United States Patent [19]

Foltyn et al.

[11] **3,877,653**

[45] **Apr. 15, 1975**

[54] **HANDLING REELS IN HIGH-SPEED TAKEUP**

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[73] Assignee: **Western Electric Company, Incorporated,** New York, N.Y.

[22] Filed: **Feb. 6, 1974**

[21] Appl. No.: **440,231**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 228,595, Feb. 23, 1972, abandoned.

[52] **U.S. Cl.** ..... **242/25 A;** 242/79

[51] **Int. Cl.** **B65h 67/04**

[58] **Field of Search** .... 242/25 A, 25 R, 18 A, 18 R, 242/79, 58.6, 35.5 A

[56] **References Cited**

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2,546,637	3/1951	Robson	242/25 A
3,174,700	3/1965	Lemaire	242/18 A
3,197,017	7/1965	Ungerer	242/79 X
3,345,011	10/1967	Martin, Sr.	242/79 X
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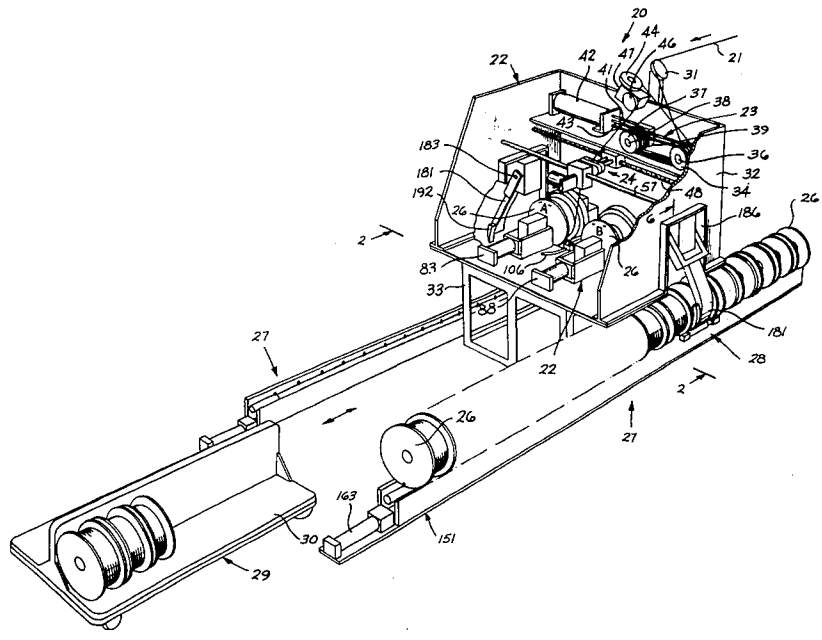
Primary Examiner—Stanley N. Gilreath
Attorney, Agent, or Firm—E. W. Somers

[57] **ABSTRACT**

A dual position takeup apparatus with spaced parallel axes of rotation includes facilities for automatically loading empty reels and unloading reels full of strand material. The full reels are removed from the takeup positions and prepared for movement from the apparatus in a manner such that essentially all the strand material is wound on the reels with no loose ends extending therefrom.

A conveyor associated with each of the takeup positions advances incrementally empty reels along a path of travel parallel to the axis of rotation of, and into proximate alignment with, the associated one of two takeup positions. A load-unload arm is moved into engagement with a leading one of the empty reels on the conveyor and then turned pivotally to move the leading one of the reels up a ramp into the associated one of the takeup positions. While strand material is distributed upon the reel in the one takeup position, the load-unload arm associated with the other takeup position is operated to permit the full reel therein to move down the associated ramp, desirably without any substantial rolling, until the full reel is received on the conveyor associated with the other takeup position. Then the full reel is turned rotatably in the direction of takeup to wind any loose ends of strand material extending therefrom. The conveyor is operated to move the full reel toward an unload position and the leading one of the empty reels into proximate transverse alignment with the other takeup position. The arm is controlled to engage the empty reel and move the empty reel up the associated ramp to the associated other one of the takeup positions.

19 Claims, 22 Drawing Figures



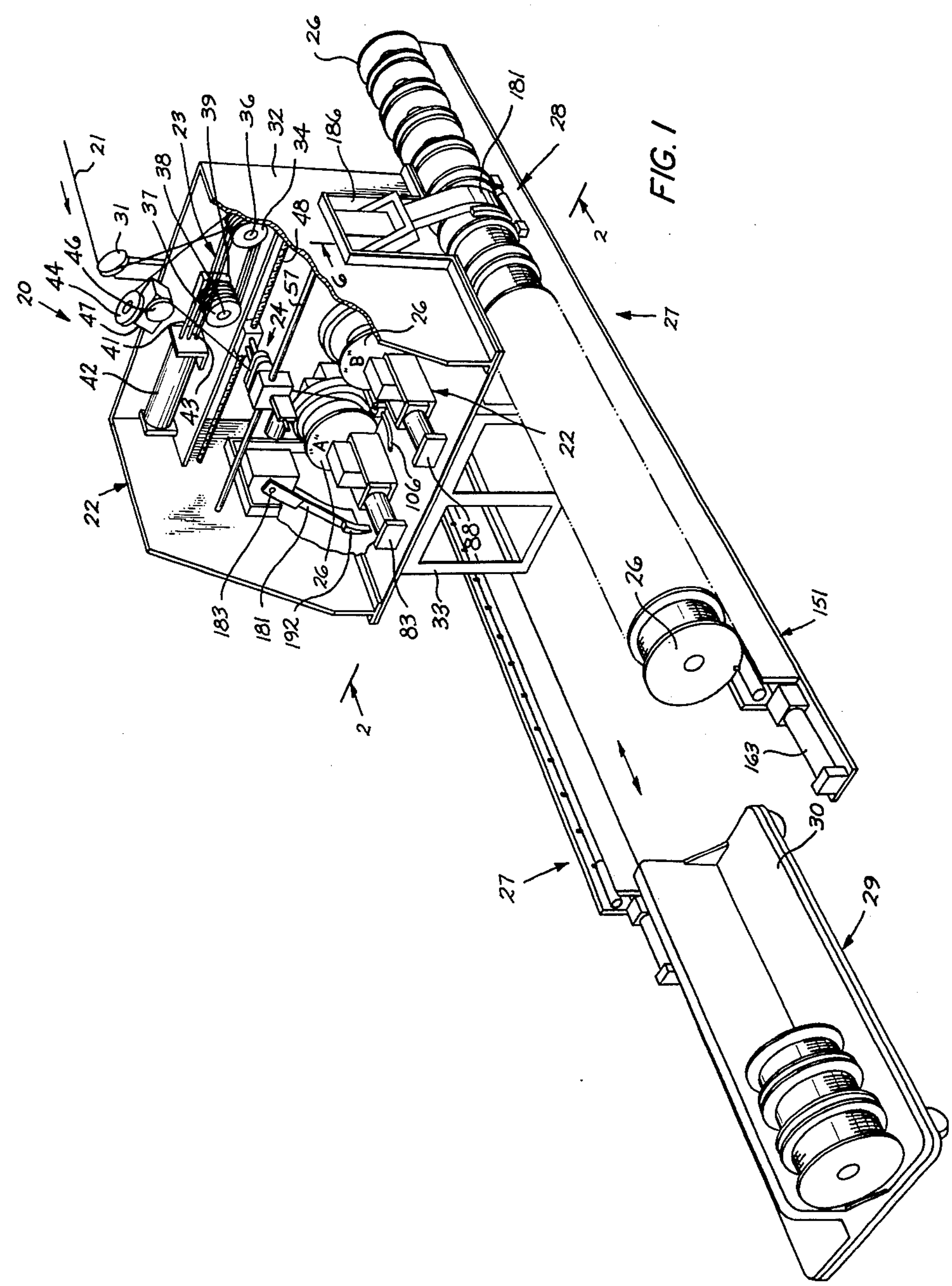

20
21
31
46
44
47
41
42
43
37
38
23
39
36
32
34
186
48
51
24
6
26
28
181
2
27
"B"
"A"
22
106
88
83
33
192
181
183
151
163
30
29

FIG. 1

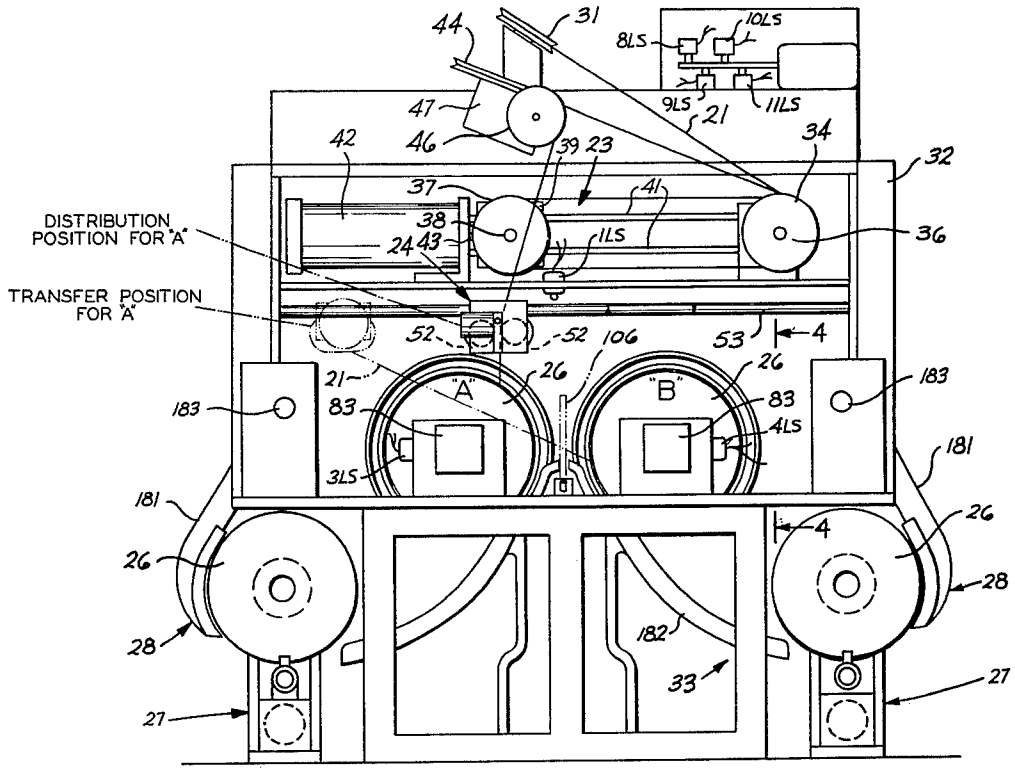

DISTRIBUTION POSITION FOR "A"
TRANSFER POSITION FOR "A"
"A"
"B"
44
31
8LS
10LS
9LS
11LS
21
47
46
42
39
23
34
32
37
41
38
24
43
1LS
36
52
106
53
4
26
183
83
4LS
3LS
181
28
182
33
27

FIG. 2

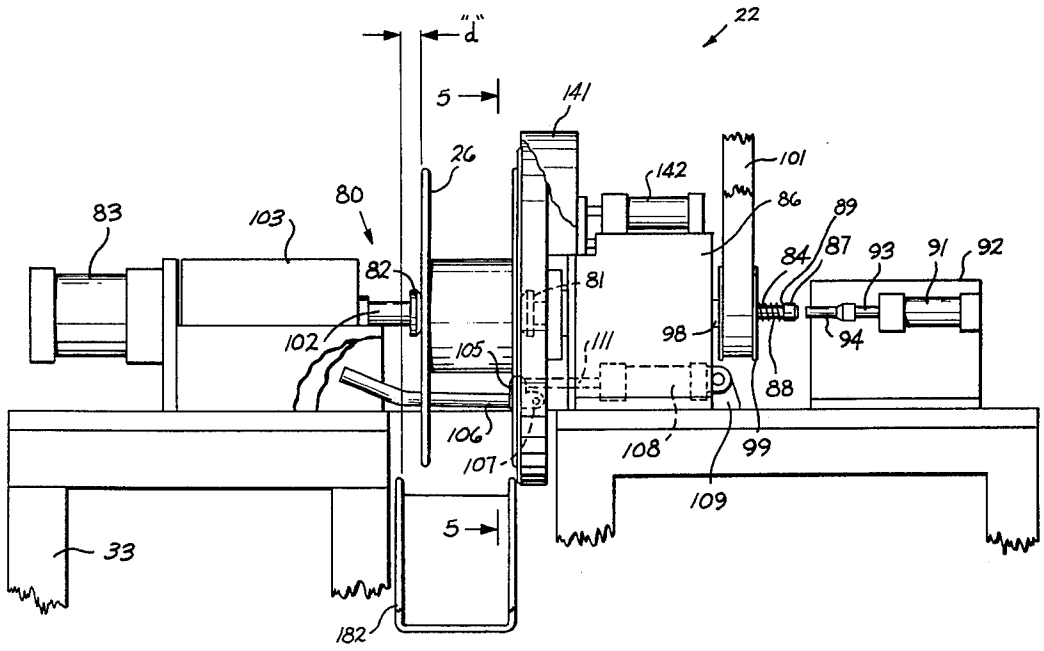

"d"
22
5
141
26
142
101
80
83
103
86
89
84
87
93
91
92
82
81
102
105
111
98
94
88
106
107
108
99
109
33
182

