disk **24** rigidly secured to the lower end of the threaded shaft **23** moves downwardly until it bears against the top of the article **10**, which is disposed in the upper right quadrant (as shown in FIG. 2) of the turntable. The collar **22** rotates in a counterclockwise (as viewed in FIG. 2) direction, and the turning disk also turns in that direction when it engages the article, thereby causing the article to be advanced toward the metering belt, and shifted laterally away from the center of the turning disk. The details of the turning motor and turntable are shown in my copending application filed September 9, 1963, Serial No. 307,682, now abandoned, and are not described here in detail, because any suitable turning device can be used.

If the article is not to be turned, the turning motor is left inactive, and the article is pushed across the turntable by a flight bar and onto the metering belt, which is operated intermittently by a metering belt motor **26**, operated by a metering belt motor control circuit **26A** (FIG. 6), and connected through a chain drive **27** to a first rotatable transverse horizontal metering belt drum **28** on a shaft **29** journaled in vertical side plates **30** of the machine. The endless metering belt is also disposed around a second transverse horizontal metering belt drum **32** on a shaft **32A** journaled in the plates **30**. (See FIG. 3.) Drums **28** and **32** are identical in size and shape. Each time an article is pushed by a flight bar across the turntable, a lug **31** on the end of the flight bar trips a counting switch **33**. The function of the counting switch is described in detail below with respect to FIG. 6.

Thus, by controlled operation of the turntable and the metering belt, the articles can be formed in rows in any selected pattern. When rows of rectangular articles are arranged side-by-side to form layers, which are stacked, the turntable permits the articles of one layer to overlap those of an adjacent layer to interlock and securely bind the stack together. The intermittent operation of the metering belt is used to control the space between the rows of articles which form each layer, and thus provide flexibility in forming layers of an almost infinite variety to handle articles of different shapes and assure interlocking layers.

After a row of articles **10** is formed on the metering belt with the desired space in between articles (although in many cases the articles will be virtually touching), the row of articles is pushed laterally from the metering belt by one of a plurality of longitudinal horizontal ejector bars **34**. Each ejector bar is secured at its ends to the lower end of a respective inverted L-shaped bracket **36** (FIG. 3). Each bracket is secured by a separate respective pivot pin **37** to a separate respective ejector bar chain **38** disposed around sprockets **39** located over the metering belt. The lower portions of the ejector bar chains travel to the left (as viewed in FIG. 3) toward a stacking area **40**, and the upper portions of the chains return to the right over the metering belt. One of the sprockets **39** is mounted on a shaft **42** which also carries sprocket **43** driven by a drive chain **44** powered from an ejector bar motor **46**, operated by an ejector bar motor control circuit **46A** (FIG. 6).

On the end of each ejector bar bracket remote from the ejector bar is mounted a longitudinal cross rod **48** which rigidly secures together pairs of longitudinally aligned ejector bar brackets. A separate roller **50** is mounted on each end of each cross bar and rides on a respective horizontal transverse support rail **52** mounted over the metering belt and a portion of the stacking area adjacent the metering belt. As each ejector bar bracket is moved by operation of the ejector bar motor, the ejector bar rollers **50** come to rest on the right (as viewed in FIG. 3) end of the support rail and forces each ejector bar to pivot slightly in a clockwise direction about its pivot pin **37** so that each ejector bar bracket assumes the position shown for the two ejector bars on the lower (as viewed in FIG. 3) portion of ejector bar conveyor chain. With the rollers **50** on the support rail, the ejector bar brackets cannot pivot in a counterclockwise (as viewed in FIG. 3) direction. Therefore, when an ejector bar engages a row of articles on the metering belt it forces the articles to slide laterally off the metering belt and onto the relatively thin and flexible horizontal separator sheet **54** disposed in a frame **55** over the stacking area. The left (as viewed in FIG. 3) end of each support rail includes a downwardly and outwardly opening slot **56** to permit each ejector bracket roller **50** to drop downwardly as the ejector bar reaches the extreme left end of its travel and starts upwardly, thereby permitting the ejector bar to move freely upwardly from the row of articles it was just pushing. The articles now rest on the separator sheet which is supported as described in detail below.

