United States Patent

Brown

[15] **3,701,491**

[45] **Oct. 31, 1972**

[54] **METHODS OF AND APPARATUS FOR CONTINUOUSLY REELING STRAND MATERIAL**

[72] Inventor: **William Brownloe Brown,** Pasadena, Md.

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

[22] Filed: **June 7, 1971**

[21] Appl. No.: **150,283**

[52] **U.S. Cl.** .....**242/25 A,** 242/46.4, 242/158.4 R

[51] **Int. Cl.** **B65h 54/02**

[58] **Field of Search**.....242/25 A

[56] **References Cited**

UNITED STATES PATENTS

3,082,967	3/1963	Hyprath et al.	242/25 A
3,148,841	9/1964	Hollingsworth et al.	242/25 A
3,420,459	1/1969	Peters	242/25 A
3,583,650	6/1971	Zaborovsky	242/25 A
3,596,844	8/1971	Engmann	242/25 A
3,620,482	11/1971	Bravin	242/251 A

FOREIGN PATENTS OR APPLICATIONS

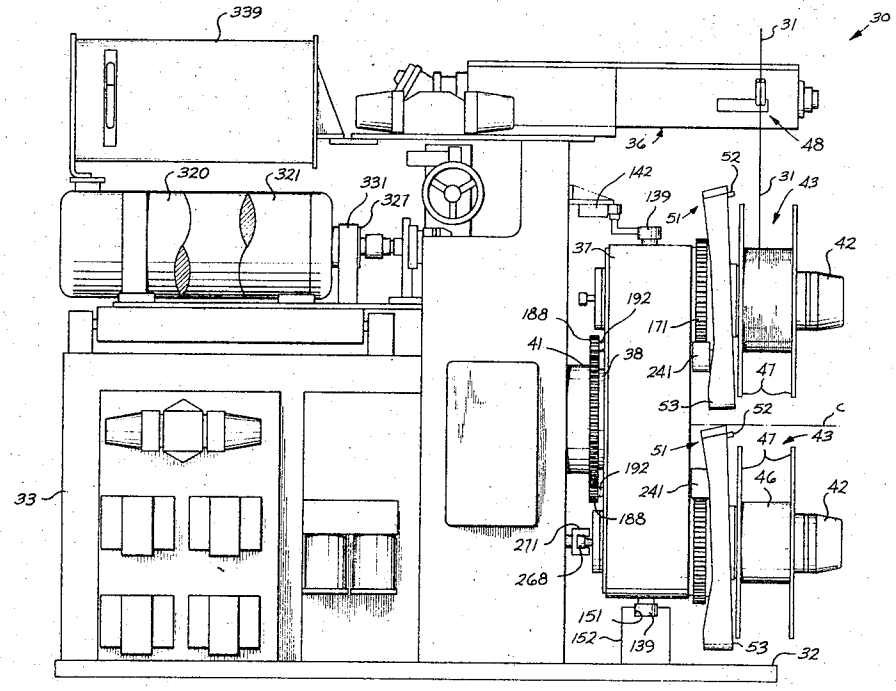
1,074,709	7/1967	Great Britain	242/25 A

Primary Examiner—Stanley N. Gilreath
Assistant Examiner—Milton S. Gerstein
Attorney—W. M. Kain, J. B. Hoofnagle, Jr. and A. C. Schwarz, Jr.

[57] **ABSTRACT**

A pair of transversely aligned arbors are rotatably cantilevered at opposite ends of a vertically disposed rotatable turret. Each arbor is provided with a plurality of internally floating, cam-operated mechanisms for locking a take-up reel thereon. Independent drive mechanisms drive the reels separately at varying speeds. A snagger device is cantedly mounted on the cantilevered end of each arbor for rotation therewith and extends a radial distance slightly greater than the adjacent flange of the reel thereon to oscillate between two points coplanar with respect to the inner and outer surfaces of the flange, respectively. A distributor adjacent to one of the reels actively taking up the strand is provided with a reversible drive screw for driving a traversable strand guide controlled alternately by a stationary limit switch adjacent to the reel flange associated with the snagger and a rectilinearly movable limit switch mounted on a second drive screw and normally positioned adjacent to the opposite reel flange. Prior to cutover from a full reel to an empty reel, when a footage counter indicates that a length of strand approximating one layer of convolutions thereof remains to be taken up: (a) the turret is rotated 180° to position an empty reel between the distributor and the nearly full reel; and the second drive screw is actuated to move the movable limit switch toward the stationary limit switch at the traverse speed of the strand guide. The limit switches continue to control the reversal of the first drive screw. When the remaining length of strand is taken up and the advancing strand is traveling close to the insider flange of the empty reel, the snagger associated therewith is thrust into the path of the stand to grip and sever its connection to the full reel and to commence winding thereof upon the empty reel. The full reel is replaced by an empty reel to await the next cutover operation.

