# United States Patent [19]

**Bahnsen**

[11] **3,761,032**

[45] **Sept. 25, 1973**


[54] **AUTOMATIC TOWEL WINDING MACHINE**


[75] Inventor: **Erwin B. Bahnsen,** Oakbrook, Ill.

[73] Assignee: **Steiner American Corporation,** Salt Lake City, Utah



[22] Filed: **Mar. 25, 1970**

[21] Appl. No.: **22,447**

[52] **U.S. Cl.** ..... **242/67.1,** 68/13 R, 242/55, 242/67.5, 242/76, 242/81

[51] **Int. Cl.** ..... **B65h 17/02,** B65h 27/00

[58] **Field of Search** ..... 242/67.3, 81, 68, 242/57.1, 55, 56.4, 56.5, 56.9, 80; 68/13 R



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,575,631 | 11/1951 | Link | 242/81 X |
| 2,968,449 | 1/1961 | Hajos | 242/57.1 |



*Primary Examiner*—George F. Mautz

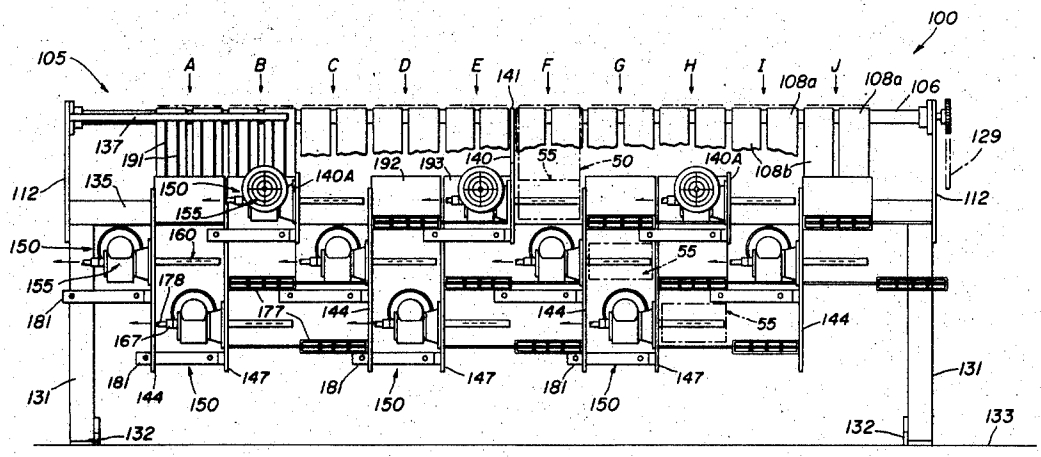
*Attorney*—Prangley, Clayton, Mullin, Dithmar and Vogel



[57] **ABSTRACT**

An automatic towel winder includes a frame supporting a plurality of winding units and a conveyor assembly for feeding a plurality of towels respectively to the winding units along a plurality of parallel side-by-side lanes, each of the winding units occupying three adjacent lanes and including a hollow winding mandrel having side perforations therein for winding the towel into a roll thereon, a constant-torque electric motor to drive the mandrel, suction means coupled to the hollow mandrel for urging the leading end of the fed towel against the mandrel to initiate winding thereon, an ejector for removing the wound towel roll from the mandrel and a receptacle for catching the ejected roll, the winding units being staggered on the frame to occupy a space only slightly wider than the combined widths of the fed towels; electric control circuitry for the winder and alternative embodiments of mandrel drive means and roll ejector are also disclosed.


**60 Claims, 23 Drawing Figures**



PATENTED SEP 25 1973

3,761,032

SHEET 01 OF 11

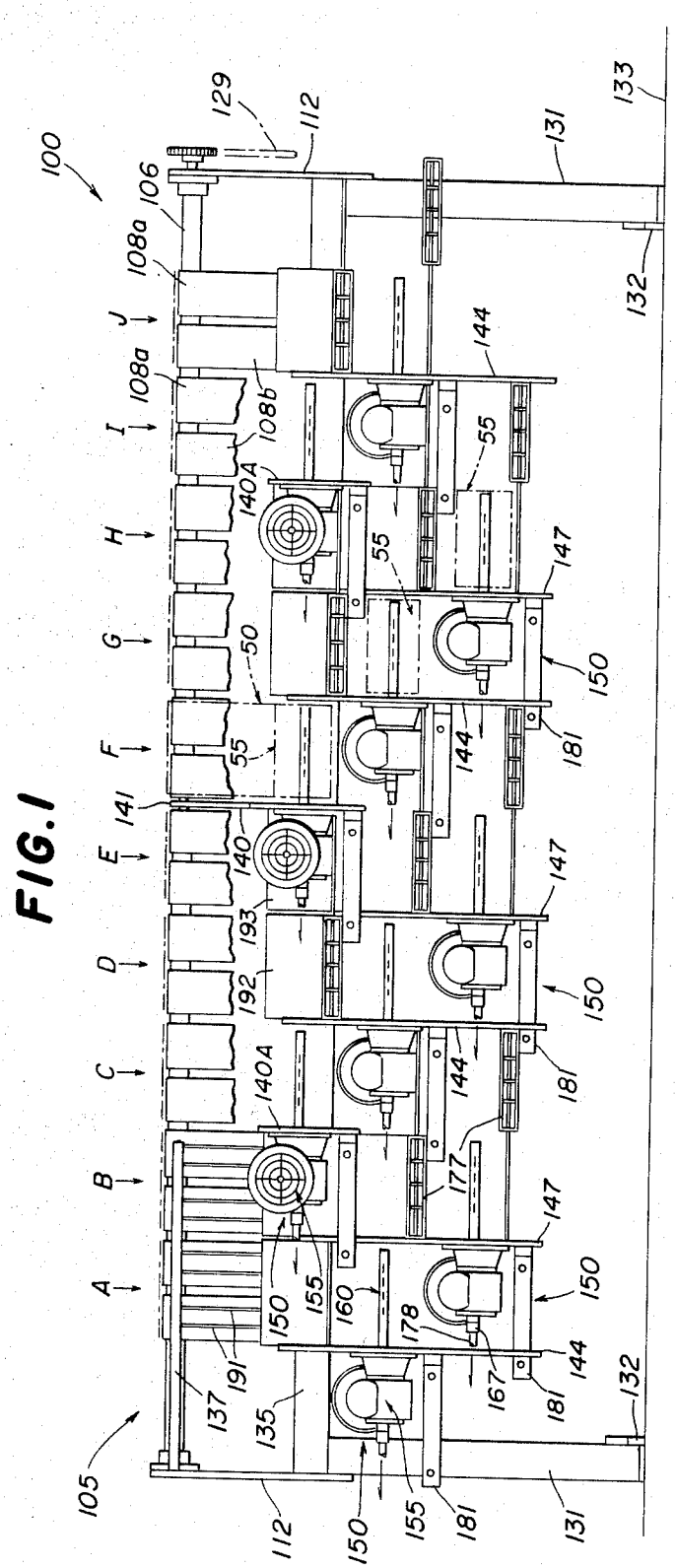



FIG. 1

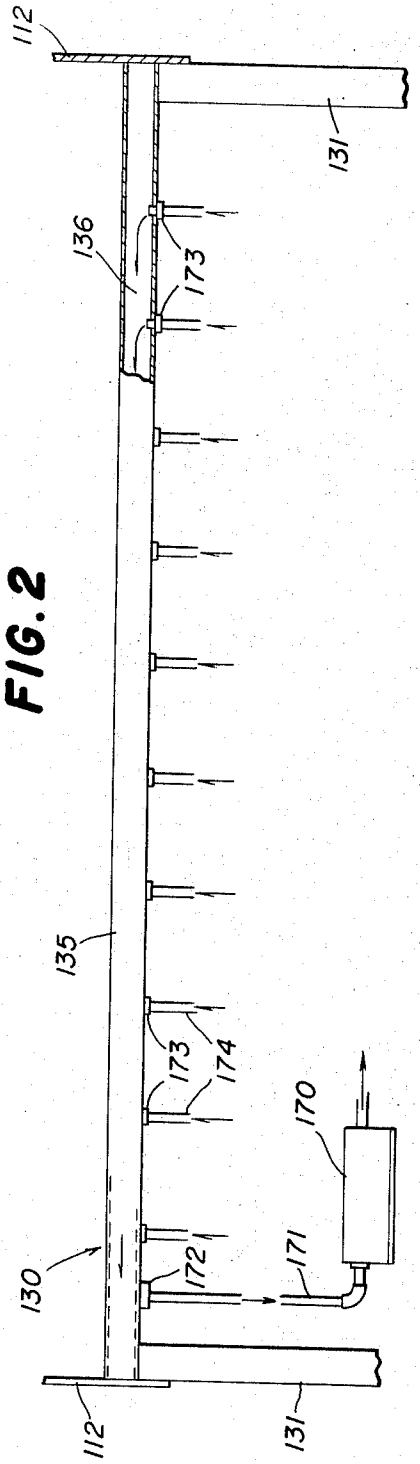



FIG. 2

INVENTOR
ERWIN B. BAHNSEN

BY
Pranglay, Clayton, Mullin,
Dithmar & Vogel
ATTYS.

FIG. 4

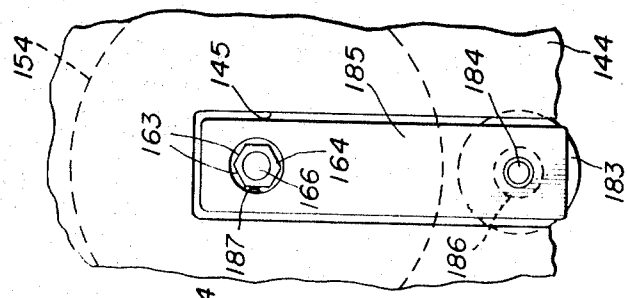



FIG. 3

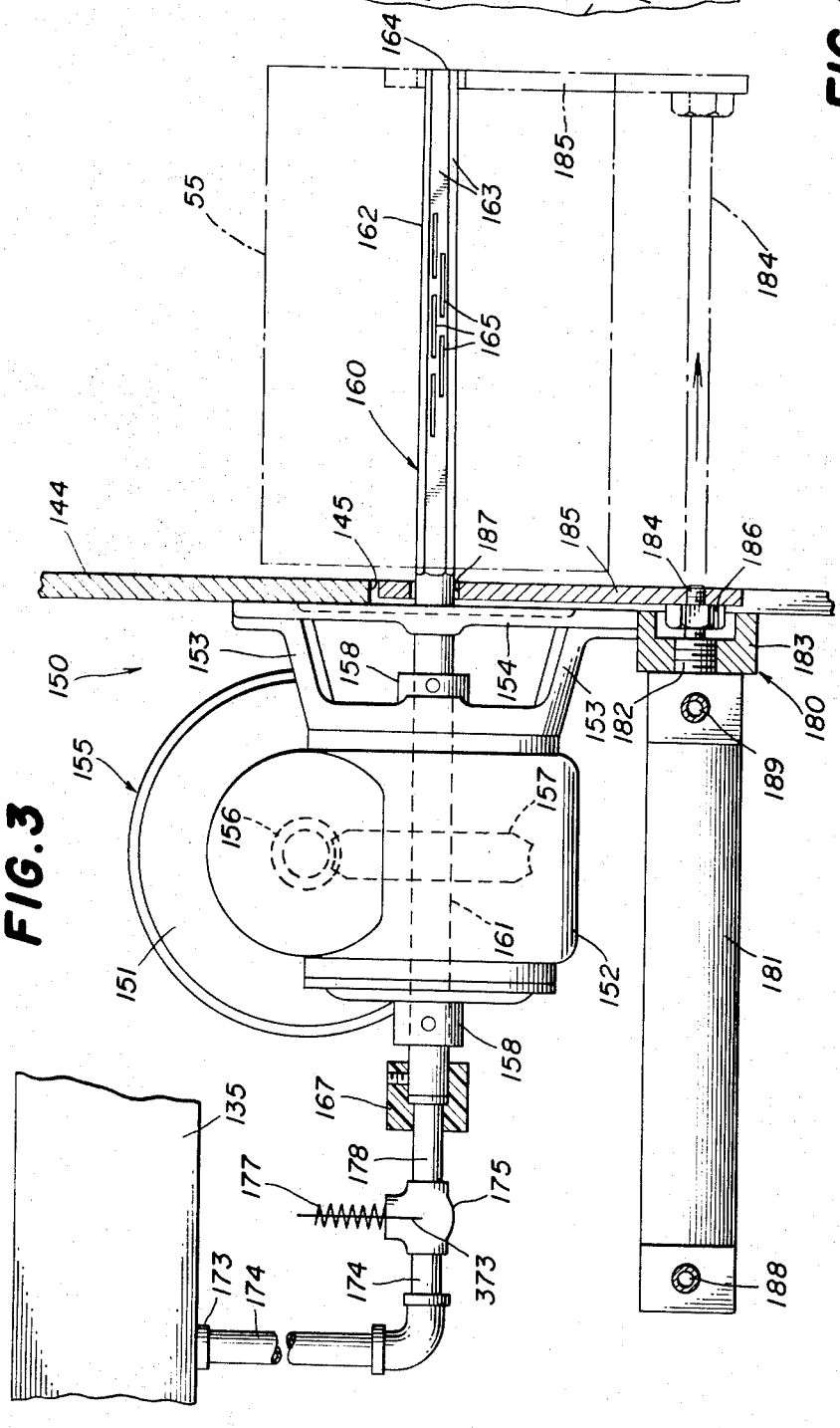



FIG. 6

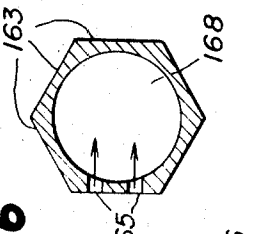
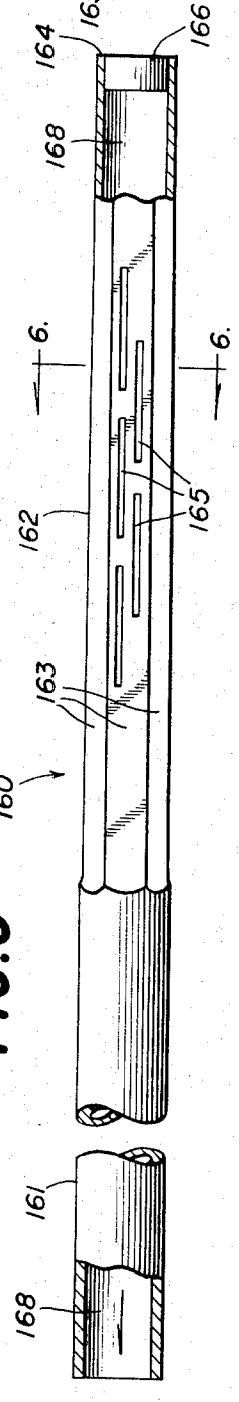



FIG. 5



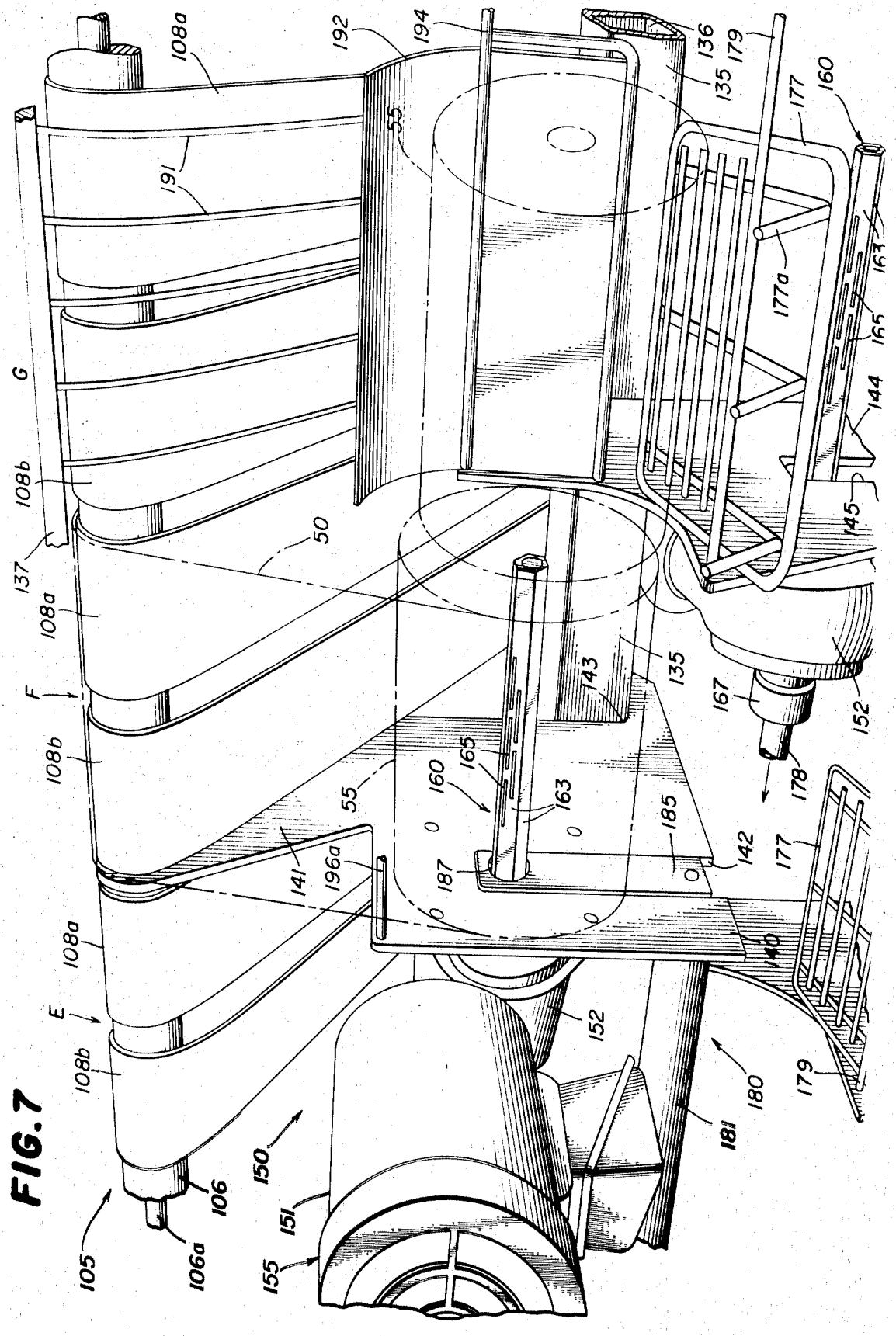

108a
192
194
136
179
135
177
160
191
55
177a
163
165
144
G
108b
145
50
137
108a
F
143
135
167
152
108b
165
160
178
55
163
185
141
196a
187
142
177
108a
140
E
152
108b
180
179
181
150
106
151
105
106a
155

FIG. 7

FIG. 8

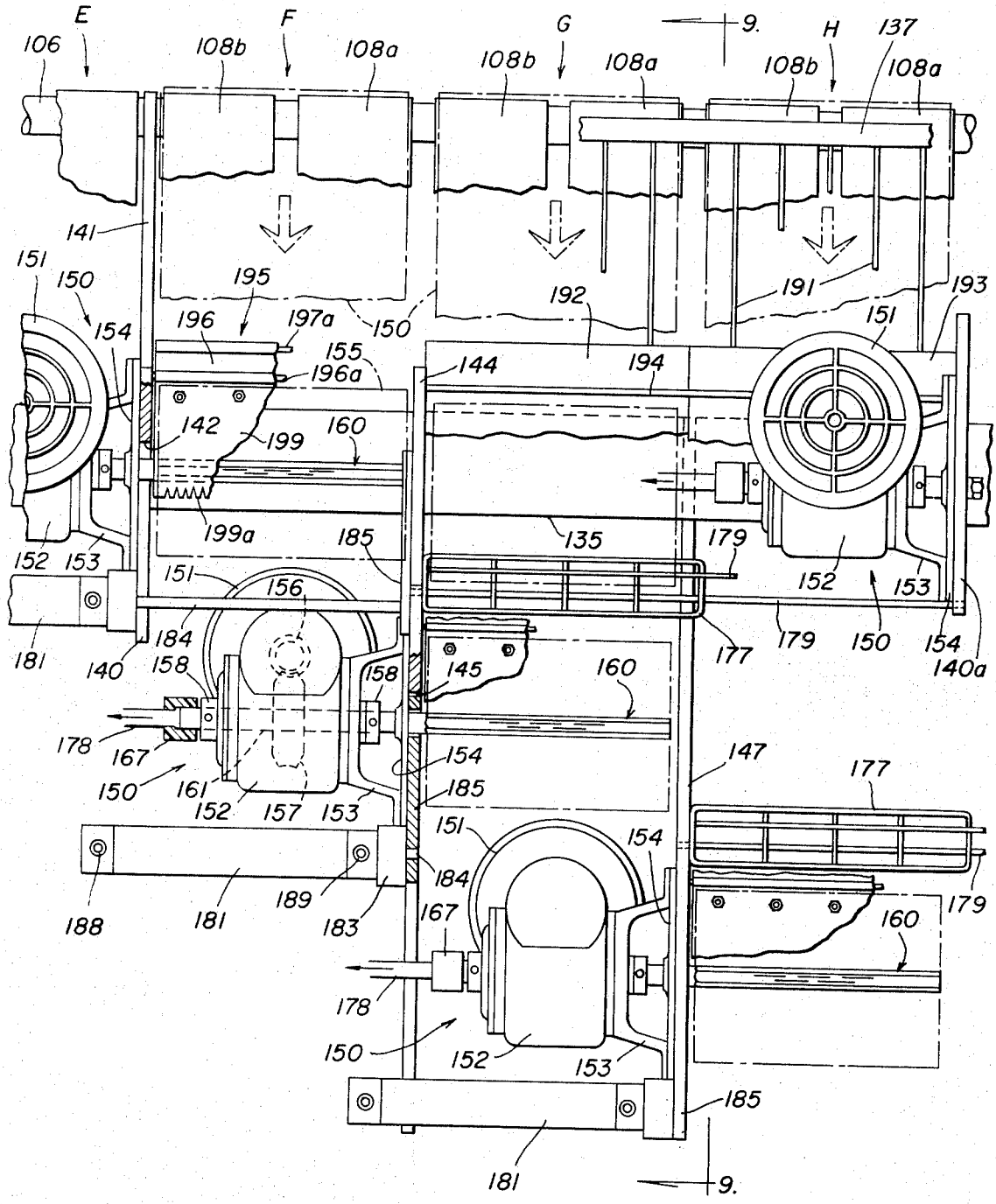

E
F
G
9.
H
106
108b
108a
108b
108a
108b
108a
137
141
151
150
154
195
196
197a
150
155
196a
192
191
193
151
144
194
142
199
160
199a
185
135
179
152
153
151
156
152
153
177
179
150
154
140a
181
140
184
158
158
145
160
178
167
150
161
152
157
153
154
185
147
177
151
154
184
167
179
160
188
181
189
183
178
150
152
153
185
181
9.

