United States Patent [19]

Reichert

[11] **3,763,750**

[45] **Oct. 9, 1973**

[54] **BOX FORMING MACHINE**

[75] Inventor: **Donald G. Reichert,** Tarpon Springs, Fla.

[73] Assignee: **ABC Packaging Machine Corporation,** Largo, Fla.

[22] Filed: **Feb. 1, 1972**

[21] Appl. No.: **222,617**

[52] **U.S. Cl.** ..... **93/53 BF,** 93/49 R

[51] **Int. Cl.** **B31b 1/76**

[58] **Field of Search** ..... 93/53 R, 53 BF, 49 R, 93/49 AC

[56] **References Cited**

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Primary Examiner—Donald R. Schran
Assistant Examiner—Leon Gilden
Attorney—Edward Taylor Newton et al.

[57] **ABSTRACT**

A machine for forming a box from a collapsed blank that includes four interconnected sidewalls having four alternately interconnected end flaps extending therefrom, in which each blank is folded flat with one pair of interconnected end flaps facing the other pair of interconnected end flaps in juxtaposition to one another. The box forming machine includes a magazine assembly for supporting a plurality of blanks in vertically oriented planes and includes means for successively dispensing individual blanks to the receiving end of the box forming machine. The receiving end of the box forming machine includes means for spreading the extended end flaps wherein one pair of interconnected end flaps is angularly disposed to one side of the plane of the collapsed blank and the second interconnected pair of end flaps is angularly disposed on an opposite side of the plane of the collapsed blank. Means is provided for retaining the flaps in their spread relationship while conveyor means advances the collapsed blank to an end flap folding station which includes means for folding the pair of end flaps back against their respective connected sides. The collapsed carton blank is then moved to a box opening station having means for engaging and angularly displacing one side of the collapsed blank to an open position while an adjacent interconnected side is engaged and held in a fixed position by stabilizing means. After the box has been opened, the bottom end flaps are folded upwardly to a position aligned with the bottom of the box.

18 Claims, 29 Drawing Figures

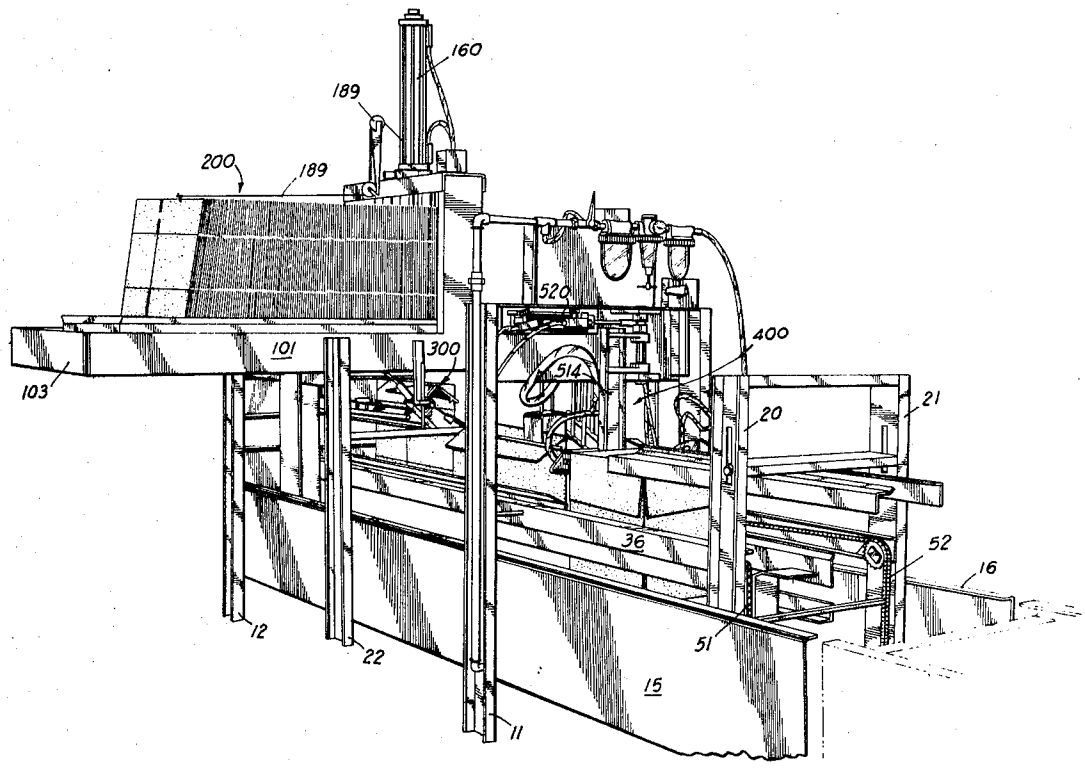
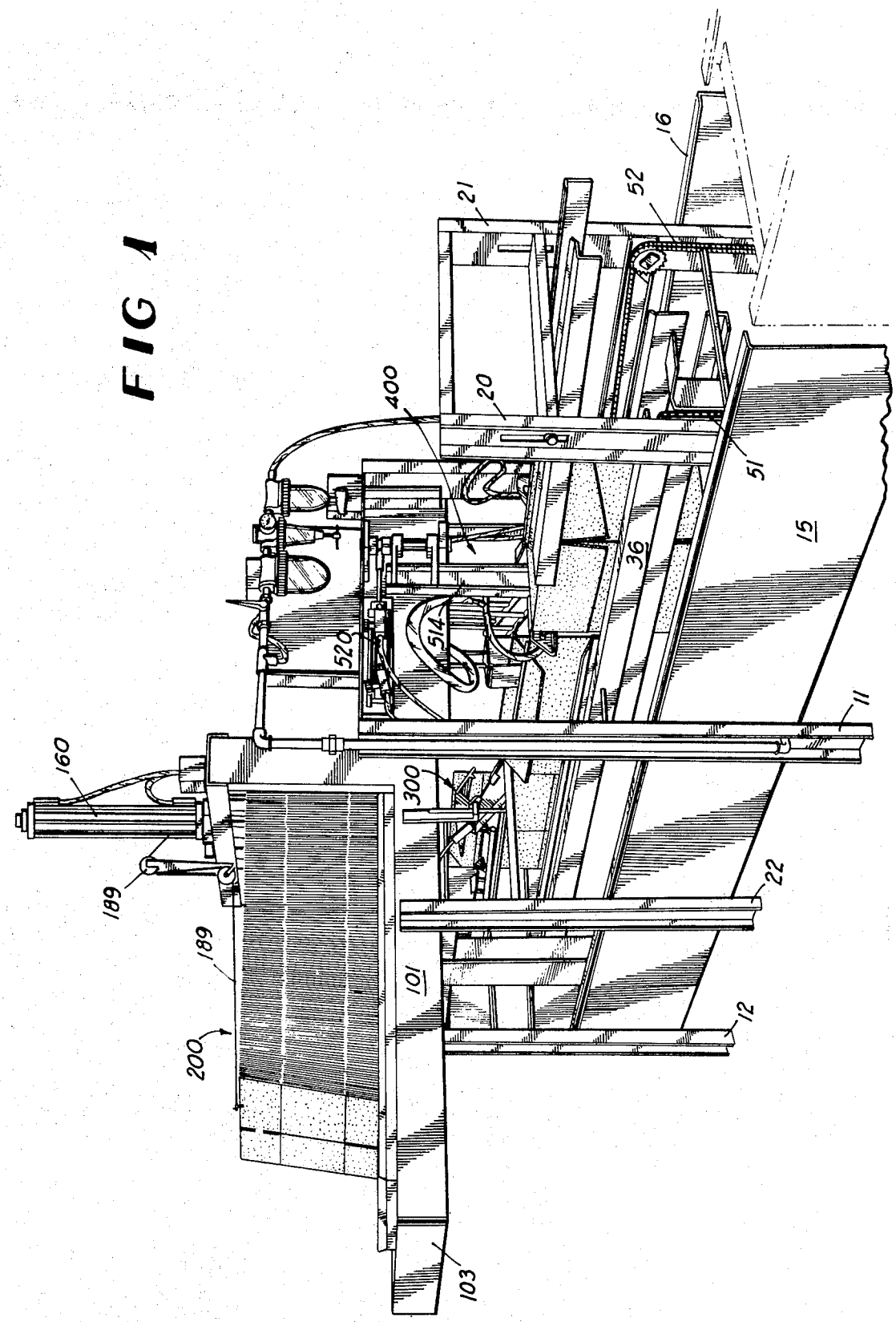


FIG 1


16
21
52
400
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51
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36
514
520
11
160
300
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189
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103

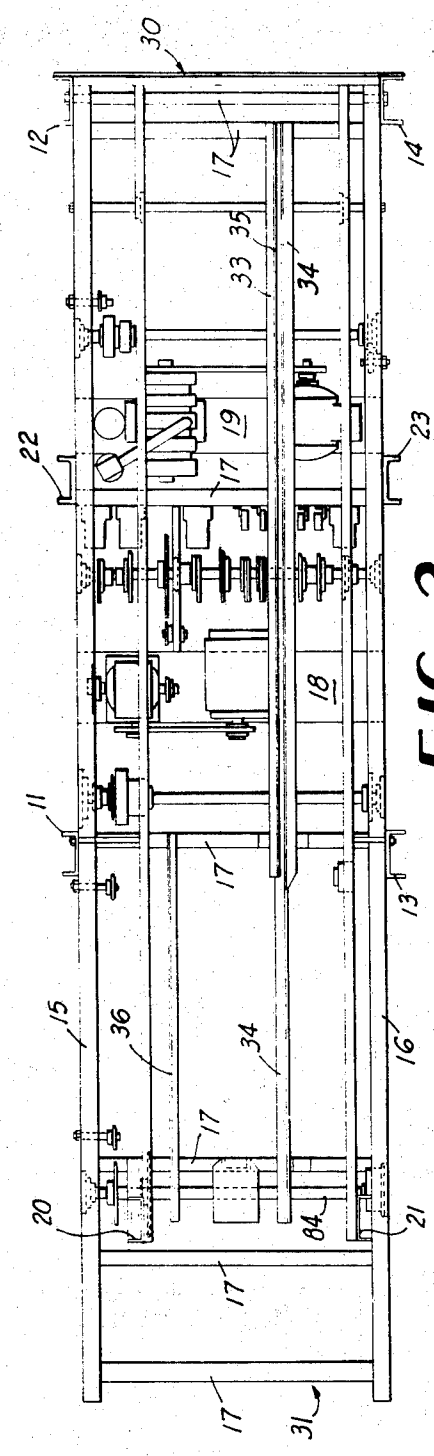

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FIG 2

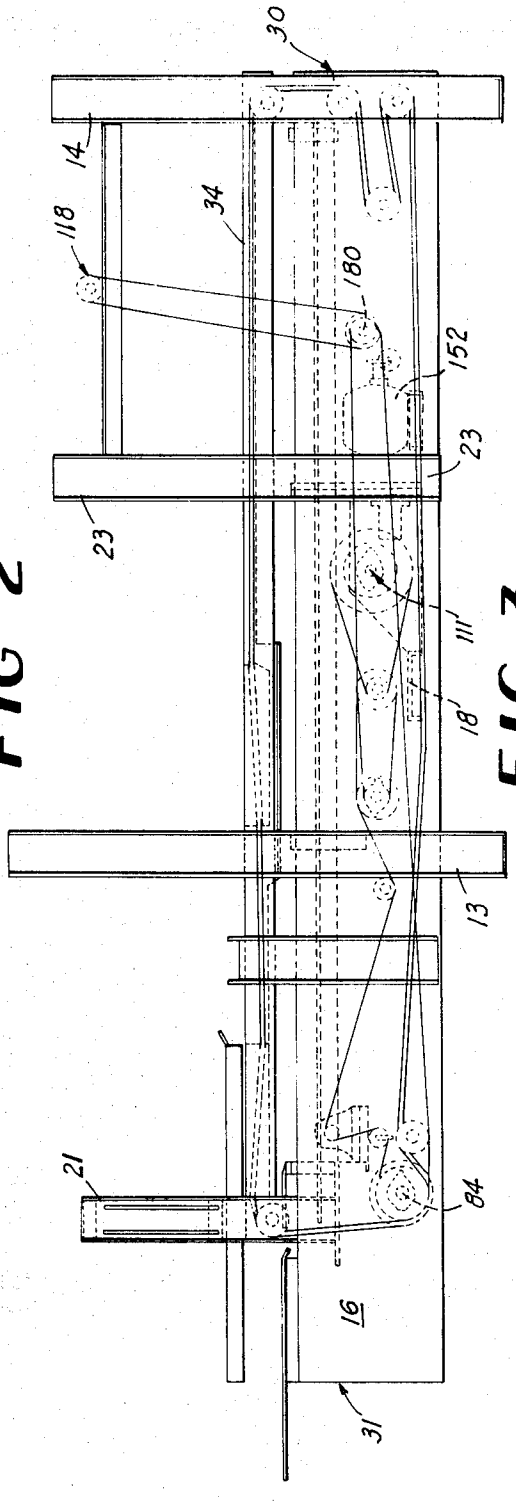

30
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118
34
180
152
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FIG 3

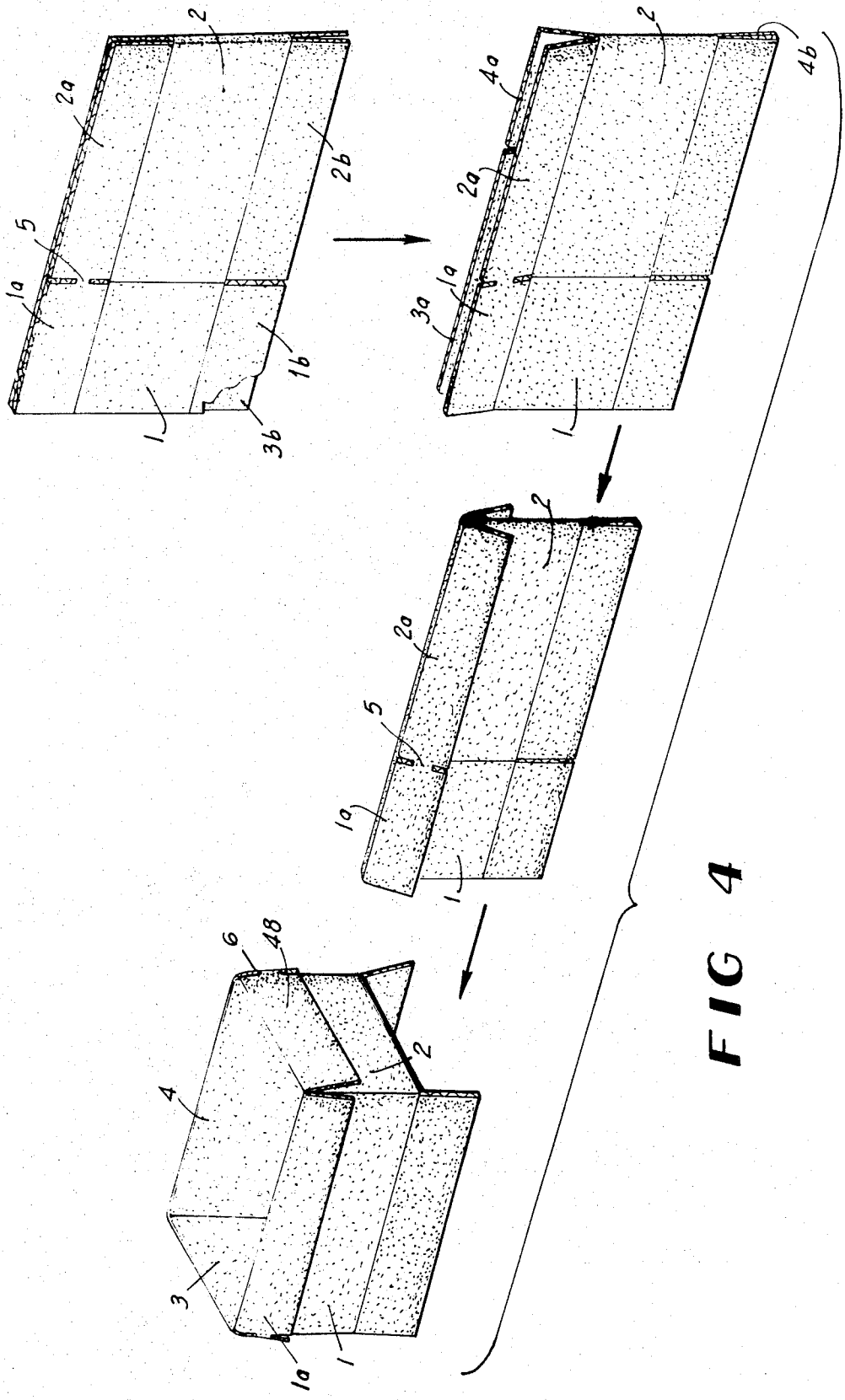


FIG 4

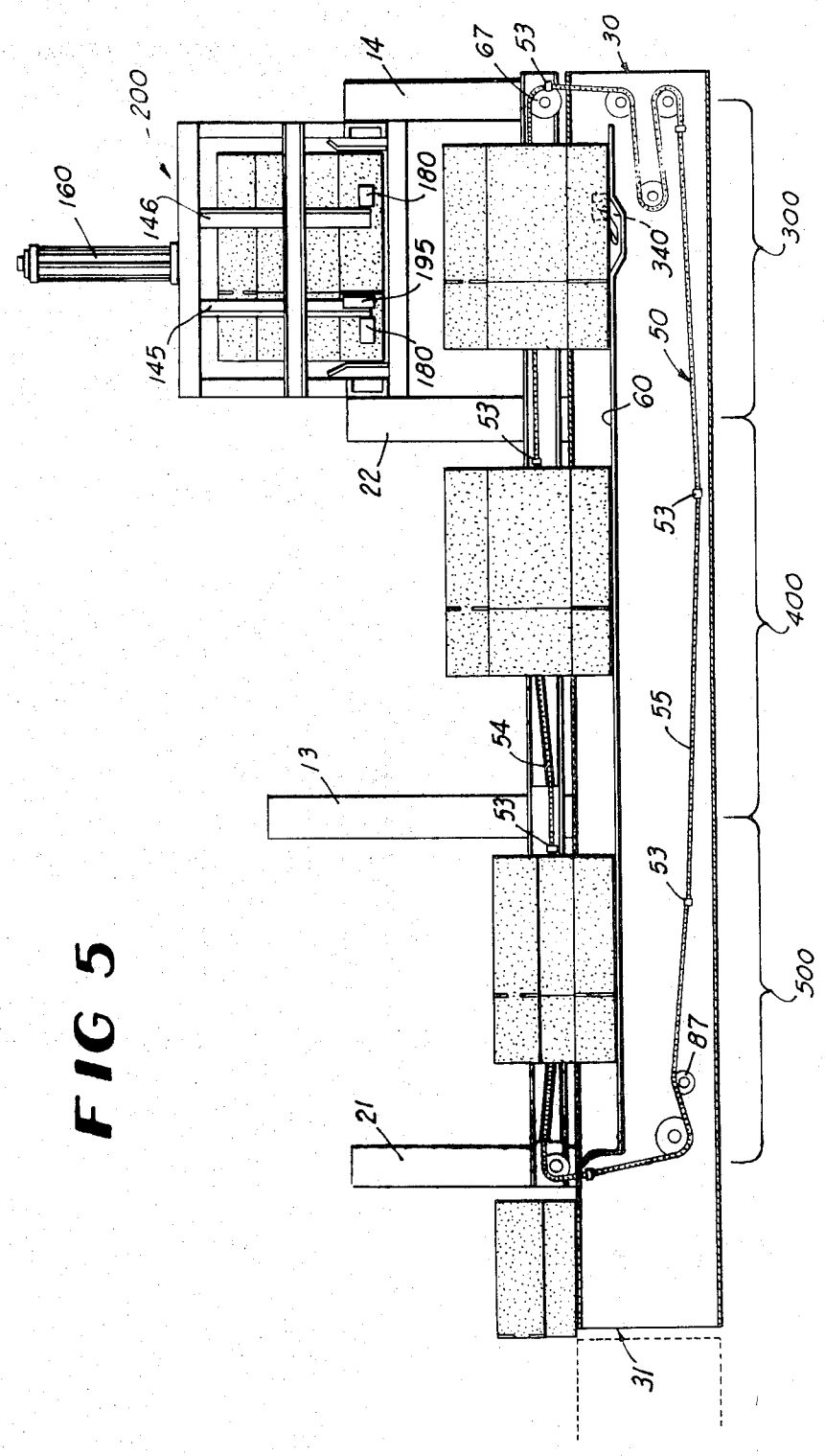

200
160
146
145
180
195
180
14
67
53
30
340
50
60
53
22
53
53
54
13
53
53
87
21
31
300
400
500