As shown best in FIG. 3, a home switch **58**, a clearance switch **59**, and a closer bar switch **60** are disposed adjacent the ejector bar drive chain **44** to be contacted successively by a lug **61** on the chain as the ejector bar motor is operated. The operation and functions of the switches are described in detail below in conjunction with FIG. 6.

A horizontal longitudinally extending feeler bar **62** is secured across the lower ends of a plurality of vertical and longitudinally spaced feeler fingers **63** secured at their upper ends to a horizontal and longitudinal feeler rod **64** journaled in a pair of vertical and longitudinally spaced side plates **65**, **66** above the stacking area. As shown best in FIG. 3, a cam **67** is mounted on the feeler rod to actuate a feeler switch **68** mounted on side plates **65** when the feeler bar is pushed outwardly to the left (as viewed in FIG. 3) by articles forced onto the flexible sheet by an ejector bar. The function and operation of feeler switch **68** are described in detail below with respect to FIG. 6.

The separator sheet frame **55** includes a pair of transverse longitudinally spaced side rails **69**, **70**, which are mounted at their respective inner ends (right, as viewed in FIG. 3) to pivot about a horizontal longitudinal separator sheet drum shaft **71** journaled in transverse side plates **65** and **66**. A hollow separator sheet drum **72**

(FIGS. 4 and 5) is mounted on the shaft **71** to be rotatable with it, and the inner end of the separator sheet **54** is wrapped around the drum and rigidly secured to it by a series of countersunk screws **74** threaded into a longitudinally extending retainer bar **76** within the separator sheet drum. Thus, the separator sheet can easily be removed to be repaired or replaced, and if the retainer bar **76** becomes worn, it can also be replaced or turned over and rebored with threaded holes. This arrangement avoids having to replace the entire drum if the sheet should become worn or damaged.

A reversible separator sheet drum motor **78**, operated by a drum motor control circuit **78A** (FIG. 6), is mounted on transverse side plate **65** and has a drive shaft **79** which extends through side plate **65** and carries a first drive gear **80** that engages a gear **82** on the separator sheet drum so that the drum is rotated when the drum motor is turned on. A drive sprocket **84** on the drum motor shaft **79** drives a chain **85** disposed around a sprocket **86** on a stub shaft **87** journaled in the frame side rail **69**. A first separator sheet drive sprocket **88** is mounted on the stub shaft **87** and drives an endless chain **89** disposed around an idler sprocket **90** mounted on a stub shaft **91** journaled in the outer end of side rail **69**.

A stub shaft **92** journaled in frame side rail **70** is rotated by a sprocket **93** mounted on it to engage a sprocket **94** on the end of the separator sheet drum adjacent frame side rail **70**. A second sprocket **96** on stub shaft **92** drives a short endless chain **97** disposed around a first sprocket **98** on a stub shaft **99** journaled in frame side rail **70**. A second sprocket **100** on stub shaft **99** drives a second endless separator sheet drive chain **102** disposed around an idler sprocket **103** mounted on a stub shaft **104** journaled on the right (as viewed in FIGS. 4 and 5) end of frame side rail **70**.

Each separator sheet drive chain **89** and **102** carries a plurality of outwardly extending teeth **106** which each fit into a respective row of perforations **107** along each side of the separator sheet, which rests on a respective horizontal transverse flange **108** each rigidly attached to the inner faces of the frame side rails **69** and **70**, and supported at their outer ends by a cross brace **109**. The idler sprocket teeth **106** individually engage the perforations **107** formed in the separator sheet **54** and extend within a slot **108A** formed in the horizontal transverse flange **108** (see FIGS. 4, 5 and 5A). Thus, as the separator sheet drum motor is turned in one direction or the other, the sheet is either extended over the stacking area **40**, or is retracted and wrapped around the drum.