FIG. 9

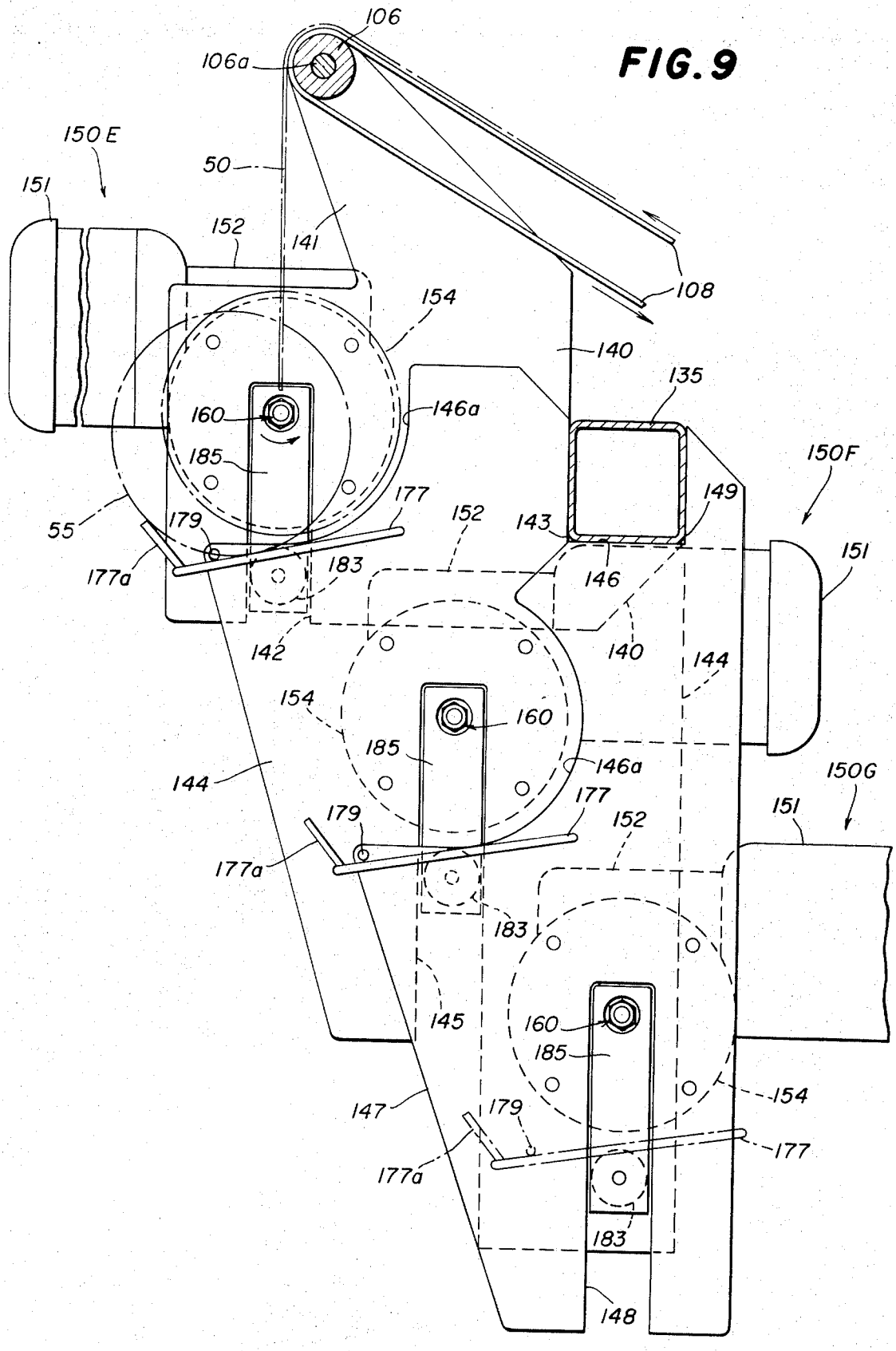

106
106a
150E
50
151
152
141
154
108
140
135
160
146a
185
150F
177
149
55
179
152
143
151
177a
183
146
142
140
144
154
160
185
146a
144
150G
177
179
151
152
177a
183
145
160
185
154
147
179
177
177a
183
148

FIG. 10

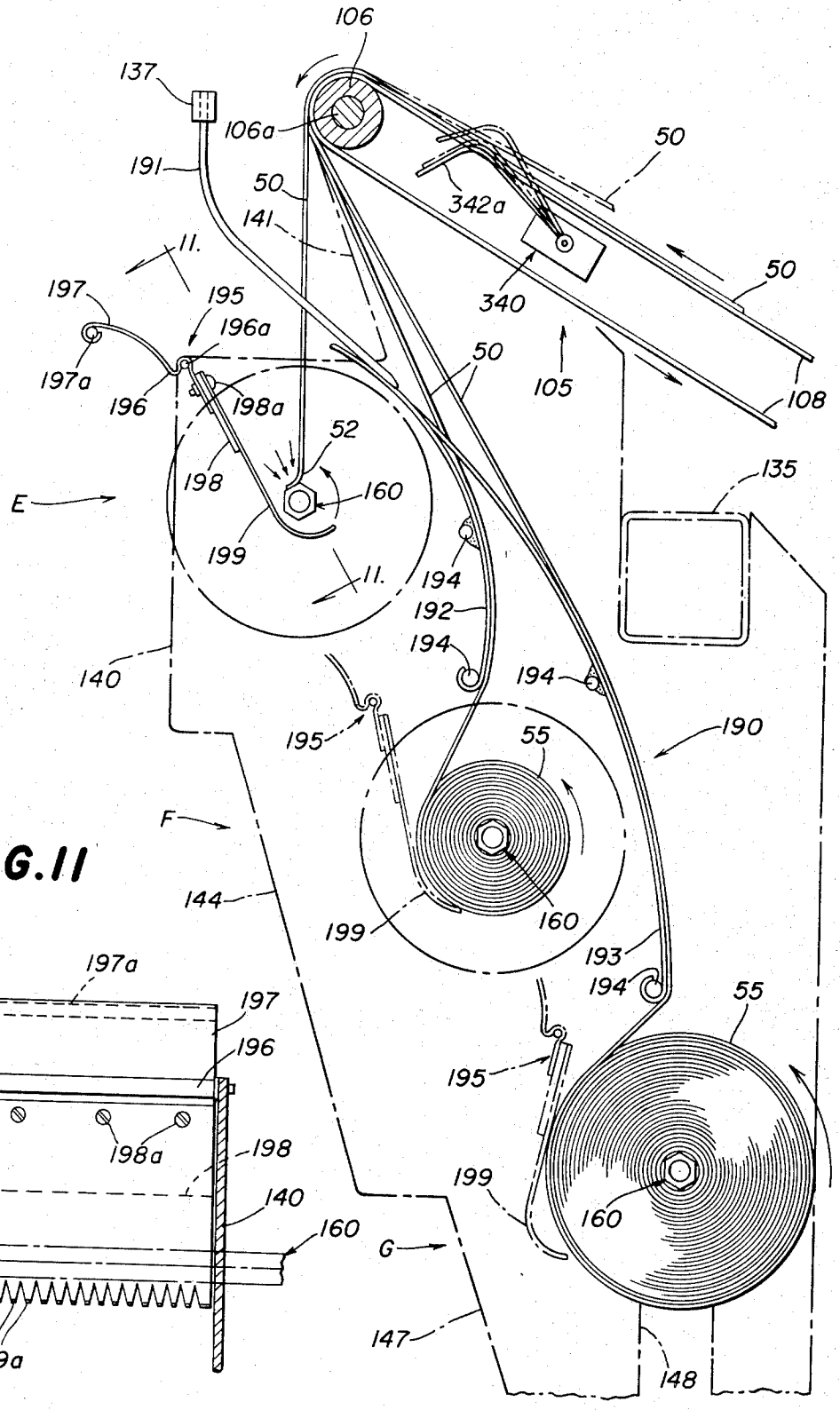

106
137
106a
191
50
141
342a
50
340
50
105
108
11.
197
195
196a
197a
196
198a
50
52
198
160
E
199
11.
135
194
192
194
140
194
190
195
55
F
144
160
199
193
194
55
195
199
160
G
147
148