18 Claims, 27 Drawing Figures



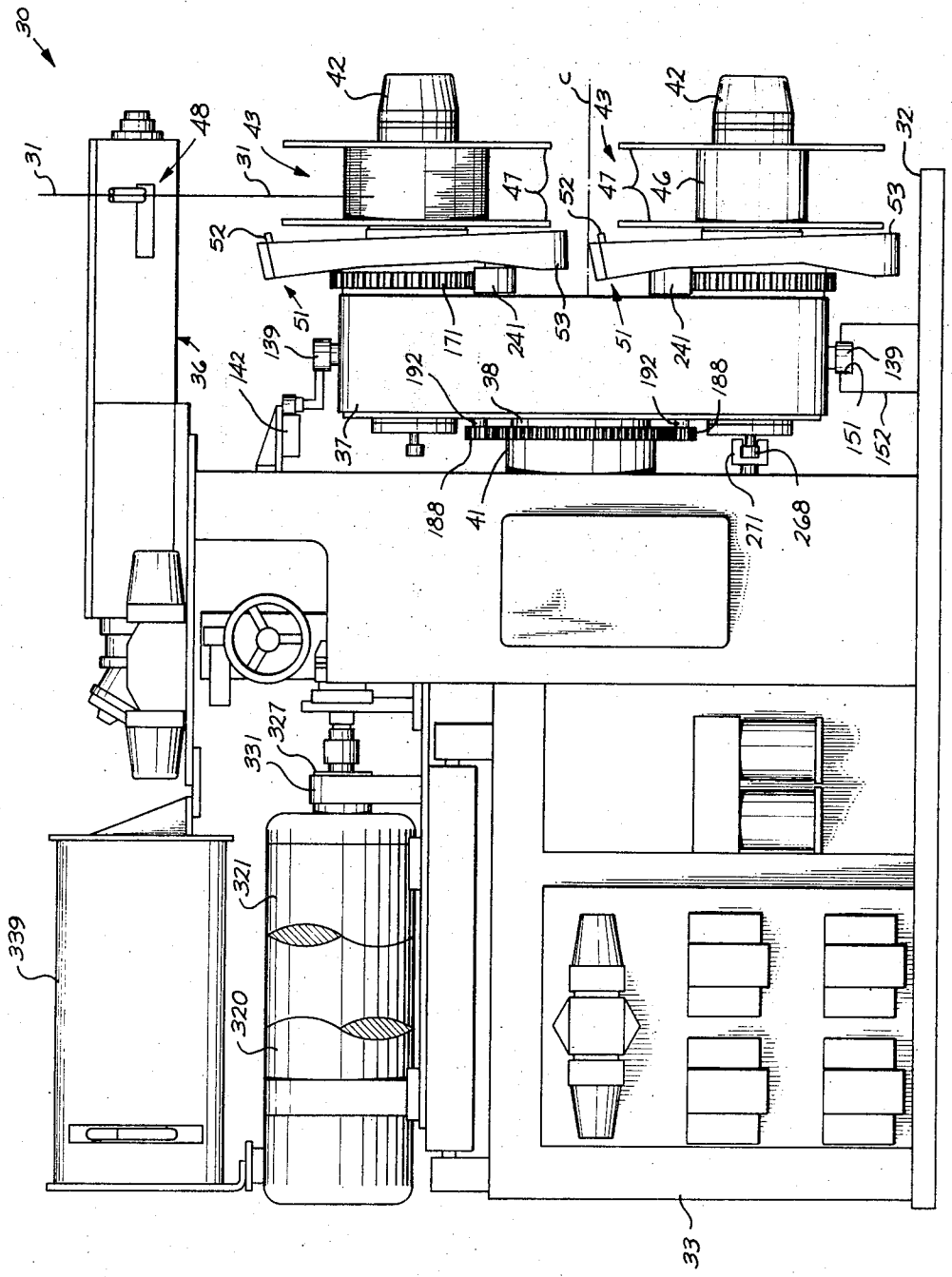


FIG. 1

INVENTOR
W.B. BROWN

BY J. M. Reveaz

ATTORNEY

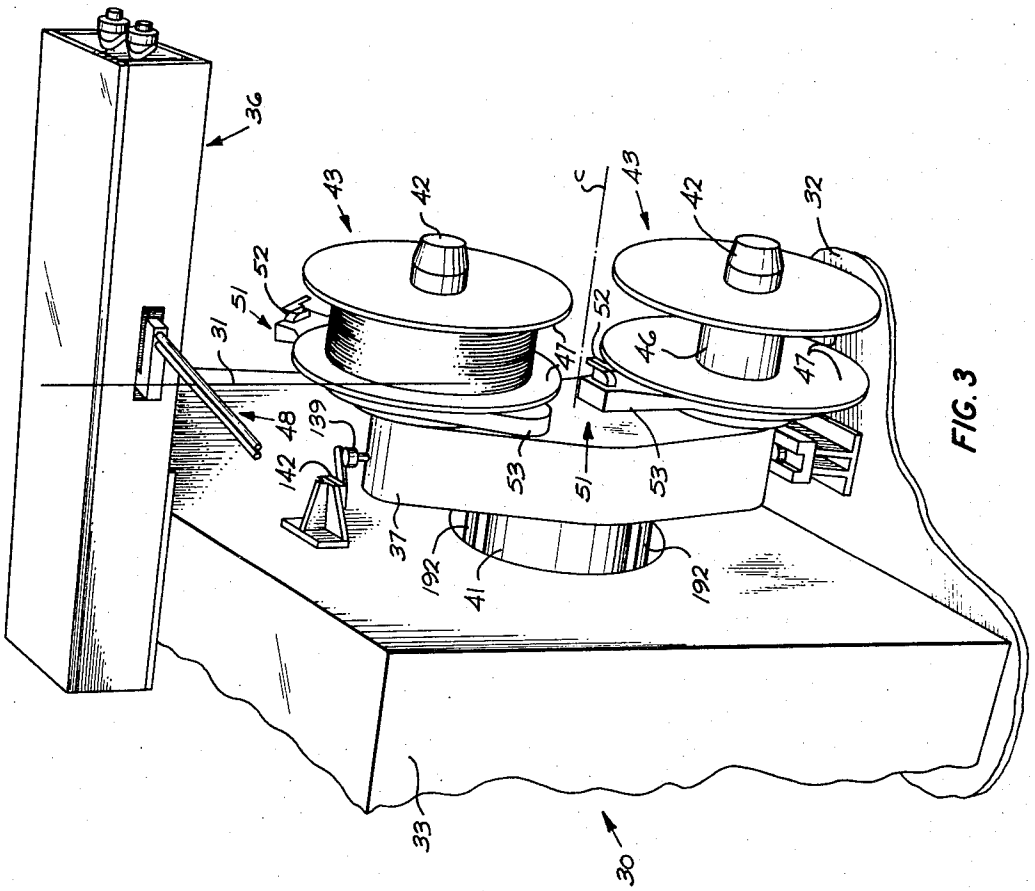

36
43
42
52
51
31
48
139
142
53
47
46
32
37
192
41
33
30

FIG. 3

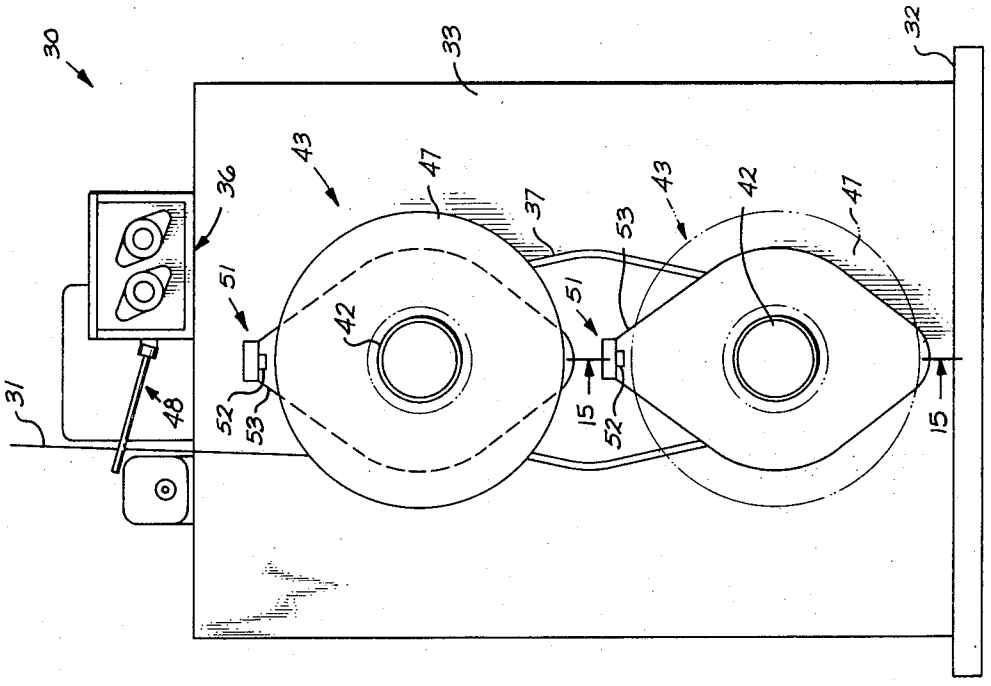

30
33
32
36
43
47
37
53
42
51
31
48
52
15

FIG. 2

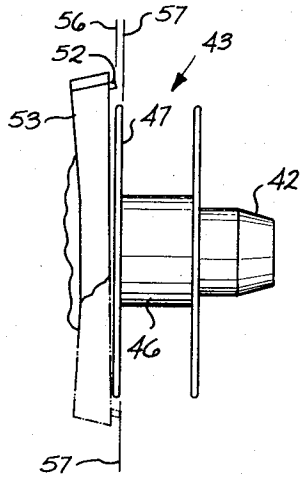


FIG. 4

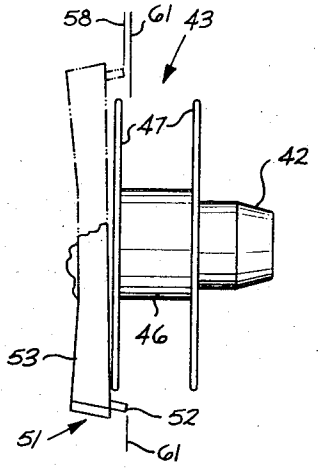


FIG. 5

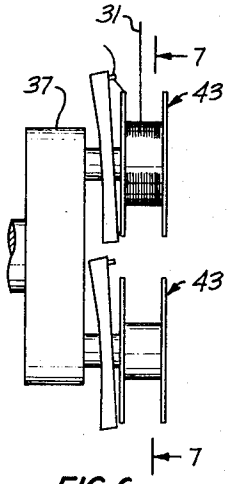


FIG. 6

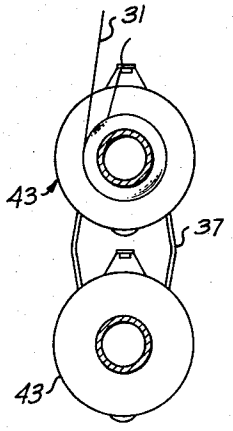


FIG. 7

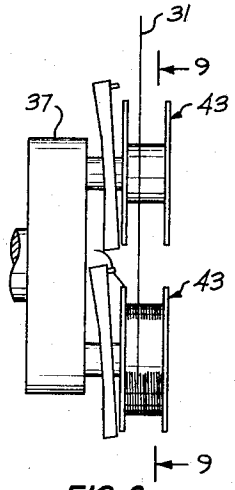


FIG. 8