A lug **109A** on the separator sheet drive chain actuates a first limit switch **109B** when the sheet is fully retracted when wrapped around the drum. In this position, the free end of the sheet is located just to the right (as viewed in FIGS. 4 and 5) of stub shaft **99**, i.e., the phantom line position indicated in FIG. 4. When the flexible sheet is fully extended, its forward edge terminates just short of stub shafts **91** and **104**, as indicated by phantom line in FIG. 4, and lug **109A** engages a second limit switch **109C** to indicate the presence of the sheet in this position. The operation and function of limit switches **109B** and **109C** are described in detail with respect to FIG. 6 below.

The frame is pivoted up and down about drum shaft **71** by a pair of vertical lift rods **110**, **111** secured at their respective lower ends by pivot pins **112** to frame side rails **70**, **69**, respectively. The upper end of each lift rod is connected to a respective crank **114** each mounted at opposite ends of a horizontal lifting shaft **116** journaled at its ends in transverse side plates **65** and **66**. A frame lifting motor **118**, operated by a frame lifting motor control circuit **118A** (FIG. 6), is connected to one end of the lifting shaft **116** so that when the motor is turned on the lifting shaft is rotated to operate cranks **114** and thereby raise and lower the frame by pivoting it about drum shaft **71**. A lug **120** (FIG. 3) on lifting shaft **116** engages a lifting switch **122** when the lifting shaft is rotated to extend the lifting rod in its lowermost position as shown in FIG. 3. The frame lifting motor **118** is operated to pivot the frame **55** upwardly when the sheet is being extended to prevent the forward edge of the sheet from engaging any part of a previously formed layer of articles, or any part of the support on which the articles rest, if a first layer has not yet been formed.

A pair of transverse closer bars **124** are mounted adjacent frame side plates **69** and **70** on the inner ends of respective pairs of longitudinal racks **126** extending through the frame side plates **69** and **70**. Each rack includes a series of teeth **128** which are engaged by splines **129** in a first transverse rotatable spline shaft **130** mounted to rotate adjacent frame side rail **69** and a second horizontal transverse spline shaft **131** mounted to rotate adjacent frame side rail **70**. A reversible closer bar motor **132**, operated by a closer bar motor control circuit **132A** (FIG. 6), is mounted on frame side rail **70** and includes a drive shaft **133** which extends through frame side plate **70** and carries a bevel gear **134** that engages a bevel gear **135** on the inner (left, as viewed in FIGS. 4 and 5) end of spline shaft **131**. A bevel gear **136** on the outer end of spline shaft **131** engages a first bevel gear **137** on one end of a cross shaft **138** journaled in the outer ends of frame side rails **69** and **70**. A second bevel gear **140** on the other end of cross shaft **138** engages a bevel gear **142** on the outer (right, as viewed in FIG. 4) end of spline shaft **130**. Thus, when the reversible closer bar motor is rotated in one direction, the closer bars are moved inwardly over the separator sheet to squeeze the layer of articles on it into a compact arrangement. The closer bars are retracted when the motor is reversed.

A support or elevator **144** is disposed under the frame and in stacking area **40**. Ordinarily, a conventional pallet **146** is mounted on transverse horizontal rollers **148** journaled in side members **149** of the elevator. When the elevator is in the lower position shown in FIG. 1, the pallet on it trips a limit switch **147**, which signals that an empty pallet is in proper position. Each roller carries a sprocket **150** which is driven by a chain **152** which, in turn, is driven by a sprocket **153** on a stub shaft **154** to which is connected a spur gear **156** that engages a spur gear **158** driven by a pallet conveyor motor **160**, operated by a stack conveyor motor control circuit **160A** (FIG. 6). However, the pallet may be eliminated for certain types of articles which can be stacked and moved without requiring a pallet. Moreover, the rollers on the elevator may be replaced by one or more endless belts.