FIG. 11


197a
197
196a
196
198a
198
199
140
160
199a

FIG. 12

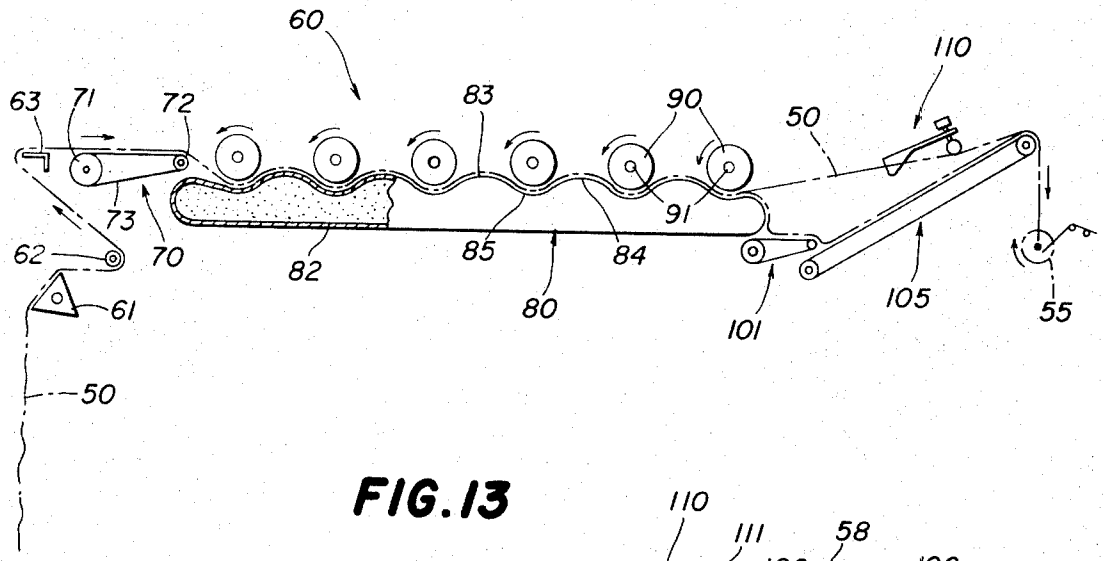



FIG. 13

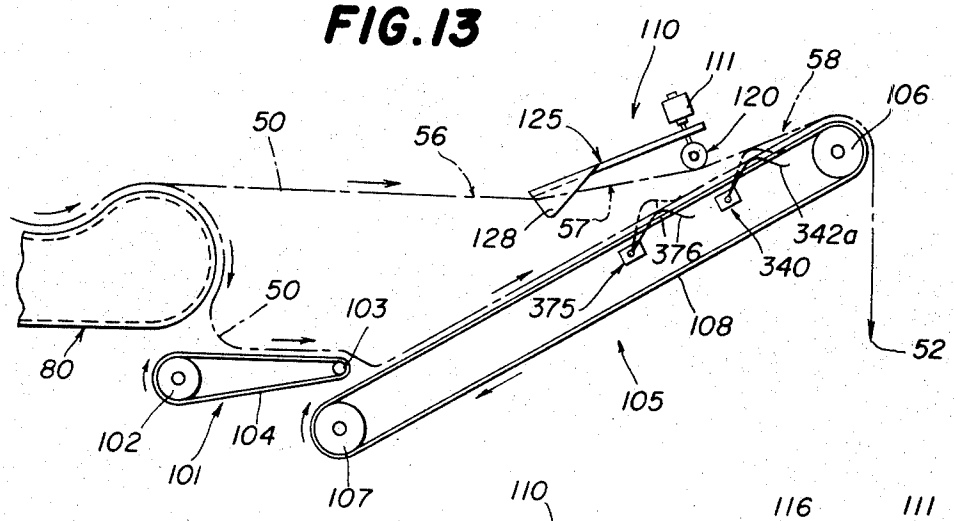



FIG. 14

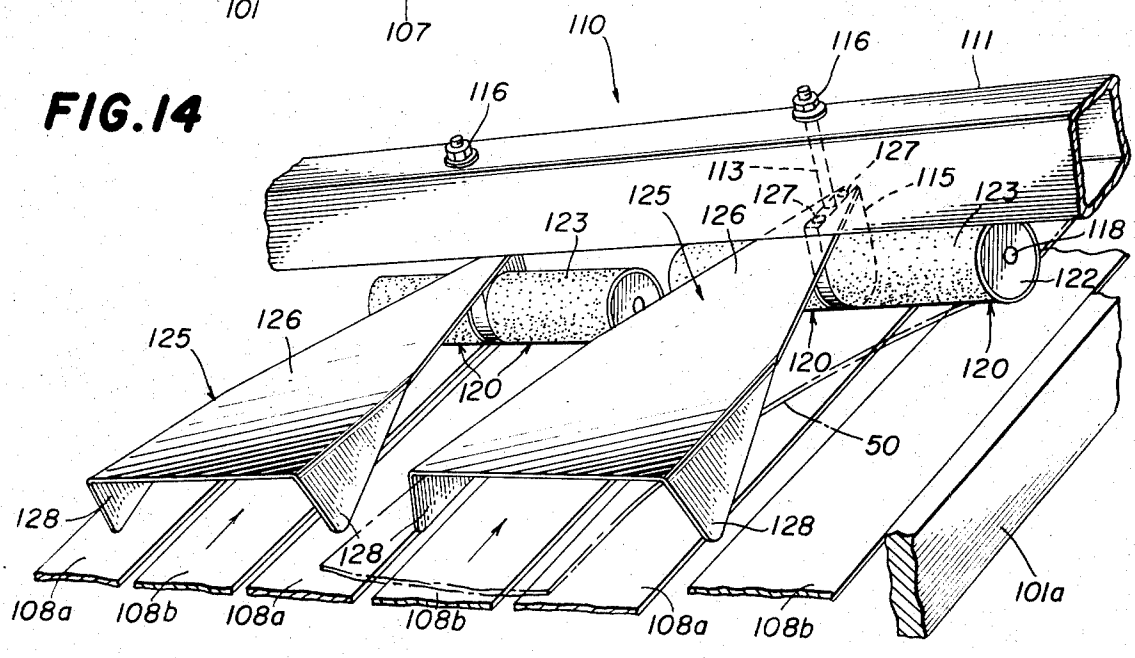


FIG. 15

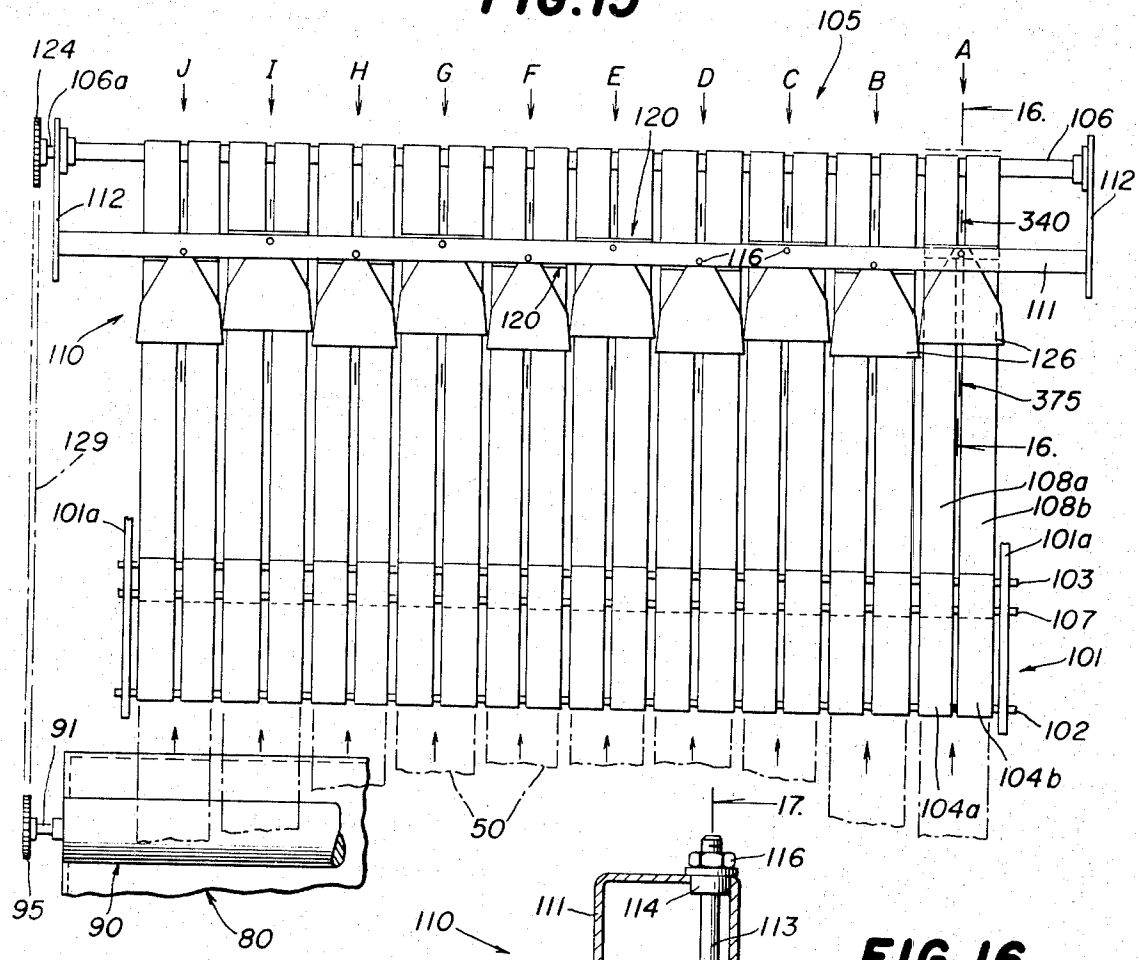



FIG. 16

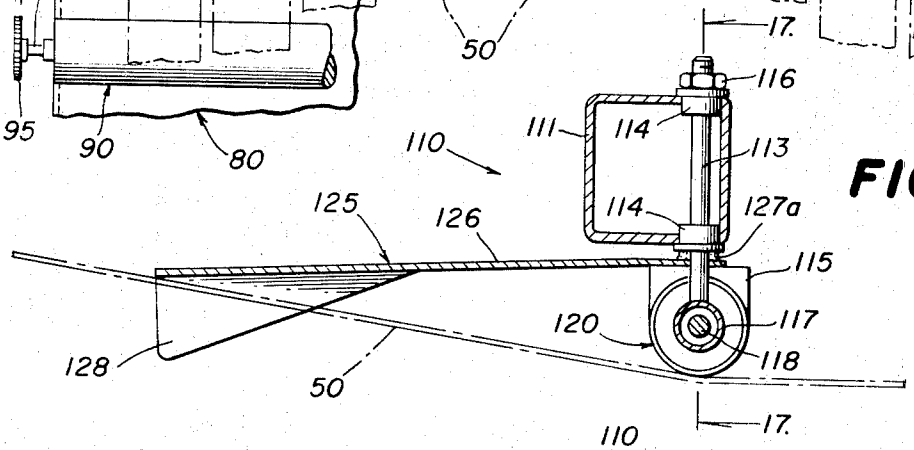



FIG. 17

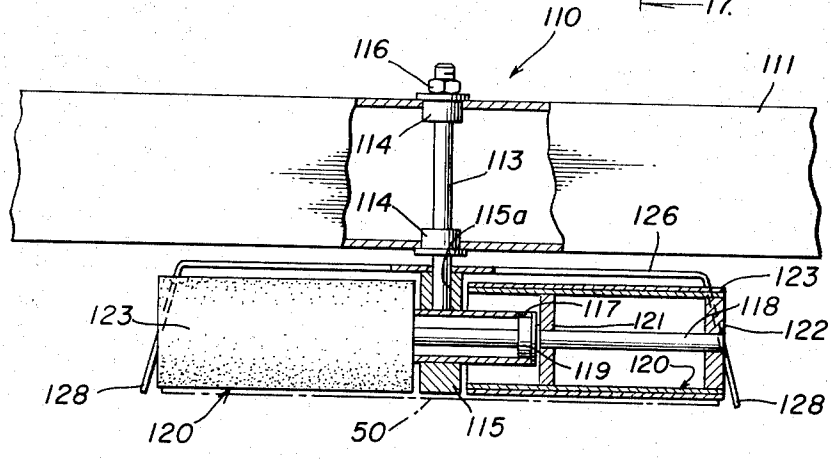


FIG. 18

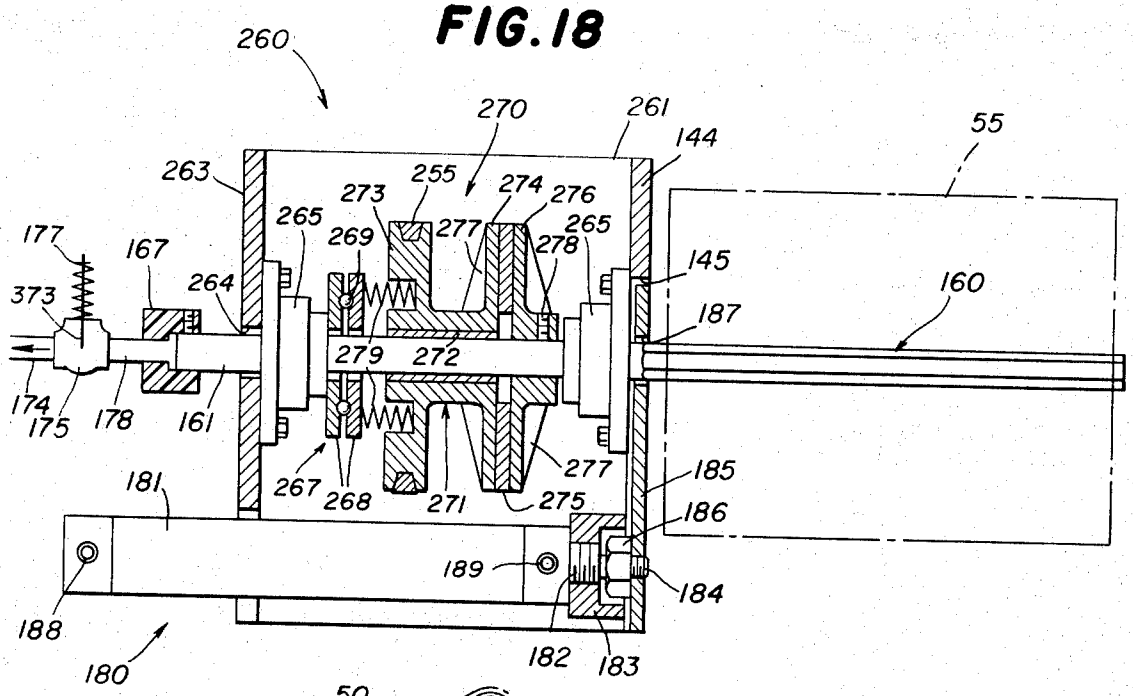



FIG. 19

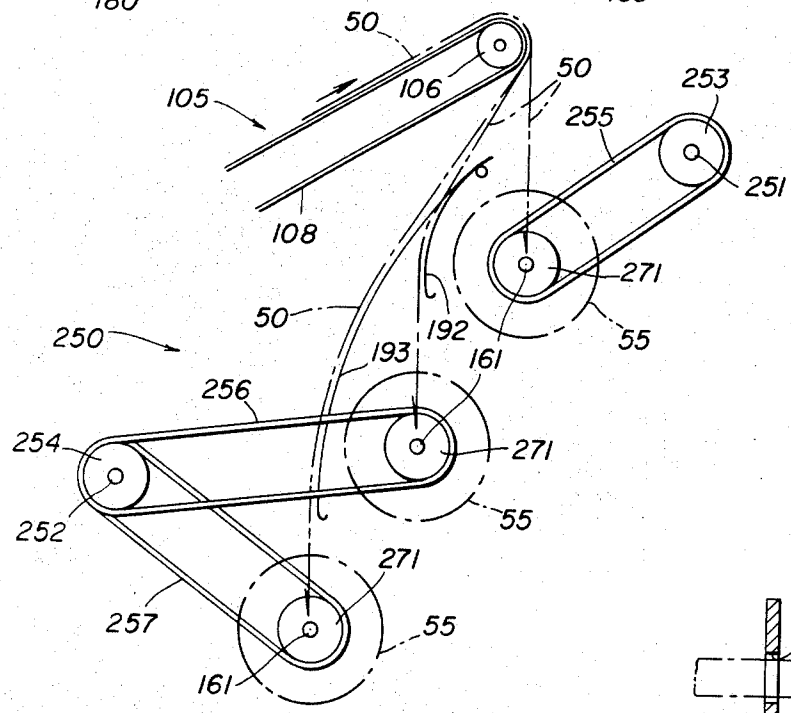



FIG. 20

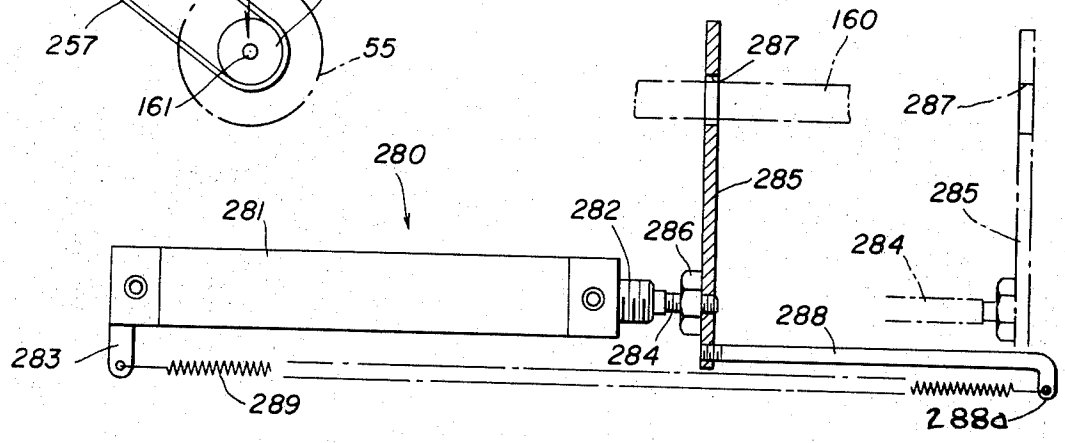


FIG. 21

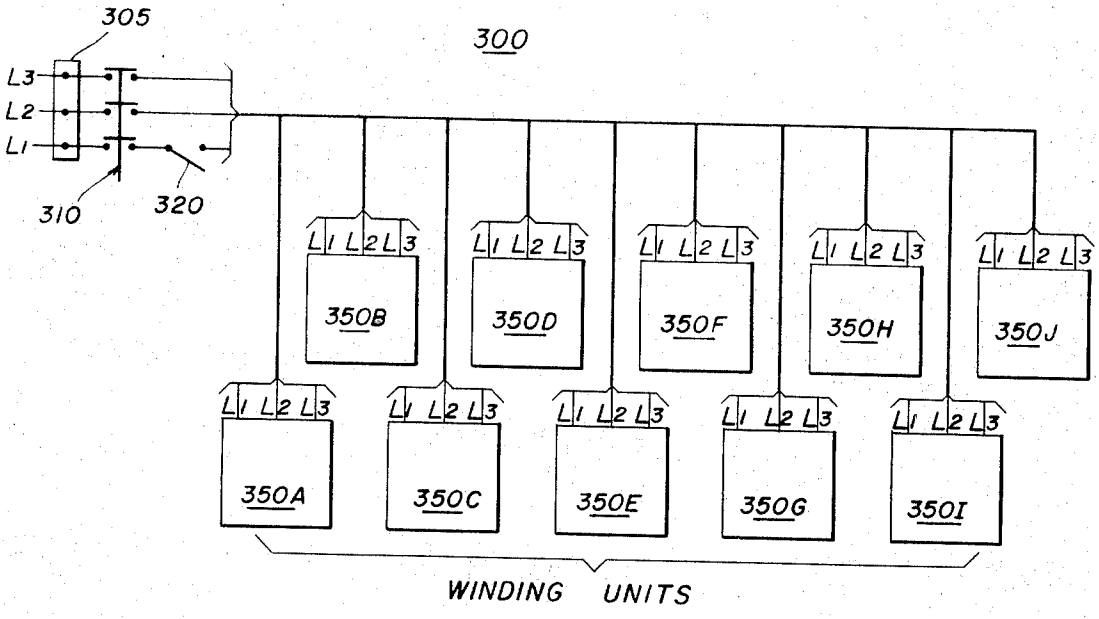

305
300
L3
L2
L1
310
320
L1 L2 L3
350B
350D
350F
350H
350J
350A
350C
350E
350G
350I
WINDING UNITS

FIG. 22

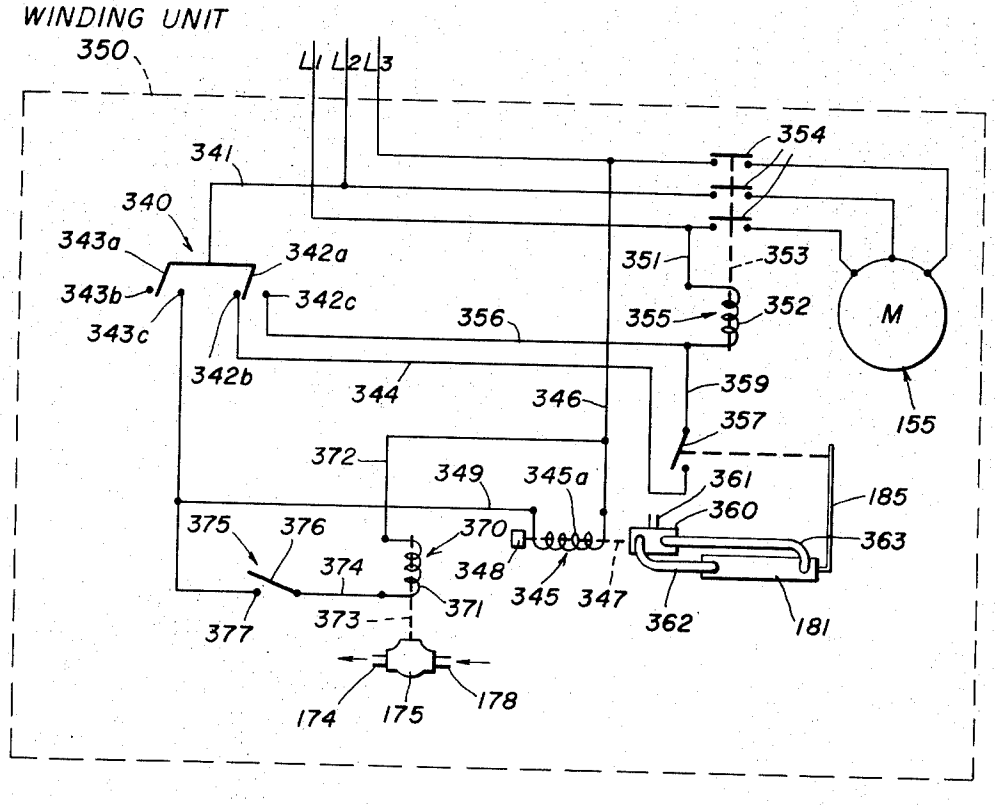
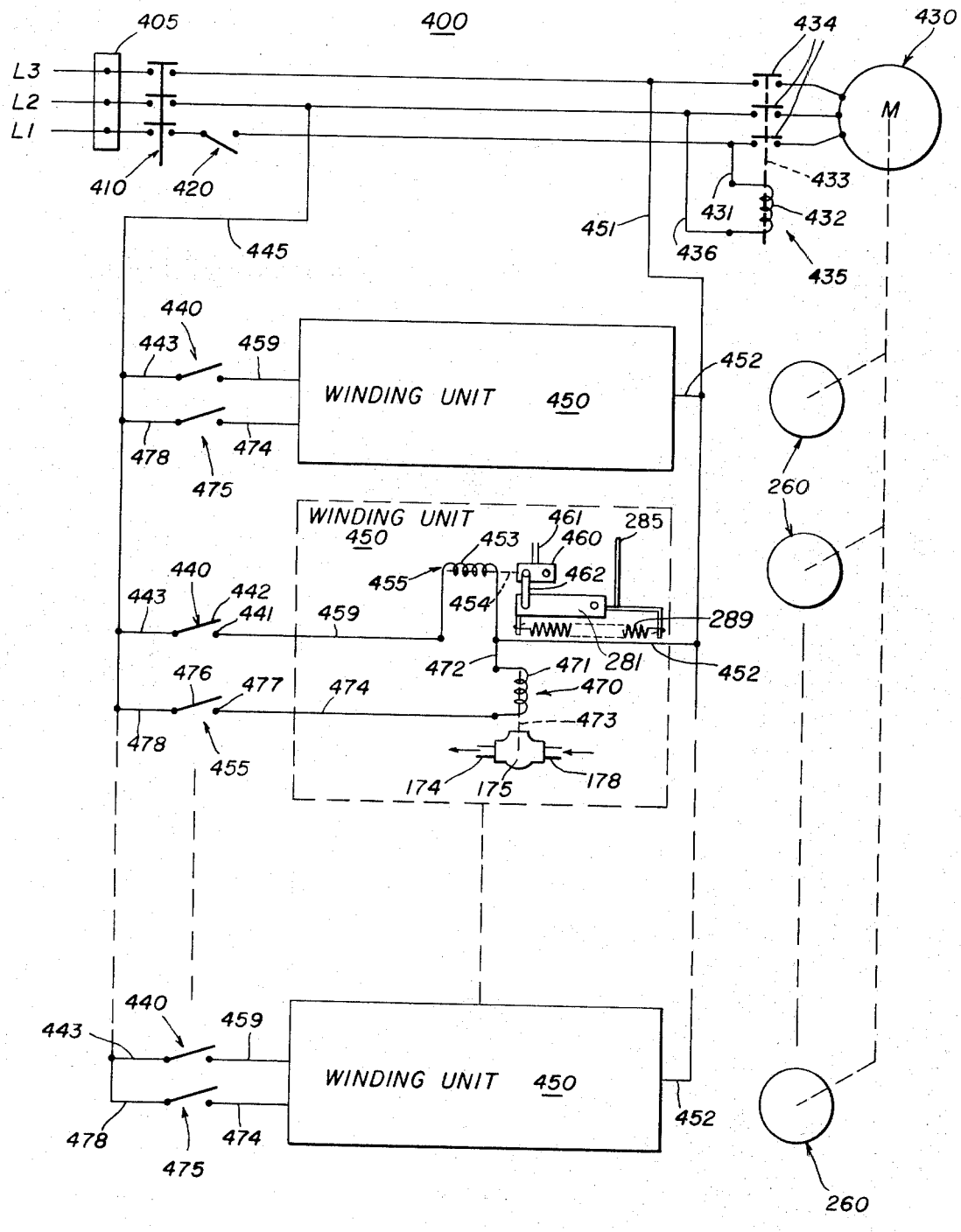

WINDING UNIT
350
L1 L2 L3
341
340
343a
343b
343c
342a
342b
342c
344
356
346
354
351
353
355
352
M
155
359
357
361
185
360
363
372
349
345a
375
376
370
348
345
347
374
371
373
377
362
181
174
175
178

FIG. 23


400
405
L3
L2
L1
410
420
445
434
430
M
433
431
432
451
436
435
440
443
459
WINDING UNIT 450
452
478
474
475
260
WINDING UNIT 450
461
285
453
460
455
462
454
289
440
443
442
441
459
472
471
281
452
476
477
474
470
473
478
455
174
175
178
440
443
459
WINDING UNIT 450
452
478
474
475
260

# AUTOMATIC TOWEL WINDING MACHINE

This invention relates to a machine for winding continuous toweling, and particularly, to a power-driven production machine which winds continuous toweling in rolls for use in towel cabinets and the like

More particularly, this invention relates to a completely automatic machine capable of winding a plurality of continuous towels into towel rolls.

It is an imp'rtant object of this invention to provide an automatic elongated towel winder comprising a support frame, a mandrel mounted on the frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by the frame and coupled to the mandrel for effecting rotation thereof, feed apparatus mounted adjacent to the mandrel for feeding an elongated towel to the mandrel, and capture means for urging the leading end of the towel against the rotating mandrel for automatically initiating the winding of the towel into a towel roll on the mandrel, whereby an elongated towel may be automatically fed to the rotating mandrel and wound in a roll thereon.

Another object of this invention is to provide a towel winder of the type set forth wherein the mandrel has a supported end mounted on the frame and a free distal end, and further including an ejector carried by the frame for removing the wound towel roll from the mandrel at the free end thereof.

Another object of this invention is to provide a towel winder of the type set forth wherein the mandrel is hollow and has an opening in the side thereof, and wherein the capture means includes a suction pump coupled to the mandrel for causing an area of reduced pressure therein and a consequent flow of air toward and through the opening which serves to move the leading end of the towel fed from the feed apparatus toward and against the rotating mandrel for automatically initiating the winding of the towel into a towel roll on the mandrel.

Still another object of this invention is to provide a towel winder of the type set forth wherein the feed apparatus is disposed adjacent to and above the mandrel for feeding the towel downwardly to the side of the mandrel in the direction of rotation thereof, and further including a guide member carried by the frame on the side of the mandrel in the direction of rotation thereof and extending beneath the mandrel a short distance therefrom, for maintaining the leading end of the towel closely adjacent to the mandrel to facilitate the pickup of the leading end of the towel by the capture means.

It is another object of this invention to provide a towel winder of the type set forth wherein the drive means is of the constant-torque type for maintaining a substantially constant torque at the mandrel, the increasing circumference of the towel roll on the mandrel as the diameter of the towel roll increases serving to decrease the rotational speed of the mandrel to maintain a substantially constant tension in the portion of the towel extending between the mandrel and the feed apparatus.

It is another object of this invention to provide a towel winder of the type set forth wherein the ejector includes an ejector member carried by the frame adjacent to the mandrel and movable between a retracted position and an ejecting position, and a fluid-actuated piston connected to the ejector member for moving the



member to the ejecting position thereof for causing the member to engage the wound towel roll and remove the towel roll from the mandrel at the free end thereof and means for returning the ejector member to the retracted position thereof at a controlled slow rate.

Yet another object of this invention is to provide a towel winder set forth, and further including control apparatus coupled to the drive means and responsive to the passage of the leading end of the towel toward the mandrel for actutating the drive means.

It is another object of this invention to provide a towel winder of the type set forth, and further including control apparatus coupled to the capture means and responsive to the passage of the leading end of the towel toward the mandrel for actuating the capture means.

It is another object of this invention to provide a towel winder of the type set forth, and further including control apparatus coupled to the ejector and responsive to the passage of the trailing end of the towel from the feed apparatus for actuating the ejector to remove the wound towel roll from the mandrel.

It is still another object of this invention to provide a towel winder of the type set forth wherein the control apparatus is coupled to both the drive means and the capture means and is responsive to the passage of the leading end of the towel toward the mandrel for actuating both the drive means and the capture means.

It is another object of this invention to provide a towel winder of the type set forth, wherein the control apparatus is coupled to both the drive means and the ejector and is responsive to the passage of the leading end of the towel toward the mandrel for actuating the drive means, the control apparatus being responsive to the passage of the trailing end of the towel from the feed apparatus for actuating the ejector to remove the wound towel roll from the mandrel.

In connection with the foregoing object, it is another object of this invention to provide a towel winder of the type set forth wherein the control apparatus is responsive to the movement of the ejector to the ejecting condition thereof for actuating the drive means, the control apparatus being responsive to the passage of the leading end of the next towel toward the mandrel for moving the ejector to the retracted condition thereof.

It is another object of this invention to provide a towel winder of the type set forth, wherein the control apparatus is coupled to both the capture means and the ejector for actuating the capture means and the ejector in the manner set forth.

Another object of this invention is to provide a towel winder of the type set forth, wherein the control apparatus is coupled to the drive means and to the capture means and to the ejector for actuating the drive means and the capture means and the ejector in the manner set forth.

In connection with the foregoing object, it is still another object of this invention to provide a towel winder of the type set forth wherein the control apparatus is responsive to the movement of the ejectpr to the ejecting condition thereof for actuating the drive means, the control apparatus being responsive to the passage of the leading end of the next towel toward the mandrel for moving the ejector to the retracted condition thereof and for actuating the capture means, the control apparatus being responsive to the initiation of the winding of the towel on the mandrel for deactuating the

capture means, the control apparatus being responsive to the passage of the trailing end of the towel from the feed apparatus for deactuating the drive means and for moving the ejector to the ejecting condition thereof.

Another object of this invention is to provide a cloth flatwork feed-directing assembly comprising feed apparatus for feeding associated flatwork in a predetermined direction from the input end to and from the discharge end of the feed apparatus, means engaging the flatwork at spaced-apart points thereon for suspending a reach thereof between the input end and the discharge end, a sensing device mounted adjacent to the feed apparatus and sensing the suspended reach of flatwork for detecting deviation of the fed flatwork from the predetermined direction, and direction correcting means acting upon the suspended reach of flatwork and coupled to the sensing device and responsive to the detection thereby of deviation of the fed flatwork from the predetermined direction for redirecting the flatwork into the predetermined direction, whereby flatwork fed by the feed apparatus is continually maintained in the predetermined direction.

In connection with the foregoing object, it is another object of this invention to provide a feed-directing assembly of the type set forth, wherein the sensing device comprises a sensing member mounted adjacent to the feed apparatus for pivotal movement about a first axis angularly disposed with respect to the plane of the suspended reach of flatwork, the sensing member engaging the suspended reach of the fed flatwork and pivoting about the first axis in response to deviation of the fed flatwork from the predetermined direction, the direction correcting means including a guide roller frictionally engaging the suspended reach of the fed flatwork and being freely rotatable about a second axis disposed substantially normal to the first axis and coupled to the sensing member for pivotal movement about the first axis, pivotal movement of the sensing member in response to deviation of the fed flatwork from the predetermined direction causing pivotal movement of the guide roller for urging the flatwork back toward the predetermined direction.