FIG. 4

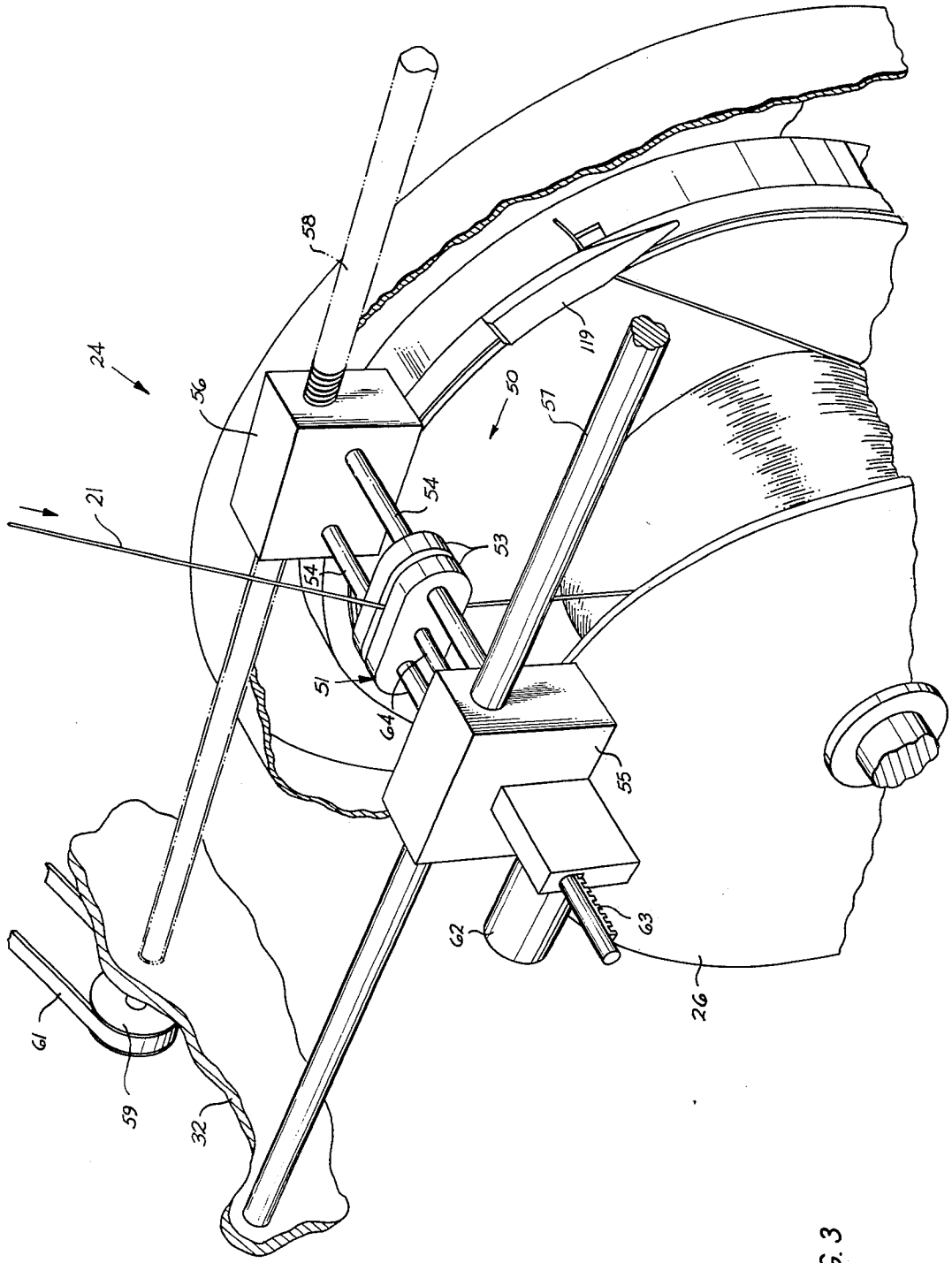


FIG. 3

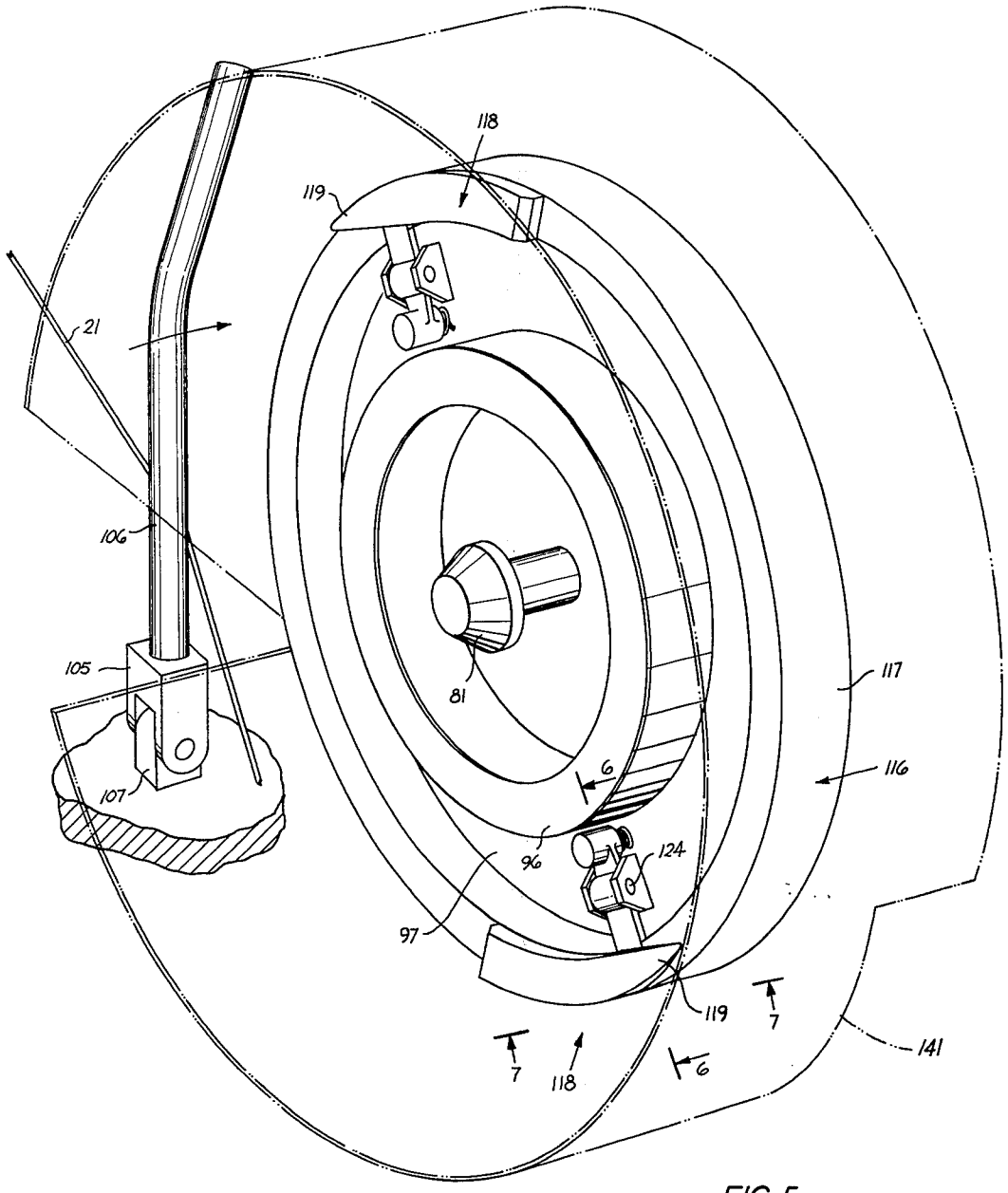


FIG. 5

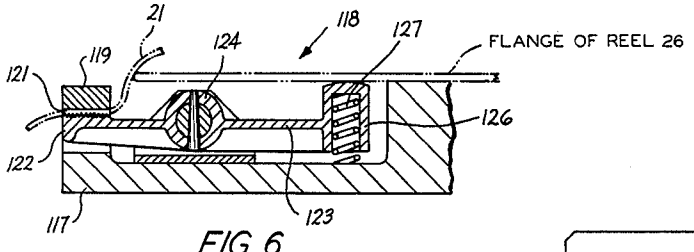


FIG. 6

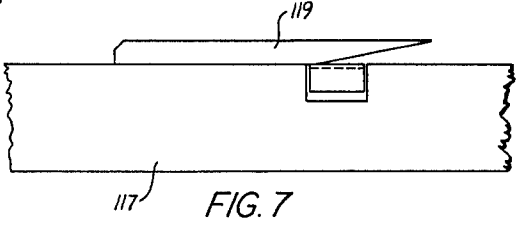


FIG. 7

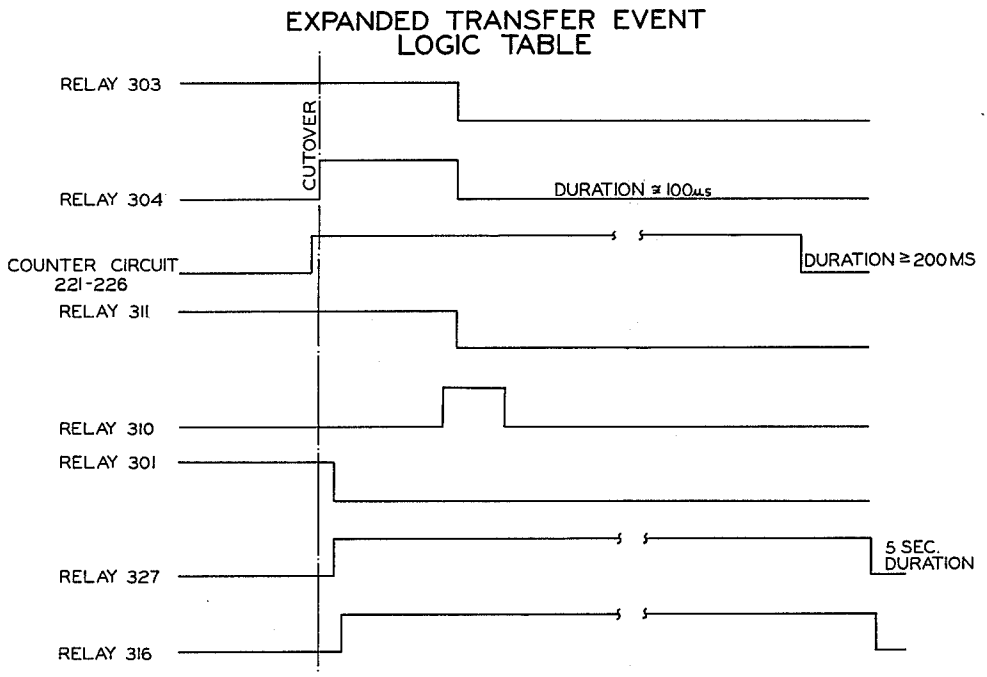

EXPANDED TRANSFER EVENT
LOGIC TABLE
RELAY 303
CUTOVER
RELAY 304
DURATION ≅ 100μs
COUNTER CIRCUIT
221-226
DURATION ≥ 200 MS
RELAY 311
RELAY 310
RELAY 301
5 SEC.
DURATION
RELAY 327
RELAY 316

FIG. 19

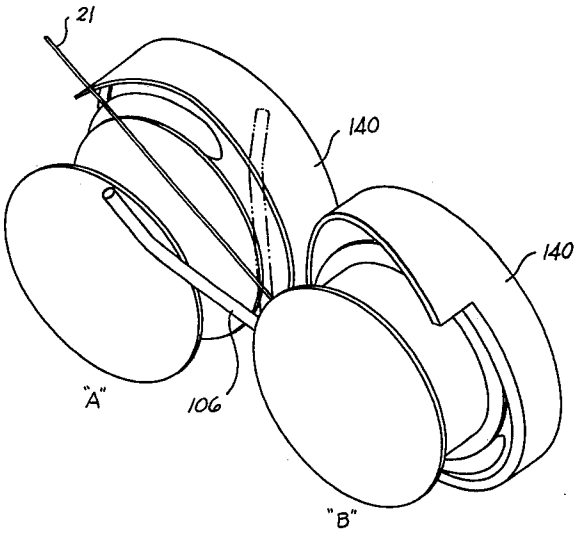

21
140
140
"A"
106
"B"

FIG. 8

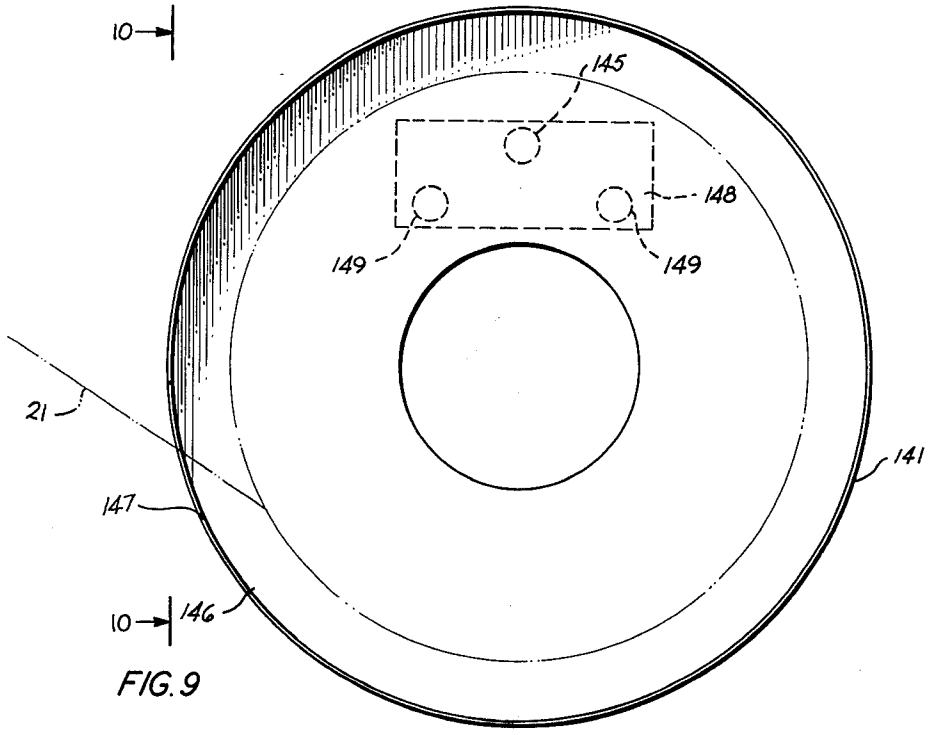

10
145
148
149
149
21
147
141
10
146

FIG. 9

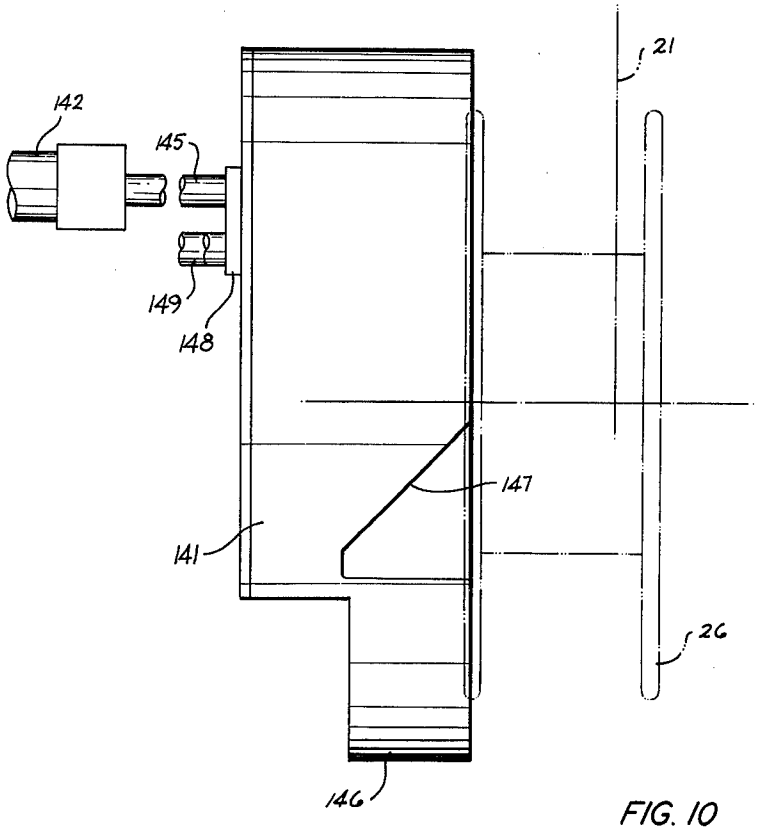
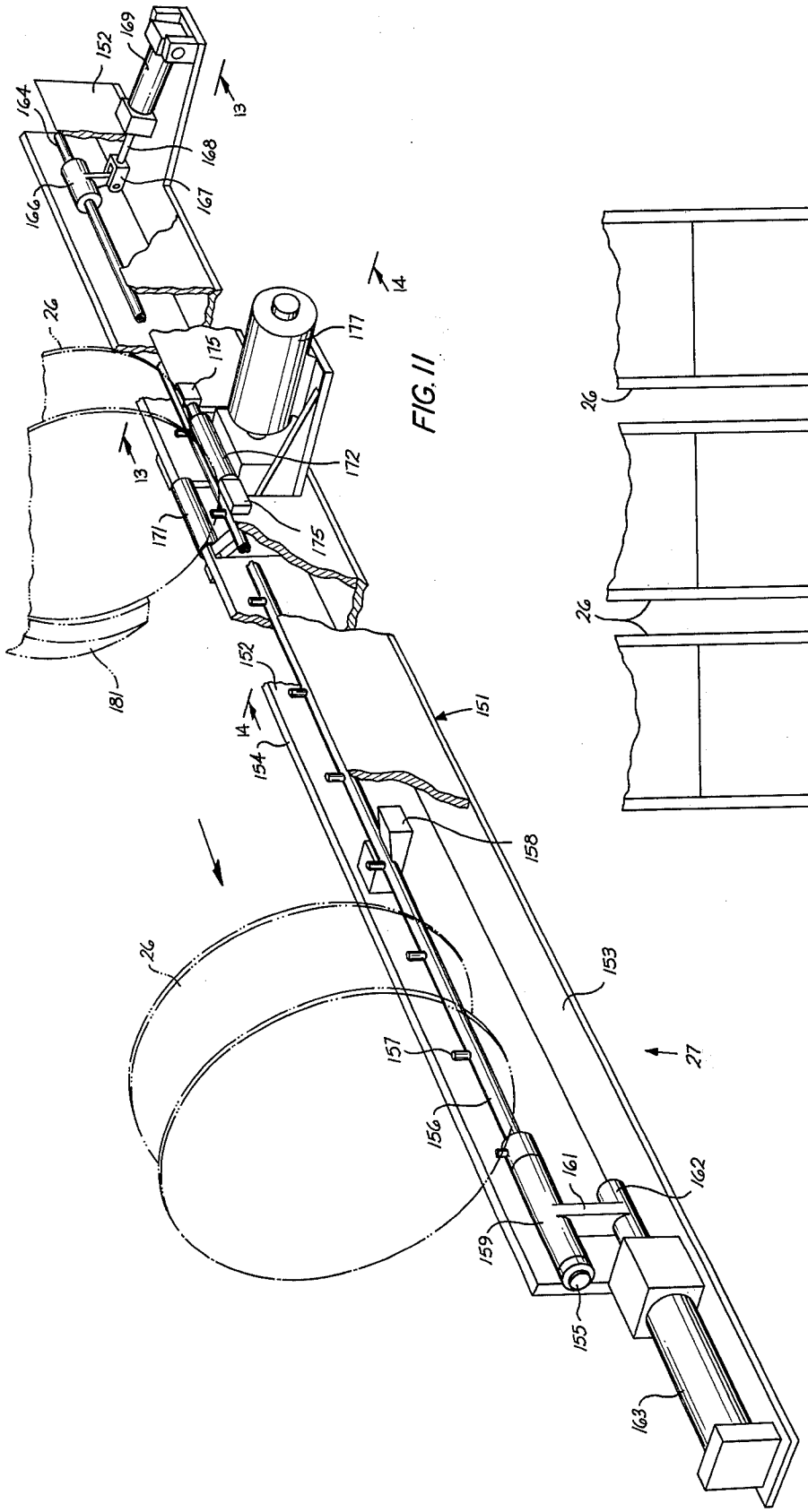