The elevator is moved up and down by a reversible elevator motor **162**, operated by an elevator motor control circuit **162A** (FIG. 6). A drive shaft **163** from the elevator motor carries first and second drive sprockets **164**, **165**, respectively. A first elevator chain **166** is disposed around first drive sprocket **164** and a sprocket **166A** on a first elevator shaft **167** journaled in upright plates **170**, **172**. A first pair of elevator hoisting endless chains **174** are each disposed around a respective sprocket **175** mounted at each end of shaft **167**. Chains **174** are secured by brackets **176** to the elevator **144** at respective corners thereof. The upper ends of elevator chains **174** are disposed around idler sprockets **178** journaled on stub shafts **179** and **180** in the side plate **172** and a plate **182**, respectively.

A second elevator drive chain **184** (FIG. 1) is disposed around sprocket **165** and a sprocket **186** attached to a second transverse elevator shaft **187** journaled in the lower portion of side plate **172** and a side plate **188**. A pair of hoisting sprockets **190** are mounted on shaft **187**, and each carries a pair of endless elevator hoisting chains **192** connected by brackets **194** to the elevator **144**. The upper parts of chains **192** are disposed around idler sprockets **195** (FIG. 1). Thus, when the elevator motor is turned in one direction, the elevator is raised, and when it is turned in the other direction, the elevator is lowered.

When the elevator is lowered to its lowermost position, spur gear **156** on the elevator engages spur gear **158** on the pallet conveyor motor, so when that motor is turned on, the rollers on the elevator are turned to drive the pallet or stacked articles off the elevator and make room for the new pallet or new stack. Preferably, the pallets are fed automatically onto the elevators by a pallet feed device described and claimed in my copending application filed July 2, 1963, Serial No. 294,502, now Patent No. 3,231,131.

A lug **196** on one of the elevator hoisting chains **192** (see FIG. 1) engages a limit switch **198** when the elevator is in its lowermost position, as shown in FIG. 1, and engages a limit switch **199** when the elevator is in its uppermost position. The operation of these two switches is disclosed in detail in conjunction with the description in FIG. 6.

The operation of the machine can best be understood and summarized by reference to FIG. 6, which is a block diagram of the control circuits for the various motors. Counting switch **33** is actuated each time a lug **31** on one of the flight bars **17** moves past the switch, indicating the movement of an article onto the metering belt. A conventional program counter control circuit **200** is set to receive a signal each time the counting switch is tripped so that each article is handled automatically for turning, straight pass-through, and formation of proper rows and layers. For example, if three articles are to be aligned on the metering belt without turning to form a row, the counter control circuit keeps track of the first three articles, and generates signals for the feed belt motor control circuit **15A**, so that the feed belt is advanced intermittently the length of one article until all three articles are formed in a row adjacent the separator sheet, which is spread over the stacking area and rests on a pallet raised to the uppermost position on the elevator. On the other hand, if one or more of the articles in the first row are to be turned, the counter control circuit develops a signal for the proper article, and actuates the turning motor control circuit **21A** to turn the required articles. The feed belt and flight bar motors are ordinarily operated continuously to move articles from right to left (as viewed in FIGS. 1 and 2). However, the program counter control circuit is arranged to generate start and stop signals for the feed belt motor control circuit **15A** and the flight bar motor control circuit **20A** when a run is to be started or stopped. Suitable interlock and safety switches in the circuit of conventional design may also be incorporated to stop the apparatus should jamming or the like occur.