It is another object of this invention to provide a towel winder of the type set forth which includes a feed-directing assembly of the type set forth.

In connection with the foregoing object, it is another object of this invention to provide a towel winder of the type set forth for use with an associated source of towels, the feed apparatus including an inclined feed conveyor having an input end disposed adjacent to and below the source of towels and an upper discharge end disposed adjacent to the mandrel, a towel from the source following a first feed path along the conveyor until the leading end of the towel is engaged by the mandrel, the initiation of the winding of the towel on the mandrel causing tension in the towel for thereby moving the towel to a second feed path wherein a reach of the towel is suspended between the source and the discharge end of the conveyor, the sensing device and the direction-correcting means acting upon the towel in the second feed path.

Still another object of this invention is to provide a towel winder of the type set forth, which further includes detectors disposed in the first and second feed paths for sensing the presence of a towel therein, the control apparatus being coupled to the detectors and responsive to the sensing thereby of towels in the first and second paths for controlling the operation of the drive means and the capture means and the ejector.

Another important object of this invention is to provide a towel winder for automatically winding a plurality of elongated towels, the winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of the feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried b the frame and equal in number to the feed lanes, each of the winding units including a mandrel disposed in an associated one of the feed lanes transversely thereof and extending substantially thereacross, the mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed adjacent to one side of the associated one feed lane and coupled to the mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against the rotating mandrel for automatically initiating winding of the towel into a towel roll on the mandrel, the drive means for one of the outer feed lanes and the intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, the winding units being arranged on the frame so that each of the intermediate feed lanes and the other of the outer feed lanes includes the mandrel of the associated winding unit with the drive means of an adjacent winding unit displaced from the lane but in longitudinal alignment therewith, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of the rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths of the towels.

In connection with the foregoing object, it is another object of this invention to provide a towel winder of the type set forth, and further including control apparatus coupled to the drive means and the capture means in each of the winding units and responsive to the passage of the leading end of a towel in any of the feed lanes toward the associated mandrel for actuating the associated drive means and the associated capture means.

Another object of this invention is to provide a towel winder of the type set forth, wherein the winding units are staggered vertically and horizontally on the frame into upper and lower levels, and further including guide chutes respectfully disposed in the feed lanes associated with the lower level mandrels for respectively guiding the associated towels from the feed apparatus past the upper level drive means aligned with the associated feed lanes and to the lower level mandrels.

It is a further object of this invention to provide a towel winder of the type set forth, wherein each of the winding units includes an ejector for removing the wound towel roll from the mandrel at the free end thereof, and a towel receptacle disposed adjacent to the other side of the associated one feed lane for receiving the ejected towel roll from the mandrel, the winding units being arranged on the frame so that each of the intermediate feed lanes includes the mandrel of the associated winding unit with the drive means of one adjacent winding unit and the towel receptacle of an-

other adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom.

In connection with the forgoing object, it is another object of this invention to provide a towel winder of the type set forth, and further including control apparatus coupled to the drive means and to the capture means and to the ejector in each of the winding units and responsive to the passage of the leading end of a towel in any of the feed lanes toward the associated mandrel for actuating the associated drive means and the associated capture means, the control apparatus being responsive to the passage of the trailing end of the towel from the feed apparatus for actuating the corresponding ejector to remove the wound towel roll from the mandrel.

It is another object of this invention to provide a towel winder of the type set forth, wherein the winding units are staggered vertically and horizontally on the frame into upper and lower and intermediate levels, and further including first guide chutes for respectively guiding the associated towels to the intermediate level mandrels, and second guide chutes for respectively guiding the associated towels to the lower level mandrels.

Another object of this invention is to provide a towel winder of the type set forth wherein a single drive means is provided for driving all of the winding units, and further including first and second line shafts respectively disposed forwardly and rearwardly of the frame and rotatably driven by the drive means, the first line shaft being coupled to each of the upper mandrels for effecting rotation thereof, and the second line shaft being coupled to each of the intermediate and lower level mandrels for effecting rotation thereof.

In connection with the foregoing object, it is a still further object of this invention to provide a towel winder of the type set forth, which further includes control apparatus coupled to the drive means and to each of the winding units and responsive to the passage of the leading end of the towel in any of the feed lanes toward the associated mandrel for actuating the drive means and the associated capture means.

Further features of the invention pertain to the particular arrangement of the parts of the towel winder whereby the above-outlined and additional operating features are obtained.

The invention, both as to its organization and method of operation together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

FIG. 1 is a front elevational view of an automatic towel winding machine according to this invention and showing ten winding units and the manner in which they are vertically staggered on the frame;

FIG. 2 is a fragmentary view in partial section of the front frame of the towel winder of FIG. 1, and showing how the frame crossbar acts as a manifold for the suction pump;

FIG. 3 is an enlarged front elevational view of one of the winding units of the towel winding machine of FIG. 1, showing the connection between the mandrel and the frame crossbar and showing the ejector arm in its retracted position in solid lines and in its ejecting position in phantom;

FIG. 4 is a fragmentary side elevational view of the winding unit of FIG. 3;

FIG. 5 is a further enlarged front elevational view in partial section of the mandrel of the winding unit of FIG. 3 with a portion of the inner end of the mandrel removed;

FIG. 6 is a further enlarged cross-sectional view of the mandrel taken along the line 6—6 in FIG. 5;

FIG. 7 is an enlarged fragmentary front perspective view of the towel winding machine of FIG. 1 showing the operation of the towel roll ejector and receptacle;

FIG. 8 is an enlarged fragmentary front elevational view of the towel winding machine of FIG. 1 showing three of the intermediate winding units and the orientation of the capture guide apparatus with respect to the mandrels;

FIG. 9 is a further enlarged composite view taken along the line 9—9 in FIG. 8 and showing the upper level and lower level and intermediate level support plates for the winding units and also showing the vertical and horizontal staggering of the winding units on the frame;

FIG. 10 is a composite view similar to FIG. 9, but showing the guide chutes and capture guide retainers for the winding units and the cooperation of one of the control switches with the towel web;

FIG. 11 is a front elevational view of one of the capture guide retainers of FIG. 10;

FIG. 12 is a reduced side elevational view in partial section of the towel ironer for use with the towel winding machine of this invention and illustrating the cooperation between the ironer and the feed apparatus of the present invention;

FIG. 13 is an enlarged side elevational view of the feed conveyers of the towel winding machine of this invention, showing the feed directing assembly and the two feed paths for the towel web;

FIG. 14 is a further enlarged fragmentary front perspective view of the feed conveyor of FIG. 13, showing the cooperation of the feed-directing assemblies therewith;

FIG. 15 is a top plan view of the feed apparatus of the towel winding machine of the present invention;

FIG. 16 is an enlarged view in vertical section of the feed directing assembly for one of the feed lanes taken along the line 16—16 in FIG. 15;

FIG. 17 is a fragmentary view in partial section of the feed-directing assembly taken along the line 17—17 in FIG. 16;

FIG. 18 is a front elevational view in partial section of one of the winding units of the towel winding machine of this invention showing an alternative embodiment of drive means including a slip-clutch assembly;

FIG. 19 is a fragmentary diagrammatic view in side elevation of the towel winding machine of this invention illustrating the line shafts in the alternative drive arrangement which utilizes the slip clutch of FIG. 18;

FIG. 20 is a front elevational view of an alternative embodiment of the roll ejector of this invention utilizing a spring return for the ejector arm;

FIG. 21 is a schematic electric circuit diagram of the winding machine showing the coupling of a three-phase electric power source to each of ten identical winding units represented in block form;

FIG. 22 is a detailed schematic circuit diagram of the control apparatus for one of the winding units of FIG. 21; and

FIG. 23 is a schematic electric circuit diagram of the control apparatus for the towel winding machine of this

invention for use with the line shaft and slip clutch drive arrangement of FIGS. **18** and **19**.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

Referring now to the drawings, and in particular to FIGS. **1, 12** and **15** thereof, there is illustrated a towel winding machine, generally designated by the numeral **100,** according to the present invention, the towel winding machine **100** including ten identical feed lanes, respectively designaet A through J, inclusive, for repsectively feeding associated elongated towels to ten winding units, each generally designated by the numeral **150,** for winding the towels into rolls.

The towel winding machine **100** is adapted for use in a towel processing system which may perform several operations on the towel including washing, ironing, winding into rolls, and wrapping of the towel rolls. Such a system may, for example, include a towel washing machine of the type set forth in applicant's copending application Ser. No. 879,764, filed Nov. 25, 1969, now U.S. Pat. No. 3,698,214, and a towel roll wrapping machine of the type set forth in applicant's copending application Ser. No. 828,533, filed May 28, 1969, now U.S. Pat. No. 3,643,397, both of which copending applications have been assigned to the assignee of the present invention. The towel rolls processed by such a system are then preferably used in towel dispensers, which may be of the type set forth in the copending application Ser. No. 727,157 of Robert L. Steiner and Erwin B. Bahnsen, filed May 7, 1968, now U.S. Pat. No. 3,502,383, and assigned to the assignee of the present invention.

A towel ironer, generally designated by the number **60,** for use with the winding machine **100** of the present invention, is illustrated in FIG. **12** of the drawings, the ironer **60** being adapted to receive a wet elongated towel web **50** from an assocated washing machine (not shown), to iron the towel web **50** and then to feed it to the associated winding machine **100** of the present invention for winding into a towel roll **55.** The ironer **60** includes a beater **61** being substantially triangular in transverse cross section and being rotatable in a counterclockwise direction as viewed in FIG. **12,** a guide bar **62** and a towel breaker member **63.** The towel web **60** is threaded over the beater **61** and around the guide bar **62** and over the breaker **63** to a conveyor **70.** The conveyor **70** is disposed substantially horizontally and includes a drive roll **71,** an idler roll **72** and an endless conveyor belt **73** extending therebetween for conveying the towel web **50** from the breaker member **63** to a steam chest, generally designated by the numeral **80.** The steam chest **80** is hollow and includes an encompassing wall **81** having a flat bottom **82** and a convoluted top **83** forming a plurality of alternating ridges **84** and valleys **85.** A plurality of pinch rolls **90** are respectively disposed in the valleys **85** of the steam chest **80,** each of the pinch rolls **90** being shaped and dimensioned complementary to the associated valley **85** of the steam chest **80** and being held therein under the controlled pressure of a spring-loading apparatus (not shown). Each of the rolls **90** is rotatable counterclockwise about a shaft **91** for moving the towel web **50** from left to right as viewed in FIG. **12.** Thus, the towel web **50** is fed from the associated washing machine over the beater **61** and roll **62** and breaker **63** for removing folds and excess water from the towel web **50,** and thence via the conveyor **70** to the steam chest **80.** The towel web **50** is then fed between the pinch rolls **90** and the upper wall **83** of the steam chest **80** from left to right along the steam chest **80** and then is discharged from the right-hand end thereof. The action of the heat provided by the steam chest **80** and the compression provided between the rollers **90** and the steam chest **80** combine to iron the towel web **50** for removing wrinkles therefrom in a well-known manner.

The towel winding machine **100** includes a feed assembly comprising a transfer conveyor **101** and a feed conveyor **105,** mounted on a supporting framework **101***a*. The transfer conveyor **101** is disposed susbstantially horizontally beneath the steam chest **80** and includes a drive roll **102** disposed immediately beneath the right-hand end of the steam chest **80,** and an idler roll **103** disposed forwardly of the drive roll **102** and an endless conveyor belt **104** connecting the drive roll **102** to the idler roll **103.** The transfer conveyor belt **104** moves in a clockwise direction as viewed in FIG. **13** and preferably has a surface speed approximately 40 percent greater than the surface speed of the towel web **50** as it is fed from the ironer **60,** whereby the towel web **50** may be fed from the ironer **60** by the transfer conveyor **101** to the right as viewed in FIG. **13** without folding upon the transfer conveyor **101.**

The feed conveyor **105** is substantially longer than the transfer conveyor **101** and is inclined at an acute angle to the horizontal. The feed conveyor **105** includes a drive roll **106** at the upper end thereof rotatably mounted on a shaft **106a** which is preferably supported at the opposite ends thereof in bearings on end plates **112** which are supported on the frame **101a** and on a winding unit frame **130** to be described. An idler roll **107** is disposed at the lower end of the feed conveyor **105** immediately below the idler roll **103** of the transfer conveyor **101.** An endless conveyor belt **108** interconnects the drive roll **106** and the idler **107** and is driven thereby in a clockwise direction, as viewed in FIG. **13,** for receiving the fed towel web **50** from the transfer conveyor **101** and feeding the towel web **50** upwardly along the feed conveyor **105** from the input end to the discharge end thereof. Thus, the transfer conveyor **101** and the feed conveyor **105** cooperate with the ironer **60** to define a first lower feed path for the towel web **50** extending from the discharge end of the ironer **60,** downwardly to the transfer conveyor **101** and forwardly therealong to the feed conveyor **105** and upwardly therealong to the discharge end thereof as is clearly indicated in FIG. **13.** Hereinafter the end of winding machine **100** toward the discharge end of the feed conveyor **105** will be referred to as the forward end and the end toward the input end of the feed conveyor **105** will be referred to as the rearward end.

It is an important feature of the present invention that the transfer conveyor **101** and the feed conveyor **105** and the ironer **60** associated therewith are all of sufficient width to accommodate a plurality of towels repsectively arranged thereon in a corresponding plurality of feed lanes, each of these feed lanes having a width only slightly greater than the width of the associated towel web **50** and being arranged substantially parallel to each other in side-by-side relationship. Referring to FIG. **15** of the drawings, it will be seen that

ten such feed lanes, respectively designated by the letters A to J, inclusive, have been provided in the preferred embodiment of this invention, but it will of course be recognized that the machinery of this invention may be constructed so as to accommodate any desired number of such feed lanes. The transfer conveyor **101** and the feed conveyor **105** are each provided with ten pairs of endless conveyor belt halves, respectively centered in the ten feed lanes A to J. More particularly, in each of the feed lanes A to J, the transfer conveyor **101** is provided with a pair of substantially parallel spaced-apart endless conveyor belt halves **104***a* and **104***b*, respectively, disposed on opposite sides of the longitudinal midline of the associated feed lane, and cooperating to define the associated conveyor belt **104.** Similarly, the feed conveyor **105** is provided in each feed lane thereof with a pair of substantially parallel spaced-apart endless conveyor belt halves **108**a and **108**b, respectively, disposed in longitudinal alignment with the corresponding pairs of conveyor belt halves **104***a* and **104***b*, and cooperating to define the conveyor belts **108.**

Connected to one end of the shaft **91** of the discharge roll **90** of the ironer **60** is a sprocket **95.** Similarly, connected to the adjacent end of the shaft **106**a of the feed conveyor drive roll **106** is a sprocket **124,** the sprockets **95** and **124** being interconnected by a drive connecting assembly **129,** whereby the feed conveyor **105** is driven in the direction indicated at a speed having a predetermined fixed relationship to the speed of the ironer **60.**

For each of the feed lanes A to J, the feed conveyor **105** is also provided with two control switches, respectively generally designated by the numerals **340** and **375,** and being disposed within the loop formed by the associated pair of conveyor belt halves **108***a* and **108***b*. The control switch **340** is disposed adjacent to the upper or discharge end of the feed con veyor **105** and is provided with a movable contact **342***a* in the form of a generally hook-shaped wire resiliently urged into a normally open position extending upwardly between the associated pair of conveyor belt halves **108***a* and **108***b* and into the first feed path of the towel web **50** along the feed conveyor **105.** The control switch **375** is disposed rearwardly of the switch **340** and is also provided with a movable contact **376** in the form of a generally hook-shaped wire resiliently urged into a normally open position extending upwardly between the associated pair of conveyor belt halves **108***a* and **108***b* and into the first feed path of the towel web **50** along the conveyor **105.** The purpose of the control switches **340** and **375** will be described more fully hereinafter.

Referring now to FIGS. **12** through **17** of the drawings, there is provided adjacent to the upper end of the feed conveyor **105,** a bridging member **111** spanning the feed lanes A to J, and supported at the opposite ends thereof on the end plates **112** of the winding machine frame a short distance above the conveyor belts **108** by suitable means. The bridging member **111** is disposed rearwardly of the dishcarge end of the feed conveyor **105** between the switch contacts **342***a* and **376** and is preferably of tubular construction having a substantially rectangular cross section, the bridge member **111** being turned slightly on its longitudinal axis so that its lower surface is substantially parallel to the plane of the feed conveyor **105.** Mounted on the bridge member **111** are 10 identical feed-directing assemblies, each generally designated by the numeral **110,** and respectively disposed in the feed lanes A to J. Each of the feed-directing assemblies **110** includes a pivot pin **113** disposed substantially normal to the upper and lower walls of the bridge member **111** and extending therethrough, the pivot pin **113** being mounted in a pair of axially aligned radially flanged bearings **114** respectively disposed in complementary openings in the upper and lower walls of the bridge member **111.** The upper end of the pivot pin **113** may be externally threaded and secured to the bridge member **111** by a nut **116.** The lower end of the pivot pin **113** is received in a complementary opening **115***a* in a pivot block **115,** the pivot block **115** having an arcuate lower surface and a flat upper surface disposed substantially parallel to the lower surface of the bridge member **111** and spaced a short distance therebelow. Disposed through another complementary opening in the pivot block **115,** is a cylindrical core member **117** having a longitudinal axis which intersects the longitudinal axis of the pivot pin **113** at substantially right angles thereto. The lower end of the pivot pin **113** is secured to the cylindrical core member **117** intermediate the ends thereof, which ends are respectively equidistantly spaced outwardly from the opposite sides of the pivot block **115.** A pair of radially flanged bearings **119** are respectively fitted into the opposite ends of the cylindrical core **117,** for supporting therethrough a shaft **118** coaxial with the cylindrical core member **117** and freely rotatable about the longitudinal axis thereof. The opposite ends of the shaft **118** respectively extend outwardly beyond the opposite ends of the cylindrical core member **117** and respectively carry thereon a pair of guide rollers, generally designated by the numeral **120.** Each of the guide rollers **120** is cylindrical in shape and is supported on the adjacent end of the shaft **118** by annular support spacers **121** and **122,** the spacer **121** being disposed adjacent to the associated end of the cylindrical core member **117** and the spacer **122** being disposed adjacent to the outer end of the shaft **118** and the guide roller **120** and forming an end cap for the guide roller **120.** The outer surface of each of the guide rollers **120** is coated with a coarse frictional material **123** for frictionally engaging an associated towel web **50** as will be described more fully hereinafter.

Each of the feed-directing assemblies **110** is also provided with a towel follower or sensing member, generally designated by the numeral **125,** the follower **125** comprising a substantially flat, wedge-shaped plate **126** having a narrow front end overlying the upper surface of the pivot block **115** and secured thereto by suitable fasteners **127,** and a wide rearward end disposed rearwardly of and below the pivot block **115.** The rearward end of the plate **126** is provided on the opposite side edges thereof with a pair of downwardly extending, generally triangular wings **128.** The rearward end of the plate **126** has a width substantially equal to the width of the associated feed lane, the downwardly extending wings **128** being adapted to straddle the associated towel web **50** in a manner to be described more fully hereinafter. The pivot block **115** and the shaft **118,** guide rollers **120** and towel follower **125** coupled thereto, are all pivotally movable about the axis of the pivot pin **113** and the guide rollers **120** are freely rotatable about the longitudinal axis of the shaft **118,** all for facilitating the feed-directing function of the assembly **110** as will be described in detail hereinafter.

