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CARTON CLAMPING AND GUIDING MEANS IN AN AUTOMATIC CARTON CLOSING MACHINE

Filed Dec. 20, 1965 9 Sheets-Sheet 1

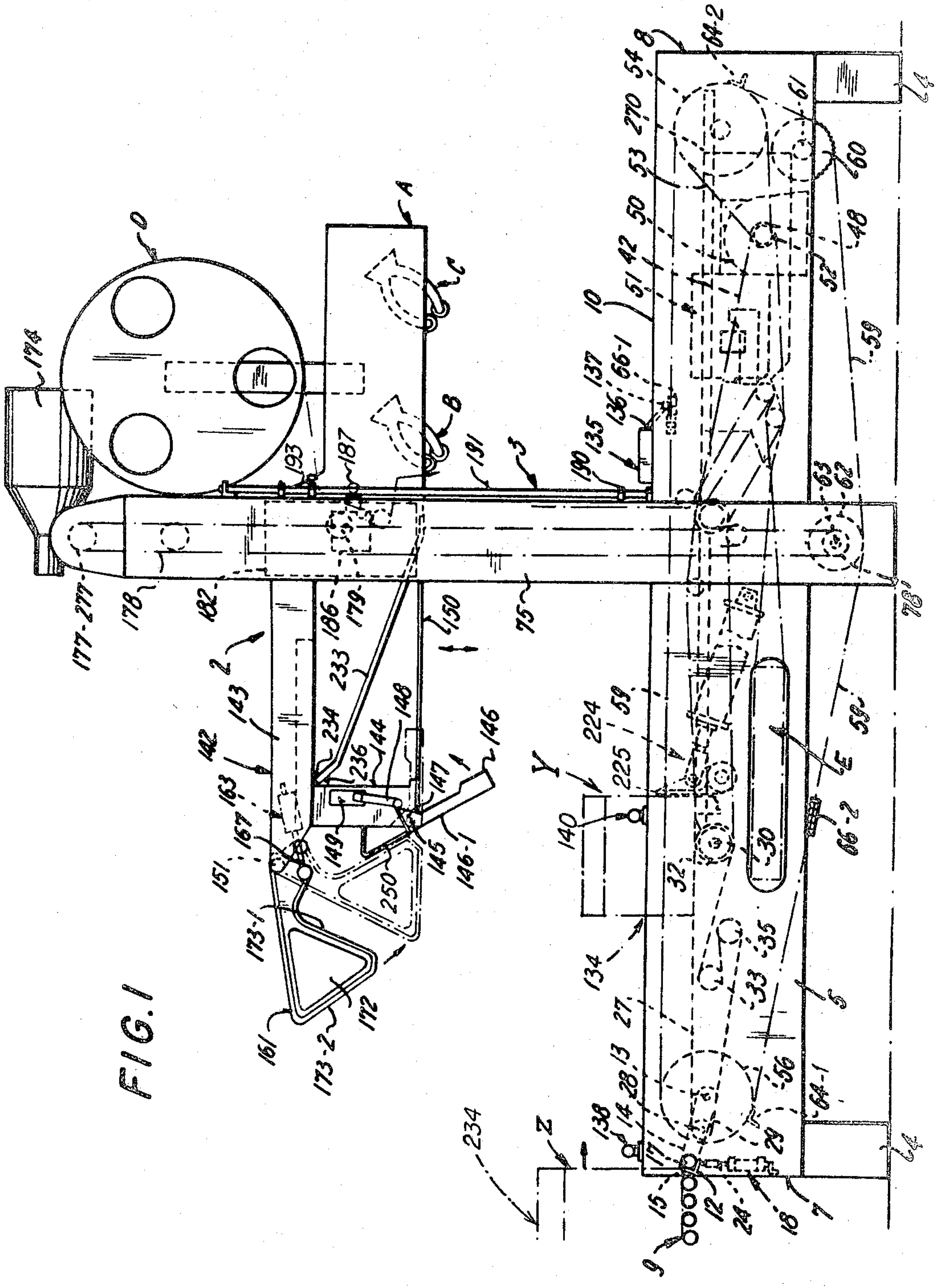

FIG. 1

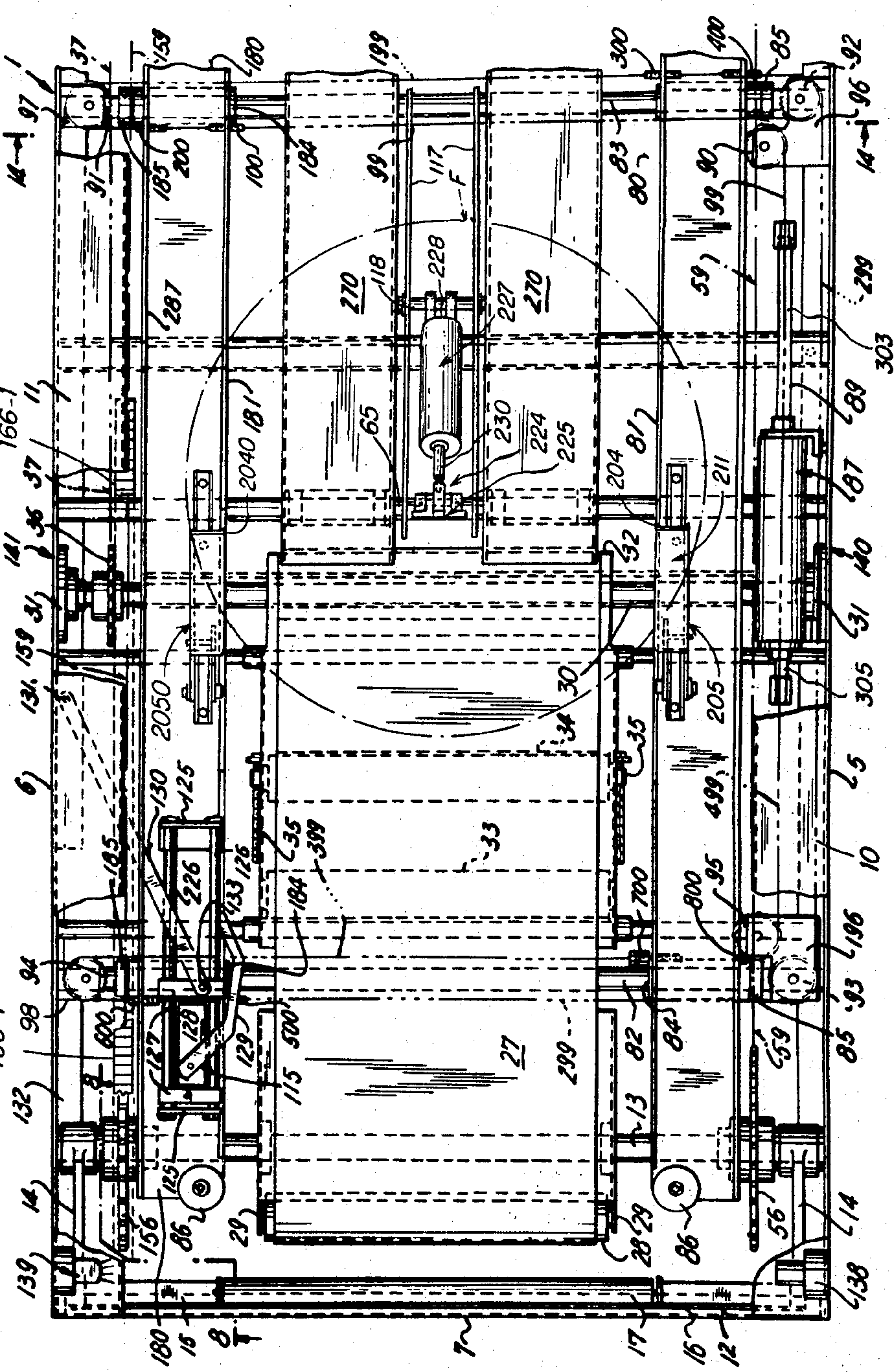

FIG. 2

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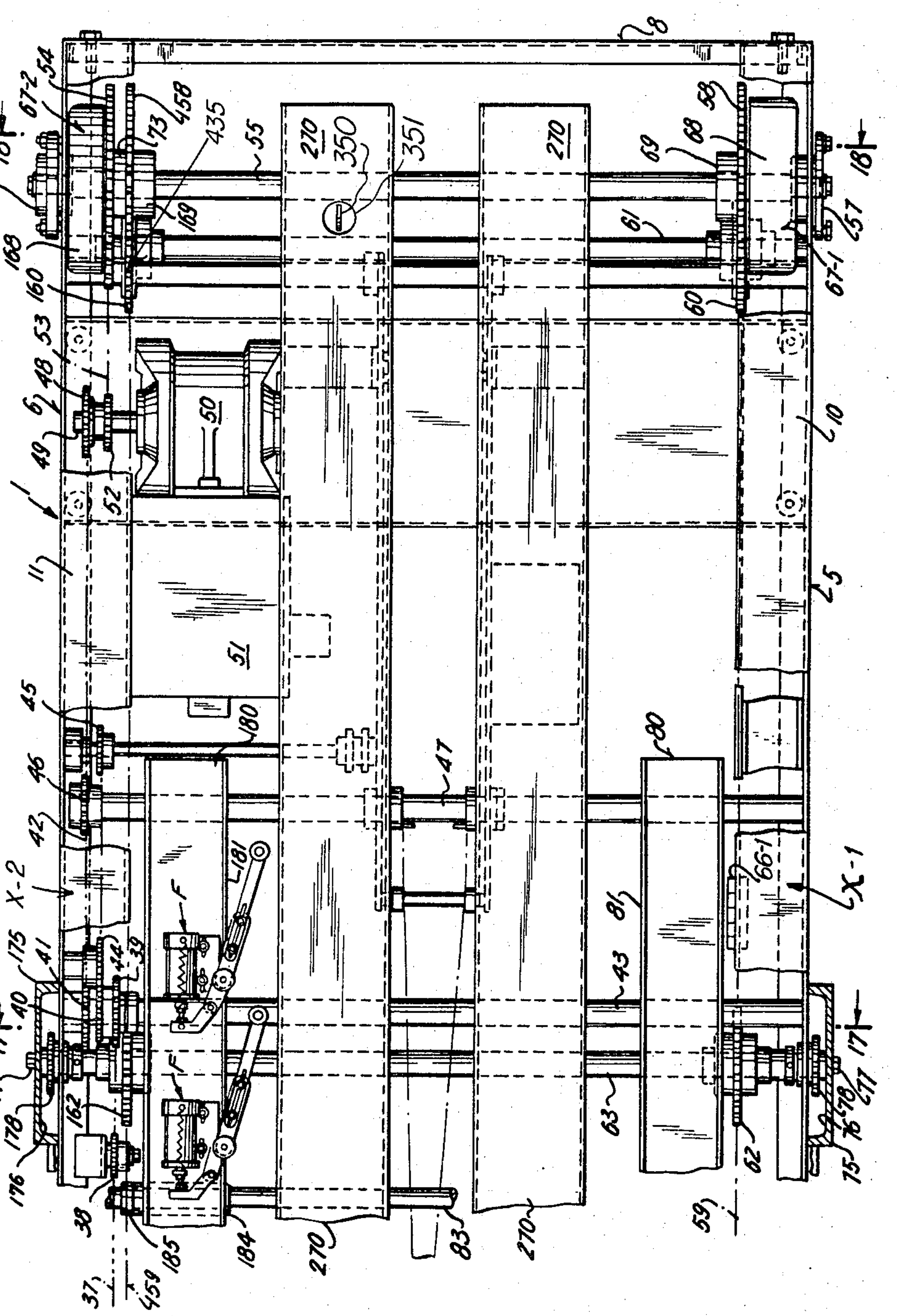

FIG. 3

CARTON CLAMPING AND GUIDING MEANS IN AN
AUTOMATIC CARTON CLOSING MACHINE

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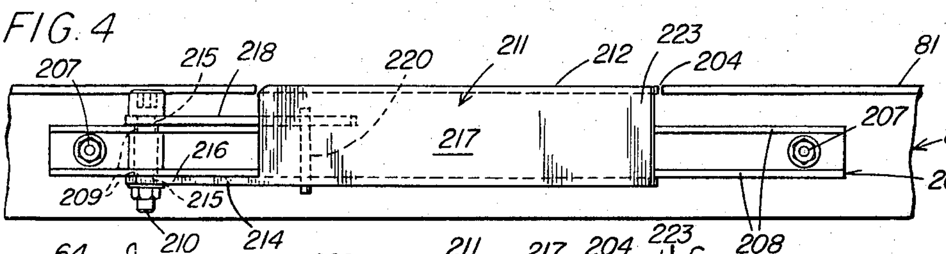
FIG. 4



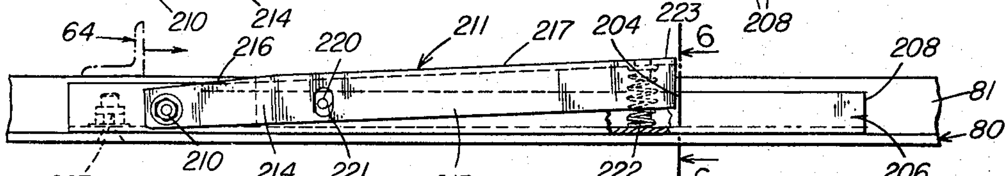


FIG. 5

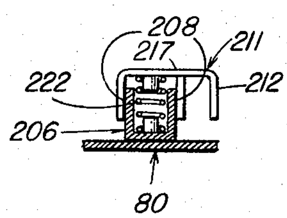


FIG. 6

FIG. 7

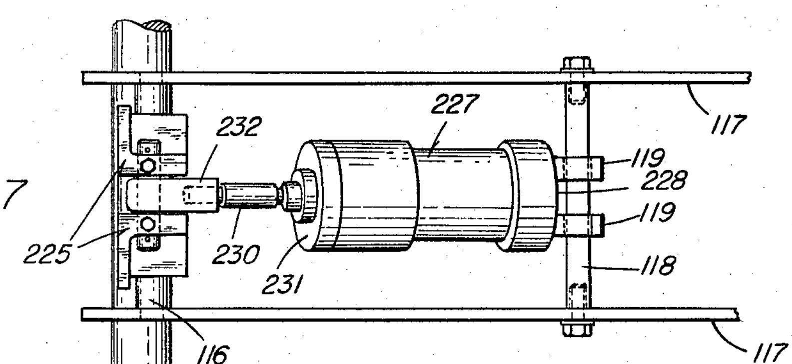
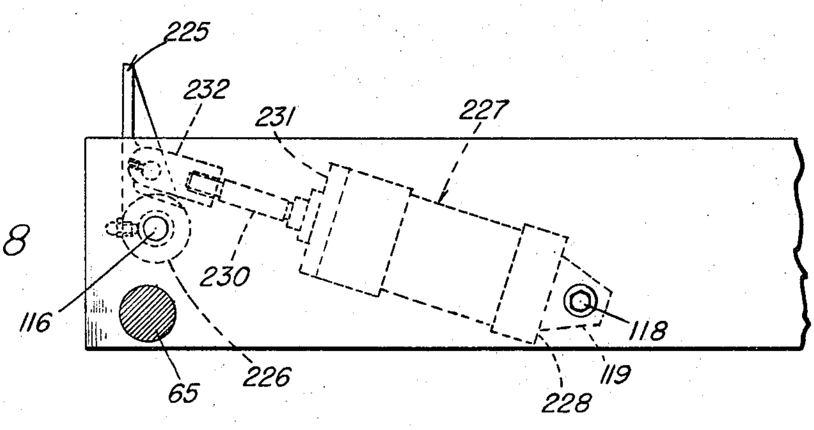


FIG. 8



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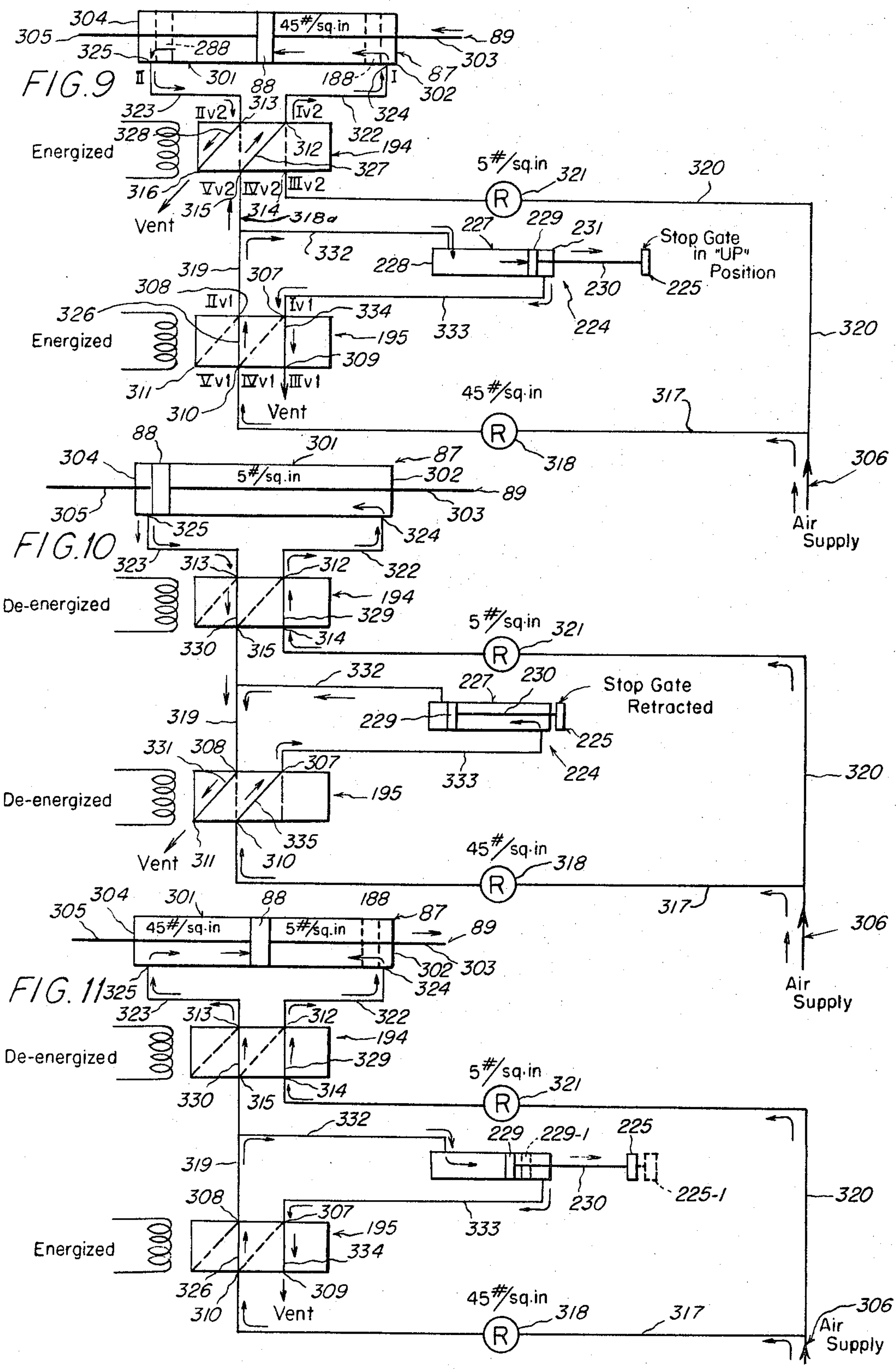
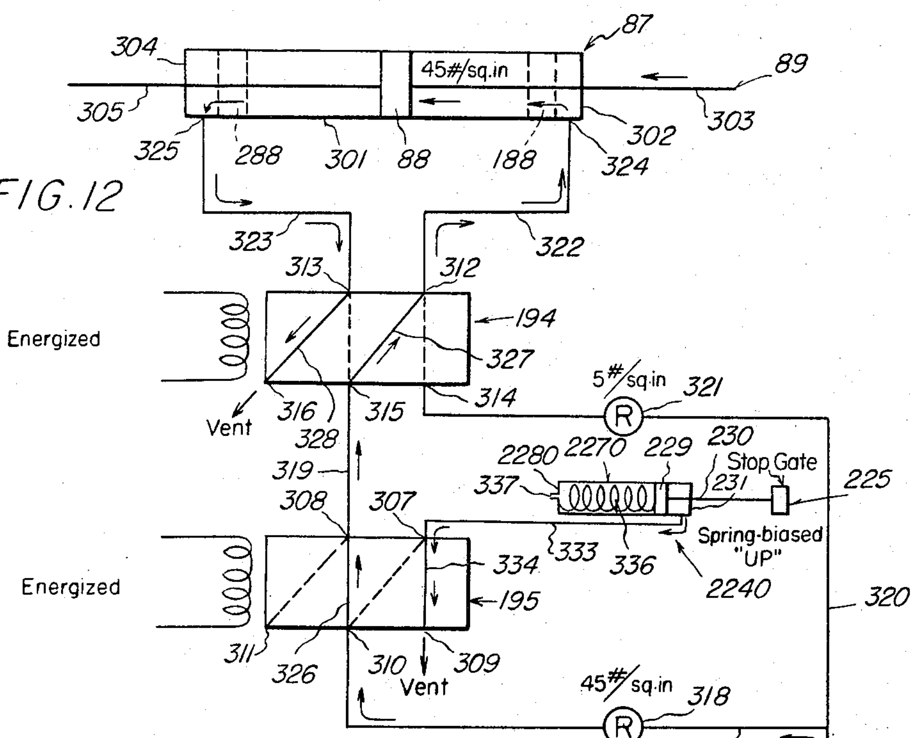