After a row has been formed on the metering belt, the metering belt is stopped by signals from the program counter control circuit and the metering belt motor control circuit. The program counter control circuit sends a signal to the ejector belt motor control circuit **46A**, which turns on the ejector bar motor to rotate ejector bar drive chain **44** and advance lug **61** (FIG. 3) sequentially from home switch **58**, past clearance switch **59**, past closer bar switch **60**, and back to home switch **58**, which, when hit by lug **61**, automatically turns off the ejector bar motor. This revolution of the chain **44** advances the ejector bar chain **38** by a distance equal to the space between adjacent ejector bars, so that the ejector bar at the extreme right, as shown in FIG. 3, is advanced across the metering belt and brought to a stop at the edge of the stacking area **40**. Thus, a first row of articles is slid onto the separator sheet.

When lug **61** activates clearance switch **59**, the metering belt control circuit receives a signal which energizes the metering belt motor to resume operation so that a succeeding row of articles can be formed on the metering belt, once the active ejector bar has cleared the metering belt area. With this arrangement, there is no need for a prolonged interruption of movement of articles while one row is pushed onto the separator sheet.

As soon as the second row is formed on the metering belt, the ejector bar motor is again activated to push the second row into the position occupied by the first, thereby sliding both the first and second rows onto the separator sheet. This procedure is repeated until the required number of rows are disposed on the separator sheet to form a first layer. The separator sheet is relatively thin (say, about .025 inch thick), and it rests directly on the pallet below, or on a preceding layer already on the pallet.

When the first layer is pushed into place by the ejector bar, the program counter control circuit and closer bar switch **60** energize the closer bar motor to advance the closer bars against the sides of the first layer and squeeze the articles into a compact arrangement. The closer bar motor is automatically reversed so that the closer bars are returned to their normal open positions shown in FIGS. 1, 2, and 4.

The program counter control circuit now sends a signal to the separator sheet motor control circuit **78A** which energizes the drum motor **78** and causes the drum to rotate in counterclockwise direction (as viewed in FIG. 5), thereby pulling the separator sheet out from under the first layer of articles and permitting them to rest directly on the platform. The flight bar which pushed the last row of the first layer into position is held firmly in place so that the first layer cannot slide with the separator sheet, but instead is forced to deposit on the pallet. Since the sheet is only a few thousandths of an inch thick, the articles are transferred smoothly to the pallet without any jolt.

A signal from the limit switch **109B**, in conjunction with the program counter control circuit, also activates the elevator motor when the stripper sheet is clear of the first layer. The feeler bar **62** is also pivoted in a clockwise direction (as viewed in FIG. 3) to activate feeler switch **68**, which develops a control signal for the elevator motor control circuit **214**. The elevator motor is now turned on to lower it a distance equal to the thickness of the first layer. This position is indicated by the return of the feeler bar to its position shown in FIG. 3, and the subsequent deactivation of feeler switch **68**, which stops the elevator motor.

Once the sheet is clear from under the first layer, limit switch **109B** (FIG. 5) is activated to stop separator sheet motor and activate the frame lifting motor control circuit **118A** in conjunction with a signal from the program counter control circuit. The frame lifting motor is driven through one revolution and stopped by lug **120** activating lifting switch **122**. During the revolution of the motor, the frame is pivoted upwardly and downwardly about the drum shaft through an angle of about 10°. While the frame is raised, a signal from the program counter control circuit to the separator sheet motor control circuit activates the drum motor to extend the separator sheet to its maximum outward position on the frame over stacking area **40**. When the sheet is in its maximum extended position, lug **109A** (FIG. 5) activates limit switch **109C**, and stops the drum motor. This operation is completed prior to the lowering of the frame back to its horizontal position shown in FIG. 3 Therefore, if there are any uneven projections on the top of the first layer, say, loose flaps on cardboard containers or the like, the separator sheet is placed down on top of any such projections, rather than ramming into them which could damage the equipment or the articles. The separator sheet comes to rest on the first layer, and a second layer is formed, as previously described. If desired, the articles in the second layer may be oriented by suitable conventional programming to overlap articles in the adjacent layer and securely bind the stack together.