Referring now to FIGS. 1 and 2 of the drawings, there is shown a forward supporting framework, generally designated by the numeral **130** and preferably formed of steel, for supporting the winding units **150** of the towel winding machine **100.** The framework **130** includes a pair of upstanding posts **131** connected at the lower ends thereof to foot plates **132** which are supported upon the floor or other supporting surface **133.** Interconnecting the posts **131** at the upper ends thereof is a tubular cross beam **135** having a substantially rectangular cross section and disposed substantially horizontally. Respectively connected to and closing the opposite ends of the tubular cross beam **135** and extending upwardly therefrom substantially normal thereto are the pair of end plates **112,** the upper ends of the plates **112** supporting the opposite ends of the feed conveyor drive **106a** as described above. Also, extending between the end plates **112** just forwardly of the drive roll **106** and substantially parallel thereto is a cross bar **137** for a purpose to be described more fully hereinafter. It will be noted that the end plates **112** cooperate with the hollow cross beam **135** to define therein a closed chamber **136.**

Referring now also to FIGS. **7** to **9** of the drawings, there are provided a plurality of flat, relatively thin upstanding plates of different shapes, including upper support plates **140** and **140*a***, intermediate support plates **144** and lower support plates **147,** all carried by the cross beam **135** and respectively disposed at the side boundaries of the feed lanes A to J substantially parallel to one another. More particularly, the support plate **140** lies in the vertical midplane of the winding machine **100** and separates the feed lane E from the feed lane F. The support plate **140** is generally rectangular in shape and is provided at the upper end thereof with a forwardly and upwardly extending arm **141** having an opening in the upper end thereof for accommodating therethrough the drive shaft **106*a*** of the feed conveyor **105.** Formed in the rear edge of the support plate **140** is a right angle notch or recess **143** shaped complementary to the cross beam **135** and receiving the cross beam **135** therein, whereby the plate **140** abuts against and is welded to the front and bottom walls of the cross beam **135,** all for securely supporting the mounting plate **140** on the cross beam **135.** Extending vertically upwardly from the bottom edge of the support plate **140** adjacent to the front end thereof is a substantially rectangular slot **142.** Disposed three lanes to either side of the support lane **141,** i.e., between feed lanes B and C and between feed lanes H and J, are support plates **140*a*** which are each constructed substantially identically to support plate **140** with the exception that the plates **140*a*** are not provided with the mounting arm **141.** The support plates **140*a*** are each disposed vertically and are connected to the cross beam **135** in the same manner as is support plate **140.**

Respectively disposed at the left-hand edge of feed lane A, between feed lanes C and D, between feed lanes F and G, and between feed lanes I and J, are four identically-constructed intermediate support plates **144,** each of the support plates **144** being disposed parallel to the central support plate **140,** but displaced a short distance downwardly and rearwardly therefrom. The support plates **144** are all identically constructed and have an irregular shape provided at the upper rear corner thereof with a notch **146** for accommodating the cross beam **135** therein, whereby the support plates **144** are connected to the cross beam **135** by appropriate means such as welding. Extending vertically upwardly from the bottom edge of each of the support plates **144,** approximately midway between the front and rear ends thereof, is a substantially rectangular slot **145.** An arcuate recess **146*a*** is formed in the top front edge of the plate **144.**

Respectively disposed between the feed lanes A and B, between the feed lanes D and E, and between the feed lanes G and H, are three identically-constructed lower support plates **147,** all disposed parallel to the intermediate support plates **144** but displaced downwardly and rearwardly a short distance therefrom. The support plates **147** are each provided at the upper end thereof with a notch **149** for accommodating the cross beam **135,** whereby the support plates **147** are connected to the cross beam **135** by appropriate means such as welding. Extending vertically upwardly from the bottom end of each of the support plates **147,** intermediate the front and rear ends thereof, is a substantially rectangular slot **148.** An arcuate recess **149a** is formed in the top front edge of the plate **147.**

It will be noted that the support plates **140, 140*a*, 144** and **147** comprise a total of ten support plates, and when the support plates **140** and **140*a*** are considered to be the same, it can be seen that these 10 plates are arranged in an alternating pattern on the frame **130.** Thus, beginning at the left-hand edge of feed lane A as viewed in FIG. **1,** the plates are arranged from left to right in a repeating pattern as follows: an intermediate plate **144,** a lower plate **147,** an upper plate **140,** an intermediate plate **144,** a lower plate **147,** etc., with a plate disposed at the left-hand boundary of each of the feed lanes A to J. Each cycle of this repeating pattern includes a set of three support plates, i.e., an upper support plate **140,** an intermediate support plate **144** and a lower support plate **147,** one of these sets of three support plates being illustrated in FIGS. **8** to **10** of the drawings. Referring to FIG. **9** it can be seen that the support plates **140** (or **140*a***), **144** and **147** in each set of the pattern are staggered horizontally and vertically on the frame **130** in such a manner that the upper ends of the slots **142, 145** and **148** are spaced equidistantly from one another. More particularly, the upper end of the slot **145** is disposed below and rearwardly of the upper end of the slot **142,** and the upper end of the slot **148** is disposed below and rearwardly of the upper end of the slot **145,** all for a purpose to be described more fully hereinafter.

Respectively mounted on the frame **130,** and more particularly on the support plates **140** (or **140*a***), **144** and **147,** are a plurality of winding units, generally designated by the numeral **150,** equal in number to the feed lanes of the winding machine **100.** The winding units **150** are all of identical construction whereby only one of these units will be described in detail. Referring, for example, to FIGS. **3** through **7** of the drawings, the winding unit **150** comprises a drive motor **155,** a winding mandrel **160,** and an ejector unit **80.** The drive motor **155** is preferably a gear head motor of the constant-torque type and is provided with a generally cylindrical motor housing **151** and a generally cylindrical gear head housing **152** connected to the motor housing **151,** with the longitudinal axis of the gear head housing **152** disposed substantially normal to the longitudinal axis of the motor housing **151.** Spaced circumferentially around the right-hand end of the gear head hous-

ing 152, as viewed in FIG. 3, and extending outwardly therefrom are a plurality of mounting legs 153, connected at the outer ends thereof to a substantially circular mounting plate 154. In use, the mounting plate 154 is disposed parallel to the associated one of the support plates 140 (or 140a), 144 or 147 (a plate 144 is shown in FIG. 3) and is fastened to the left-hand side thereof (as viewed in FIG. 3) by suitable fastening means such as screws or bolts for supporting the drive motor 155 on the support plate 144. The mounting plate 154 is so oriented that the axis thereof passes through the vertical midline of the slot 145 in the support plate 144, a short distance below the upper end of the slot 145. The output shaft of the drive motor 155 is provided with a worm 156 adapted for meshing engagement with a worm gear 157 in the gear head housing 152. Connected to the opposite ends of the gear head housing 152 and coaxial therewith are a pair of bearings 158. The mandrel 160 is disposed substantially horizontally and has a cylindrical inner portion 161 (disposed to the left in FIG. 3) and an outer portion 162, the inner portion 161 extending through the slot 145 in the support plate 144, through a complementary opening centrally disposed in the mounting plate 154 and through the bearings 158 and gear head housing 152 coaxial therewith, the inner portion 161 of the mandrel 160 being coupled to the worm gear 157, whereby the mandrel 160 is rotatably driven about the longitudinal axis thereof in a counterclockwise direction as viewed in FIGS. 9 and 10. The outer portion 162 of the mandrel 160 extends to the right of the support plate 144, as viewed in FIG. 3, and is substantially hexagonal in transverse cross section, being provided with six equal outer side faces 163. The mandrel 160 is of hollow metal tubular construction and is closed by a plug 166 force fed into the free distal end 164 thereof to define an enclosed chamber 168 therein. Formed in one of the side faces 163 of the mandrel 160 are a plurality of elongated slots or openings 165 communicating with the chamber 168.

The towel winding machine 100 is also provided with a suction pump 170, which is coupled by means of a connecting pipe or conduit 171 to a fitting 172 extending through one wall of the hollow cross beam 135, whereby communication is provided between the suction pump 170 and chamber 136 in the cross beam 135. A plurality of input fittings 173 equal in number to the winding units 150 are also provided through the wall of the cross beam 135. Coupled to each of the fittings 173 is a lead conduit or pipe 174 which is in turn coupled to a control valve 175, which is in turn coupled to connector 178, the connector 178 being coupled to the open inner end of the mandrel 160 by an air-tight nylon coupler 167 which permits free rotation of the mandrel 160 therein. Thus, it can be seen that the hollow cross beam 135 acts as a manifold between the suction pump 170 and the mandrels 160 of each of the winding units 150. The control valve 175 is preferably solenoid-actuated, and is provided with a solenoid armature 373 and a bias spring 177, the details of operation of the control valve 175 to be described hereinafter.

When the valve 175 is open, the suction pump 17 will draw air from the chamber 168 in the mandrel 160, thereby causing an area of reduced pressure in the chamber 168 and a consequent flow of air into the chamber 168 through the openings 165 in the side of the mandrel 160. There is thus created a vacuum or suction effect through the openings 165 for attracting the leading end of the towel web 50 to the mandrel 160 when the towel web 50 is fed to the vicinity of the mandrel 160 for automatically initiating the winding of the towel web 50 on the mandrel 160. Preferably, the suction pump 170 maintains a pressure within the chamber 168 of approximately 10 inches of mercury column, it having been found that this degree of vacuum will produce a sufficient suction through the openings 165 to effectively capture the leading end 52 of the towel web 50.

The winding unit 150 is also provided with an ejector unit, generally designated by the numeral 180, the ejector unit 180 preferably being fluid-actuated and including an air cylinder 181 provided with an externally threaded stud 182 at one end thereof. Threadedly engaged with the stud 182 ia an annular mounting bracket 183 which abuts against the left-hand side of the support plate 144, as viewed in FIG. 3, immediately below the drive motor mounting plate 154. The cylinder 181 is disposed substantially horizontally and is provided with a movable piston 184 therein, the right-hand end of the piston 184 being externally threaded and extending outwardly beyond the stud 182. The longitudinal axis of the piston 184 passes through the vertical midline of the slot 145 of the support plate 144 substantially normal thereto, with the threaded end of the piston 184 extending through the slot 145. A flat, upstanding ejector arm 185 is coupled to the piston 184, the threaded end of the piston 184 being received through a complementary opening in the ejector arm 185 and secured thereto by a nut 186. The ejector arm 185 is shaped complementary to the slot 145 in the support plate 144 and has a thickness slightly less than the thickness of the support plate 144, whereby the ejector arm 185 may be nested within the slot 145. At the upper end of the ejector arm 185 is a circular opening 187 for accommodating the mandrel 160 therethrough. The cylinder 181 is provided with two air inlet ports 188 and 189 adapted for coupling to a suitable source of air (not shown) for moving the piston 184 between an ejecting position illustrated in phantom in FIG. 3, and a retracted position illustrated in solid line in FIG. 3. In the ejecting position thereof, the piston 184 is fully extended to the right of the cylinder 181, with the ejector arm 185 being disposed at the free distal end 164 of the mandrel 160. When the piston 184 is in its retracted position, it is fully withdrawn into the cylinder 181 with the ejector arm 185 disposed completely within the slot 145 in the support plate 144 so as not to interfere with the winding of the towel web 50 on the mandrel 160 as will be described below.

It will be noted that the mandrel 160 has a length nearly equal to twice the width of the associated feed lane, whereby the tapered portion 162 of the mandrel extends substantially across the associated feed lane, while the cylindrical end 161 of the mandrel 160 and the drive motor 155 coupled thereto are disposed in longitudinal alignment with an adjacent feed lane, viz., the feed lane immediately to the left of the feed lane associated with the winding unit 150. In addition, it will be noted that the cylinder 181 of the ejector unit 180 is also disposed in longitudinal alignment with the feed lane adjacent to the left-hand side of the associated feed lane. In fact, the cylinder 181 has a length greater than the length of the feed lane, whereby it extends even beyond the adjacent feed lane, as indicated, for

example, in FIG. 8. Furthermore, each of the winding units 150 is provided with a towel roll receptacle or catcher 177, which is of a wire or rod mesh construction, and is disposed beneath and immediately to the right of the free distal end 164 of the mandrel 160, as indicated in FIGS. 7 and 8. Since the mandrel 160 extends across substantially the entire width of the associated feed lane, the roll receptacle 177 is disposed in longitudinal alignment with the next adjacent feed lane to the right of the associated feed lane as viewed in FIG. 8, the receptacle 177 being supported between the support plates bordering the adjacent feed lane by means of a mounting rod 179, the receptacle 177 being tilted slightly downwardly and forwardly of the winding machine 100 and being provided with a plurality of upturned prongs 177*a* at the forward end thereof for retaining the associated towel roll thereon. Thus, it can be seen that while the winding unit 150 is associated with only one of the feed lanes A to J, it has an overall width substantially equal to the combined widths of three such feed lanes. For example, referring to FIG. 8, the winding unit 150 associated with feed lane G has a mandrel 160 with the tapered section 162 disposed in feed lane G, and with the cylindrical section 161 and drive motor 155 and ejector cylinder 181 disposed in alignment with feed lane F, and with the roll receptacle 177 disposed in feed lane H.

Accordingly, in order to accommodate the winding units 150 in a space having approximately the same width as the feed conveyor 105, i.e., a width substantially equal to the combined widths of the feed lanes A to J, it is necessary to stagger the winding units 150 on the frame 130. This staggering is accomplished by the staggering of the support plates 140 (or 140*a*), 144 and 147 described above. Considering, for example, a set of three such support plates as is set forth in FIG. 9, it will be apparent that when the winding units 150 for each of the feed lanes A to J are mounted on the support plates as described above, i.e., with the mandrel 160 and the ejector arm 185 disposed in the rectangular slot of the associated support plate, there will result a horizontal and vertical staggering of the winding units 150 wherein a winding unit 150 associated with an intermediate support plate 144 is disposed below and rearwardly of a winding unit 150 associated with an upper support plate 140 and is disposed above and forwardly of a winding unit 150 associated with a lower support plate 147. Thus, neither the drive motor 155 nor the ejector cylinder 181 nor the roll receptacle 177 of the winding unit 150 will interfere with the mandrel 160 of an adjacent winding unit 150, but all ten of the winding units 150 may be completely accommodated in a space having a width only slightly greater than the combined widths of the feed lanes A to J.

Referring to FIG. 1, it will be seen that this staggered arrangement of the winding units 150 results in a pattern wherein each of the intermediate feed lanes B to I has the mandrel 160 of the associated winding unit 150 disposed therein, with the drive motor 155 and ejector cylinder 181 of one adjacent winding unit 150 and with the roll receptacle 177 of the other adjacent winding unit 150 disposed in longitudinal alignment with the feed lane but displaced therefrom. One of the end feed lanes, i.e., feed lane J, has the mandrel 160 of the associated winding unit 150 disposed therein and has the towel roll receptacle 177 associated with the feed lane I disposed in longitudinal alignment with the feed lane J but displaced therefrom, there being no drive motor 155 in longitudinal alignment with the feed lane J. The other end feed lane, i.e., feed lane A, has the mandrel 160 of the associated winding unit disposed therein, and has the drive motor 155 associated with the feed lane B disposed in longitudinal alignment with the feed lane A but displaced therefrom, there being no roll receptacle 177 in alignment with the feed lane A. It will also be noted that the framework 130 must be slightly wider than the total width of the feed lanes A to J in order to accommodate the drive motor 155 associated with the feed land A and the roll receptacle 177 associated with the feed lane J.

Referring now to FIG. 10 of the drawings, it will be seen that when the leading end 52 of a towel 50 is fed from the discharge end of the feed conveyor 105 it falls vertically under the force of gravity to the associated winding unit 150. Accordingly, it is desirable that the associated winding unit 150 be so positioned on the frame 130 that the mandrel 160 will lie directly beneath the discharge end of the feed conveyor 105 so that the leading end of the associated towel web may fall directly thereupon. However, by reason of the horizontal staggering of the winding units 150 described above, only certain ones of the winding units 150 may be so positioned. As described above the winding units 150 have been arranged in three vertically spaced-apart horizontal levels, an upper level including the three winding units 150 associated with the upper support plates 140 (or 140*a*), an intermediate level including the four winding units 150 associated with the intermediate support plates 144 and a lower level including the three winding units 150 associated with the lower support plates 147. The winding units 150 have been so arranged on the frame 130 that the mandrels 160 of the upper level winding units 150 are disposed directly beneath the discharge end of the feed conveyor 105, whereby the leading ends 52 of the associated towel webs 50 may fall directly onto these upper level mandrels 160. However, the intermediate level and the lower level mandrels 160 are displaced rearwardly of the discharge end of the feed conveyor 105, and there is therefore provided a plurality of guide chute assemblies, generally designated by the numeral 190, for respectively guiding the associated towel webs 50 to the mandrels 160 of these rearwardly displaced winding units 150.

More particularly, each of the lower level and intermediate level winding units 150 is provided with a plurality of parallel, spaced-apart curved guide rods 191 disposed in the associated feed lane, each of the guide rods 191 being connected at the upper end thereof to the cross bar 137 and extending downwardly and rearwardly therefrom to a point above and rearwardly of the portion of the adjacent winding unit 150 aligned with the associated feed lane. Each of the intermediate level winding units 150 is provided with a curved guide chute 192 which may preferably be formed of sheet metal and extends downwardly and rearwardly from the rearward end of the associated guide rods 191, behind the towel receptacle 177 the adjacent winding unit 150 aligned with the associated feed lane, and terminating in a lower end disposed directly above the associated mandrel 160, the guide chute 192 cooperating with the associated guide rods 191 for guiding the leading end 52 of the associated towel web 50 to the mandrel 160 of the associated intermediate level winding

unit 150. Each of the lower level winding units 150 is provided with a curved guide chute 193, which may also be formed of sheet metal, and extends downwardly and rearwardly from the bottom ends of the associated guide rods 191, behind the drive motor 155 and roll receptacle 177 of the adjacent upper level and intermediate level winding units 150 aligned with the associated feed lane, and terminating in a lower end disposed directly above the associated mandrel 160, the guide chute 193 cooperating with the associated guide rods 191 for guiding the leading end 52 of the associated towel web 50 to the mandrel 160 of the associated lower level winding unit 150. Each of the guide chutes 192 and 193 is mounted between the support plates bordering the associated feed lane by means of mounting rods 194.

As was indicated above, each of the drive motors 155 is provided with a right angle housing which includes a motor housing 152 and a gear head housing 151. The drive motors 155 of each of the intermediate level and lower level winding units 150 are so arranged that the motor housing 151 extends rearwardly of the gear head housing 152. However, as indicated in FIGS. 1, 8 and 9, the drive motors 155 of the upper level winding units 150 must be so arranged that the motor housings 151 thereof extend forwardly of the associated gear head housings 152 in order that the motor housings 151 will not interfere with the guide rods 190 and guide chutes 193 disposed in the feed lanes with which the upper level drive motors 155 are aligned.

In order to insure that the leading end 52 of the towel web 50 fed from the feed conveyor 105 will be held in close proximity to the mandrel 160, each of the winding units 150 is provided with a guide retainer 195, the guide retainer 195 comprising a pivot bracket 196 mounted for pivotal movement about a pivot pin 196*a* which is supported at the opposite ends thereof by the support plates bordering the associated feed lane and is disposed above and forwardly of the mandrel 160 substantially parallel to the longitudinal axis thereof. The pivot bracket 196 is provided with a forwardly extending flange 197, carrying at the outer end thereof a counterweight 197*a*. Connected to the pivot bracket 196 at the rearward end thereof is a guide plate 199, preferably formed of polyethylene and extending downwardly and rearwardly toward the associated mandrel 160. A polyethylene backing plate 198 is disposed between the pivot bracket 196 of the guide plate 199, all of these members being secured together by suitable fasteners 198a such as screws or bolts. The lower end of the guide plate 199 is curved beneath the mandrel 160 in the direction of rotation thereof and extends outwardly a short distance beyond the opposite side of the mandrel 160. The guide apparatus 195 is urged by the counterweight 197*a* into a rest position shwon in FIG. 10, wherein the lower end of the guide plate 199 is disposed only a short distance away from the associated mandrel 160. The free edge of the curved lower end of the guide plate 199 is provided with a plurality of teeth or serrations 199*a* therealong for a purpose to be explained more fully hereinafter.

In operation, a plurality of towel webs 50 equal in number to the feed lanes of the towel winding machine 100 and the ironer 60, may be simultaneously processed by the ironer 60 and the towel winding machine 100. In this case, the operation of each of the winding units 150 and the movement of each of the towel webs 50 along the feed conveyors 101 and 105 is identical, whereby the operation of only one of the winding units 150 will be described in detail. When the leading end 52 of the towel web 50 is fed from the discharge end of the steam chest 80, it falls upon the transfer conveyor belt 104 and is moved by the clockwise rotation thereof to the right as viewed in FIG. 13. By reason of the fact that the surface speed of the transfer conveyor belt 104 is substantially greater than the surface speed of the towel web 50 as it is fed from the ironer 60, the towel web 50 is fed smoothly along the transfer conveyor 101 without folding. The leading end 52 of the towel web 50 is fed from the transfer conveyor 101 to the input end of the feed conveyor 105, and is carried upwardly therealong to the discharge end thereof. As the leading end 52 of the towel web 50 passes over the movable contacts 376 and 342*a* of the control switches 375 and 340, respectively, it depresses these contacts into the closed positions thereof as will be explained more fully hereinafter. From the discharge end of the feed conveyor 105, the leading end 52 of the towel web 50 passes vertically downwardly under the force of gravity to the mandrel 160 of the associated winding unit 150. If the associated winding unit 150 is in the upper level on the frame 130, the leading end 52 of the towel web 50 will fall directly onto the mandrel 160 as was described above and as is illustrated in FIG. 10 of the drawings. If the associated winding unit 150 is in the intermediate level on the frame 130, the leading end 52 of the towel web 50 will fall onto the guide rods 191 and will be guided thereby and by the associated guide chute 192 to a point immediately above the associated intermediate level winding unit, from which point the leading end 52 of the towel web 50 will drop vertically onto the associated mandrel 160. If the associated winding unit 150 is disposed in the lower level on the frame 130, the leading end 52 of the towel web 50 will fall again onto the guide rods 191 and will be guided thereby and by the associated guide chute 193 to a point immediately above the associated mandrel 160 from which point it will drop vertically to the mandrel 160.