FIG. 12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302
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288
301
88
188
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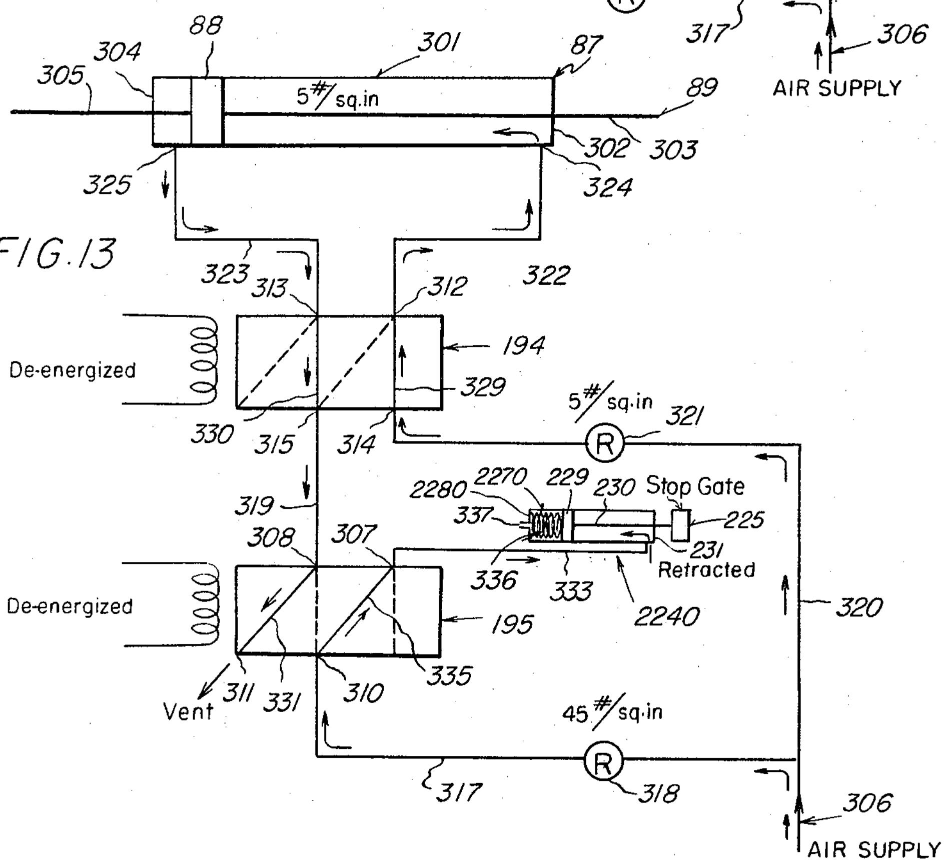
323
322
313
312
Energized
194
327
5#/sq.in
321
316
315
314
Vent
328
230
2280
2270
229
Stop Gate
225
319
231
337
308
307
Spring-biased
"UP"
333
334
336
Energized
195
2240
320
311
326
310
309
Vent
45#/sq.in
318
317
306
AIR SUPPLY

FIG. 13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87
305
5#/sq.in
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303
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324
323
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312
322
De-energized
194
329
5#/sq.in
321
330
315
314
2280
2270
229
230
Stop Gate
337
225
319
231
Retracted
308
307
336
333
De-energized
195
2240
320
311
331
310
335
Vent
45#/sq.in
317
318
306
AIR SUPPLY

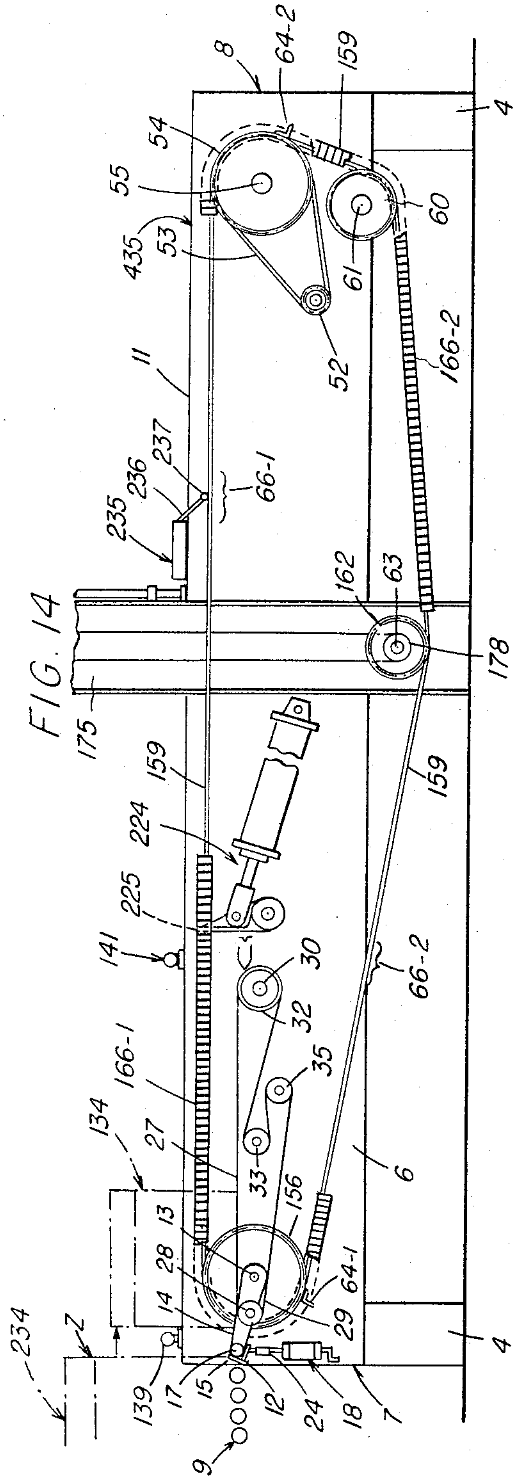

FIG. 14

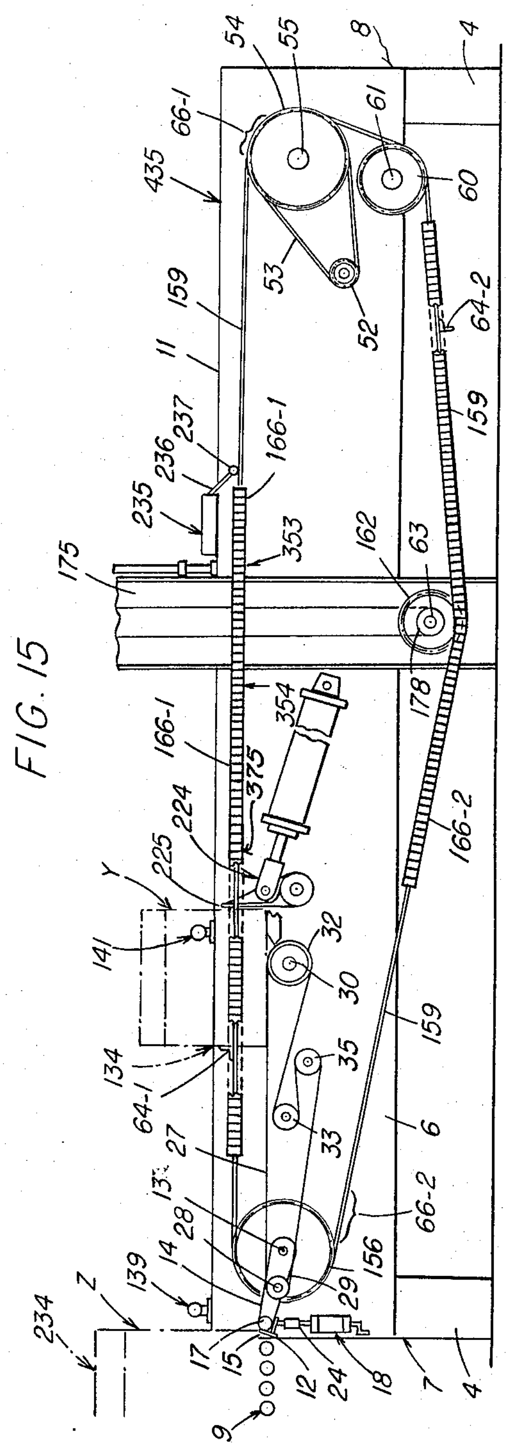

FIG. 15

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CARTON CLAMPING AND GUIDING MEANS IN AN AUTOMATIC CARTON CLOSING MACHINE

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FIG. 16

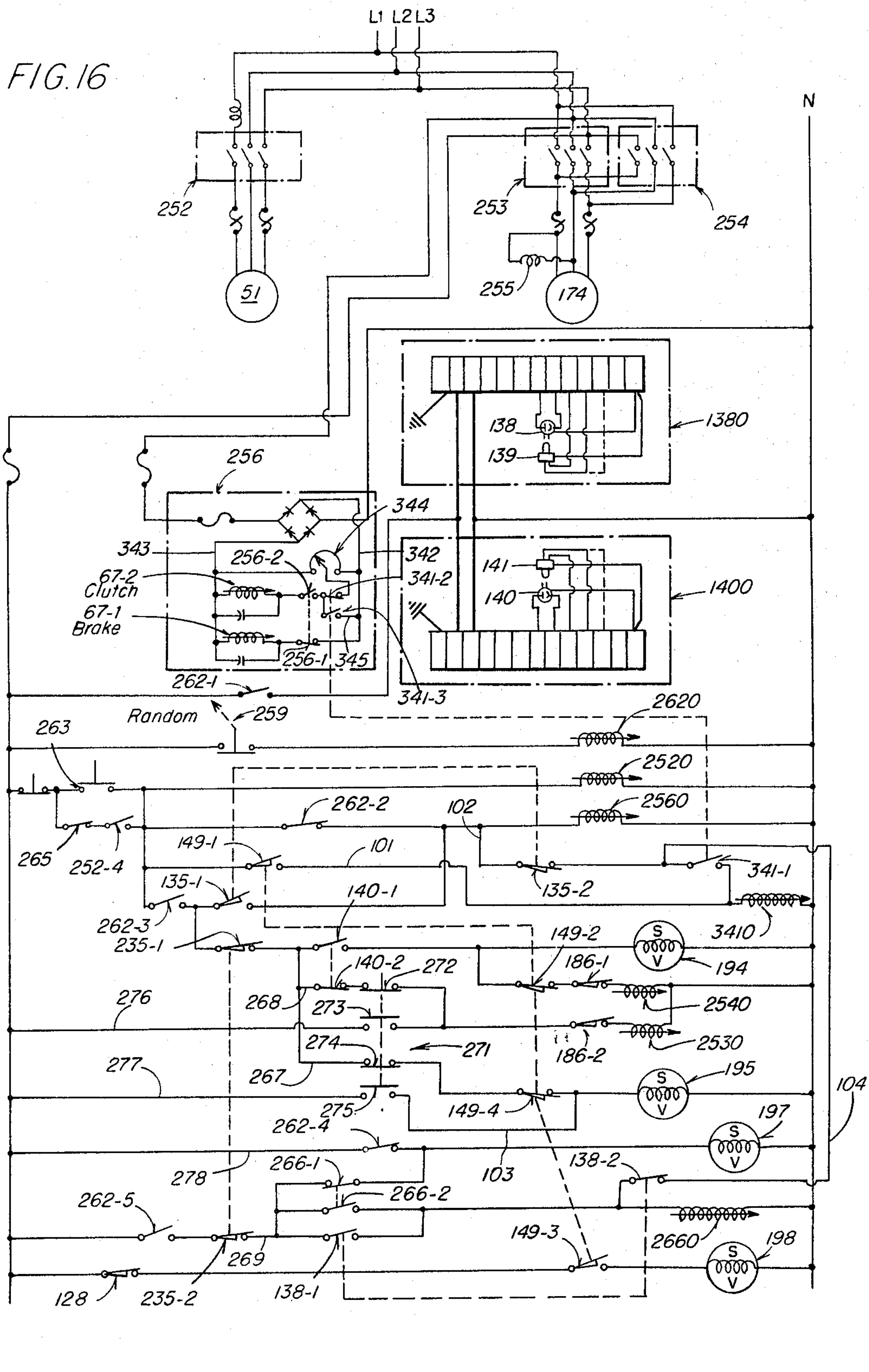
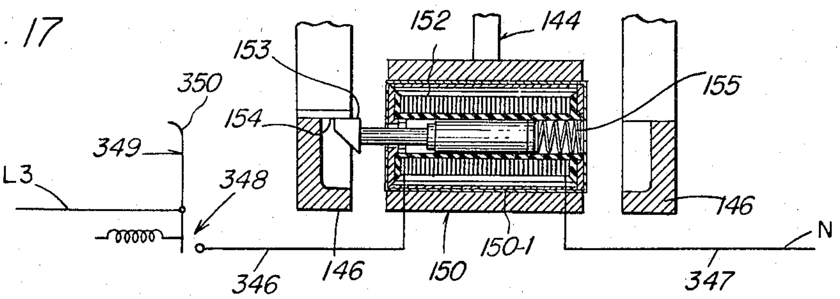


FIG. 17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144
153
155
350
154
349
L3
348
146
N
346
146
150
150-1
347

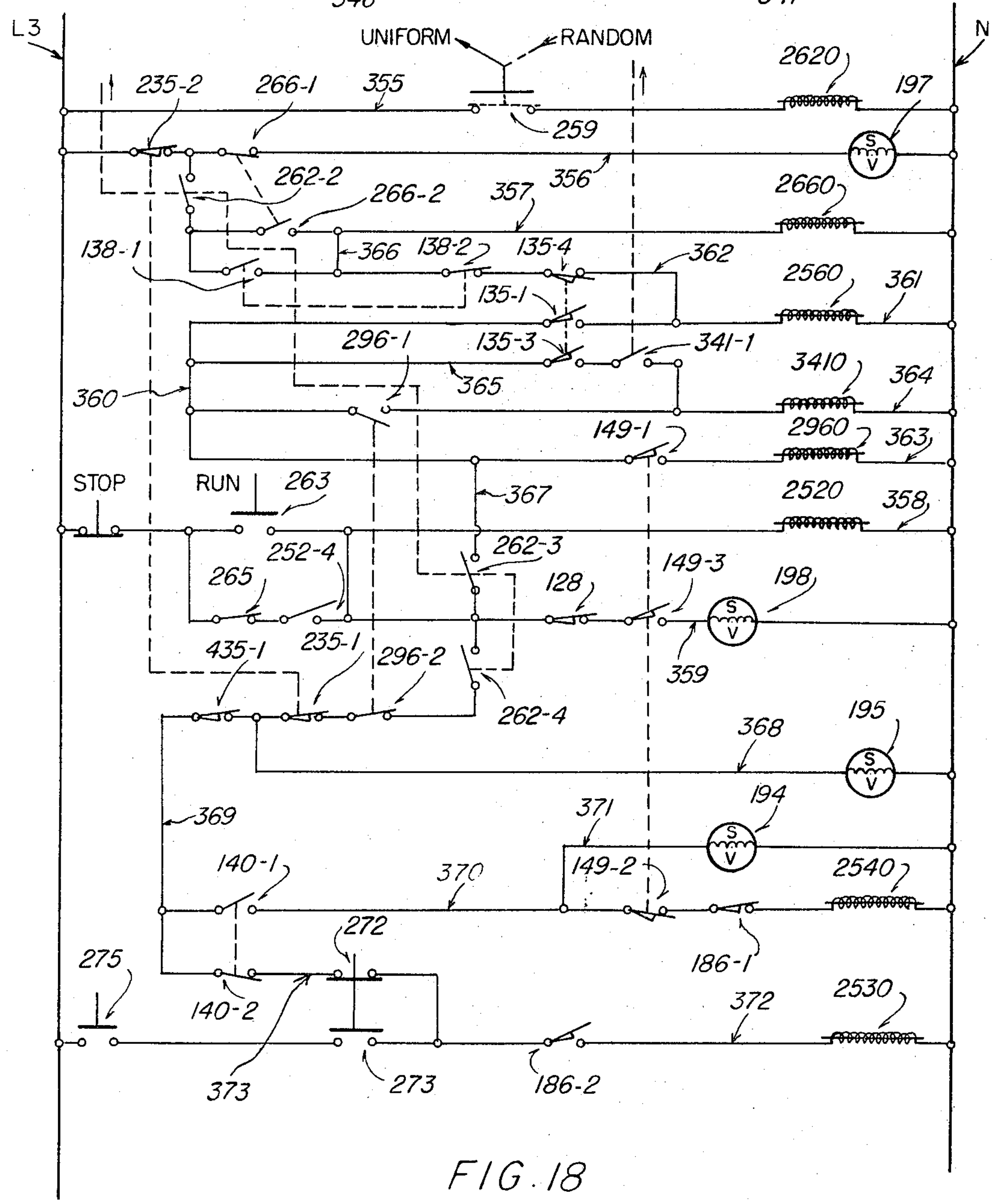
L3
N
UNIFORM
RANDOM
2620
235-2
266-1
355
197
259
356
262-2
266-2
357
2660
138-1
366
138-2
135-4
362
2560
361
135-1
296-1
135-3
341-1
3410
364
365
360
149-1
2960
363
STOP
RUN
263
367
2520
358
262-3
252-4
265
128
149-3
198
435-1
235-1
296-2
359
262-4
368
195
369
371
194
140-1
370
149-2
2540
272
186-1
275
372
2530
140-2
373
273
186-2

FIG. 18

United States Patent Office 3,382,645 Patented May 14, 1968

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CARTON CLAMPING AND GUIDING MEANS IN AN AUTOMATIC CARTON CLOSING MACHINE

Winton Loveland, Freeport, and Saul Warshaw, New York, N.Y., assignors to The Loveshaw Corporation, Farmingdale, N.Y., a corporation of New York

Continuation-in-part of application Ser. No. 219,212, Aug. 24, 1962. This application Dec. 20, 1965, Ser. No. 514,943
20 Claims. (Cl. 53—75)

This application is a continuation-in-part of our application Ser. No. 219,212, filed Aug. 24, 1962, now Patent No. 3,236,022, for Automatic Carton Closing Machine.

The present invention relates to an automatic carton closing machine and, more particularly, to mechanisms therein for clamping each of a series of cartons fed therethrough successively in a temporarily stopped position at a flap folding station while flap folding operations are performed thereon and then guiding them through to the discharge end of the machine.

One aspect of this invention is particularly concerned with the problem of folding down the top flaps of cartons of relatively shallow depths, such as of the order of three to four and one-half inches (3″–4½″) in height, in a machine that will efficiently perform such operations on cartons of random size which are higher than four and one-half inches (4½″). Such small cartons which have heights in this range frequently have rounded corners and are difficult to square between and to be clamped securely by opposed clamping members translated transversely relative to each other for this purpose.

In a machine of the construction of our copending application Ser. No. 219,212, filed Aug. 24, 1962, such carton clamping means are in the form of transversely spaced, elongated, parallel members or rails mounted for drive toward each other temporarily to clamp therebetween each carton when stopped at a carton sensing and flap folding station and then to release the closed carton for conveyor transport forward while the clamping rails serve as guides in such forward travel of the carton. The opposed inside faces of these clamping rails serve as the carton sides contacting means thereof and, in one form, are provided by upstanding edge flanges that flank opposite sides of the flap folding station and there clamp an intervening carton temporarily stopped at this station. The conveyor means which picks up each carton at the flap folding station and transports it forward after a flap folding operation is performed thereon preferably is of the chain conveyor type having transverse flight bars that travel above these rail inside flanges beneath the elevating head at the flap folding station which carries the mechanisms for folding the top flaps down to carton closing positions. When, as is proposed in that parent application, this flap folding head also carries beyond the flap folding station top taping mechanism, interference with the latter by the transverse flight bars of the chain conveyor must be avoided.

For this purpose and in connection with the development of one phase of the present invention the conveyor flight bars had to be lowered relative to the top edges of the opposed inside flanges of the clamping rails so that there was only about one-eighth of an inch (⅛″) clearance and the height of these rail inside flanges required reduction to about one inch (1″). The resulting narrow carton clamping faces of these rail flanges increased the danger of crushing carton sides in the clamping action, and in the case of the small cartons having heights in the three to four and one-half inch (3″–4½″) range effective clamping and properly aligned orientation was found to be unreliably attained due to the prevalence of the rounded corners and resulting tendency for such small cartons to be forced up or to jump over the opposed low rail side flanges.

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It was further found in the development of the present invention that cartons of all sizes receivable by this closing machine, including the small ones of heights in the three to four and one-half inch (3″–4½″) range, could be effectively centered in square orientation and securely clamped if the opposed clamping faces of the clamping and guiding members or the opposed rails thereof were provided in a form to attain an effective elevation at the time of clamping action of a minimum of about one and one-half inches (1½″). This led to the solution of the present invention.

These problems were solved by designing elevating and retractable carton side engaging means supported on at least one of the pair of opposed carton clamping and guiding members or rails at the inner side of the latter to constitute the means of contacting a side of a carton pausing at the flap folding station. In the event that one of these members or rails is embodied with a fixed mount in a position to extend outside of the interference zone, i.e., transversely beyond the path of the transverse flight bars, it may have an inner side clamping and guide face of the required minimum elevation in the form of a fixed face or flange structure. The opposed and cooperative clamping and guiding member or rail is mounted for transverse drive and retraction relative to this fixed one and is equipped with this carton side engaging means of unique form characterizing the present invention. Preferably both of the clamping and guiding members or rails are mounted within the interference zone and are thus provided on their inner clamping sides with such carton side engaging means.

The present invention also provides means movably mounting each such carton side engaging means on the clamping and guiding member or rail supporting it for alternate elevation and retraction or motion away from the latter and the conveyor means toward the flap folding sub-assembly carried by the elevating head, for appreciable lap against the opposed carton side, and lowering such carton side engaging means toward the member or rail supporting it and the conveyor means to minimize projection thereof. This invention also provides means to effect such retraction as the conveyor means picks up the pausing carton at this station and transports it forward. The retraction of the extending carton side engaging means thus permits the free passage of each lowered flight bar of the conveyor means.

In association with such novel carton side engaging means there is also provided unique improvements in the mechanism for driving the opposed carton clamping and guiding members or rails toward each other to carton clamping positions and to reduce the clamping pressure against the carton sides sufficiently to permit each closed carton to be carried forward by the conveyor means with the opposed members or rails serving as effective guides. Such unique improvements simplifies the structure and mechanisms provided for this purpose in the identified parent application Ser. No. 219,212. The present invention also encompasses an improvement in the means for temporarily stopping each carton at the flap folding station and then releasing it for forward transport by the conveyor means to beneath the top tape applying mechanism in the event that the machine is equipped with such, this stopping means being separate from the conveyor means for separate operation thereof.

Another aspect of the present invention is concerned with a speed up of the rate of flap folding and carton closing operations effected by mechanisms of the machine to realize an appreciable increase in the rate of production performed by the machine. This is accomplished by so operating the periodically stopped chain conveyor section of the machine as to cause it to coast up to abutment of one of its transverse flight bars against the back end of each carton temporarily clamped in a stopped position at the flap folding station, so that when the carton is released thereafter for further transport forward it will be picked up almost instantaneously for the further transport.

In the event that any one of the group of cartons is delivered to the flap folding station ahead of the next oncoming flight bar of the chain conveyor and, in connection with this second aspect of the invention, the carton is stopped at this station by means separate from the chain conveyor there is no need to apply braking action to the chain conveyor. If in the temporary absence of such braking action the chain conveyor carries forward such following flight bar to abutment of the rear end of the carton stopped at the flap folding station the chain conveyor will be stopped by the pausing carton which is held by its separate stopping means. In accomplishing this action the drive of the chain conveyor must be reduced in force with ultimate slippage in order to avoid crushing the carton which, in accordance with the present invention, is accomplished in a unique manner.

This new development in the carton stopping and chain conveyor drive also takes into account in an effective manner the possibility that the next succeeding carton may not be delivered past the entrance gate at the time the chain conveyor advances its next oncoming flight bar toward such initially critical position of this next entering carton. In such case braking power is applied to the chain conveyor to hold it stopped until this succeeding carton is delivered forward past such initially critical position toward or to the flap folding station and the separate carton stopping means thereat.