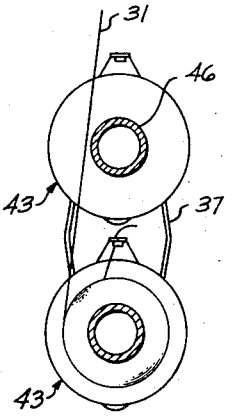


FIG. 9

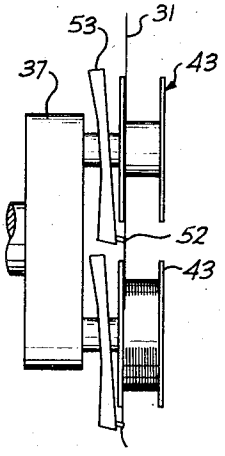


FIG. 10

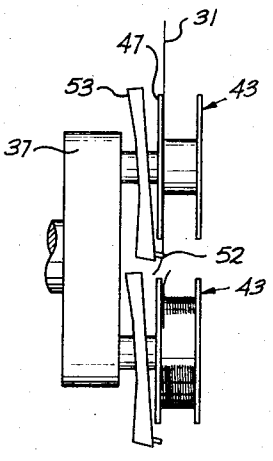


FIG. 11

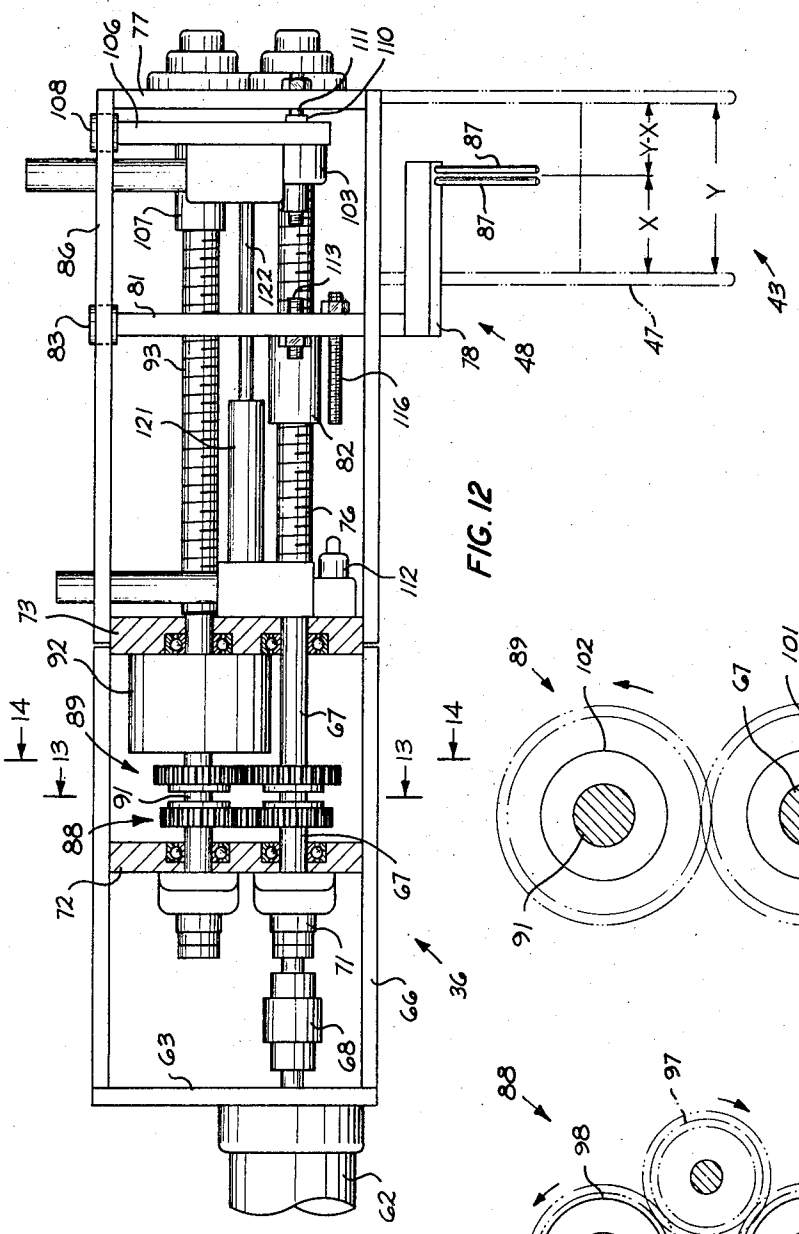


FIG. 12

FIG. 14

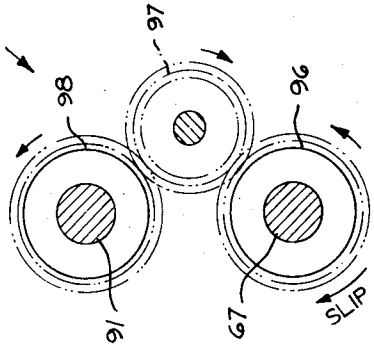


FIG. 13

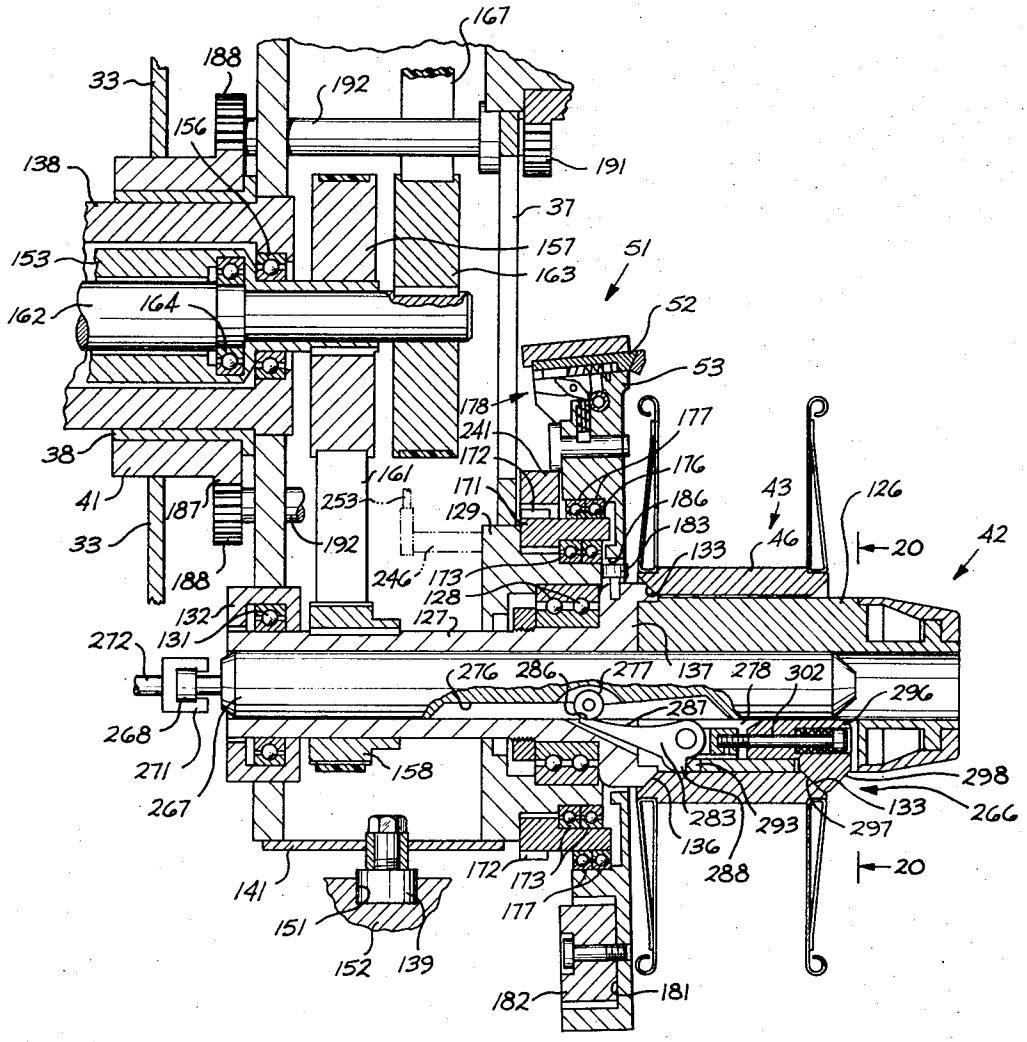

167
188
33
192
156
191
138
37
157
153
51
163
162
164
52
53
178
241
177
38
172
176
171
186
41
187
253
161
129
183
43
126
33
192
246
173
133
46
20
42
188
128
132
127
131
272
276
286
277
137
278
302
296
287
268
271
158
267
298
133
266
283
293
297
136
288
20
141
172
173
177
151
152
139
182
181