21
142
145
149
148
147
141
26
146

FIG. 10


152
169
164
13
168
166
167
26
14
177
175
172
13
171
175
181
152
14
154
151
158
26
153
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156
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162
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155
163

FIG. 11

26
26
153
154

FIG. 12

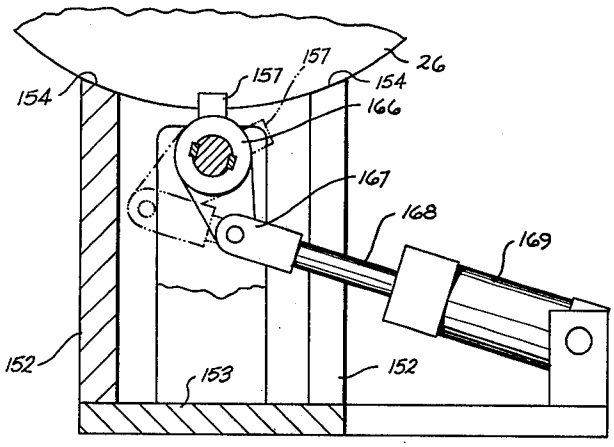

154
157
157
154
26
166
167
168
169
152
153
152

FIG. 13

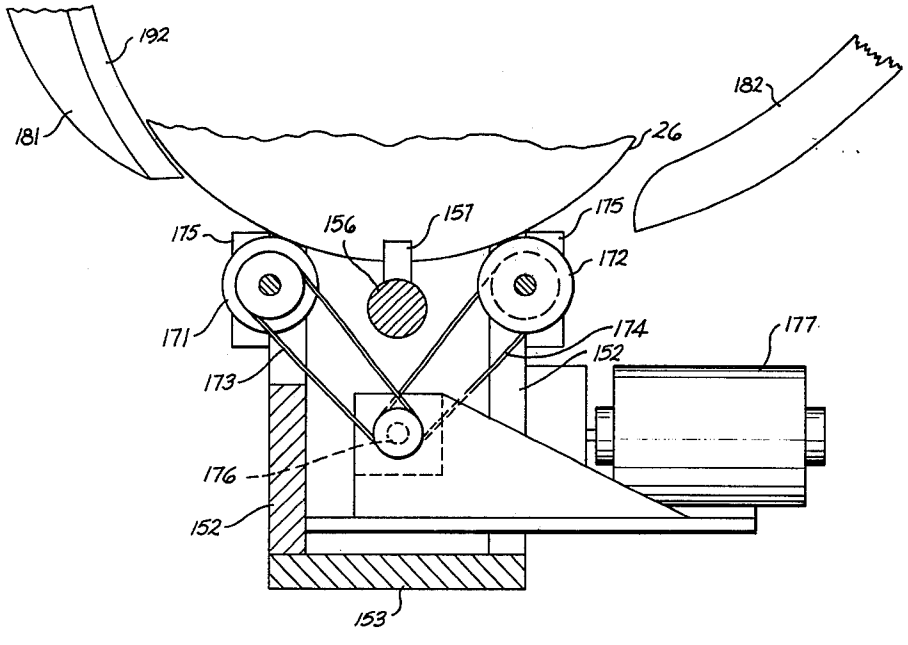

192
181
182
26
175
156
157
175
172
171
174
177
152
173
176
152
153

FIG. 14

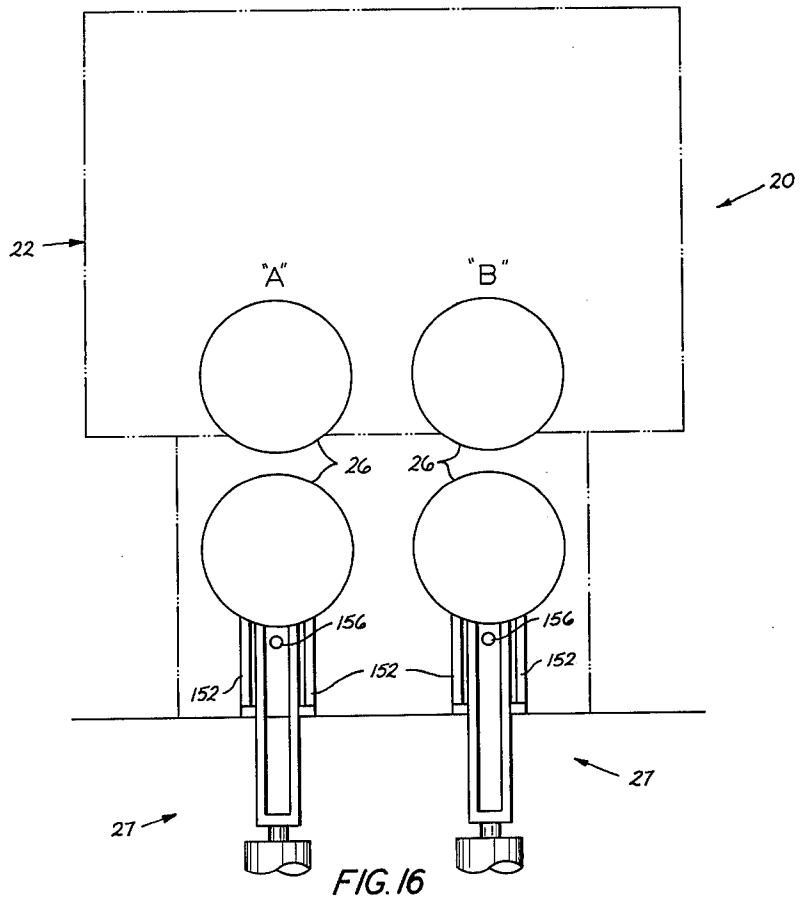

20
22
"A"
"B"
26
26
156
156
152
152
152
27
27

FIG. 16

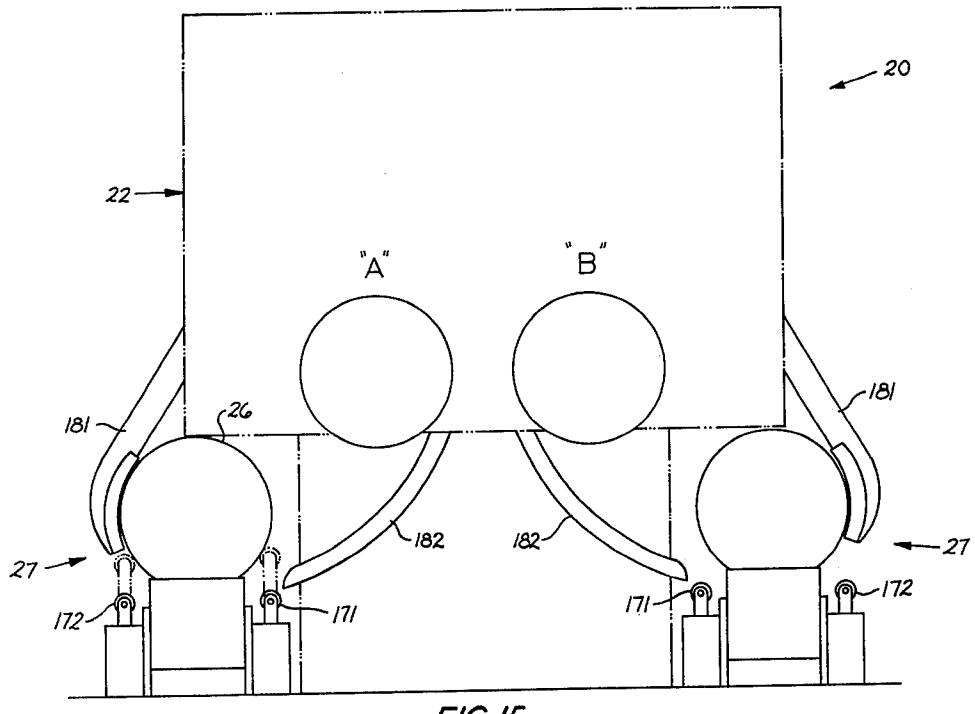

20
22
"A"
"B"
181
181
26
182
182
27
27
172
171
171
172

FIG. 15

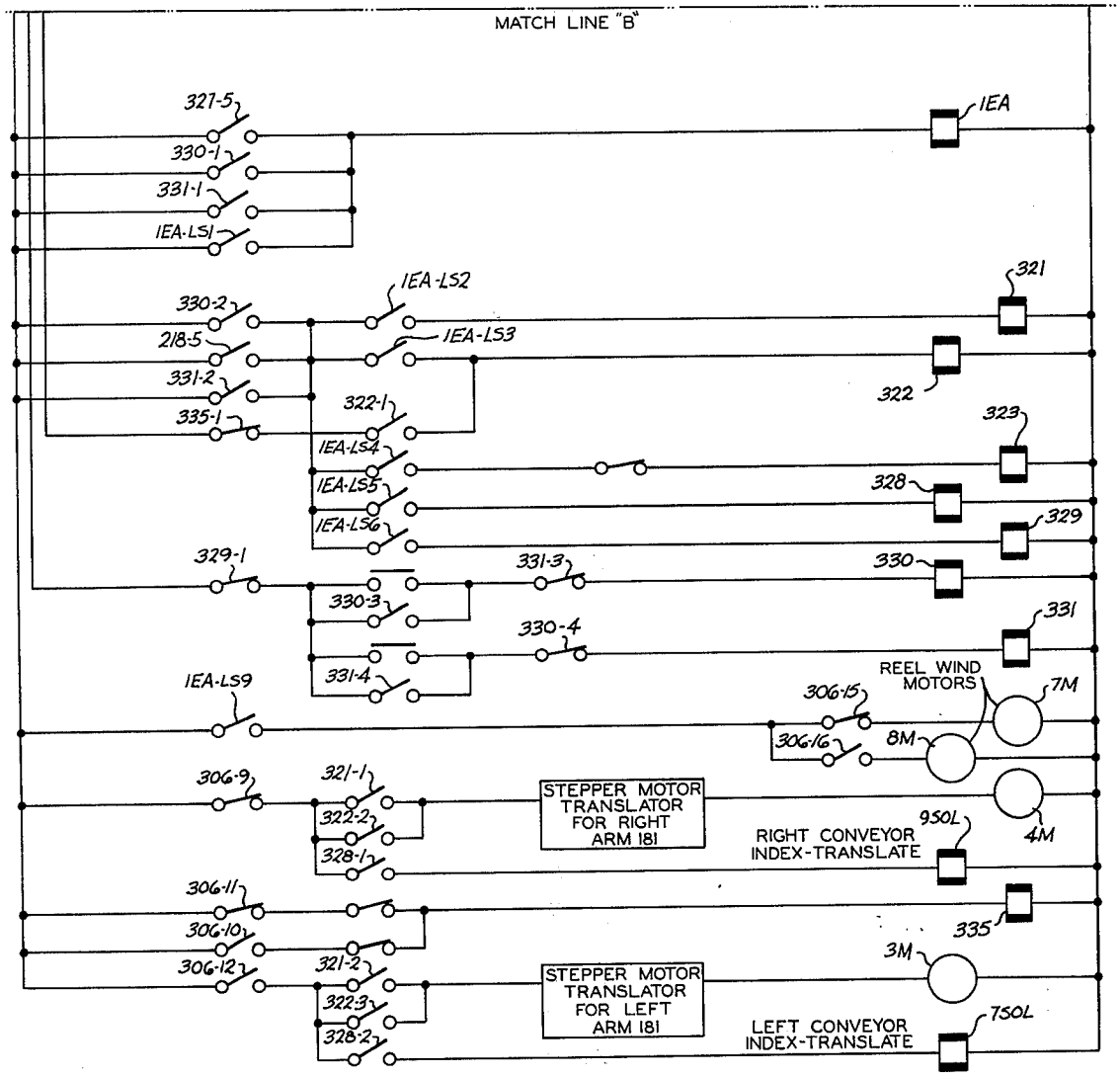


FIG. 17C

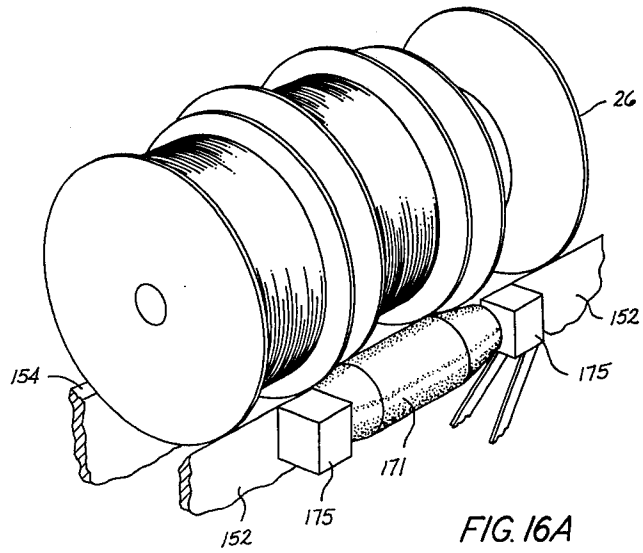


FIG. 16A

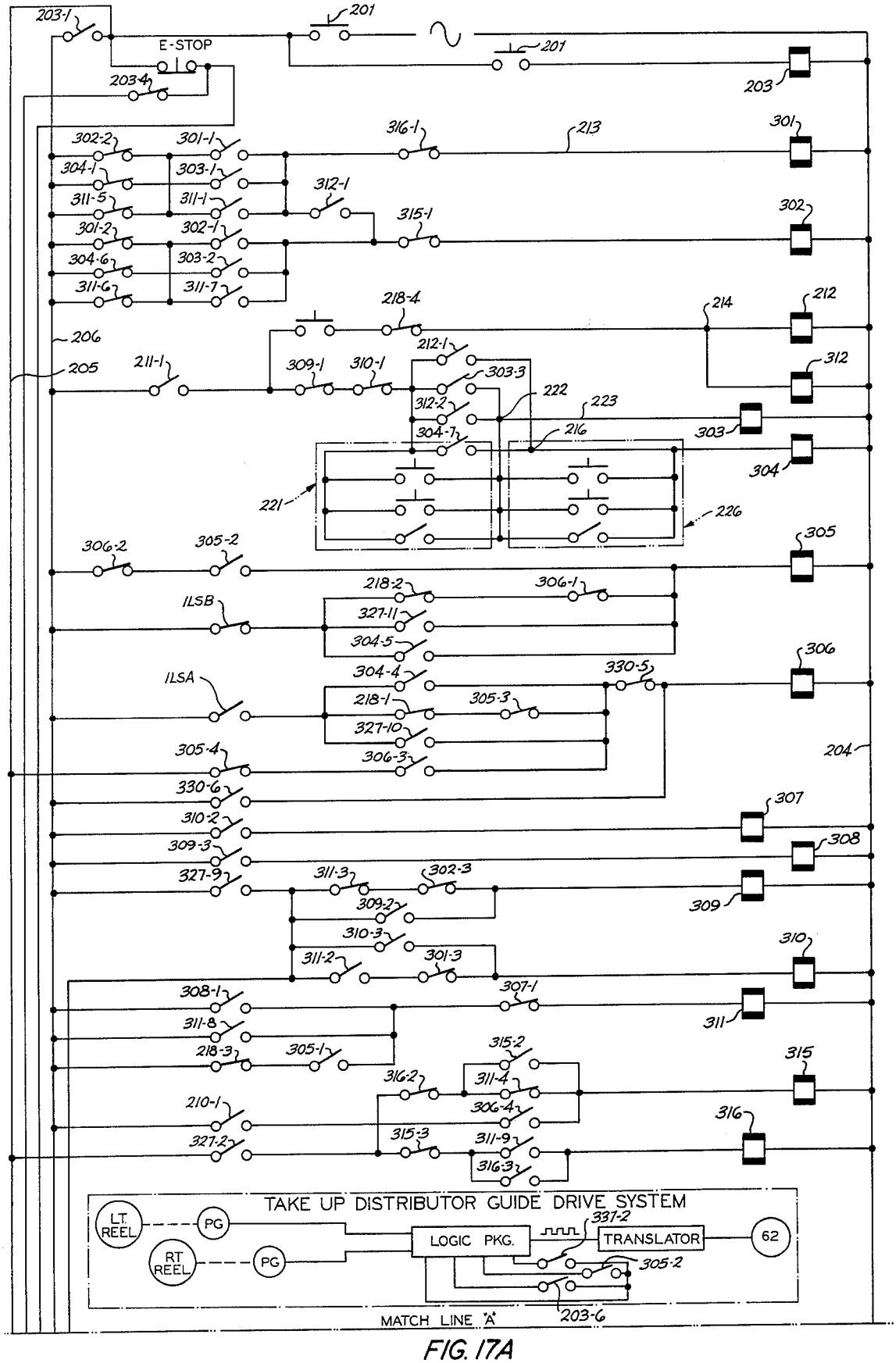

203-1
E-STOP
203-4
201
201
203
316-1
213
301
302-2
301-1
304-1
303-1
311-5
311-1
312-1
315-1
302
301-2
302-1
304-6
303-2
311-6
311-7
218-4
214
212
206
212-1
205
211-1
309-1
310-1
303-3
312
222
223
312-2
304-7
216
303
304
221
226
306-2
305-2
305
218-2
306-1
ILSB
327-11
304-5
306
ILSA
304-4
330-5
218-1
305-3
327-10
306-3
204
305-4
330-6
307
310-2
309-3
308
327-9
311-3
302-3
309-2
309
310-3
310
311-2
301-3
308-1
307-1
311
311-8
218-3
305-1
315-2
315
316-2
311-4
306-4
210-1
316
327-2
315-3
311-9
316-3
TAKE UP DISTRIBUTOR GUIDE DRIVE SYSTEM
LT. REEL
PG
RT REEL
PG
LOGIC PKG.
331-2
TRANSLATOR
62
305-2
MATCH LINE "A"
203-6