FIG 5

FIG 6

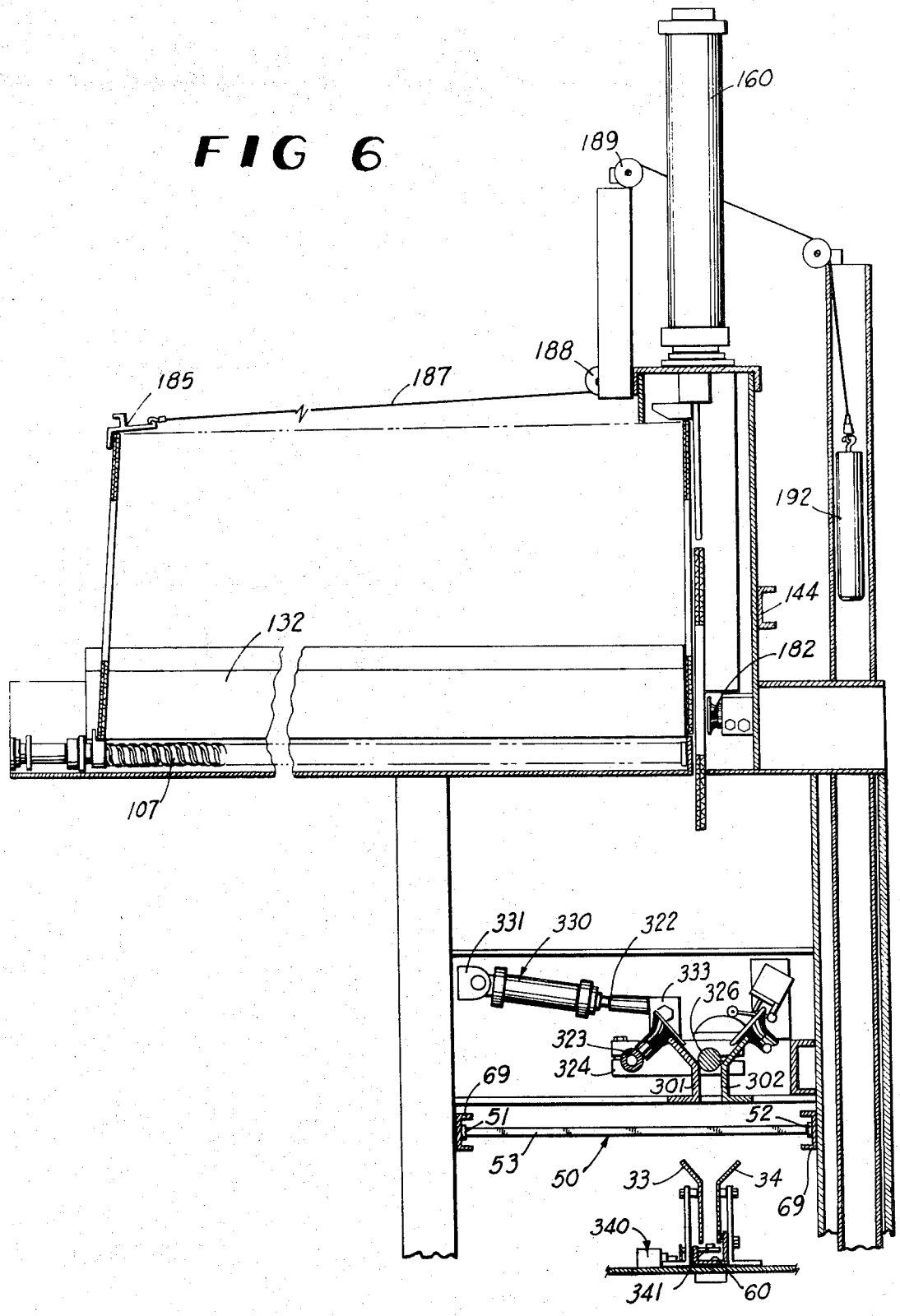
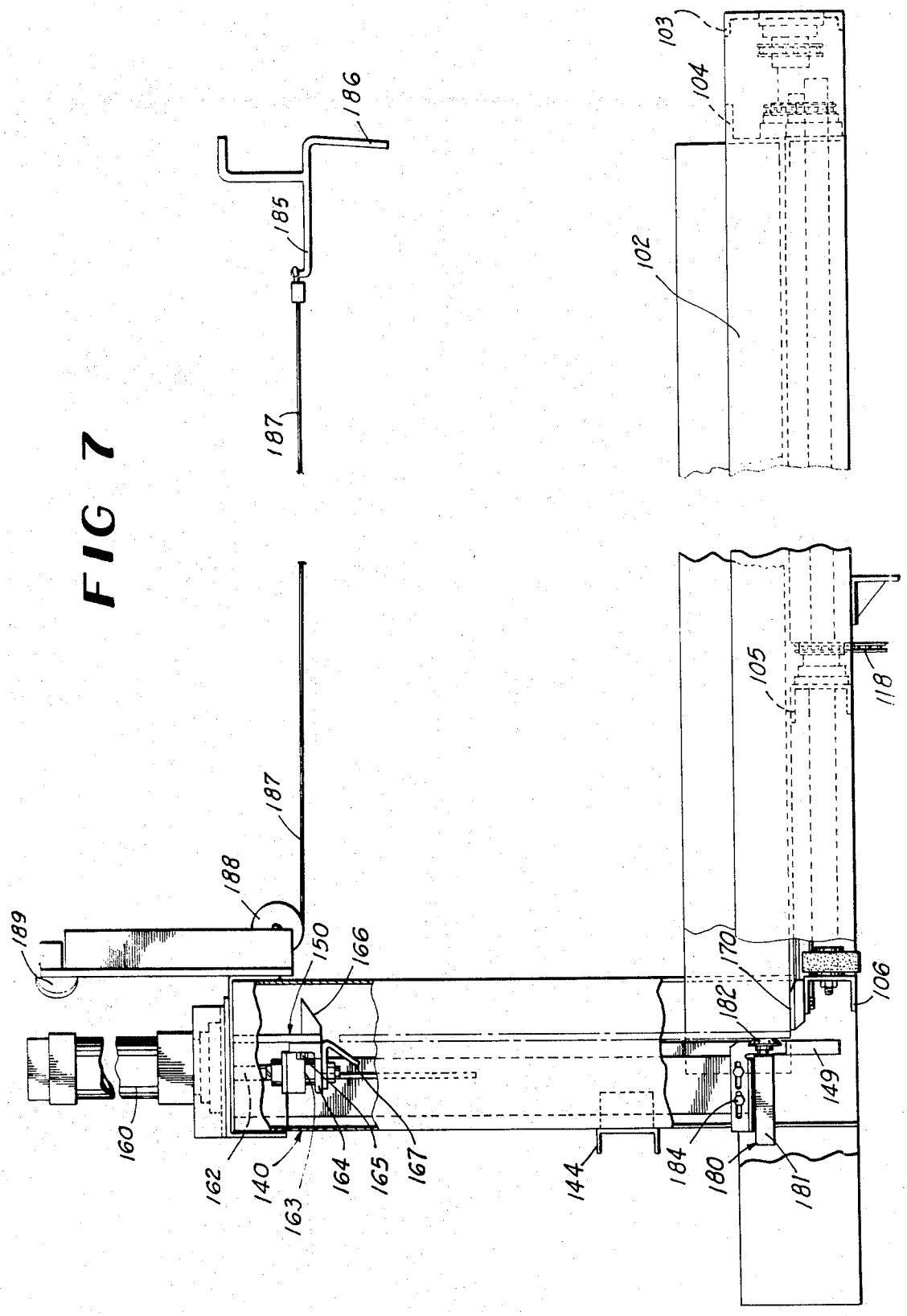

160
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185
187
192
144
132
182
107
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330
322
333
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323
324
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69
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69
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FIG 7


186
185
187
103
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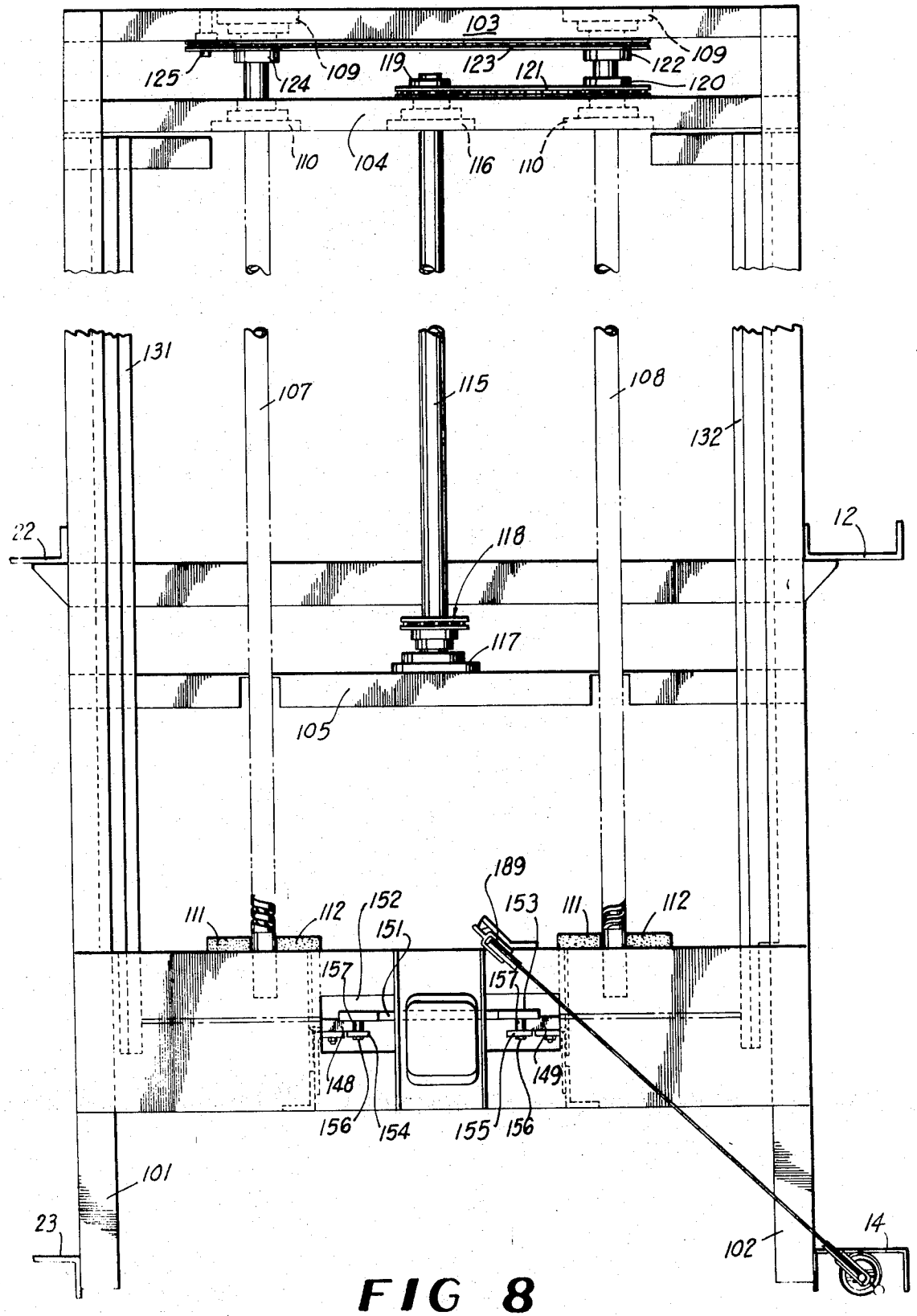
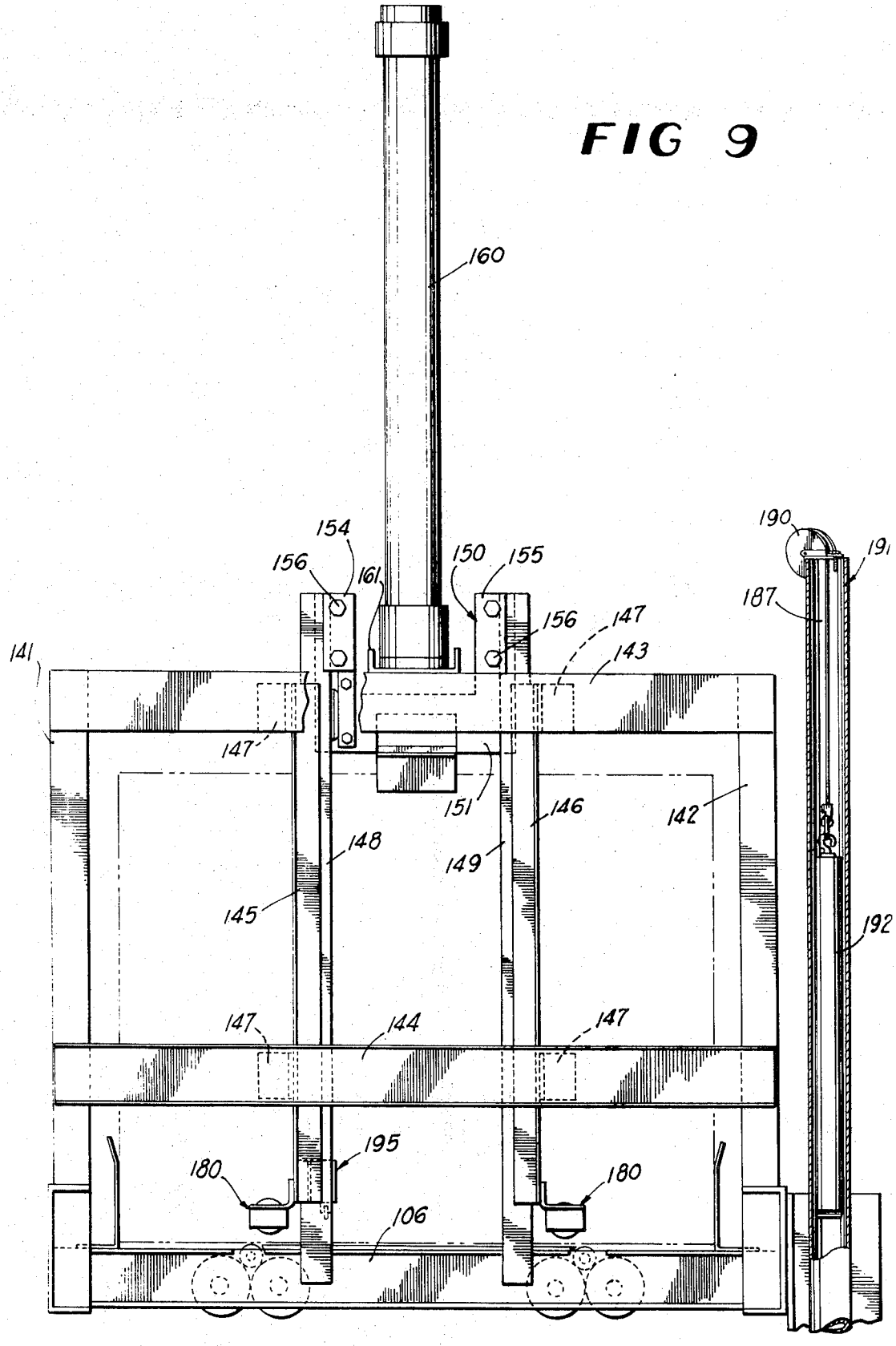

103
125
124
109
119
123
121
122
109
120
110
104
116
110
131
107
115
108
132
22
12
118
117
105
189
153
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112
152
151
111
112
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102
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FIG 8

FIG 9


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106

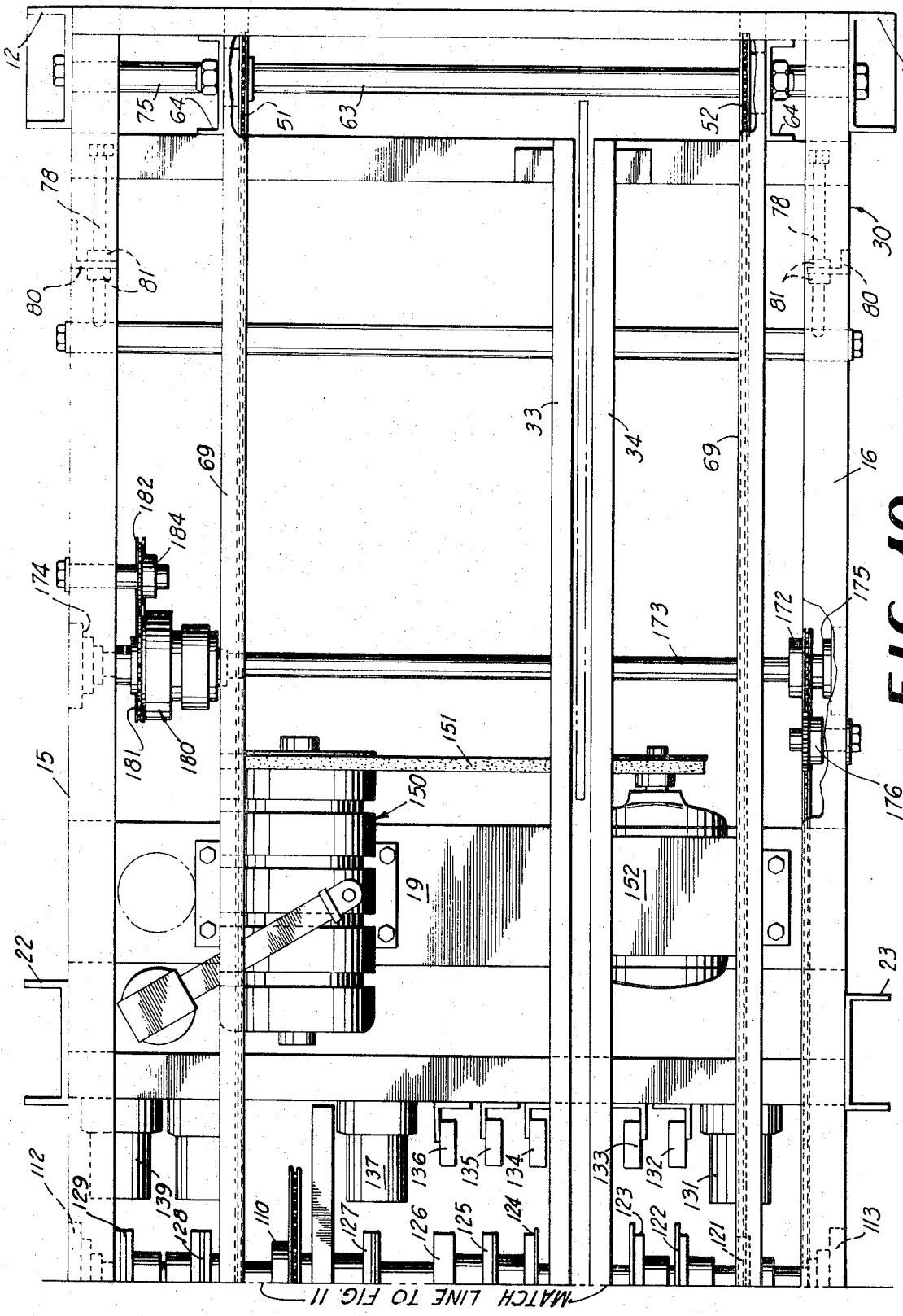


FIG 10

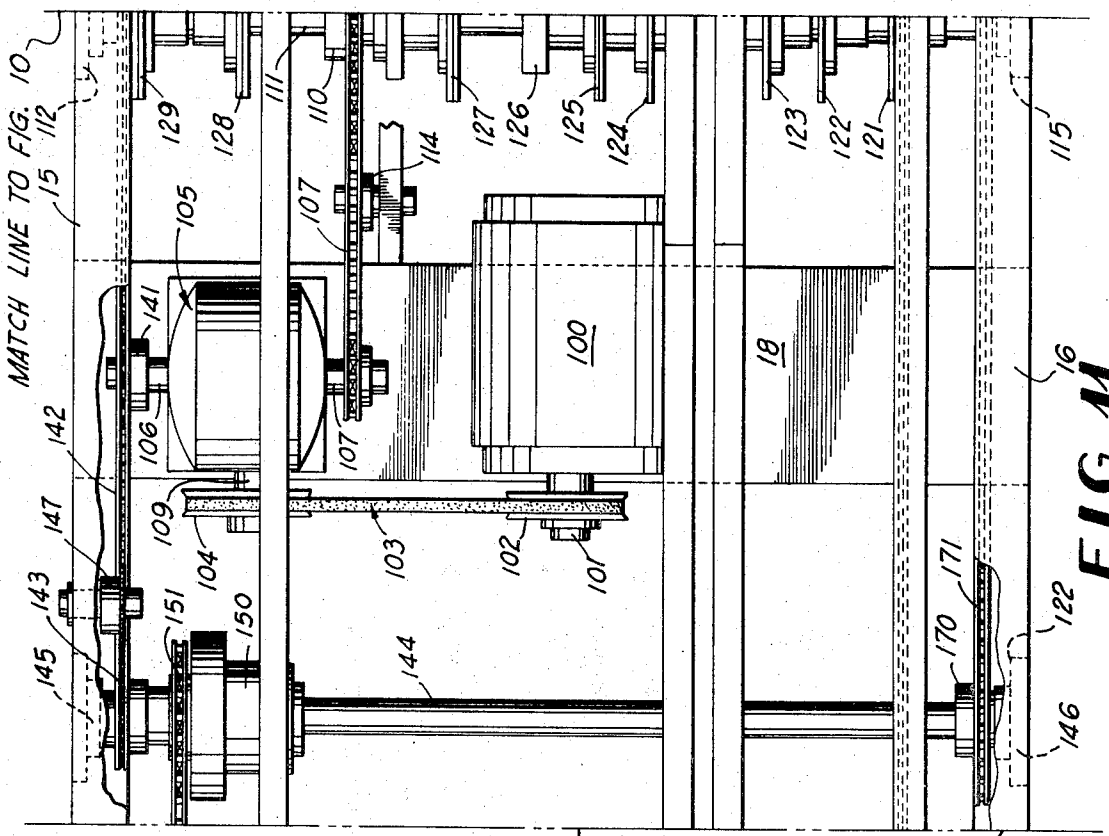

MATCH LINE TO FIG. 10
MATCH LINE TO FIG. 12
MATCH LINE TO FIG. 13
MATCH LINE TO FIG. 15
100
18
16

FIG 11

FIG 14

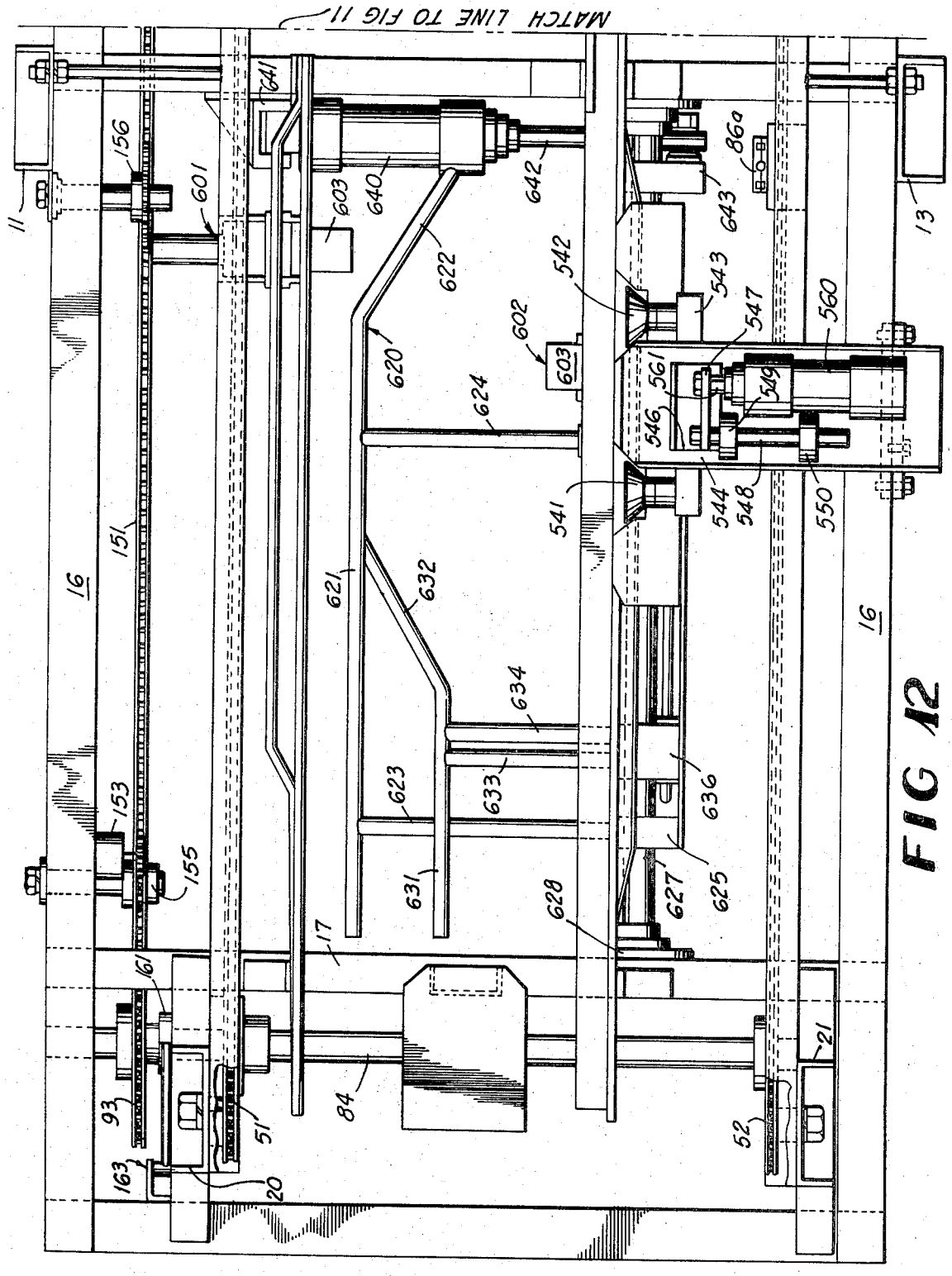

MATCH LINE TO FIG 11
11
156
601
641
603
640
642
622
620
602
603
624
542
543
547
560
561
549
546
544
548
550
541
86a
643
13
16
151
621
632
634
623
633
636
631
628
627
625
153
155
161
17
84
93
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163
20
52
21