FIG. 15

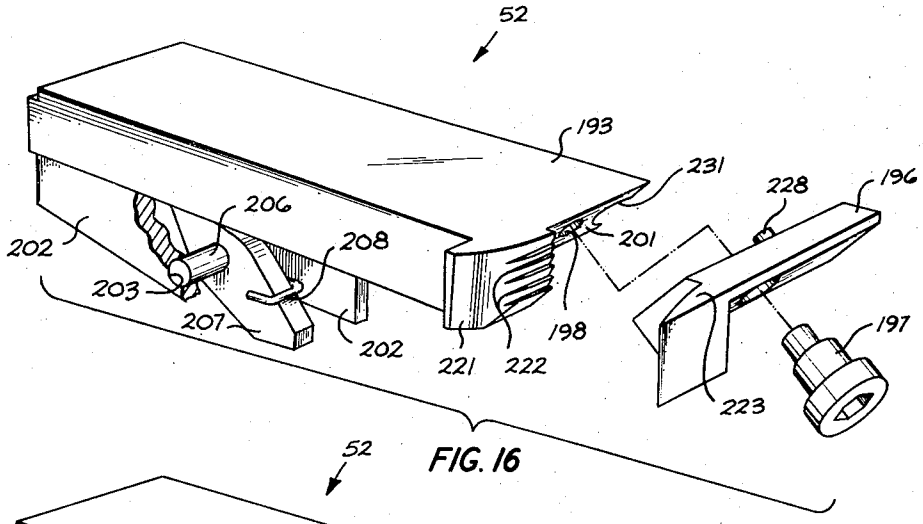


FIG. 16

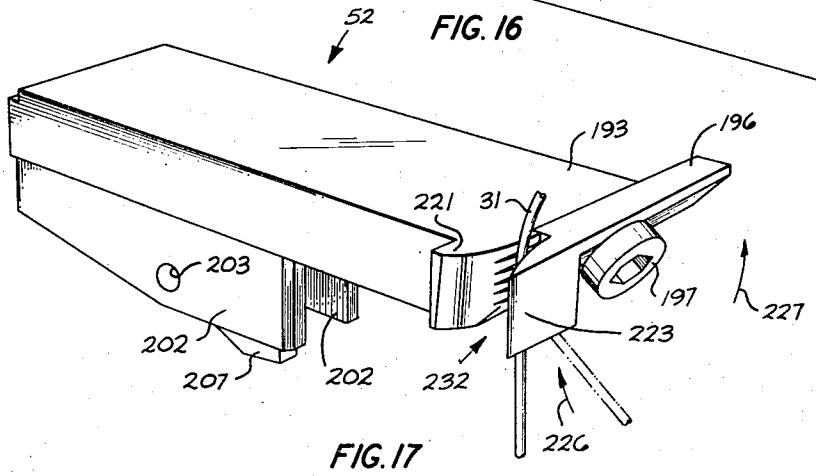


FIG. 17

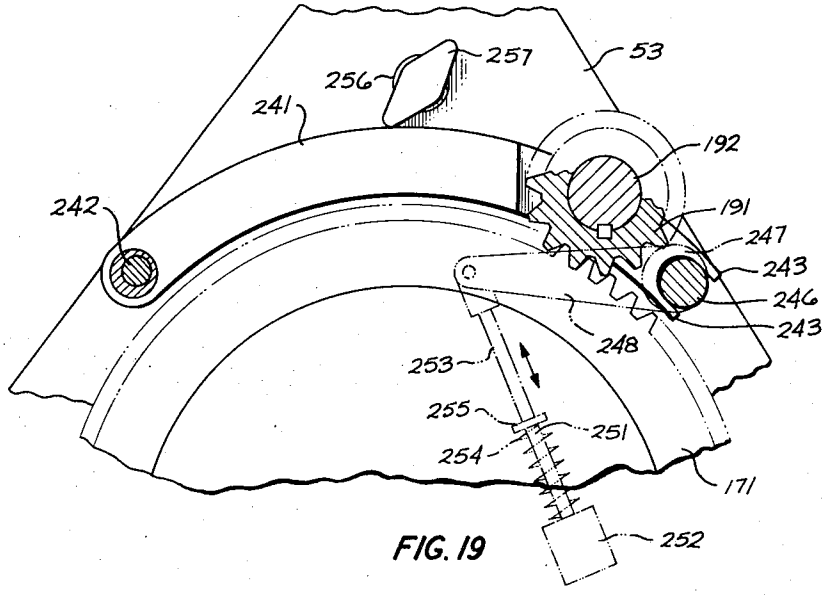


FIG. 19

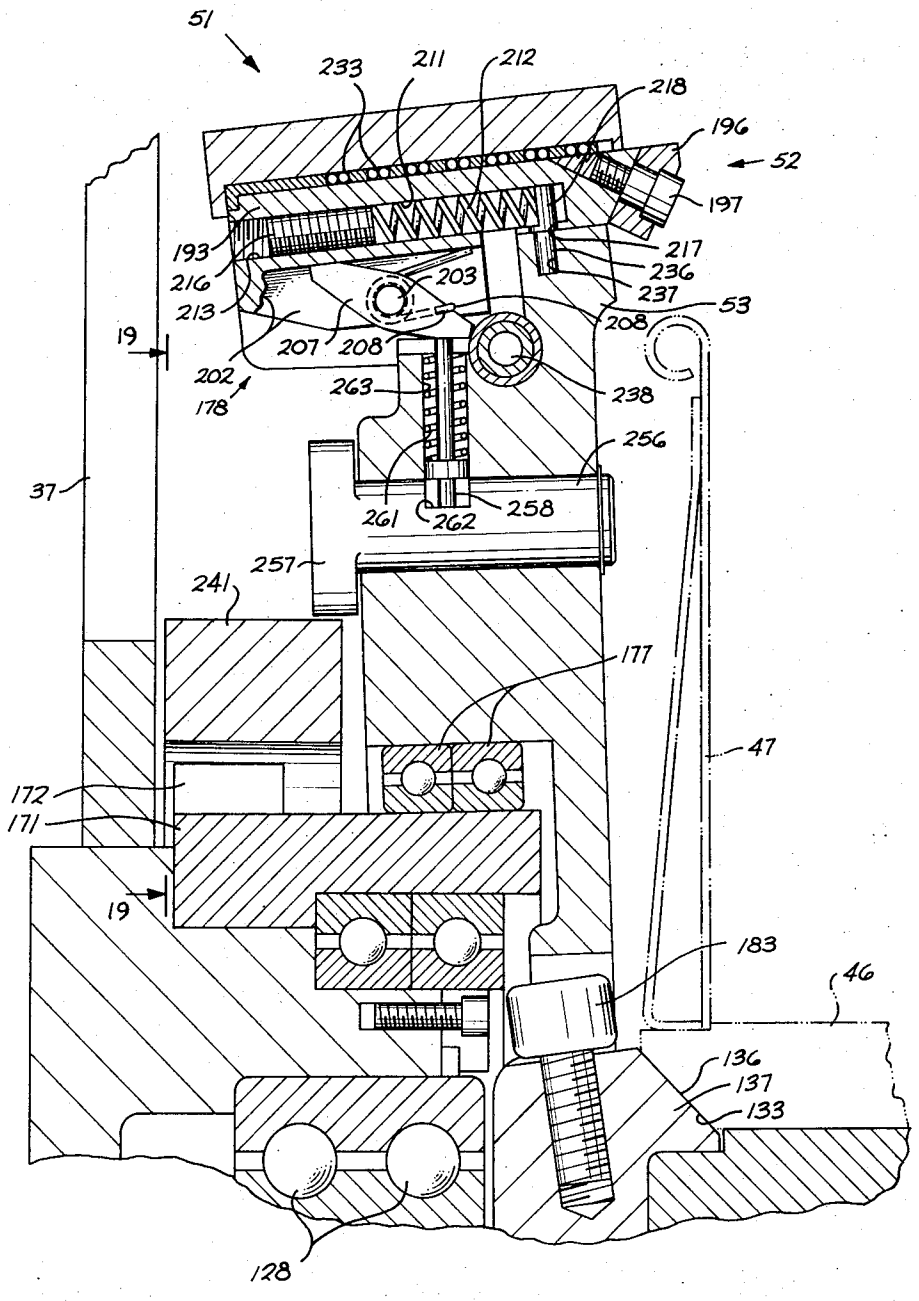

51
233
211
212
218
196
52
197
193
216
213
217
236
237
203
53
208
19
207
208
202
178
263
238
256
37
261
262
258
257
241
177
47
172
171
19
183
46
136
137
133
128

FIG. 18

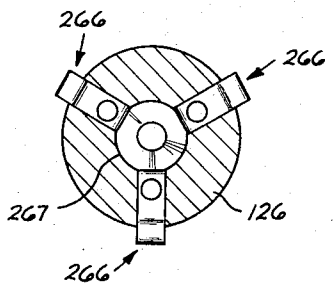

266
266
267
126
266

FIG. 20

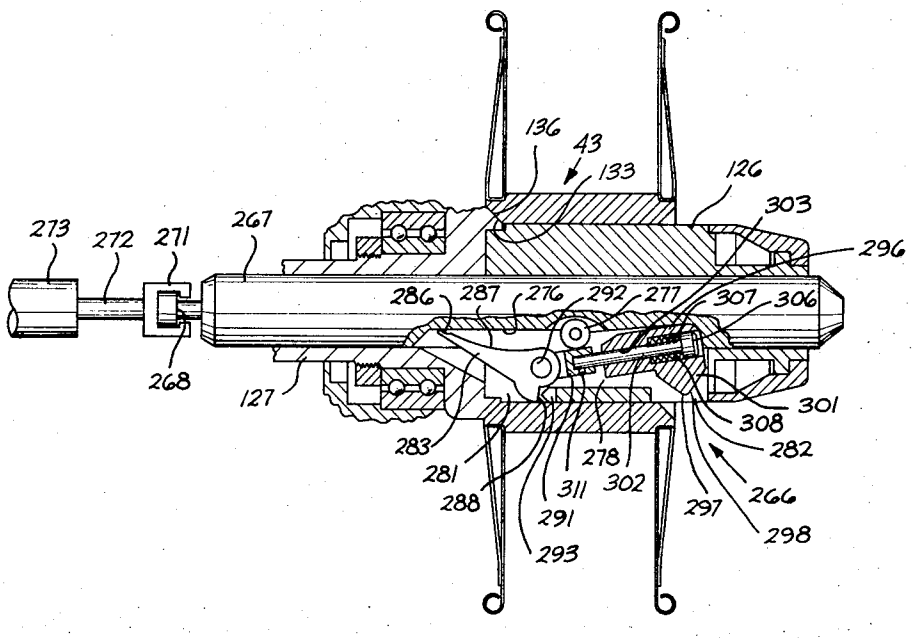

136
43
133
126
303
296
273
272
271
267
286
287
276
292
277
307
306
268
127
301
308
282
283
281
278
311
302
266
288
291
297
298
293