FIG. 17A

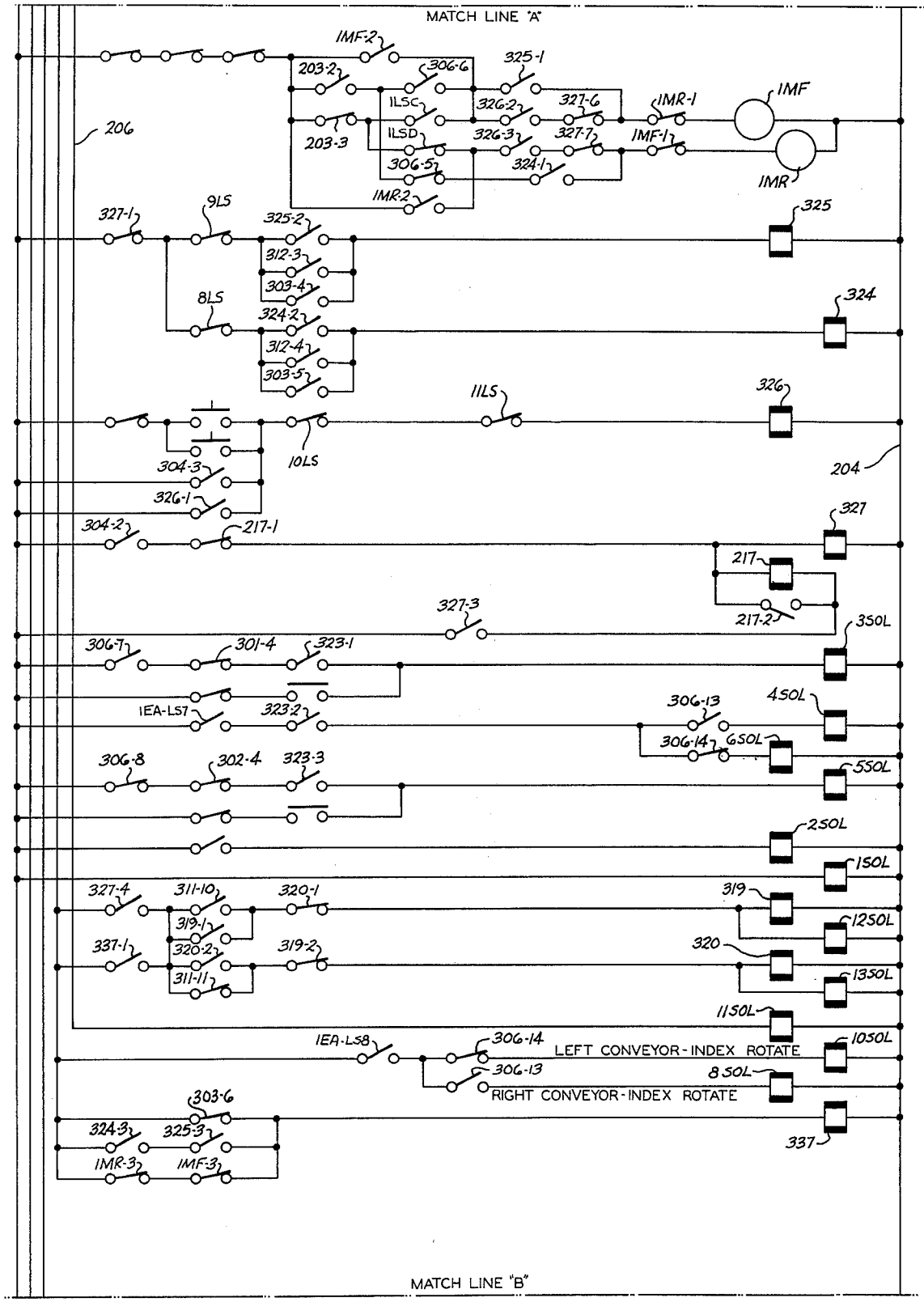
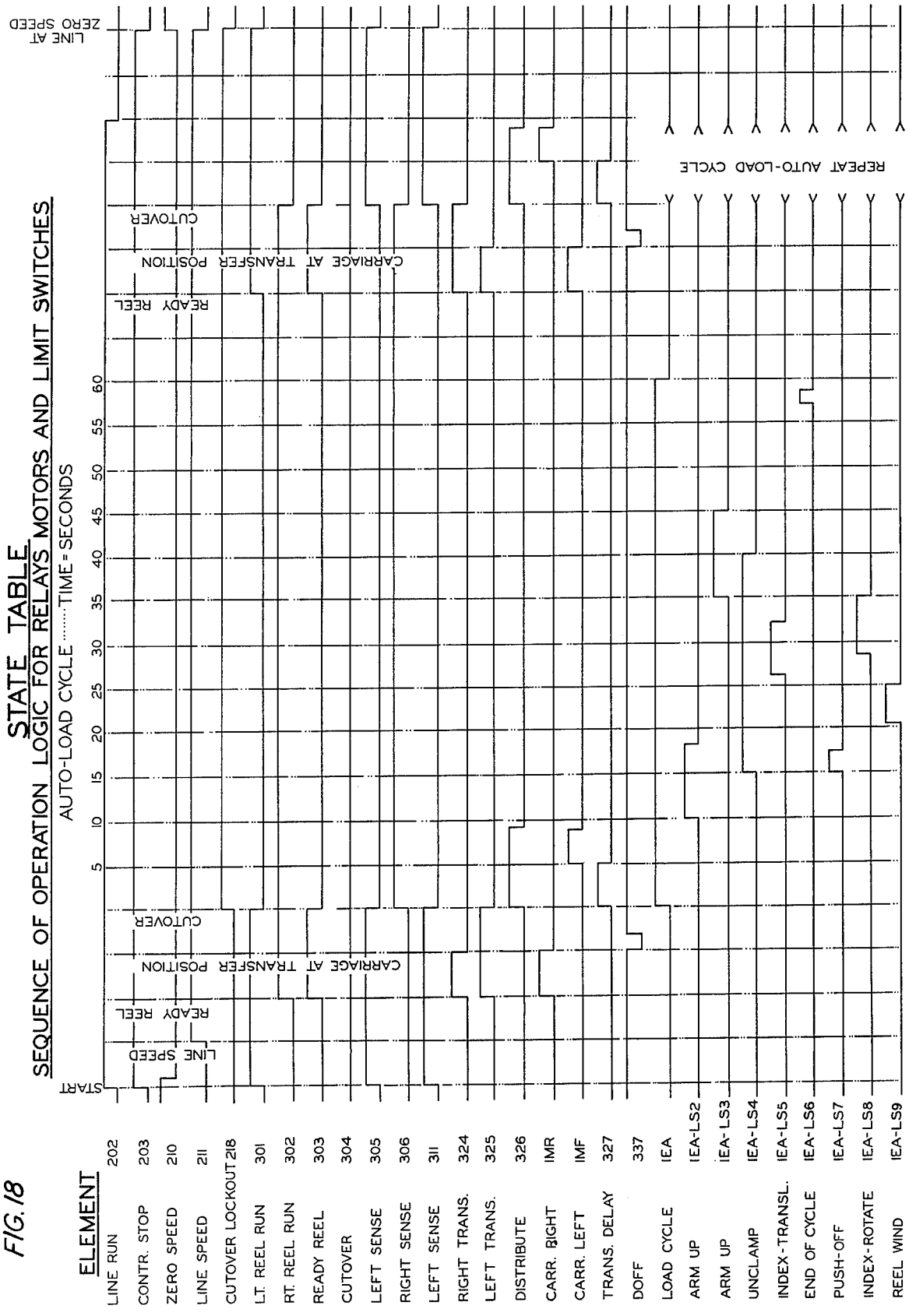

MATCH LINE "A"
IMF-2
203-2
306-6
325-1
ILSC
326-2
327-6
IMR-1
IMF
206
203-3
ILSD
326-3
327-7
IMF-1
306-5
324-1
IMR
IMR-2
327-1
9LS
325-2
325
312-3
303-4
8LS
324-2
324
312-4
303-5
11LS
326
10LS
204
304-3
326-1
304-2
217-1
327
217
217-2
327-3
350L
306-7
301-4
323-1
IEA-LS7
323-2
306-13
450L
306-14
GSOL
306-8
302-4
323-3
550L
250L
150L
327-4
311-10
320-1
319
319-1
1250L
337-1
320-2
319-2
320
311-11
1350L
1150L
IEA-LS8
306-14
LEFT CONVEYOR-INDEX ROTATE
1050L
306-13
RIGHT CONVEYOR-INDEX ROTATE
850L
303-6
337
324-3
325-3
IMR-3
IMF-3
MATCH LINE "B"

FIG. 17B

FIG. 18


STATE TABLE
SEQUENCE OF OPERATION LOGIC FOR RELAYS MOTORS AND LIMIT SWITCHES
AUTO-LOAD CYCLE ·····TIME = SECONDS
ELEMENT
LINE RUN 202
CONTR. STOP 203
ZERO SPEED 210
LINE SPEED 211
CUTOVER LOCKOUT 218
LT. REEL RUN 301
RT. REEL RUN 302
READY REEL 303
CUTOVER 304
LEFT SENSE 305
RIGHT SENSE 306
LEFT SENSE 311
RIGHT TRANS. 324
LEFT TRANS. 325
DISTRIBUTE 326
CARR. RIGHT IMR
CARR. LEFT IMF
TRANS. DELAY 327
DOFF 337
LOAD CYCLE IEA
ARM UP IEA-LS2
ARM UP IEA-LS3
UNCLAMP IEA-LS4
INDEX-TRANSL. IEA-LS5
END OF CYCLE IEA-LS6
PUSH-OFF IEA-LS7
INDEX-ROTATE IEA-LS8
REEL WIND IEA-LS9
START
LINE SPEED
READY REEL
CARRIAGE AT TRANSFER POSITION
CUTOVER
CUTOVER
CARRIAGE AT TRANSFER POSITION
READY REEL
LINE AT ZERO SPEED
REPEAT AUTO-LOAD CYCLE
5 10 15 20 25 30 35 40 45 50 55 60

HANDLING REELS IN HIGH-SPEED TAKEUP

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of application Ser. No. 228,595, filed Feb. 23, 1972, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to handling reels for taking up elongated material, and, more particularly, to methods of and apparatus for automatically supplying empty reels to two takeup positions and removing full reels therefrom with improved facilities for eliminating the extension of free end portions of the strand material from the full reels.

2. Technical Considerations and the Prior Art

One of the problems associated with the taking up of strand material has been the loading and unloading of reels. Many of the earlier takeups supported the takeup reels on a common axis of rotation. In at least one such apparatus, a leading one of a supply of empty reels is rolled into alignment with a takeup position and an elevator is controlled to raise the empty reel into the takeup position. After the reel is full, the elevator lowers the reel to a roll-off position where the fully wound reel is rolled from the elevator onto the floor. Adjustable inclined runways leading from the takeup positions to the manufacturing floor have been used in order to permit the easy removal of a full reel of strand material without manually having to lift the reel.

The use of two takeup reels arranged on a common axis has involved certain drawbacks. For example, at cutover, the strand material being taken up is directed to span across two snaggers, one associated with each of the takeup positions. This causes an undue amount of shock to the strand material and has been the source of wire breaks in the past. Moreover, common axis takeups have never been conducive to the higher line speeds used today. In high speed takeups, it is not uncommon to mount the takeup reels on spaced parallel axes. A takeup apparatus of this type is exemplified by that shown in U.S. Pat. No. 2,546,637, issued Mar. 27, 1951, to Duer C. Robson.

With the trend toward higher line speeds of 4,000–5,000 feet per minute and even more, while retaining conventionally sized standard reels, the frequency of reel changes becomes a problem of more concern. To achieve manufacturing economies, it becomes necessary to incorporate an automatic handling feature requiring minimum space into the high-speed takeup so as to be able to supply empty reels to the takeup positions while removing the full reels.

In one commercially available high-speed takeup, the reel positions having parallel spaced axes are serviced by a conveyor and elevator arrangement. There, empty reels are moved along an inclined track or ramp along a path of travel transverse of the parallel spaced axes into alignment with and beneath one of the takeup positions. An elevator lifts the leading one of the reels upwardly into alignment with the one takeup position. After the reel in the other one of the takeup position is full, the full reel is lowered from that takeup position by an elevator to the track below and rolls down an inclined track to a loading pallet. Then, the next successive one of the empty reels is moved into alignment with the other one of the takeup positions and elevated into that takeup position in anticipation of cutover.

In this, empty reels are advanced in one direction into one side of the takeup apparatus into both takeup positions, and the full reels are removed from those positions in the same direction but exit from an opposite side of the apparatus. This requires considerable floor space in order to have an acceptable supply of the reels backed up behind the takeup positions. Also, as the full reels are lowered by the elevators from the associated takeup positions to the inclined ramp or track to permit the reels to roll toward the pallet, half the reels tend to roll so as to unwind the convolutions of the strand material.

In the transfer of the strand material from one takeup reel to the other takeup reel, the one severed end portion of the strand material is held by the snagger associated with the empty reel. When the rotation of the full reel is discontinued, the snagger is designed to release the free leading end of the strand material. The accumulation of dirt and grease or conductor scraps may cause a malfunction of the snagger release. In that event, a full reel may be removed from the takeup position with an end of the strand material extending to the snagger. This could cause further malfunctioning of the apparatus.

Another problem relates to the free trailing end portion of the strand material wound on the full reel. This end is desirably contained within a cover which has priorly been moved over a portion of the full reel including the flange. Frequently, the trailing portion of the strand material escapes from the confines of the peripheral cover and forms a loose stock end of formidable length which whips around in uncontrolled fashion until the reel comes to a stop. A loose end spinning around with a full reel usually hits and rebounds more or less sharply from some part or parts of the takeup and becomes marred or otherwise damaged. Moreover, damage is frequently sustained by the top layer of the wound strand material on being hit in whip-like fashion by the severed end portion. This undesirable occurrence leads to what is referred to in the art as "slapnicks."

The prior art discloses facilities for averting any whipping of a loose end of strand material against the convolutions of strand material wound on a takeup reel in a common reel axis type takeup. Shields are used which are in the whip path of a loose end of strand material and which extend generally around the reels. These serve as fixed tracks which intercept and lead the loose ends harmlessly around the full reel until the latter comes to a stop. The shield is provided with a gap in the cutover and wind-on regions so as to not obstruct the admission of strand material onto the reel and of the crossover sections of the strand material to the snaggers of both reels, but over the width of which a loose strand end is free to whip outwardly. A length of one shield immediately following the gap in the drive direction of the reel is substantially linear and leads tangentially into the remainder of the shield which is of substantially circular shape. Any loose strand material passing through the shield gap whips against this straight portion and is dragged harmlessly thereover. Facilities equally as effective must be provided in high-speed parallel axis takeups.