Other objects of the invention will in part be obvious and will in part appear hereinafter, and the invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts, which will be exemplified in the constructions hereinafter set forth.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view to reduced scale, with parts omitted for clarity, of a type of automatic carton closing machine which embodies forms of carton clamping and guiding means and also conveyor mechanism and carton stopping means of the present invention;

FIG. 2 is a top plan view to larger scale, with parts broken away, of the entrance end of the bed unit of the machine shown in FIG. 1, and illustrating features of the present carton clamping and guiding means and of the conveyor and stopping means;

FIG. 3 is a view similar to FIG. 2, with parts in section, of the remaining discharge end of the bed of the machine;

FIG. 4 is a top plan view of a section of one of the carton clamping and guiding members or rails shown in FIG. 2, with parts broken away, on which is mounted a carton side engaging means, that, by way of example and as is illustrated therein, may comprise a movable shoe capable of being alternatively elevated and retracted;

FIG. 5 is a side elevational view of the structure shown in FIG. 4, with one of the shoe operating transverse flight bars of the chain conveyor being indicated in broken lines to illustrate its service in retracting the carton side engaging shoe;

FIG. 6 is a sectional view taken substantially on line 6—6 of FIG. 5;

FIG. 7 is a top plan view to larger scale of carton stop gate means shown in FIG. 2, with parts broken away;

FIG. 8 is a side elevational view of the structure shown in FIG. 7;

FIG. 9 is a diagrammatic view of pneumatic equipment primarily designed to operate or transversely drive toward each other and alternatively to retract the carton clamping and guiding members or rails, as well as secondarily pneumatic means associated therewith that may serve effectively to elevate and retract the carton stop gate at the flap folding station; the parts of such pneumatic system being shown in their relative positions to effect driving of the clamping and guiding rails in toward each other to opposite sides of a carton stopped at the flap folding station;

FIG. 10 is a diagrammatic view similar to FIG. 9, illustrating parts of the pneumatic system in their relative positions as a carton is clamped at the flap folding station between the opposed clamping and guiding members or rails;

FIG. 11 is a diagrammatic view similar to FIGS. 9 and 10, showing parts of the pneumatic system in relative positions to effect retraction of the carton clamping and guiding rails so as to spread them apart appreciably to initial positions for receiving therebetween a next succeeding carton as transported forward to the flap folding station;

FIG. 12 is a diagrammatic view similar to FIG. 9, but illustrating another type of mechanism for operating the carton stopping gate at the flap folding station;

FIG. 13 is a view similar to FIG. 10 of the pneumatic equipment shown in FIG. 12 under the FIG. 10 conditions;

FIG. 14 is a partially diagrammatic side elevational view, with parts broken away and omitted for clarity, of the machine shown in FIG. 1, with the near side thereof removed for observation of conveyor operated control mechanism located on the far side thereof, and showing the relationship of conveyor parts, carton entrance supply and feed means, carton stop means at the flap folding station and photocell controls with respect to a carton initially being fed thereto;

FIG. 15 is a view similar to FIG. 14 showing the advance position of parts of such mechanisms as the carton is delivered to the flap folding station and conveyor means advanced to a position assuring substantially instantaneous pick up thereby of a carton at the flap folding station after a flap folding operation has been performed at this station;

FIG. 16 is a schematic wiring diagram of the electrical circuitry of the machine depicted in FIGS. 1 to 3 incl. as well as solenoid valves illustrated in FIGS. 9 to 13 incl.;

FIG. 17 is a detail view, with parts in section and others schematic, of solenoid operated latch mechanism which may be associated with the front flap folding arm structure to hold this arm in its up, horizontal postiion for a time so as, during that period, to maintain the respective manipulated open and closed conditions of a gang of switches operated by the movement of this flap folding arm, and until a closed carton has advanced through the machine to a certain point; and

FIG. 18 is a schematic wiring diagram of a portion of electrical circuitry of another eembodiment of the machine shown in FIGS. 1 to 3 incl. which employs variations of the electrical equipment proposed in FIG. 16 with respect to certain features and operational characteristics thereof.

Referring to the drawings, in which like numerals identify similar parts throughout, it will be seen, and particularly from FIGS. 1, 2 and 3, that the embodiment of the automatic carton closing machine illustrated by way of example therein may be similar to that of our above-identified patent application Ser. No. 219,212 and comprise a bed unit 1 and an elevating head unit 2 supported on the former by upwardly-extending standards or columnar structure 3. Conventially the parts of the machine are made of suitable meals. The bed unit 1 has a rectangular frame structure supported upon suitable legs 4. The frame structure may include opposed sidewalls 5 and 6, a relatively low end wall 7 at the entrance end, and another end wall 8 at the discharge end.

The bed unit 1 is equipped with lateral conveyor means suitably supported by the frame sidewalls 5 and 6, and this conveyor means has an entrance end in the vicinity of end wall 7 and a discharge end in the vicinity of end end wall 8. This conveyor means defines a longitudinal path of forward carton travel along which it successively transports a plurality of open-top cartons which may be of random sizes including those of relatively small heights, such as in the range of about three inches to four and one-half inches (3"–4½"). Such cartons are of conventional form being constructed, if desired, from corrugated board and rectangular in cross section with the edges of the top thereof provided with upwardly-extending front and back flaps respectively on the leading and trailing top edges and opposed upwardly-extending side flaps on the side top edges, all to be folded down to closed lateral lapping positions for securement in carton closing positions. The machine of the present invention is designed automatically to close successively the tops of such cartons in this manner after they have been loaded with the products to be marketed or shipped therein. Accordingly, any suitable feeding means, such as a roller conveyor 9, illustrated in FIG. 1, will be mounted adjacent the entrance end of the bed unit 1, i.e., adjacent the end wall 7, successively to feed a supply of the loaded cartons over the top edge of the latter to the conveyor means. The frame structure of the bed unit 1 may include lateral sheet metal ledges 10 and 11 extending inwardly from the top edges of the sidewalls 5 and 6 for support of certain control devices as will appear hereinafter, and strengthening cross framing members may be embodied.

At the entrance end of the bed unit 1, in the vicinity of end wall 7, is mounted a liftable gate 12 shown in FIGS. 1 and 2. A cross shaft 13, having its ends supported by sidewalls 5 and 6 of the frame structure, pivotally supports a pair of swinging arms 14 which carry on their back ends a gate bar 15. The gate bar 15 may be in the form of a length of angle stock having an upwardly-extending, carton-barring flange 16. The gate bar 15 preferably supports thereon a rotatable roll 17 over which the bottom of a loaded carton may advance readily after a leading portion advances thereover. It will be understood that when the gate arms 14 are swung upwardly, or in a clockwise direction as viewed in FIG. 1, the gate flange 16 will swing up above the plane defined by the tops of the series of feed rollers 9 to bar the leading end of a carton bottom supplied across the latter until this gate flange is lowered below this feed plane.

The conveyor means includes a continuously driven, initial endless section 27 indicated in FIG. 1 and seen in FIG. 2. For this purpose, an idling roller 28 may be rotatably supported by a pair of arms 29 pivotally mounted on the cross shaft 13, or, if desired, on a fixed position axis by suitable supporting means mounted to the machine frame. A driving shaft 30 is rotatably supported by bearing units 31 between the frame sidewalls 5 and 6, and carries fixed thereto a driving roller 32. The initial conveyor section 27 preferably is in the form of an endless belt lapped about the rollers 28 and 32. As will be best seen from FIG. 1, a bottom run of the conveyor belt 27 is lapped back and forth about idling rolls 33 and 34 with the latter supported by tension adjusting devices 35. The shaft 30 carries a sprocket 36 fixed thereto to be driven by a drive chain indicated by dot-dot-dot-dash lines 37 in FIGS. 2 and 3. The endless driving chain 37 has a run lapped against a guiding idler 38 and is lapped about a driving sprocket 39. Driving sprocket 39 is one of a group of three thereof fixed together with the second 40 constituting means for driving tape feeding mechanism and the third 41 constituting the driving sprocket about which is lapped a driving chain indicated by dot-dot-dash lines at 42 in FIG. 3. The group of sprockets 39, 40 and 41 are rotatably supported by a cross shaft 43 and the tape feed sprocket drives tape feeding mechanism comprising sprockets 44 and 45 about which an endless chain is lapped and a sprocket 46 against which the drive chain 42 is lapped in turn to drive a cross shaft 47 of tape feed mechanism. The endless chain 42 is lapped about a driving sprocket 48 fixed to a driving stub shaft 49 of a reduction gear unit 50 operated by a main driving electric motor 51. The driving stub shaft 49 also carries fixed thereto another driving sprocket 52 about which is lapped an endless driving chain indicated by dot-dash lines at 53 in FIG. 3, in turn lapped about a driven sprocket 54 rotatably supported by a cross shaft 55 equipped with suitable brake and clutch devices for drive of a second conveyor section as is explained hereinafter.

Cross shaft 13 also carries, rotatably supported thereon, a pair of near and far idler sprockets 56 and 156, as will be seen in FIG. 2, while cross shaft 55 is rotatably supported by bearing units 57 and 157 carried by frame sidewalls 5 and 6. As will be seen in FIG. 3, drive shaft 55 carries fixed thereto a pair of near and far sprockets 58 and 158 respectively aligned with sprockets 56 and 156. The second endless conveyor section preferably is in the form of a pair of endless chains, indicated by dot-dash lines 59 and 159 in FIGS. 2 and 3, respectively lapped about sprockets 56 and 58, and 156 and 158, for drive by sprockets 58 and 158. As will be best understood from FIG. 1, the lower run of each of the endless chains 59 and 159 is lapped beneath one of a pair of idlers 60 and 160 rotatably supported by a cross shaft 61 mounted between frame sidewalls 5 and 6, and beneath another of a pair of idlers 62 and 162 rotatably supported by another cross shaft 63. The second endless conveyor section also includes a series of carton transporting flight bars 64 which, as is indicated in FIG. 1, may be two in number spaced longitudinally appreciably apart. The pair of conveyor chains 59 and 159 also may carry a plurality of reversed flight bars which may be similar to the flight bars 64. There may be a pair of these reversed flight bars, and each will constitute a carton stop having the function of holding a carton at a sensing and flap folding station when the second conveyor section pauses or is held in stop position. However, the illustrated embodiment of the machine preferably employs movable gate means at the exit end of this station to serve as such carton stop, and this mechanism is fully described hereinafter. The endless conveyor chain 59 on the near side, as viewed in FIG. 1, also is equipped with a pair of tripping lugs 66–1 and 66–2 to be carried along therewith for operating certain limit conveyor means, and in order to attain certain production speed-up of similar but longer tripping lugs 266–1 and 266–2 preferably are mounted on the companion conveyor chain 159 for a similar purpose as is demonstrated in FIGS. 14 and 15.

It will thus be seen that the initial conveyor section comprising endless belt 27 has an entrance end near the vicinity of the selector gate 12 and a discharge end at a point appreciably in advance thereof which is at a carton sensing and flap folding station. From the discharge end of the initial conveyor section or belt 27 suitable fixed carton-supporting structure extends forward, and this may be in the form of a pair of fixed flat plates or rails 270 suitably supported between the frame sidewalls 5 and 6, such as by fixed cross rod 65 beneath their front ends (see FIG. 2) and other similar support means. Carton support plates or rails 270 terminate in the vicinity of the discharge end wall 8, as will be seen from FIG. 3. The second conveyor section comprising conveyor chains 59 and 159 and their flights 64 extend forward at least from the discharge end of the belt conveyor 27 to the discharge end of the bed unit 1. As will be apparent from

FIG. 2, preferably the entrance end of the chain conveyor appreciably laps the discharge end of the belt conveyor and, in fact, has its chain-supporting front sprockets 56 and 156 rotatably supported on the same cross shaft 13 which pivotally carries the arms 29 rotatably supporting roller 28 about which the entrance end of the conveyor belt 27 is lapped. Thus, any carton which is delivered to the sensing and flap folding station by the conveyor belt 27 will be picked up there by an oncoming flight 64 of the chain conveyor to be slid forward over the rails 270 to the discharge end of the bed unit 1.

The near end of driven cross shaft 55 carries a housed magnetic brake 67–1 and the far end thereof carries a housed magnetic clutch 67–2, both of which are indicated in FIG. 3, and these units may be of conventional construction. For example, the frame sidewall 5 may fixedly support through fixed housing 68 of the brake unit 67–1 fixed field coils and core structure thereof opposed to an axially slidable armature therein. Hub 69 of drive sprocket 58 is keyed to the drive shaft 55 and the sprocket in turn carries circumferentially-spaced, axially-extending pins on which is slidably mounted for axial motion the armature, which may be in the form of a paramagnetic disc (hidden in housing 68). The fixed core structure is annular and has a friction face equipped with suitable brake lining material opposed to a face of the slidable armature plate, so that when the brake field coil is energized the armature plate is drawn axially against the brake lining of the fixed magnetic core structure to clamp it thereto and prevent the driven cross shaft 55 from rotating. The clutch unit 67–2 is of somewhat similar structure with the field coil thereof also fixedly supported by housing 168 therewithin, which in turn is fixedly mounted to the frame sidewall 6. The annular core structure is carried by a hub keyed to the driven shaft 55. While the hub 169 of sprocket 158 is also keyed to the driven shaft 55, the drive sprocket 54 has its hub freely supported on this shaft for relative rotation and axial motion toward the keyed core structure, and sprocket 54 may be constructed of paramagnetic material to serve as the annular armature. Thus, when the field coil of the clutch unit 67–2 is energized, the drive sprocket 54 will be slid axially outward a short distance to have its outer face engage a friction facing of suitable material carried by the annular magnetic core structure keyed to the shaft, to connect the shaft and the conveyor chain driving sprockets 58 and 158 keyed thereto to the shaft drive sprocket 54. Since the magnetic brake and clutch units 67–1 and 67–2 are of conventional construction, further structural details thereof are not necessary to an understanding of their functions and operations, and they are alternately operated or energized for alternate periodic drive and pause of the chain conveyor section.

As will be understood from FIGS. 1 and 3, the support structure 3 includes an opposed pair of upwardly extending standards or columns 75 and 175 which constitute supports for the elevating head unit 2, and these columns are fixedly mounted to the frame sidewalls 5 and 6 of the bed unit 1 in any suitable manner. The columns 75 and 175 preferably are of channel construction so as to provide guiding channels 76 and 176 for slides or carriage means therein that serve to carry a flap folding subassembly, and to house elevating mechanism. Opposite ends of the cross shaft 63 extend into the channels 76 and 176 and are fixedly mounted to these columns by any suitable means, such as stud bolts 77. Within the channels 76 and 176, fixed cross shaft 63 rotatably supports sprockets 78 and 178, forming a part of head elevating mechanism.

As will be understood from FIGS. 2 and 3, the bed unit 1 is equipped with suitable carton clamping and carton travel guiding means, preferably extending from the vicinity of the entrance end to a distance short of the discharge end of the bed unit 1, but entirely through the carton sensing and flap folding station in the vicinity of the discharge end of the initial conveyor section or belt 27. This carton clamping and guiding structure may be in the form of a pair of rails 80 and 180, which may be of channel formation, as shown, to provide on the inner sides thereof opposed upstanding flanges 81 and 181. As will be understood from FIGS. 2 and 3, the clamping and guiding rails 80 and 180 are suitably supported by a pair of transverse rods 82 and 83 mounted to the frame sidewalls 5 and 6. Each of the rods 82 and 83 supports a pair of slides 84 and 184 carrying bracket arms 85 and 185 to each of which is mounted one of the rails 80 and 180. Thus, the guiding and clamping rails 80 and 180 are slidably supported on transverse rods 82 and 83 for transverse movement inward and outward relative to the center of the path of carton travel defined by the longitudinally-extending conveyor means. In their outward positions, depicted in FIGS. 2 and 3, the rails 80 and 180 are at their initial carton-receptive positions to permit a carton fed over depressed gate 12 to the entrance end of the initial conveyor section belt 27 to advance therebetween. The front end of each of the rails 80 and 180 preferably is equipped with a freely rotating carton guide roller 86 to facilitiate entrance of a carton therebetween.

The clamping and guiding rails 80 and 180 are slid transversely back and forth on the guide rods 82 and 83 by suitable driving mechanism. Such rail driving mechanism may be in the form of a fluid pressure motor, such as a pneumatic cylinder 87 of the double-action type having its piston head 88 equipped with a through piston rod 89. The rail driving mechanism includes lateral sprockets 90, 91, 92, 93, 94 and 95. Sprockets 90 and 92 are supported on frame sidewall 5 by a bracket 96 while sprockets 93 and 95 are supported by a similar, reversely-shaped bracket 196. Sprocket 91 is supported on sidewall 6 by a bracket 97 and a similar bracket 98 is employed to support sprocket 94 on the latter sidewall, as will be understood from FIG. 2. Lengths of link chain are lapped about the sprockets 90 to 95 incl. and anchored to opposite ends of the piston rod 89, with suitable connections to the slides 84 and 184 to drive the rails 80 and 180 transversely inward and outward. For example, a length 99 of such link chain is anchored to the right end of piston rod 89 as viewed in FIG. 2 and lapped about sprocket 90 to extend transversely to an anchor bolt 100 carried by slide 184 on slide rod 83. Slide 184 also carries another chain anchor bolt 200 to which one end of another chain length 199 is anchored, with the latter lapped about sprocket 91 to extend transversely back to another anchor bolt 300 carried by slide 84 on slide rod 83. The latter slide 84 also carries an additional anchor bolt 400 to which a third length 299 of the chain is connected, with the latter lapped about sprocket 92 to extend longitudinally back for lap about sprocket 93 and then transversely to a fifth anchor bolt 500 carried in like manner by slide 184 on slide rod 82. This latter slide 184 also carries another anchor bolt 600 to which a fourth length of chain 399 is anchored and then lapped about sprocket 94 to extend transversely back to an additional anchor bolt 700 carried by slide 84 on slide rod 82, with a further anchor bolt 800 on the latter slide having connected thereto a fifth length of chain 499 lapped about sprocket 95 to extend longitudinally forward to connection with the left hand end of the piston rod 89. Thus, when the piston rod 89 of the pneumatic cylinder 87 is slid longitudinally to the right, as viewed in FIG. 2, the clamping and guiding rails 80 and 180 are driven transversely outward to their initial carton-receptive positions shown therein, and when the piston rod is then reciprocated in the opposite direction to the left in FIG. 2 these rails are driven transversely inward toward each other for approach of their inside flanges 81 and 181 to opposite sides of a carton delivered therebetween.

The front end of guiding and clamping rail 180 carries opposite the belt conveyor section 27, in the area of the carton sensing and flap folding station an adjustable control or sensing device **115**, as will be seen in FIG. 2. For the purpose of supporting the adjustable control **115** upon the guiding and clamping rail **180**, the latter carries a pair of opposed brackets **125** (see FIG. 2). The brackets **125** support therebetween a pair of longitudinally-extending guide rods **126** and **226** upon which a carriage **127** is slidably mounted. Carriage **127** supports a control device **128**, which may be in the form of an electrical circuit switch biased to one of its open and closed positions and manipulated to the other thereof by an actuating arm **129**. The switch actuating arm **129** is elongated and extends longitudinally forward while having its mid-section shaped to be disposed substantially parallel to the inward face of flange **181** of rail **180** when retracted or swung back by contact with carton side structure. Thus, when the rails **80** and **180** are driven inward toward each other with a carton disposed therebetween opposite the control **115**, the back side of the carton which is opposed to the switch operating arm **129** will first be contacted thereby. Then, as the rails **80** and **180** are brought to clamping positions against the opposite sides of the carton, this switch operating arm **129** will be retracted or pushed back to operate the switch **128**. The control device comprising switch **128** and its actuating arm **129** are automatically adjustable along the path of carton forward travel as dictated by the width of the carton. For example, a narrow carton causes the clamping rails **80** and **180** to be driven inward toward each other an appreciable distance and the control device **128** will be advanced forward an appreciable distance. With wider cartons, where inward travel of the clamping rails **80** and **180** is relatively small, the control device **128** will be advanced forward only a short distance. This automatic adjustment of the position of the control device **128** is attained by substantially rigid tie means pivotally connected to the fixed structure of the bed frame and to the control carriage **127**. For example, elongated rigid arm or strap **130** is pivotally mounted at **131** to bed frame wall **6**, with its other end pivotally connected at **133** to the carriage **127**, as will be understood from FIG. 2. Thus, as rail **80** is driven transversely inward toward the center of the longitudinal path of carton forward travel, the tie **130** is swung counterclockwise to pull the control carriage **127** forward along the guide rods **126** and **226**. This forward adjustment of the position of the control device **115** is proportionate to the width of the carton at the carton sensing and flap folding station.

The machine bed unit **1** also is provided with additional control equipment. As will be seen from FIG. 1, the frame of the bed unit **1** supports a limit control **135**, which may be in the form of electrical circuit switching means having a plurality of switches mechanically linked together for simultaneous operation. The limit switch **135** is provided with an actuating trigger **136** designed to be swung up and down and biased to its downward position with a drag roller **137** carried by its lower end. Limit switch **135** preferably is supported upon ledge **10** beyond the head-supporting upright column **75**, such as in the vicinity of the location X–1 indicated in FIG. 3, so that the roller **137** on the actuating trigger **136** will be dragged over the next oncoming traveling lug **66–1** or **66–2** carried by conveyor chain **59**. When the upper run of conveyor chain **59** in its forward travel causes lug **66–1** to engage the trigger **136**, the latter will be swung up to actuate the switches in the limit switch unit **135**, and the circuit switches thereof will be held to their respective manipulated positions until this run of the conveyor chain advances sufficiently to free the trigger and thus permit the limit switches to be returned to their initial positions. A similar limit switch **235** preferably is mounted at location X–2 on frame ledge **11** (FIG. 3) to be tripped by lugs **266–1** and **266–2** carried by conveyor chain **159** (see FIGS. 2, 14 and 15).

Additional sensing devices are provided on the machine bed unit **1**, which may be in the form of optical carton sensing devices. For example, as will be seen from FIGS. 1 and 2, the ledge **10** may support at **138**, in the vicinity of the selector gate **12** and slightly in advance thereof a photocell responsive to the light beam from a light source **139** supported on the opposite side by ledge **11**. At the sensing and flap folding station Y, ledge **10** may support in similar fashion, substantially at the point **140**, a second photocell arranged opposite to a second light source for response to the beam thereof, with the latter being located substantially at the point **141**. The functions of the photocells at **138** and **140** will be explained in connection with the wiring diagram of FIG. 16 and the operation of the machine detailed hereinafter.