FIG 12

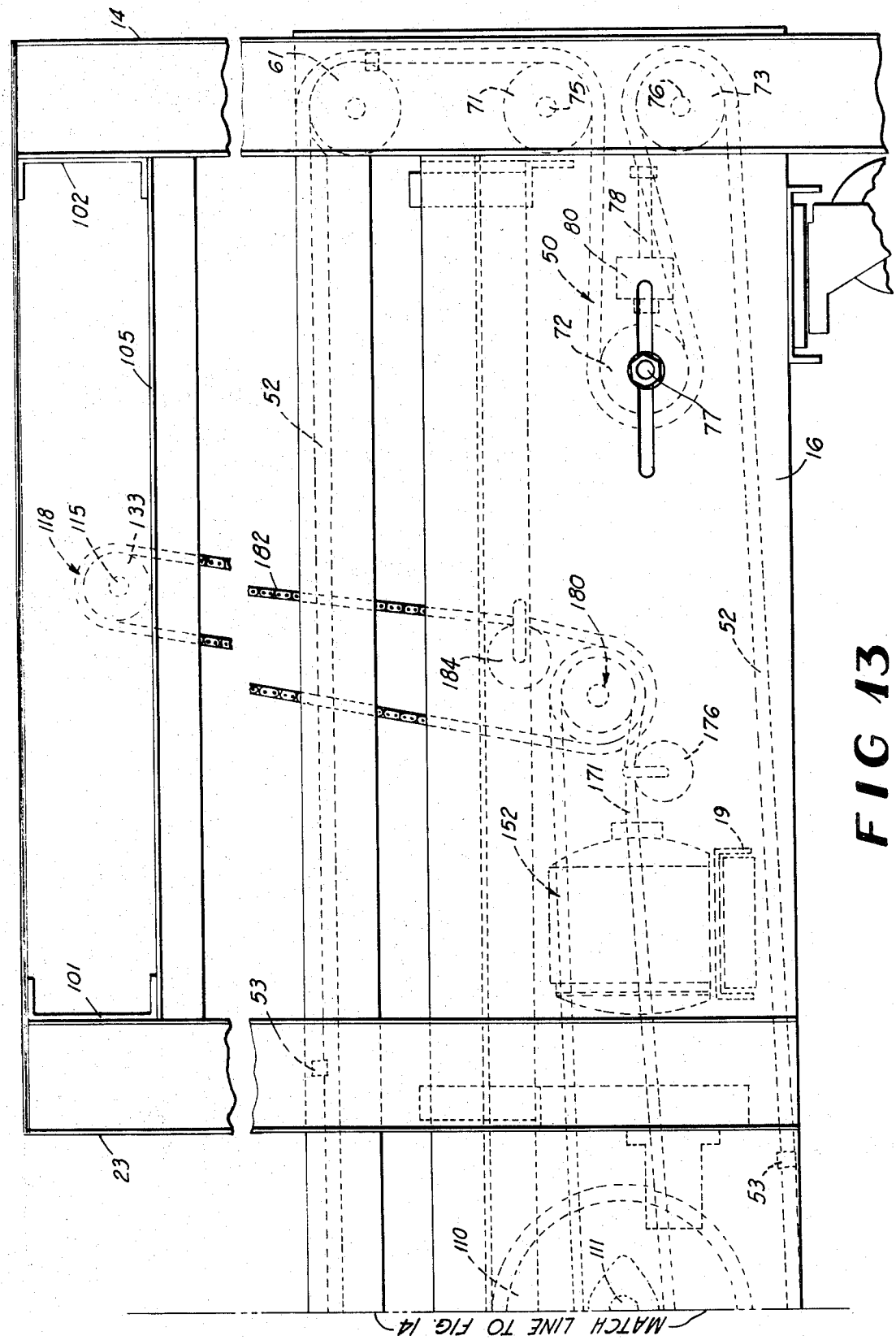

14
61
71
75
76
73
102
78
80
50
72
77
105
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118
115
133
182
180
184
176
171
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152
101
53
23
110
111
MATCH LINE TO FIG. 14

FIG 13

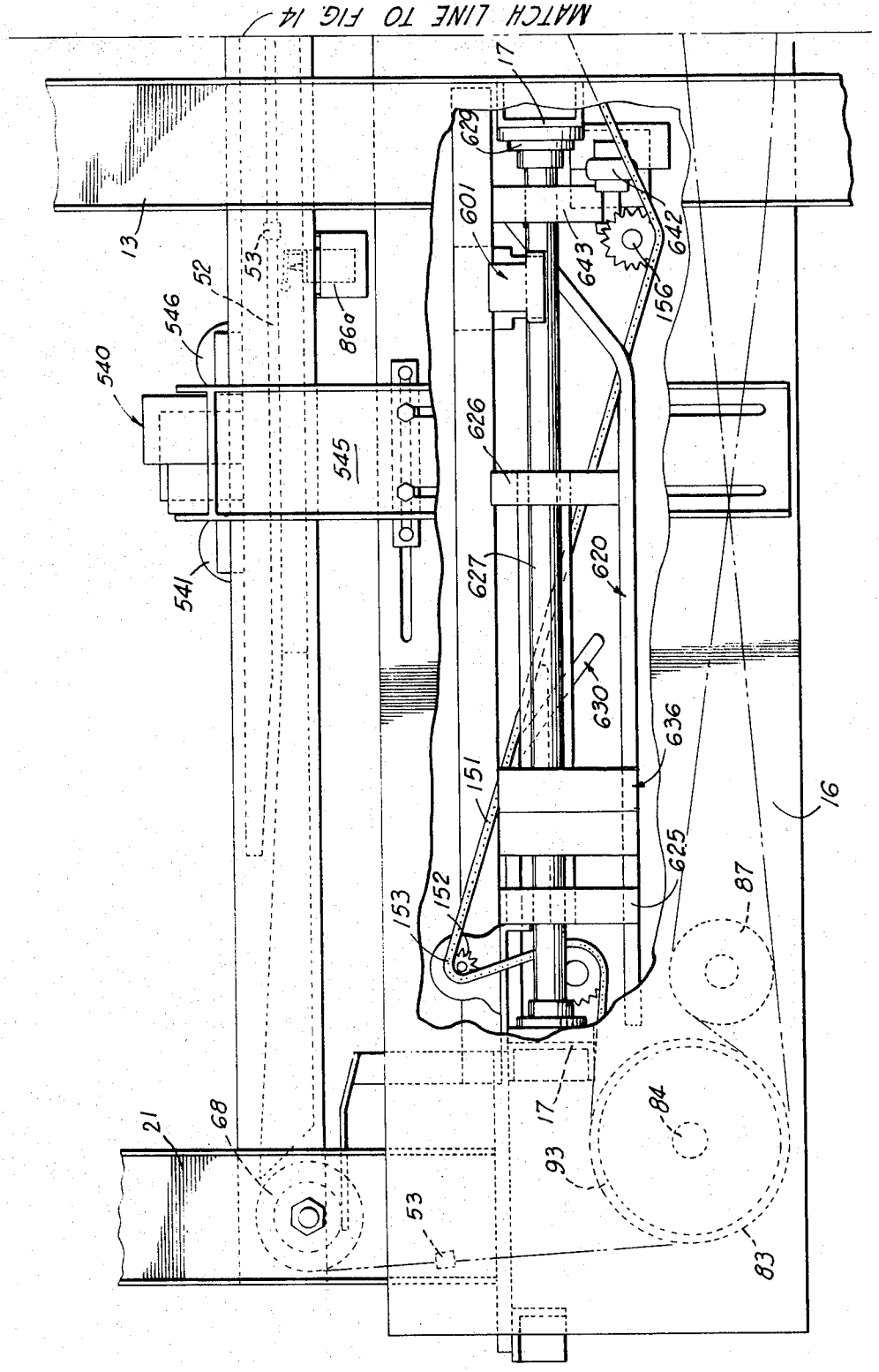

MATCH LINE TO FIG. 14
17
629
601
642
643
156
13
52
53
546
860
540
626
545
541
627
620
630
636
151
16
625
87
153
152
17
84
21
68
93
53
83

FIG 15

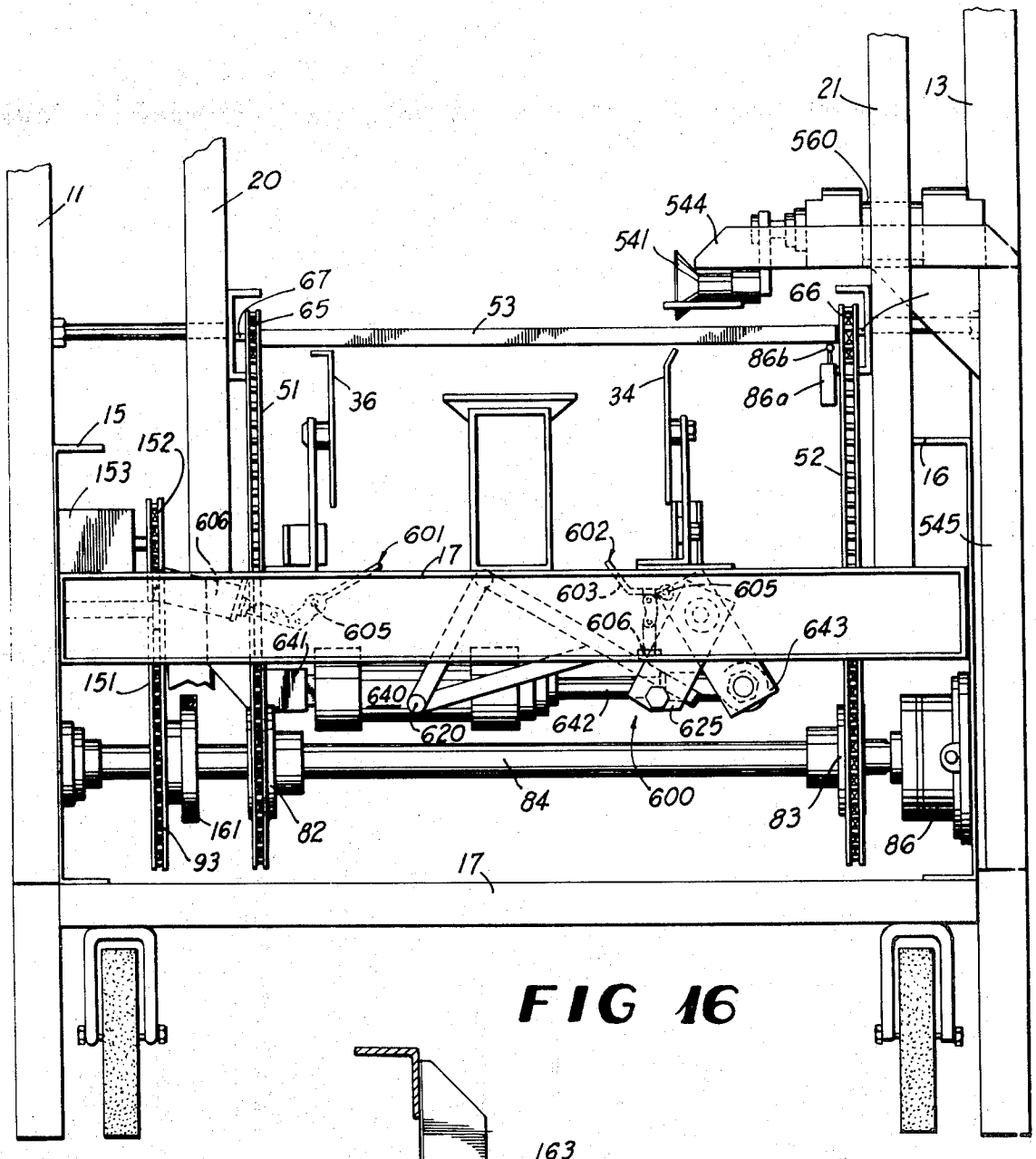


FIG 16

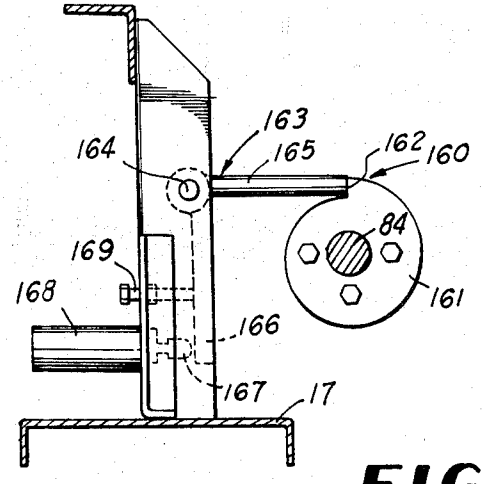


FIG 16A

FIG 17

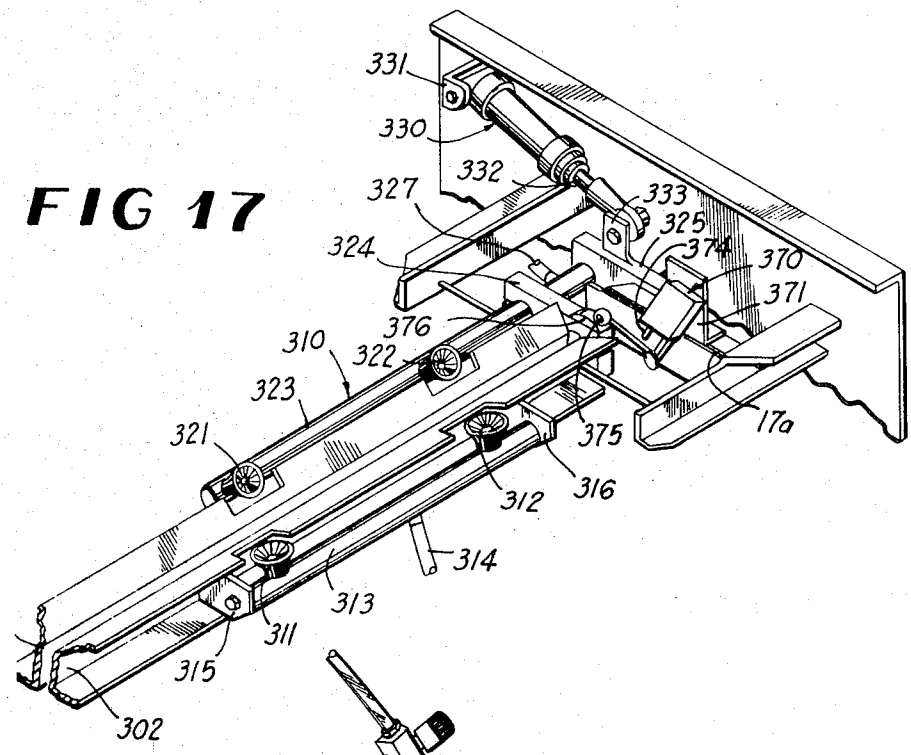
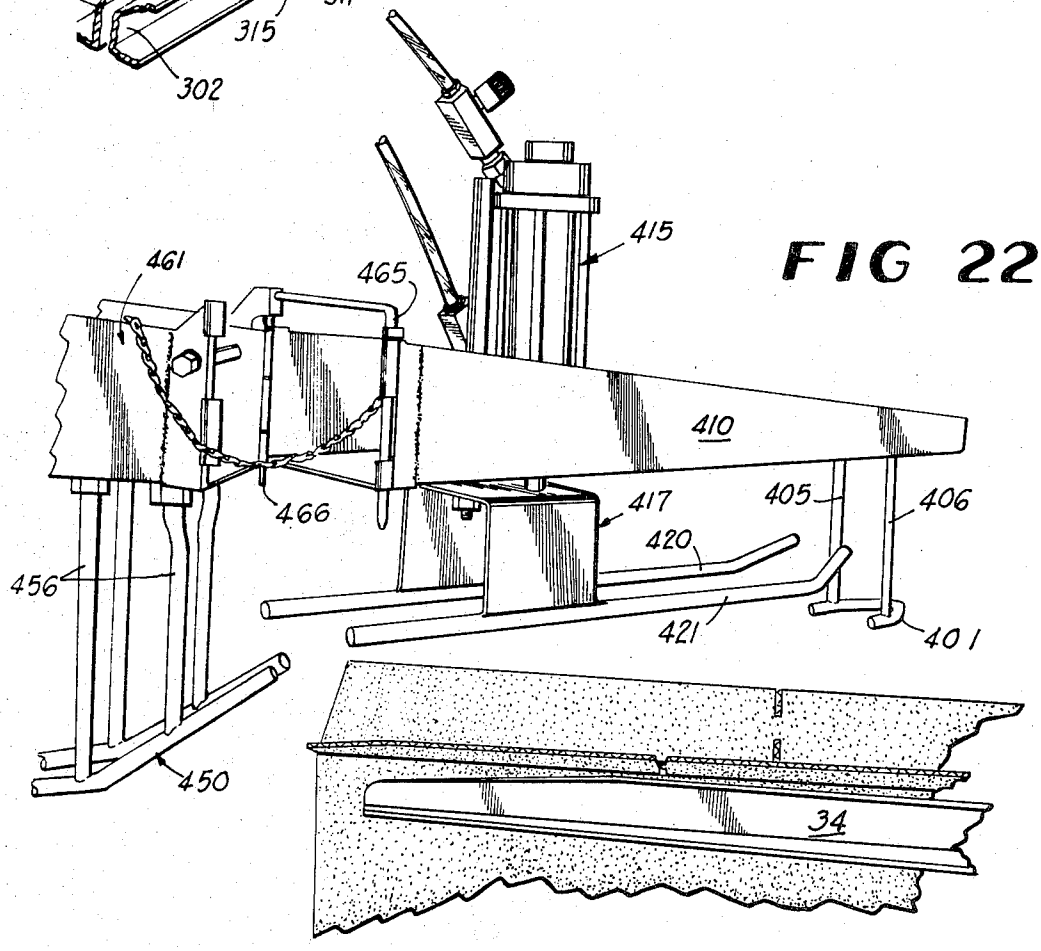

331
330
332
327
333
325
324
374
370
371
376
310
322
323
321
375
17a
316
312
314
313
311
315
302