SUMMARY OF THE INVENTION

A method of taking up successive sections of an elongated material on reels and which embodies certain principles of this invention includes moving empty reels along a path of travel to position successive leading ones of the reels into a transfer position associated with a takeup position, moving each successive leading one of the empty reels from the path of travel of the empty reels into the takeup position, supporting each successive leading one of the empty reels for rotation in the takeup position, rotating the reel in the takeup position while advancing and guiding elongated material transversely reciprocally across a winding surface of the reel in the takeup position to distribute the elongated material in successive layers on the reel, and then discontinuing the rotation of the reel in the takeup position when the reel is full of the elongated material. Then each of the full reels is removed from the takeup position to a path of travel associated with the full reels while regulating turning of the full reel to insure that each of the full reels to be advanced subsequently along the path of travel thereof has substantially all the elongated material wound thereon and that there are substantially no loose tails of elongated material extending therefrom.

An apparatus for taking up elongated material on reels which embodies certain principles of this invention includes facilities for moving a plurality of empty reels along a path of travel to position successive leading ones of the reels into a transfer position associated with a takeup position, facilities for moving each successive leading one of the empty reels from the path of travel of the empty reels into the takeup position, facilities for supporting rotatably each successive leading one of the empty reels in the takeup position, facilities for advancing and guiding successive sections of elongated material transversely reciprocally across a winding surface of the reel in the takeup position to distribute the elongated material in successive layers on the reel, and facilities for rotating the reel in the takeup position during the distribution of the elongated material thereon and for discontinuing the rotation when the reel is full. Facilities are provided for removing each of the full reels from the takeup position to a path of travel associated with the full reels and regulating turning of the full reel to insure that essentially all the elongated material is wound on the reel and that there are no loose tails of elongated material extending therefrom.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description when considered in conjunction with the accompanying drawings.

FIG. **1** is a perspective view of an apparatus for taking up strand material embodying certain principles of this invention;

FIG. **2** is a view in elevation of the apparatus of FIG. **1** and taken along the lines **2—2** thereof and showing facilities for the automatic loading and unloading of the takeup positions;

FIG. **3** is an enlarged perspective view of a distributor carriage and traverse mechanism for distributing successive layers of convolutions of the strand material on a reel supported in a takeup position;

FIG. **4** is a view in elevation of the apparatus shown in FIG. **2** and taken along lines **4—4** thereof illustrating certain apparatus for holding one of the reels in one of the takeup positions together with facilities for loading empty reels thereonto and for unloading full reels therefrom;

FIG. **5** is a view of a snagger and reel drive facilities associated with one of the takeup positions and showing a deflector arm for use during cutover from a full reel to an empty reel;

FIG. **6** is an enlarged view in elevation of the snagger shown in FIG. **5** and taken along lines **6—6** thereof;

FIG. **7** is an enlarged view of a portion of the snagger shown in FIG. **5** taken along lines **7—7** thereof;

FIG. **8** is a perspective view of a prior art shroud used in a takeup apparatus;

FIG. **9** is an enlarged front elevational view showing an improved shroud design for each of the takeup positions;

FIG. **10** is an enlarged side elevational view of the shroud in FIG. **9** taken along lines **10—10** and showing the shroud relative to the reel takeup position;

FIG. **11** is an enlarged perspective view of portions of the conveying facilities shown in FIG. **1** and illustrating a device for indexing the conveyor to advance successive ones of the reels;

FIG. **12** is an enlarged elevational view of a portion of the conveying facilities shown in FIG. **11** associated with each one of the takeup positions;

FIG. **13** is an enlarged end view of the conveyor shown in FIG. **11** and taken along lines **13—13** thereof;

FIG. **14** is an enlarged end view of the conveyor shown in FIG. **11** along lines **14—14** and showing facilities for turning the full reel;

FIGS. **15, 16** and **16A** are elevational views of alternate embodiments of apparatus embodying the principles of this invention;

FIGS. **17A, 17B** and **17C** are schematic views of an electrical circuit for controlling the operation of the apparatus shown in FIG. **1**; and

FIGS. **18** and **19** are graphical views of a table indicating a sequence of operations of the circuit shown in FIGS. **17A, 17B** and **17C**.

DETAILED DESCRIPTION

General Overall

Referring now to FIG. **1**, there is shown an apparatus, designated generally by the numeral **20**, for taking up a strand material **21**. Strand material **21** is advanced into a takeup mechanism, designated generally by the numeral **22**, which includes an accumulator, designated generally by the numeral **23**, and then past a distributor, designated generally by the numeral **24**, which distributes the strand material in convolutions on a reel **26** supported in either of two takeup positions, designated A and B. The distribution is conducted cyclically, first on a reel **26** in one of the takeup positions and then on a reel in the other takeup position. A takeup position is to be construed as the position of the reel supported for rotation and for the distribution of strand material thereon. A plurality of empty reels **26—26** are advanced along an associated one of a pair of identical conveyors, each designated generally by the numeral **27**. Successive leading ones of the reels **26—26** are moved by load-unload facilities, designated generally by the numeral **28**, from the conveyors **27—27** into an associated one of the takeup positions A or B.

After the reel **26** currently having the convolutions of the strand material **21** wound thereon is full, and after cutover has been effected to the empty reel in the other one of the takeup positions, the associated load-unload facilities **28** are controlled to move the full reel onto the associated conveyor **27**. Then the conveyor **27** is indexed to advance the next successive leading empty reel **26** into lateral alignment with the takeup positions. The associated load-unload facilities **28** are controlled to move the now aligned next successive leading one of the empty reels **26—26** from the conveyor **27** and into the associated takeup position A or B.

Subsequent to the accumulation of a predetermined number of full reels **26—26** of the strand material **21** downstream of the takeup mechanism **22**, an operator moves a dolly, designated generally by the numeral **29**, between the conveyors **27—27**. The full reels **26—26** are rolled from the conveyors **27—27** onto a pallet **30** supported on the dolly **29** and the dolly is then moved to other phases of the manufacturing operation.

Takeup Mechanism

Referring now to FIGS. **1** and **2**, there is shown the takeup mechanism **22** which includes the two reel takeup positions designated A and B having spaced parallel axes of rotation. The strand material **21** is advanced over a sheave **31** and into engagement with the accumulator **23** positioned within an enclosure **32** supported on a frame **33**. Of course, the enclosure **32** is provided with appropriate access windows and doors (not shown) which are used for observation and maintenance purposes, respectively. The strand material **21** is passed alternately around ones of a plurality of sheaves **34—34** which are mounted rotatably on a spindle **36** fixed with respect to the frame and around ones of a plurality of sheaves **37—37** which are mounted on a shaft **38** extending from a support block **39** that is mounted slidably on a pair of spaced rods **41—41**.

The accumulator **23** also includes a cylinder **42** having a piston rod **43** extending therefrom between the rods **41—41** and connected to the support block **39**. The cylinder **42** extends or retracts the piston rod **43** to move the support block **39** slidably along the rods **41—41** to maintain a predetermined tension in the loops of the strand material **21**. After the strand material **21** has been passed alternately between the sheaves **34—34** and the sheaves **37—37** of the accumulator **23**, the strand material is passed over a sheave **44**, then around a sheave **46**, both of which are mounted on a block **47** attached to the frame **33**, and then into engagement with the distributor **24**.

As can best be seen in FIGS. **1, 2** and **3**, the distributor **24** includes a carriage **50** which may be moved adjacent either of the takeup positions. The carriage **50** is comprised of a distributor head **51** having a pair of spaced distributor rollers **52—52** mounted freely rotatably between two side plates **53—53** and on associated ones of a pair of parallel guide rods **54—54** which extend through the side plates. The guide rods **54—54** are supported at the ends thereof in a block **55** and a block **56** which are mounted on a guide rail **57** and a lead screw **58**, respectively. The guide rail **57** and the lead screw **58** are mounted to the frame **33** such that the guide rail and the lead screw are parallel and support the blocks **55** and **56** adjacent the outwardly facing surfaces of the flanges of the reel **26**.

Moreover, the lead screw **58** is connected to a pulley **59** around which is passed a timing belt **61**. As the timing belt **61** is advanced in a first direction, the lead screw **58** is turned to move the block **56** and hence the carriage **50** in a first direction transverse of the axes of rotation of the reels in the takeup positions. On the other hand, when the timing belt **61** is advanced in an opposite direction, the lead screw **58** is turned rotatably in an opposite direction to move the carriage **50** in a second direction, opposite to the first direction.

In order to distribute the strand material **21** on the reel **26**, the head **51** is mounted for transverse movement between the blocks **55** and **56** and parallel to the axes of rotation of the reels **26—26**. A stepping motor **62** is mounted external to the block **55** and is connected through a rack **63** and pinion gear (not shown) to a rod **64** attached to one of the side plates **53—53**. The stepping motor **62** is controlled to cyclically reverse the movement of the distributor head **51** along the rods **54—54**. Of course, a conventionally used hydraulic cylinder (not shown) may replace the stepping motor with the movement of the head **51** being controlled by limit switches (not shown) set at the limits of head travel in each direction.

In the past, it has been somewhat conventional to have the distributor **24** assume a position along the lead screw **58** during takeup which is intermediate the reels **26—26** in the takeup positions A and B. The distributor **24** of the apparatus **20**, embodying the principles of the invention, assumes alternately either of two positions, each of the positions being associated with one of the takeup positions A or B. The distributing position associated with each one of the reel takeup positions A and B is located intermediate the centerline between the two reel positions and the one reel position. The carriage **50**, as seen in FIG. **2**, is in a distribution position for the takeup position A. In this way, the carriage **50** is desirably during distribution as close as possible to the layers of convolutions of the strand material **21**.

As can best be seen in FIGS. **4** and **5**, the takeup mechanism **22** includes facilities **80** for supporting one of the reels **26—26** in each one of the takeup positions A or B. Each of the facilities **80** associated with one of the takeup positions A and B includes a first spring-loaded cone **81** which is adapted to be received in one of the hub openings of one of the reels **26—26** and a second cone **82** adapted to be received in the other one of the hub openings. A reel clamping cylinder **83** is controlled to move the second cone **82** into the hub opening of the reel **26** to move the reel into seating engagement with the first cone **81**.

As can best be seen in FIG. **4**, the first cone **81** is connected to one end of a spindle **84** having an enlarged end **87** and which is slidably mounted in a housing **86**. A compression spring **88** concentrically disposed about the spindle **84** between and engaging a shoulder **89** biases the spindle to the right as viewed in FIG. **4**.

The spindle **84** functions as an eject mechanism for the reel **26**. To accomplish this, a push-off cylinder **91** attached to a stanchion **92** supported on the frame **33** has a piston rod **93** extending therefrom and aligned with the axis of the spindle **84** (see FIG. **4**). The piston rod **93** has a contacting element **94** attached to the end thereof for engaging the enlarged end **87** and transmitting forces from the cylinder **91** to the spindle **84** to move the cone **81** to the left as viewed in FIG. **4**. When the push-off cylinder **91** is controlled to retract the pis-

ton rod **93** and disengage the contacting element **94** from the enlarged end **87**, the compression spring **88** urges the spindle **84** to the right as viewed in FIG. **4**, to reposition the cone **81** in a reel support position.

A reel **26** supported in one of the takeup positions A or B is turned rotatably about the axis of rotation by a frictional drive which includes a pad **96** (see FIG. **5**) of material, e.g., rubber cork material, having a high coefficient of friction. The pad **96** engages with the radial surfaces of the reel flange adjacent the support cone **81** when the reel is supported on the support cones. The pad **96** is mounted on a plate **97** attached to a shaft **98** (see FIG. **4**) disposed concentrically about the spindle **84** and extending through the housing **86**. The shaft **98** has a pulley **99** attached thereto and over which is passed a belt **101** for turning the pulley.

The second cone **82** is mounted for movement colinearly along the axes of the spindle **84** and the piston rod **93**. The cone **82** is attached to one end of a rod **102** extending through a housing **103** and connected to a piston rod (not shown) of the reel clamping cylinder **83**.

Facilities are also provided for effecting a cutover of the strand material between takeup positions. As is best shown in FIGS. **2**, **4** and **5**, a deflector arm **106** positioned intermediate the takeup positions A and B is mounted for pivotal movement in a plane parallel to the axes of rotation in the takeup positions A and B. The deflector arm **106** is attached to a clevis **105** which is pinned to a bearing **107**. The deflector arm **106** is moved by a cylinder **108** pin-connected to the frame **33** with a piston rod **111** extending from the cylinder and connected to the clevis **105**.

The cutover facilities associated with each of the takeup positions A and B includes snagging facilities, designated generally by the numeral **116** and best shown in FIGS. **5**, **6** and **7**. The snagging facilities **116** includes an annular member **117** mounted on the plate **97** and including diametrically opposed snaggers, each designated generally by the numerals **118—118**.

Each of the snaggers **118—118** includes a tooth **119** projecting outwardly from the annular member **117**. The tooth **119** is designed to form an opening **121** between the tooth and an enlarged end **122** of a lever **123** mounted pivotally about a fulcrum **124**. The other end of the lever **123** includes a housing **126** adapted to receive a compression spring **127** which is in engagement with the annular member **117**. The spring **127** tends to bias the lever **123** in a counterclockwise direction as viewed in FIG. **6**.

The compression spring **127** is selected so that when an empty reel **26** is positioned in the takeup position, the reel flange engages the housing **126** (see FIG. **6**), overcomes the spring and urges the lever **123** in a clockwise direction to form a captive slot between the tooth **119** and the enlarged end **122**. At cutover, a portion of the strand material **21** is gripped therebetween so that takeup may proceed.

The snagging facilities **116** associated with each of the takeup positions A and B positively mechanically releases the end portion of the strand material therefrom at the conclusion of the rotation of the takeup reel. The operation of the eject facilities to move the reel **26** through the distance *d* shown in FIG. **4** causes the reel flange to become disengaged from the housing **126** (see FIG. **6**). This permits the spring **126** to urge the lever **123** in a counterclockwise direction, as viewed in FIG. **6**, and enlarge the opening between the tooth **119** and the enlarged end **122** of the lever. This causes the strand material **21** to be positively released.

Still further improvements have been made to the cutover facilities for transferring the takeup of the strand material from say position A to position B. Customarily, during cutover in a takeup arrangement such as this, the distributor **24**, assuming the takeup of strand material is nearly complete on a reel **26** in the takeup position A, is moved transverse of the axis of rotation through the position B and to the external side thereof. Subsequently, the deflector arm **106** is moved to engage the strand material and move the strand material toward that portion of the empty reel adjacent the snagging facilities **116**.

Just prior thereto, a slidably mounted shroud **140** (see FIG. **8**) aligned concentrically with the snagger plate **97** is moved to cover the snagger plate as well as the reel flange engaged by the snagger pad **96**. This arrangement is necessary in order to prevent the snagging facilities **116** associated with the full reel from engaging the strand material **21** at cutover. The rotation of the full reel **26** of strand material **21** in one direction, clockwise, and the rotation of the empty reel **26** in an opposite counterclockwise direction, causes the strand material to be broken and the new leading end to be snagged by the facilities **118** associated with the empty reel.

The trailing, newly established free end of the strand material **21** on the full reel **26** may, if not properly contained, be whipped around the reel **26** prior to deceleration and ultimate stopping of the reel, thereby engaging other parts of the apparatus and causing damage to the free end. Also, the free end whips into engagement with the topmost layer of convolutions and causes damage to the insulation thereof. Additionally, the free, whipping end of the strand material **21** may interfere with the functioning of the distributor **24**.

Priorly used equipment has not been entirely satisfactory in containing the loose end of the strand material on the full reel to remain within the shroud **140** and be dragged harmlessly therearound during deceleration. There is illustrated in FIG. **8** a typical prior art shroud. The shroud **140** there has a flared out portion which begins at approximately three o'clock when facing the shroud as viewed in FIG. **8**. The shroud **140** decreases gradually in width as measured parallel to the reel axis of rotation and beginning at approximately nine o'clock assumes a generally constant width. At cutover, the loose end of the strand material **21** is first engaged by the entrance portion at the three o'clock point. Since the strand material **21** is severed generally in the vicinity of the deflector arm **106**, the loose end must whip around the reel for approximately one-half revolution before engaging the shroud **140**. This causes damage to the loose end and, moreover, decreases the probability that the loose end will be captured within the shroud **140**. This is especially true if the cutover occurs, other occurs adjacent the inner reel flange.