In FIG. 1 is shown in dot-dash lines an open-top carton **134** of relatively shallow depth or short height located opposite the photocell optical sensing device **140** at the sensing and flap folding station Y, beneath a flap folding and carton closing head **142** supported for elevating travel upon the upright columns **75** and **175**. Head **142** includes a lateral frame member or beam **143** which supports a flap folding sub-assembly which may include a depending post **144**. The bottom end of depending post **144** pivotally carries at **145** a front flap folding arm structure **146**, which, due to gravity biasing, normally depends in the top elevated position of the head **142** shown in FIG. 1 obliquely down and forward to the full line position shown in FIG. 1. The front flap folding arm structure **146** carries a finger **147** which engages a trigger **148** of another limit control, which may be an electrical circuit switch device **149** supported on the post **144**. In the full line position of the front flap folding arm structure **146** shown in FIG. 1 its finger **147** holds the switch trigger **148** forward to a tripped position to hold the switch in one of its open and closed positions. When the front flap folding arm structure **146** is swung upward to a lateral position, indicated by broken lines in FIG. 1, the trigger **148** of switch **149** is released to permit the switch to be actuated to the other of its two positions. The bottom of the depending post **144** has anchored thereto, such as by welding, one end of a folded flap hold-down device in the form of a resilient presser strip **150**, which extends forward with its free end unsupported, to cooperate with the front flap folding arm structure **146**. As will be seen from FIG. 1, the flap hold-down strip **150** may have a continuating portion at its anchored back end, which is turned up obliquely and then inward to additional anchorage to the depending post **144**, so as to provide a wedge-shaped stop **250** for a back flap folding arm or kicker hereinafter described.

The elevating flap folding head **142** also may have a forwardly extending lateral frame member A which supports suitable flap securing mechanism, which may be tape applying means of the type disclosed in our copending patent application for U.S. Letters Patent Ser. No. 139,676, filed Sept. 21, 1961, now Patent No. 3,236,716, including pairs of wipe down arms B and C, to which are supplied from a suitable tape supply reel D lengths of gummed tape to be adhesively affixed over overlapping flaps of a carton top after the flaps have been folded down in stacked or overlapping relation. Similar tape applying devices are carried by the bed unit **1**, including another adhesive tape supply reel E (see FIG. 1), tape feed and drive sprockets **40**, **44** and **45**, tape mechanism cross shaft **47** and sprocket **46** supported thereby, tape feed actuators F (supported on rail **180**, see FIG. 3) and associated structure.

The lateral frame member or beam **143** of head **142** pivotally supports at **151** a carton back flap folding arm or kicker **161** as part of the flap holding sub-assembly, as will be seen from FIG. 1. The back flap folding arm or kicker **161** is normally held in an extended or substantially lateral position when the flap folding head **142** is elevated to the maximum height of its vertical travel, as is shown in FIG. 1. For this purpose the lateral beam **143** carries a kicker actuating means, preferably in the form of a pneumatic cylinder 163, as is shown in FIG. 1. This pneumatic cylinder 163 is of the double-action type with pressurized fluid being alternately fed to opposite ends on opposite sides of its piston head by suitable conduit means. Piston rod 167 mounted to the piston head of the pneumatic cylinder 163 is connected by a knuckle to a lever arm fixed to the pivoted kicker 161. Thus, when pressurized air is supplied to the back end of pneumatic cylinder 163 the rear flap kicker 161 is swung backward and upwardly to its substantially lateral cocked position, shown in full lines in FIG. 1, with the head space of the cylinder in front of its piston head being vented. It will be seen from FIG. 1 that the bottom side of the rear flap kicker 161 is provided with a depending tapered nose 172 having an oblique rear face 173–1 which, when the kicker is swung down to its depending position indicated in dot-dash lines in FIG. 1, is oriented to substantial parallelism with the oblique stop 250. The cocked kicker 161 is swung down to this position to engage or strike the rear face of an upstanding back flap on the trailing end of the open top of a carton and kick it forward to folded lateral position by reversing the pneumatic connections to cylinder 163 to retract the piston rod 167. When the kicker 161 is swung down the oblique rear face 173–2 of its tapered nose 172 provides a flat lateral bottom surface substantially in the horizontal plane of the bottom surface 146–1 of front flap folding arm structure 146 when swung up, as are indicated in dot-dash lines in FIG. 1. These aligned bottom surfaces of the flap folding arms 146 and 161 maintain the folded front and back flaps in a common lateral plane during forward transport of the carton which effects the folding down of the side flaps.

The top of the column 75 and 175, which support the head 2 for vertical reciprocation, fixedly support at their top ends a reversing electric motor 174, as is indicated in FIG. 1. The drive of reversing motor 174 is suitably geared to a pair of top drive sprockets 177 and 277 carried by the top ends of the columns 75 and 175. Drive chain 178 is lapped about drive sprocket 177 in the vicinity of the top end of column channel 75 and about the bottom idler sprocket 78, shown in FIG. 3 with opposed ends thereof anchored by suitable means at 179 to a slide 182 riding up and down in channel 76. In similar fashion, a like chain (not shown) is lapped about the far top sprocket 277 and bottom idler sprocket 178, and is anchored in like fashion to a similar slide of reversed form located in channel 176 of column 175. The opposed pair of slides 182 are suitably tied together to act as a carriage unit. The carriage comprising the pair of slides 182 and its companion suitably support the lateral frame member or beam 143 for vertical travel down and up therewith. Thus, when the reversing vertical travel motor 174 is driven in one direction the entire head structure 2 is lowered to position its flap folding means above an open top carton at the sensing and flap folding station Y, such as carton 134 indicated in FIG. 1, and when driven in the opposite direction will lift this head structure to its initial elevated position, such as that indicated in full lines in FIG. 1.

Maximum limits of up and down motion of the head structure 2 are dictated by suitable limit means, which may be in the form of switch means in electrical circuitry of the reversing motor 174. Such switch means may be of the double-throw type so as alternately to open the energizing circuits of the reversing motor 174 to limit the down and up drive thereof. Such reversing motor control switch unit 186 is suitably mounted on slide 182. Switch unit 186 is provided with a double-action actuating trigger 187 arranged to be abutted in its up and down travel to bottom and top stop collars 190 and 193, fixed upon a vertical control rod 191 supported by bed unit frame ledge 10 and the back edge flange of column channel 75. The bottom stop collar 190 will limit lowering of the head structure 2, so as to assure that no parts thereof will be driven down to jam against any of the bed unit structure should the down energizing circuit of the reversing motor 174 accidentally be closed in the absence of a carton at the sensing and flap folding station, thus being provided as a safety measure.

As will be seen from FIG. 1, the flap folding head structure 142 includes suitable carton side flap folding plows 233 having their initial top ends at 234 mounted to the head beam 143 by a bracket block 236 and from which they extend obliquely down in an advance direction while converging toward each other. As is presently known in the art, plows of such shape will gradually turn over and fold down upwardly-extending carton flaps when they are moved forward to engagement of their outside faces against the inner sides of such plows.

As has been previously indicated each of the carton clamping and guiding members or rails 80 and 180 is provided with a carton side engaging means carried thereby or supported thereon at its inner side in the area of the sensing and flap folding station Y to constitute the means of contacting a side of a carton, pausing at this station, by structure of these members or rails. Such carton side engaging means are shown at 205 and 2050 in FIG. 2, with the parts of the latter being mirrored duplicates of those of the former. Thus, the structure of the device shown at 205 will here only be described in detail. The inward side of the clamping and guiding member or rail 80, and its inside flange 81 are provided with an elongated notch 204, and a like notch 2040 is provided in the opposed side of the cooperating or companion member or rail 180.

As will be more fully understood from FIGS. 4 to 6 incl., upon the top face of the web of rail 80 is fixedly mounted a U-shaped channel section 206 by bolts 207 with its upstanding flanges 208 provided with transversely aligned holes 209 through which extends a pivot pin or bolt 210. A shoe 211 is pivotally mounted upon the pivot pin or bolt 210. Shoe 211 is in the shape of an inverted channel section having an inward side flange 212 fitted for vertical motion in the notch or gap 204 and an outward side flange 213 provided with a rearwardly extending extension 214 having a hole 215 through which the transverse pivot pin or bolt 210 extends. As will be seen from FIG. 5, the top edge 216 of the flange extension 214 is sloped in a forward direction obliquely upward to the top face of the shoe web 217 for camming upwardly an oncoming chain conveyor transverse flight bar 64, as will be explained later. An arm 218 is welded to the underside of the web 217 and is provided with a like hole 215 aligned with that in the flange extension 214 through which the transverse pivot pin or bolt 210 extends for pivotal mount of the shoe 211.

The upstanding flanges 208 of the channel section 206 carry a transverse fixed pin 220 and the inverted flange 213 of the shoe 211 and the forward end of the arm 218 have provided therein transversely aligned slots 221 in which the projecting ends of the pin 220 ride as stop means for limiting up and down swing of the shoe 211. Upon the forward end of the channel section 206 is mounted a helical compression spring 222 upon which the forward end 223 of the pivoted shoe 211 rests so that it is spring biased upwardly.

It will thus be understood that with the pivoted shoes 211 of the carton side engaging means 205 and 2050 swung upwardly to their extended positions as dictated by the biasing of their springs 222 the opposed inward side flanges 212 will be brought to secure clamping contact against opposite sides of the carton 134 at the sensing and flap floiding station Y, there to have maximum lap against the surfaces of these carton sides and to assure the provision of the minimum height of clamping action to about one and one-half inches (1½″) found to be necessary to assure secure carton anchorage with properly aligned orientation of the latter. As the front flap folding operation is performed at station Y upon the carton **134** held securely clamped thereat between the clamping rails **80** and **180** the chain conveyor is started so that its top run travels forward to carry up behind the stopped carton one of the flight bars **64** and cause it to pick up this carton for carrying it forward for performance of the flap folding operation on the upstanding rear carton flap. Then as the carton is carried farther forward by forwardly traveling flight bar **64** the upstanding carton side flaps are lapped down over the folded front and rear flaps to complete the closure of the carton top after which the closed carton is carried still farther forward beneath the tape applying mechanism mounted on beam A.

As will be explained later the clamping action of the clamping members or rails **80** and **180** is converted to a guide operation by reducing the clamping force to a low biasing pressure so as to permit the closed carton to be so carried forward from the flap folding station Y with guidance by these opposed rails. During this forward transport of the closed carton by the transverse flight bar **64** the upwardly projecting clamping shoes **211** which have their forward ends intercepting the path of forward travel of the transverse flight bars must be lowered to permit free pasage of the latter. The oncoming flight bar **64**, indicated in broken lines in FIG. 5, will ride along the upwardly sloping top edge **216** of the shoe web **217** and over the latter to depress each shoe **211** for permitting such free passage of the flight bar. In order that the attendant frictional drag between the bottom of each flight bar **64** and the top structure of each pivoted shoe **211** will not cause such rapid wear as to undesirably limit the life of the shoe structure the flight bar, or at least its bottom section, and the shoe, or at least its top section, advantageously may be made of steel and surface hardened. Alternately such friction surfaces may be protectively covered by tough friction reducing material, such as Teflon or simlar composition.

As has been previously indicated means for stopping each oncoming carton at the flap folding station Y, for performance thereon of the front flap folding operation, thereafter to be withdrawn to permit the carton to be picked up by the chain conveyor and transported forward, may be a reversed transverse flight bar of the type and function taught in our prior application Ser. No. 219,212. However, this function may be performed by movable gate means illustrated at **224** in FIG. 2 and shown in detail in FIGS. 7 and 8. This stop gate means may be in the form of a lift gate which in its elevated position intercepts the carton path and which may be retracted or lowered out of this path at the proper time.

It is preferred that such movable gate means **224** be in the form of a pivoted stop paddle structure **225** having a journal **226** through which a transverse pivot pin **116** extends. Movable gate means **224** is supported by means of a pair of longitudinal plates **117** supported on transverse rods **65** and **83** of the machine frame, and these plates are tied together by a tie bolt structure **118** (see FIGS. 2, 7 and 8). Plates **117** support the transverse pivot pin **116**. For the purpose of swinging this paddle structure **225** rearwardly up to intercept the carton path and swinging it forwardly down to a retracted position a pneumatic motor is provided which includes a cylinder **227** suitably supported at its back end **228**, such as by ears **119** which pivotally receive therethrough tie bolt **118** for swinging motion of this cylinder, and the latter carries a reciprocating piston head **229** (see FIGS. 9 to 13 incl.). The piston structure of this pneumatic motor includes with the piston head **229** a piston rod **230** extending from out of the other end **231** of the cylinder **227** for driving connection with the pivoted stop paddle structure **225**, such as by means of connector knuckle **232**. Thus, when the piston rod **230** is thrust forward, i.e., back toward the entrance end of the machine, it will swing the pivoted paddle structure **225** counterclockwise to lift it up into the carton travel path to constitute a stop for each carton as the latter is moved up by the conveyor means into the flap folding station Y, as is indicated in FIG. 2. This stop paddle structure **225** will be retracted out of the carton travel path by clockwise swing forward upon retraction of the piston rod **230**. Such reciprocative action of the piston rod **230** with attendant elevation and retraction of the stop gate paddle structure **225** will be explained more fully in connection with FIGS. 9 to 14 incl.

In FIGS. 9 to 11 incl. are shown diagrammatically pneumatic circuitry for association with and control of the clamping rail driving motor **87** including a source of pressurized gaseous medium or air and a pair of solenoid valves. It is therein proposed also to associate with such pneumatic circuitry the pneumatic means for controlling and manipulating the movable gate means **224** in the form of the pivoted stop paddle structure **225**. As will be seen from FIGS. 9 to 11 incl. the pneumatic motor **87** includes a double-ended cylinder **301** in which is reciprocatively mounted piston head **88** provided with a through piston rod **89** fixed thereto. One end **302** of the cylinder **301** has projecting therethrough leading section **303** of the double-ended piston rod **89** to which the initial section of the traverse chain **99** is connected for moving or driving the spread-apart clamping and guiding rails **80** and **180** from their initial positions of FIG. 2 inward toward each other to clamping of an intervening carton at the station Y upon inward motion of this piston section. The other end **304** of pneumatic motor cylinder **301** has projecting therethrough the other end section **305** of the double-ended piston for connection to the traverse chain section **499** which, upon outward travel, cooperates in such inward drive or approach of these clamping rails **80** and **180**. In FIG. 9 the initial position of the piston head **88**, as would be occupied under the FIG. 2 conditions, is indicated in dotted lines at **188**, and it is shown traveling to the left for effecting the drive of the clamping rails **80** and **180** inward toward each other to opposite sides of a carton stopped at the flap folding station Y.

The pneumatic circuitry diagrammatically illustrated in FIGS. 9 to 11 incl. is shown in FIG. 9 as including a pair of solenoid valves **194** and **195**. Since the main pressurized air supply, indicated at **306**, is connected directly to one orifice of the solenoid valve **195** and thence through the next solenoid valve **194** to the pneumatic motor cylinder **301**, solenoid valve **195** will be here identified as a first such valve, and solenoid valve **194** will here be considered as a second such valve. The solenoid valves **195** and **194** are modified forms of four-way valves. The first solenoid valve **195** has two orifices on the outlet side thereof, i.e., **Iv1** and **IIv1**, indicated respectively at **307** and **308**. This first solenoid valve **195** also has three orifices on the inlet side thereof, i.e., **IIIv1**, **IVv1**, and **Vv1**, indicated respectively at **309**, **310** and **311**.

Similarly, the second solenoid valve **194** has two orifices **Iv2** and **IIv2** on its outlet side respectively indicated at **312** and **313**. The second solenoid valve **194** also has on its inlet side three orifices **IIIv2**, **IVv2** and **Vv2** respectively indicated at **314**, **315** and **316**.

The third and fifth orifices of solenoid valve **195**, at **309** and **311**, alternately serve as vents to atmosphere, and the fifth orifice at **316** of the second solenoid valve **194** periodically serves as a similar vent.

The supply of pressurized air **306** is connected by a conduit **317** through a regulator **318** to the fourth orifice of solenoid valve **195** at **310**, and its second orifice at **308** is connected by a conduit **319** to the fourth orifice **315** of the second solenoid valve **194**. The supply of pressurized air **306** is also connnected by a conduit **320** through a regulator **321** to the third orifice **314** of the second solenoid valve **194**. The first and second orifices at **312** and **313** of the second solenoid valve **194** are respectively connected by conduits **322** and **323** to first and second ducts or passages at I and II at **324** and **325** which communicate with the chamber of the pneumatic motor cylinder **301** at its respective ends **302** and **304**. The regulator **318** is set to provide a relatively high pressure of the gaseous medium or pressurized air, e.g., forty-five pounds per square inch (45 lbs./sq. in.), and that at **321** is set to provide a relatively low pressure of the gaseous medium or pressurized air, e.g., five pounds per square inch (5 lbs./sq. in.).

It may be found desirable to apply greater gaseous pressure to the stop gate operating cylinder **227** than that which is applied to the rail driving cylinder **301** as the relatively high pressure is fed to the latter. This may become desirable in connection with the handling of relatively heavily loaded cartons which entails application of appreciable positive pressure to the stop gate operator **229** to assure that the stop gate **225** will effect the required positive stoppage of such cartons at the flap folding station Y, while limiting the maximum pressure feed to the rail driving cylinder **301**. This may be accomplished in a simple manner by moving the pressure regulator **318** out of the conduit **319** to a point intervening orifice **315** of the second solenoid valve **194** and the interconnection between conduit **319** and the conduit **332** which deliver the relatively high pressure to the stop gate operating cylinder **227**, such as to the alternate point indicated at **318***a* in FIG. 9. As a consequence, the pressure of the source **306** may be raised to that determined to be sufficient to bias the carton stop gate **225** to its up position under all conditions of maximum load demand while assuring that the maximum pressure supplied to the rail driving cylinder **301** through the solenoid valve **194** will be limited to a lower value, such as forty-five pounds per square inch (45 lbs./sq. in.), as dictated by the regulator **319**, when the later is located at the point **318***a*.

With the clamping rails **80** and **180**, their traverse equipment and the piston structure of the pneumatic motor **87** in the initial positions illustrated in FIG. 2, energization of both of the solenoid valves **195** and **194** by means hereinafter described in connection with the diagrammatic showing in FIG. 16 of the electrical and pneumatic circuitries, pneumatic flow passages through these valves illustrated in FIG. 9 are attained. Thus, inlet orifice **310** of the first energized solenoid valve **195** is connected by a cross-passage **326** to its orifice **308** for feed through conduit **319** to orifice **315** of the second energized solenoid valve **194**. Orifice **315** of energized solenoid valve **194** is connected by a cross-passage **327** to its orifice **312**, whereby the relatively high pressure air is conducted through conduit **322** to the forward end **302** of the cylinder **301**, so as to thrust the piston **88** in the latter back from its position at **188** toward its terminal position **288**, both such positions being indicated in dotted lines. This action will cause the traverse chain **99–499** to drive the clamping rails **80** and **180** inward from their initial widely spread-apart positions toward each other with their clamping shoes **211** approaching to abutment of opposite sides of the carton **134** temporarily held stopped at the flap folding station Y by lift or stop gate **225**. During such feed of the relatively high pressure air to the forward end **302** of the chamber of the pneumatic motor cylinder **301** air in the latter on the opposite side or behind the piston head **88** will be bled out through conduit **323** to orifice **313** of the second energized solneoid valve **194** for venting through orifice **316** thereof by a cross-passage **328**.

After the front flap on the leading end on the carton **134**, while the latter is clamped at the station Y, is folded back and downward upon the top of this carton the chain conveyor is started up to carry forward one of its transverse flight bars **64–1** and **64–2**, so that the latter is brought up behind this carton to pick it up and transport it forward between the opposed rails **80** and **180** in their inward position which now serves as guides. For this purpose, the clamping pressure must be relieved to an appreciable degree so as to permit such slide of the carton between these now lightly elastically biased rails **80** and **180** in their inward positions. This is accomplished by deenergizing both of the solenoid valves **195** and **194**

to manipulate them for establishing the flow passages therethrough illustrated in FIG. 10. Now the relatively high pressure or gaseous medium delivered through conduit **317** is cut off at the first de-energized solenoid valve **195** from communication to the pneumatic motor cylinder **301**. However, the relatively low pressure gaseous medium is delivered through conduit **320** to orifice **314** of the second de-energized solenoid valve **194** for feed through its cross-passage **329** to orifice **312** for delivery by conduit **322** to the forward end **302** of the chamber of the cylinder **301**. At the same time the air in the other end **304** of the cylinder **301** located on the opposite side of piston head **88** is continued to be vented through conduit **323** and now cross-passage **330** established between orifices **313** and **315** of de-energized solenoid valve **194**, thence via conduit **319** and finally from orifice **308** to vent orifice **311** by way of cross-passage **331** of de-energized solenoid valve **195**. As a result, the rails **80** and **180** are elastically biased to opposite sides of the carton **134** under relatively light pressure, such as five pounds per square inch (5 lbs./sq. in.) to permit the carton to slide forward therebetween.

As will be best understood from the following description of operation in connection with the showing in FIG. 16 a very short period may intervene the attainment of the conditions depicted in FIGS. 9 and 10. During this period the solenoid valve **195** may be de-energized shortly before solenoid valve **194** is de-energized so that valve **195** is conditioned as shown in FIG. 10 while valve **194** remains energized as is indicated in FIG. 9. In this event solenoid valve **195** will feed the relatively high pressure air across from orifice **310** to orifice **307** for conduction by conduit **333** to the front end **231** of cylinder **227**, thereby effecting retraction of stop gate **225**. This is accompanied by venting the back end **228** of cylinder **227** through conduit **332**, orifice **308**, passage **331** and out vent orifice **311**. As this occurs both supplies of pressurized air are cut off from communication with the clamping rail traverse cylinder **301**, the relatively high at orifice **310** and the relatively low at orifice **314**. The inwardly positioned clamping rails **80** and **180** remain abutted against the opposite sides of the carton at the flap folding station for the short time until the condition of FIG. 10 is attained to apply relatively low biasing pressure to these rails.

When the succeeding carton is admitted into the entrance end of the machine and fed forward toward the flap folding station Y the first solenoid valve **195** again becomes energized while the second solenoid valve **194** remains de-energized. The condition of the pneumatic circuitry associated with the pneumatic motor **87** at such time is illustrated in FIG. 11. It will there be seen that now the relatively high pressure gaseous medium is again fed through conduit **317**, e.g., at forty-five pounds per square inch (45 lbs./sq. in.), to the energized first solenoid valve **195**, through its cross-passage **326** to conduit **319**, and thence through cross-passage **330** through the de-energized second solenoid valve **194** to conduit **323**, to be supplied through the back end **304** of pneumatic motor cylinder **301** behind the piston head **88** for urging the latter forward, back to its initial position **188**. At the same time relatively low pressure gaseous medium, e.g., at five pounds per square inch (5 lbs./sq. in.), is supplied through conduit **320** and by way of cross-passage **329** through de-energized second solenoid valve **194** and conduit **322** to the forward end **302** of the pneumatic motor cylinder **301**, ahead of the piston **88** therein. The differential in pressures on opposite sides of the piston **88**, e.g., forty pounds per square inch (40 lbs./sq. in.), is thus applied behind the piston head **88** to thrust it forward toward its initial position **188**, so as to return the rail traversing equipment back to its initial positions of FIG. 2. This action retracts the rails **80** and **180** away from each other, so as to spread them apart for receiving therebetween the next succeeding carton as it enters the entrance end of the machine.