FIG. 21

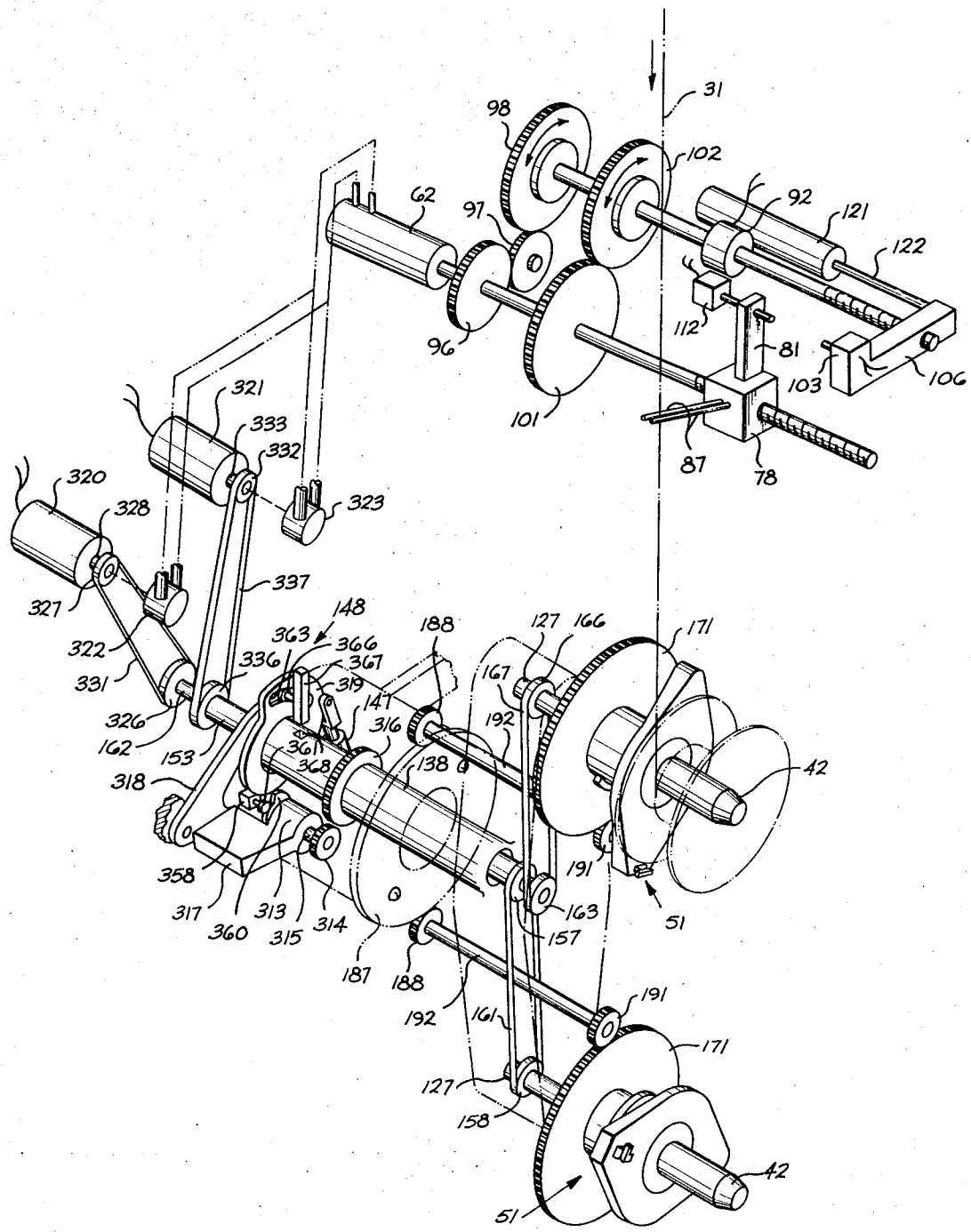

31
98
102
62
91
92
121
122
112
81
103
106
96
101
87
78
321
333
332
320
328
323
327
337
148
363
366
367
322
331
336
319
326
162
153
141
316
361
368
138
318
358
317
360
313
315
314
187
188
192
161
127
158
51
188
127
166
171
167
192
42
191
163
157
51
191
171
42

FIG. 22

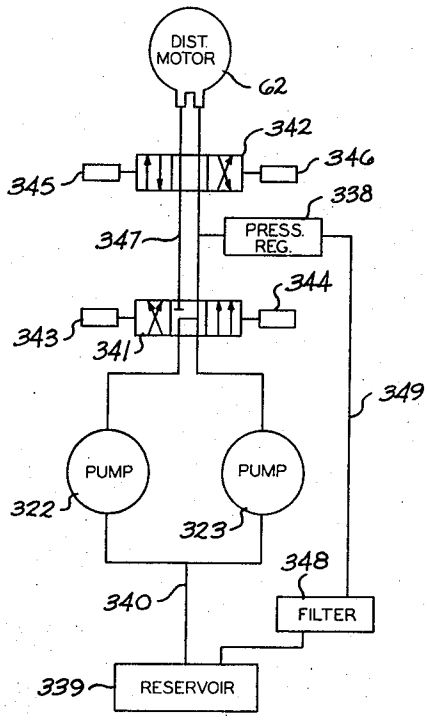

DIST. MOTOR
62
342
346
345
338
PRESS. REG.
347
344
343
341
349
PUMP
PUMP
322
323
348
340
FILTER
339
RESERVOIR

FIG. 23

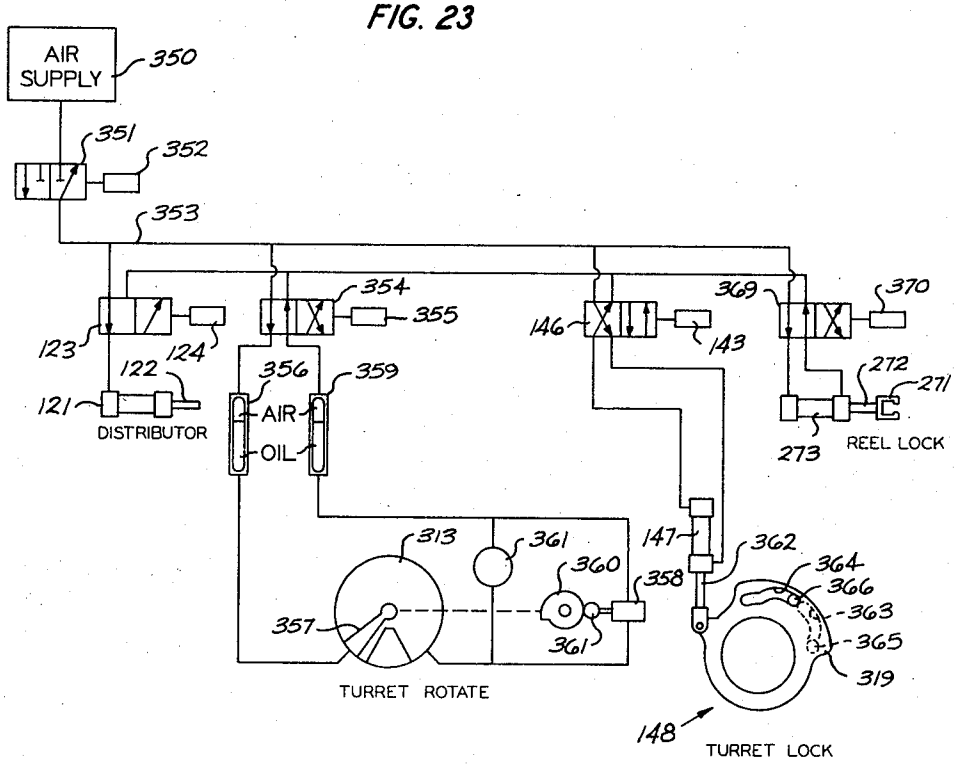

AIR SUPPLY
350
351
352
353
354
355
369
370
123
124
122
121
DISTRIBUTOR
356
359
AIR
OIL
146
143
272
271
273
REEL LOCK
313
361
360
358
357
361
TURRET ROTATE
147
362
364
366
363
365
319
148
TURRET LOCK