An improved shroud **141** (see FIGS. **5** and **9**) includes a reduced width portion **146** with a lead-in or guide section **147** at approximately eight o'clock when viewing the shroud as shown in FIG. **9**. The width of the top portion of the shroud **141** as viewed in FIG. **9** and **10** and beginning at approximately 9 o'clock assumes a generally constant width. In this way, when the strand material **21** is broken, the loose end is engaged by the shroud **141** almost contemporaneously with the break-

ing. As before, and as is shown in FIG. **10**, the shroud **141** is mounted on a plate **148** connected to a pair of slidably mounted support rods **149—149**. The shroud **141** is moved into an extended position covering the reel **26** by actuating an air cylinder **142** to extend a piston rod **145** connected to the plate **148**. After cutover, the operation of the air cylinder **142** is reversed to retract the shroud **141**.

It should also be pointed out that further modifications of the shroud **141** may be made within the scope of this invention. The shroud **141** (see FIG. **10**) may be mounted on either the spindle side of each takeup position or on the clamping cone **82** side. Because of space limitations, a shroud mounted on the cone **81** or spindle side is not sufficiently large to cover the full reel completely. These space limitations are not present on the cone **82** side. Hence, the shroud **141** shown in FIG. **10** could be mounted on the cone **82** side and be large enough to cover substantially the entire width of the reel when moved thereover by the cylinder **142**.

Handling Facilities

In order to automate the handling of reels **26—26**, the apparatus **20** is provided with the conveyors **27—27** and the load-unload facility **28** associated with each one of the take-up positions.

Each one of the conveyors **27—27** includes an elongated track **151** (see FIG. **1**) and is designed to move the reels **26—26** along a path parallel to the axes of rotation of the takeup positions. The track **151** (see FIG. **11**) includes two plates **152—152** upstanding from a base **153**. A top edge surface **154** of each of the plates is beveled to support the reels **26—26** straddled thereacross (see FIG. **13**).

Facilities are provided for indexing the reels **26—26** along the track **151**. A longitudinally extending rod **156** having a plurality of pins **157—157** projecting laterally therefrom (see FIG. **11**) is supported rotatably in bearings **158—158** extending between the plates **152—152**.

The conveyor **27** is designed so that reels **26—26** span across the plates **152—152** such that the lowermost portions of the flanges are spaced slightly above the rod **156** (see FIG. **13**) but below the tops of the pins **157—157**. Moreover, the pins **157—157** are spaced along the rod **156** such that one of the reels **26—26** may be received between each adjacent pair of the pins (see FIG. **12**).

One end **155** of the rod **156** is mounted in a bushing **159** attached through a plate **161** to a piston extension **162** connected to an air cylinder **163**. It should be observed that the end **155** of the rod **156** is held within the bushing **159** such that the rod may be moved rotatably within or with respect to the bushing but may not be moved longitudinally with respect thereto.

The other end **164** of the rod **156** has a sleeve **166** attached thereto (see FIG. **11**) with the sleeve attached through a linkage **167** to a piston rod **168** of a pivotally mounted cylinder **169**. Upon actuation of the cylinder **169**, the piston rod **168** is withdrawn within the cylinder to turn the sleeve **166** to turn the rod **156** and rotate the pins **157—157** to the position as shown in phantom in FIG. **13**.

Additionally, and as can best be seen in FIGS. **11** and **14**, the conveyor **27** includes a pair of spaced rollers **171** and **172**. The rollers **171** and **172** are mounted rotatably in the reel transfer position associated with each of the takeup positions A and B. Each of the rollers **171** and **172** is connected through belts **173** and **174**, respectively, (see FIG. **14**) to a shaft **176** which is driven through a gear arrangement (not shown) by a motor **177**.

It should also be observed that when the reel **26** is supported between the rollers **171** and **172** that each of the flanges of the reels is supported along a line which is coplanar with one of the beveled surfaces **154—154** on the upstanding plates **152—152** which form the track **151** of the conveyor **27**.

It should be noted that the conveyor **27** as depicted in FIG. **11** is associated with the takeup position B. The orientation must be such that the rollers **171** and **172** be adjacent the takeup position with bearings **175—175** therefor being disposed on opposite sides thereof (see FIG. **14**). This will facilitate ones of reels **26—26** being moved from the track **151** into engagement with the remainder of the load-unload facilitates.

The takeup apparatus **20** also includes load-unload facilitates for transferring successive leading ones of the empty reels **26—26** from the conveyor **27** to the associated takeup position and full reels from the takeup position to the associated one of the conveyors **27—27**. The load-unload facilities **28** (see FIGS. **1, 2, 4** and **11**) include a pivotally mounted arm **181** which cooperates with a loading ramp **182** associated with each of the takeup positions.

The loading arm **181** is mounted pivotally on a shaft **183** of a rotary motor (not shown). The loading arm **181** associated with the other one of the takeup positions is mounted to be turned pivotally in an opposite direction. The motor (not shown) is controlled by an electrical control circuit **200** to move the arm in a clockwise or counterclockwise direction through an opening **186** (see FIG. **1**) in the enclosure **32**. The arm **181** is moveable between two limiting positions as determined by counting pulses if, for example, the motor is a stepper motor (see motors 3M and 4M, FIG. 17C).

The width of the arm **181** is sufficient to span across the reel flanges to move the reels up and down the associated one of the ramps **182—182**. Moreover, the arm **181** is constructed to include a flange **192** (see FIGS. **1** and **14**) along that edge of the arm which is on side of the arm opposite that side adjacent the associated support cone **81**. The flange **192** acts as a guide as the arm is controlled to move the reel **26** along the ramp **182**.

The flange **192** serves the dual function of being a stop to limit the movement of the reel **26** to the left, as viewed in FIG. **4**, by the eject facilities. The other side of the arm **181** must be unobstructed to permit the eject facilities to move the reel **26** off the cone **81** transversely of and into alignment with the arm. This also permits sliding off one of the empty reels **26—26** from the arm **181** into clamping position between the cones **81** and **82**.

The ramp **182** comprises a channel track of a width sufficient to accommodate the outside flange-to-flange dimensions of the reels **26—26**. The ramp **182** associated with each of the reel positions defines an arcuate path from a position adjacent to and aligned with the rollers **171** and **172** upwardly to a position below the associated takeup positions A and B. Moreover, the lower portion of each of the ramps **182—182** is at the same level as the topmost portion of the path of travel of the rollers **171** and **172**.

The length and arcuate shape of the arm **181** and the ramp **182** are designed so that one of the reels **26—26** is moved by the arm **181** up the ramp until the reel axis is aligned colinearly with the axis of rotation of the takeup position. At that time, the reel **26** is aligned axially such that the reel is spaced slightly, e.g., one-quarter inch from the closest portion of the driving side cone **81.** The reel **26** must be moved approximately 1 inch from the ramp **182** into a clamped position between the cones **81** and **82** with the cones extending into the hub opening.

Some commercial takeup apparatus permit empty reels to roll into alignment with the takeup positions and full reels to roll out therefrom. This has led to the undesirable unraveling of the strand material **21.**

The apparatus **20** is designed to minimize the rolling of the reels **26—26.** It is important that the reel **26** not be rolled along the ramp **182** but merely be guided thereby and moved by the arm **181.** This does not become an important consideration in the upper reaches of the ramp **182** since the arm **181** approaches a generally horizontal position and the reel **26** is supported solely by the arm **181.**

On the other hand, as a full reel of strand material approaches the lower, generally horizontal, end of the ramp **182,** there has been a tendency for the reels to roll a slight distance, thereupon unraveling a short length of the strand material **21.** In order to overcome this, the lower portion of the ramp **182** may be covered with a material such as TEFLON which has a low coefficient of friction. This insures that the reel **26** slides without substantial turning thereof about the hub axis, thereby avoiding undesirable rolling.

These provisions for insuring that each final package of strand material **21** does not have loose ends extending therefrom are supplemented by the rollers **171** and **172.** Should there be a slight turning of the full reel **26** or should a loose tail be held at some point in the takeup position, e.g., a malfunctioning snagger release, the turning of the rollers causes the reel to wind up any loose strand material **21.**

Portions of the strand material **21** adjacent the free trailing end tend to become unwound from the reel **26,** especially with particular insulation materials. If the conductor is covered with tougher stiffer materials such as polypropylene, the final layer of convolutions tend to become loose or unraveled after takeup. This is generally not true with the more flexible insulative materials.

Alternate Embodiments

The principles of this invention may also be used in a common axis takeup. An input conveyor for moving empty reels may be positioned on one side of the takeup positions parallel to the axis of rotation and with a full reel conveyor positioned on the other side of the takeup positions. Four arms **181—181** could be used, two being on each side of the takeup positions. One of the arms may be used to load empty ones of the reels into one of the takeup positions along an associated ramp while a second arm associated with the one takeup position may be used to remove full reels of the strand material **21** to the full reel conveyor.

Also, it is within the scope of the invention to use a parallel-spaced axes of rotation arrangement as described in the preferred embodiment of the invention with a single conveyor positioned intermediate the takeup position and with a single arm having forked portions extending in opposite directions to alternately move reels to and from selected ones of the two takeup positions.

The conveyor **27** could be modified as shown in FIG. **15.** There the rollers **171** and **172** are mounted for reciprocal movement. As is shown in the left portion of that figure, after the full reel is returned to the conveyor **27** associated with the takeup position A, the rollers **171** and **172** are moved upwardly to disengage the reel **26** from the plates **152—152** and then turn the reel. This permits the use of an unbroken track **151.**

Another embodiment of a takeup apparatus embodying the principles of this invention is shown in FIG. **16.** There, the conveyors **27—27** are located vertically below each of the takeup positions. Elevator arrangements employing nonrotating cylinder rods move the empty reels **26—26** to the takeup positions and return full reels to the conveyors without rotation. This embodiment also, desirably, includes the rollers **171** and **172** to wind up any loose ends of strand material **21** extending from the reels **26—26** because of, for example, a malfunctioning snagger release.

Of course, the rollers **171** and **172** could be modified as shown in FIG. **16A.** The rollers there are generally cylindrical with tapered ends. The topmost portion of each tapered end is slightly above the top of the associated side plate **152.** The indexing of the reels **26—26** causes a reel to be moved up along the tapered ends and onto the enlarged center portions for turning. In this embodiment, the rollers need not be interposed between sections of the track, but could be positioned adjacent thereto as shown in FIG. **15.** The use of tapered ends avoids having to raise the rollers to turn the reel **26.** Since the reel **26** indexed onto the enlarged portions is raised above the beveled tops **154—154** of the plates **152—152,** turning of the reel supported on the rollers may be accomplished.

Operation

In carrying out the principles of the methods of this invention, an operator periodically loads empty ones of the reels **26—26** at the upstream end of each of the conveyors **27—27** associated with each of the takeup positions A and B. Also, the operator moves one of the reel dollies **29—29** into a receiving position intermediate the downstream ends of the conveyors **27—27** as shown in FIG. **1.**

Referring now to FIGS. **17A—17C,** there is shown in schematic an electrical circuit, designated generally by the numeral **200,** for controlling the operation of the takeup apparatus **20.** It is assumed hereinafter that the operation will begin with the left side of the apparatus **20.** In order to initiate the operation of the apparatus **20,** the operator depresses a pushbutton **201** on the overall line control which causes a line run relay **202** (see FIG. **18**) and a controlled stop relay **203** connected across a main power supply to be energized. The energization of the relay **203** closes a normally open contact **203-1** (FIG. 17A) in a line between main branch lines **204, 205** and **206,** closes a normally open contact **203-2** (FIG. 17B) and opens normally closed contacts **203-3** (FIG. 17B) and **203-4** (FIG. 17A).

The circuit also includes relays **305, 306** and **311** which are sensing relays and which function to indicate in which takeup position the strand material **21** is being wound. A limit switch 1LS is a memory limit switch. If the carriage **50** is in position over the right reel or B

takeup position, then the limit switch 1LSA is closed and the relay **306** energized through a circuit completed from the line **206** through a closed contact **218-1** of a cutover lockout relay **218** external to the circuit **200** and shown in FIG. **18**, and normally closed contacts **305-3** and **330-5** to the line **204.** On the other hand, when the carriage **50** is on the left side, a limit switch 1LSB is closed to complete a circuit from the line **206** through normally closed contacts **218-2** and **306-1** to energize the relay **305.** The relay **311** is also energized when the carriage **50** is in position with respect to the left reel **26.** This occurs as the relay **305** is energized and closes a contact **305-1** to complete a circuit from line **206** through normally closed contact **218-3** and now closed contact **305-1** to the line **204.**

A normally open contact **210-1** (FIG. 17A) of a relay **210** (see FIG. **18**) is closed with the initiation of the operation and remains closed until the line is running above an approximate line speed of 100 feet per minute. At that time, the relay **210** becomes deenergized, thereby causing the contact **210-1** to open. The energizing of the relay **210** completes a circuit through a left reel transfer clear relay **315** to energize the relay. This opens normally closed contact **315-1** to lock out a relay **302,** closes contact **315-2** to lock in the relay **315** and opens contact **315-3** to lock out a right reel transfer clear relay **316** (see FIG. 17A). This sets up the right reel or B position in a transfer clear condition.

The relay **203** is a line run relay which is energized until zero speed or until an emergency pushbutton is operated. In the event that the relay **203** is deenergized, the relay **202** becomes deenergized and drops out of the circuit **200.**

A relay **211,** external to the circuit **200** and shown in FIG. **18,** is timer-actuated relative to the time that it takes in order for the apparatus **20** to achieve running line speed. When the apparatus **20** has reached running speed, the relay **211** is energized, thereby causing normally open contact **211-1** (see FIG. 17A) to close and enable a first transfer and ready reel-for-cutover portion of the circuit. If an automatic transfer select switch is closed, the closing of the contact **211-1** completes a circuit from the line **206** through a closed contact **218-4** and then through a relay **212** to the line **204** to energize the relay and set up a delayed closing of contact **212-1** to energize a cutover relay **304** (see FIG. 17A).

The energization of the left sensing relays **305** and **311** (see FIG. 17A) causes a contact **311-1** to be closed to complete a circuit through normally closed contact **302-2,** through the now closed contact **311-1** to a line **213** through a normally closed contact **316-1** and a relay **301** (see FIG. 17A) to energize the relay. The energization of the relay **301** closes a contact **301-1** and opens normally closed contacts **301-2, 301-3** and **301-4.**

The closing of the contact **211-1** also completes a circuit from a junction point **214** through a relay **312** (see FIG. 17A) to energize the relay. This closes contacts **312-1, 312-2, 312-3** and **312-4** in readiness for the first transfer.

The energization of the relays **311** and **312** and the closing of the contacts **311-1** and **312-1** completes a circuit from the line **206** through the right reel run relay **302** (see FIG. 17A) to energize the relay. The energization of the relay **302** closes a contact **302-1** and opens contacts **302-2, 302-3** and **302-4.** The opening of the contact **302-4** (see FIG. 17B) disables a right reel loading-unclamping solenoid 5SOL.

The energization of contact **312-2** completes a circuit through a ready reel relay **303** (see FIG. 17A) to energize the relay. The relay **303** closes contacts **303-1,** 303-2, 303-3, 303-4 and **303-5** and opens normally closed contact **303-6.** The relay **303** is a ready-reel-for-cutover relay to enable the carriage **50** to move over to a transfer position to the right of the position B as viewed in FIG. **2.** When this occurs, the apparatus **20** has the intelligence to begin the operation of the reel **26** in the other one of the takeup positions so that it will be in a speed match mode and ready for cutover. The ready reel cutover relay controls the reel in position B to go to the speed match mode while the left reel in position A is being filled. when the relay **303** is energized, the right reel begins to be turned rotatably in order to be prepared for a cutover operation.

The carriage motor logic is embodied in a relay **324** and a relay **325** (see FIG. 17B). The relay **324** is referred to as the right transfer position relay for causing the apparatus **20** to move the carriage **50** to a transfer position to the right, as viewed in FIG. **2,** of the reel in the transfer position B. The relay **325** causes the carriage **50** to be moved to the left as viewed in FIG. **2,** to the transfer position associated with the takeup position "A." As can be seen from the timing table in FIGS. **18** and **19,** these two relays are energized simultaneously.