At this time, the rotation of associated mandrel 160 has been started and the suction valve 175 has been opened and the ejector arm 185 has been retracted, all by control apparatus which will be described below, and in order to insure that the leading end 52 of the towel web 50 will be maintained in close proximity to the rotating mandrel 160 and will not miss the mandrel 160, because of windage from fans or ventilating equipment for example, the guide plate 199 is provided for holding the towel web 50 close to the mandrel 160. Thus, if the leading end 52 of the towel web 50 is blown forwardly of the mandrel 160, it will fall upon the guide plate 199 and will be guided thereby downwardly beneath and around the mandrel 160 in the direction of rotation thereof. It will be noted that the lower end of the guide plate 199 has a normal or rest position disposed closely adjacent to the mandrel 160 for facilitating the operation of the capture means of the winding unit 150. Thus, when the face 163 of the mandrel 160 which is provided with the openings 165 rotates around to the side of the mandrel closest to the towel web 50, the suction through the openings 165 will readily draw the towel web against the mandrel 160 causing it to adhere thereto for initiation of the winding of the towel web 50 into a towel roll on the mandrel 160. Since the

passage of the leading end **52** of the towel web **50** along the guide plate **199** may result in a certain amount of suction therebetween tending to cause the towel web **50** to adhere to the guide plate **199,** the distal end of the guide plate **199** is provided with the serrations **199a** thereon for breaking this suction and facilitating the capture of the towel web **50** from the guide plate **199** by the suction through the mandrel **160.**

It should be noted that at the time when the mandrel **160** first contacts the towel web **50** the drive motor **155** is unloaded and is, therefore, driving the mandrel **160** at a relatively high rotational speed such that the surface speed of the mandrel **160** is somewhat greater than the surface speed of the towel web **50** as it is fed from the feed conveyor **105.** Thus, as the towel web **50** begins to be wound on the mandrel **160** it will be wound thereon faster than it is being fed from the feed conveyor **105.** Since the towel web **50** is being held securely by the pinch rolls **90** of the ironer **60,** the initiation of the winding of the towel on the mandrel **160** will cause tension in the portion of the towel web **50** extending between the mandrel **160** and the ironer **60** and the slack in this portion of the towel **60** will be taken up causing the towel web **50** to be moved from its lower feed path lying along the surfaces of the conveyor belts **104** and **108** to a second tensioned feed path in which a reach of the towel web **50** extends directly from the discharge end of the ironer **60** to the discharge end of the feed conveyor **105,** spanning the transfer conveyor **101** and the input end of the feed conveyor **105** as is clearly indicated in FIG. **13.**

Since the guide rollers **120** and the towel follower **125** of the associated feed-directing assembly are disposed below the level of the discharge end of the feed conveyor web **105,** they will be engaged by the towel web **50** when it is pulled into its tensioned second feed path, as is indicated in FIG. **13.** Thus, the towel web **50** in the second feed path thereof will be deflected by the feed-directing assembly **110** into three distinct sections or reaches, respectively generally designated by the numerals **56, 57** and **58,** the first reach **56** extending substantially horizontally from the discharge end of the ironer **60** to the rearward end of the towel follower **125,** the second reach **57** extending upwardly at a slight angle to the first reach **56** from the rearward end of the follower **125** to the bottom of the guide rollers **120,** and the third reach **58** extending upwardly at a slight angle to the second reach **57** from the bottom of the guide rollers **120** to the discharge end of the feed conveyor **105.** Referring to FIGS. **10** and **13** of the drawings, it will be seen that the reach **58** is disposed at a very slight angle to the surface of the feed conveyor belt **108** and is disposed only a slight distance thereabove. Thus, when the towel web **50** moves to the second feed path, the movable contact **342a** of the switch **340** is able to move a slight distance upwardly, but not enough to open the switch **340,** whereby the switch **340** is maintained in its closed condition by the towel web **50** in the second feed path thereof. However, the reach **57** of the towel web **50** is disposed at a substantial angle to the surface of the feed conveyor belts **108** and at a substantial distance thereabove, whereby when the towel web **50** is moved to the second feed path thereof, the movable contact **376** of the control switch **375** is permitted to move upwardly into its normally open position for opening the control switch **375.**

It is essential for the proper operation of the winding machine **100** that the towel web **50** be maintained in its associated feed lane in a predetermined direction which will carry it to the associated mandrel **160** so as to be properly centered thereupon. As long as the towel web **50** is centered in the associated feed lane and is being fed in the predetermined direction, it will be centered between the wings **128** of the towel follower **125** out of contact therewith. However, if the towel web **50** should veer in the second feed path to either side of the associated feed lane and thus deviate from the predetermined direction, the edge of the towel web **50** will engage the inner surface of the adjacent wing **128,** thereby urging the rearward end of the follower **125** in the direction of the deviation. For example, referring to FIG. **14,** if the towel web **50** veers to the left of the predetermined direction, it will move the rearward end of the follower **125** to the left, thus pivoting the follower **125** in a counterclockwise direction about the pivot pin **113.** Since the forward end of the follower **125** is connected to the pivot block **115** which is in turn connected to the shaft **118** of the guide rollers **120,** the shaft **118** will also be pivoted in the counterclockwise direction about the axis of the pivot pin **113.** This will result in the forward surfaces of rollers **120** being pointed toward the right, i.e., away from the direction of deviation of the towel web **50,** and by reason of the frictional engagement between the towel web **50** and the coarse frictional surface **123** of the guide rollers **120,** the guide rollers **120** will urge the towel web **50** to the right, i.e., away from the direction of deviation and back toward the predetermined direction. As the towel web **50** returns to the predetermined direction, it will engage the right-hand one of the wings **128** thus moving the follower **125** and rollers **120** back to a normal orientation centered with respect to the associated feed lane and the predetermined direction of the towel web **50.** In this manner, the towel web **50** is continuously maintained in the predetermined direction so that, as it leaves the discharge end of the feed conveyor **105,** it will be properly centered with respect to the associated mandrel **160** of the associated winding unit **150.** In a constructional example of the feed-directing assembly **110,** it has been found that the towel web **50** is maintained within one-fourth of an inch of the center of the associated feed lane.

As explained above the drive motor **155** is preferably an induction motor of the constant-torque type and will, therefore, maintain a substantially constant torque at the mandrel **160.** Thus, as the circumference of the towel roll **55** on the mandrel **160** increases, the load on the drive motor **155** also increases. Accordingly, in order that a substantially constant-torque may be maintained at the mandrel **160** the rotational speed of the drive motor **155** decreases, thereby decreasing the rotational speed of the mandrel **160.** In this manner, the surface speed of the towel web **50** along the periphery of the towel roll **55** will be maintained substantially constant as the diameter of the towel roll increases so that the surface speed of the towel roll **55** will be substantially the same as the surface speed of the feed conveyor **105** to insure a smooth and even winding of the towel web **50** on the mandrel **160.** It will also be noted that as the diameter of the towel roll **55** increases, the periphery thereof will engage the guide plate **199** thereby pivotally moving the guide plate **199** outwardly from the mandrel **160** about the pivot pin **196a** for

thereby accommodating the increasing diameter of the towel roll 55.

When the trailing end of the towel web 50 passes from the discharge end of the feed conveyor 105, the movable contact 342a of the control switch 340 is permitted to move to its normally open position, thereby opening the switch 340. The opening of the switch 340 serves to actuate the ejector unit 180 in a manner to be described more fully hereinafter. Thus, air will be fed from a suitable source (not shown) to the air inlet 188 of the cylinder 181 for moving the piston 184 to the right as viewed in FIG. 3, thereby carrying the ejector arm 185 to the right until it engages the left-hand end of the towel roll 55. As the piston 184 is moved to its fully extended position, the ejector arm 185 is moved to its ejecting position shown in phantom in FIG. 3, thereby moving the towel roll 55 from the mandrel 160 at the free end 164 thereof. When the towel roll 55 is thus removed from the mandrel 160, the guide plate 199 will be moved under the urging of the counterweight 197a back to the normal or rest position thereof closely adjacent to the mandrel 160. When the towel roll 55 has been removed from the mandrel 160 in the manner described it falls into the associated receptacle 177 and rolls downwardly therealong to the forward end thereof at which point it is retained by prongs 177a (see FIG. 7). Preferably, the receptacle 177 extends forwardly of the associated mandrel 160 a sufficient distance to permit accommodation of a plurality of ejected rolls thereon, which rolls may be periodically removed from the receptacle 177 by an attendant or by other appropriate means. The ejector arm 185 will remain in its ejecting position until the next towel web 50 is fed from the ironer 60 into the associated feed lane of the feed conveyor 105. When the leading end 52 of this next towel roll 50 engages and closes the movable contact 342a of the control switch 340, the ejector assembly 180 will be deactuated in such a manner that air will be forced into the air inlet 189 for moving the piston 184 to the left and thereby moving the ejector arm 185 back to the retracted position thereof within the slot 145 of the associated support plate 144. The timing of the apparatus is set so that the ejector arm 185 will be completely retracted before the leading end 52 of the next towel web 50 arrives at the mandrel 160 so as not to interfere with the winding of the towel web 50 on the mandrel 160.

Referring now to FIGS. 18 and 19 of the drawings, there is shown an alternative embodiment of the drive means for the winding units 150 of this invention. In the embodiment of FIGS. 18 and 19, instead of each winding unit 150 having its own drive motor 155 there is a central drive motor (not shown) for the winding machine 100 which drives all of the winding units 150. The drive motor is preferably of a constant speed type for driving the mandrels 160 so that in the unload conditions thereof they have a surface speed slightly greater than the surface speed of the feed conveyor 105. Coupled to the drive motor by appropriate means and rotatably driven thereby are two line shafts 251 and 252 respectively extending substantially the entire width of the winding machine 100 parallel to the drive shaft 106 of the feed conveyor 105. The line shaft 251 is disposed above and forwardly of the upper level of winding units 150, while the drive shaft 252 is disposed rearwardly of the lower level winding units 150. The upper line shaft 251 is provided with a plurality of sheaves or sprockets 253 therealong equal in number to the upper level winding units 150, the sprockets 253 being respectively coupled to the mandrels of the associated upper level winding units by drive belts or chains 255. Similarly, the lower line shaft 252 is provided with a plurality of sheaves or sprockets 254 therealong equal in number to the total of the lower and intermediate level winding unit 150, the sprockets 254 being respectively coupled to the mandrels 160 of the associated intermediate level winding units 150 by drive belts or chains 256 and being coupled to the mandrels 160 of the associated lower level winding units 150 by drive chains or belts 257. It is necessary that the upper level winding units 150 be driven from a position forwardly thereof because otherwise the guide chutes 192 and 193 leading to the lower level and intermediate level winding units 150 would interfere with the drive belts or chains 255. Similarly, it is necessary that the lower level and intermediate level winding units 150 be driven from rearwardly thereof, since otherwise the drive chains or belts 256 and 257 would interfere with either the winding or the ejection of the towel rolls 55 in adjacent feed lanes.

In order that a constant torque may be maintained at the mandrels 160 for decreasing the rotational speed thereof as the diameters of the towel rolls 55 increase for the reasons set forth above, each of the winding units 150 is provided with a slip clutch assembly, generally designated by the numeral 260, only one of which slip clutch assembly 260 will be described in detail. The slip clutch assembly 260 is provided with a channel-shaped housing 261 which is mounted on the left-hand side of the associated support plate 144 (for example) as viewed in FIG. 18, whereby it is disposed in longitudinal alignment with the feed lane adjacent to the left-hand side of the feed lane associated with the winding unit 150. The housing 261 has an outer flange 263 at the left-hand side thereof substantially parallel to the associated support plate 144, the flange 263 being provided with a circular opening 264 therethrough. Respectively mounted on the inner surfaces of the support plate 144 and the housing flange 263 are a pair of radially flanged bearings 265 arranged coaxially with each other and with the circular opening 264, the bearings 265 being securely fastened to the support plate 144 and the housing flange 263, respectively, by suitable fasteners such as screws or bolts passed through the outer bearing flanges. The cylindrical inner end of the mandrel 160 is passed through the slot 145 of the support plate 144 in the manner described above with respect to the embodiment of the FIG. 3, and is then passed through the bearings 265 and the circular opening 264 whereby the mandrel 160 is rotatably supported by the bearings 265. Disposed adjacent to the inner end of the left-hand one of the bearings 265, as viewed in FIG. 18, is a thrust bearing, generally designated by the numeral 267, and comprising a pair of identical parallel annular plates 268 arranged in surrounding relationship with the inner end 161 of the mandrel 160 coaxial therewith, and being separated by a bearing ring 269. Disposed adjacent to the inner end of the right-hand one of the bearings 265 is a slip clutch, generally designated by the numeral 270, and including an annular sheave 271 disposed in surrounding relationship with the inner end 161 of the mandrel 160 coaxial therewith and separated therefrom by a cylindrical sleeve 272. The sleave 271 is provided at the

left-hand end thereof with a radially extending circular sprocket plate **273**, and is provided at the right-hand end thereof with a radially extending backing plate **274**. An annular clutch plate **276** is disposed immediately to the right of the backing plate **274** and is separated therefrom by an annular frictional disk **275**, the clutch plate **276** having an outer diameter substantially equal to the outer diameter of the backing plate **274** and being fixed in position on the inner end **161** of the mandrel **160** by a set screw **278**. The backing plate **274** and the clutch plate **276** are each provided with a plurality of radially extending cooling fins **277** spaced circumferentially therearound. A plurality of bearing springs **279** are spaced circumferentially about the right-hand one of the bearing plates **268**. Each of the springs **279** extends substantially parallel to the mandrel **160**, the right-hand ends of the springs **279** being received in complementary recesses in the sprocket plate **273** for urging the sheave **271** into frictional engagement with the friction plate **275** and the clutch plate **276**. Formed around the periphery of the sprocket plate **273** is a recess for receiving an associated drive belt **255** for rotatably driving the slip clutch **270**.

In operation, the frictional engagement between the sheave **271** and the clutch plate **276** by way of the friction plate **275** is such that when the mandrel **160** is unloaded, the rotational movement of the sheave **271** will be transmitted to the clutch plate **276** and by means of the set screw **278** to the mandrel **160** for effecting rotation thereof. However, as the circumference of the towel roll **55** increases, the drag on the clutch plate **276** increases so as to overcome the friction of the friction plate **275** and thereby provide slippage between the clutch plate **276** and the sheave **271**. The friction between the sheave **271** and the clutch plate **276** is set at a predetermined value such that a substantially constant torque will be maintained in the mandrel **160**, whereby the rotational speed of the mandrel **160** will decrease as the diameter of the roll **55** thereon increases to maintain the surface speed of the roll **55** in step with the surface speed of the feed conveyor **105** for the reasons described above.

Referring to FIG. **20** of the drawings, there is shown an alternative embodiment, generally designated by the numeral **280**, of the ejector unit of this invention. The ejector unit **280** comprises a cylinder **281** being provided with a pair of air inlets and is substantially identical to the cylinder **181**. The cylinder **281** is provided with an externally threaded stud at the right-hand end thereof for threaded engagement with a mounting bracket (not shown) which may be identical to the mounting bracket **183** in the embodiment of FIG. **3**. Extending downwardly from the opposite end of the cylinder **281** is a tab **283**. There is provided within the cylinder **283** a piston rod **284**, the right-hand end of which is externally threaded and extends outwardly beyond the stud **282** and is threadedly engaged with an ejector arm **285** by means of a nut **286**. The ejector arm **285** is substantially identical to the ejector arm **185** in the embodiment of FIG. **3**, and is provided with an opening **287** therein for receiving the associated mandrel **160** therethrough. Threadedly engaged with the lower end of the ejector arm **285** is a spring-retaining rod **288** which extends outwardly to the right of the ejector arm **285** substantially normal thereto, the rod **288** being provided at the outer end thereof with a downturned projection **288***a*. Connected to the tab **283** and to the projection **288***a* and extending therebetween is a tension spring **289**, which urges the ejector arm **285** into the retracted position thereof as explained above.

In operation, the ejector unit **280** is moved to the ejecting condition thereof in the same manner as is the ejector **180** in the embodiment of FIG. **3**. However, when the ejector arm **285** has been moved to the ejecting position thereof (indicated in phantom in FIG. **20**), and after the switch **340** has been closed by the presence of the next towel web **50** on the feed conveyor **105**, the air inlet will be disconnected from the air source and connected to a metered exhaust port, whereby the ejector arm **285** will be returned to the retracted position thereof at a controlled slow rate under the urging of the tension spring **289**.

Referring now to FIGS. **21** and **22** of the drawings, there is illustrated the control apparatus **300** for the automatic winding machine **100**, and, in particular, for the embodiment thereof illustrated in FIGS. **1** through **17** of the drawings. Each of the drive motors **155** is preferably of the three-phase type, adapted to be operated by a three-phase source of electrical power. Accordingly, referring to FIG. **21** of the drawings, there is shown the power lines **L1**, **L2** and **L3** of a three-phase source of alternating current electrical power, the lines **L1**, **L2** and **L3** leading from a terminal block **305** through a main circuit breaker **310** to each of the winding units of the winding machine. More particularly, the power lines **L1**, **L2** and **L3** are each connected to each of the winding units **350A** to **350J** in parallel, the individual winding units **350** being designated in block form in FIG. **21**. There is also provided in the power line **L1** a feed equipment interlock switch **320** which is coupled to the drive equipment of the associated ironer **60** and washing machine, the switch **320** being closed when the associated ironer and washing machine are operating and the switch **320** automatically opening when the associated ironer **60** or washing machine is stopped in order to cut off the power to the drive motors **155** of the winding units **350** in order to avoid damage thereto.

In FIG. **22**, there is shown a detailed circuit diagram of the control apparatus for one of the winding units **350**, the control circuitry of each of the windings **350** being identical. The power lines **L1**, **L2** and **L3** are connected to the three terminals of the constant torque drive motor **155** through the contacts **354** of a starting relay **355**. The relay **355** is provided with a coil winding **352**, one terminal of which is connected to the power line **L1** by a conductor **351**. The relay **355** is also provided with an armature **353** connected to the contacts **354** for effecting operation thereof, the contacts **354** being normally open and being closed upon energization of the relay **355**. A double-pole, double-throw switch **340** is also provided and is mounted on the feed conveyor **105** as described above. One pole of the switch **340** comprises a movable contact **342a** having a pair of fixed contacts **342***b* and **342***c*, the movable contact **342***a* being physically in the form of a curved wire and extending into the first feed path of the towel web **50** along the feed conveyor **105** as has been described above. The other pole of the switch **340** comprises a movable contact **343***a* and a pair of fixed contacts **343***b* and **343***c*. While only the movable contact **342***a* has been physically shown in the drawings (see FIG. **13**), it will be appreciated that contact **342***a* is me-

chanically coupled to contact 343*a*, and any movement of one of these contacts results in a corresponding movement of the other in typical double-pole fashion. The switch **340** has a normally open position illustrated in FIG. 22, wherein the movable contact 342*a* is in contact with the fixed contact 342*b* and wherein the movable contact 343*a* engages the fixed contact 343*b*. The switch **340** will be in this normally open position when there is no towel web **50** in the first feed path along the feed conveyor **105**. The movable contacts 342*a* and 343*a* of the switch **340** are connected to the power line L2 by a conductor **341**. The other terminal of the relay coil **352** is connected to the fixed contact 342*c* of the switch **340** by a conductor **356**, and is also connected by a conductor **359** to the movable contact of a switch **357**, the fixed contact of the switch **357** being connected to the fixed contact 342*b* of the switch **340** by a conductor **344**. The switch **357** is mechanically coupled to the ejector arm **185** of the ejector unit **180**, so that the switch **357** is open when the ejector arm **185** in the retracted position thereof and the switch **357** is closed when the ejector arm **185** is in the ejecting position thereof.

The ejector unit **180** is controlled by a solenoid actuated valve **360** which is coupled by an inlet **361** to a suitable source of air (not shown). The control valve **360** is also coupled by conduits **362** and **363** respectively to the air inlets **188** and **189** of the cylinder **181**. The valve **360** is controlled by a solenoid **345** which includes a coil winding 345*a* and an armature **347**, the armature **347** being mechanically coupled to the valve **360**. One terminal of the solenoid coil 345*a* is connected to the power line L3 by a conductor **346**, the other terminal of the solenoid coil 345*a* being connected to the fixed contact 343*c* of the switch **340** by a conductor **349**. The solenoid **345** is so arranged that it is normally deenergized when there is no towel in the associated feed lane of the conveyor **105**, the armature **347** holding the valve **360** in such a condition that air passes through the conduit **362** into the cylinder **181** for holding the ejector arm **185** in the ejecting position thereof. When the solenoid **345** is energized, the armature **347** thereof changes the condition of the valve **360** so that air is passed through the conduit **363** to the cylinder **181** and air is exhausted from the cylinder **181** to the conduit **362** for moving the ejector arm **185** to the retracted position thereof. The armature **347** of the coil **345** is provided with an adjustable delay mechanism **348**, which may be in the form of an adjustable restriction which creates a vacuum and delays the movement of the armature, the delay mechanism **348** preferably being set so that when the solenoid **345** is deenergized there will be a delay of approximatly two seconds before the armature **347** actuates the valve **360**, thus permitting the mandrel **160** to come to a stop before the ejector arm **185** is moved to the ejecting position thereof, as will be explained more fully below.

There is also provided a suction control valve solenoid **370** for controlling the operation of the suction valve **175**. As was described above, the valve **175** is coupled by a connector **178** to the open end of the mandrel **160** and is coupled by a conduit **174** to the manifold provided in the cross beam **135** of the frame **130**. The solenoid **370** comprises a coil winding **371** and an armature **373**, one terminal of the coil **371** being coupled by a conductor **372** to the conductor **346** and the other terminal fo the coil **371** being connected to the conductor **349** by a conductor **374**. The armature **373** is mechanically coupled to the valve **175**, the solenoid **370** being so arranged that when it is energized the armature **373** will open the valve **175** thereby permitting passage of air therethrough, whereby the suction pump **170** will create a suction through the openings **165** in the mandrel **160** as described above. When the solenoid **370** is deernergized a coil spring **177** (see FIG. 3) will return the armature **373** to close the valve **175** thereby isolating the mandrel **160** from the suction pump **170** and permitting the pressure in the mandrel **160** to return to atmospheric pressure for terminating the suction through the openings **165**. Disposed in the conductor **374** is a normally open switch **375** which includes a movable contact **376** and a fixed contact **377**. As explained above the switch **375** is mounted on the feed conveyor **105** so that the movable contact **376** in the normally open position thereof is disposed in both the first and second feed paths of the towel web **50** along the feed conveyor **105**.