FIG. 24

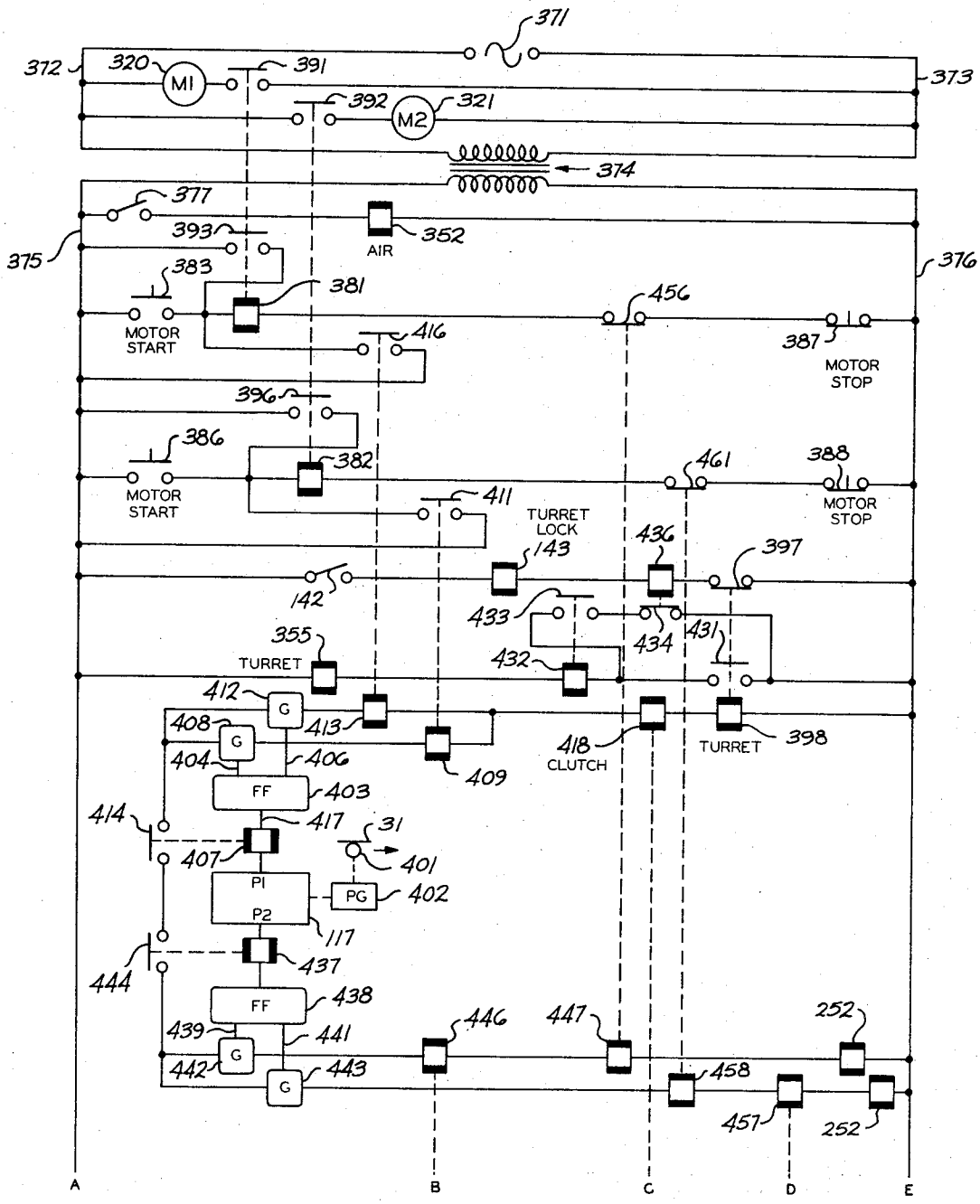

371
372
320
M1
391
373
392
M2
321
374
377
393
AIR
352
375
376
383
381
456
MOTOR START
416
387
MOTOR STOP
396
386
382
461
388
MOTOR START
411
MOTOR STOP
TURRET LOCK
143
436
397
142
433
434
431
355
TURRET
432
412
G
413
408
G
404
406
418
CLUTCH
TURRET
398
FF
403
409
414
417
31
407
401
PI
PG
402
P2
117
444
437
FF
438
439
441
446
447
252
G
442
443
458
G
457
252
A
B
C
D
E

FIG. 25

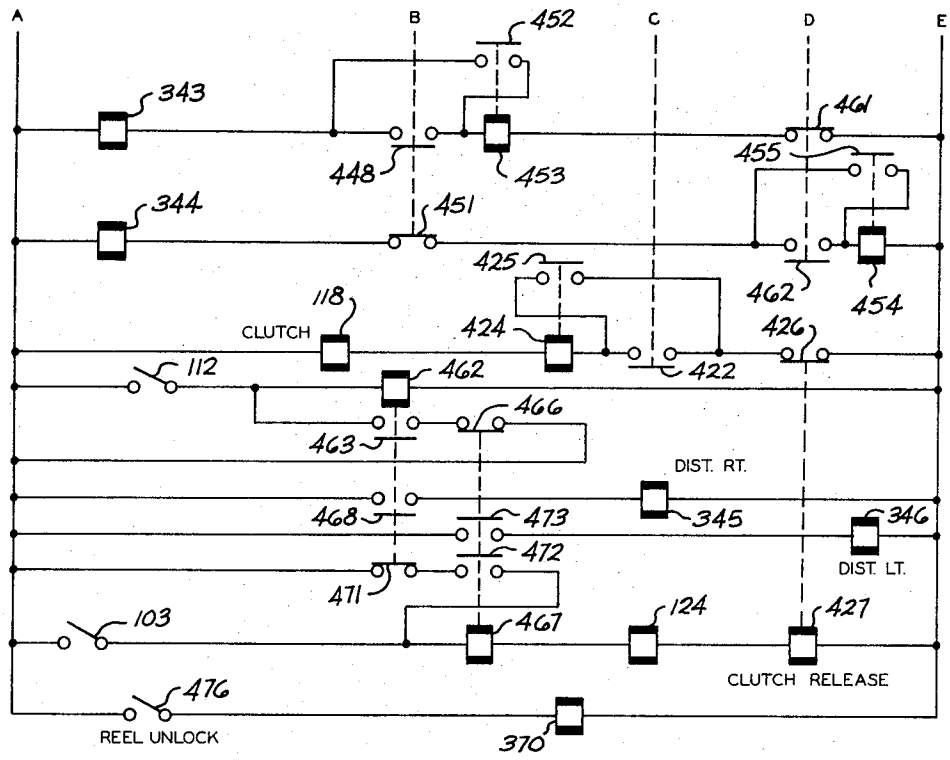

A
B
C
D
E
452
343
461
448
453
455
344
451
425
462
454
118
CLUTCH
424
426
112
462
422
466
463
DIST. RT.
468
473
345
346
472
DIST. LT.
471
103
467
124
427
CLUTCH RELEASE
476
REEL UNLOCK
370

FIG. 26

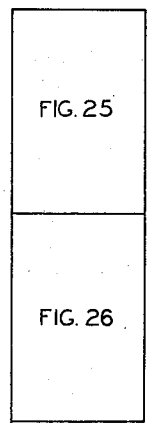

FIG. 25
FIG. 26

FIG. 27

METHODS OF AND APPARATUS FOR CONTINUOUSLY REELING STRAND MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to methods of and apparatus for continuously reeling strand material and more particularly to methods of and apparatus for taking up a continuously advancing strand automatically onto a pair of take-up reels releasably secured to a pair of transversely aligned arbors rotatably mounted in cantilever fashion on a centrally pivotable turret.

2. Description of the Prior Art

In the manufacture of strand material, for example, plastic insulated conductor wire, a finished insulated wire is directed continuously from an extruding process at a substantially constant linear speed. In order that the extrusion process may continue without interruption, it is common practice to take up the finished wire onto successive or alternate reels of a strand-reeling apparatus.

When a predetermined length of insulated wire has been wound upon one of take-up reels, the advancing wire is transferred to an empty take-up reel without interrupting the advancement of the wire emerging from the extruding apparatus. When the reels are aligned transversely, i.e., for rotation about spaced parallel axes, a snagger device may be mounted for rotation adjacent to a flange of each reel. To accomplish transfer of the wire from a full reel to an empty reel or cutover, as it is called, relative movement must occur between the snagger associated with the empty reel and the insulated wire for the former to intercept, sever and capture the latter for subsequent take-up on the empty reel. During this cutover operation it is desirable to avoid a sudden diversion of the path of the wire into the snagger since the stress produced in the wire, especially if it is being advanced at high speed, may be sufficient to cause the wire to break before snagging occurs. For the same reason it is desirable to avoid subsequent contact between a later advanced section of the wire and the snagger after cutover to the empty reel has occurred. In this connection the relative movement between the advancing insulated wire and the snagger must be kept to a minimum. It follows, therefore, that cutover should occur when the wire is closest to the flange of the empty reel adjacent to the snagger. This has been considered the most favorable position for transfer of the wire.

One method of assuring that a wire will be in a favorable position for transfer is to cause the distributor to remain in a fixed position adjacent to the flange of the reel associated with the snagger when the reel taking up the wire is almost full. The use of this method, however, involves the risk of wire tangling and breakage due to the occurrence of wire pile-up at the flange.

Another method of assuring that a wire will be in a favorable position for transfer is to cause the stroke of the wire distributor to be shortened to a path lying towards the flange adjacent to the snagger at a time immediately prior to cutover. The use of this method, however, does not carry an assurance that transfer of the wire will take place when the distance between the wire and the flange adjacent to the snagger is at a minimum.

It is also desirable to design a take-up apparatus to be compatible with various types of automatic loading and unloading facilities which may be utilized to minimize handling of the reels or the apparatus by an operator and thus avoid the risk of injury to the operator or damage to the reels, the wire or the apparatus.

Finally, it is desirable to provide automatic means for positively locking the rotatable reels in place during the operation of the apparatus and for unlocking the reels to permit easy removal thereof as they are filled.

SUMMARY OF THE INVENTION

One object of the present invention is to provide new and improved methods of and apparatus for reeling strand material.

Another object of the present invention is to provide new and improved methods of and apparatus for taking up a continuously advancing strand onto transversely aligned, rotatable take-up reels.

Another object of the present invention is to provide new and improved methods of and apparatus for distributing strand material onto a take-up reel.

Another object of the present invention is to provide new and improved methods of and apparatus for distributing and winding strand material, such as, for example, insulated conductor wire, on successive reels without stopping the distributing and winding of the material.

Another object of the present invention is to provide new and improved methods of and apparatus for controlling the distribution of strand material onto a take-up reel just prior to and during the time in which the strand is transferred from a full reel to an empty reel.

Another object of the present invention is to provide new and improved methods of and apparatus for distributing a predetermined amount of advancing strand in superimposed layers of convolutions between first and second axial limits on the winding surface of a take-up reel.

Another object of the present invention is to provide new and improved methods of and apparatus for distributing a length of strand substantially equal to one final layer of convolutions thereof between first and second boundaries on the winding surface of a rotating take-up reel.

Another object of the present invention is to provide new and improved methods of and apparatus for gripping an advancing strand.

Another object of the present invention is to provide a new and improved snagging device for a continuous take-up unit.

Another object of the present invention is to provide new and improved methods of and apparatus for snagging an advancing strand guided past a take-up element and in proximity to the periphery thereof.

Another object of the present invention is to provide new and improved methods of and apparatus for effecting the transfer of a moving strand from a first driven reel to a second driven reel aligned transversely with the first reel.

Another object of the present invention is to provide new and improved methods of and apparatus for snagging an advancing strand being distributed onto a take-up reel when a predetermined amount of strand has been taken up on the reel and for winding the

snagged strand onto an empty reel without subsequent risk of breaking the wire.