The action described above in connection with FIGS. 9, 10 and 11 is then repeated with this next carton as it is fed forward by continually traveling endless conveyor belt 27 to the flap folding station Y. As has been previously indicated, stop mechanism is required at the forward end of the flap folding station Y, intercepting the path of forward travel of this succeeding oncoming carton, so as to stop it in proper position for lowering of the elevating head 2 down thereover to effect the initial flap folding operation, i.e., the folding back and down upon the top end of the carton its upstanding leading flap. As is pointed out above the stop mechanism to intercept this oncoming carton and cause it to pause at the flap folding station Y may be in the form of a retracted gate, such as that shown at 225 in FIGS. 1, 2, 7 and 8 or in FIGS. 9, 10 and 11, which is to be lifted into a carton path intercepting position for abutment thereagainst of the leading end of the succeeding carton. As will be seen from the diagrammatic showing of the pneumatic circuitry in FIGS. 9 and 11 the pneumatic cylinder 227 and its piston structure 229, 230 may perform this gate lifting operation by having the back end 228 of the chamber in this cylinder connected by a conduit 332 to the interconnecting conduit 319, to supply thereto, behind piston head 229 the relatively high pressure gaseous medium, e.g., at forty-five pounds per square inch (45 lbs./sq. in.), to thrust this piston head forward causing piston rod 230 to raise the stop gate 225 to its full line position shown therein. This action occurs when first the solenoid valve 195 is energized, and may happen when the clamping rails 80 and 180 are in their relative inward clamping positions and while solenoid valve 194 is de-energized, as depicted in FIG. 11, so that these clamping rails will be driven away from each other to their spread-apart positions of FIG. 2, to be maintained in this up carton intercepting position as solenoid valve 194 is then energized, as indicated in FIG. 9, to drive these spread-apart rails inward toward their carton clamping positions. In starting up operation of the inactive machine the stop gate 225 is raised immediately when the circuitry is first supplied with power causing solenoid valve 195 to be immediately energized, as will be explained in the description of FIG. 16. Thus the stop gate 225 is raised to its intercepting position to stop the next oncoming carton at the flap folding station Y and then the clamping rails 80 and 180 are brought snugly against opposite sides of the stopped carton at the flap folding station, with their clamping shoes 211 abutted to opposite sides of the carton under relatively high clamping pressure, e.g., forty-five pounds per square inch (45 lbs./sq. in.). With the application of the relatively high pressure gaseous medium behind the piston head 229 the gaseous medium or air in the head end 231 of the chamber of the cylinder 227 was vented by a conduit 333 connected to orifice 307 of the first energized solenoid valve 195 for venting through cross-passage 334 of the latter and its vent orifice 309.

As will be seen from FIG. 10 when both solenoid valves 195 and 194 are then de-energized, the relatively high pressure gaseous medium is supplied through orifice 310 and cross-passage 335 of the first de-energized solenoid valve 195 to be fed through conduit 333 to the head end 231 of the chamber of stop gate cylinder 227. This causes the relatively high pressure to be applied to the opposite side or in front of the piston head 229 to cause it to retract piston rod 230 and effect attendant retraction or lowering of the stop gate 225. This gate retraction releases the carton for further forward transport at the time the inwardly located clamping rails 80 and 180 become biased with relatively low pressure gaseous medium to convert them to guiding rails. By reference to FIG. 11 it will be seen that when the first solenoid valve 195 again becomes energized with maintenance of the de-energization of the second solenoid valve 194 retraction of the guiding rails 80 and 180 is begun and again relatively high pressure gaseous medium is fed to behind piston head 229 in the cylinder 227 to thrust it toward its maximum position of advance 229–1 for raising the gate 225 to its carton stopping position 225–1.

This cycle of operation of lifting and retracting the carton stopping gate 225 is cyclically performed simultaneously with the recycling operations of the inward drive and outward retraction of the rails 80 and 180, as are illustrated in FIGS. 9, 10 and 11.

It is to be understood that the alternate lifting and retraction of the stop gate 225 need not depend upon alternate pneumatic drive of its operating mechanism, such as the piston 229 of cylinder motor 227. As will be seen from FIGS. 12 and 13 the interconnecting conduit 332, which in FIGS. 9, 10 and 11 connects the back end of the chamber of cylinder 227 to the interconnecting conduit 319 for supply of relatively high pressure gaseous medium thereto periodically, may be omitted. In such case the stop gate mechanism 2240 may include a helical compression spring 336 mounted within the cylinder 2270 behind the piston head 229, with the back end 2280 of this cylinder vented, such as is indicated at 337. Such compression spring 336 thus constitutes the motor which thrusts the piston head 229 forward to cause piston rod 230 to raise the stop gate 225 to its carton path intercepting position, as is indicated in FIG. 12. This expansion of the motor spring 336 is permitted when the front end 231 of the cylinder 2270 is connected by means of conduit 333 to the vent orifice 309 by way of cross-passage 334 of the first energized solenoid valve 195, with the cylinder chamber behind the piston head 229 being permitted to aspirate air through vent 337. Thus this lifting force is applied to the stop gate 225 to lift it up to its carton path intercepting position takes place at all times that retracting pressure is not applied to the front end 231 of cylinder 2270, including the time when the opposed rails 80 and 180 are driven to more progressively inward toward opposite sides of an oncoming carton, so as to stop the latter at the flap folding station Y, there ultimately to be securely clamped by these rails and their clamping shoes 211.

As will be seen from FIG. 13 when both of the solenoid valves 195 and 194 are de-energized to apply relatively low pressure gaseous medium to the opposite side of the piston head 88 in the cylinder 301 of rail driving pneumatic motor 87 for conversion of these rails to carton guiding means the relatively high gaseous medium, e.g., at forty-five pounds per square inch (45 lbs./sq. in.), is supplied from conduit 317 through cross-passage 325 of the first deenergized solenoid valve 195 and by way of conduit 333 to the front end of 231 of the cylinder 2270 so as to retract the piston head 229 and its piston rod 230 for withdrawing the stop gate 225 from the path of the carton to allow it to be transported forward from the flap folding station Y. This action compresses the motor spring 336 with vent of air through the vent 337. This condition of FIG. 13 is maintained until the first solenoid valve 195 is again energized, such as while the de-energization of the second solenoid valve 194 is maintained for effecting the retraction of the guiding rails 80 and 180 from each other to permit reception of the next oncoming carton, as in FIG. 11, at which time feed of relatively high pressure gaseous medium to the front end 231 of cylinder 2270 is cut off to permit the spring 336 again to raise the stop gate 225.

As will be seen in FIGS. 14 and 15 lugs 266–1 and 266–2 carried by the far conveyor chain 159 are of appreciable length, being about thirty inches (30″) long in an operative embodiment of the machine depicted by way of example in the drawings. As was previously indicated these lugs 266–1 and 266–2 are provided for successively engaging beneath roller 237 on the tip of trigger 236 which manipulates a second limit switch 235, the latter being biased to one condition of circuit control and when its trigger is tripped upwardly by either of such lugs carried therebeneath to manipulate it to another condition of circuit control. These lugs 266–1 and 266–2 are of the appreciable length shown so that the second condition of circuit control effected by the tripping may be maintained for a proper time release. The relative positions of the pair limit switch tripping lugs 66–1 and 66–2 with respect to tripping lugs 266–1 and 266–2 are shown therein by the bracketing of the positions of the former (not viewable in FIGS. 14 and 15) for an understanding of the relative timing of the operations of the limit switches 135 and 235, respectively controlled by the switch tripping lugs 66–1 and 66–2 on the conveyor chain 59 and the switch tripping lugs 266–1 and 266–2 carried by the conveyor chain 159. The operations illustrated in FIGS. 14 and 15 and the actions dictated thereby are here explained in connection with the operational details described with refeernce to the circuitry shown in FIG. 16.

As is illustrated in FIG. 16 the electrical circuitry of the machine, shown by way of example in the accompanying drawings, includes AC power supply lines L1, L2 and L3, to which are connected in parallel circuits to supply such power to main motor 51 and AC reversing starter switches 253 and 254 of the vertical motion motor 174. Starter switches 252 are closed by energization of a relay coil 2520. The Up starter switches 253, which dictate drive of motor 174 in one direction for the lift of the head 2, are closed by energization of a relay coil 2530, and the Down starter switches at 254, which dictate reversed drive of this motor for lowering the head, are closed by energization of relay coil 2540. A brake coil 255 is associated with motor 174 to hold it in stopped position. A rectifier circuit 256 for converting AC power to DC energy supplies the latter to magnetic brake 67–1 and magnetic clutch 67–2 through parallel circuits between conductors 342 and 343 thereof, and these parallel circuits are alternately closed. The circuit of the magnetic brake 67–1 includes a biased-closed switch 256–1 and the circuit of the magnetic clutch 67–2 includes a biased-open switch 256–2, and these switches are tied together for simultaneous alternate opening and closing by a relay coil 2560. Since relay coil 2560 is initially de-energized, the brake circuit switch 256–1 remains closed with the brake applied to the drive of the chain conveyor 59–159. In the illustrated machine it is desirable to connect the clutch switch 256–2 to conductor 342 alternately through a voltage reducer 344 and a full voltage line 345 respectively by means of a normally closed switch 341–2 and a normally open switch 341–3 tied together for simultaneous manipulation.

The rectifier circuit 256 also supplies DC power to a photocell system 1380, which includes the photocell 138 in the vicinity of the entrance selector gate 12 (see FIG. 1) and a light source 139 arranged on the opposite side of the machine for directing a photocell exciting beam upon this photocell (see FIGS. 14 and 15), and a photocell system 1400, which includes the photocell 140 at the sensing and flap folding station Y (see FIG. 1) and its exciting light source 141 on the opposite side of the machine (see FIGS. 14 and 15). The energizing circuit for the photocell systems 1380 and 1400 includes a normally open switch 262–1 which is to be closed by energization of a relay coil 2620.

A normally open switch 259, which is to be closed manually to effect initial operation of the machine, is connected in series with the relay coil 2620 in one of a plurality of parallel circuits connected to neutral line N of the power supply circuit for bridging across the latter. Another one of these parallel circuits includes a normally open Start push button switch 263 connected in series with the relay coil 2520 which controls the main motor starter switches 252. The Start push button switch 263 is shunted by a holding circuit which includes a magnetic overload switch 265 and a normally open switch 252–4 controlled by relay coil 2520, so that when the latter is energized this holding circuit will continue to supply energy to the branch circuits leading from this Start push button switch. There is connected to the parallel circuit which includes in series the Start push button switch 263 and the relay coil 2520, at a point therebetween, a branch circuit which includes in series a normally closed switch 262–2, which is under the control of relay coil 2620, and the relay coil 2560. This normally closed switch 262–2 is shunted by a holding circuit which includes in series a normally open switch 262–3, also under the control of relay coil 2620 and a held open switch 135–1 which is biased toward closure. To the same common point of connection between the Start push button switch 263 and the relay coil 2520 is connected another branch circuit which includes a held open head switch 149–1 that is biased toward closure, a conductor 101 which leads to a normally open switch 341–1 that is tied to normally closed switch 341–2 and normally open switch 341–3 for simultaneous manipulation, a held closed switch 135–2 which is biased toward open position, and a conductor 102 connected to the branch line which includes in series the normally closed switch 262–2 and the relay coil 2560 at a point intermediate these latter switch and relay coils. A relay coil 3410 is connected between conductor 101 and the neutral line N to be in parallel with the normally open switch 341–1, held closed switch 135–2 and relay coil 2560. Relay coil 3410 when de-energized under the conditions depicted in FIG. 16 permits switches 341–1 and 341–3 to remain open and switch 341–2 to remain closed, and when energized closes switches 341–1 and 341–3 and opens switch 341–2.

Held open switch 135–1, which is biased toward closure, and switch 135–2, which is held closed and biased toward open condition, are tied together for simultaneous manipulation. These two switches are embodied in the limit switch 135 that is under the control of the trigger 136 which is periodically tripped successively by the lugs 66–1 and 66–2 carried by the conveyor chain 59 (see FIG. 1). For example, when the lug 66-1 is beneath the trigger 136 of limit switch 135 to trip it up and hold it in such tripped position switch 135–1 is open and switch 135–2 is closed, as is indicated in FIG. 16, and they are held in these respective conditions by the maintenance of this tripping by this lug located beneath the roller 137 of the tripping trigger 136, as in FIG. 1.

A branch circuit is connected to the common point between the Start push button switch 263 and the relay coil 2520 through normally open switch 262–3 (by connection to the mentioned shunt circuit between the latter and the held open switch 135–1) with this branch circuit including in series a biased closed switch 235–1 of limit switch 135, normally open photocell switch 140–1, a held closed head switch 149–2 which is biased toward open position, a biased closed travel limit switch 186–1 and the relay coil 2540, thence to the neutral line N. At a point intermediate the normally open photocell switch 140–1 and the held closed head switch 149–2 and the neutral line N is connected a branch circuit including the energizing winding of solenoid valve 194. Beyond the biased closed limit switch 235–1 is provided a second branch circuit for simultaneous control with the immediately precedingly described branch circuit, this second branch circuit including in series a conductor 268 connected to this intermediate point ahead of photocell switch 140–1, second normally closed photocell switch 140–2, a normally closed manual switch 272, another biased closed travel limit switch 186–2 and the relay coil 2530, thence to connection with the neutral line N. To the common connection between photocell switches 140–1 and 140–2, intermediate the biased closed limit switch 235–1 and the normally open photocell switch 140–1 is connected another branch conductor 267 which includes a normally closed manual switch 274, another held closed head switch 149–4 which is biased toward open position, and the winding of solenoid valve 195, thence to the neutral line N. The normally open photocell switch

140–1 and the normally closed photocell switch 140–2 are tied together for simultaneous manipulation when the photocell system 1400 is energized by a light beam emanating from light source 141 falling upon photocell 140 (in the absence of an intervening carton at the flap folding station Y). Thus, when the photocell system 1400 becomes de-energized (by interception of this light beam emanating from light source 141 to prevent it from impinging upon photocell 140 as a result of intervention by a carton) normally open photocell switch 140–1 is closed and its companion switch 140–2 is opened.

A pair of normally open manual switches 273 and 275 are respectively connected in parallel circuit conductors 276 and 277 with normally open switch 273 leading to connection with biased closed travel limit switch 186–2. The normally open manual switch 275 is connected by a conductor 103 to a point intermediate the held closed head switch 149–4 and the winding of solenoid valve 195. The bank 271 of manually and simultaneously operable switches, consisting of normally closed switches 272 and 274, and normally open switches 273 and 275, are provided so as to permit quick and ready freeing by a single manual act of a damaged carton in the machine. Thus no further consideration need given here to this bank 271 of manual switches with respect to the operation of the machine in successively closing a plurality of random sized cartons.

Parallel circuit 278 includes in series normally closed switch 262–4 and the winding of selector entrance gate solenoid valve 197, this normally closed switch being opened enegization of relay coil 2620 so that the selector gate 12 is initially in its up, carton-barring position shown in FIG. 1. Parallel circuit 269 has connected in series therein a normally open switch 262–5, a second biased closed limit switch 235–2, a normally open photocell switch 138–1 and a relay coil 2660, thence to the neutral line N. A cross-connection between parallel circuits 269 and 278 is provided through a normally closed switch 266–1 between a point intervening biased closed switch 235–2 and normally open photocell switch 138–1, and a point intervening normally closed switch 262–4 and entrance gate solenoid valve 197. Thus, when switch 262–5 is closed by energization of relay coil 2620 upon initial closure of the manual switch 259 with resulting opening of switch 262–4 (also associated with this now energized relay coil) the entrance gate solenoid valve 197 will be energized for a short period to permit entrance of an open carton at the position Z in FIG. 1 to the machine for closing, as will be explained more fully later in connection with the description of a typical operation of the machine. The entrance of such carton to the machine will cause it to intercept the beam of light impinging upon the photocell 138 at the entrance gate so as to stop excitation thereof and effect closure of the photocell switch 138–1. Thus the relay coil 2660 becomes energized to open its normally closed switch 266–1 for de-energizing entrance gate solenoid valve 197 and closing its normally open switch 266–2 which is shunted around photocell switch 138–1 to provide a holding circuit for this relay coil. This circuitry also has associated therewith another energizing circuit for the relay coil 2560. This other energizing circuit for relay 2560 consists of a conductor 104 having one end connected between the relay coil 2660 on the one hand and the switches 266–2 and 138–1 on the other hand. The other end of conductor 104 is connected between the switches 341–1 of relay coil 3410 and the conveyor operated limit switch 135–2. Conductor 104 has therein a second photoswitch 138–2 which is normally closed to be opened when the photocell 138 is de-excited.

Another parallel circuit which provides for alternate retractive and flap-folding striking action of the back flap kicker 161 is provided and includes in series biased closed sensing switch 128, a held open head switch 149–3 which is biased toward closed position and solenoid valve 198 which operates the back flap kicker.

It will thus be seen that relay coil 2620 controls five switches, viz., normally open switches 262–1, 262–3, and 262–5 and normally closed switches 262–2 and 262–4. It will also be seen that the relay coil 2520 controls four normally open switches, viz., the three in the power supply lines connected to the main motor 51 and holding circuit switch 252–4 shunted around the Start push button 263. Relay coil 2560 manipulates simultaneously the normally closed brake circuit switch 256–1 and the normally open clutch circuit switch 256–2. The relay coil 3410 simultaneously manipulates its normally open switches 341–1 and 341–3 and its normally closed switch 341–2. The head switch 149, which is carried by the elevating head 2 and is manipulated by the front flap folder arm 146, has embodied therein four switches, viz., held open switches 149–1 and 149–3 which are biased toward closed positions and held closed switches 149–2 and 149–4 which are biased toward open positions. Entrance gate photocell 138 simultaneously controls normally open photocell switch 138–1 and normally closed photocell switch 138–2. Flap folding station photocell 140 simultaneously controls normally open photocell switch 140–1 and normally closed photocell switch 140–2. Held open limit switch 135–1 which is biased toward closed position and held closed limit switch 135–2 which is biased toward open position are tied together for simultaneous operation by tripping of the limit switch 135 upon travel therepast of tripping lugs 66–1 and 66–2 carried by conveyor chain 59. Biased closed limit switches 235–1 and 235–2 are tied together and embodied in limit switch 235 which is operated periodically by travel therepast of the tripping lugs 266–1 and 266–2 carried by the other conveyor chain 159. The biased closed switches 186–1 and 186–2 in the head lowering and elevating circuits are embodied in the switch 186 carried by the elevating head 2 with switch 186–1 being opened upon contact of the switch trigger 187 with the bottom trip collar 190 to limit downward movement of this head and with switch 186–2 being opened upon trip of this trigger by top collar 193 upon raising of the head (see FIG. 1).

Operation on random size cartons which may include some of 3" to 4½" depth

The machine illustrated by way of example in the drawings, when equipped with electrical and pneumatic systems diagrammatically depicted in FIGS. 9, 10, 11 and 16, will operate as follows when a series of cartons of random size are fed to the entrance end thereof by the supply conveyor 9. Such random size cartons may include some relatively small ones which have shallow depths in the range of about three to four and one-half inches (3"–4½"), or may consist of all such small cartons. Reference should be made to the wiring diagram of FIG. 16. The power is turned on to feed current to main supply lines L1, L2 and L3, the switch 259 is closed manually to energize relay coil 2620 and the "Start" push button switch 263 is closed to energize relay coil 2520. Resulting energization of relay coil 2620 closes its normally open switches 262–1, 262–3 and 262–5 and opens its normally closed switches 262–2 and 262–4. The energization of relay coil 2520 closes starter switches 252 to effect continued drive of the main motor 51 (FIGS. 1 and 3) and holding switch 252–4 shunted around push button switch 263 to continue the energization of this relay coil. With the supply of power to the FIG. 16 circuitry the rectifier circuit 256 was also energized. The drive of main motor 51 effects constant drive of initial belt section 27 of the conveyor means.

The second section of the conveyor means, which is preferably in the form of a chain conveyor provided with a pair of uniformly spaced transverse flight bars 64–1 and 64–2, is held in stop position by virtue of the fact that tripping lug 66–1 is located beneath the trigger 136 of limit switch **135** to hold it up so as to maintain open position of its switch **135–1** and the closed position of its switch **135–2**. This chain conveyor **59–159** will not be driven until relay coil **2560** is energized and thus the coil of brake **67–1** remains energized through closed brake switch **256–1** to prevent movement of this conveyor section.

Let it be assumed that a supply of succeeding cartons is provided on the feeding roller conveyor **9** and that the first carton thereof, such as **134** when in the position Z, was initially barred from entering by the lifted entrance gate **12**, as is illustrated in the left hand end of FIG. 1 with respect to another carton therefollowing. When the power was turned on selector entrance gate solenoid valve **197** became energized through normally closed switch **266–1** so as to temporarily retract this selector gate and permit the leading edge of the bottom of this first carton to enter thereover. As the leading edge of the bottom of this first carton at Z enters over the retracted selector gate **12**, the beam of light from the light source **139** which impinges upon the photocell **138** to excite it is interrupted and the excitation of the latter is thus discontinued to effect closure of its normally open photoswitch **138–1** and to open its normally closed photoswitch **138–2**. This closure of photoswitch **138–1** causes relay coil **2660** to be energized for opening its normally closed switch **266–1** so as to deenergize entrance gate-operating solenoid valve **197**. Consequently, the selector gate **12** is allowed to raise and lift its roller **17** beneath the bottom of the entering carton which permits the latter to glide forward onto the constantly driven conveyor belt **27** while positioning the carton-barring gate flange **16** into the path of the next oncoming carton supplied by feed conveyor **9**, such as **234** which will now occupy position Z. The driven conveyor belt **27** transports this first carton **134** forward to between the retracted guide rails **80** and **180** and on toward the sensing and flap folding station Y until the front or leading end of this carton is brought to abutment of the lifted stop gate **225** (see FIG. 1).

As soon as power was supplied to the rail traverse and stop gate operating solenoid valve **195** became energized through the switch **262–3** (closed by the energization of relay coil **2620**), the closed limit switch **235–1**, conductor **267** including closed manual switch **274** and the held closed head switch **149–4**. Since solenoid valve **194** remained deenergized by virtue of the open condition of its circuit at normally open photoswitch **140–1** the conditions of FIG. 11 were obtained to assure that the clamping rails **80** and **180** were spread apart to their fully retracted positions for reception of this oncoming carton therebetween and to effect the lift of the stop gate **225** to its carton stopping position for holding this cartion at the flap folding station Y.

As this open-top carton **134** was delivered to the constantly driven conveyor belt section **27** and carried forward a short distance to clear the beam of light projected by the light source **139** toward the photocell **138**, such as in the broken line position illustrated in FIG. 14, the resulting re-excitation of this photocell again permitted the photocell switch **138–1** to open and the photocell switch **138–2** to close. Since, during the closure of photocell switch **138–1** while the carton **134** was traveling from the position Z to the broken line position shown in FIG. 14, its photocell switch **138–1** was closed to energize relay coil **2660** and cause the latter to close its normally open holding switch **266–2** energization of this relay coil will be continued through this now closed holding switch and the latter will deliver current through closed photoswitch **138–2**, conductor **104**, held closed limit switch **135–2** and conductor **102** to energize relay coil **2560**. Relay coil **2560** had been de-energized since switch **262–2** was opened by energization of relay coil **2620**.