The operation of one of the winding units **350** of the control apparatus **300** will now be described in detail. When there is no towel web **50** in the associated feed lane of the feed conveyor **105**, the switches **340** and **375** will be in their normally open positions, whereby the relay **355** and the solenoids **345** and **370** are all deenergized. The winding unit **350** is designed to operate on a continuously repeating cycle as towels are repeatedly fed into the associated feed lane, and it will be simplest to describe the detailed operation of one such cycle by beginning at the point therein when a completely wound towel roll has been ejected from the mandrel **160**. When the ejector **180** is actuated to move the ejector arm **185** to its ejecting position for removing the wound towel roll **155** from the mandrel **160**, this movement of the ejector arm **185** to its ejecting position will close the switch **357**, thereby immediately energizing the starting relay **355** through a circuit including power line L3, conductor **351**, relay coil **352**, conductor **359**, switch **357**, conductor **344**, contacts 342a and 342b of switch **340**, conductor **341** and power line L2. This energization of the relay **355** will close the contacts **354** thereof, thereby completing an obvious circuit for energizing the drive motor **155** and thereby beginning rotation of the mandrel **160**. Until the next towel web **50** is fed from the associated ironer **60**, the motor **155** will run unloaded at relatively high speed which will facilitate the cooling of the motor **155**. When the leading end **52** of the next towel web **50** is fed onto the feed conveyor **105** along the first feed path described above, it will engage the movable contact **376** and move it to the closed position thereof for closing the switch **375**; an instant later the towel web **50** will also engage and close the movable contacts 342*a* and 343*a* of the switch **340**, whereupon these movable contacts will be moved into engagement with the fixed contacts 342*c* and 343*c*. When thus closed, the switches **340** and **375** will permit energization of the solenoid **345** along a circuit including power line L3, conductor **346**, coil 345*a*, conductor **349**, switch contacts 343*a* and 343*c*, conductor **341** and the power line L2. The energization of the solenoid **345** will cause the valve **360** to be so conditioned as to shut off the cylinder air inlet **188** and the conduit **362** from the air supply and open the conduit **362** to the exhaust, while connecting the conduit **363** and the cylinder air inlet **189** to the source of air, thereby permitting the ejector arm

185 to return to the retracted position thereof. The valve 360 is preferably metered so that the ejector arm 185 is retracted at a controlled slow rate. When the ejector arm is thus retracted, the switch 357 will be opened, thus breaking the energizing circuit for the motor starting relay 355, but the relay 355 will be held energized through a holding circuit including conductor 356 and the contacts 342*a* and 342*c* of switch 340.

The closing of the switches 340 and 375 also provides a circuit for energizing the solenoid 370, this circuit including power line L3, conductors 346 and 372, solenoid coil 371, conductor 374, switch 375, conductor 349, contacts 343*a* and 343*c* of switch 340, conductor 341 and power line L2. When the solenoid 370 is thus energized, the valve 175 will be opened against the bias of the spring 177 to permit suction through the mandrel 160 in the maner described above. When the leading end 52 of the towel web 50 approaches the mandrel 160, it will be captured by the action of the suction through the mandrel openings 165 to initiate the winding of the towel web 50 on the rotating mandrel 160. The initiation of this winding will cause the towel web 50 to move from the first feed path along the feed conveyor 105 to the second feed path as described above, thereby opening the switch 375. The opening of the switch 375 deenergizes the solenoid 370, thereby closing the valve 175 and cutting off the suction through the mandrel 160, since this suction is no longer needed once the winding of the towel has been initiated. The winding of the towel web 50 on the mandrel 160 will continue until the towel has been completely wound into a towel roll 55. When the trailing end of the towel web 50 passes from the feed conveyor 105, the switch 340 will be opened, thereby deenergizing the solenoid 345 and the relay 355. The deenergization of the relay 355 opens the contacts 354 thereof for deenergizing the drive motor 155, whereupon the mandrel 160 will come to a halt. The deenergization of the solenoid 345 so conditions the valve 360 that the air supply will be connected to the air inlet 188 of the cylinder 181 through the conduit 362 after a delay of about two seconds caused by the delay device 348 to permit the mandrel 160 to come to a halt. When the air source is thus connected to the cylinder 181 the ejector arm 185 will be moved to its ejecting position thereby removing the wound towel roll 55 from the mandrel 160 and depositing it in the receptacle 177. Movement of the ejector arm 185 to the ejecting position thereof will also close the switch 357 for thereby immediately re-energizing the starting relay 355 and restarting the drive motor 155. The ejector arm 185 will then remain in its ejecting position until the appearance of the next towel web 50 in the associated feed lane of the feed conveyor 105.

If for any reason the towel processing equipment feeding the automatic towel winding 100 has to be stopped, the interlock switch 320 will be opened, thereby opening the power line L1 and deenergizing the starting relay 355 in each of the winding units 350A to 350J. However, the circuit between the power lines L2 and L3 energizing the ejector solenoid 345 will not be opened, so that the ejectors 180 will not be actuated to eject partially wound towel rolls 55 when the processing equipment and drive motors are thus stopped. Thus, the drive motors 155 of the winding units may be stopped in mid-cycle to avoid damage thereto and may be started again to complete the cycle when the associated processing equipment is restarted.

Referring now to FIG. 23 of the drawings, there is shown a control apparatus 400 for the single drive motor embodiment of the winding machine illustrated in FIGS. 18 and 19 of the drawings. The single drive motor, generally designated by the numeral 430, is a three-phase motor and is driven from a suitable source of three-phase alternating current electrical power (not shown). Power lines L1, L2 and L3 from this source of three-phase electric power are fed through a terminal block 405 and a main circuit breaker 410 and, thence through the contacts 434 of a starting relay 435 to the terminals of the motor 430. There is also provided in the power line L1 between the circuit breaker 410 and the starting relay contact 434 a feed equipment interlock switch 420 which is identical in construction and operation to the feed equipment interlock switch 320 in the control apparatus 300. The starting relay 435 comprises a coil winding 432 and an armature 433 coupled to the contacts 434 for effecting movement thereof. One terminal of the coil winding 432 is connected by a conductor 431 to the power line L1, the other terminal of the coil winding 432 being connected by a conductor 436 to the power line L2. The contacts 434 of the starting relay 435 are normally open and are closed upon energization of the relay 435.

The control apparatus 400 includes a plurality of identical winding units 450, several of the winding units 450 being represented in block form in FIG. 23, with only one of these winding units being illustrated in detail. Each of the winding units 450 has associated therewith a control switch 440 and a control switch 475 mounted on the feed conveyor 105 and respectively corresponding to the control switches 340 and 375 in the control apparatus 300. The switch 440 is a single-pole, single-throw switch having a fixed contact 441 and a movable contact 442, the movable contact 442 being connected by a conductor 443 to a conductor 445 which is in turn connected to the power line L2. Similarly, the switch 475 is of the single-pole, single-throw variety and includes a movable contact 476 and a fixed contact 477, the movable contact 476 being connected to the conductor 445 by a conductor 478. Thus, it can be seen that each of the switches 440 and 475 for all of the winding units 450 are connected in parallel to the conductor 445 and the power line L2. While the control circuit 400 is such that the switch 440 need be only of the single-pole, single-throw variety it would, of course, be possible to utilize the double-pole, double-throw switch 340 of the control apparatus 300 in place of the switch 440 by simply leaving one of the poles unconnected. In this way, the feed conveyor 105 could be used interchangeably with either type of drive arrangement without changing the control switches thereon. In any event, the movable contacts 442 and 476 of the switches 440 and 475 are physically of the same construction as the movable contacts 342*a* and 376 in the embodiment of FIG. 22, and are similarly disposed in their normally opened positions in the first feed path of the towel web 50 along the feed conveyor 105, and will function exactly the same as the contacts 342*a* and 376 in the embodiment of FIG. 22.

The winding unit 450 is provided with an ejector unit 280 of the type illustrated in FIG. 20 of the drawings, but it will, of course, be recognized that the ejector unit 180, illustrated in FIG. 3 of the drawings may also be used. Furthermore, the ejector unit 280 may be substituted for the ejector unit 180 in the arrangement of

FIG. 22. The ejector unit 280 is controlled by a solenoid-actuated control valve 460 which is coupled by an inlet 461 to a suitable source of air (not shown). The control valve 460 is also coupled by a conduit 462 to the air inlet 288 of the cylinder 281. The valve 360 is controlled by a solenoid 455 which includes a coil winding 453 and an armature 454, the armature 454 being mechanically coupled to the valve 460. One terminal of the solenoid coil 453 is connected to the power line L3 by a conductor 451 and a conductor 452, the other terminal of the solenoid coil 454 being connected by a conductor 459 to the fixed contact 441 of the control switch 440. The solenoid 455 is so arranged that it is normally de-energized when there is no towel in the associated feed lane of the feed conveyor 105, the armature 454 then holding the valve 460 in such a condition that air passes through the conduit 462 into the cylinder 281 for holding the ejector arm 285 in the ejecting position thereof. When the solenoid 455 is energized, the armature 454 thereof changes the condition of the valve 460 so that the conduit 462 is disconnected from the source of air and is connected to an exhaust port, preferably having a controllable restriction or bleed opening, whereby air is exhausted from the cylinder 281 and the ejector arm 285 is moved to the retracted position thereof under the urging of the coil spring 289 at a controlled slow rate.

There is also provided a suction control valve solenoid 470 for controlling the operation of the suction valve 175. As was described above, the valve 175 is coupled by a connector 178 to the open end of the mandrel 160 and is coupled by a conduit 174 to the manifold provided in the cross beam 135 of the frame 130. The solenoid 470 comprises a coil winding 471 and an armature 473, one terminal of the coil 471 being connected by a conductor 472 to the conductor 452 and the other terminal of the coil 471 being connected by a conductor 474 to the fixed contact 477 of the control switch 475. The armature 473 is mechanically coupled to the valve 175, the solenoid 470 being so arranged that when it is energized the armature 473 will open the valve 175 thereby permitting passage of air therethrough, whereby the suction pump 170 will create a suction through the openings 165 in the mandrel 160 as described above. When the solenoid 470 is de-energized, a coil spring 177 (see FIG. 18) will return the armature 473 to close the valve 175 thereby isolating the mandrel 160 from the suction pump 170 and permitting the pressure in the mandrel 160 to return to atmospheric pressure for terminating the suction through the openings 165. As was explained above with respect to FIGS. 18 and 19, the drive motor 430 is mechanically coupled to the mandrel 160 of each of the winding units by means of a plurality of slip clutch assemblies 260, the slip clutch assemblies 260 being diagrammatically illustrated in FIG. 23.

The operation of one of the winding units 450 of the control apparatus 400 will now be described in detail. When there is no towel web 50 in the associated feed lane of the feed conveyor 105, the switches 440 and 475 will be in their normally open positions, whereby the starting relay 435 and the solenoids 455 and 470 are all de-energized. As is apparent from FIG. 23, the drive motor 430 will normally be operated continuously as long as the circuit breaker 410 and the feed equipment interlock switch 420 are closed. However, the winding unit 450 is designed to operate on a continuously repeating cycle as towels are repeatedly fed into the associated feed lane. When the leading end 52 of a towel web 50 is fed onto the feed conveyor 105 along the first path described above, it will engage the movable contact 476 of the control switch 475 and move it to the closed position thereof for closing the switch 475. When thus closed, the switch 475 will permit energization of the solenoid 470 along a circuit including power line L3, conductors 451, 452 and 472, coil 471, conductor 474, switch 475, conductors 478 and 445 and power line L2. The energization of solenoid 470 will cause the valve 175 to be opened against the bias of the spring 177 to permit suction through the mandrel 160 in the manner described above. An instant after closing the switch 475, the leading end 52 of the towel web 50 will engage the movable contact 442 and move it to the closed position thereof for closing the control switch 440. When thus closed, the switch 440 will permit energization of the solenoid 455 along a circuit including the power line L3, conductors 451 and 452, coil 453, conductor 459, switch 440, conductors 443 and 445 and power line L2. The energization of solenoid 455 will cause the valve 460 to be so conditioned as to shut off the cylinder air inlet 288 and the conduit 462 from the air supply and open the conduit 462 to the exhaust, thereby permitting the ejector arm 285 to return to the retracted position thereof at a controlled slow rate, the ejector arm 285 having been left in its ejecting position after ejection of the previous towel roll 55. When the leading end 52 of the towel web 50 approaches the mandrel 160, it will be captured by the action of the suction through the mandrel 160 to initiate the winding of the towel web 50 on the mandrel 160. The initiation of this winding will cause the towel web 50 to move from the first feed path along the conveyor 105 to the second feed path described above, thus opening the switch 475. This opening of the switch 475 de-energizes the solenoid 470, thereby allowing the valve 175 to close under the action of the spring 177 for cutting off the suction through the mandrel 160, since this suction is no longer needed once the winding of the towel has been initiated. The winding of the towel web 50 on the mandrel 160 will continue until the towel is completely wound into a towel roll 55. When the trailing end of the towel web 50 passes from the feed conveyor 105, the switch 440 will be opened thereby de-energizing the solenoid 455. The de-energization of the solenoid 455 so conditions the valve 460 that the air supply will be connected to the air inlet 288 of the cylinder 281 through the conduit 462 for moving the ejector arm 285 to its ejecting position, thereby removing the wound towel roll 55 from the mandrel 160 and depositing it in the receptacle 177. The ejector arm 285 will then remain in its ejecting position until the appearance of the next towel web 50 in the associated feed lane of the feed conveyor 105 for beginning the cycle anew.

As described above, the slip clutch assembly 260 operates to maintain a substantially constant torque at the mandrel 160, whereby as the weight and diameter of the towel roll 55 increases, the slippage in the clutch assembly 260 will cause the rotational speed of the mandrel 160 to be reduced for keeping the surface speed of the towel roll 55 substantially the same as the surface speed of the feed conveyor 105. This operation of the slip clutch assembly 260 generates a substantial amount of heat in the backing plate 274, the friction

plate **275** and the clutch plate **276,** which heat is dissipated by the cooling fins **277** as described above, in connection with FIG. **18.** It will be noted that the drive motor **430** runs continuously during and between cycles of the winding units **450,** thereby facilitating the cooling of the clutch assembly **260** by providing a period of unloaded free running between winding cycles for dissipating the heat generated during the previous winding cycle.

From the foregoing, it will be observed that there has been provided an automatic towel winding machine which is capable of automatically winding a plurality of elongated towels simultaneously. In particular, there has been provided an automatic towel winding machine which may be used in conjunction with an automatic towel ironer and which provides completely automatic operation from the time that the towels are fed to the ironer to the time that they are ejected as completely wound towel rolls from the towel winding machine.

There has also been provided a novel feed apparatus for the towel winding machine, the feed apparatus including a high-speed transfer conveyor to prevent folding of the towel webs as they are fed from the associated ironer and an inclined feed conveyor for transporting the towel webs from the transfer conveyor to a point immediately above the associated winding unit whereby the towel web may be fed downwardly by gravity to the associated winding unit.

There has also been provided an automatic winding unit having a suction-operated capture means for urging the leading end of the towel web fed from the feed apparatus against the winding mandrel and causing it to adhere thereto to obviate hand starting of the towel on the mandrel and thereby provide fully automatic towel winding.

There has also been provided a fluid-actuated ejector unit for automatically ejecting the wound towel roll from the mandrel into a towel receptacle, two different embodiments of the ejector having been provided for returning the ejector to a retracted position at a controlled slow rate.

There has also been provided a winding machine wherein a plurality of towels are fed along a plurality of parallel feed lanes arranged in side-by-side relationship and each having a width only slightly greater than the width of the associated towel. In particular, there has been provided a towel winding machine wherein the winding units for each of the feed lanes has a width approximately three times the width of the associated feed lane, the winding units being uniquely arranged on a supporting frame so that the entire winding machine occupies a width only slightly greater than the combined widths of the feed lanes. In connection with this unique arrangement of the winding units, there has been provided quide apparatus for guiding each of the towel webs to its associated winding mandrels without interfering with the winding units of adjacent feed lanes.

There has also been provided a winding machine wherein the towel web is fed in the associated feed lane along a first path until the initiation of the winding of the towel on the mandrel is begun, at which time the towel web moves to a second feed path in the feed lane wherein the towel web is maintained under tension. In addition, there has been provided a novel feed-directing assembly for continuously maintaining the towel web in a predetermined direction toward the associated winding mandrel when the towel web is in the tensioned second feed path thereof.

There has also been provided a winding unit having a novel torque motor for effecting rotation of the winding mandrel and maintaining a substantially constant torque thereat, whereby as the diameter of the towel roll increases on the mandrel, the rotational speed of the mandrel will correspondingly decrease so that the surface speed of the towell roll will be maintained substantially the same as the surface speed of the feed apparatus.

There has also been provided an alternative drive arrangement for the winding machine wherein a single drive motor drives all of the winding units through a pair of line shafts, each of the line shafts being coupled to a plurality of the winding mandrels. In particular, there has been provided a single-motor drive arrangement which is coupled to each of the winding mandrels through a slip clutch for maintaining a substantially constant torque at the winding mandrel.

Finally, there has been provided for each of the embodiments of the drive means for the winding units an electric control circuit for effecting the completely automatic operation of the towel winding machine.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

**1.** An automatic elongated towel winder comprising a support frame, a hollow mandrel having an open end mounted on said frame and having a closed free distal end and having an opening in the side thereof, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof in a predetermined direction, feed apparatus disposed adjacent to and above said mandrel for feeding an elongated towel to the side of the mandrel in the direction of rotation thereof, a suction pump connected to the open end of said mandrel for causing an area of reduced pressure within said mandrel and a consequent flow of air toward and through said opening, the flow of air toward and through said opening serving to move the leading end of the towel fed from said feed apparatus toward said mandrel and causing the leading end of the towel to adhere to said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, and a guide member carried by said frame on the side of said mandrel in the direction of rotation thereof and extending beneath said mandrel a short distance therefrom, said guide member guiding the leading end of the towel from said feed apparatus around said mandrel in the direction of rotation thereof and holding the leading end of the towel closely adjacent to said mandrel to facilitate the pickup of the leading end of the towel by the flow of air toward said mandrel, the end of said guide member extending under said mandrel being provided with a toothed edge to facilitate separation of the guided towel from said guide member under the action of the flow of air through said opening, whereby an elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon.

**2.** An automatic elongated towel winder comprising a support frame, a mandrel mounted on said frame and

rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, normally de-actuated drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, and control apparatus coupled to said drive means and responsive to the passage of the leading end of the towel toward said mandrel for actuating said drive means, whereby an elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon.

**3.** The towel winder set forth in claim **2,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power.

**4.** The towel winder set forth in claim **2,** wherein said control apparatus includes means responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means.

**5.** An automatic elongated towel winder comprising a support frame, a mandrel mounted on said frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, normally de-actuated capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, and control apparatus coupled to said capture means and responsive to the passage of the leading end of the towel toward said mandrel for actuating said capture means, whereby an elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon.

**6.** The towel winder set forth in claim **5,** wherein said control apparatus includes means responsive to the intiation of the winding of the towel on said mandrel for deactuating said capture means.

**7.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, an ejector carried by said frame and movable with respect to said mandrel for removing the wound towel roll therefrom at the free end thereof, and control apparatus coupled to said ejector and responsive to the passage of the trailing end of the towel from said feed apparatus for actuating said ejector to remove the wound towel roll from said mandrel, whereby an elongated towel may be fed to said rotating mandrel and wound in a roll thereon and automatically removed therefrom when the roll is completely wound.

**8.** The towel winder set forth in claim **7,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for deactuating said ejector.

**9.** The towel winder set forth in claim **7,** wherein said ejector includes an ejector member movable between a retracted position and an ejecting position, said control apparatus includes means responsive to the passage of the trailing end of the towel from said feed apparatus for moving said ejector member to the ejecting position thereof for causing said member to engage the wound towel roll and remove the towel roll from said mandrel at the free end thereof, said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for moving said ejector member back to the retracted position thereof.

**10.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, an ejector carried by said frame and movable with respect to said mandrel between a retracted condition and an ejecting condition, movement of said ejector from the retracted condition to the ejecting condition thereof serving to remove the towel roll from said mandrel at the free end thereof, and control apparatus coupled to said drive means and to said ejector and responsive to the movement of said ejector to the ejecting condition thereof for actuating said drive means, said control apparatus being responsive to the passage of the leading end of the next towel toward said mandrel for moving said ejector to the retracted condition thereof, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means and for moving said ejector to the ejecting condition thereof, whereby elongated towels may be automatically fed to said rotating mandrel and wound on a roll thereon and removed therefrom when the roll is completely wound.

**11.** The towel winder set forth in claim **10,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power.

**12.** The towel winder set forth in claim **10,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for holding said drive means in an actuated condition after the return of said ejector to the retracted position thereof.

**13.** An automatic elongated towel winder comprising a support frame, a mandrel mounted on said frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, and control apparatus coupled to said drive means and to said capture means and responsive to the passage of the leading end of the towel toward said mandrel for actuating said drive means and said capture means, whereby an elon-

gated towel may be automatically fed to said rotating mandrel and wound in a roll thereon.

**14.** The towel winder set forth in claim **13,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means, said control apparatus being responsive to the initiation of the winding of the towel on said mandrel for deactuating said capture means.

**15.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, normally de-actuated drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, an ejector carried by said frame for removing the wound towel roll from said mandrel at the free end thereof, and control apparatus coupled to said drive means and to said ejector and responsive to the passage of the leading end of the towel toward said mandrel for actuating said drive means, said control apparatus includes means responsive to the passage of the trailing end of the towel from said feed apparatus for actuating said ejector to remove the wound towel roll from said mandrel, whereby an elongated towel may be fed to said rotating mandrel and wound in a roll thereon and automatically removed therefrom when the roll is completely wound.

**16.** The towel winder set forth in claim **15,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for deactuating said ejector, and means responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means.

**17.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, an ejector carried by said frame for removing the wound towel roll from said mandrel at the free end thereof, and control apparatus coupled to said capture means and to said ejector and responsive to the passage of the leading end of the towel toward said mandrel for actuating said capture means, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus for actuating said ejector to remove the wound towel roll from said mandrel, whereby an elongated towel may be fed to said rotating mandrel and wound in a roll thereon and automatically removed therefrom when the roll is completely wound.