FIG 22


415
461
465
410
466
417
405
406
420
456
421
401
450
34

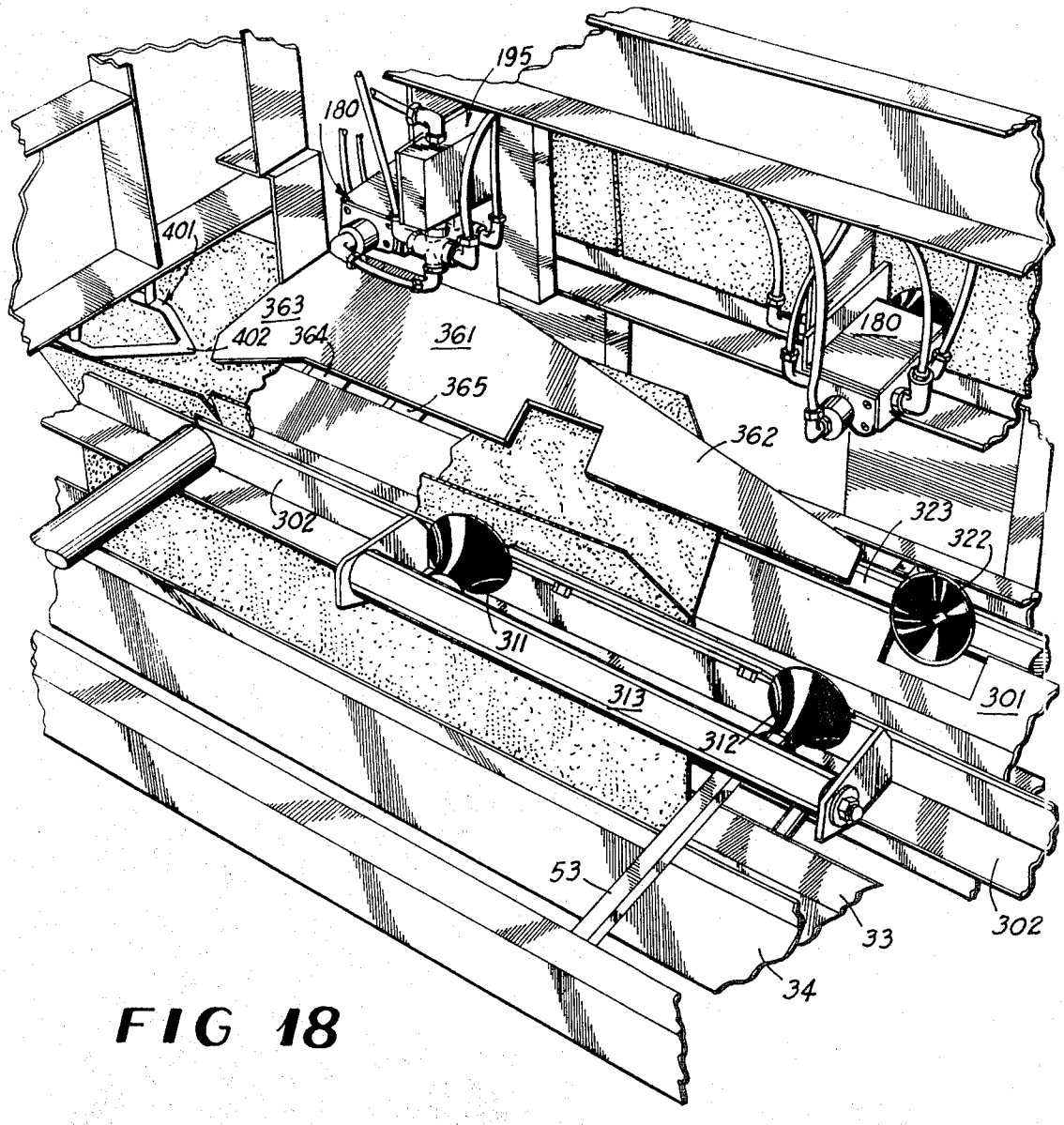

195
180
401
363
402
364
361
365
180
362
323
322
302
311
313
301
312
53
33
302
34

FIG 18

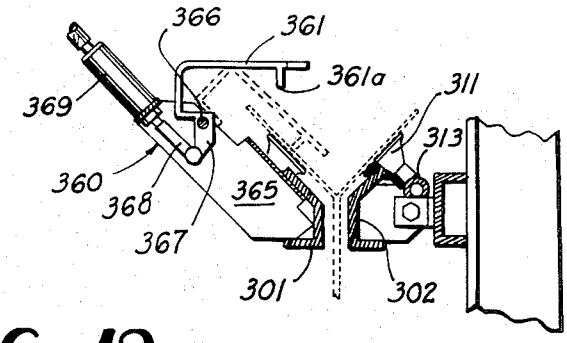
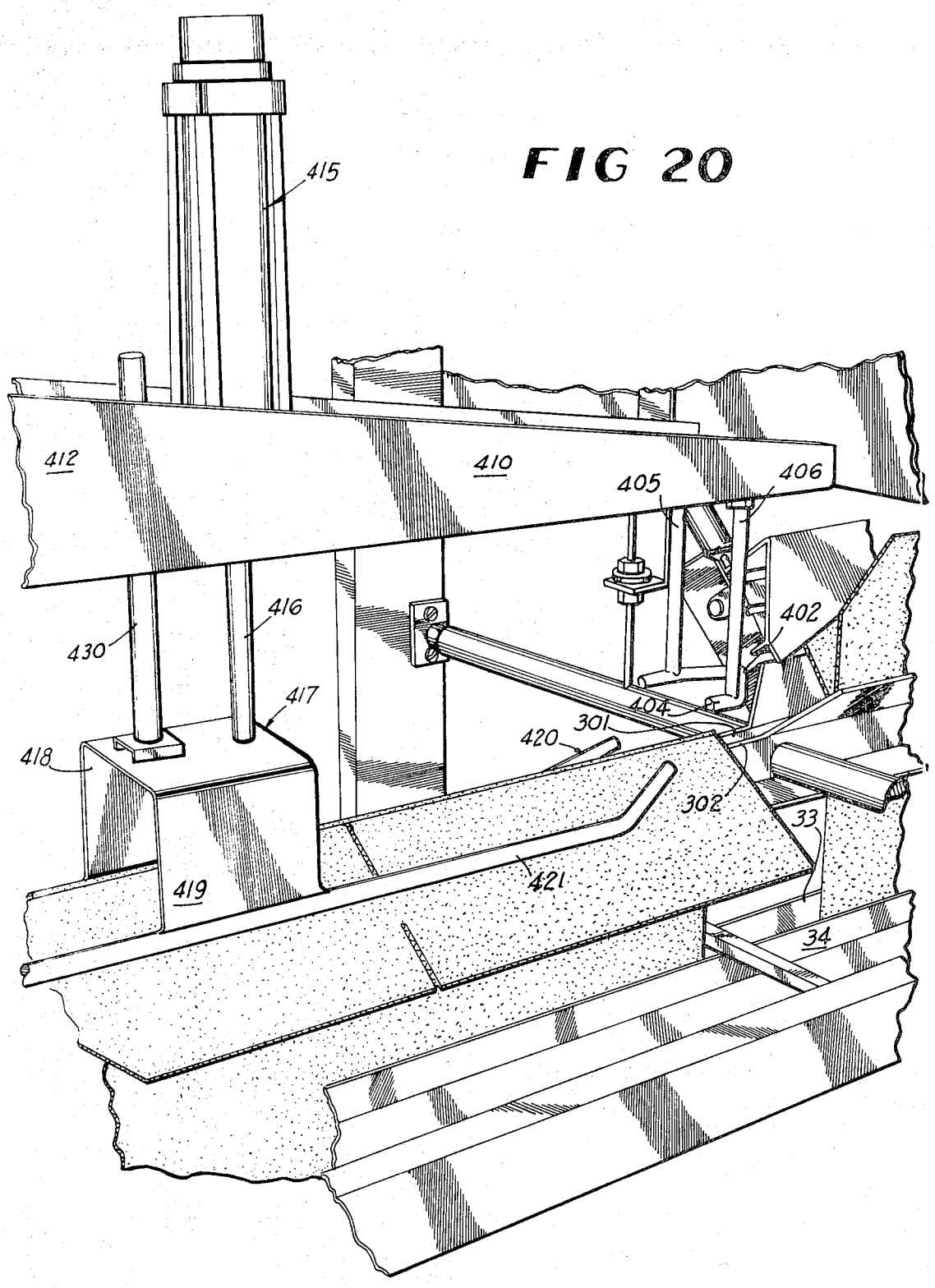

366
361
361a
311
369
313
360
368
365
367
301
302

FIG 19

FIG 20


415
412
410
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430
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418
302
33
421
419
34

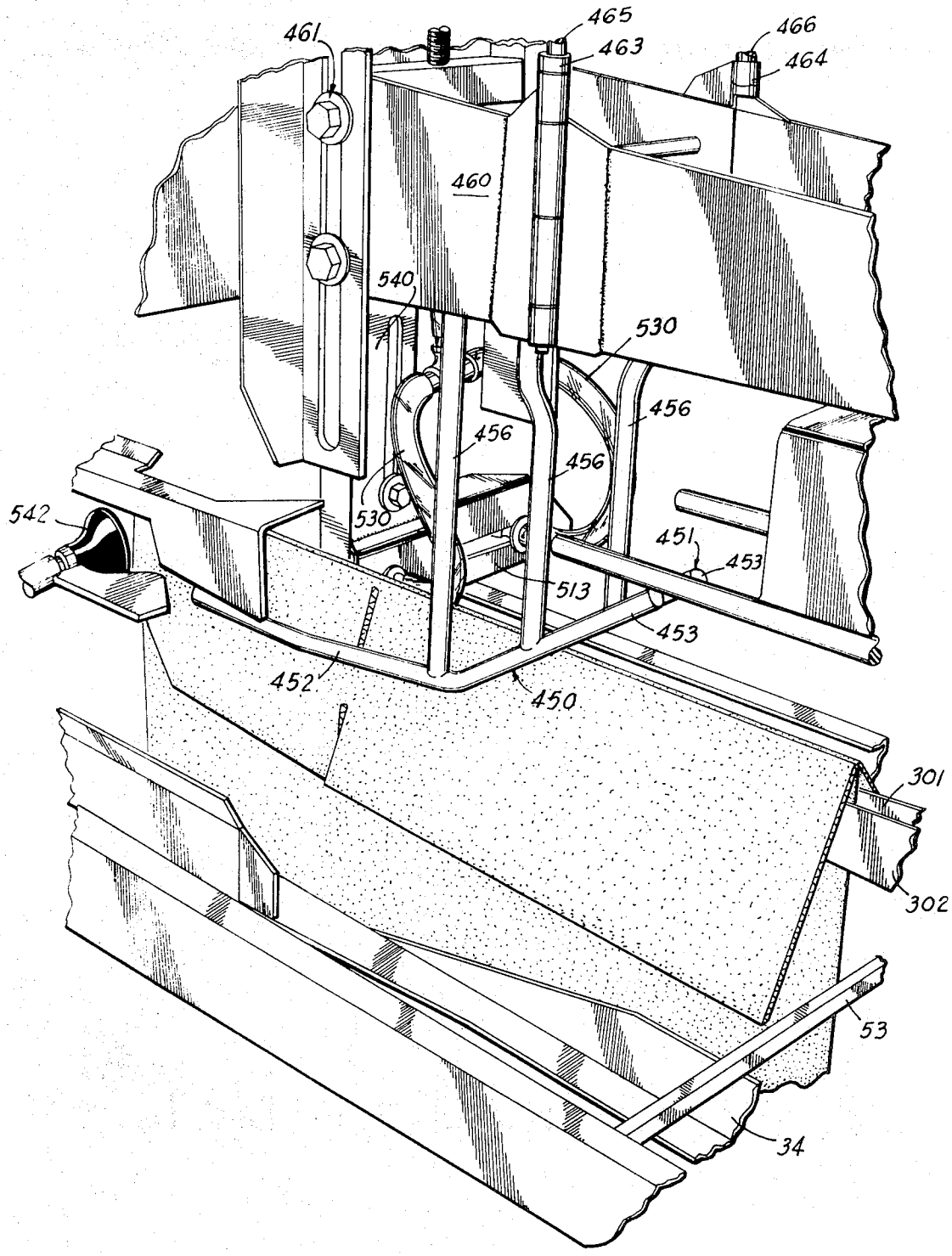

461
465
463
466
464
460
540
530
456
456
456
530
542
451
453
513
453
452
450
301
302
53
34

FIG 21

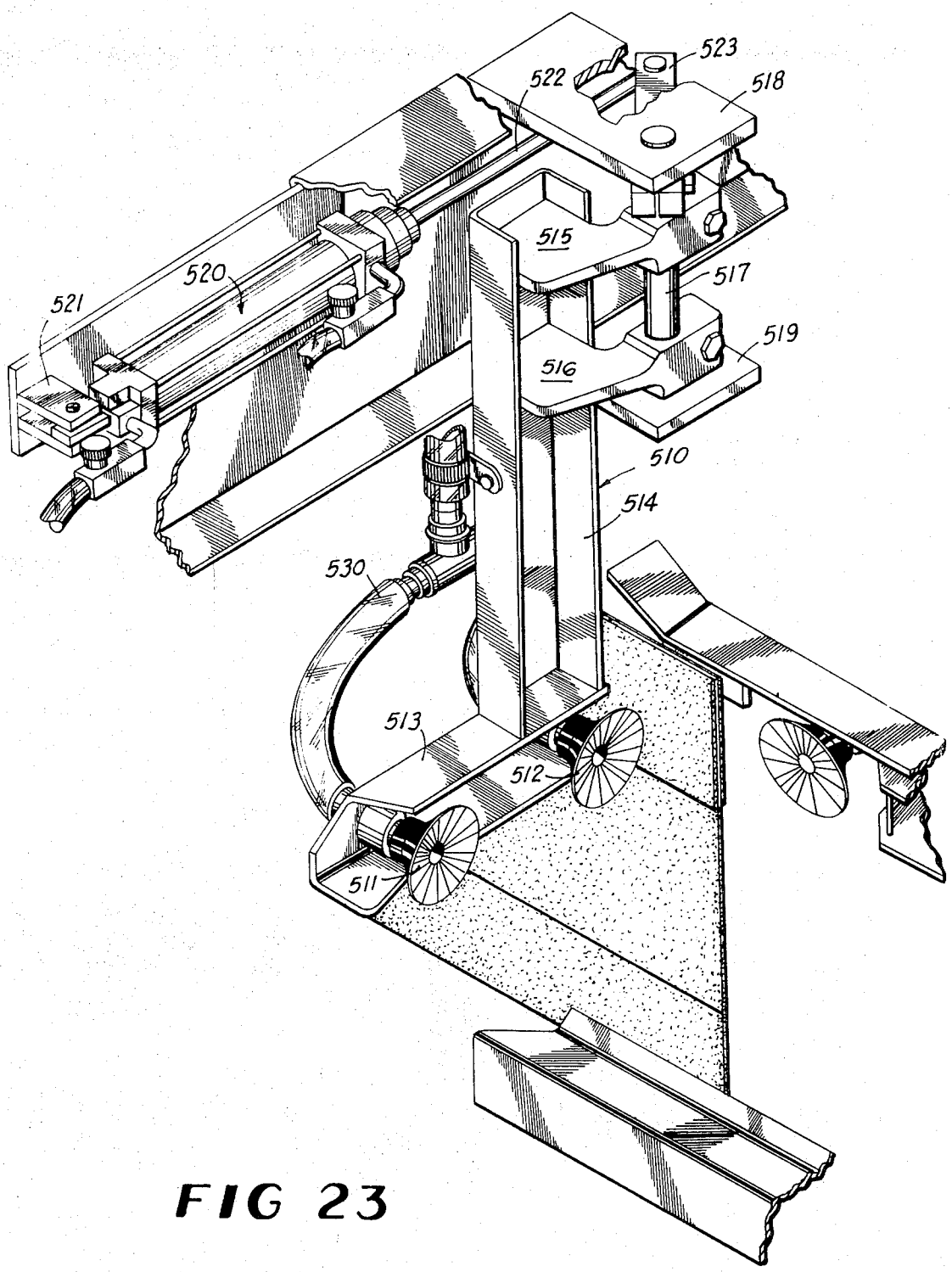


FIG 23

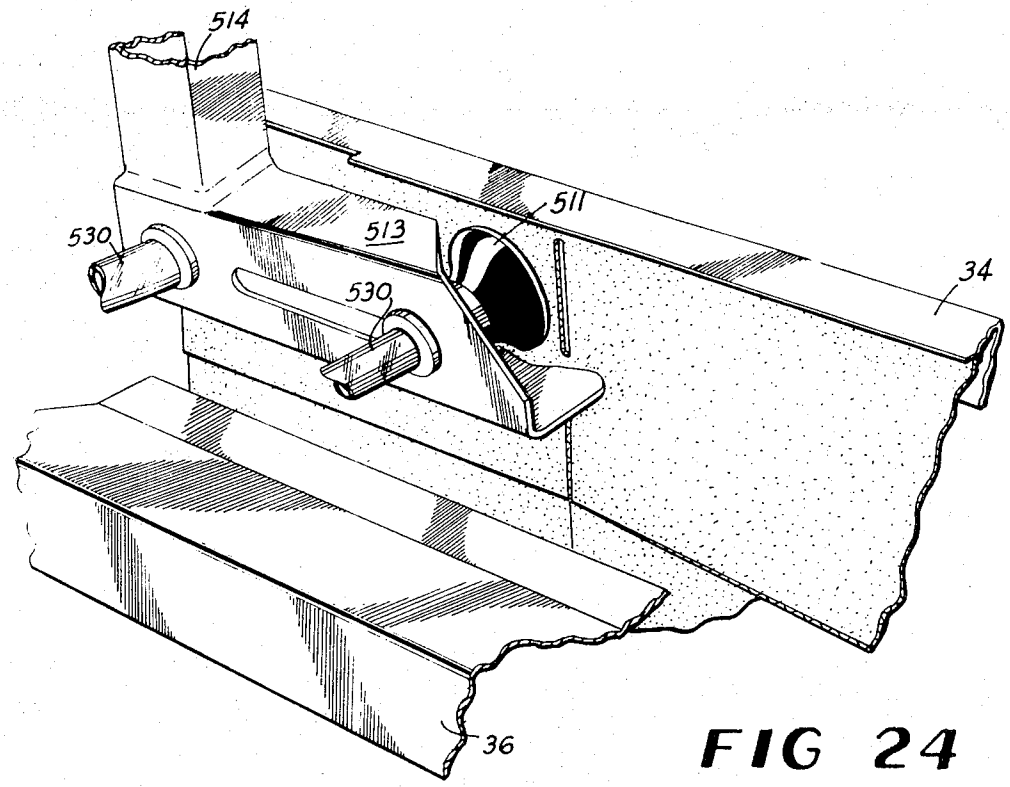


FIG 24

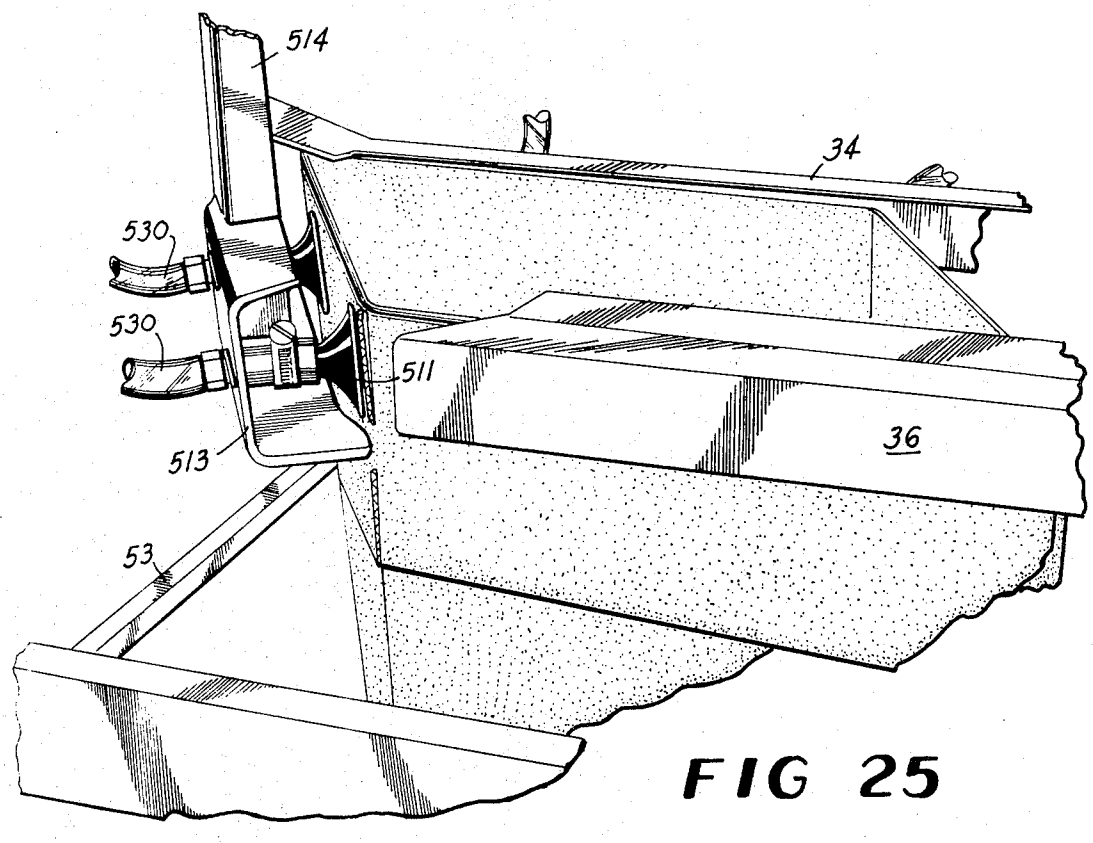


FIG 25

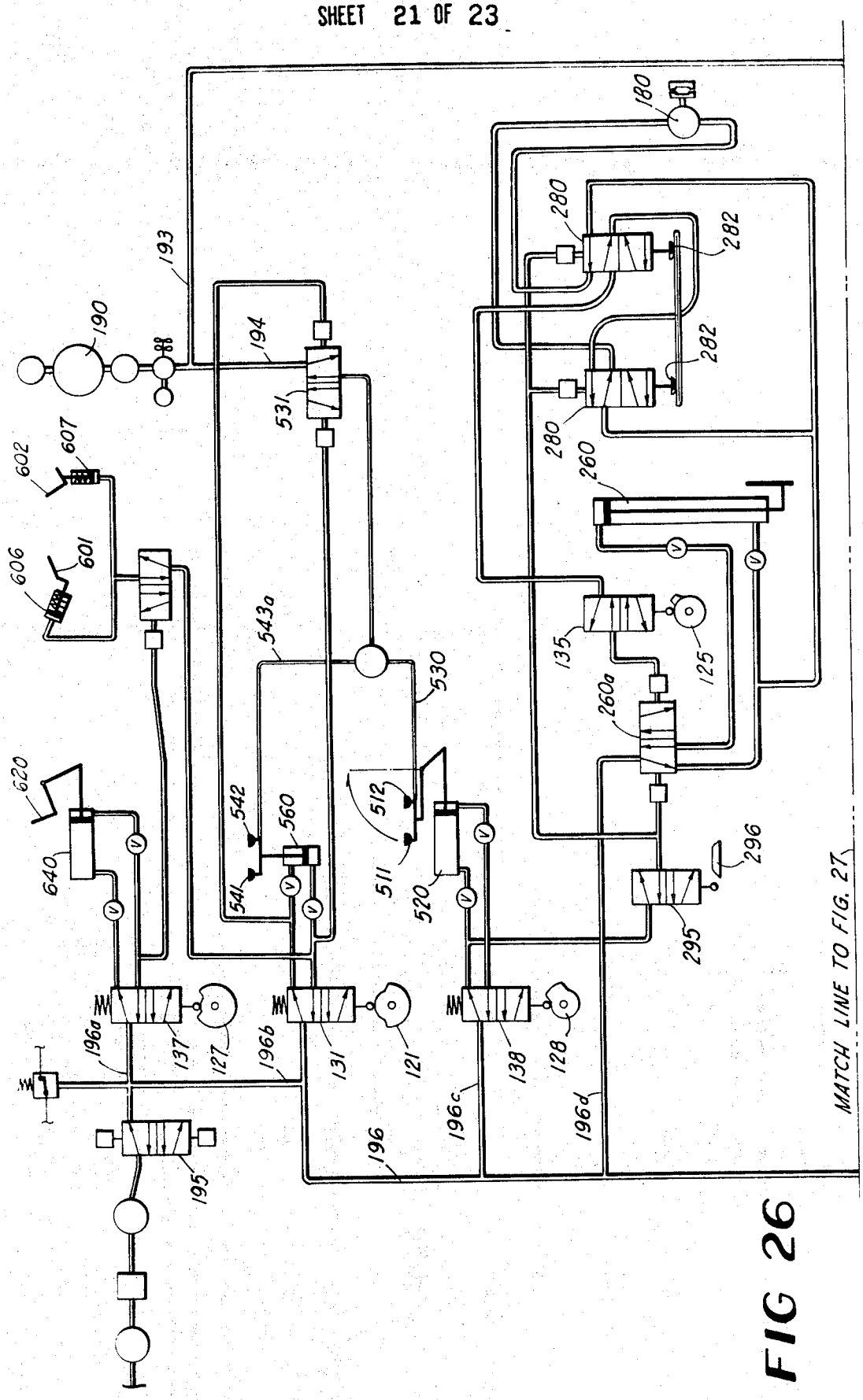

180
280
282
193
190
194
531
602
607
606
601
260
543a
530
135
125
260a
620
542
560
512
640
541
511
520
296
295
196a
137
127
196b
131
121
138
128
196c
196d
196
195
MATCH LINE TO FIG. 27