The resulting energization of relay coils **2560** causes it to open its brake switch **256–1** and close its clutch

switch **256–2**, so that the winding of friction clutch **67–2** is energized at relatively low voltage through closed switch **341–2** and the voltage regulator **344** to engage the clutch lightly. Consequently, drive of the chain conveyor **59–159** begins so as to drag the tripping lug **66–1** from beneath the trigger **136** of the limit switch **135** (see FIG. 1) to permit the limit switch **135–1** to close and the limit switch **135–2** to open. Thus energization of the relay coil **2560** is continued through the holding circuit now closed at switch **135–1** although supply of energy thereto was discontinued through the conductor **104** by virtue of the simultaneous opening of the limit switch **135–2**. Continued drive of the chain conveyor **59–59** is thus established so as to carry forward the transverse flight bar **64–1** to follow up behind the advancing carton **134**, finally to attain the conditions illustrated in FIG. 15.

As is indicated in FIG. 15 carton **134** was delivered to the flap folding station Y and held stopped by the raised stop gate **225**. The chain conveyor **59–159** was coasted forward under low driving power to bring the following flight bar **64–1** up to abutment of the trailing or back end of the carton as it is held stopped at the flap folding station Y. Consequently, the flight bar **64–1**, by being abutted against the back end of the pausing carton, is located for effecting substantially instantaneous pick-up when the chain conveyor **59–159** is permitted again to travel forward. The clutch continues to be engaged by energization of the relay coil **2560**, but under low power applied through switch **341–2** and voltage reducing regulator **344**, so that the following flight bar **64–1** engaged the back end of the carton held stopped by the lifted stop gate **225** with relatively light pressure to avoid crushing of the carton. Since the clutch **67–2** is of the friction type it permits slippage when engaged under low power and this continues until the stop gate **225** is retracted a short time thereafter following completion of a flap folding operation.

As the carton **134** was delivered to this flap folding station Y by conveyor belt **27** it interrupted the beam of light emanating from the light source **141** to block off impingement thereof on the second photocell **140**, so as to discontinue its excitation for effecting closure of its normally open photoswitch **140–1** and opening of its normally closed photoswitch **140–2**. The closure of the photoswitch **140–1** now effects energization of solenoid valve **194** so that it is energized while the energization of the solenoid valve **195** is continued to obtain the condition of FIG. 9. As a result, the retracted clamping rails **80** and **180** are driven inwardly to opposite sides of the carton as it is stopped under the conditions of FIG. 15 at the flap folding station Y. Full clamping pressure is applied to opposite sides of the stopped carton **134** through the raised shoes **211** carried by the inwardly positioned clamping rails **80** and **180**.

This closure of the photoswitch **140–1** also effected energization of the Down relay coil **2540** through the closed limit switch **235–1** and the held closed head switch **149–2**. Thus the down switches **254** of the elevating motor **174** are closed to cause the flap folding head **2** to be lowered to the open top of the pausing carton **134**. As a result, the upstanding front flap of the carton **134** at the flap folding station Y is folded back and down upon the open top of the carton by engagement of the pivoted depending front flap folding arm **146** as it is lowered with the head. During this folding action the front flap folding arm **146** is pivoted up counterclockwise to the horizontal broken line position shown in FIG. 1, so as to permit the biased switch operating arm **148** to be released and effect manipulation of the head switch **149**. The release of the head switch **149** permits its held closed switch **149–2** to open so as to discontinue energization of the Down relay coil **2540** to stop the lowering action of the head 2. This manipulation of head switch assembly **149** also permitted closure of its head switches **149–1** and **149–3** and allowed the head switch **149–4** to open.

The resulting de-energization of solenoid valve **195** causes retraction of the raised stop gate **225** so as to free the carton **134** for further forward transport by the chain conveyor **59–159**, by the action illustrated in the lower portion of FIG. 10.

The simultaneous closure of the head switch **149–1** caused relay coil **3410** to be energized through conductor **101** so that this relay coil closes its switches **341–1** and **341–3** and opens its switch **341–2**. Thus, the low power switch **341–2** is opened and full power is applied to the winding of clutch **67–2** through the closed switches **341–3** and **256–2** so that with the maintenance of energization of relay coil **2560** through the closed holding limit switch **135–1** the carton **134** with its front flap folded back and down is instantaneously picked up by the abutting flight bar **64–1** of the released chain conveyor **59–159** for transport forward beneath the tape applying mechanism carried by the lowered beam A to the discharge end **8** of the machine. The retraction of stop gate **225** effected this release of the chain conveyor **59–159**. With head switch **149–1** remaining closed the energization of relay coil **3410** is maintained throughout this period to keep its switch **341–3** closed with continuance of the open position of its switch **341–2** so that the carton is carried forward toward discharge under fully applied clutch power.

As was previously indicated when the clamping rails were driven inwardly toward each other to opposite sides of the carton **134** pausing at the flap folding station Y the switch manipulating arm **129** was retracted to hold open the sensing switch **128** (in the bottom parallel circuit of FIG. 16). Thus, although the head switch **149–3** was permitted to close upon lowering of the head down to the open top of the carton at the flap folding station Y the solenoid valve **198** remained de-energized to hold the back flap kicker **161** up in its full line cocked position shown in FIG. 1. When the carton was freed by the retraction of the stop gate **225** and the chain conveyor **59–159** thus was permitted again to travel forward so that its following flight bar **64–1** withdrew the carton therefrom for further forward transport, this partially closed carton soon was carried beyond the retracted switch operating arm **129** to free it and again permit the sensing switch **128** to close. Thus, the back flap kicker valve **198** became energized through closed sensing switch **128** and closed head switch **149–3** to cause the kicker **161** to be swung down and forward sharply, so as to fold forward the upstanding back flap and down upon the partially open top of the forwardly traveling carton for maintenance of the folded conditions of the front and back flaps by forward drag beneath the pressure plate **150**, the horizontal face **146–1** of the upwardly swung front flap folding arm **146** and the horizontal bottom face **173–2** of the downwardly swung kicker **161**, so as to permit the side flaps to be folded thereover by the plows **233** and then tape to be applied by the tape applying mechanism carried by beam A.

It will be seen from FIG. 15 that the front end of trip lug **166–1** carried by conveyor chain **159** is located only a slight distance behind the depending trigger **236** of the far limit switch **235**. Shortly after the partially closed carton **134** was released at the flap folding station Y, by retraction of the stop gate **225** for further transport forward by the now released chain conveyor **59–159** and its flight bar **64–1** abutting the back side of the carton, trip lug **166–1**, carried by the conveyor chain **159**, engages beneath the trigger **236** and trips it up to manipulate the limit switch **235**. This tripping of the limit switch **235** caused its switches **235–1** and **235–2** to open and to be held open while this long tripping lug is traveling forward beneath this switch trigger. As a result, solenoid valve **194** is de-energized by opening of the limit switch **235–1** and the de-energization of the solenoid valve **195** is continued so that their simultaneous de-energization obtains the condition illustrated in FIG. 10, to cause light biasing force to be applied to the inwardly positioned clamping rails **80** and **180** for conversion to guide rails which apply light pressure to opposite sides of the forwardly traveling carton. As is illustrated in FIG. 10, the retraction of the stop gate **225** is maintained.

Before the trailing end of the long tripping lug **166–1** is drawn forward from beneath the limit switch trigger **236** to permit the limit switches **235–1** and **235–2** again to close, the partially closed carton **134** is carried forward beyond the photocell **140** and the light source **141** to permit the beam of light emanating from the latter to impinge upon the former so as to re-excite this photocell. As a result, photocell switch **140–1** is again opened to maintain the de-energization of solenoid valve **194** after the trailing end of the long tripping lug **166–1** is dragged from beneath the limit switch trigger **236** so as to effect reclosure of the limit switches **235–1** and **235–2**. With this opening of the photoswitch **140–1** the companion photoswitch **140–2** recloses the circuit to the Up relay coil **2530**, so as to cause the latter to close the bank of switches **253** of the elevating motor **174** for reversing the operation of the latter to elevate the head **2** back up to its initial position. The front flap folder **146** is permitted ultimately to swing down again to depend for reconditioning the head switch **149**. The attendant reclosing of the head switches **149–2** and **149–4** conditions the circuits of the Down relay coil **2540** and the solenoid coil **195** for ultimate re-energization thereof, and the attendant opening of the head switches **149–1** and **149–3** respectively de-energizes relay coil **3410** and solenoid valve **198**. The de-energizing of relay coil **3410** again permits opening of its switches **341–1** and **341–3** and effects closure of its switch **341–2** to recondition the circuitry of the clutch **67–2** for low power operation. The opening of the head switch **149–3** to cause de-energization of the back flap kicker solenoid valve **198** causes recocking of this kicker from the broken line position shown in FIG. 1 back up to the full line position shown therein.

As the partially closed carton **134** was carried forward by flight bar **64–1** of chain conveyor **59–159** from the flap folding station Y this flight bar dragged up over oblique top edge **216** and web **217** of each of the spring-biased and pivoted clamping shoes **211** temporarily to depress their high forward ends **223** so as to permit free passage of this flight bar, as was explained with reference to FIG. 5. Thereafter, these forward ends **223** of the clamping shoes **211** were permitted to be raised by their biasing springs **222** back up to their efficient carton clamping positions for clamping securely the next oncoming carton **234** at the flap folding station Y.

As the forward travel of the chain conveyor **59–159** drags the trailing end of the long tripping lug **166–1** from beneath the trigger **236** of the far limit switch **235**, switches **235–1** and **235–2** are permitted to reclose so that solenoid valve **195** will be re-energized through closed limit switch **235–1** to obtain the condition illustrated in FIG. 11. Consequently, the guiding rails **80** and **180** are retracted to their carton receptive positions and the stop gate **225** is again raised. With continued drive of the chain conveyor **59–159** ultimately the next short lug **66–2** on the near conveyor chain **59** is dragged to beneath the trigger **136** of the limit switch assembly **135** to open its switch **135–1** and discontinue the energization of relay coil **2560**, and also to close its switch **135–2**.

De-energization of relay coil **2660** is accomplished at the proper time to permit its switch **266–1** to reclose for re-energizing selector entrance gate solenoid valve **197** temporarily, so as to retract momentarily the entrance gate **12** for permitting entry of the next oncoming carton, before the limit switch **235–2** is permitted to reclose by the forward travel of the long tripping lug **166–1** from beneath limit switch trigger **236**. When the head switch **149–1** was closed by lowering of the flap folding head **2** to the open top of the carton **134** at the flap folding station Y, effected by upward swing of the front flap folding arm 146 as it was brought down to folding contact of the upwardly extending front flap, to effect energization of the power shifting relay coil 3410, this head switch also performed another important function. The resulting energization of the relay coil 3410, in effecting the shift from a condition dictating relatively low power energization of the clutch 67–2 to full power energization thereof, closes its switch 34–1, as was previously pointed out. A holding shunt circuit is thus established through temporarily closed head switch 149–1, conductor 101, now closed switch 341–1, conductor 104, normally closed photoswitch 138–2 and relay coil 2660. In the absence of such shunt holding circuit the supply of energy to the relay coil 2660 through its closed switch 266–2 and closed limit switch 235–2 would be discontinued when the latter was opened by ultimate chain conveyor travel. As was pointed out this occurs shortly after the release of the powered chain conveyor section 59–159 which is effected by retraction of the stop gate 225 at the flap folding station Y to permit the partially closed carton 134 at this flap folding station to be moved forward by the urging of the flight bar 64–1 pressing against its back end, as will be understood from FIG. 15. The closing of switch 266–1, attendant upon such early de-energization of relay coil 2660, would cause re-energization of the entrance gate solenoid valve 197 to effect retraction of this gate for permitting entrance of the succeeding carton 234 while the preceding carton 134 was being withdrawn from the flap folding station Y and before the solenoid valve 195 could be re-energized by reclosure of head switch 149–4 and limit switch 235–1 to raise the stop gate 225 at the flap folding station into the path of this next oncoming carton. With continued energization of the relay coil 2660 assured by such shunt holding circuit upon the closure of the head switch 149–1 the continued de-energization of the entrance gate solenoid valve 197 is assured until such time as the head switch 149–4 can be reclosed as switch 149–1 is opened, which may be effected by drop of the front flap folding arm 146 in the absence of means to hold switches 149–1 and 149–3 closed and switches 149–2 and 149–4 open for a longer period of time, and the limit switches 235–1 and 235–2 can be reclosed by drag of the long tripping lug (either 266–1 or 266–2 as the case may be) from beneath trigger 236 of limit switch assembly 235, so as to raise the stop gate 225 into the path of the next oncoming carton. This continued energization of the relay coil 2660 is maintained by the maintenance of the closure of the head switch 149–1 until the closing operations performed on the advancing carton 134 are completed, and is then opened before the limit switch 235–2 recloses so that the latter will not continue energization of this relay coil to maintain indefinitely the open position of switch 266–1 and attendant elevation of the entrance gate 12 to prevent entrance of a succeeding carton. When the limit switch 235–2 then recloses very shortly after opening of the head switch 149–1 the simultaneous closure of the limit switch 235–1 effects the properly timed energization of the Up relay coil 2530 to raise the head 2, and the reclosure of the head switch 149–4 simultaneously with the opening of the head switch 149–1 permits this closure of limit switch 235–1 to energize the rail traverse and stop gate lifting solenoid valve 195 for retracting the rails 80 and 180 to their carton-receptive positions and to bar the path of the next oncoming carton at the flap folding station Y.

The circuitry of the machine is thus reconditioned for recycling with the next supplied carton 234 which has been held waiting at the position Z by the raised entrance gate 12 for succeeding entry into the machine until the closing operations performed on carton 134 are completed and it is ready to be cleared from the machine. The drive of the chain conveyor 59–159 section was continued until it was brought to a stop by drag of its tripping lug 66–2 beneath limit switch trigger 136. This reconditioned circuitry is that illustrated in FIG. 16 except that the manual switch 259 remains closed to maintain energization of relay coil 2660 for holding its switches 262–1, 262–3 and 262–5 closed and its switches 262–2 and 262–4 open, and relay coil 2520 remains energized to hold its main motor switches 252 and holding switch 252–4 closed to keep the machine powered and the conveyor belt section 27 running. With entry of the next carton over the momentarily retracted gate 12 the above operations are repeated.

In order to assure the above sequence and timing of the operations of the parts of the machine with respect to a single carton substantially through the machine before the next supplied carton is permitted entry to the conveyor means thereof means are provided to maintain the closure of head switches 149–1 and 149–3 and the open condition of head switches 149–2 and 149–4 until this single carton is transported by the chain conveyor 59–159 from the station Y to a point forward of the tape applying mechanism (when provided), such as that supported on head beam A. It may be preferred to employ for this purpose that which has been provided in the embodiment of the machine being used commercially, described hereinafter.

This function of maintaining the head switches 149–1 and 149–3 closed and the head switches 149–2 and 149–4 open until any certain carton, after being closed by flap folding means carried by elevating head 2, has cleared the tape applying mechanism carried by head beam A (if provided) by means other than such holding switch means. For example, mechanical latch means may be provided to hold during this period the front flap folding arm 146 up in its horizontal position shown in broken lines in FIG. 1. Such mechanical latch means may be a variation of that shown in FIGS. 5, 6 and 7 of our parent application Ser. No. 219,212, in a form automatically to engage and hold the flap folding arm 146 when swung up to its horizontal position as it infolds the front flap and then to release this arm after the closed carton has been transported forward toward the machine discharge end beyond the head supported equipment, such as the tape applying mechanism. For this purpose the depending head post 144 may support an electrical solenoid having a winding in which is reciprocatively mounted a laterally-extending plunger core carrying a latch head extending toward strike means on flap folding arm 146 and spring-biased forward to latched position. Such strike means may be in the form of a latch plate carried by the flap folding arm 146 beneath an opposed edge of which the latch head of the plunger core will engage when the solenoid is deenergized and this core is thrust outwardly by its biasing spring means.

It will be seen from FIG. 17 that the front flap folding arm 146 may, for this purpose, be bifurcated or in the form of a fork between the furcation of which is located the lateral and forwardly-extending plate 150 supported upon a body 150–1 carried by the lower end of depending head post 144. The body 150–1 is equipped with a solenoid having a winding 152 in which is reciprocatively mounted a plunger core having a latch head 153 and spring biased forward to latch position by a compression spring 155. One of the furcations of the front flap folding arm structure 146 carries a latch plate 154 beneath the inside edge of which the latch head 153 will engage when the solenoid plunger is biased outwardly by its compression spring 155. The winding 152 of this plunger solenoid has one end connected to the neutral line N of the FIG. 16 circuitry by conductor 347 and its other end connected by conductor 346 through a normally open switch 348 to supply line L3 of that circuitry. Pivoted contact arm 349 of this switch is provided with an upstanding trigger 350 to be located in the path of an oncoming closed carton after it has been delivered from between the terminal forward ends of the guide rails 80 and 180 and from beneath the head beam A which carries the top tape applying mechanism, such as, for example, in the near vicinity of the discharge end of the machine. Switch **348** may thus be supported on the underside of one of carton glide plates with its carton-engaging trigger **350** extending up through a clearance hole **351** in this plate indicated in FIG. 3 as to location by way of example. When the closed oncoming carton, in its approach to the discharge end of the machine, strikes the switch trigger **350** to close the switch **348** the solenoid winding **152** will be energized to retract the plunger latch head **153** from beneath the latch plate **154**, so as to free the horizontal front flap folding arm structure **146** and permit it to swing down from its broken line position to its full line position shown in FIG. 1. The resulting manipulation of the head switch trigger **148** permits opening of head switch **149–1** with simultaneous closure of head switch **149–4** respectively to de-energize relay coil **3410** for shifting the engagement of clutch **67–2** from high power to low power and to permit re-energization of the rail traverse and carton stop solenoid valve **195**. This opening of the head switch **149–1** is to occur prior to reclosure of limit switch **235–2** so as to de-energize relay coil **2660** for allowing closure of its switch **266–1** to effect re-energization of selector entrance gate operating solenoid valve **197** upon the following closure of this limit switch.

In the event that the next supplied or succeeding carton, such as that indicated at **234** in FIG. 14, may not be in position Z ready to be delivered past the entrance gate **12** at the time the chain conveyor **59–159** is stopped by opening of limit switch **135–1** as the next chain lug (such as **66–2**) trips limit switch **135** to hold the latter in tripped position, so as to hold the next oncoming chain conveyor flight bar (such as **64–2**) back in the required position relative to this next entering carton, i.e., behind the latter, as such carton is delivered to its initially critical position upon the rear end of the constantly driven conveyor belt section **27** between the exciting light source **139** and photocell **138** to de-excite the latter, the de-energization of relay coil **2560** (caused by opening of limit switch **135–1**) is continued. As a result, clutch switch **256–2** remains open to continue the de-energization of the winding of clutch **67–2** and brake switch **256–1** remains closed for continued energization of the winding of brake **67–1** to maintain application of braking power thereby to the chain conveyor **59–159** so as to hold the latter stopped until this succeeding carton is delivered forward to such initially critical position for forward belt transport toward the flap folding station Y and the separate carton stopping means in the form of the lifted stop gate **225**. When the next succeeding carton is delivered after such delay the chain conveyor **59–159** will be started and driven by release of the brake **67–1** and light engagement of clutch **67–2** under low voltage, as previously explained, to coast its oncoming flight bar (**64–1** or **64–2** as the case may be) up to the rear end of this carton as the latter is stopped at the flap folding station Y by the raised stop gate **225** in the manner previously described.

It will be noted that the shifting of the drive of the chain conveyor section **59–159** to relatively low power action follows an interval of pause or stop of this conveyor section dictated by trip of limit switch **135** by either of the chain lugs **66–1** and **66–2**. Also, it is to be noted that this shifting is dictated by the optical sensing control comprising the photocell **138** and its exciting light source **139** just beyond the entrance gate **12** and by its photoswitch **138–1** with its other switch **138–2** dictating delay of effective control thereby until each entering carton has cleared such optical sensing device by forward chain conveyor transport. The drive of the chain conveyor section under the conditions dictated by the relatively low power action are then maintained by the closure of the shunt limit switch **135–1** when the conveyor tripping lug (either **66–1** or **66–2**) is dragged from beneath limit switch trigger **136** upon release of the partially closed carton at the flap folding station Y by retraction of the stop gate **225**. Further, it has been shown that the shift from relatively low power action to relatively high power action takes place by closure of the head switch **149–1** upon folding down the carton front flap to energize relay coil **3410** and cause it to close the full power switch **341–3** with simultaneous opening of the low power switch **341–2** as the stop gate is retracted by simultaneous opening of head switch **149–4**. This full power drive of the chain conveyor section **59–159** is continued at least until the closed carton is transported forward thereby from beneath the lowered flap folding and tape applying head **2** for discharge from the machine. The second optical sensing means, comprising photocell **140**, its exciting light source **141** and photoswitches **140–1** and **140–2** at the flap folding station, has a bearing on the effective actuation of the head switch **149–1** and thus through the latter the shifting of the low power action to the high power action. Only when the Down relay coil **2540** is energized is lowering of the head **2** dictated and this energization is effected only upon closure of the photoswitch **140–1** upon de-excitation of the photocell **140** by cutting off its exciting beam with the presence of a carton stopped at the flap folding station Y. The attendant energization of rail traverse solenoid valve **194** while previously energized rail traverse solenoid valve **195** remains energized effects drive of the clamping rails **80** and **180** inwardly to their carton clamping positions and they are to remain in these relatively inward positions to serve as guides until this carton is discharged from the machine. Thus the limit switch **235–1** is tripped open by long tripping lug **166–1** carried by conveyor chain **159** while the partially closed carton is being withdrawn from the flap folding station Y and then held open by this traveling long tripping lug to keep the Up relay coil **2530** de-energized, and to de-energize both rail traverse valves **194** and **195** for conversion of the clamping rails **80** and **180** to lightly biased guides and keep them in this condition until closed carton discharge before re-energizing solenoid valve **195** by reclosure of limit switch **235–1** to effect retraction of these guiding rails. Since the driving action of the chain conveyor section **59–159** is shifted back to a condition for attaining the low power driving action upon freeing of the front flap folding arm **146** and its resulting swing down to its depending full line position of FIG. 1 this is obtained by the time the chain **59** of the driven chain conveyor section carries its next tripping lug **66–2** to beneath limit switch trigger **136** to trip open holding switch **135–1** of limit switch **135** for repeat operation with the next oncoming carton.

While the sensing controls at the entrance gate **12** and flap folding station Y are of the optical type, as embodied in the photocell systems **1380** and **1400**, it is to be understood that either or both may be of a physical type, such as is sensing switch **128** and its operating feeling arm **129** to effect response by contact with carton structure.