The designations 1MF and 1MR (see FIG. 17B) refer to a carriage motor starter which controls the portion of the apparatus **20** to which the carriage **50** is moved. For example, the MF designation refers to the carriage going left as viewed in FIG. **2,** whereas the MR refers to a direction to go right. On the other hand, the limit switch 1LS indicates the side on which the carriage **50** is located. Upon depressing the ready reel pushbutton, the relay **325** is energized and causes the carriage **50** to go left.

It is assumed that there is an empty one of the reels **26–26** in the takeup position B supported by the cones **81** and **82.** The energization of the relays **303** or **312** and closing of the associated contacts **303-4, 303-5,** 312-3, and **312-4,** respectively, completes a circuit from the line **206** through a normally closed contact **327-1** (see FIG. 17B) and limit switches 9LS and 8LS through the relays **325** and **324,** respectively, to energize those relays.

The energization of the relay **325** closes contacts **325-1, 325-2** and **325-3.** The energization of the relay **324** closes contacts **324-1, 324-2** and **324-3.** This completes a circuit through the contacts **203-3** through a limit switch 1LSD (see FIG. 17B), through now closed contact **324-1,** through a normally closed contact 1MF-1 and through the motor starter 1MR to the line **204** to energize the motor 1MR. This causes the carriage **50** to be moved to the transfer position associated with the takeup position B (see FIG. **2**).

Referring now to FIGS. 17A and B and FIG. **18,** it can be seen that a doff relay **337** is normally energized. The doff relay **337** controls pulse generators (not shown) which are connected to drive motors (see FIG. **4**) for the reels in the takeup positions. The doff system coordinates the distribution of the strand material **21** across the reel **26.**

As the carriage **50** is moved to the right transfer position, a limit switch 9LS (see FIG. 17B) remains closed,

whereas a limit switch 8LS is engaged and operated, thereby causing the relay 324 (see FIG. 17B) to become deenergized. The deenergization of the relay 324 opens the contacts 324-1, 324-2 and 324-3, thereby interrupting the circuit through the motor 1MR (see FIG. 17B) to deactivate the movement of the carriage 50.

Since the limit switch 9LS (see FIG. 17B) remains closed, the circuit through the relay 325 remains closed. When a cutover is being made from a reel 26 in takeup position A to a reel in the takeup position B, the relay 325 will be reset at cutover whereas the relay 324 drops out when the carriage arrives at the right transfer position. It should also be observed from FIG. 18 that the doff relay 337 is deenergized for a brief time period after the carriage 50 has been moved into the transfer position.

The relay 304 (see FIG. 17A and table in FIG. 18) is a change reel or cutover relay for causing the deflector 106 to be moved pivotally upward to deflect the strand material 21 and cause the strand material to be snagged by the snagger 118. This, in effect, completes the cutover operation of the strand material from the reel in position A to the reel in takeup position B.

The relay 304 is a momentary contact closure relay for effecting cutover from one of the reel positions to the other. An expanded timing table relating to the relay 304 is shown in FIG. 19 and is required because of the extremely small time period during which the relay 304 is energized.

After the cutover has been effected, it is required that the relay 304 be deenergized. Referring now to FIG. 17A, it can be seen that the relay 304 is connected from the line 206 through the normally open, now closed, contact 211-1, through a pair of normally closed contacts 309-1 and 310-1, through the normally open contact 212-1 to a junction point 216 and then through the relay to the line 204.

Once the line is at desired line speed, the relay 211 is energized, thereby closing the contact 211-1. The contact 211-1 remains closed until the line is shut down. After the time delay relay 212 has been energized, a preset time elapses. Then the contact 212-1 is closed to complete the circuit through the relay 304 to energize the relay.

The energization of the relay 304 closes a contact 304-2 (see FIG. 17B) to complete a circuit through a normally closed contact 217-1 and energize a relay 327. The relay 327 is timed to remain energized for a preset time, e.g., 5 seconds, in the preferred embodiment. The energization of the relay 327 closes contacts 327-2, 327-3, 327-4 and 327-5 and opens contacts 327-6, 327-7, 327-1 and 327-8. The opening of the contacts 327-6, 327-7 and 327-1 (see FIG. 17B) interrupts subcircuits through the motor starters 1MR and 1MF and interrupts the circuit through the relay 325 to deenergize that relay and lock out the motor starter 1MF.

The energization of the relay 304 closes contact 304-3 (see FIG. 17B) to complete a circuit through the relay 326 to energize the relay. This causes contacts 326-1, 326-2 and 326-3 to close. The closing of the contact 326-1 locks in the relay 326 until the movement of the carriage 50 to the left operates limit switch 10LS or 11LS (see FIG. 17B). The operation of one of these switches opens the circuit through 326 to cause the relay 326 to drop out. The relay 326 and the limit switches 10LS or 11LS have the intelligence to indicate to the carriage 50 to stop in a normal distribution position. The energization of the relay 326 and the closing of the contacts 326-2 and 326-3 (see FIG. 17B) conditions the subcircuits through the motor starters 1MR and 1MF.

If the operation is started as assumed on the left or A position side of the takeup, the relay 306 (see FIG. 17A) is deenergized and the normally closed contact 306-1 is closed. When the carriage 50 is moved to the right transfer position, the limit switch 1LSA is closed to complete a circuit through the relay 306 to energize the relay. This opens contacts 306-2 and 306-1 (see FIG. 17A) to interrupt the circuit through the relay 305 to deenergize that relay. When the carriage 50 is in the left takeup position, the relay 311 (see FIG. 17A) is energized and contact 311-2 closed. Then, when the relay 327 (see FIG. 17B) is energized, the contact 327-9 (see FIG. 17A) is closed to complete a circuit through the relay 310 to energize the relay. This occurs at transfer. The contact 310-2 (see FIG. 17A) is closed to energize the relay 307 which opens contact 307-1 (see FIG. 17A) and deenergizes the relay 311 (see FIG. 17A).

At the first cutover, the cutover lockout relay 218 is energized and remains so until the line goes down. This opens contact 218-4 (see FIG. 17A) to deenergize the time delay relay 212 (see FIG. 17A) and opens the contact 218-2 to lock out the relay 305. Also, the contact 218-3 is opened to lock out the companion relay 311. The contact 218-1 is also opened, but the relay 306 is held in by the closing of the momentarily closed contact 304-4 and the contact 330-5. A contact 218-5 (see FIG. 17C) is closed for the remainder of the operation (see FIG. 18) to condition a circuit through a relay 321. The relay 321 when energized is effective to cause one of the arms 181—181 to be moved.

After cutover, the relay 304 must be deenergized to indicate that a transfer clear condition is present so that the carriage 50 may be moved to the transfer position for the other one of the takeup positions. At the time the relay 304 is energized, the relay 327 (see FIG. 17B) is also energized. The energization of the relay 327 closes normally open contact 327-9 (see FIG. 17A) to complete a circuit through the relay 309. This causes a contact 309-1 normally closed to open to interrupt the circuit through and deenergize the relay 304. The relay 311 is deenergized during the time the relay 304 is energized, thereby closing a contact 311-3. The relay 309 is also locked in by now closed contact 309-2. The opening of the contact 309-1 also interrupts the circuit through the relay 303, thereby deenergizing that relay.

The relay 307 and 308, 309 and 310, and 315 and 316 are companion relays. For example, the relays 310 and 316 are energized together, as is 307, in order to transfer left (takeup position A) to right (transfer position B). On the other hand, the relays 308, 309 and 315 are operated together in order to transfer right to left.

The opening of contact 218-4 (see FIG. 17A) of relay 218 deenergizes relay 312. The opening of the relay 303 opens contacts 303-1, 303-2, 303-3, 303-4 and 303-5 and closes contacts 303-6. The deenergization of the relays 303, 304 and 311 eliminates any possible circuit completion through the relay 301, thereby causing the relay 301 to be deenergized.

The relay 326 remains energized until the carriage 50 is moved to a normal distribute position for takeup position B. This is determined when the carriage engages and operates a limit switch 10LS or a limit switch 11LS.

Also, the closing of the contact 327-5 (see FIG. 17C) by the energized relay 327 completes a circuit through a motor 1EA to operate the motor and begins a reel-load cycle and closes a limit switch 1EA-LS1 to lock in the motor 1EA for the duration of the reel-load cycle. The motor shaft is turned to rotate a plurality of cams (not shown) attached to the motor shaft. The cams are positioned to engage sequentially associated limit switches.

After a five second delay, the relay 327 is deenergized. The deenergization of the relay 327 opens contacts 327-2, 327-3, 327-4 and 327-5 and closes normally closed contacts 327-6, 327-7, 327-1 and 327-8. Although the contact 327-5 is opened, the motor 1EA is held locked in by the now closed limit switch 1EA-LS1.

The closing of the contacts 326-2 and 327-6 (see FIG. 17B) causes a circuit to be completed through the starter 1MF. This causes the contact 1MF-1 to be opened to lock out the motor starter 1MR while causing the carriage 50 to be moved to the left, as viewed in FIG. 2, until the carriage engages and operates one of the limit switches 10LS and 11LS.

After the carriage operates one of the limit switches 9LS or 10LS, the circuit through the relay 326 is interrupted to deenergize the relay. This causes the contacts 326-2, 326--3 and 326-1 to be opened. The opening of these contacts deactivates the motor 1MF and the carriage 50 is in a normal distribute position for takeup position B.

The circuit 200 includes a takeup distributor guide drive system shown in FIG. 17A. The turning of the reel in the left (A) or right (B) takeup position causes the generation of pulses which together with appropriate inputs caused by closing of contacts 203-6, 305-2 and 337-2 are received by a logic package. The logic package is connected through a translator to the stepper motor 62 to move the head 51 transversely of the reel 26.

The turning of the shaft of the motor 1EA causes one of the cams thereon to turn and operate a limit switch 1EA-LS2 (see FIG. 18). This completes a circuit through a contact 330-2 (see FIG. 17C) of a pair of manually operated relays 330 and 331 through the relay 321 to energize the relay. The relay 321 closes contacts 321-1 and 321-2 to complete a circuit through now closed contact 306-12 and a stepper motor translator to a motor 3M to operate the motor. Similar provisions (ss motor 4M, FIG. 17C) are included in the circuit 200 for the arm 181 associated with the other takeup position. This causes the A position arm 181 to be moved pivotally upwardly to remove a full reel 26 from that takeup position.

Subsequent rotation of the motor 1EA causes a limit switch 1EA-LS4 (see FIG. 18) to be operated to operate the cylinder 103 to withdraw the cone 82 (see FIG. 4) and unclamp the full reel. Also at that time, the limit switch 1EA-LS7 (see FIGS. 17B and 18) is closed to operate the cylinder 91 to push the cone 81 to eject the reel 26 from the cones. The element 94 engages the end 87 of the spindle 84 to urge the spindle and cone 81 to the left, as viewed in FIG. 4, to move the reel 26 onto the arm 181.

The reel 26 is moved over the unflanged edge of the arm 181 simultaneously with the withdrawal of the cone 82. In this way, the full reel 26 is supported by the cones 81 and 82 as they are moved in unison to move the reel onto the arm 181.

Then the limit switch 1EA-LS7 is deactivated (see FIG. 18) to cause the cylinder 91 to retract the element 94 and permit the cone 82 to be spring-returned to the right as viewed in FIG. 4. At this time, the full reel 26 is supported on the arm 181 and aligned with the ramp 182.

Then the limit switch 1EA-LS2 is operated to return the arm 181 in a clockwise direction as viewed in FIG. 4. The reel 26 is received between the side flanges of and is guided down the ramp and comes to rest straddled across the rollers 171 and 172 in the transfer position. There, the reel 26 is aligned generally, offset slightly, laterally, in the direction of path of travel of the conveyor 27 from the reel takeup position A. This is to allow for the lateral movement of the reel 26 from the cones to accommodate the loading onto the loading arm 181.

The limit switch 1EA-LS9 is timed to be operated after the full reel has been positioned on the rollers 171 and 172 to cause the motor 177 to be operated to rotate the rollers. This causes the reel 26 to be turned to wind up any loose ends of the strand material 21 extending from the full reel. The amount of rotation of the rollers 171 and 172 is preset into the timing sequence of the limit switch 1EA-LS9. This, of course, may be adjusted to meet operating conditions. After the preset time, the limit switch 1EA-LS9 is returned to an operated condition by disengagement of the associated cam on the 1EA motor shaft.

Then the rotation of the motor 1EA causes the index-translate limit switch 1EA-LS5 to be operated. This operates the cylinder 163 to extend the rod 156 longitudinally of the conveyor 27 toward the front or unloading end thereof. This causes the full reel 26 just turned by the rollers 171 and 172 to be advanced by the trailing pin 157 adjacent thereto one position toward the front of the apparatus 20. Also, the next successive leading one of the empty reels is advanced onto the rollers into the transfer position offset slightly laterally of the takeup position B.

Then the limit switch 1EA-LS8 (see FIGS. 17B and 18) is operated to complete a circuit through a solenoid 10SOL to cause the cylinder 169 to be operated to extend the rod 168 to cause the rod 156 to be turned through 90° (see phantom position FIG. 13). The forward mode of the limit switch 1EA-LS5 is deenergized to withdraw the rod 156 a distance equal to the distance between adjacent ones of the reels 26—26. At that time switch 1EA-LS8 is opened to permit the rod 156 to be returned through the ninety degrees so as to position each of the pins 157—157 as shown in FIG. 13 between adjacent ones of the reels 26—26.

Subsequently, the limit switch 1EA-LS3 is operated to again move the arm 181 associated with the takeup position A pivotally in a counterclockwise direction as viewed in FIG. 2 into engagement with the empty reel 26 now in the load-position on the associated rollers 171 and 172 which is offset slightly transversely with the associated reel takeup position A. The arm 181 moves the empty reel 26 up along the ramp 182 until the reel is supported on the arm and aligned colinearly with the axes of the support cones 81 and 82.

The operation of the double-acting reel clamping cylinder 83 is time-controlled by the motor 1EA and the limit switch 1EA-LS4 to initiate operation thereof in a

direction opposite to that used to unload a full reel a predetermined time after the arm **181** begins to be turned in a clockwise direction. The reel clamping cylinder **83** is operated to move the bearing support **103** and the spindle **102** and the cone **82** to the right as viewed in FIG. **4** to move the cone into engagement with the left hand one of the hub openings in the reel **26.** The operation is continued to move the cone **82** a further distance to the right to move the reel **26** laterally off the arm **181** and over the unflanged edge thereof until the other one of the hub openings is moved to the right sufficiently to engage the wall thereof with the other one **81** of the support cones. The lateral movement of the reel **26** from the arm **181** into the takeup position A (or B) and supported rotatably between the cones **81** and **82** is approximately 1 inch. Then the limit switch 1EA-LS3 is deenergized to cause the arm **181** associated with the takeup position A to be moved in a counterclockwise direction, as viewed in FIG. **4,** until the arm is in the normally unoperated position shown in FIG. **2.**

Then the limit switch 1EA-LS6 (see FIG. **18**) is operated by one of the cams on the shaft of the motor 1EA. This signals the end of load cycle and clears the pair of manually operated relays **330** and **331.**

It should be realized that as the winding of the convolutions of the strand material **21** on the reel **26** in the takeup position B begins, the leading one of the empty reels on the conveyor **27** aligned with the takeup position A is moved by the associated load-unload arm **181** into the takeup position A. In this way, when the reel **26** currently being used to take up the strand material **21** in position B is full, cutover may be effected to the empty reel in position A.

The opening of the contact **327-9** (see FIG. 17A) causes the relays **309** and **310** to be deenergized. This causes the normally closed contact **309-1** to be closed. The winding of the convolutions of the strand material **21** on the reel **26** in the right hand takeup position B continues until a footage counter **221** (see FIG. 17A) reaches a so-called "ready footage setting." This causes a circuit to be completed from the line **206** through the now closed contacts **309-1** and **310-1** through the ready footage counter **221** to a junction point **222** along a line **223** and through the relay **303** to the line **204.** This causes the relay **303** to be energized to ready the empty reel **26** now in takeup position A for cutover by accelerating the empty reel to a preset rotational speed. The preset speed will be such that the linear speed of the reel hub surface is equal to or slightly less than the speed at which the strand material **21** is being advanced.

The energization of the relay **303** causes the left reel run relay **301** (see FIG. 17A) to be energized. As described hereinbefore, the energization of the relay **303** causes the closing of the contacts **303-4** and **303-5** to energize the transfer position relays **324** and **325.** By means of the circuitry described herebefore, this causes the carriage-left motor 1MF to be energized to move the carriage **50** to the left transfer position to the left of takeup position A, as viewed in FIG. **2.**

At this time the movement of the carriage **50** engages and operates the limit switch LS9 (see FIG. 17B). The limit switch LS8, it will be recalled, is operatd when the carriage **50** is moved to the right transfer position and is not operated during this transfer operation. This causes the relay **325** to be deenergized with the relay **324** remaining energized. At this time also, the doff relay **337** is deenergized (see FIG. **18**).