The foregoing is repeated until a completed stack is formed, and the elevator is in its lowermost position, so that spur gear **156** on it is engaged with spur gear **158** on the pallet motor. Limit switch **198** (FIG. 1) is actuated by lug **196** on the elevator hoisting chain **192** (FIG. 1).

The signal from limit switch **198**, in conjunction with the signal from the program counter control circuit, stops the elevator motor, and starts the pallet or stack conveyor motor to move the stack out of the stacking area. An empty pallet is moved onto the elevator, and its presence is indicated by contact with the limit switch which, in conjunction with the signal from the program counter, actuates the elevator motor control circuit to raise the elevator and empty pallet back under the separator sheet until lug **196** engages limit switch **199** and stops the elevator motor so that a new stack can be formed as just described.

FIGS. 7 and 8 show an alternate embodiment of the invention in which the frame **55** and separator sheet drum **72** are mounted on a head **300**, which carries the metering belt **16** between a pair of longitudinal side plates **301** and **302**.

The head is moved up and down on a pair of hoisting chains **304**, each disposed around a separate hoisting sprocket **306**, each mounted at a respective end of longitudinal hoisting shaft **307** journaled in the upper ends of vertical posts **308**. A head hoisting motor **310** is mounted at the upper end of one of the posts and is connected to the hoisting shaft to rotate it. A longitudinally extending cross bar **312** is secured at each end to the upper ends of the vertical posts to provide rigidity.

FIG. 8 shows how one of the head hoisting chains is connected to the head, and a detailed description with respect to that figure will suffice for both chains.

One end of hoisting chain **304** is secured to a bracket **314** rigidly attached to side plate **301** of the head. The bracket includes an outwardly opening channel **316** which fits around one web **317** of an I-beam that forms post **304**. Vertically spaced pairs of rollers **318** are mounted within the channel **316** to make a close rolling fit on opposite sides of the flange **317** and of the web **319** of the post. As the hoisting shaft is turned in one direction, the head is raised, and as the shaft is turned in the opposite direction, the head is lowered. The lower portion of chain **304** is disposed around a conventional idler sprocket (not shown).

The feed belt **11** is mounted between a pair of elongated plates **322** which are connected by transverse pivot pins **324** in longitudinal slots **326** in side plates **301** and **302** at the inlet end of the metering belt. The feed belt side plates extend downwardly away from the metering belt and are connected at their lower ends by transverse pivot pins **328** to a supply conveyor **329**, which delivers articles to the feed belt. Thus, as the head moves up and down, the upper end of the feed belt side plates are free to slide slightly with respect to the metering belt side plates and provide the required play to accommodate the slight variation in distance of the head from the supply conveyor as the head moves vertically. The feed belt is sufficiently long that the relative longitudinal movement of the feed belt side plates with respect to the metering belt side plates is on the order of an inch or so, and the gap between the feed belt and metering belt is never so large as to prevent articles from easily being transferred from the feed belt to the metering belt.

The operation of the apparatus shown in FIGS. 7 and 8 is similar to that shown in FIGS. 1 through 6, except that the head is moved up and down instead of a pallet being moved as the stack of articles is formed. In the beginning, a pallet (not shown) is located under the frame, and the head is lowered until the frame is down over the pallet. The flexible sheet (not shown) is extended so that it rests on top of the pallet. Articles are fed onto the metering belt, and pushed onto the flexible sheet to form a layer as previously described. When the first layer is formed, the sheet is withdrawn, leaving the articles resting directly on the pallet. With the sheet still withdrawn, the head is hoisted by a distance approximately equal to the thickness of the first layer, and the flexible sheet is extended over the first layer of articles. The second layer is then formed, and deposited on the first. This process is repeated until the completed stack is formed, and the head is raised sufficiently to clear the frame above the top limit of the stack, which is then moved out of the stacking area.