In order to make possible improved operation of the box closing machine described above in connection with the embodiment shown in FIGS. 1 to 16 incl. the machine has been improved as to pneumatic and electrical circuitry so as to permit unusual speeds of box closing production and a greater efficiency and better assurance of attainment of desired operational functions. The electrical circuitry of the present commercial box closing machine employs that of the upper half of FIG. 16 down to the first parallel circuit in which the Random switch **259** is embodied. The parallel circuits of the improved electrical circuitry, including the top one in which the switch **259** is embodied are schematically illustrated in FIG. 18. A description of the parts embodied in these parallel circuits, and the functions and the timing relations of the latter will appear hereinafter in connection with the description of a typical operation of such commercial embodiment.

As to the schematic arrangement of the pneumatic system shown in FIGS. 9, 10 and 11 for embodiment in the present box closing machine some minor flow connection changes were made. These changes consisted of disconnecting the low pressure conduit **320** from the orifice **314** of solenoid valve **194** and connecting it over to the orifice **316** thereof; and a reversal of the connections of the rail driving cylinder **301** to this solenoid valve so that the cylinder back end **302** has its input orifice **324** connected to the valve output orifice **313** and its input orifice **325** of its head end **304** connected to valve output orifice **312**. Also the flow paths of solenoid valve **194** shown in the upper half of FIG. 9 will be those of this valve when it is de-energized rather than energized. Additionally, the location of the relatively high pressure regulator **318** is removed from the supply line **317** and inserted in the interconnecting conduit **319** at the point **318***a*, so as to permit the full pressure of the source **306** to be supplied to the stop gate operating cylinder **227** while the relatively high pressure air through the regulator **318**, such as forty-five pounds per square inch (45 lbs./sq. in.), is supplied through the solenoid valve **194** to the rail operating cylinder **301**.

If the pressurized air of source **306** is then supplied to this changed pneumatic system before power is supplied to the electrical circuitry including the upper half of FIG. 16 and the parallel circuits of FIG. 18 both solenoid valves **194** and **195** will be de-energized. Thus the full pressure of the source **306** will be supplied through conduit **317** to inlet orifice **310** of de-energized solenoid valve **195**, thence through internal duct **335** to outlet orifice **307** of this valve and, by way of conduit **333**, fed to the front end **231** of the stop gate operating cylinder **227** to retract its piston **229** for lowering or retracting the stop gate **225** out of the carton path. The back end **228** of the stop gate operating cylinder **227** will be connected by conduit **332** and a lower portion of conduit **319** to orifice **308** of de-energized solenoid valve **195** and thence by way of cross-connection **331** to venting port **311**. The upper portion of conduit **319**, in which is inserted the relatively high pressure regulator **318**, has a common connection with conduit **332** and orifice **308** of solenoid valve **195** and is connected to input orifice **315** of de-energized solenoid valve **194**. By virtue of the de-energization of solenoid valve **194** input orifice **315** thereof is cross-connected by internal duct **327** to output orifice **312**, which, in turn, is connected to input orifice **325** of the rail driving cylinder **301**. The low pressure conduit **320**, in which is inserted the relatively low pressure regulator **321**, which may be set to feed pressurized air at five to ten pounds per square inch (5–10 lbs./sq. in.), is connected to orifice **316** of de-energized solenoid valve **194** and, by way of internal duct **328**, output orifice **313** and conduit **322** is connected to the input orifice **324** of the end **302** of rail driving cylinder **301**. As a consequence, air at the pressure of the source **306** is supplied to the front end of the stop gate operating cylinder **227** to retract the piston **229** therein and lower this gate, the back end of this cylinder being vented through orifice **311**. Since there will be no flow through de-energized solenoid valve **194** during such operation solenoid valve **195** may be termed the "stop paddle" solenoid valve, and the other solenoid valve **194** may be termed the "rail operating" solenoid valve.

Upon initial closure of the Random switch **259** and the "Run" push button switch **263** the relay coil **2520** is energized for closing the holding switch **252–4**. Also the relay coil **2620** is energized to cause it to effect closure of its gang of switches **262–1** (in the upper portion of the FIG. 16 circuitry), **262–2**, **262–3** and **262–4**, as will be seen from FIG. 18. As a result, a circuit is established for energizing stop paddle solenoid valve **195** which includes in series therewith closed switches **265**, **252–4**, **262–4**, **296–2** and **235–1**. The rail operating solenoid valve **194** is connected through this series of switches, closed conveyor switch **435–1** and open photocell switch **140–1** across the same energizing circuit. While stop paddle solenoid valve **195** is thus energized when power is supplied to the electrical circuitry the rail operating solenoid valve **194** remains de-energized due to the open condition of the photocell switch **140–1**.

While the relocation of the relatively high pressure solenoid valve **318** to the point **318***a* is not essential it is desired since the pressurized air source **306** can be at a much higher pressure than that required for supply to the rail operating cylinder **301** and thus, if the stop gate **225** is in the form of the pivoted stop paddle illustrated in FIGS. 1, 7 and 8, the air at the higher pressure of the source may be desirably fed to the stop gate operating cylinder **227** in order to assure that it will not be retracted by a heavily loaded oncoming carton as it is delivered to the flap folding station Y. The switch **435–1** is embodied in a trip switch unit of the type illustrated at **235** in FIGS. 14 and 15 and will be located on the far side ledge **11** for trip operation by the long chain lugs **166–1** and **166–2** with its location being in the vicinity of the point **435** indicated in FIG. 3, i.e., near the discharge end **8** of the machine.

With the stop paddle solenoid valve **195** initially energized and the rail operating solenoid valve **194** initially de-energized the high pressure air of the source **306** will be supplied through conduit **317**, inlet orifice **310**, internal duct **326** and outlet orifice **308** of solenoid valve **195**, and conduit connetcions **319** and **332** to the back end of stop gate operating cylinder **227**, so as to force the piston **229** therein forward and lift this stop gate to the Up position of FIG. 9. The front end **231** of this cylinder **227** is vented by way of conduit **333**, orifice **307**, internal duct **334** and orifice **309** to atmosphere. At the same time, the relatively high pressure, such as at forty-five pounds per square inch (45 lbs./sq. in.), is supplied to the inlet orifice **315** of the rail operating solenoid valve **194**, thence through its internal duct **327**, orifice **312** and conduit **323** to the input orifice **325** of rail driving cylinder **301**, so as to supply the pressurized air at forty-five pounds per square inch (45 lbs./sq. in.) ahead of the piston **88** in the latter for holding the widely separated rails **80** and **180** apart in their carton-receptive positions, so as to permit an oncoming carton fed over the retracted entrance gate **12** to enter therebetween. The force which biases these separated clamping rails **80** and **180** apart is the resultant of the relatively high pressure forty-five pounds per square inch (45 lbs./sq. in.) and the opposed relatively low pressure, such as five pounds per square inch (5 lbs./sq. in.), since the latter is supplied simultaneously through conduit **320** to the input orifice **316** of the rail operating solenoid valve **194**, and thence through its internal duct **328**, output orifice **313**, conduit **322**, and cylinder input orifice **324** to the opposite side of the piston **88**.

Thereafter, when the rail operating solenoid valve **194** is energized, in the maner explained hereinafter, so that both solenoid valves **194** and **195** are simultaneously energized, the stop gate **225** will remain biased upwardly in its carton intercepting position. The relatively high pressure air at forty-five pounds per square inch (45 lbs./sq. in.) will be supplied through energized solenoid valve **195** to input orifice **315** of now energized solenoid valve **194**, and thence through internal duct **330** and output orifice **313** of the latter to conduit **322** for supply through cylinder input orifice **324** behind the piston **88** to cause it to be driven forward for driving the clamping rails **80** and **180** inward toward each other to opposite sides of the carton at the flap folding station Y. Simultaneously the opposite side of the piston **88** is vented through cylinder orifice **325**, conduit **323**, rail operating valve orifice **312**, internal duct **329** of the latter and out through its venting orifice **314**. Thus the carton which is supplied by the constantly driven initial belt section **27** of the conveyor means to abutment of the lifted stop gate **225** for stop at the flap folding station Y, there to cut off the beam of light emanating from the source **141** that otherwise impinges upon the photocell **140** to cause closure of the photoswitch **140–1**, is there clamped between the inwardly driven clamping rails **80** and **180** which are held firmly abutted against its opposite sides.

Ultimately, both solenoid valves **195** and **194** will then be de-energized by opening of the closed switch **296–2** (after photoswitch **140–1** is closed) so as to reverse the connections through these valves. As a consequence, the full pressure of the air source **306** is supplied by conduit **317** through input orifice **310** of solenoid valve **195**, its internal duct **335** and output orifice **307**, and thence by way of conduit **333** to the front end **231** of stop gate operating cylinder **227**, so as to retract the piston **229** in the latter and lower the gate **225**. At this same time the back end of cylinder **227** is vented by conduit **332**, the lower portion of conduit **319**, thence through orifice **308** of solenoid valve **195**, its internal duct **331** and orifice **311** to atmosphere. Simultaneously, the relatively low pressure air, such as at five pounds per square inch (5 lbs./sq. in.), is supplied by conduit **320** through orifice **316** of solenoid valve **194**, its internal duct **328** and orifice **313**, and thence through conduit **322** to input orifice **324** of the rail operating cylinder **301**, so as to bias the inwardly positioned clamping rails **80** and **180** lightly against opposite sides of the carton as it is released at the flap folding station by retraction of the stop gate **225**. This light biasing of the rails **80** and **180** in their inward positions converts them to guiding rails which, while lightly biasing the sides of the partly closed carton, permit slide of the latter therebetween to the tape applying mechanism (if employed) and toward the delivery end of the machine.

While the carton is traveling forward from the flap folding station Y to the delivery end of the machine chain conveyor operated switch **235–1**, which is biased toward closed position, is opened before the opened switch **296–2** is closed again, so as to maintain temporarily the deenergized conditions of both solenoid valves **194** and **195**. Thereafter switch **296–2** is closed as the closed carton clears the flap folding station Y while chain conveyor operated switch **235–1** is held open and chain conveyor operated switch **435–1** is opened before closure of photoswitch **140–1** by arrival of the next carton at the flap folding station so that upon reclosure of switch **235–1** the solenoid valve **195** will be re-energized while the circuit of solenoid valve **194** is held open so as to maintain the de-energization of solenoid valve **194**. This latter conditioning of the two solenoid valves **195** and **194** is described above as effecting lift of the stop gate **225** to its carton-barring position, so as to check the travel of the next oncoming carton at the flap folding station while the clamping rails are urged out to and held in their open retracted positions with a resultant force of, for example, forty pounds per square inch (40 lbs./sq. in.).

While the top half portion of FIG. 16 when combined with the parallel circuitry of FIG. 18, as proposed above, and the showing in FIG. 1 teach for successively lowering and elevating of the flap folding head **2** by electrical means, including reversible motor **174** and its reversing switch equipments **253** and **254** under the control of relays **2530** and **2540**, some embodiments of the present commercial machine are equipped with a pneumatic elevating system in lieu of that electrical equipment in which solenoid valves are substituted for relays **2530** and **2540**. Such improved pneumatic elevating mechanism permits omission of the lowering or Down limit switch **186–1**, but the raising of Up elevating limit switch **186–2** is retained for two purposes. One purpose is to permit vertical manual adjustment of the top stop collar **193** which dictates trip of the switch unit **186** to manipulate switches **186–1** and **186–2** thereof so as to adapt the height of elevation of the flap folding head **2** to the maximum size of the particular group of cartons to be fed through the machine in a particular period, so as to avoid unnecessary excessive elevation of the head and thus speed carton handling. The other purpose is to provide a timed control for the raising or Up operation of the elevating head **2**, this timed control being effected by the retention of the elevating switch **186–2** which is biased toward closed position and is tripped to and held in open position when the switch trigger **187** engages the top stop **193**. Upon lowering of the flap folding head **2** elevating limit switch **186–2** is permitted to close as the switch trigger **187** is lowered away from the stop **193** so as to condition the circuit of the Up relay coil **2530** when the photoswitch **140–2** is closed for energizing this Up relay coil upon closure of its current supplying circuit through closed switches **435–1**, **235–1** and **296–2**.

Operation of the embodiment of the machine when equipped with the altered pneumatic circuit and the electrical circuitry of FIG. 18

As will be seen from FIG. 18 the first parallel circuit thereof, extending between power supply line "L3" and the ground line N, consists of a conductor **355** in which is inserted the Uniform-Random switch **259**, for closure to handle a group of random size cartons, and relay coil **2620**. The second parallel circuit **356** has inserted therein chain conveyor operated switch **235–2** which is biased to closed position, closed relay switch **266–1** and the entrance gate-operating solenoid valve **197**. The third parallel circuit **357** extends from a point of connection to circuit **356** between switches **235–2** and **266–1** to the neutral line N and has inserted therein the initially open relay switches **262–2** and **266–2**, and relay coil **2660**. Parallel circuit **358** constitutes the machine running circuit having therein a closed push button STOP switch in series with a normally open push button RUN switch **263**, to be pushed closed for initiating operation of the machine, and relay coil **2520**. Parallel circuit **359** is connected to circuit **358** between the STOP and RUN switches and the neutral line "N," having therein in series an overload switch **265**, a holding switch **252–4**, normally closed sensing switch **128**, normally open head switch **149–3**, and back flap kicker solenoid valve **198**. Circuits **358** and **359** are cross-connected from a point beyond switch **263** to a point between switches **252–4** and **128**. A loop circuit **360** has its end legs **361** and **363** connected to the neutral line "N," with leg **361** including open chain conveyor operated switch **135–1** which is biased toward closed position and relay coil **2560**. A cross-connection is effected between circuit **357** and loop circuit leg **361** by a conductor **362** having in series therein normally open photoswitch **138–1**, normallly closed photoswitch **138–2**, and closed chain conveyor operated switch **135–4** which is biased toward open position. A bridge **366** is connected across between circuit **357** from a point beyond relay switch **266–2** and conductor **362** at a point between the photocell switches **138–1** and **138–2**. The other leg **363** of the loop circuit **360** has in series therein open head switch **149–1** which is biased toward closure, and relay coil **2960**. An intermediate leg **364** of loop circuit **360** includes normally open relay switch **296–1** and relay coil **3410**. A bridge conductor **365** is shunted around relay switch **296–1** and includes in series open conveyor operated switch **135–3**, which is biased toward closed position, and normally open relay switch **341–1**. A bridge **367** connects the loop leg **363** to the circuit **359** respectively ahead of the head switch **149–1** in the former and sensing switch **128** in the latter, and includes a normally open relay switch **262–3**. Circuit **368** is connected to circuit **359** between switches **252–4** and **128** and neutral line N, and includes therein in series open relay switch **262–4**, closed relay switch **296–2**, closed chain conveyor operated switch **235–1**, which is biased toward closed position, and stop gate operating solenoid valve **195**. Circuit **370** is connected by conductor **369** to circuit **368** at a point beyond switch **235–1** through normally closed chain conveyor operated switch **435–1**, which is biased to closed position, and includes in series therein open photoswitch **140–1**, closed head switch **149–2** which is biased toward open position, closed bottom elevating limit switch **186–1** which is biased to closed position, and Down relay coil **2540**. Switches **149–2**, **186–1** and relay coil **2540** in circuit **370** are shunted by a bridging conductor **371** which has therein rail operating solenoid valve **194**. Parallel circuit **372** is connected through open switches **275** and **273**, open top elevating limit switch **186–2** which is biased toward closure, and "Up" relay coil **2530**, to neutral line N. A bridge **373** is connected between conductor **369** ahead of photoswitch **140–1** and circuit **372** at a point between switches **273** and **186–2**, and includes closed photoswitch **140–2** and closed switch **272** in series.

Conveyor chain operated switches **235–1** and **235–2** are ganged together for simultaneous operation. Relay switches **262–2**, **262–3** and **262–4** are ganged together and to switch **262–1** which energizes the photocell units **1380** and **1400** of the top portion of FIG. 16 for simultaneous operation. Relay switches **266–1** and **266–2** are ganged together similarly. Photoswitches **138–1** and **138–2** are ganged together for like purpose. Relay switches **296–1** and **296–2** are ganged together similarly. Conveyor chain operated switches **135–1**, **135–3** and **135–4** are ganged together for simultaneous operation. Relay switch **341–1** is ganged together with low power relay switch **341–2** and high power relay switch **241–3** in the top portion of FIG. 16. Head switches **149–1**, **149–2** and **149–3** are ganged together for simultaneous operation. Photoswitches **140–1** and **140–2** are ganged together for like purpose. Switches **272**, **273** and **275** are provided for manual operation to allow ready release of a carton in the machine which is jammed or damaged. The gang of switches **262** are provided to be left open for Uniform carton operation.

Assume the embodiment of the machine illustrated in FIG. 18 is to be readied for operation by providing a group of successive cartons on the feed conveyor **9** (FIG. 1) and that these are random sizes. Switch **259** will be closed to Random position so as to energize relay coil **2620** which will then close the gang of switches **262** to supply current through switch **262–2** to circuit **357**, close the bridge **367** at switch **262–3** and connect circuit **368** to circuit **359** through the switch **262–4**. Momentary closure of push button "RUN" switch **263** will energize relay coil **2520** to close its holding switch **252–4**, so as to start and maintain the running of the main drive motor **51** (see top portion of FIG. 16), continuously to run initial conveyor section endless belt **27**. Upon supply of power to the FIG. 18 electrical circuitry, entrance gate solenoid valve **197** became energized through closed chain conveyor operated switch **235–2** and closed relay switch **266–1**.

Upon such energization of the solenoid valve **197** entrance gate **12** was retracted to permit entrance of the leading carton thereacross to the running endless belt **27**. As the entering carton passes the photocell **138** it cuts off the beam of light impinging thereon which emanated from light source **139**, to close photoswitch **138–1** and open photoswitch **138–2**. The closure of photoswitch **138–1** energizes relay coil **2660** to close its holding switch **266–2** and open its switch **266–1**, so as to de-energize the gate retracting solenoid valve **197** at the latter, thereby permitting the entrance gate to rise beneath the entering carton and providing a barring obstruction for the next oncoming carton. Since the relay coil **2560** remains de-energized by the opening of photoswitch **138–2** the brake coil **67–1** (top portion of FIG. 16) remains energized to continue to hold the second conveyor section, consisting of chain conveyor **59–159**, undriven. Relay coils **3410** and **2960** remain de-energized (since switches **296–1** and **149–1** are open), while relay coil **2520** remains energized to continue to hold its holding switch **252–4** closed. Back flap kicker solenoid valve **198** remains de-energized since head switch **149–3** is still open and it thus holds the kicker **161** up in the cocked position illustrated in FIG. 1.

Since with the closure of holding switch **252–4** current was supplied through the series of closed switches **262–4**, **262–2** and **235–1** to the stop gate solenoid valve **195** to energize it while rail operating solenoid valve **194** remains de-energized because photoswitch **140–1** is still open the stop paddle **225** is raised up into the path of the oncoming carton at the flap folding station Y, as was explained above in connection with the description of the conjoint operation of the solenoid valves **194** and **195**. Since the clamping rails **80** and **180** were initially spread apart to their fully separated relation they received therebetween the oncoming carton carried by the continuously driven endless belt **27** to deliver it to the flap folding station Y for abutment against the raised stop gate **225**.

As the carton is delivered to the flap folding station Y it interrupts the beam of light emanating from the light source at **141** to discontinue impingement thereof upon photocell **140**, so as to close the photoswitch **140–1** and open the photoswitch **140–2**. The closure of photoswitch **140–1** supplies current to the Down relay coil **2540** so as to energize it and cause the lowering of the flap folding head **2**. As was previously explained, the lowering of the flap folding head **2** causes the front flap folding arm **146** to fold the upstanding front flap down and back upon the open top of the carton, thereby freeing the head switch assembly **149** so as to permit closure of head switches **149–1** and **149–3**, and opening of the head switch **149–2** to break the circuit of relay coil **2540** and stop the lowering of the flap folding head **2**. The lowering of the head **2** freed its top limit switch **186–2** for closure to ready the energizing circuit of Up relay coil **2530**. As the carton traveled forward to the flap folding station Y its far side engaged and retracted the sensing switch operating arm **129** to open sensing switch **128** so that the de-energized condition of the kicker solenoid valve **198** would be maintained upon such closure of the head switch **149–3**, thereby continuing the cocked condition of back flap folding kicker **161**.

Since rail operating solenoid valve **195** remains energized until relay switch **296–2** is opened and stop paddle solenoid valve **194** is energized upon closing of the photoswitch **140–1** the simultaneous energization thereof maintains the stop paddle **225** up to hold the carton **134** at the flap folding station while the clamping rails **80** and **180** are driven inwardly toward each other by the relatively high pressure of forty-five pounds per square inch (45 lbs./sq. in.) to abut opposite sides of the carton and securely clamp it in the manner described above before the head **2** reaches the bottom of its downward travel to close headswitch **149–1**.

Also, as the carton passed beyond photocell **138** it permitted the latter again to be energized by the beam of light emanating from the light source **139** so as again to close photoswitch **138–1** and open photoswitch **138–2**. Thus relay coil **2560** becomes energized through closed switches **235–2**, **252–2**, **266–2**, **138–2** and **135–4**. This action releases the brake **67–1** and engages the clutch **67–2** (see top portion of FIG. 16) so as to drive the second conveyor section or chain conveyor **59–159** under low power operating condition so as to coast up behind the carton stopped at the flap folding station Y the following transverse conveyor flight **64–1** (see FIGS. 14 and 15). With this low power drive of the chain conveyor **59–159** its lug **66–1** is dragged from beneath trigger **136** of chain conveyor operated switch **135** (see FIG. 1) simultaneously to open switch **135–4** and close switches **135–1** and **135–3**. The relay coil **2560** remains energized despite the opening of the switch **135–4** since switch **135–1** is simultaneously closed to complete an energizing circuit through closed switches **265**, **252–4**, **262–3**, bridge **367** and the head portion of circuit loop **360**.

There is thus a tendency to continue low power drive of the chain conveyor **59–159**, but the abutment of its transverse flight **64–1** to the trailing end of the carton **134** held stopped at the flap folding station Y by the raised stop paddle **225**, resists by such abutment this low power drive tendency with consequent stoppage of the chain conveyor. Consequently, the transverse conveyor flight **64–1** remains snugly against the trailing end of the carton **134** while the clutch **67–2** is slipping on low power drive, so as to permit the chain conveyor immediately to pick up this carton and carry it forward on through the machine to discharge as soon as the stop paddle **225** is retracted from in front of this carton. It will also be noted from FIG. 15 that when the low power drive of the chain conveyor **59–159** is stopped in this manner the leading end of long tripping lug **266–1** is located short of the trigger **236** of chain conveyor operated switch **235**. Such long lugs **166–1** and **166–2** on the far side chain of this conveyor are to be varied in length with respect to the dimensions of the cartons being handled. For example, if the machine is to accept a group of cartons the maximum length (from front to back ends) of which is twenty inches (20″) the leading end of the long lug **266–1** will terminate approximately at the point **353**. And if the maximum length of the cartons is thirty-six inches (36″) the leading end of this long lug will terminate approximately at the point **354** (see FIG. 15). These adjustments of the lengths of the long lugs **166–1** and **166–2** are effected readily at the time the machine is being set up to handle any particular group of cartons, due to a sectioned character of such lug assemblies and ease with which each lug section can be slipped off of chain conveyor **159**.