Another object of the present invention is to provide new and improved apparatus for supporting a hollow cylindrical article.

Another object of the present invention is to provide new and improved apparatus for releasably supporting a reel.

A method of taking up a continuously advancing strand onto first and second transversely aligned take-up reels mounted for rotation about spaced, parallel axes, embodying certain features of the invention, may include driving the first reel, distributing the advancing strand onto the first reel by guiding the strand back and forth across the winding surface of the first reel to wind successive layers of convolutions thereon, driving the second reel, interchanging the positions of the reels to position the second reel along the path of the strand being distributed onto the first reel, altering the distribution of strand onto the first reel in a predetermined sequence wherein the equivalent of the final layer of convolutions of strand is guided onto a part of the winding surface of the first reel, the end of the sequence occurring when the strand is being guided past a predetermined end of the second reel, and transferring the distributed strand from the first reel to the second reel at a time coincident with the end of the sequence.

An apparatus for taking up a continuously advancing strand onto first and second transversely aligned take-up reels mounted for rotation about spaced, parallel axes, embodying certain features of the invention, may include means for driving the first reel, means for distributing the advancing strand onto the first reel by guiding the strand back and forth across the winding surface of the first reel to wind successive layers of convolutions thereon, means for driving the second reel, means for interchanging the positions of the reels to position the second reel along the path of the strand being distributed onto the first reel, means for altering the distribution of the strand onto the first reel in a predetermined sequence wherein the equivalent of the final layer of convolutions of strand is guided onto a part of the winding surface of the first reel, the end of the sequence occurring when the strand is being guided past a predetermined end of the second reel, and means for transferring the distributed strand from the first reel to the second reel at a time coincident with the end of the sequence.

A method of controlling the distribution of a predetermined length of continuously advancing strand onto and traversing the winding surface of a rotating take-up reel reversibly between first and second longitudinally spaced limits, embodying certain features of the invention, may include moving the second limit linearly toward the first limit at a speed substantially equal to the speed of traverse of the strand, reversing the direction of traverse of the strand when it reaches the moving second limit, and terminating the advancement of the strand onto the reel at a time subsequent to the reversal of the strand at the moving second limit when the strand is next adjacent to the first limit.

An apparatus for controlling the distribution of a predetermined amount of continuously advancing strand onto and traversing the winding surface of a rotating take-up reel reversibly between first and second longitudinally spaced limits, embodying certain features of the invention, may include means for moving the second limit linearly toward the first limit at a speed substantially equal to the speed of traverse of the advancing strand, means for reversing the direction of traverse of the advancing strand when it reaches the moving second limit, and means for terminating the advancement of the strand onto the reel at a time subsequent to the reversal of the strand at the moving second limit when the strand is next adjacent to the first limit.

A method of gripping an advancing strand embodying certain features of the invention may include revolving a snagger about a first axis in an annular path having an axis intersecting the first axis at an angle to oscillate the snagger between a pair of spaced planes perpendicular to the first axis, and imparting relative movement between the advancing strand and the snagger to position the strand in a path between the spaced planes intersecting the path of the revolving snagger to cause the snagger to intercept and grip the strand.

An apparatus for gripping an advancing strand, embodying certain features of the invention, may include a snagger mounted for revolution about a first axis in an annular path having an axis intersecting the first axis at an angle, means driving the snagger for oscillating the snagger between a pair of spaced parallel planes perpendicular to the first axis, means for imparting relative movement between the advancing strand and the snagger to position the strand in a path between the spaced planes intersecting the path of the revolving snagger whereby the snagger intercepts and grips the strand.

An apparatus for supporting a hollow, cylindrical article, embodying certain features of the invention, may include a hollow, generally cylindrical hub having a peripheral article mounting surface formed with an aperture therethrough adjacent to the article mounting surface, means on the hub, longitudinally spaced from the aperture, for abutting an annular edge of the article, a member having a transverse projection formed on a longitudinal body, the member being loosely disposed longitudinally within the hub and confined for limited longitudinal and lateral movement therein with the projection thereon adjacent to the aperture, resilient means associated with the elongated member for urging the member pivotally toward the axis of the hub to urge the projection thereon away from the aperture aligned therewith, an actuator disposed within the hub for axial movement, and means for rendering the actuator operable to move axially within the hub into engagement with the member to pivot the member against the effect of the resilient means away from the axis of the hub to cause the projection to protrude through the aperture to engage a section of an opposite annular edge on the article frictionally to secure the article onto the hub.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and various features of the invention will be more readily understood from the following detailed description of a specific embodiment thereof when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a front elevational view of a strand take-up apparatus embodying the principles of the present invention;

FIG. 2 is a fragmentary, side elevational view of the apparatus of FIG. 1;

FIG. 3 is a perspective view of part of the apparatus of FIGS. 1 and 2, showing an advancing strand being guided by a distributor and wound upon one of a pair of take-up reels mounted on a pair of arbors supported on a rotational turret;

FIG. 4 is a schematic illustration of the closest and remotest points at which an orbiting snagger, retracted into a rotating snagger support, is proximate to a flange on a take-up reel adjacent to and rotating with the snagger support;

FIG. 5 is a schematic illustration similar to FIG. 4, illustrating the proximity of the orbiting snagger to the flange on the take-up reel after the snagger is moved from a retracted position within the support to an extended position partially without the support;

FIG. 6 is a front elevational schematic illustration of the relative positions of the turret, the take-up reels and a pair of snagger devices during the normal take-up operation;

FIG. 7 is a sectional view of the turret, the take-up reels and the snagger devices taken along lines 7—7 of FIG. 6;

FIG. 8 is a front elevational schematic illustration of the relative positions of the turret, the take-up reels and the snagger devices at a time just prior to cutover from a full reel to an empty reel when the turret has been rotated 180° from the position shown in FIG. 6;

FIG. 9 is a sectional view of the turret, the take-up reels and the snagger devices, taken along the lines 9—9 of FIG. 8;

FIG. 10 is a front elevational schematic illustration of the take-up reels and snagger devices at the instant of cutover;

FIG. 11 is a front elevational schematic illustration of the take-up reels and snagger devices at a time immediately subsequent to cutover;

FIG. 12 is a plan view, partly in section, of the distributor shown in FIGS. 1 to 3, illustrating the manner in which a strand is controlled to assure cutover of the apparatus at the proper time;

FIG. 13 is a sectional view of a first one-way clutch, taken along the lines 13—13 of FIG. 12;

FIG. 14 is a sectional view of a second one-way clutch, taken along the lines 14—14 of FIG. 12;

FIG. 15 is a sectional view of a supporting arrangement of the turret and a rotatable reel mounting arbor of the apparatus of FIG. 1, taken along lines 15—15 of FIG. 2;

FIG. 16 is an exploded perspective view of a snagger associated with the take-up apparatus;

FIG. 17 is a perspective view of the snagger of FIG. 14 in an assembled condition illustrating the manner in which a strand may be gripped thereby or removed therefrom;

FIG. 18 is a sectional view of one of the rotatable snagger devices illustrating a portion of a mechanism for actuating a snagger;

FIG. 19 is a sectional view of the remainder of the snagger actuating mechanism taken along the lines 19—19 of FIG. 18;

FIG. 20 is a sectional view of three mechanisms for locking a reel onto an arbor taken along the lines 20—20 of FIG. 15;

FIG. 21 is a sectional view of an arbor illustrating the manner in which one of the locking mechanisms is actuated for releasing a reel from an arbor;

FIG. 22 is a perspective view of the drive system for the distributor, the turret and the arbors associated with the take-up apparatus of the invention;

FIG. 23 is a schematic representation of a hydraulic control system for a strand-reeling apparatus in accordance with the principles of the invention;

FIG. 24 is a schematic representation of a pneumatic system for a strand-reeling apparatus in accordance with the principles of the invention;

FIGS. 25 and 26, taken together, represent a schematic representation of an electrical control system for a strand-reeling apparatus in accordance with the principles of the invention, and

FIG. 27 illustrates the manner in which FIGS. 25 and 26 are to be combined.

DETAILED DESCRIPTION

1. General Description of the Take-up Operation

Referring now to FIGS. 1, 2 and 3, there is shown a take-up apparatus, generally indicated at 30 for taking up an advancing strand 31 continuously. The strand 31 may be, for example, an insulated wire, advanced at a substantially constant relatively high speed from an insulation extruder (not shown) by a conventional motor drive (not shown).

The apparatus 30 includes a flat, rigid base plate 32 for supporting a frame 33 upon which is mounted a wire distributor 36 and a centrally pivotable support arm or turret 37. The turret 37 is journaled in a sleeve bearing 38 mounted in a hub 41 secured to the frame 33, for rotation about a central axis C. A pair of transversely aligned, reel-supporting spindles or arbors 42—42 are mounted in cantilever fashion on turret 37 for rotation about spaced axes which are parallel to the axis C of the turret 37.

A pair of identical take-up reels 43—43, each comprising a cylindrical winding surface or drum 46 and a pair of flanges 47—47 secured fixedly at opposite ends of the drum 46, are mounted on arbors 42—42 and are rotatable therewith. As will become more apparent from the following description, locking means associated with each arbor 42 releasably secure each reel 43 thereon.