**18.** The towel winder set forth in claim **17,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for deactuating said ejector, and means responsive to the initiation of the winding of the towel on said mandrel for deactuating said capture means.

**19.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, an ejector carried by said frame for removing the wound towel roll from said mandrel at the free end thereof, and control apparatus coupled to said drive means and to said capture means and to said ejector and responsive to the passage of the leading end of the towel toward said mandrel for actuating said drive means and said capture means, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus actuating said ejector to remove the wound towel roll from said mandrel, whereby the elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon and removed therefrom when the roll is completely wound.

**20.** The towel set forth in claim **19,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for deactuating said ejector, means responsive to the initiation of the winding of the towel of said mandrel for deactuating said capture means, and means responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means.

**21.** An automatic elongated towel winder comprising a support frame, a mandrel having a supported end mounted on said frame and a free distal end, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, an ejector carried by said frame and movable between a retracted condition and an ejecting condition, movement of said ejector from the retracted condition to the ejecting condition thereof serving to remove the towel roll from said mandrel at the free end thereof, and control apparatus coupled to said drive means and to said capture means and to said ejector and responsive to the movement of said ejector to the ejecting condition thereof for actuating said drive means, said control apparatus being responsive to the passage of the leading end of the next towel toward said mandrel for moving said ejector to the retracted condition thereof and for actuating said capture means, said control apparatus being responsive to the initiation of the winding of the towel on said mandrel for deactuating said capture means, said control apparatus being responsive to the passage

of the trailing end of the towel from said feed apparatus for deactuating said drive means and for moving said ejector to the ejecting condition thereof, whereby elongated towels may be automatically fed to said rotating mandrel and wound on a roll thereon and removed therefrom when the roll is completely wound.

**22.** The towel winder set forth in claim **21,** wherein said control apparatus includes means responsive to the passage of the leading end of the towel toward said mandrel for holding said drive means in an actuated condition after the return of said ejector to the retracted position thereof.

**23.** An elongated towel winder for use with an associated source of towels, said winder comprising a support frame, a mandrel mounted on said frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, an inclined feed conveyor having an input end disposed adjacent to and below the source of towels and an upper discharge end disposed adjacent to said mandrel, a first feed path for feeding towels to said mandrel in a predetermined direction extending from the source of towels downwardly to the input end of said feed conveyor and along said conveyor to the discharge end thereof, a second feed path for feeding towels to said mandrel in the predetermined direction and extending from the source of towels directly to the discharge end of said conveyor out of contact with the input end thereof, and a towel from the source following said first feed path until the leading end of the towel is engaged by said mandrel, the initiation of the winding of the towel on said mandrel causing tension in the towel for thereby moving the towel from said first feed path to said second feed path, a sensing device mounted adjacent to said conveyor and sensing the towel in said second feed path for detecting deviation of the towel from the predetermined direction, and direction correcting means acting upon the towel in said second feed path and coupled to said sensing device and responsive to the detection thereby of deviation of the feed towel from the predetermined direction for redirecting the towel into the predetermined direction, whereby an elongated towel may be feed to said rotating mandrel in a predetermined direction and wound on a roll thereon.

**24.** The towel winder set forth in claim **23,** and further including a transfer conveyor disposed adjacent to the input end of said feed conveyor and feeding the towels from the source of towels to the input end of said feed conveyor along said first feed path, the surface speed of said transfer conveyor being greater than the surface speed of the towels fed from the source for preventing folding of towels as they are fed from the source.

**25.** An elongated towel winder for use with an associated source of towels, said winder comprising a support frame, a mandrel mounted on said frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, an inclined feed conveyor having an input end disposed adjacent to and below the source of towels and an upper discharge end disposed adjacent to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, a first feed path for feeding towels to said mandrel in a predetermined direction extending from the source of towels downwardly to the input end of said conveyor and along said conveyor to the discharge end thereof, a second feed path for feeding towels to said mandrel in the predetermined direction and extending from the source of towels directly to the discharge end of said conveyor, a towel from the source following said first feed path until the leading end of the towel is engaged by said mandrel, the initiation of the winding of the towel on said mandrel causing tension in the towel for thereby moving the towel from said first feed path to said second feed path, an ejector carried by said frame for removing the wound towel roll from said mandrel at the free end thereof, a first detector disposed in said first feed path for sensing the presence of a towel therein, a second detector disposed in both said first and second feed paths for sensing the presence of a towel in either of said first and second paths, control apparatus coupled to said first and second detectors and to said drive means and to said capture means and to said ejector and responsive to the sensing of a towel in said first path by said first and second detectors for actuating said drive means and said capture means, said control apparatus being responsive to the sensing by said first detector of the absence of the towel from said first path when the towel is moved to said second path for deactuating said capture means, said control apparatus being responsive to the sensing by said second detector of the absence of the towel from said first and second paths when the trailing end of the towel passes from said feed apparatus for deactuating said drive means and for actuating said ejector, whereby an elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon and removed therefrom when the roll is completely wound.

**26.** The towel winder set forth in claim **25,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power.

**27.** The towel winder set forth in claim **25,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power, said first detector comprises a first switch having a movable contact disposed in said first feed path and engageable by a towel therein for closing said first switch, and said second detector comprises a second switch having a movable contact disposed in both said first and second feed paths and engageable by a towel in either of said paths for closing said second switch.

**28.** The towel winder set forth in claim **25,** wherein said feed conveyor includes a pair of spaced apart parallel conveyor belts, the movable contacts of said first and second switches extending between said pair of conveyor belts and into said feed paths.

**29.** The towel winder set forth in claim **25,** wherein said control apparatus includes an interlock switch coupled to the source of towels for deactuating said towel winder upon deactuation of the source of towels.

**30.** An elongated towel winder for use with an associated source of towels, said winder comprising a support frame, a mandrel mounted on said frame and rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, an inclined feed conveyor having an input end disposed adjacent to and below the

source of towels and an upper discharge end disposed adjacent to said mandrel, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating the winding of the towel into a towel roll on said mandrel, a first feed path for feeding towels to said mandrel in a predetermined direction extending from the source of towels downardly to the input end of said conveyor and along said conveyor to the discharge end thereof, a second feed path for feeding towels to said mandrel in the predetermined direction and extending from the source of towels directly to the discharge end of said conveyor, a towel from the source following said first feed path until the leading end of the towel is engaged by said mandrel, the initiation of the winding of the towel on said mandrel causing tension in the towel for thereby moving the towel from said first feed path to said second feed path, a sensing device mounted adjacent to said conveyor and sensing the towel in said second feed path for detecting deviation of the towel from the predetermined direction, and direction correcting means acting upon the towel in said second feed path and coupled to said sensing device and responsive to the detection thereby of deviation of the fed towel from the predetermined direction for redirecting the towel into the predetermined direction, an ejector carried by said frame for removing the wound towel roll from said mandrel at the free end thereof, a first detector disposed in said first feed path for sensing the presence of a towel therein, a second detector disposed in both said first and second feed paths for sensing the presence of a towel in either of said first and second paths, control apparatus coupled to said first and second detectors and to said drive means and to said capture means and to said ejector and responsive to the sensing of a towel in said first path by said first and second detectors for actuating said drive means and said capture means, said control apparatus being responsive to the sensing by said first detector of the absence of the towel from said first path when the towel is moved to said second path for deactuating said capture means, said control apparatus being responsive to the sensing by said second detector of the absence of the towel from said first and second paths when the trailing end of the towel passes from said feed apparatus for deactuating said drive means and for actuating said ejector, whereby an elongated towel may be automatically fed to said rotating mandrel in a predetermined direction and wound in a roll thereon and removed therefrom when the roll is completely wound.

**31.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, the drive means for one of said outer feed lanes and said intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being arranged on said frame so that each of said intermediate feed lanes and the other of said outer feed lanes includes the mandrel of the associated winding unit with the drive means of an adjacent winding unit displaced from the lane but in longitudinal alignment therewith, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths of the towels.

**32.** The towel winder set forth in claim **31**, wherein the number of said winding units is ten.

**33.** The towel winder set forth in claim **31**, wherein said winding units are vertically staggered on said frame into upper and lower levels, and said winding units are horizontally staggered on said frame so that the winding units in the lower level are disposed rearwardly of the winding units in the upper level.

**34.** The towel winder set forth in claim **31**, wherein said frame is of hollow construction, and each of said mandrels is hollow having an open end mounted on said frame and having a closed free distal end and having an opening in the side thereof, and wherein said capture means includes a suction pump coupled to said hollow frame, and means coupling said hollow frame to the open ends of each of said mandrels and causing an area of reduced pressure within said mandrels and a consequent flow of air toward and through said openings, the flow of air toward and through said openings serving to move the leading ends of the towels from said feed apparatus toward said mandrels and causing the leading ends of the towels to adhere to said rotating mandrels and automatically initiating the winding of the towels into towel rolls on said mandrels.

**35.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, the drive means for one of said outer feed lanes and said intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being staggered

vertically and horizontally on said frame into upper and lower levels so that each of said intermediate feed lanes and the other of said outer feed lanes includes the mandrel of the associated winding unit with the drive means of an adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, and guide chutes equal in number to the mandrels in aid lower level and respectively disposed in the feed lanes associated with said lower level mandrels, said guide chutes extending between said feed apparatus and corresponding ones of said lower level mandrels for respectively guiding the associated towels past the upper level drive means aligned with the associated feed lanes and to said lower level mandrels, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths of the towels.

**36.** The towel winder set forth in claim **35,** wherein said winding units are arranged on said frame so that the winding units in said lower level are disposed rearwardly of the winding units in said upper level.

**37.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed in a feed lane adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, the drive means for one of said outer feed lanes and said intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being arranged on said frame so that each of said intermediate feed lanes and the other of said outer feed lanes includes the mandrel of the associated winding unit with the drive means of an adjacent winding unit displaced from the lane but in longitudinal alignment therewith, and control apparatus coupled to said drive means and to said capture means in each of said winding units and responsive to the passage of the leading end of a towel in any of said feed lanes toward the associated mandrel for actuating the associated drive means and the associated capture means, whereby a plurality of elongated towels may be respectively automatically fed to associated ones of said rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths for the towels.

**38.** The towel winder set forth in claim **37,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power.

**39.** The towel winder set forth in claim **37,** wherein said control apparatus includes means responsive to the passage of the trailing end of a towel from said feed apparatus for deactuating the associated drive means, and means responsive to the initiation of the winding of a towel on the associated mandrel for actuating the associated capture means.

**40.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a pluralty of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel having a supported end mounted on said frame and a free distal end and disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, an ejector for removing the wound towel roll from said mandrel at the free end thereof, and a towel receptacle disposed adjacent to the other side of the associated one feed lanes for receiving the ejected towel roll from said mandrel, the drive means for one of said outer feed lanes and said intermediate feed lanes and the receptacles for the other of said outer feed lanes and said intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being arranged on said frame so that each of said intermediate feed lanes includes the mandrel of the associated winding unit with the drive means of one adjacent winding unit and the towel receptacle of another adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon and removed therefrom when the rolls are completely wound in a space having a width only slightly greater than the combined widths of the towels.

**41.** The towel winder set forth in claim **40,** wherein the number of said winding units is ten.

**42.** The towel winder set forth in claim **40,** wherein said drive of units are vertically staggered on said frame into upper and lower and intermediate levels, and said winding units are horizontally staggered on said frame so that the winding units in the intermediate level are disposed rearwardly of the winding units in the upper level and are disposed forwardly of the winding units in the lower level.

**43.** The towel winder set forth in claim **40,** wherein said ejector includes an ejector member carried by said frame adjacent to said mandrel and movable between a retracted position and ejecting position, and a piston assembly connected to said ejector member for effecting movement thereof, said piston assembly being dis-

posed to said one side of the associated feed lane in longitudinal alignment with the adjacent feed lane but displaced therefrom.

**44.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel having a supported end mounted on said frame and a free distal end and disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive means disposed adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, an ejector for removing the wound towel roll from said mandrel at the free end thereof, and a towel receptacle disposed adjacent to the other side of the associated one feed lane for receiving the ejected towel roll from said mandrel, said winding units being staggered vertically and horizontally on said frame into upper and lower and intermediate levels so that each of said intermediate feed lanes includes the mandrel of the associated winding unit with the ejector of one adjacent winding unit and the drive means of another adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, first guide chutes equal in number to the mandrels in said intermediate level and respectively disposed in the feed lanes associated with said intermediate level mandrels, said first guide chutes extending between said feed apparatus and the corresponding ones of said intermediate level mandrels for respectively guiding the associated towels past the parts of adjacent upper level winding units aligned with the associated feed lanes and to said intermediate level mandrels, and second guide chutes equal in number to the mandrels in said lower level and respectively disposed in the feed lanes associated with said lower level mandrels, said second guide chutes extending between said feed apparatus and the corresponding ones of said lower level mandrels for respectively guiding the associated towels past the parts of adjacent upper level and intermediate level winding units aligned with the associated feed lanes and to said lower level mandrels, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon and removed therefrom when the rolls are completely wound in a space having a width only slightly greater than the combined widths of the towels.

**45.** The towel winder set forth in claim **44**, wherein the number of said winding units is ten.

**46.** The towel winder set forth in claim **44**, wherein said winding units are arranged on said frame so that the winding units in the intermediate level are disposed rearwardly of the winding units in the upper level and are disposed forwardly of the winding units in the lower level.

**47.** The towel winder set forth in claim **44**, wherein each of said first guide shutes comprises an upper portion extending from said feed apparatus to the upper level of winding units, and a lower portion coupled to said upper portion and extending therefrom along the associated feed lane behind the portion of the upper level winding unit alinged with the associated feed lane and to the associated intermediate level mandrel, and each of said second guide shutes includes an upper portion extending from said feed apparatus to the upper level of winding units, and a lower portion coupled to said second guide chute upper portion and extending downwardly along the associated feed lane behind the portions of the upper level and intermediate level winding units aligned with the associated feed lane and to the associated lower level mandrel.

**48.** The towel winder set forth in claim **47**, wherein the upper portion of each of said first and second guide chutes comprises a plurality of downwardly extending spaced-apart parallel rods.

**49.** The towel winder set forth in claim **44**, wherein each of said drive means includes a gear head motor having a motor housing and a gear head housing disposed substantially normal to each other, the longitudinal axis of said gear head housing lying along the longitudinal axis of the associated mandrel, said drive means being arranged on said frame so that the motor housings of the upper level winding units are disposed forwardly of the associated gear-head housings for accommodating said first and second chutes.

**50.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel having a supported end mounted on said frame and a free distal end and disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, drive meand disposed adjacent to one side of the associated one feed lane and coupled to said mandrel for effecting rotation thereof, capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, an ejector for removing the wound towel roll from said mandrel at the free end thereof, and a towel receptacle disposed adjacent to the other side of the associated one feed lane for receiving the ejected towel roll from said mandrel, the drive means for one of said outer feed lanes and said intermediate feed lanes and the receptacles for the other of said outer feed lanes and said intermediate feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being arranged on said frame so that each of said intermediate feed lanes includes the mandrel of the associated winding unit with the drive means of one adja-

cent winding unit and the towel receptacle of another adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, control apparatus coupled to said drive means and to said capture means and to said ejector in each of said winding units and responsive to the passage of the leading end of a towel in any of said feed lanes toward the associated mandrel for actuating the associated drive means and the associated capture means, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus for actuating the corresponding ejector to remove the wound towel roll from said mandrel, whereby a plurality of elongated towels may be respectively automatically fed to associated ones of said rotating mandrels and wound in rolls thereon and removed therefrom when the rolls are completely wound in a space having a width only slightly greater than the combined widths of the towels.

**51.** The towel winder set forth in claim **50,** wherein said control apparatus comprises an electric circuit adapted for coupling to a source of electric power.

**52.** The towel winder set forth in claim **50,** wherein said control apparatus includes means responsive to the passage of the trailing end of a towel from said feed apparatus for deactuating the associated drive means, means responsive to the initiation of the winding of a towel on the associated mandrel for actuating the associated capture means, and means responsive to the passage of the leading end of a towel toward the associated mandrel for deactuating the associated ejector.

**53.** The towel winder set forth in claim **50,** wherein said ejector is movable between a retracted condition and an ejecting condition, movement of said ejector from the retracted condition to the ejecting condition thereof serving to remove the towel roll from said mandrel at the free end thereof, said control apparatus being responsive to the movement of said ejector to the ejecting condition thereof for actuating said drive means, said control apparatus being responsive to the passage of the leading end of the next towel toward said mandrel for moving said ejector to the retracted condition thereof, said control apparatus being responsive to the passage of the trailing end of the towel from said feed apparatus for deactuating said drive means and for moving said ejector to the ejecting condition thereof.

**54.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, drive means disposed adjacent to said feed apparatus, a first line shaft disposed forwardly of said frame adjacent to the upper end thereof and coupled to said drive means and rotatably driven thereby, a second line shaft disposed rearwardly of said frame adjacent to the lower end thereof and coupled to said drive means and rotatably driven thereby, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel disposed in an associated one of said feed lanes dtransversely thereof and extending substantially thereacross, said mandrel being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, coupling means disposed adjacent to one side of the associated one feed lane and coupling one of said line shafts to said mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, the coupling means for each of said intermediate feed lanes and one of said outer feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being vertically staggered on said frame into upper and lower levels with each of said intermediate feed lanes and one of said outer feed lanes including the mandrel of the associated winding unit with the coupling means of an adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, the coupling means of said upper level winding units being coupled to said first line shaft and the coupling means of said lower level winding units being coupled to said second line shaft, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths of the towels.

**55.** The towel winder set forth in claim **54,** wherein each of said coupling means includes an endless drive belt.

**56.** The towel winder set forth in claim **54,** wherein each of said coupling means includes a slip clutch coupled to the associated mandrel for maintaining a constant torque thereat, and a drive belt coupling said clutch to the associated one of said line shafts for effecting rotation of said clutch and said mandrel.

**57.** The towel winder set forth in claim **54,** wherein each of said winding units further includes an ejector for removing the wound towel roll from said mandrel at the free end thereof, and a towel receptacle disposed adjacent to the other side of the associated one feed lane for receiving the ejected towel roll from said mandrel, said winding units being staggered vertically and horizontally on said frame into upper and lower and intermediate levels so that each of said intermediate feed lanes includes the mandrel of the associated winding unit with the ejector of one adjacent winding unit and the drive means of another adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom.

**58.** A towel winder for automatically winding a plurality of elongated towels, said winder comprising a support frame, feed apparatus for feeding a plurality of elongated towels respectively along a plurality of substantially parallel feed lanes including two outer feed lanes and at least one intermediate feed lane all arranged in side-by-side relationship, each of said feed lanes having a width only slightly greater than the width of the associated towel, drive means disposed adjacent to said feed apparatus, a first line shaft disposed forwardly to said frame adjacent to the upper end thereof and coupled to said drive means and rotatably driven whereby, a second line shaft disposed rearwardly of said frame adjacent to the lower end thereof and coupled to said drive means and rotatably driven thereby, a plurality of winding units carried by said frame and equal in number to said feed lanes, each of said winding units including a mandrel disposed in an associated one of said feed lanes transversely thereof and extending substantially thereacross, said mandrel being rotatable

about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, coupling means disposed adjacent to one side of the associated one feed lane and coupling one of said line shafts to said mandrel for effecting rotation thereof, and capture means for urging the leading end of the towel against said rotating mandrel for automatically initiating winding of the towel into a towel roll on said mandrel, the coupling means for each of said intermediate feed lanes and one of said outer feed lanes being respectively disposed in longitudinal alignment with adjacent feed lanes but displaced therefrom, said winding units being vertically staggered on said frame into upper and lower levels with each of said intermediate feed lanes and one of said outer feed lanes including the mandrel of the associated winding unit with the coupling means of an adjacent winding unit disposed in longitudinal alignment with the lane but displaced therefrom, the coupling means of said upper level winding units being coupled to said first line shaft and the coupling means of said lower level winding units being coupled to said second line shaft, and control apparatus coupled to said drive means and to each of said winding units and responsive to the passage of the leading end of a towel in any of said feed lanes toward the associated mandrel for actuating said drive means and the associated capture means, whereby a plurality of elongated towels may be respectively automatically fed to corresponding ones of said rotating mandrels and wound in rolls thereon in a space having a width only slightly greater than the combined widths of the towels.

**59.** The towel winder set forth in claim **58,** wherein said control apparatus includes means responsive to the absence of towels from said feed apparatus for deactuating said drive means, and means responsive to the initiation of the winding of a towel on the associated mandrel for deactuating the associated capture means.

**60.** An automatic elongated towel winder comprising a support frame, a hollow mandrel having an open end mounted on said frame and being rotatable about the longitudinal axis thereof for winding an associated elongated towel into a roll thereon, said mandrel having a closed free distal end and having an opening in the side thereof, drive means carried by said frame and coupled to said mandrel for effecting rotation thereof, feed apparatus mounted adjacent to said mandrel for feeding an elongated towel to said mandrel, capture means for urging the leading end of the towel into a towel roll on said mandrel, said capture means including a suction pump coupled to the open end of said mandrel for causing an area of reduced pressure within said mandrel and a consequent flow of air toward and through said opening to move the leading end of the towel toward and against said mandrel, said capture means further including a valve coupled between said suction pump and said mandrel for controlling the flow of air therethrough, and control apparatus coupled to said valve and responsive to the passage of the leading end of the towel toward said mandrel for opening said valve to actuate said capture means, said control apparatus being responsive to the initiation of the winding of the towel on said mandrel for closing said valve to de-actuate said capture means, whereby an elongated towel may be automatically fed to said rotating mandrel and wound in a roll thereon.

* * * * *