A cutover reel counter **226** (see FIG. 17A) counts the footage of the strand material **21** between transfer time until cutover is desired. At that time, the cutover reel counter **226** completes a circuit from the line **206** through now closed contacts **221-1, 309-1** and **310-1** through the relay **304** to energize the relay. The energization of the relay **304** closes the contacts **304-2** and **304-3** to energize the relays **327** and **326,** respectively.

Also at the time, a contact **304-4** is closed to energize the left-sensing relay **305.** The relay **309** is closed by the closing of the contact **327-9,** thereby closing **309-3** to energize a relay **308** (see FIG. 17A). The energizing of the relay **308** completes a circuit through now closed contact **308-1** and normally closed contact **307-1** and the relay **311** to energize the relay.

From the table shown in FIG. **18,** the relay **210** drops out before first cutover. This returns the contact **210-1** to a normally open position, thereby deenergizing the relay **315** and hence maintaining the contact **315-1** in a normally closed position. Then when the contact **327-2** is closed, a circuit is completed through a normally closed contact **316-2** and a normally closed contact **311-4** to energize the relay **315.** This opens the contact **315-1** and deenergizes the relay **302.** Also at that time, the ready reel counter **221** causes the circuit through the relay **303** to be interrupted to deenergize that relay.

The energization of the relay **327** opens the contact **327-1** to cause the relay **324** to become deenergized. Finally, at cutover with the momentary energization of the relay **304,** the contact **304-3** (see FIG. 17B) is closed to energize the relay **326** and close the contact **326-1** thereof to lock in the relay.

The momentary operation of the relay **304** causes the deflector arm **106** (see FIGS. **2, 4,** and **5**) to be moved upwardly as before to engage the strand material **21** and cause the strand material to be moved into engagement with the snagger **118** of the empty reel **26** now on the left hand or takeup position A. The movement of the shroud over the inside flange of the full reel in the position B prevents the strand material **21** from being snagged by the snagger **118** associated with that position.

At this time, the reel in takeup position B is taking up the strand material **21.** At ready reel time, the carriage **50** is transferred to the left transfer position (see FIG. **2**). The left sensing relay **311** (see FIG. 17A), which senses the presence of the carriage **50** in the left or A takeup position, is energized at transfer, thereby closing contact **311-2** and opening contact **311-3.** The closing of the contact **311-2** (see FIG. 17A) completes a circuit through the left reel transfer-clear relay **310** to energize that relay. The energization of the relay **310** occurs simultaneously with cutover of the takeup from the reel in position B to the reel in position A. The energization of the relay **310** causes contact **310-1** to open, thereupon interrupting the circuit through and hence deenergizing the relay **304.** This sets the relay **304** in condition for cutover in a subsequent cycle of operation.

When the distributor carriage **50** has been moved to the extreme left position outside the takeup position B as shown in FIG. **2,** the strand material **21** has a path extending from the distributor rollers **52-52** to the reel **26** in the takeup position A and tangentially across the

outwardly facing surface of the hub of the reel in the takeup position B. Also, the strand material **21** extends transversely through the plane of the path of pivotal movement of the deflector arm **106**. The deflector arm **106** in an unoperated position is normally horizontal as viewed in FIG. **4**.

Referring now to FIGS. **6** and **7**, the strand material **21** is moved into the V-shaped opening between the tooth **119** and the annular member **117** of the snagging facilities **116** associated with the takeup position B. The strand material **21** is moved into the opening formed between the wall of the opening **121** and the enlarged end **122** of the lever **123**. The decreased opening there is maintained so long as the inner reel flange is in engagement with the spring end **126** of the lever **123** (see FIG. **6**). This causes a section of the strand material **21** to be gripped within. The described gripping permits the beginning of the takeup of the convolutions of the strand material on the reel **26** in the takeup position B. Subsequently, when the full reel **26** is removed, the spring **127** (see FIG. **6**) causes the lever to be pivoted about the fulcrum **124** to disengage the end **122** from and release the strand material.

The timed relay **327** (see FIG. **17B**) is deenergized to close normally closed contact **327-7** to complete a circuit through the motor starter **1MR**. The carriage **50** is then moved to the right as viewed in FIG. **2** to the normal distribution position between the centerline of the apparatus **20** and the takeup position A. The movement of the carriage **50** to the right is discontinued when the carriage engages and opens a limit switch **11LS** (see FIG. **17B**). The opening of the limit switch **11LS** causes the relay **326** to be deenergized.

Following the movement of the carriage **50** to the left distribute position, the full reel in position B is removed by another cycle of operation of the motor **1EA** and permitted to move down the ramp **182** onto the rollers **171** and **172**. Then the rollers **171** and **172** are turned rotatably to turn the reel and wind up any loose ends of the strand material **21** extending therefrom. The conveyor **27** is indexed by the cylinder **163** and the next successive leading one of the empty reels **26—26** is moved from the conveyor **27** into the takeup position B.

The counter-rotation of the empty takeup reel **26** in the clockwise direction as viewed in FIG. **2** and of the full reel in the counterclockwise direction with the accompanying snagging of a section of the strand material **21** by the empty reel snagging facilities **116** causes the strand material to be broken intermediate the reels. Prior thereto, when the deflector arm **106** is moved pivotally, the strand material extends between the deflector arm and the full reel **26** in the takeup position A and along the guide portion **137** of the full reel shroud **141**. In this way, it is assured that when the strand material **21** is broken as hereinbefore described, the loose trailing end thereof associated with the full reel will be caused to be drawn into the shroud **141** and moved around therein harmlessly in engagement with the inwardly facing surface thereof. This prevents damage to the loose end and the occurrence of "slap-nicks."

The three to four second braking time for the reel **26** full of strand material may be increased when using the newly designed shroud **141**. This will permit the improved shroud **141** to become fully effective to capture and retain the loose trailing end of the strand material **21** before bringing the reel **26** to a complete stop.

It should be observed that the effect of the increment of indexing of the conveyor **27** is to advance the full reel **25** one position toward the dolly end of the takeup apparatus **20**. Simultaneously, the next successive leading one of the empty reels **26—26** is advanced into lateral alignment with the ramp **182** and the load-unload arm **181**. After a predetermined number of full reels **26—26** of strand material **21** have been transferred to the conveyor **27** and indexed toward the dolly **29**, the operator normally transfers the reels to the pallet **30** on the dolly. Then the operator withdraws the dolly **29** and replaces the pallet **30** with an empty pallet to receive the next batch of loaded reels from the conveyors **27—27**.

The importance of the methods and apparatus of the invention resides in an environment of automatically supplying empty reels to a takeup apparatus and then removing the full reels of strand material **21** therefrom. The methods and apparatus of this invention provide the capability of controlling the handling of the full reels to insure that there are no loose tails extending therefrom and that substantially all the strand material is wound on the reels. This arrangement of loading and unloading reels has proved to be extremely efficient in a manufacturing environment.

This controlled amount of turning of each of the full reels brought down the ramp **182** is generally something less than 90 degrees and creates no problems of unraveling of the strand material **21**. Moreover, any loose tails of strand material **21** as may be experienced are caused to be rewound by the operation of the rollers **171** and **172**.

Of course, an apparatus constructed in accordance with the principles of this invention including an elevator associated with each one of the takeup positions A and B, (see FIG. **16**) involves no turning of the full reels **26—26** during transfer from the takeup positions to the associated conveyor **27**.

It is to be understood that the above-described arrangements are simply illustrative of the principles of the invention. Other arrangements may be devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A method of handling reels in a dual position takeup apparatus, which includes the steps of:

moving empty reels along a path of travel to position successive leading ones of the reels in proximate alignment with one of the takeup positions;

moving each successive leading one of the empty reels from the path of travel of the empty reels to position the reel so that the axis of rotation of the reel is colinear with the axis of rotation of the one takeup position;

supporting each successive leading one of the empty reels for rotation in the one takeup position;

rotating the reel in the one takeup position; while

advancing and guiding elongated material transversely reciprocally across a winding surface of the reel in the one takeup position to distribute the elongated material in successive layers on the reel;

discontinuing the rotation of the reel in the one takeup position when the reel is full of elongated material; and

removing each of the full reels from the one takeup position to an associated path of travel for full reels; and

regulating turning of the full reel to insure that each of the full reels to be advanced subsequently along the path of travel thereof has substantially all the elongated material wound thereon and substantially without loose tails of elongated material extending therefrom.

2. The method of claim **1**, wherein the axes of rotation of the takeup positions are colinear.

3. The method of claim **2**, wherein the axes of rotation of the takeup position are parallel.

4. The method of claim **3**, wherein the reels are aligned transversely of, and the successive leading ones of the reels are moved into alignment with, the takeup positions such that the each successive leading one of the reels is offset a predetermined distance from the associated takeup position, the distance being measured parallel to the axes of rotation.

5. The method of claim **4**, wherein the path of travel of the empty reels and the path of travel of the full reels are colinear.

6. The method of claim **5**, wherein each of the takeup positions has a path of travel associated therewith.

7. A method of taking up successive sections of a strand material cyclically on an empty reel in one takeup position and then on an empty reel in another takeup position, the axes of rotation of the reels in the takeup positions being parallel, which includes the steps of:

moving a plurality of empty reels along a path of travel associated with each of the takeup positions and parallel to the axes of rotation to position successive leading ones of the empty reels in a transfer position along the path of travel in proximate alignment with the associated takeup position such that each successive one of the reels is offset a predetermined distance from the associated takeup position as measured parallel to the axes of rotation;

transferring each successive leading one of the empty reels from the associated path of travel transversely of the path of travel into axial alignment with the associated one of the takeup positions;

moving the empty reel axially along the associated axis of rotation into the takeup position;

supporting rotatably each successive leading one of the empty reels in the associated one of the takeup positions;

rotating the reel in the one takeup position; while

advancing and guiding successive sections of a strand material reciprocally transversely across a winding surface of the reel in the one takeup position to distribute the strand material in successive layers of convolutions of the reel in the one takeup position;

rotating the reel in the other one of the takeup positions; while

transferring the distribution of the strand material from the reel in the one takeup position to the reel in the other one of the takeup positions;

discontinuing the rotation of the reel in the one takeup position when the reel is full of strand material;

moving the full reel axially of the takeup position;

removing the full reel transversely of the path of travel from the one takeup position to the transfer position in the associated path of travel; and

regulating turning of each successive one of the full reels to provide a package of strand material with essentially all strand material being wound in convolutions thereon and substantially without loose tails of strand material extending therefrom.

8. The method of claim **7**, wherein the regulating turning of each of the full reels includes:

moving the full reels from the one takeup position to the transfer position in the associated path of travel with a minimal turning of the reel; and then

turning the full reel of strand material in the path of travel to wind up any loose ends of strand material extending therefrom; and further including the steps of:

moving the full reel out of the transfer position associated with the one takeup position while moving the next successive leading one of the empty reels into the transfer position; and

transferring the next successive leading one of the reels into the one takeup position while the successive layers of convolutions of strand material are being distributed on the reel in the other one of the takeup positions.

9. An apparatus for handling reels in a dual position takeup for elongated material, which includes:

means for moving a plurality of empty reels along a path of travel to position successive leading ones of the reels in alignment with one of the takeup positions;

means for moving each successive leading one of the empty reels from the path of travel of the empty reels into the one takeup position;

means for supporting rotatably each successive leading one of the empty reels in the one takeup position;

means for advancing and guiding an elongated material transversely reciprocally across a winding surface of the reel in the one takeup position to distribute the elongated material in successive layers on the reel;

means for rotating the reel in the one takeup position during the distribution of the elongated material thereon and for discontinuing the rotation when the reel is full;

means for moving each of the full reels from the one takeup position to an associated path of travel for full reels; and

means for regulating turning of the full reels to insure that each of the full reels to be advanced subsequently along the path of travel has substantially all the elongated material wound thereon and substantially without loose tails of elongated material extending therefrom.

10. The apparatus of claim **9**, wherein the axes of rotation of reels in the takeup positions are parallel.

11. The apparatus of claim **9**, wherein the axes of rotation of the reels in the takeup positions are colinear.

12. The apparatus of claim **9**, wherein each of the takeup positions has a path of travel associated therewith.

13. The apparatus of claim **9**, wherein the reels are aligned transversely and the successive leading ones of the empty reels are moved into transverse alignment with the takeup positions.

14. The apparatus of claim **13**, wherein the path of travel of the empty reels and the path of travel of the full reels are colinear.

15. An apparatus for taking up successive sections of a strand material cyclically on a reel in one takeup position and then on a reel in another takeup position, which includes:

means for supporting rotatably a reel in each of the takeup positions;

means for rotating the reel in the one takeup position;

means for advancing and guiding successive sections of a strand material transversely reciprocally across a winding surface of the reel in the one takeup position to distribute the strand material in successive layers of convolutions on the reel in the one takeup position;

means for rotating the reel in the other one of the takeup positions;

means for transferring the distribution of the strand material from the reel in the one takeup position to the reel in the other one of the takeup positions;

means for discontinuing the rotation of the reel in the one takeup position;

means for intermittently advancing a plurality of empty reels along a path of travel associated with each of the takeup positions to move successive leading ones of the empty reels into a transfer position associated with the takeup position and responsive to a full reel in the transfer position for moving the full reel along the path of travel and out of the transfer position and moving the next successive one of the empty reels thereinto; and

means responsive to each successive leading one of the empty reels being moved into the transfer position for transferring each successive leading one of the empty reels from the transfer position transversely of the path of travel into the associated one of the takeup positions while the distribution of strand material on the other reel is proceeding and for removing the reel full of the strand material from the one takeup position transversely of the path of travel into the transfer position in the path of travel associated with the one takeup position while regulating turning of the full reel to provide a full reel with essentially all strand material being wound thereon.

16. The apparatus of claim 15, wherein the transfer position associated with each of the takeup positions is offset laterally therefrom a predetermined distance as measured along the axis of rotation of the takeup position and the transferring means moves each successive empty reel into alignment with the axis of rotation of the associated takeup position and further includes:

means rendered effective upon alignment of an empty one of the reels with the associated takeup position for displacing the reel laterally along the axis of rotation into the takeup position; and

means responsive to the discontinuance of rotation of a full one of the reels for ejecting the full reel from the associated takeup position laterally along the axis of rotation to permit the transferring means to move the reel to the transfer position in the associated path of travel.

17. The apparatus of claim 15, wherein the means for transferring the full reel while regulating turning of the full reel includes:

means for moving the full reel from the takeup position to the associated path of travel with a minimal turning of the reel; and

means for turning the full reel of strand material in the path of travel in the direction of takeup to wind up any loose ends of strand material extending therefrom.

18. The apparatus of claim 17, wherein:

the means for moving the reel with minimal amount of turning includes:

an arcuately shaped ramp extending from each of the takeup positions to an associated one of the advancing means;

an arcuately shaped pivotally mounted arm having a width greater than the flange-to-flange distance of each of the reels;

means mounting the arm for pivotal movement between a first position adjacent the associated one of the reel takeup positions and a second position spanning across the associated advancing means; and the means for turning the full reel includes:

a pair of spaced rollers for receiving a reel therebetween and having axes of rotation parallel to the axes of rotation of the takeup positions, the path of travel of the reels being intermediate the rollers.

19. The apparatus of claim 18, wherein:

the pivotally shaped arm is formed with an upstanding flange along one edge thereof;

the arm being effective to slide the reel along the ramp until the axis of the reel is colinear with the axis of rotation of the takeup position;

each of the means for supporting a reel for rotation includes a pair of spaced axially aligned cones, each of the cones adapted to be received in a hub opening of one of the reels to engage the walls of the hub opening;

the displacing and ejecting means of the transferring means also including:

means rendered effective by the transfer of an empty one of the reels from the transfer position by the arm into the alignment thereof with the axes of rotation for engaging one of the cones with the reel hub and then pushing the reel laterally of the arm off the unflanged side thereoff until the other heel opening of the reel is moved over the other one of the cones and the reel is supported on the cones; and

means responsive to the completion of the taking up of the strand material on the reel in the one takeup position for retracting the one cone and for simultaneously pushing the reel along the axis of rotation until the reel is aligned with the arm whereupon the one cone is moved further to disengage the one cone from the reel and the other cone retracted and the reel is supported on the arm.

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