The ultimate closure of head switch **149–1** as the lowering flap folding head **2** is brought down upon the top of the stopped carton **134**, resulting from the upward swing of front flap folding arm **146** to free switch assembly **149**, effects energization of relay coil **2960** to close its switch **296–1** and open its switch **296–2**. Thus solenoid valves **194** and **195** are simultaneously de-energized so as to bias the piston **88** in the rail operating cylinder **301** with relatively low pressure, such as five pounds per square inch (5 lbs./sq. in.), thereby converting the clamping rails to guiding rails with light biasing thereof against opposite sides of the carton to permit the latter to glide forward therebetween upon release from the flap folding station **225**. Simultaneously, the de-energization of solenoid valve **195** causes retraction of the stop paddle **225** from in front of the carton **134** to permit the chain conveyor **59–159** to pick it up instantly and transport it forward. The closure of relay switch **296–1** causes energization of the relay coil **3410** to close its holding switch **341–1** and to close the high power switch **341–3** and open the low power switch **341–2** of the brake-clutch system **256** (see the top portion of FIG. 16). The chain conveyor **59–159** is thus driven under full or high power to carry the released carton **134** forward beneath the lowered head **2**, and the tape applying mechanism if used, to the front discharge end of the machine. As the carton is carried forward its trailing end drags past the sensing switch operating arm **129** to free it and thus permit closure of the sensing switch **128** in properly timed relation with respect to the forwardly traveling upstanding carton back flap and operation of the cocked back flap kicker **161**. Closure of the sensing switch **128** energizes kicker solenoid valve **198** to cause the kicker **161** to strike down against the back side of the upstanding back flap and fold it forward upon the open top of the forwardly moving carton.

As the carton **134** leaves the flap folding station Y under full power drive of chain conveyor **59–159** it discontinues interception of the beam of light emanating from the light source **141**, thereby permitting the light beam again to impinge upon the photocell **140**, so that the latter effects reopening of the photoswitch **140–1** and circuit-readying reclosing of the photoswitch **140–2**. However, Up relay coil **2530** remains de-energized for a time since conveyor operated switch **235–1** in its energizing circuit is opened and continues to be held open by conveyor long lug **166–1** until the latter is dragged from beneath trigger **236** of switch unit **235**, this circuit being maintained open for a time thereafter by switch **435**. It will be made to appear later that before chain conveyor operated switch **235–1** is permitted to reclose the switch **435–1** is opened by the same long lug **166–1** and not until the latter clears the trigger of switch unit **435** will the Up relay coil **2530** be energized to raise the flap folding head **2**.

With forward travel of the chain conveyor **59–159** under full power to withdraw closed carton **134** from the flap folding station Y the leading end of the long tripping lug **166–1** is carried to beneath the operating trigger **236** of switch **235** to open switches **235–1** and **235–2**. The opening of the energizing circuit of the Up relay coil **2530** at switch **235–1** before relay switch **296–2** recloses causes the head to remain down in its lowered position until the trailing end of the closed carton is brought forward to beneath the center of the advance pair of tape wipe-on arms C (FIG. 1). In this particular system it is not necessary to hold the entrance gate **12** up in its carton barring position to delay the entrance of the next following carton until the preceding closed carton is discharged from the machine, and thus the operation of the machine can be speeded up for efficient rapid production. An ultimate reclosing of the conveyor chain operated switch **235–2** effects re-energization of the entrance gate retracting solenoid valve **197** to permit the next carton to enter thereover due to the fact that the switch **266–1** was reclosed upon de-energization of the relay coil **2660** with the opening of the chain conveyor operated switch **235–2**. The reopening of the flap folding head switch **149–3**, such as by raising the flap folding head **2** or permitting front flap folding arm **146** to drop behind the closed carton **134** being transported forward from the flap holding station Y, whichever may occur first, effects de-energization of the back flap kicker solenoid valve **198** so as to recock the kicker **161** to the full line position shown in FIG. 1. Since raising of the head **2** is delayed until the closed and taped carton **134** clears the taping mechanism speed-up in handling successive cartons is assured by permitting the front flap folding arm **146** to drop down behind the closed carton as it is cleared from the flag folding station Y, which forces head switches **149–1** and **149–3** to reopen and **149–2** to reclose. Reclosure of head switch **149–2** readies the energizing circuit of Down relay coil **2540** to be reclosed later. Reopening of head switch **149–1** de-energizes relay coil **2690** to reclose its switch **296–2** and reopen its switch **296–1** which would tend to de-energize relay coil **3410** in the absence of an alternate energizing circuit for this relay coil. Such an alternate energizing circuit for high power drive relay coil **3410** is provided through now closed chain conveyor operated switch **135–3** and closed holding switch **341–1**, to maintain the energization of this relay coil. With the entrance of the next oncoming carton the attendant closure of the photoswitch **138–1** again re-energizes relay coil **2660** to open its switch **266–1** and de-energize the entrance gate solenoid valve **197** for again lifting the gate **12** to carton barring position with respect to the next supplied carton. Such energization of relay coil **2660** recloses its holding switch **266–2** to maintain energization of the former until chain conveyor switch **235–2** is reopened.

As the trailing end of the long tripping lug **166–1** is dragged from beneath the trigger **236** of chain conveyor operated switch **235**, to permit reclosure of its switch **235–1**, the stop gate operating solenoid valve **195** becomes energized through now closed switches **296–2** and **235–1**, while rail driving solenoid valve **194** remains de-energized due to the open condition of the photoswitch **140–1**. With the solenoid valve **195** energized while the de-energization of the solenoid valve **194** is so continued the relatively high pressure of say forty-five pounds per square inch (45 lbs./sq. in.) is supplied to the front end of the rail driving cylinder **301** while the relatively low pressure of say five pounds per square inch (5 lbs./sq.

in.) is supplied to the opposite end thereof to impose a resultant retracting pressure of say forty pounds per square inch (40 lbs./sq. inch) ahead of its piston 88, so as to effect the retraction of the guide rails **80** and **180** to their initial carton-receptive positions. At the same time the retracted stop gate **225** is again raised across the path of the next oncoming carton to intercept it at the flap folding station Y there to cause it to stop beneath the flap folding head **2**.

The leading end of the long tripping lug **166–1** trips, the trigger of the chain conveyor operated switch unit **435**, which is located at the point indicated in FIGS. 14 and 15, so as to open its switch **435–1** before chain conveyor operated switch **235–1** is permitted to reclose, so as to continue de-energization of the Up relay coil **2530** (as well as of the Down relay coil **2540**), and also of the operating solenoid valve **194** for raising the stop paddle **225** into the path of the next oncoming carton at the flap folding station Y. Thus the long tripping lug **166–1** is to be of such length as to bridge across from the trigger **236** of the chain conveyor operated switch unit **235** to the trigger of the chain conveyor operated switch unit **435** to hold open simultaneously for a few seconds their switches **235–1** and **435–1**. Since the chain conveyor operated switch **435–1** is to control the raising of the flap folding head **2** before the photoswitch **140–2** is opened again by the next oncoming carton arriving at the flap folding station Y, so as to prevent jamming of this next oncoming carton against the lowered head, and particularly at the moment that the trailing end of the preceding closed and taped carton **134** arrives at a point beneath the forward tape wipe-on arms at C (FIG. 1), the trailing end of the long tripping lug **166–1** must be dragged from beneath the trigger of this switch unit **435** at this time to permit reclosure of the conveyor chain operated switch **435–1** for the energization of the Up relay coil **2530**. Thus the chain conveyor long tripping lug **166–1** should be foreshortened on its trailing end in a showing of the type depicted in FIG. 15 for proper operation of this embodiment of the invention. For example, the trailing end of such long tripping lug **166–1** may terminate in the FIG. 15 showing at a point somewhat ahead of the leading end of the carton **134**, such as at about that indicated at **375**. With the understanding that adjustability of the length of each of the long tripping lugs **166–1** and **166–2**, as well as the locations of the chain operated switch units **235** and **435** along the length of the machine bed, may be required so as to adapt the machine to effective operation upon any particular group of cartons to attain the certain required sequence of operations of the switches **296–2**, **235–1** and **435–1**, one skilled in the art readily can make such adjustments to fit the requirements. In doing so, one must remember that switch **296–2** must first be opened by energization of its operating relay coil **2960**, to be effected by the closure of head switch **149–1** as the head **2** is lowered by energization of the Down relay coil **2540** upon the top of the carton held stopped at the flap folding station Y. Also, that then the conveyor chain operated switch **235–1** is to be opened before closure of switch **296–2** by transporting the carton forward beyond the flap folding station Y, so as to continue de-energization of the stop paddle operating solenoid valve **195** for maintaining the carton guiding conditions of the lightly biased rails **80** and **180** until the closed carton clears the head **2**. And finally, that the conveyor chain operated switch **435–1** must be opened before the chain operated conveyor switch **235–1** is again closed, with these actions being dictated by the same chain conveyor long tripping lug **166–1** or **166–2** as the case may be, so as to maintain de-energization of the rail driving solenoid valve **194** and the Up head elevating relay coil **2530**, for retracting the rails **80** and **180** to their carton-receptive positions and to raise the stop paddle **225** into the path of the next oncoming carton and for raising the flap folding head **2** above this next oncoming carton before it arrives at the flap folding station Y. When this next oncoming carton does arrive at the flap folding station Y to abutment of the raised stop paddle **225**, so as to close the photoswitch **140–1** simultaneously with opening of the photoswitch **140–2**, with the head switch **149–2** reclosed by drop of the front flap folding arm **146** behind the preceding carton **134** as it is transported forward beyond the flap folding station Y, the Down relay coil **2540** will become energized again upon reclosure of the conveyor chain operated switch **435–1** as the trailing end of the long tripping lug **166–1**, or **166–2** as the case may be, clears the trigger of the switch unit **435**. Consequently, the flap folding head **2** is lowered to the top of this next succeeding carton which is beind held stopped by the raised stop paddle **225** at the flap folding station Y, and the embodiment of the machine which features the electrical circuitry of FIG. 18 is readied for recycling action.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In an automatic carton closing machine for folding down and inward the upwardly-extending front and rear flaps of a series of successive open-top cartons to closed lateral positions, including those of relatively shallow depths, the combination with

(A) lateral conveyor means having an entrance end and a discharge end and defining a path of forward carton travel along which said conveyor means transports each carton,

(B) a carton sensing and flap folding station located at a point along said path,

(C) a movable front and rear flap folding sub-assembly mounted for motion along a path at an angle to said carton travel path toward and away from the open top of a carton at said station,

(D) carton sensing means located along said carton travel path responsive to the presence of an open-top carton at said station to dictate advance of said flap folding means toward the unfolded and upwardly-extending flaps thereof and to fold the front flap back and inward to closing position,

(E) carton height control means at said station responsive to the top of said carton to stop the advance of said flap folding sub-assembly upon inward folding of the front flap down upon the carton top,

(F) movable rear flap folding means also carried by said flap folding sub-assembly to fold the rear flap forward and inward to closing position,

(G) means to cause each open-top carton to pause at said station for permitting advance of said flap folding sub-assembly to the top of said pausing carton and after performance of a flap-folding operation thereon to release said pausing carton from said station for transport by said conveyor means to the discharge end,

(H) a pair of opposed, longitudinally-extending, carton clamping and guiding members flanking opposite sides of said station with at least one movable transversely relative to the other for relative approach temporarily to clamp therebetween a carton pausing at said station and for relative retraction to permit reception therebetween of a succeeding carton, and

(I) means to drive at least one of said clamping and guiding members transversely for advance thereof toward the other to effect such carton clamping approach and for the relative retraction thereof; of

(a) carton side engaging means supported on one of said carton clamping and guiding members at the inner side of the latter to constitute the means of contacting a side of a carton pausing at said station by structure of said member,

(b) means movably mounting said carton side engaging means on said member for alternate motion away from the latter and said conveyor means toward said flap folding sub-assembly for appreciable lap against the opposed carton side and retraction toward said member and conveyor means to minimize projection of said carton side engaging means, and

(c) means to effect such retraction of said carton side engaging means as said conveyor means picks up the pausing carton at said station and transports it forward.

2. The carton closing machine equipment as defined in claim 1 in which said conveyor means is equipped with a transverse flight to effect such carton pick-up at said station by sweep through the latter past said flap folding sub-assembly with this flight extending toward the latter a minimum distance whereby said flap folding sub-assembly may be located close to said conveyor means at said station for closing operations on cartons of relatively shallow depth, said flight constituting said means to effect the retraction of said carton side engaging means when swept over the latter through said station.

3. The carton closing machine equipment as defined in claim 2 in which each of both of said carton clamping and guiding members is equipped with one of a pair of said carton side engaging means arranged in opposed relation.

4. The carton closing machine equipment as defined in claim 3 in which each of said carton side engaging means is in the form of an elongated shoe pivotally mounted on a transverse axis to the member supporting it and having a free end extending in the direction of travel of cartons along said path from its axis retractably biased outwardly from said member toward said flap folding sub-assembly.

5. The carton closing machine equipment as defined in claim 4 in which said shoe free end is biased outwardly by spring means intervening this end and said member supporting said shoe.

6. The carton closing machine equipment as defined in claim 1 in which said drive means for said clamping and guiding members comprises a double-ended pneumatic motor including a cylinder and piston means reciprocatively mounted in said cylinder, means connecting at least one of said clamping and guiding members to said piston means to cause it to advance toward the other member upon thrust of said piston means in said cylinder in one direction and to retract said member relative to the other upon thrust of said piston means in the opposite direction, a pair of fluid-conducting passages respectively connected to opposite ends of said cylinder on opposite sides of said piston means, sources of relatively low pressure and relatively high pressure gaseous medium, and plural-position valve means provided with multiple passages connected between said gaseous medium sources and said cylinder passages which in one position supplies the relatively high pressure gaseous medium through a first one of said cylinder passages behind said piston means to thrust it forward in member advancing direction, in a second position substitutes the relatively low pressure gaseous medium for the relatively high pressure gaseous medium behind said piston means elastically to bias at relatively low pressure said members to their relative advanced positions against opposite sides of a carton therebetween at said station to convert said members to guides for this carton and permit its advance therebetween by said conveyor means beyond said station, and in a third position supplies the relatively high pressure gaseous medium through the second cylinder passage ahead of said piston means to thrust it back in member retracting direction.

7. The carton closing machine equipment as defined in claim 6 in which said valve means in the third position maintains connection between the source of the relatively low pressure gaseous medium and said first cylinder passage for application of this pressure behind said piston means while connection between the source of the relatively high pressure gaseous medium and said second cylinder passage is maintained with application ahead of said piston means of the differential of these pressures as the medium of applying the back thrust.

8. The carton closing machine equipment as defined in claim 7 in which said valve means comprises a pair of four-way valves each equipped with first and second orifices on the delivery side thereof and third, fourth and fifth orifices on the receiving side thereof, said first delivery side orifice of each valve being alternately connectable by valve manipulation to said third and fourth receiving side orifices of this valve and said second delivery side orifice thereof being simultaneously alternately connectable by the same valve manipulation to said fourth and fifth receiving side orifices of this valve, said relatively high pressure source of gaseous medium being connected to said fourth receiving side orifice of a first one of said valves with said second delivery side orifice of the latter connected to said fourth receiving side orifice of the second one of said valves and said relatively low pressure source of gaseous medium being connected to said third receiving side orifice of this second valve, said first and second delivery side orifices of said second valve being respectively connected to said first and second cylinder passages of said cylinder, said third and fifth receiving side orifices of said first valve and said fifth receiving side orifice of said second valve constituting vents.

9. The carton closing machine equipment as defined in claim 8 in which said means to cause each carton to pause at said station comprises movable gate means mounted at the exit end of said station and in an initial position located in the path of forward carton travel to intercept a carton traveling along this path to said station, said gate means being withdrawable from said path to permit carton transport by said conveyor means beyond said station, and a second pneumatic motor having piston means retractable by pressurized gaseous medium supplied to a first end of said cylinder, means connecting said piston means of said second pneumatic motor to said gate means to effect withdrawal of the latter from said path upon retraction of said piston means, conduit means connecting said first delivery side orifice of said first valve to said first end of said cylinder of said second pneumatic motor to supply the relatively high pressure gaseous medium behind said piston means of the latter to retract this piston means and said gate means therewith, and means to return said withdrawn gate means to its carton interception initial position as said clamping members are retracted relative to each other for reception therebetween of a succeeding carton.

10. The carton closing machine equipment as defined in claim 9 in which said gate return means comprises conduit means connected between said second delivery side orifice of said first valve and the other end of said second pneumatic motor alternatively to supply the relatively high pressure gaseous medium to the opposite side of said piston means of said second pneumatic motor for return thrust of this piston means.

11. The carton closing machine equipment as defined in claim 6 in which said means to cause each carton to pause at said station comprises movable gate means mounted at the exit end of said station and in an initial position located in the path of forward carton travel to intercept a carton traveling along this path to said station, said gate means being withdrawable from said path to

permit carton transport by said conveyor means beyond said station, and a second pneumatic motor having piston means retractable by pressurized gaseous medium supplied to a first end of said cylinder, means connecting said piston means of said second pneumatic motor to said gate means to effect withdrawal of the latter from said path upon retraction of said piston means, conduit means connecting said first end of said cylinder of said second pneumatic motor to said valve means for conduction of the relatively high pressure gaseous medium through the latter in its second position to behind said piston means of this second pneumatic motor to retract said piston means and said gate means therewith, and means to return said withdrawn gate means to its carton interception initial position as said clamping members are retracted relative to each other for reception therebetween of a succeeding carton.

12. The carton closing machine as defined in claim **11** in which said gate return means comprises conduit means connecting the other end of said cylinder of said second pneumatic motor to said valve means for conduction of the relatively high pressure gaseous medium through the latter in its third position to the opposite side of said piston means of said second pneumatic motor for return thrust of this piston means to effect return of said gate means to its carton interception initial position as said clamping members are retracted relative to each other.

13. In an automatic carton closing machine for folding down and inward to closed lateral positions the upwardly-extending front and rear flaps of a series of supplied successive open-top cartons while said cartons are being transported through said machine, the combination with

(A) lateral conveyor means having an entrance end and a discharge end and defining a path of forward carton travel from the entrance end along which said conveyor means transports each carton comprising a section provided with a plurality of longitudinally-spaced carton pick-up flight means each to be carried up behind a carton as it is delivered into the entrance end for forward carton transport,

(B) movable entrance gate means at the entrance end periodically to permit entrance to said conveyor means of a single carton at a time and to hold back temporarily each of the next of the series of supplied open cartons until closing operations are performed on the preceding carton,

(C) a carton sensing and flap folding station located at a point along said path forward of the entrance end at which each carton is caused to pause in its forward transport through said machine by said conveyor means,

(D) a movable carton flap folding sub-assembly mounted for motion along a path at an angle to said carton travel path toward and away from the open top of a carton pausing at said station, and,

(E) means to drive forward said flight equipped conveyor section periodically; of

(a) carton stop means at said station separate from said conveyor means alternately movable to a position of engagement of each oncoming carton transported forward along said path of forward carton travel to hold it stopped temporarily at said station for performance of a flap folding operation thereon and then retractable to free this carton for further forward transport by said conveyor section,

(b) means associated with said conveyor driving means alternately to shift the action thereof between a relatively low power type that will carry one of said flight means up behind a carton being delivered beyond said entrance gate means to said station to abutment of the back end of said carton with relatively light pressure thereagainst as said carton is stopped at said station by said stop means to cause stoppage of said conveyor section without carton crushage, and a relatively high power type upon retraction of said stop means, and

(c) carton sensing means at said entrance end connected to said drive shifting means to dictate and initiate relatively low power action of said driving means as each carton is delivered therepast toward said station to carry the next flight means up behind this carton.

14. The carton transport equipment as defined in claim **13** in which brake means are associated with said conveyor driving means periodically to apply braking power to the latter to hold said conveyor means stopped in the absence of a carton in said machine, and brake releasing means are provided which are controlled by said carton sensing means to release said brake means as the low power driving action is initiated thereby.

15. The carton transport equipment as defined in claim **14** in which control means are mounted on said movable carton flap folding sub-assembly responsive to said pausing carton as said sub-assembly is advanced to the latter to initiate retraction of said carton stop means at said station and operation of said shifting means to change the drive of said conveyor driving means from the relatively low power action to the relatively high power action.

16. The carton transport equipment as defined in claim **15** in which said driving means is in the form of friction clutch means and said drive shifting means is of a structure alternately to effect application of relatively light engagement pressure between friction driving and driven means of said clutch means for the relatively low power action while permitting relative slippage when said conveyor section is stopped by abutment of its oncoming flight means to the back end of a carton held stopped by said stop means at said flap folding station and then to effect application of greater engagement pressure to attain relatively high power drive of said conveyor section and cause its abutted flight means to pick up said carton at said station when released by retraction of said stop means.

17. The carton transport equipment as defined in claim **16** in which is provided a carton closing head mounted for alternate movement to the open top of a carton at said station and away from the carton top with said head carrying said flap folding sub-assembly and means responding to the presence and absence of a carton top adjacent said head, and in which said driving shifting means is operatively responsive to electrical energy and includes an electrical energizing control circuit, there being provided on said head switch means in said circuit alternately to close and open the latter with said switch means being operable by said means responding to the presence and absence of a carton top adjacent said head.

18. The carton transport equipment as defined in claim **17** in which said carton stop means at said flap folding station is manipulated by electrical means including an energizing circuit, and said switch means includes circuit making and breaking means in the latter energizing circuit to alter its condition upon movement of said head to an open carton top at said station for effecting thereupon the retraction of said stop means.

19. The carton transport equipment as defined in claim **17** in which said entrance gate means has connected thereto means momentarily to retract it to permit entrance of an open top carton during periods said conveyor section is undriven and electrical means to operate said retracting means including an electrical energizing circuit, an entrance gate control switch is located in said gate retracting circuit which in one position effects the momentary gate retraction and in a second position causes said gate to bar entrance of a succeeding carton, and electrical entrance gate control means is provided to operate said entrance gate control switch including an energizing circuit having therein said head switch means whereby the latter continues the second position of said entrance gate control switch while said relatively high power action of said conveyor section prevails.

20. The carton transport equipment as defined in claim **19** in which is provided a second electrical energizing circuit connected to said electrical means that operates said entrance gate control switch with this second circuit including electrical limit switch means operable by travel of said conveyor section and a switch operable by said carton sensing means at said entrance end whereby said circuits alternately maintain the carton barring position

of said entrance gate means at times other than when said conveyor section is undriven.

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