FIG 26

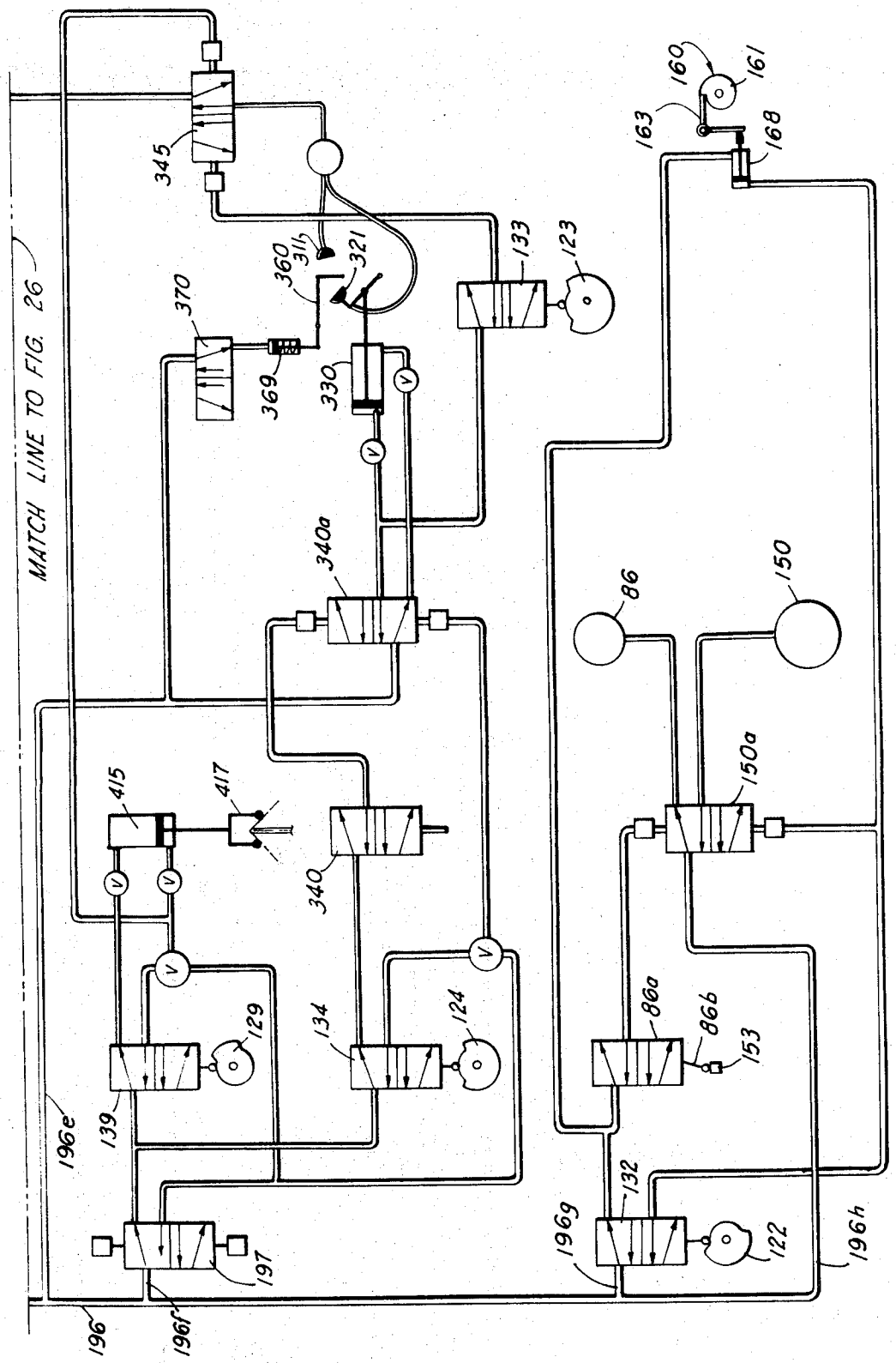

MATCH LINE TO FIG. 26
345
360
311
321
133
123
370
369
330
340a
340
415
417
129
139
134
124
197
196e
196
196f
160
161
163
168
86
150
150a
86a
86b
153
132
122
196g
196h

FIG 27

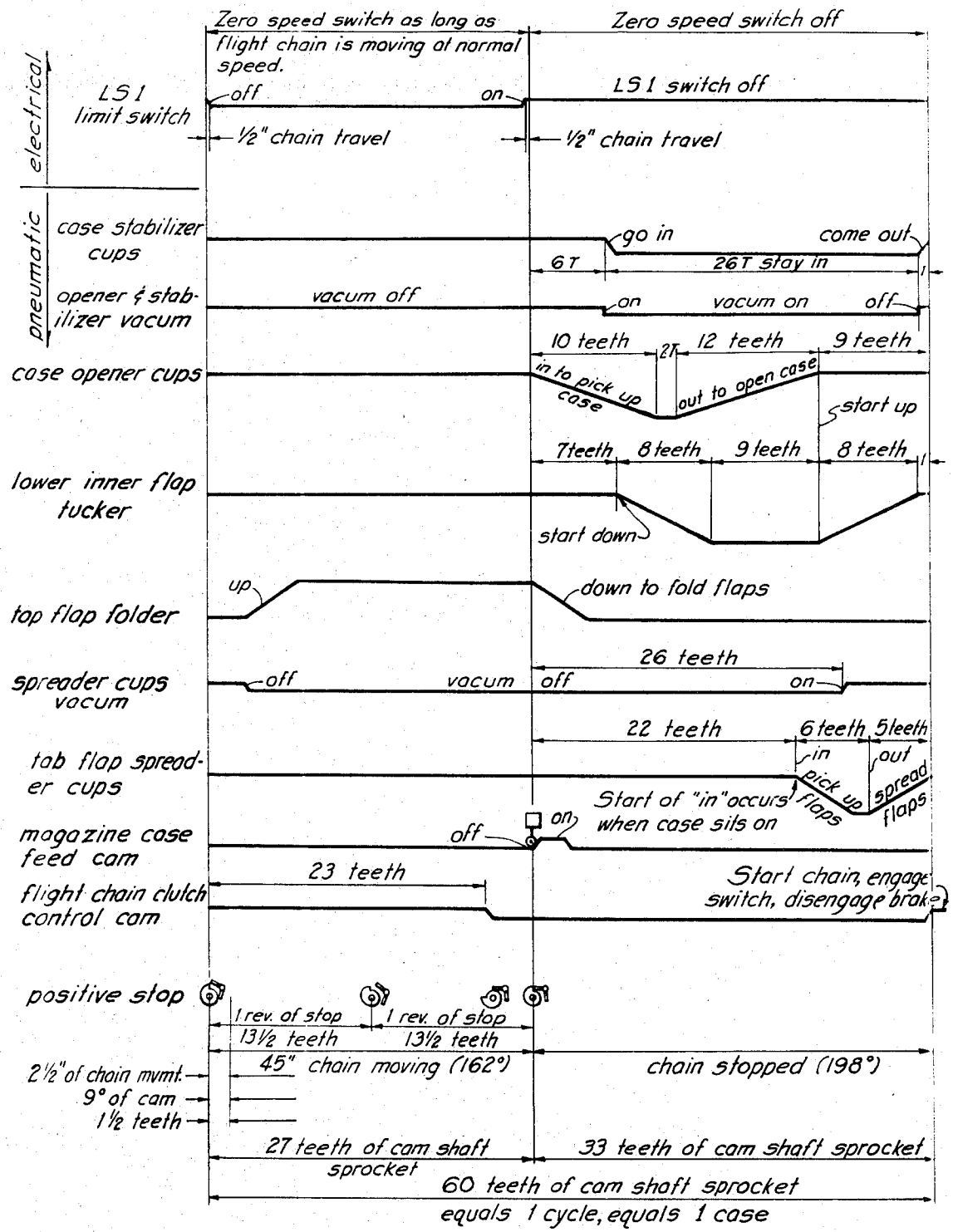

Zero speed switch as long as flight chain is moving at normal speed.
Zero speed switch off
electrical
LS 1 limit switch
off
on
LS 1 switch off
½" chain travel
½" chain travel
pneumatic
case stabilizer cups
go in
come out
6T
26T stay in
opener & stabilizer vacum
vacum off
on
vacum on
off
10 teeth
2T
12 teeth
9 teeth
case opener cups
in to pick up case
out to open case
start up
7teeth
8 teeth
9 teeth
8 teeth
lower inner flap tucker
start down
up
down to fold flaps
top flap folder
26 teeth
spreader cups vacum
off
vacum
off
on
22 teeth
6 teeth
5teeth
tab flap spreader cups
in pick up flaps
out spread flaps
Start of "in" occurs when case sits on
magazine case feed cam
off
on
23 teeth
Start chain, engage switch, disengage brake
flight chain clutch control cam
positive stop
1 rev. of stop
1 rev. of stop
13½ teeth
13½ teeth
2½" of chain mvmt.
9° of cam
1½ teeth
45" chain moving (162°)
chain stopped (198°)
27 teeth of cam shaft sprocket
33 teeth of cam shaft sprocket
60 teeth of cam shaft sprocket
equals 1 cycle, equals 1 case

FIG 28

BOX FORMING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to a box forming apparatus wherein box blanks are moved from a collapsed position to an open position. More particularly, this invention is directed to a box forming machine for use with boxes having four interconnecting sidewalls with four alternately interconnecting end flaps.

In the shipment of products from the factory to the various distribution outlets, the products are normally stored in cardboard boxes. The cardboard boxes are manufactured at one facility and maintained in a collapsed position for shipment to a second facility wherein the boxes are provided with goods. In setting up boxes for receiving products, the collapsed blanks are normally supported on a magazine section of an automatic box forming machine and are serially advanced through the box forming machine which includes a number of stations which perform various folding and assembling operations on the collapsed blank.

In certain types of products which are placed in cardboard boxes for shipment, such as bottles of liquid which are filled by automatic machinery, it is necessary to maintain the top flaps of the box in an open position for receiving the liquid container from the automatic filling machines. Some types of box forming machinery are provided with retaining members which will engage and retain the top end flaps in an open position during a filling operation.

One type of specialized carton blank has been manufactured for use in maintaining the top end flaps in an open relationship during placement of containers within the box. This special type of blank includes four interconnected sidewalls with four alternately interconnected end flaps extending therefrom. The box blanks are shipped from the factory with the sidewalls and interconnected end flaps in coplanar relationship relative to each other and are stored in this position on the box forming machine for assembling the box into an open position for receiving products. In utilizing the specially formed carton blank, one pair of interconnected end flaps is folded back against the sidewalls from which they extend and the second pair of interconnected end flaps is also folded back against the sidewalls from which they extend, before the carton blank is opened. With the interconnected end flaps folded back against their respective sides, the box can then be opened to a rectangular position wherein the interconnected portion between the end flaps will maintain the end flaps in a folded position against the sides of the box during further handling of the box to place liquid containers or other products therein.

The above described specialized box blanks are primarily used in the liquid packaging industry wherein the liquid containers are manufactured at one plant, placed in the boxes with the interconnected end flaps folded against the sides and shipped to a second plant wherein the containers are removed therefrom, filled with liquid and again replaced in the box. After the filled containers have been placed in the box, the tabs extending between the interconnected flaps are severed and the end flaps are folded to a cover position and secured in such position for further shipment.

The use of the specialized box blanks having the four interconnected sides with four alternately interconnected end flaps described hereinabove, requires special box forming machinery for automatically forming the boxes into an assembled relationship. One such specialized box forming machine is disclosed in the U.S. Pat. to Pearson, No. 3,421,415 issued Jan. 14, 1969.

One problem with the prior art box forming machine capable of utilizing the specialized boxes having interconnected flaps, is that the carton or box blanks are supported in one plane in the magazine storage section and are adjusted to a second plane during a box setting up process, which angular adjustment complicates the mechanism required, thus rendering the machine more susceptible to breakdown. The prior art magazine section supports the carton blank in generally horizontal planes vertically stacked above each other. In dispensing the carton blanks from the vertically stacked array of blanks, it is necessary to provide complicated holding mechanisms for holding the remainder of the stack while retrieving the bottom collapsed blank for use.

In the manufacture of the specialized carton blanks, the blank is scored at a number of areas where the blank is to be folded in a box forming operation. Sometimes the dies which perform the scoring operation are not properly set, thus the score effected is too light. Also, if corrugated cartons remain in storage for any length of time these scores have a tendency to disappear. If these scores are not deep enough they will cause problems when an attempt is made to open the flaps with interconnected tabs on them.

Another problem in forming a box which includes interconnected pairs of end flaps utilizing the prior art box forming machine, is that one end flap is normally engaged and cammed to a folding position which will put an undue strain on the interconnecting tabs. Often, the camming of one end flap will cause this interconnected tab to tear and break easily. If it breaks or tears, it wil jam the machine and also cause a ruined case. These tabs are put in the case when the case is made by means of a splitter. If the splitter is not set correctly of if it is dull, it can often leave a tab that is not cut to the proper depth, perhaps smaller than specified or a dull knife can cause a rip or a tear. In either event, this will cause the tab to break easily in a folding operation by camming of one end flap to effect movement of adjacent interconnected end flap.

Another problem is in storage of the cases. If the cases are stored for any length of time or in a hot or dry atmosphere, such as a warehouse or loft, the paper dries out and becomes quite brittle, and when the corrugated flaps are cammed to their folded position, the tabs will snap.

A further problem with the prior art box forming machine for use with specialized cartons is that the machinery is not capable of utilizing a number of various sized blanks, thus requiring a separate machine for each size of carton blank being used.

SUMMARY OF THE INVENTION

The above disadvantages of the prior art and the requirements for using specialized carton blanks have been overcome by the present invention which basically includes a box forming machine having a magazine storage station wherein the collapsed carton blanks are stored in generally vertically oriented planes and horizontally stacked in juxtaposition adjacent each other, with individual carton blanks being dispensed from the magazine station and transferred along a substantially common plane through the various box form-

ing operations. The box forming machine of the present invention includes a receiving station, a box opening station and a bottom flap folding station. Conveyor means is operatively associated with the box forming machine and cyclically controlled for advancing a collapsed blank from the receiving station to each of the box forming stations and for discharge adjacent an opposite end. The end flap spreading station includes one pair of fixed vacuum cups and a second pair of movable vacuum cups which are operatively associated with each other for spreading adjacent interconnected end flaps prior to advancement of the collapsed blank to the end flap folding station. In the end flap folding station, the pairs of interconnected end flaps are folded back against the sides from which they extend with the carton blanks remaining in the collapsed condition. The box opening station includes one pair of vacuum cups for grasping and stabilizing one side of the blank while a second pair of movable vacuum cups grasps and effects displacement of an adjacent interconnected side through an angle of substantially 90° to cause the box to be opened while maintaining the interconnected end flaps in folded relationship against their sides. The bottom flap folding station includes means for folding the leading and trailing end flaps into horizontal alignment with the box bottom for discharge from the box forming machine wherein glue can be readily applied in a next adjacent machine.

One important feature of the present invention is the storage of the carton blanks in vertical planes wherein the blanks can be transferred directly to a coplanar path of movement for transfer through the box forming machine.

A further feature of the present invention provides means for folding both pairs of interconnected end flaps in one angular direction away from the plane of the carton blank and then folding one interconnected pair of end flaps in an opposite offset angular relationship. This folding of the end flaps will not only serve to separate the end flaps but will also break predetermined score lines between the end flap and carton sides, which is an advantage over a carton blank which has improperly scored lines or in which the scored lines have disappeared.

Another feature of the present invention includes the method of folding the interconnected pairs of end flaps back against the outer sides, wherein the folding operation includes means for contacting and moving an interconnected pair of end flaps in a common plane during movement back against the sides from which they extend. By placing a force and effecting movement of the interconnected pair in a common plane, this will prevent the interconnected tabs from tearing or breaking.

Another important feature of the present invention is the alignment of the box forming stations wherein various steps of a box forming operation can be performed without changing the plane or path of movement of the blank during advancement through the various stations.

It is therefore a primary object of the present invention to provide a box forming machine which is capable of forming a box from a collapsed blank having four interconnected sidewalls with four alternately interconnected end flaps extended therefrom in which each blank is folded flat with one pair of interconnected flaps facing the other pair of interconnected flaps in juxtaposition to one another.

A further object of the present invention is to provide a box forming machine wherein the collapsed box blanks are maintained in a common plane as they are dispensed from the magazine station, and advanced through the various box forming stations.

Another object of the present invention is to provide a box forming machine having a magazine station which is operable for storing a plurality of box blanks and cyclically controlled for dispensing individual box blanks to the receiving end of a box forming machine.

A still further object of the present invention is to provide a box forming machine having an end flap spreading station which is operable for spreading two pairs of alternately interconnected end flaps without adjusting the plane of movement of the collapsed blank.

Still another object of the present invention is to provide a box forming machine having an end flap folding station wherein the alternately interconnected end flaps are folded back against the sides from which they extend without the box blank being adjusted from the common plane of movement through the box forming machine.

Yet another object of the present invention is to provide a box forming machine having a box opening station wherein the sides of the box blank are opened by adjusting the sides to substantially 90° angles relative to each other and wherein at least one side of the box blanks remains in the common plane of movement of the blank from the preceding end flap folding station.

A further object of this invention is to provide cyclic control means for effecting advancement of a collapsed carton blank from a receiving end of a box forming machine and through each of the box forming stations for discharge at the opposite end of the box forming machine.

An additional object of the present invention is to provide a box forming machine which is simple in construction and operation, economical to manufacture and reliable in performance.

These and other objects and advantages of the details of construction will become apparent after reading the following description of the illustrative embodiment of a box forming machine embodying the principles of the present invention with reference to the attached drawings wherein like reference numerals have been used to refer to like parts throughout the several figures, and wherein:

BRIEF DESCRIPTION OF THE FIGURES OR DRAWING

FIG. 1 is a perspective view of a box forming machine embodying the principles of the present invention;

FIG. 2 is a top plan view of the box forming machine showing the structural framework and drive control means, with certain parts omitted for purpose of clarity;

FIG. 3 is an elevational side view of FIG. 2;

FIG. 4 is a flow diagram showing the progression of the box blanks through the various forming operations;

FIG. 5 is a schematic elevational view taken substantially longitudinally through the box forming machine showing the progression of the blank through the various stations of the box forming machine, with certain parts omitted for purpose of clarity;

FIG. 6 is an enlarged vertical sectional view taken transversely through the receiving end and end flap spreading station and through the magazine assembly as shown in FIG. 5, with certain parts omitted for purpose of clarity;

FIG. 7 is an enlarged side elevational view of the magazine assembly, with certain parts broken away and shown in section and certain parts omitted for purpose of clarity;

FIG. 8 is a top plan view of FIG. 7, with certain parts omitted for purpose of clarity;

FIG. 9 is an end elevational view as seen from the left of FIG. 8 with certain parts omitted and certain parts broken away and shown in section for purpose of clarity;

FIGS. 10, 11, and 12 are enlarged plan views adapted to be connected along match line A—A and B—B showing the structural framework and drive control system, with certain parts broken away and shown in section and certain parts omitted for purpose of clarity;

FIGS. 13, 14 and 15 are side elevational views of FIGS. 10, 11, 12 with the views adapted to be connected along match line C—C and D—D;

FIG. 16 is an end elevational view of the box forming machine as seen from the left of FIG. 15 with certain parts omitted for purpose of clarity;

FIG. 16*a* is an enlarged vertical sectional view taken along lines 16—16*a* of FIG. 16;

FIG. 17 is an enlarged fragmentary perspective view of the end flap spreading station;

FIG. 18 is an enlarged fragmentary perspective view of the end flap spreading station showing the end flap retaining means, with certain parts broken away and certain parts omitted for purpose of clarity;

FIG. 19 is a vertical sectional view taken transversely through the end flap retaining plate and looking from left to right in FIG. 18;

FIG. 20 is an enlarged framentary perspective view of the end flap folding station, with certain parts omitted and certain parts broken away and shown in section for purpose of clarity;

FIG. 21 is an enlarged fragmentary perspective view of still another portion of the end flap folding station with certain parts omitted and certain parts broken away and shown in section for purpose of clarity;

FIG. 22 is an enlarged fragmentary perspective view of the end flap folding station with the folding assembly moved to an adjusted inoperable position;

FIG. 23 is an enlarged fragmentary perspective view of the box opening station with certain parts omitted and certain parts broken away and shown in section for purpose of clarity;

FIG. 24 is an enlarged fragmentary perspective view showing the opening assembly of FIG. 23 moved to an adjusted position;

FIG. 25 is an enlarged fragmentary perspective view similar to FIG. 24 showing the box opening assembly moved to a second adjusted position;

FIGS. 26, 27 are schematic pneumatic flow diagrams adapted to be connected along lines E—E and showing the various pneumatic control systems utilized in the box forming machine; and

FIG. 28 is a timing chart of the main program control shaft.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

GENERAL DESCRIPTION

The box forming machine embodying the principles of the present invention is shown in the drawings and generally represented by the reference numeral 10 (FIG. 1). The box forming machine will be described with reference to the support-ing framework as shown in FIGS. 1–3 and 10–15 and represented by numerals 11, 12, etc.; a conveyor 50 shown in FIGS. 2, 3, 5 and 10–15; a drive control system shown in FIGS. 10–15 and 26–28 and represented by numerals 100,101, etc.; a magazine assembly shown in FIGS. 1 and 5–9 and generally represented by numeral 200; an end flap spreading station shown in FIGS. 5, 6 and 17–19 and generally represented by numeral 300; an end flap folding station shown in FIGS. 5 and 20–22 and generally represented by the reference numeral 400; a box opening station shown in FIGS. 1, 5, 12, 16 and 23–25 and generally represented by numeral 500 and a bottom end flap folding assembly shown in FIGS. 12, 15 and 16 and generally represented by the reference numeral 600.