I claim:

1. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, means for moving the frame up and down over the stacking area between a lower and upper position, a rotatable drum mounted adjacent the frame, a flexible sheet mounted to be wrapped and unwrapped from around the drum, guide means on the frame for receiving the sheet and guiding it over the stacking area as the drum is rotated to wrap and unwrap the sheet, means for rotating the drum to wrap the sheet around it and withdraw the sheet from the stacking area when the frame is in the lower position, means for moving the frame to the upper position, means for rotating the drum to unwrap the sheet from around it to extend over the stacking area while the frame is in the upper position, means for moving the frame to the lower position while the sheet is over the stacking area, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

2. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, means mounting the frame to be pivotable up and down over the stacking area, between a lower and an upper position, a rotatable drum mounted adjacent the frame, a flexible sheet mounted to be wrapped and unwrapped from around the drum, guide means on the frame for receiving the sheet and guiding it over the stacking area as the drum is rotated to wrap and unwrap the sheet, means for rotating the drum to wrap the sheet around it and withdraw the sheet from the stacking area when the frame is in the lower position, means for moving the frame to the upper position, means for rotating the drum to unwrap the sheet from around it to extend over the stacking area while the frame is in the upper position, means for moving the frame to the lower position while the sheet is over the stacking area, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

3. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, a rotatable drum mounted on the frame, means for pivoting the frame up and down about the axis of rotation of the drum between a lower and an upper position over the stacking area, a flexible sheet mounted to be wrapped and unwrapped from around the drum, guide means on the frame for receiving the sheet and guiding it over the stacking area as the drum is rotated to wrap and unwrap the sheet, means for rotating the drum to wrap the sheet around it and withdraw the sheet from the stacking area when the frame is in the lower position, means for moving the frame to the upper position, means for rotating the drum to unwrap the sheet from around it to extend over the stacking area while the frame is in the upper position, means for moving the frame to the lower position while the sheet is over the stacking area, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

4. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, means for moving the frame

up and down over the stacking area between an upper and a lower position, a rotatable drum mounted adjacent the frame, a flexible sheet mounted to be wrapped and unwrapped from around the drum, the sheet having a series of recesses extending in a direction transverse to the axis of drum rotation, means for engaging the sheet in the recesses and moving them toward the drum to wrap the sheet on the drum and withdraw the sheet from the stacking area when the frame is in the lower position, means for moving the frame to the upper position, means for engaging the sheet in the recesses and moving them away from the drum to unwrap the sheet from the drum to extend over the stacking area while the frame is in the upper position, means for moving the frame to the lower position while the sheet is over the stacking area, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

5. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, a rotatable drum mounted adjacent the frame, a flexible sheet mounted to be wrapped and unwrapped from around the drum, the sheet having a series of recesses extending in a direction transverse to the axis of drum rotation, means for engaging the sheet in the recesses, means for driving the drum and sheet-engaging means for moving the sheet toward and away from the drum to wrap and unwrap the sheet on the drum, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

6. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, a rotatable drum mounted adjacent the frame, a pair of spaced guides on the frame, a flexible sheet disposed on the guides and mounted to be wrapped and unwrapped from around the drum, the sheet having a series of recesses extending in a direction transverse to the axis of drum rotation, means for engaging the sheet in the recesses and moving them toward and away from the drum to wrap and unwrap the sheet on the drum, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

7. Apparatus for stacking articles in layers in a stacking area, the apparatus comprising a frame disposed around the stacking area, a rotatable drum mounted adjacent the frame, a flexible sheet mounted to be wrapped and unwrapped from around the drum, the sheet having a series of recesses extending in a direction transverse to the axis of drum rotation, an elongated conveyor disposed adjacent the recesses in the sheet, projections on the conveyor extending into the recesses, means for moving the projections on the conveyor toward and away from the drum to wrap and unwrap the sheet on the drum, means for moving articles onto the flexible sheet when it is unwrapped from the drum and disposed over the stacking area, and means for restraining the articles from moving from the stacking area as the drum is rotated to wrap the sheet around it and remove the sheet from over the stacking area.

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