The box forming machine embodying the principles of the present invention is designed for particular application to a carton blank which includes four interconnected sides 1, 2, 3 and 4, as shown in FIG. 4. Each of the interconnected sides 1–4 includes an upwardly extending end flap 1*a*, 2*a*, 3*a* and 4*a*. The interconnected pairs of end flaps 1*a* and 2*a* are connected by an integrally formed tab portion 5. The adjacent pairs of end flaps 3*a* and 4*a* are connected by an integrally formed tab portion 6. The sides 1–4 of the collapsed carton blank also includes downwardly directed flaps 1*b*, 2*b*, 3*b* and 4*b*. In a collapsed storage position, the carton blank is supported such that the sides 1 and 2 are in juxtaposition against the sides 3 and 4, and with their respectively extending end flaps also supported in juxtaposition relative to each other.

FIG. 4 shows a flow diagram of the carton blank moving from a first collapsed position within the magazine assembly to a second position wherein the interconnected end flaps 1*a* and 2*a* are spread or folded to one angular displaced position on one side of the plane of the collapsed carton blank and the interconnected end flaps 3*a* and 4*a* are folded to an angular displaced position on an opposite side of the plane of the collapsed carton blank. The carton blank is then advanced to a third station wherein the interconnected end flaps 1*a* and 2*a* are folded back against the carton blank sides 1 and 2 and the interconnected end flaps 3*a* and 4*a* are folded back against the sides 3, 4, respectively. After the collapsed carton blank interconnected end flaps have been folded back against their sides, the blank is advanced to a box opening station wherein the the adjacent sides 1–4 are moved to angular displaced positions disposed substantially 90° relative to each other to form a rectangular box configuration. In movement of the carton blank sides to the box forming position, the integrally formed tab portions 5, 6 will maintain the end flaps 1*a*–4*a* in the folded position against their respective sides for use in facilitating the placement and removal of liquid containers or other articles therefrom. With the box in the box opening station, the bottom end flaps 16 and 46 are folded to a substantially horizontal position aligned with the bottom edge of the

box. The box is then advanced in this condition to a next adjacent machine for applying glue or other adhesive means and for folding and pressing bottom flaps *2b* and *3b* to a closed and sealed position.

The function of the supporting framework is to provide means for supporting the various box forming stations in operative association with each other and to provide a structural framework for supporting the drive and pneumatic control system.

The function of the conveyor is to provide means for advancing a carton blank cyclically through the various stations of the box forming machine.

The function of the drive control system is to provide means for controlling cyclic operation of the magazine assembly, the end flap spreading station, the end flap folding station, the box opening station and the bottom end flap folding station.

The function of the magazine assembly is to provide means for supporting a plurality of collapsed carton blanks in position to be dispensed individually to the first station of the box forming machine.

The function of the end flap spreading station is to provide means for receiving a collapsed carton blank from the magazine assembly and to provide means for separating and spreading adjacent interconnected pairs of end flaps.

The function of the end flap folding station is to provide means for receiving a collapsed carton blank with the end flaps spread from the end flap spreading station and to provide means for folding the adjacent interconnected pairs of end flaps back against the sides of the collapsed carton blanks.

The function of the box opening station is to provide means for receiving the collapsed carton blanks from the end flap folding station and to provide means for moving the sides of the collapsed carton blanks to a position of substantially ninety degrees relative to each other whereby the box will be opened to a substantially rectangular configuration.

The function of the bottom end flap folding station is to provide means for moving the downwardly hanging end flaps to a horizontally adjusted position in alignment with the bottom of the opened box.

The details of construction of each of the component parts and stations of the box forming machine will be described in detail hereinbelow in a separate section directed to each of the stations. An automatic cyclic control operation of the component parts of the various box forming stations will be described in the description of the operation of a collapsed carton blank being advanced through the box forming machine.

SUPPORTING FRAMEWORK

As shown in FIGS. **1–3** and **10–15**, the box forming machine is supported in an assembled box forming relationship by a plurality of conventional metal stock structural members which are connected to each other by conventional means such as welding or threaded bolt connecting elements. The supporting frame means includes four channel-shaped vertical legs **11–14.** The leg members **11–14** are connected to the outer surface of a pair of longitudinally extending inwardly directed channel-shaped members **15, 16.** The longitudinal extending frame members **15, 16** are secured in horizontally spaced parallel arranged relationship by a plurality of transverse cross-connecting frame elements **17.**

As shown in FIGS. **2, 3, 10** and **11,** the supporting framework includes a pair of horizontally oriented cross con-necting supporting plates **18, 19.** The supporting plate members **18** will provide a supporting surface for a motor and gear box drive means and the supporting plate **19** will provide a supporting surface for a pneumatic drive control means, both of which will be described in more detail hereinbelow. The supporting framework also includes four vertically extending post elements **20, 21, 22, 23.** The vertically extending support posts **20–23** are utilized for supporting various component parts of the box forming machine in position relative to the main supporting framework. The components of the box forming machine are supported to define a receiving end generally represented by the reference numeral **30** and a discharge end generally represented by the reference numeral **31.**

A collapsed carton blank is guided from the receiving end toward the discharge end by means of a pair of angular guide track members **33, 34.** The guide track members **33, 34** are supported in laterally spaced horizontally oriented relationship and are parallel arranged relative to each other to define a slot **35** therebetween for receiving and guiding a collapsed carton blank.

As shown in FIG. **2,** the guide track member **33** terminates at a point short of the end of guide track member **34** with the framework being provided with a second horizontally spaced guide track member **36.** Guide track members **34** and **36** will provide means to guide an open box through the box opening and bottom end flap folding station.

CONVEYOR

As shown in FIG. **5,** a collapsed carton blank will be advanced from adjacent the receiving end through the various box forming stations by means of a conveyor assembly generally represented by the reference numeral **50** and including a pair of endless chain members **51, 52.** Each of the endless chain members **51, 52** are vertically oriented and horizontally spaced relative to each other to provide a distance therebetween which will accommodate an open box adjacent the discharge end of the box forming machine. A collapsed blank and an open box are advanced with the conveyor chain **51, 52** by a plurality of cross connecting bars **53.** Cross connecting bars **53** are connected at their opposite ends to the chain members **51, 52** and are operable for engaging the trailing edge of a collapsed blank and a trailing edge of an open box for effecting movement of the blank and box through the box forming machine.

As shown in FIG. **5,** the conveyor means **50** is provided with an upper run which is represented by the reference numeral **54** and a lower run which is represented by the reference numeral **55.** A collapsed blank and an open box are advanced during movement of the cross connecting bars **53** along the upper run of the conveyor. As shown in FIG. **5,** the lower edges of the collapsed blank and the open box are supported by bottom guide means **60.** The guide means **60** is detailed in dimensions to extend between the guide members **33, 34** to maintain the collapsed blank in a vertically aligned position during movement through the various forming operations.

Referring now particularly to FIGS. **5** and **13,** the conveyor chain members **51, 52** are supported adjacent the entrance end and adjacent the upper run of the conveyor by means of a pair of sprockets **61, 62** which

are supported by a cross support shaft **63.** Cross support shaft **63** is rotatably supported by conventional bearing means on an upper edge of a pair of vertically extending channel-shaped support members **64.** The upper run of the chains **51, 52** are supported adjacent the discharge end by a pair of sprockets **65, 66.** The sprockets **65, 66** are coplanar aligned relative to the sprockets **61, 62,** respectively. Sprockets **65, 66** are supported by stud shafts **67, 68.** The stud shafts **67, 68** are mounted on a pair of inwardly directed channel-shaped members **69. 70.** The channel-shaped members **69, 70** extend throughout the length of the box forming machine and provide a guiding support for the upper run of the chain members **51, 52** and cross bars **53.**

As shown in FIGS. **10** and **13,** the chain members **51, 52** are supported adjacent the conveyor lower run **55** and adjacent the receiving end of a chain adjustment assembly which includes three pairs of axially spaced sprockets **71, 72,** and **73.** One set of the three sprockets is aligned in a common plane for supporting each of the chain elements **51, 52.** The sprockets **71, 73** are secured in an aligned set position by support shaft **75, 76.** Sprockets **72** are supported on a cross support shaft **77.** The opposite ends of shaft **77** is supported for sliding movement within elongated slot **78** provided in each of the longitudinally extending frame members **15, 16.** As shown in FIGS. **10** and **13,** the support shaft **72** is adjusted to a selectively set position within slot **78** by means of a pair of threaded bolt adjustment members **79.** The threaded bolt adjustment members **79** are secured in a selectively set position relative to support brackets **80** by means of a pair of conventional threaded locking nuts **81.** The adjustable sprockets **72** will provide effective means for applying the proper tension to the conveyor chains **51, 52.** Conveyor chains **51, 52** are supported adjacent the discharge end lower run by a pair of sprockets **82, 83.** Sprockets **82, 83** are fixed in axially spaced location on a cross support shaft **84.** Cross support shaft **84** is supported adjacent one end by a conventional bearing means **85** and is supported adjacent an opposite end by means of a conventional brake assembly **86.** The conveyor chain members **51, 52** are provided with additional support adjacent sprockets **82, 83** by a pair of idler sprockets **87, 88** as shown in FIGS. **5** and **15.**

DRIVE CONTROL SYSTEM

Referring now particularly to FIGS. **10–12, 16** and **16a** a drive control system is shown for use in effecting cyclic operation of the conveyor means **50,** program control shaft and magazine assembly indexing drive means.

AS shown in FIG. **11,** the drive control system includes a conventional electric motor **100** mounted on the upper surface of cross support plate **18.** Motor **100** includes an output drive shaft **101** having a pulley **102** mounted thereon. Drive from motor and pulley **102** is delivered by a belt **103** to pulley **104** operatively associated with a conventional gear reduction housing **105.** Gear reduction housing **105** includes a first output drive shaft **106** and a second output drive shaft **107.** A sprocket element **108** is fixed to shaft **107** and is in driving engagement with a chain **109** which delivers rotary movement to sprocket **110** fixed to program control shaft **111.** The opposite ends of program control shaft **111** is supported by conventional bearing means **112, 113** in the frame members **15, 16,** respectively. Chain **109** is supported in an adjusted driving relationship by means of an idler sprocket **114.**

As shown in FIGS. **10** and **11,** the program control shaft **111** includes a plurality of cams **121–129** which are fixed thereto in angular set relationship and detailed in design for controlling a plurality of control valves **131–139** operatively associated therewith, respectively. The specific operation of a cam and its associated control valve will be described in more detail hereinbelow in the description of the various component and subassemblies of the box forming machine.

Referring now particularly to FIG. **11,** the gear reduction housing output drive shaft **106** includes a sprocket **141** which is in driving engagement with a chain **142.** An opposite end of chain **142** is supported in driving engagement with a sprocket **143.** Sprocket **143** is fixed to a drive shaft **144.** The opposite ends of drive shaft **144** are supported by conventional bearing means **145, 146** in the longitudinal extending side frame members **15, 16,** respectively. Drive chain **142** is maintained in an adjusted driving relationship by means of an idler sprocket **147.** Shaft **144** is provided with a clutch assembly **150** which includes means for selectively coupling a drive chain **151** to the shaft **144** whereby rotary movement of shaft **144** will effect corresponding movement of chain **151.**

As shown in FIG. **12,** chain **151** is supported at its opposite end by a first sprocket **152.** Sprocket **152** is mounted on a shaft which is supported by a zero speed switch control mechanism **153.** Chain **151** is also supported in driving engagement with a sprocket **154** which is fixed to the conveyor drive shaft **84.** Drive chain **151** is maintained in an adjusted driving relationship by a pair of adjustable idler sprockets **155, 156.**

As shown in FIG. **16***a*, the sprocket **154** is fixed to shaft **84** and includes a positive stop clutch assembly **160** operatively associated therewith. The positive stop clutch assembly includes a limit stop cam element **161** having a stop surface **162** operatively associated with a bell crank **163.** Bell crank **163** is pivoted on a frame element at **164** and includes a first arm **165** detailed in dimension for engaging the limit stop surface **162** to maintain drive shaft **84** in an angular set position. Bell crank **163** also includes a lower depending arm **166.** Arm **166** is supported for contact by a reciprocably operable piston rod **167.** Piston rod **167** is supported for reciprocating movement by means of a conventional pneumatic cylinder **168.** Operation of pneumatic cylinder will effect movement of piston rod **167** to the right to thereby effect a counterclockwise movement of bell crank **163** to disengage the limit stop arm **165** from limit stop surface **162.** As shown in FIG. **16***a*, an adjustable set screw means **169** is operatively associated with the bell crank arm **166** for limiting the extent of clockwise movement of bell crank about pivot **64.**

The conveyor clutch assembly **160** is operated to release the limit stop cam element **161** by effecting operation of cylinder **168.** Cylinder **168** is moved to an operable position for effecting disengagement of cam element **161** by operation of a control valve **132.** Valve **132** is actuated by cam **122** mounted on the program control shaft **111.** As shown in FIG. **27,** movement of control valve **132** to a position for effecting a disengagement of the limit stop element **161** will also effect movement of clutch control valve **150***a* to an operable position to energize the conveyor clutch assembly **150** whereby drive can be transferred through chain **151** to

effect operation of conveyor **50.** The conveyor brake assembly **86** is also controlled by valve **150***a*. With the valve **150***a* in one position, the brake assembly **86** is operated, and with valve **150***a* in second adjusted position, the clutch assembly is operated.

Movement of valve **150***a* to a conveyor braking position is effected by means of a control valve **86***a* which includes an actuator element **86***b* operatively associated with a conveyor cross connecting bar **53.** The control valve **86***a* is located adjacent the box opening station, wherein the conveyor will be stopped when a blank has been moved into position for opening in the box opening station. The cross connecting conveyor bar **53** will effect movement of the actuator **86***b* to an operable position whereby valve **150***a* will be adjusted to effect operation of brake assembly **86.** The control valve **86***a* is connected in series with program control valve **132** whereby the valve **86***a* is only operable provided the program control valve **132** is not angularly positioned to effect operation of the clutch assemblies **150, 160.** A sequence of operation of the conveyor, including the control of the clutch and brake assemblies by the program control valve means will be described in more detail hereinbelow in the description of the operation of the box forming machine.

Referring now to FIGS. **10** and **11,** the drive control system includes a sprocket **170** which is fixed to drive shaft **144** adjacent longitudinal extending support frame members **16.** Sprocket **170** is supported in driving engagement with a chain **171.** An opposite end of chain **171** is supported in driving engagement with a sprocket **172.** Sprocket **172** is fixed to drive shaft **173.** The opposite ends of drive shaft **173** are supported by conventional bearing means **174, 175** mounted on the side frame members **15, 16,** respectively. Chain **171** is maintained in an adjusted driving relationship by means of an idler sprocket **176.**

As shown in FIG. **10,** drive shaft **173** is provided with a clutch assembly **180.** Clutch assembly **180** includes a sprocket **181** which is supported in driving engagement with a chain **182.** An upper end of chain **182** is connected to a sprocket **183** on the magazine drive shaft. Chain **182** is maintained in an adjusted driving relationship by means of an adjustable idler sprocket **184.**

The clutch assembly **180** is operative for connecting the sprocket **181** and chain **182** to the drive shaft **173** whereby drive can be delivered from motor **100** to the magazine drive mechanism, as will be described in more detail hereinbelow.

The box forming machine drive control system includes a vacuum supply source shown in FIG. **10** and generally represented by the reference numeral **190.** The vacuum supply source **190** is driven by a conventional belt and pulley drive means **191** from a drive motor **192.** The vacuum supply source **190** and drive motor **192** are supported on the upper surface of the crosssupport plate member **19.** Vacuum supply source **190** is operable for furnishing a vacuum supply to a plurality of suction cups, as will be described in more detail hereinbelow.

Vacuum supply source **190** is connected by a pair of supply lines **193, 194** to vacuum control valves **345, 531,** respectively. The description and operation of vacuum control valves **345, 531,** will be described in more detail hereinbelow, as they relate to the particular elements to be operated.

As shown in FIGS. **26** and **27,** the box forming machine includes a plurality of pneumatic cylinders operatively associated with a number of cyclically controlled box forming mechanisms mentioned above, which cylinders will be described in detail below as they relate to the various stations and assemblies.

As shown in FIGS. **26, 27,** a conventional pneumatic supply source (not shown) is operatively connected to a manual control valve **195.** Manual control valve **195** includes a supply line **196** having a plurality of branch supply lines **196***a*, **196***b*, **196***c*, **196***d*, **196***e*, **196***f*, **196***g*, and **196***h*. Branch supply line **196**a is operatively connected to control valve **137**; branch supply line **196***b* is operatively connected to control valve **131**; branch supply line **196***c* is operatively connected to control valve **138**; branch supply line **196***d* is operatively connected to control valve **260***a;* branch supply line **196***e* is operatively connected to control valve **340**; branch supply line **196***f* is operatively connected through manual control valve **197** to control valves **134** and **139**; branch supply line **196***g* is operatively connected to control valve **132**; and, branch supply line **196***h* is operatively connected to control valve **150***a*. The description of operation of the above mentioned control valves and their associated cylinders will be described in more detail hereinbelow in the description of each of the stations and assemblies and in the description of the operation of the box forming machine.

MAGAZINE ASSEMBLY

Referring now particularly to FIGS. **1** and **5–9,** the magazine assembly is shown and generally represented by the reference numeral **200.** The magazine assembly is located adjacent the entrance end of the box forming machine and is operable for supporting a plurality of carton blanks in position to be individually dispensed to the receiving end of the box forming machine.

As shown in FIGS. **1, 8** and **9,** the magazine assembly is constructed to include a pair of base frame members **201, 202.** Base frame member **201** is attached to the upper extended ends of channel-shaped post members **22, 23** with the base frame member **202** being supported on the upper extended ends of leg members **12, 14.** The frame members **201, 202** are connected to the vertically extended posts and leg members by conventional means such as welding or threaded connecting bolts (not shown). Base frame members **201, 202** are supported in a substantially horizontal position to include a first portion which extends transversely between the leg members and post members and includes a second portion which is cantilevered to the left of the main frame assembly, as shown in FIG. **1.**

As shown in FIGS. **1** and **8,** the left extended ends of the base frame members **201, 202** are connected by an end frame element **203.** The magazine assembly frame means also includes a number of cross connecting frame members **204, 205** and **206.** The frame members **201-206** provide means for supporting a plurality of collapsed carton blanks, for supporting indexing means for advancing the blanks to a blank dispensing position and for supporting a dispensing assembly for dispensing individual collapsed blanks to the end flap spreading station.

As shown in FIGS. **1** and **6,** a plurality of collapsed carton blanks are supported on the magazine assembly in vertically oriented planes horizontally positioned in juxtapositioned relationship. The carton blanks are

supported for indexing movement to a dispensing position by a pair of horizontally oriented parallel arranged support shafts **207, 208.** The support shafts **207, 208** are supported adjacent one end by bearing members **209, 210,** which are mounted on the frame elements **203, 204,** respectively. The opposite ends of support shafts **207, 208** are rotatably supported by the peripheral surface of a pair of rollers **211, 212.** Rollers **211, 212** are mounted on the frame member **206,** as shown in FIGS. **7** and **8.** Support shafts **207, 208** are provided with oppositely directed threaded surfaces which provide a support for the carton blanks, with the threaded surfaces operable for effecting movement of the collapsed carton blanks toward the dispensing assembly during intermittent rotary movement of the support shafts **207, 208.**

As shown in FIGS. **2, 3, 7, 8, 10** and **13,** support shafts **207, 208** are intermittently driven for advancing the collapsed carton blanks to a dispensing position by means of a control shaft **215.** Control shaft **215** is rotatably supported by conventional bearing means **216, 217** mounted on frame members **204, 205,** respectively. Control shaft **215** is driven from the main drive assembly described hereinabove by drive chain **182** and clutch control mechanism **180.**

As shown in FIG. **8,** the control shaft **215** includes an extended end which passes through bearing **216** and is provided with a sprocket **219.** Sprocket **219** transfers drive to a coplanar aligned sprocket **220** mounted on shaft **208** by means of a chain **221.** A second sprocket **222** is fixed to shaft **208.** A chain **223** is supported in driving engagement with sprocket **222** and in driving engagement with a coplanar aligned sprocket **224** mounted on support shaft **207.** Chain **223** extends beyond sprocket **224** and is supported by an idler sprocket **225.** Idler sprocket **225** will support chain **223** such that the lower run of the chain will be in driving engagement with sprocket **224** whereby the support shafts **207, 208** are both driven in a counterclockwise direction of rotation as shown in FIG. **9.** The intermittent drive delivered to the support shafts **207, 208** for effecting serial advancement of individual carton blanks to a dispensing position will be described in more detail hereinbelow.

The collapsed carton blanks are maintained in a horizontally aligned position by a pair of guide members **231, 232.** Guide members **231, 232** are detailed in horizontal spacing to confine the lateral edges of collapsed carton blanks therebetween and to maintain the collapsed carton blanks in a horizontally aligned position as they are advanced along the surface of the support shafts **207, 208.**

As shown in FIGS. **6–9,** the magazine assembly **200** includes a dispensing assembly generally represented by the reference numeral **240** which is operable for dispensing individual carton blanks from the magazine into the receiving end of the box forming machine. The dispensing assembly **240** includes a structural framework having a pair of vertically extending channel-shaped frame members **241, 242** which are connected adjacent their upward ends by a horizontal extending channel-shaped frame **243.** A second cross connecting frame member **244** extends between the vertically oriented frame members **241, 242** in substantially parallel relationship to and below frame member **243.**

As shown in FIG. **9,** the dispensing framework includes a pair of parallel arranged vertically extended frame elements **245, 246** which are connected to frame members **243, 244** by bracket elements **247.** Frame elements **245, 246** provide a support for a pair of guide tracks **248, 249.** Guide tracks **248, 249** are constructed of a suitable synthetic material which will provide a self-lubricating surface for supporting a reciprocally operable dispensing member **250.**

Dispensing member **250** is constructed in the form of a U-shaped member having a base portion **251** and a pair of vertically extending legs **252, 253,** as shown in FIG. **8.** The legs **252, 253** are supported for sliding movement along one surface of the guide tracks **248, 249** and are maintained in position relative thereto by means of a pair of retaining bars **254, 255.** Retaining bars **254, 255** are detailed for slidably engaging an opposite surface of the guide tracks **248, 249.** Retainer bars **254, 255** are maintained in proper alignment and connected with legs **252, 253** by a plurality of connecting bolt means **256** and spacer members **257.** The dispensing member **250** is supported for vertical translating movement along the guide tracks **248, 249** from an upper retracted position, as shown in FIG. **9** to an extended position adjacent the lower edge of the guide tracks **248, 249.** When the dispensing member **250** is moved to the lower position, a collapsed carton blank will be moved into position adjacent the receiving end of the box forming machine.

Vertical translating movement of the dispensing member **250** is effected by means of a pneumatic control cylinder **260.** Cylinder **260** is supported on the upper surface of frame member **243** and includes a conventional piston rod **262** having a threaded connecting element **263** which is connected to an angle member **265.** Angle member **265** is connected to the base **251** of the dispensing member by conventional threaded bolt connecting means **265.** The length of piston rod **262** is detailed for effecting movement of the dispenser member **250** from the upper retracted position to the lower dispensing position.

As shown in FIG. **7,** the dispensing member **250** includes an angled guide member **266** which is supported thereon for guiding the upper edges of collapsed carton blanks into position beneath the dispensing member base portion **251.** A stop member **267** is supported beneath the angle frame element **264** for serving as a limit position to align the collapsed carton blank beneath the dispensing member base frame portion **251.**

As shown in FIG. **7,** the magazine assembly includes a pair of support elements **270** which are supported in horizontally spaced position on the upper surface of the cross connecting frame element **206.** The support elements **270** are detailed in vertical spacing to present an upper surface which is coplanar with the upper surface of the support shafts **207, 208.** The support members **270** are detailed in spacing relative to the guide tracks **248, 249** to define a space therebetween which will permit a single collapsed carton blank to pass therethrough in a dispensing operation.

In operation, the support shafts **207, 208** are operable for successively advancing the leading vertically oriented carton blanks into a dispensing position aligned with the space between support elements **270** and guide tracks **248, 249.** Movement of a collapsed carton blank to a dispensing position will effect operation of a pair of pneumatic control sensing valves **280** having valve actuators **282.** Sensing valves **280** are supported adjacent the lower edge of the frame members

245, 246 and include conventional slot and bolt adjustment means 284 which will permit the valves to be adjusted to a selectively set position of alignment. Valves 280 are utilized to sense the location of a carton blank in the dispensing position for controlling operation of cylinder 260, as will be described below.

As shown in FIGS. 1 and 6–8, the upper edges of the collapsed carton blanks are urged forward to a dispensing position by means of a cable arrangement which includes a bracket element 285. Bracket element 285 includes a downwardly extending leg member 286 which is detailed for engaging an outside vertical surface of the outmost collapsed carton blank. The bracket member 285 is urged toward the dispensing position by means of a cable 287 which extends around a pair of pulleys 288, 289 and over a third pulley 290. Pulley 290 is supported adjacent an upper edge of a tubular conduit member 291. The tubular conduit member 291 is attached to leg member 114. The extended free end of cable 287 is connected to a weight 292. The above described weight and cable arrangement is operable for applying pressure to the outer surface of the outmost carton blank for urging all of the cartons toward the dispensing position and for maintaining the collapsed carton blanks in generally vertically oriented planes during advancement of the carton blanks to the dispensing position by the support shafts 207, 208.

A collapsed carton blank dispensing cycle is effected by operation of the pneumatic cylinder 260 through actuation of valve 260a. Valve 260a is controlled by valve 135 operatively associated with cam 125 on the main program shaft and by the sensing valves 280. Operation of the valve 135 will actuate valve 260a to energize pneumatic cylinder 260, provided sensing valves 280 are actuated, to effect advancement of the dispensing member 250 from the upper retracted position to the extended dispensing position. During movement of the dispensing member 250 downward, the base portion 251 will engage the upper edge of a collapsed carton blank and will slide the collapsed carton blank downward against the surface of guide tracks 248, 249 and into position within the receiving end of the box forming machine. The extent of downward movement of the dispensing member 250 is controlled by means of a sensing valve 295 located adjacent the lower edge of frame element 245. The sensing valve 295 includes conventional pivotal arm and valve actuator means which are operated by a cam element 296 supported on the dispensing member leg portion 252 (FIG. 9). Cam 296 effects operation of the valve 295 after the dispensing member 250 has been moved to a lower limit position to reverse operation of valve 260a, to cause the dispensing member 250 to be moved to the upper retracted position for engaging a next collapsed carton blank. After a first collapsed carton blank has been dispensed to the box forming machine, clutch 180 will be actuated due to a carton blank moving away from sensing valve actuators 282 to effect an intermittent drive to rotate support shafts 207, 208 for advancing the supported carton blanks toward the dispensing assembly wherein a next adjacent collapsed carton blank will be moved to an aligned dispensing position and in contact with valve actuator 282.

END FLAP SPREADING STATION

Referring now particularly to FIGS. 5, 6, 10 and 17–19, the box forming machine includes an end flap spreading station which is generally represented by the reference numeral 300. The end flap spreading station is located between the receiving end 30 of the box forming machine and the vertically extending supporting post members 22, 23. As shown in FIG. 6, the end flap spreading station is located directly beneath the magazine dispensing assembly wherein a collapsed carton blank dispensed from the magazine assembly will be directed into the space defined between the guide members 33, 34.

As shown in FIGS. 6 and 18, a second pair of guide members 301, 302 are supported in vertically spaced relationship above the guide members 33, 34. Guide members 301, 302 are horizontally spaced to provide a space therebetween for receiving a collapsed carton blank. The space between guide members 301, 302 is vertically aligned relative to the space defined between guide members 33, 34. Guide members 301, 302 include an upper edge portion aligned with a scored area between the carton sides and end flaps. Guide members 301, 302 are supported above the conveyor assembly 50 such that the conveyor cross connecting members 53 will engage a trailing edge of a collapsed carton blank received therein and will effect movement of the collapsed carton blank to the next adjacent forming station. The space defined between carton blank guide members 33, 34, 301, 302 is coplanar to the magazine assembly dispensing position defined between guide tracks.

After a collapsed carton blank has been received at station 300, the adjacent pairs of interconnected end flaps of the carton blank are separated and spread open by an end flap spreading assembly 310. The end flap spreading assembly includes a first pair of vacuum cups 311, 312 which are operatively connected to a fixed vacuum manifold 313 is connected to the vacuum source 190 by a control line 314. The opposite ends of the vacuum manifold 313 are supported in a fixed position by a pair of bracket elements 315, 316 which extend outwardly from the guide member 302, as shown in FIG. 17. The flap spreader assembly also includes a pair of vacuum cups 321, 322 operatively supported on a movable manifold 323. The vacuum manifold 323 is supported for cyclic movement from a retracted home position, as shown in FIG. 17, to an extended end flap spreading position by a pair of pivotally mounted arms 324, 325. Arms 324, 325 are supported by a pivot support shaft 326 mounted in an end cross connecting frame member 17 and an intermediate cantilevered frame member 17a. Vacuum manifold 323 is connected to vacuum source 190 by a control line 327. Cyclic movement of vacuum cups 321, 322 from the retracted home position to the extended flap spreading position is effected by the means of a pneumatic cylinder 330. Pneumatic cylinder 330 is connected adjacent its base end to a fixed supporting bracket 331 and includes a conventional reciprocably operable piston rod 332 which is connected at its extended end to an upstanding bracket 333. Bracket 333 is fixed to the upper surface of arm 335. Cylinder 330 is detailed in length and extent of cyclic movement to effect movement of vacuum cups 321, 322 from the retracted home position to the extended flap spreading position. When the vacuum cups 321, 322 are moved to the extended flap spreading position, the cups are positioned adjacent the fixed vacuum cups 311, 312, with the adjacent pairs of interconnected end flaps supported therebetween.

When vacuum cups **321, 322** are moved to the extended end flap spreading position, one pair of interconnected end flaps will be pressed into position with the vacuum cups **311, 312** and will be maintained thereagainst by vacuum being applied to cups **311, 312.** A vacuum applied to the cups **321, 322** will maintain the second pair of interconnected end flaps into engagement with the cups **321, 322** and will pull this second pair of connected end flaps away from the first pair to a position substantially as shown in FIG. **19.**

The vacuum cups **311, 312** are supported in a displaced position located on one side of the plane of movement of a carton blank and the vacuum cups **321, 322** are supported in their home position at a displaced position on an opposite side of the plane. In the movement of both pairs of interconnected end flaps in a first direction toward the fixed vacuum cups **311, 312** the scored area between the end flaps and the carton blank sides will be broken due to the bending movement of the end flaps relative to the carton blank sides which are maintained in a fixed position by the upper edge portions of guide members **301, 302.** The breaking or creasing of the scored area between the end flaps and the carton sides will ensure that all carton blanks will be provided with a sufficiently creased or scored area regardless of deficiency included in the scored area in the manufacture of the boxes.

Pneumatic cylinder **330** is controlled in effecting movement of vacuum cups **321, 322** by means of control valve **340** and a sensing valve **340a.** Sensing valve **340a** includes a sensing arm **341** which is supported in position between the guide members **33, 34** to be contacted by a collapsed carton blank being received in the end flap folding station **300.** A control valve **132** operatively associated with cam **122** on the main program control shaft **111** is connected in series with valve **340***a*. When a collapsed carton blank is advanced into position at station **300,** sensing arm **341** will be depressed to operate valve **340***a* which will allow the control valve **340** to energize the pneumatic cylinder **330,** provided cam **122** has operated valve **132.** As cylinder **330** is energized, the vacuum cups **321, 322** will be moved into position adjacent the vacuum cups **311, 312** as described hereinabove. A reversing operation of the pneumatic cylinder **330** is controlled by valve **132** and cam **122.** With a first adjacent interconnected pair of end flaps held by vacuum cups **311, 312** the second adjacent interconnected pair of end flaps will be moved away from the first interconnected pair of end flaps, as cylinder **330** retracts the vacuum cups **321, 322** to the home position. The vacuum source **190** will be supplied to suction cups **311, 312, 321** and **322** through valve **345** in a timed sequence of operation of cylinder **330** by operation of a control valve **133** actuated by cam **123** on the program shaft **111.**

Referring now particularly to FIGS. **18** and **19,** the pairs of interconnected end flaps are maintained in their spread relationship by means of an end flap retaining assembly generally represented by the reference numeral **360.** The end flap retaining assembly **360** includes a retaining plate **361.** Retaining plate **361** is constructed of an elongated member having a formed receiving end **362** and a formed exit end **363.** Retaining plate **361** is supported for pivotal movement by a support shaft **366** having its opposite ends supported on a pair of frame elements **364, 365.**

As shown in FIG. **19,** the end flap retaining plate **361** includes an actuating arm **367** which is connected to the extended end of a piston rod **368.** Piston rod **368** is reciprocally supported by a conventional pneumatic cylinder **369.** Cylinder **369** and piston rod **368** are operable for effecting movement of the end flap retaining plate **361** from a retracted inoperable position, as shown in solid lines of FIG. **19,** to an extended operable position, as shown in dotted lines of FIG. **19.** With the end flap retaining plate **361** in a retracted inoperable position, a collapsed carton blank can be dispensed into station **300** and the end flaps can be spread relative to each other without interferring or engaging the retaining plate **361.** After the end flaps have been spread open as shown in FIG. **19,** retaining plate **361** is adjusted to an operable position, as shown in the dotted lines of FIG. **19,** wherein retaining plate guide bar **361a** will engage and hold one interconnected pair of end flaps in a spread relationship and an extended edge of plate **361** will hold the other pair of end flaps, as the collapsed carton blank is advanced from station **300** to the next adjacent end flap folding station.

Operation of pneumatic cylinder **369** is effected by means of a control valve **370** mounted on a support bracket **371.** Support bracket **371** is attached to the upper surface of the cantilevered support frame elements **17***a*. Control valve **370** includes a control arm **372** which is pivotally mounted thereon for effecting operation of a valve actuator stem **374.** An extended end of control arm **372** is provided with a roller element **375** supported in engagement with a control cam **376.** Control cam **376** is mounted on the upper surface of arm **324.** Cam **376** is detailed in design to effect operation of the control valve **370** when the vacuum cups **321, 322** have been moved to the retracted home position such that one pair of interconnected end flaps is held by cups **311, 312** and the second pair of interconnected end flaps is held by cups **321, 322.** With the adjacent pairs of interconnected end flaps spread open, cam **376** will effect operation of control valve **370** which will in turn operate the pneumatic control cylinder **369** to advance the flap retaining plate **361** to an extended operable position. After the end flaps have been spread open and the retaining plate has been moved into position, the conveyor means **50** will be operated such that the carton blank will be moved forward to the next adjacent end flap folding station, as will be described in more detail hereinbelow.

END FLAP FOLDING STATION

Referring now particularly to FIGS. **5** and **20–22,** the box forming machine includes an end flap folding station which is generally represented by the reference numeral **400,** (FIG. **5**). The end flap folding station is located between the vertically extending post elements **22, 23** and the supporting leg members **11, 12** and adjacent spreading station **300.** The guide frame members **33, 34** and **301, 302** extend substantially throughout the length of the end flap folding station for maintaining the collapsed carton blank in a substantially upright position during conveying therethrough.

As shown in FIGS. **18** and **20,** the end flap folding station includes a substantially V-shaped guide member **401.** The V-shaped guide member **401** includes a pointed forward end **402** with a pair of trailing leg members **403, 404.** The V-shaped guide member **401** is supported in a substantially horizontally oriented po-

sition by a pair of downwardly extending connecting rods **405, 406.** Connecting rods **405, 406** mounted to a forwardly extending end of a framework assembly **410.** As shown in FIGS. **18** and **20** the V-shaped guide member **401** is supported such that the end portion **402** is in vertical alignment with the slot provided between the guide members **301, 302** and is vertically adjusted to contact the end flaps and hold the end flaps in a spread position as they are advanced from station **300** to the end flap folding station **400.**

The end flap folding station includes a folding assembly mounted on framework **410.** The mounting framework **410** includes a pair of vertically oriented horizontally spaced plate elements **411, 412.** A pneumatic cylinder means **415** is supported between plate elements **411, 412** in a substantially vertically oriented position and includes a conventional piston rod element **416** which extends therebelow and is connected to a substantially inverted U-shaped bracket **417.** Bracket **417** includes a pair of downwardly extending leg members **418, 419.** A first folding rod element **420** is connected to the extended end of leg **418** with a second folding rod element **421** connected to the extended end of leg **419.** Bracket **417** with legs **418, 419** are detailed for supporting the folding rods **420, 421** in a horizontally oriented and spaced parallel relationship. The end flap folding assembly **417, 418** etc. is maintained in longitudinal aligned relationship relative to a carton blank by means of a stabilizer rod **430.** Stabilizer rod **430** is connected to the upper surface of bracket **417** and includes an upwardly extending end which is reciprocally supported by a sleeve element (not shown) mounted between the plate elements **411, 412.** The stabilizer rod **430** will prevent angular displacement of the bracket **417** to thereby maintain the folding rods in a proper longitudinally aligned relationship. The folding rods **421, 422** are detailed in length to contact and apply a simultaneous force to the interconnected pairs of end flaps in a folding operation to prevent undue strain being placed on the connecting tab.

The pneumatic cylinder **415** is operable for effecting movement of the end flap folding assembly from an upper retracted position, as shown in FIG. **21,** to a downwardly extended end flap folding position, as shown in FIG. **20.** Cyclic operation of the end flap folding assembly from the upper retracted position to the downwardly extended end flap folding position is effected by means of a control valve **139** which is operated by cam **129** supported on the main program control shaft **111.** Cam **129** is detailed such that when a carton blank is moved into position beneath the end flap folding assembly **400,** the cam element will operate the control valve **139** to supply pneumatic pressure to the cylinder **415** whereby the cylinder will move the folding bars **420, 421** downward into engagement with the spread end flaps. Downward movement of the folding bars **420, 421** will contact the upper surface of the spread end flaps and fold the end flaps back down toward the outer surface of the carton blank sides. The folding bars **420, 421** will be maintained in the downward flap folding position during advancement of the carton blank through the receiving station **400.** As the carton blank is advanced through the receiving station **400,** the end flaps which are folded back toward the carton blank sides will engage a pair of angularly formed guide rods **450, 451.** The guide rods **450, 451** include a horizontally oriented portion **452** and an upwardly inclined portion **453.** During an advancement of the carton blank through the end flap folding folding station, inclined portions **453** will contact the outer or upper surface of the end flaps and in response to further advancement of the carton blank, the interconnected flaps will be folded down against the outer side of the carton blanks and will be maintained thereagainst by the horizontally disposed portions **452,** as the carton blank is discharged from the end flap folding station **400.** The end flap folding guide rods **450, 451** are supported in aligned position relative to the guide members **301, 302** by a number of vertically extending connecting rods **456.** Rods **456** are connected adjacent their upper end to a framework assembly **460.** The framework assembly **460** is secured on the main frame assembly by a conventional slot-and-bolt connecting means **461.** The slot-and-bolt connecting means **461** will permit the frame assembly **460** to be vertically adjusted relative to the main frame assembly.

As shown in FIGS. **21** and **22** the supporting plate elements **411, 412** are connected to the frame assembly **460** by a pair of vertically oriented hinge members **463, 464.** Hinge members **463, 464** are maintained in an assembled relationship by conventional hinge pins **465, 466,** respectively. As shown in FIG. **22,** the end flap folding assembly can be moved to an outwardly displaced inoperable position by removing one of the hinge pins and pivoting the end flap holding assembly about the other hinge pin.

It is apparent from the above description of the end flap folding station that a carton blank which is fed to the end flap folding station with the end flaps in a partially spread position will be engaged by the V-shaped guide member **401** which will maintain the end flaps in the spread position and will guide the end flaps and carton blank into position beneath the end flap folding assembly **417.** With a carton blank in position beneath the end flap folding assembly **417,** the control valve **139** will be operated by the cam element **129** to effect a downward extension of piston rod **416** to cause the folding bars **420, 421** to contact the upper surface of the spread end flaps and move them back toward the outer sides of the carton blank. The folding bars **420, 421** will maintain the flaps in the downwardly folded relationship as they are advanced through the folding station; and with a continued advancement of the carton blank through folding station **400,** the incline portion of the guide rods **450, 451** will effect a further downward folding of the interconnected end flaps to move the end flaps into contact with the outside surfaces of the carton blank sides. The carton blank is advanced through the end flap folding station by the conveyor means **50** with cross-connecting bars **53.** After a carton blank has been advanced through the end flap folding station **400,** the carton blank is moved into position within box opening station **500,** as will be described hereinbelow.

BOX OPENING STATION

Referring now particularly to FIGS. **1, 5, 12, 16** and **23–25,** the box forming machine includes a box opening station which is generally represented by the reference numeral **500** (FIG. **5**). The box opening station **500** is located on the main supporting framework between the leg members **11, 12** and the post elements **20, 21.** The box opening station is located immediately adjacent the end flap folding station **400** and a carton

blank with the end flaps folded back against its sides is advanced from the end flap folding station into the box opening station by the conveyor cross connecting bars **53**. A carton blank moved into position within the opening station will be supported in engagement with a lateral surface of the guide member **34**. After a carton blank has been moved into a position within the opening station, the carton blank is opened and the box is righted by an opening assembly **510**. The opening assembly **510** includes a pair of vacuum cups **511, 512** which are carried by a channel-shaped support arm **513**. The channel-shaped support arm **513** is connected to the lower end of a vertically extending support member **514**.

As shown in FIG. **23**, the upper extended end of support member **514** includes a pair of vertically spaced laterally projecting arms **515, 516**. The extended ends of arms **515, 516** are mounted on a pivot support shaft **517**. Pivot support shaft **517** is rotatably supported by a pair of vertically spaced horizontally extending plate members **518, 519**. The pair of vacuum cups **511, 512** are moved between angularly adjusted positions by a pneumatic control cylinder **520**. Cylinder **520** is supported adjacent its base end by a pair of support brackets **521**. Cylinder **520** includes a reciprocally operable piston rod **522** which has its extended end connected to an actuator arm **523** mounted on the pivot shaft **517**, directly below the support plate **518**. Cylinder **531** is controlled in a box opening operation by a control valve **138** which is operated by cam **128** on the main program control shaft **111**. A supply of vacuum is furnished to the cups **511, 512** by a conventional supply line **530** which is operatively connected to the vacuum source **190** through valve **531** (FIG. **26**). Valve **531** is controlled by cam **121** and valve **131**. The above described case opening assembly including vacuum cups **511, 512** are operable for engaging one end wall of a collapsed carton blank and for moving the end wall to an angularly displaced position substantially ninety degrees relative to the sidewall, to open the box in a box righting operation.

In order to maintain an adjacent interconnected sidewall in a fixed position during an opening operation, a pair of stabilizing vacuum cups **541, 542** are supported in position above the guide frame member **34** and in position to engage and hold the carton blank side disposed thereagainst. Vacuum cups **541, 542** are mounted on a vacuum block manifold **543** which is connected to the pneumatic source by a supply line **543a** (FIG. **26**). The vacuum manifold block **543** is supported for reciprocating movement relative to the guide frame member **34** by means of a channel-shaped support member **544**. The channel-shaped support member **544** is attached to the upper extended end of a vertically oriented support leg **545**. Support leg **545** is attached to the outside surface of the longitudinally extending frame **16**.

As shown in FIG. **12**, the support frame member **544** includes a slot **546** detailed for receiving a vertically extending bracket **547** which is attached to the manifold block **543**. One horizontal edge portion of the bracket **547** is connected to a supporting rod **548**. Rod **548** is reciprocally supported by a pair of bushings **549, 550** with an extended end of the support rod being attached to bracket **547**, by conventional threaded bolt connecting means. Bracket **547** is controlled in a reciprocating cycle of operation by means of a pneumatic cylinder **560**. Cylinder **560** is supported on the upper surface of the supporting plate **544** and includes a conventional piston rod **561** which has an extended end connected to bracket **547**. A reciprocating cycle of operation of the cylinder **566** will effect movement of the supporting bracket **547**, manifold **543** and the supported pair of vacuum cups **541, 542** to an outwardly extended position in engagement with a sidewall of a carton blank supported in position against guide member **34**. Movement of the stabilizer cups **541, 542** to an outwardly extended carton engaging position is effected by of a control valve **121** which is operatively associated with cam **131** mounted on the main program control shaft **111**. A supply of vacuum is furnished to stabilizer cups **541, 542** through valve **531** as controlled by cam **121** and valve **131** described above.

BOTTOM END FLAP FOLDING ASSEMBLY

After a box has been opened or righted in the box opening station **500** the bottom end flaps are folded to a generally horizontal position prior to being dispensed from the box forming machine. The function of folding the end flaps to a horizontal position is to allow glue or other conventional adhesive means to be applied thereto so that the side flaps can be folded and pressed thereagainst for connecting the end flaps and side flaps in an assembled relationship. The glue or adhesive applying means and the side flap folding and pressing means is provided on an adjacent machine which forms no part of the present invention and the details of which are not described herein.

The flap folding assembly is supported on the main framework immediately below the box opening station **500**. The end flap folding assembly is generally represented by the reference numeral **600** (FIG. **16**). The end flap folding assembly includes a pair of side flap retaining elements **601, 602**. The function of the side flap retainer elements **601, 602** is to engage the inner surface of the bottom side flaps and to hold them in a vertically aligned position during a folding operation of the end flaps. As shown in FIG. **16**, each of the side flap retainer elements **601, 602** include pivotally mounted elements **603, 604** which are supported for pivotal movement by cross support shafts **605**. The side flap retaining elements **601, 602** are moved from a downwardly displaced inoperable position, as shown in FIG. **16**, to an upwardly extended operable position in engagement with the side flaps, by pneumatic cylinders **606, 607**. Cylinders **606, 607** are controlled in a reciprocating cycle of operation by valve **608** which is controlled by cam **131** described above.

As shown in FIGS. **12, 15**, and **16**, the end flap folding assembly includes a first or trailing end flap folding bar generally represented by the reference numeral **620**. The end flap folding bar **620** includes a horizontally oriented straight portion **621** and an angular inclined portion **622**. Folding bar **620** is supported adjacent the extended ends of a pair of arms **623, 624**. The inner ends of arms **623, 624** are attached to collars **625, 626**, respectively. Collars **625, 626** are mounted on a support shaft **627**. The opposite ends of support shaft **627** are mounted in conventional bearing means **628, 629** which are carried by transversely extending framework elements **17**. The end flap folding assembly also includes a second or leading end flap folding bar **630** (FIG. **12**). The second end flap folding bar **630** includes a longitudinally aligned portion **631** and an an-

gular inclined portion **632.** Folding bar **630** is mounted on the extended ends of a pair of support arms **633, 634.** The inner ends of arms **633, 634** are attached to a collar **636.** Collar **636** is mounted on support shaft **627** and is longitudinally adjustable relative to the support shaft **627.** Collar **636** is maintained in a selectively set position relative thereto by conventional set screw means (not shown). The purpose of adjusting collar **636** and its supported folding arm **630** is to adjust the folding assembly for use with various sized boxes. The end flap folding assembly is normally maintained in a downwardly extended or retracted inoperable position wherein the folding end portions **622, 632** are generally vertically oriented and angularly disposed relative to downwardly hanging end flaps.

The end flap folding assembly, including bars **620, 630,** are moved to an upwardly adjusted end flap folding position by means of pneumatic control cylinder **640.** Cylinder **640** is connected adjacent its base end to a supporting bracket **641** and includes a piston rod **642** which is connected adjacent its extended end, as shown in FIG. **16,** to an actuator arm **643.** Actuator arm **643** is fixed to the support shaft **627** whereby angular displacement of the actuator arm **643** will effect corresponding angular displacement of the support shaft **627** and the supported end flap folding bars **620, 630.** When the end flap folding bars are moved from their downwardly displaced position to their upwardly adjusted end flap folding position, the downwardly hanging end flaps will contact the inclined portions **622, 632.** As the inclined end portion **622** is moved upwardly to an operable end flap folding position, a downwardly hanging trailing end flap will engage the angle portion **622** and will be moved inwardly within the box and advanced upwardly to a horizontal position aligned with the bottom surface of the box. Movement of the angle portion **632** of folding bar **630** will contact the leading end flap and will effect a camming displacement of the leading end flap from a vertically hanging position upwardly to a horizontal position aligned with the bottom edge of the box. With the end flap folding bars **620, 630** moved upwardly to a flap folding position, the longitudinally oriented portion **621, 631** will provide a horizontally extending guide surface for guiding the end flaps during advancement of the box to the next glue applying and sealing station (not shown). Cylinder **640** is controlled in a cycle of operation for effecting movement of the folding bars **620, 630** by a control valve **137** and cam element **127.** A cycle of operation of the end flap folding bars will be described in more detail hereinbelow in the description of the operation of the box forming machine.

OPERATION

Prior to effecting automatic operation of the box forming machine, a source of air pressure is connected to the manual control valve **195** and electrical power is supplied to drive motor **100** and the vacuum pump **190,** whereby a supply of air pressure can be delivered to the associated cylinders, drive can be delivered to the conveyor and magazine assembly and a supply of vacuum can be delivered to the above described vacuum cups.

After the electrical power, vacuum and air pressure supply means have been energized, a plurality of collapsed carton blanks are supported on the magazine assembly as shown in FIGS. **1** and **6,** with the collapsed carton blanks supported in vertically oriented planes in juxtaposition adjacent each other.

A cycle of box forming operation is then effected by moving a manual control switch (not shown) to an on position for effecting operation of the electrical motor **100.** Operation of motor **100** will rotate the program control shaft **111** and will deliver an input drive to the conveyor clutch assembly **150** and the magazine indexing clutch assembly **180.** A cycle of operation of the main program control shaft **111** will effect angular displacement of the cams **121–129** to thereby effect movement of the control valves **131–139** to a displaced operable position in a timed sequence of operation. Reference is made to the timing chart shown in FIG. **8** for the angular relationship of the cams **121–129** relative to each other for controlling the sequence of operation.

With a plurality of collapsed carton blanks supported in the magazine assembly and with the motor drive means **100,** pneumatic pressure source (not shown) and vacuum source **190** energized, the indexing clutch **180** will be operated to advance a collapsed carton blank into an aligned dispensing position in contact with the sensing actuators **282.** When a collapsed carton blank contacts the sensing actuators **282,** the control valve **280** will be adjusted to thereby supply pneumatic pressure to control valve **135.** With a supply of pneumatic pressure furnished to control valve **135,** the associated program control cam **125** will effect movement of the valve to an actuated position for adjusting control valve **260***a* to effect operation of the pneumatic cylinder **260.** Operation of the pneumatic cylinder **260** will cause the transfer element **250** to contact a collapsed carton blank supported in an aligned dispensing position and will effect movement of the collapsed carton blank downward into the receiving end of the box forming machine.

As shown in the timing chart of FIG. **28,** during movement of the collapsed carton blank downward to the receiving end of the box forming machine, the conveyor control clutches **150** and **160** will be deenergized and the brake assembly **86** will be energized to maintain the conveyor in a static position as the collapsed carton blank is moved into position within the receiving end of the box forming machine. After the pneumatic cylinder **260** has effected movement of the collapsed carton blank into the receiving end of the box forming machine, the cam element **296** will operate sensing valve **295** for moving the control valve **260a** to an adjusted position to effect movement of the pneumatic cylinder **260a** to a retracted position.

When a first collapsed carton blank has been moved away from the sensing actuators **282,** the clutch **180** will be operated to thereby index the carton blanks supported on the magazine forward to advance the next blank in an alligned dispensing position and for effecting operation of the sensing actuators **282.**

Movement of a collapsed carton blank into the receiving end of the box forming maching will contact the sensing arm **341** operatively associated with control valve **340.** With the control valve **340** operated by a case being moved into a proper position, cam **124** will adjust control valve **134** to thereby deliver pneumatic pressure to effect adjustment of control valve **340***a.* Adjustment of control valve **340***a* will operate to energize cylinder **330.** When cylinder **330** is energized, the movable vacuum cups **321, 332** will move into position

to contact one interconnected pair of end flaps and will bend the contacted interconnected pair of end flaps against the adjacent interconnected pair of end flaps and will fold both interconnected pairs of end flaps in an angular displaced position toward the fixed vacuum cups **311, 312.**

During movement of the vacuum cups **321, 322** to the adjusted position, the program shaft cam **123** will adjust valve **133** for effecting displacement of vacuum control valve **345** whereby a supply of vacuum will be furnished along supply line **193** to the vacuum cups **311, 312, 321** and **322.** After the vacuum cups **321, 322** have been displaced angularly a sufficient amount so that one pair of interconnected end flaps are in contact and grasped by the vacuum cups **311, 312** the program cam **124** will adjust valve **134** to move valve **340***a* to a second adjusted position to cause cylinder **330** to retract. As cylinder **330** retracts, the vacuum cups **321, 322** will be moved to their original home position. As the vacuum cups **321, 322** move to their home position, and due to the vacuum source being supplied thereto, the interconnected pair of end flaps contacted by vacuum cups **321, 322** will be grasped and displaced to a position angularly offset on an opposite side of the plane of the collapsed carton blank, causing the two interconnected pairs of end flaps to be spread relative to each other. Movement of the vacuum cups **321, 322** to their home position will cause cam **376** to effect operation of valve **370.** Operation of valve **370** will energize cylinder **369** to effect movement of the retaining element **360** to its adjusted operable position in engagement with the spread end flaps to maintain them in their spread condition during advancement of the carton blank to the end flap folding station.

As shown by the timing chart of FIG. **28,** after the cylinder **330** has been deenergized to effect movement of the vacuum cups **321, 322** to their home position, the clutch assemblies **150,160** associated with the conveyor will be energized for effecting a driving movement of conveyor **50.** As conveyor **50** is driven, a cross connecting bar **53** will advance the collapsed carton blanks to the end flap folding station. During movement of the collapsed carton blank to the end flap folding station, the fixed guide member **401** will move into position between the spread pairs of end flaps to maintain them in their spread relation during forward movement of the collapsed carton blank.

After the collapsed carton blank has been moved into an aligned position within the end flap folding station, the conveyor clutch assemblies **150, 160** will be deenergized to stop the collapsed carton blank in position beneath the end flap folding mechanism. With the collapsed carton blanks supported in the end flap folding station, program control cam **129** will effect adjustment of valve **139** to thereby operate cylinder **415.** Operation of cylinder **415** will effect movement of the folding bars **420, 421** to a downwardly displaced position in contact with the inside surfaces of the interconnected pairs of end flaps.

As shown in FIG. **20,** the folding bars **420, 421** are detailed in design and length to contact both of the interconnected pairs of end flaps and to maintain them in a common plane relative to each other during a folding operation. After cylinder **415** has been energized to effect a downward displacement of folding bars **420, 421,** the conveyor clutch assemblies **150, 160** will be energized to advance the collapsed carton blank with the sides folded downward to the box opening station. During movement of the collapsed carton blank to the box opening station, the fixed guide bars **452, 453** will contact the downwardly folded end flaps to maintain them in a folded position in contact with the side from which they extend as they move forward to the box opening station.

After a collapsed carton blank has been advanced into position within the box opening station, a cross connecting bar **53** will contact and effect operation of sensing valve **86***a* and since the program cam **122** is properly position to effect operation of valve **132,** the clutch assemblies **150, 160** will be deenergized. With a collapsed carton blank supported in an aligned position in the box opening station, program control cam **128** will effect operation of valve **138** to thereby energize cylinder **520.** As cylinder **520** is energized, the vacuum cups **511, 512** will be angularly adjusted into position for engaging one side of the collapsed carton blank. Simultaneously with movement of vacuum cups **511, 512** to an adjusted position, the vacuum cups **541, 542** will be moved to an adjusted position for engaging an adjacent side of the collapsed carton blank by operation of control valve **131** with program cam **121.**

Cam **121** and valve **131** will also effect operation of vacuum control valve **531** to thereby supply a vacuum source to the vacuum cups **511, 512, 541** and **542.** After the vacuum cups **511, 512** have been moved to their angular adjusted position and engaged a side of the collapsed carton blank, program cam **128** will adjust control valve **138** to cause cylinder **520** to retract for effecting movement of the vacuum cups **511, 512** to their original home position. As the vacuum cups **511, 512** move to their original home position, the engaged side of the collapsed carton blank will be angularly displaced relative to the adjacent side which is held by vacuum cups **541, 542,** thereby opening the box, whereby the interconnected sides are disposed substantially ninety degrees relative to each other and in substantially a rectangular configuration.

As shown by a timing chart of FIG. **28,** the bottom end flap folding assembly **600** will be operated as soon as the cylinder **520** has been retracted to the original home position. The end flap folding assembly is operated by program cam **127** which will effect adjustment of control valve **137.** Control valve **137** will effect a simultaneous operation of the side flap retaining cylinders **606, 607** and the bottom end flap control cylinder **640.** The control cylinders **606, 607** and **640** will operate to adjust the bottom end flaps to a horizontally aligned folded position as described hereinabove. After the box has been opened at the box opening station and the bottom end flaps have been folded to an adjusted position, the conveyor clutches **150,160** will be operated to advance the box through the discharge end of the box forming machine for movement onto a next box forming machine for applying glue or other suitable adhesive means to the bottom flaps and for pressing the bottom flaps to a closed and sealed condition.

It now becomes apparent that the above described illustrative embodiment of a box forming machine is capable of obtaining the above stated objects and advantages. It is obvious that those skilled in the art may make modification on the details of construction without departing from the spirit of the invention which is to be limited only by the scope of the appended claims.

What is claimed is:

1. Apparatus for forming a box from collapsed carton blanks, wherein the collapsed carton blanks include four interconnected sidewalls with each sidewall including an end flap and wherein alternate end flaps are interconnected with each other and in which each blank is folded flat with one pair of interconnected flaps facing the other pair of interconnected flaps in juxtaposition with one another, said apparatus comprising, in combination:

a. a frame supporting means;

b. means on said frame for storing said flattened carton blanks, said storage means including power operable indexing means for effecting intermittent advancement of said stored carton blanks to serially transfer individual blanks to a delivery position;

c. means operatively associated with said storage means for dispensing one blank at a time from said storage means;

d. means on said supporting frame for spreading said pairs of interconnected flaps;

e. means on said supporting frame for folding said interconnected flaps back upon the outer surfaces of the sidewalls from which they respectively extend; and

f. means on said supporting frame for opening a blank to form a box with said interconnected flaps folded back against said sidewalls.

2. Apparatus as defined in claim 1 further characterized in that said storage means is detailed in construction for supporting a plurality of flat carton blanks in vertically oriented planes with the sides thereof supported in juxtaposition to each other, and wherein said indexing means is operable in response to one carton blank being dispensed from said storage means.

3. Apparatus as defined in claim 1 further characterized in that said storage means includes a reciprocally operable transfer element supported above said storage means for engaging a carton blank supported in a dispensing position to effect a transfer of said carton blank to said end flap spreading means.

4. Apparatus as defined in claim 3 further characterized in that said storage means includes means for sensing a carton blank moved to said aligned transfer position for controlling operation of said transfer element.

5. Apparatus as defined in claim 1 further characterized in that said apparatus includes a carton blank receiving means supported in vertical alignment with said transfer element, said carton blank receiving means including guide means for supporting and retaining said carton blank in a substantially vertical plane and wherein conveyor means is operatively associated with said apparatus for effecting advancement of said carton blank along a first predetermined path.

6. Apparatus as defined in claim 5 further characterized in that said spreading means includes end flap grasping means supported adjacent opposite sides of said predetermined path, and wherein one of said end flap grasping means is cyclically movable for bending both pairs of connected end flaps toward said other end flap grasping means, said other end flap grasping means is operable for grasping and holding one pair of end flaps in angularly displaced position relative to said predetermined path, and wherein said one end flap grasping means is movable to an angularly displaced position located on opposite side of said predetermined path and is operable for grasping and holding said other pair of end flaps in angularly displaced position relative to said predetermined path whereby said alternate pairs of end flaps are separated from each other.

7. Apparatus as defined in claim 6 further characterized in that said apparatus includes end flap retaining means, and wherein said end flap retaining means is cyclically movable to an operable retaining position for holding said end flaps in said angularly displaced position.

8. Apparatus as defined in claim 7 further characterized in that said apparatus includes means for engaging and holding said alternate interconnected end flaps in said angularly displaced separated position in response to movement of a carton blank from said separating to said end flap folding means, and wherein said end flap folding means includes reciprocally operable means for engaging and folding said alternate pair of end flaps back against said collapsed sidewalls of said carton blank, with said alternate pair of adjacent end flaps remaining interconnected.

9. Apparatus as defined in claim 8 further characterized in that conveyor means is operable for advancing said carton blank with said end flaps folded back against said sidewalls along said predetermined path to said box opening means, said box opening means includes means for grasping adjacent sidewalls of said collapsed carton blanks, and wherein one of said grasping means is movable for opening said carton blanks to a rectangular box forming position.

10. A box forming apparatus for setting a box from a collapsed carton blank, wherein the carton blanks include four interconnected sidewalls, with each sidewall including extending end flaps, with integrally formed interconnecting tab means alternately connected between adjacent pairs of end flaps, with one pair of interconnected end flaps facing the other pair of interconnected end flaps in juxtaposition to one another, said apparatus comprising, in combination:

a. supporting frame;

b. means supported on said frame for guiding a carton blank along a predetermined path from a receiving end to a discharge end;

c. conveyor means operatively associated with said box forming apparatus for effecting advancement of a carton blank along said predetermined path from said receiving end to said discharge end;

d. storage means supported adjacent said receiving end of said box forming machine, said storage means detailed for supporting a plurality of collapsed carton blanks in vertically oriented planes, with the sidewalls and end flaps of adjacent carton blanks supported in juxtaposition to each other, and wherein said storage means includes a blank transfer position, said transfer position being vertically aligned with said predetermined path, said storage means including indexing means for effecting serial advancement of said plurality of carton blanks toward said transfer position, and wherein said storage means includes reciprocally operable transfer means for effecting a transfer of a carton blank supported in said transfer position to said receiving end of said predetermined path;

e. means supported on said frame adjacent said receiving end of said predetermined path for separating said alternate pairs of end flaps and including means for maintaining said end flaps in a separated

position during advancement along said predetermined path;

f. means on said frame for folding said interconnected pairs of end flaps back upon the outer surfaces of the sidewall from which they respectively extend; and,

g. means on said frame for opening said collapsed carton blank into a rectangular configuration with said interconnecting flaps folded back against the sidewalls.

11. A box forming apparatus as defined in claim **10** further characterized in that said end flap separating means is located adjacent said receiving end and includes first end flap grasping means located along one side of predetermined path and second end flap grasping means located on an opposite side of said predetermined path, and wherein one of said end flap grasping means is cyclically movable for bending both pair of end flaps toward said other end flap grasping means, with said other end flap grasping means being operable for grasping and holding one pair of end flaps moved into contact therewith, and wherein said cyclically movable end flap grasping means is operable for grasping and moving said other pair of end flaps back to an angularly displaced position on an opposite side of said predetermined path, and wherein said end flap separating means includes retaining means cyclically movable from an inoperable position spaced above said separated end flaps to a retaining position located between said separated pairs of end flaps for maintaining said end flaps in said separated position during movement along said predetermined path.

12. A box forming apparatus as defined in claim **11** further characterized in that said means for folding said interconnected end flaps back against the sides of said collapsed carton blank includes cyclically operable means supported above said predetermined path and aligned with said end flaps in said separated condition, with said end flap folding means being moved downward against said separated end flaps for effecting a folding of said end flaps back against the sides of said collapsed carton blank, and wherein fixed guide means is operatively associated with said predetermined path for maintaining said end flaps in said folded position against said collapsed carton sides during movement of said carton blank along said predetermined path to said box opening means.

13. A box forming apparatus as defined in claim **12** further characterized in that said carton blank opening means includes means located adjacent one side of said predetermined path and operable for grasping and holding one side of said collapsed carton blank, said opening means including cyclically movable grasping means located adjacent an opposite side of said predetermined path, and wherein said movable grasping means is operable for engaging an adjacent side of said carton blank from said first grasping means and is cyclically movable for pivoting said second engaged side away from said first engaged side for opening said collapsed carton blank into a rectangular position.

14. A box forming apparatus for setting up a box from a collapsed carton blank having interconnected sides with each side including an extended end flap, and wherein one pair of adjacent end flaps are interconnected by integrally formed tab means and wherein a second pair of adjacent end flaps is interconnected by integrally formed tab means, wherein said collapsed carton blank is supported with one pair of end flaps facing said second pair of end flaps and in juxtaposition thereagainst, said box forming apparatus including, in combination:

a. an elongated frame support means having a cyclically operable conveyor means which defines a carton blank receiving end and a formed box discharge end;

b. a carton blank guide means longitudinally aligned with the direction of movement of said conveyor means to form a predetermined path of movement of a carton blank through said box forming apparatus;

c. storage means adjacent to and above said receiving end of said conveyor means, said storage means including means for supporting plurality of juxtapositioned collapsed carton blanks in vertically oriented planes, and wherein said storage means includes a blank transfer position vertically aligned with and supported above said predetermined path, said blank storage means includes means for effecting a transfer of a carton blank supported in a transfer position to said predetermined path in response to a controlled cycle of movement of said conveyor means, said blank storage means including indexing means for advancing said plurality of blanks toward said transfer position to effect serial movement of the next adjacent carton blanks to said transfer position, and wherein said storage means includes means for sensing movement of said next blank to said aligned transfer position;

d. means supported adjacent said receiving end of said predetermined path for separating said interconnected end flaps and for maintaining said separated end flaps in angularly displaced positions on opposite sides of said predetermined path;

e. means on said conveyor means for effecting movement of a carton blank along said predetermined path;

f. means supported adjacent said predetermined path for folding said end flaps back against the outer surfaces of said carton blank sides, and wherein said end flap folding means includes means for maintaining said end flaps in said folded position in response to movement of said blank along said predetermined path;

g. means supported adjacent said predetermined path for grasping two adjacent sides of said collapsed carton blank, with one grasping means operable for maintaining one side of said blank in an aligned position with said predetermined path and with said second grasping means being movable for angularly displacing said adjacent side through an angle of substantially ninety degrees to form said carton blank into a rectangular box.

15. Apparatus for forming a box from a collapsed carton blank, wherein the collapsed carton blank includes four interconnected sidewalls with each sidewall including an end flap and wherein alternate end flaps are interconnected to each other and in which each blank is folded flat with one pair of interconnected flaps facing the other pair of interconnected flaps in juxtaposition with one another, said apparatus comprising, in combination:

a. means operatively associated with said apparatus for holding both pairs of interconnected flaps in a

first direction angularly displaced from the plane of said carton blank;

b. means for engaging and holding one interconnected pair of end flaps in angularly displaced relationship on one side of said plane;

c. means for folding said other interconnected pair of flaps to a position angularly disposed on an opposite side of said plane; and,

d. means for advancing said collapsed carton blanks with said interconnected pairs of end flaps folded in angularly disposed relationship on opposite sides of said common plane along a predetermined path.

16. Apparatus as defined in claim **15** further characterized in that said interconnected pairs of end flaps are maintained in a common plane relative to each other during folding movement to said angularly displaced positions.

17. Apparatus as defined in claim **15** further characterized in that said apparatus includes means for folding said interconnected flaps back upon the outer surface of the sidewalls from which they respectively extend, and wherein said folding means includes means for maintaining said interconnected flaps in a common plane during folding movement against the outer surface of said sidewalls.

18. Apparatus as defined in claim **17** further characterized in that said apparatus includes means for opening a collapsed carton blank for forming a box with said interconnected flaps folded back against said sidewalls.

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