The distributor 36 includes a traversible strand guide 48 which is reciprocated horizontally to guide the advancing insulated wire 31 across the drum 46 of the reel 43 in the upper position on the turret 37 adjacent to the distributor 36 to distribute successively advanced sections of insulated wire 31 in superimposed layers of convolutions on the upper reel 43.

Triggerable snagger device 51 is mounted at the supported end of each arbor 42 and is rotatable therewith. Each snagger device 51 includes a snagger clamp or snagger 52 normally maintained in a retracted position within a snagger support 53 which rotates with its associated arbor. Each snagger support 53 is mounted at a predetermined angle with respect to the axis of each arbor 42 (see FIGS. 4 and 5) to orbit each snagger 52 about an axis of revolution which intersects the axis of

the arbor 42 but is not axially coincident therewith. The snagger 52 is positioned at a slightly greater radial distance from the axis of arbor 42 than the peripheral edge of the flange 47 on the reel 43 adjacent thereto.

As seen from FIG. 4, during its orbital movement the retracted snagger 52 traverses from a point in a plane 56 approximately flush with the outside face of flange 47 to a point in a plane 57 approximately flush with the inside face of the flange 47. Similarly, as seen from FIG. 5, the snagger 52 may be triggered to move out of the support 53 from its retracted position therein into an extended position, to traverse, while it orbits, from a point in a plane 58 approximately flush with the inside face of reel flange 47 to a point in a plane 61 spaced from the inside face of flange 47.

FIGS. 6 to 11, inclusive, illustrate schematically a series of steps in an exemplary cutover operation wherein the advancing insulated wire 31 is transferred from a full reel to an empty reel to continue taking up wire 31. During normal operation (FIGS. 6 and 7) one reel 43 is in an active condition on the upper part of turret 37, taking up wire 31. When the active reel 43 is nearly full, e.g., when an amount of accumulated strand equal to a predetermined amount of wire less than the amount desired to constitute a full reel is detected by a footage counting system, turret 37 is rotated 180° to revolve the active reel 43 to a lower loading and unloading position (FIGS. 8 and 9) 180° away from its former position. At the same time a passive or empty reel 43 is revolved from the lower loading and unloading position into the upper position formerly occupied by the active reel 43. At this time the active reel 43 continues to rotate in the lower position on turret 37 to continue taking up insulated wire 31, now passing across drum 46 of the empty reel 43, which is acceleratedly driven to ultimate take-up speed.

As set forth in detail in the following description, when a predetermined amount of wire 31, representative of a full reel, has been taken up on the active reel 43 a footage counter detects this condition and triggers the snagger 52 associated with the empty reel 43 to extend the snagger 52 outwardly into the path of the wire 31 passing in proximity to the reel flange 47 adjacent to the snagger device 51 to intercept, grip and break the connection of the wire 31 to the full reel 43 at a point between the reels 43—43 (FIGS. 10 and 11).

The distributor 36 is operated to alter the movement of the strand guide 48 to position the path of travel of the wire 31 near the flange 47 of the empty reel 43 adjacent to the snagger 52 just prior to the time that the latter is triggered to insure that cutover occurs at the moment when the predetermined amount of wire 31 is taken up on the full reel 43.

After cutover takes place, subsequently advanced sections of wire 31 are wound onto the newly activated formerly empty reel 43 in the upper position on turret 37. Since the wire 31 only approaches the newly activated reel 43 from a side thereof opposite the side on which the snagger 52 caught the wire 31, i.e., from the side of the reel nearest to the distributor 36, and since the snagger 52 is traversed away from adjacent flange 47 when it is orbited to that side of the reel, there is no need to retract the snagger 52 after it is triggered to prevent it from re-snagging the oncoming wire. The full reel 43 in the lower position on turret 37 is then stopped from rotating and removed from the arbor 42 and a new empty reel is loaded thereon to await the next cutover cycle. Since the loading and unloading of the reels 43—43 on arbors 42—42 takes place in the lower position on turret 37, the arrangement may be used with various types of automatic reel loading and unloading facilities.

2. Automatic Take-Up Apparatus

A. Distributor Assembly

Referring now to FIG. 12, the distributor 36 includes a reversible fluid-operated motor 62 secured to a left end support 63 of a housing 66. The motor 62 is coupled to a drive shaft 67 through sleeve couplings 68 and 71. The drive shaft 67 is rotatably supported in suitable bearings mounted in a pair of cross braces 72 and 73 and is coupled to one end of a first drive screw 76 rotatably supported at its other end in a suitable bearing mounted in a right end support 77 of housing 66. The strand guide 48 includes a roller support plate 78 secured to a movable support arm 81 fastened to a threaded sleeve 82, threadedly mounted for reciprocating movement along drive screw 76. A roller 83 on arm 81 engages the underside of a side brace 86 on housing 66. A pair of spaced guide rollers 87—87 are rotatably mounted on the support plate 78 for guiding the advancing insulated wire 31 therebetween and reciprocally onto the winding drum 46 of a rotating take-up reel 43.

A pair of spaced, gear-driven first and second one-way clutches, generally indicated at 88 and 89 respectively, are mounted adjacent to one another on drive shaft 67. Clutches 88 and 89 are operatively coupled to a second drive shaft 91 rotatably supported at one end in suitable bearings in cross brace 72 and coupled at the other end through a selectively actuable third clutch 92 to a second drive screw 93, rotatably mounted in suitable bearings in cross brace 73 and the right end support 77 of housing 66. The one-way clutches 88 and 89 function to convert the reversible rotary movement of the shaft 67 by the motor 62 to substantially continuous, unidirectional, rotary movement of the shaft 91 such that the shaft 91 always rotates in the same direction, regardless of the direction of rotation of shaft 67.

The conversion of the reversible movement of the shaft 67 into unidirectional movement of the shaft 91 is accomplished by arranging each of the one-way clutches 88 and 89 to slip when shaft 67 is rotated in a first direction and to rotate shaft 91 counterclockwise when shaft 67 is rotated in a second opposite direction. As illustrated in FIGS. 13 and 14, a gear 96 of clutch 88 is arranged to slip in response to clockwise rotation of shaft 67 and to couple shaft 67 to shaft 91 through gears 97 and 98 to rotate shaft 91 counterclockwise in response to counterclockwise rotation of shaft 67. Conversely, a gear 101 of clutch 89 is arranged to slip in response to counterclockwise rotation of shaft 67 and to couple shaft 67 to shaft 91 through a gear 102 to rotate shaft 91 counterclockwise in response to clockwise rotation of shaft 67. Thus clutches 88 and 89 function to rotate shaft 91 counterclockwise in response to any rotational movement of shaft 67.

A first control limit switch 103 is mounted on an arm 106 secured to a threaded sleeve 107 threadedly mounted for movement along the drive screw 93.

Threaded sleeve **107** and drive screw **93** are formed with the same pitch or lead per revolution as threaded sleeve **82** and drive screw **76**, respectively. Arm **106**, having a roller **108** thereon which engages the underside of brace **86**, is formed with a pad **110** thereon normally engaging a stop **111** in right end support **77**. Limit switch **103** is normally positioned adjacent to the right end support **77** of housing **66** at a spaced distance from a second control limit switch **112** fixedly mounted on the cross brace **73**. During normal operation of the distributor **36**, the support arm **81** is driven along and by the drive screw **76** until either of two switch actuators **113** or **116** fastened on opposite sides of arm **81** actuates control limit switch **103** or **112**, respectively aligned therewith, alternately to reverse the direction of distributor motor **62** and thus reverse drive screw **76** to impart conventional reciprocating movement to the strand guide **48** to guide an advancing wire **31** through guide rollers **87—87** to distribute wire **31** evenly onto the winding drum **46** of a take-up reel **43** between flanges **47–47** thereof.

The third clutch **92** is normally disengaged to maintain the drive screw **93** in a nondriven condition to maintain the limit switch **103** in a nonmoving position adjacent to the right end support **77**.

As mentioned previously, in order to initiate the snagging operation, the insulated wire **31** must be in a position immediately adjacent to the leftmost flange **47** of the take-up reel **43** adjacent to the snagger device **51**. To insure the timely occurrence of this condition, a footage counting system or counter **117** (FIG. **25**) is actuated when a predetermined length of wire representing one final layer of convolutions thereof remains to be taken up by the reel **43** in the upper active position on turret **37**. The counter **117** continuously monitors the length in feet of the wire **31** wound upon the active take-up reel **43**. At a time when the count on the counter **117** indicates that a predetermined amount of insulated wire **31** remains to be taken up to make a full reel, a first preset signal is generated on an output **P1** of the counter **117** which alters the operation of the distributor **36** to insure that the wire **31** is in a position near to the reel flange **47** associated with the snagger device **51** at the time the snagging operation is to occur.

To illustrate the operation of the distributor **36**, it is assumed that the strand guide **48** is being reciprocated normally in reverse directions along a rectilinear path having a length Y equal to the width of a reel **43** between flanges **47—47**, if lead angles are neglected, when counter **117** generates a signal on output **P1**. At this time the support arm **78** can be traveling either to the right or to the left in FIG. **12** and the turret **37** is rotated **180°** to position the almost full reel below the empty reel.

For the purpose of this illustration it is assumed that 1000 feet of wire remains to be taken up when the counter **117** generates a signal on output **P1** and that one complete layer of convolutions of wire **31** in substantially the last full layer thereof is substantially equal to 1000 feet. It is desired to complete the take-up of this final 1000 feet of wire **31** at the leftmost flange **47** of the empty reel **43**. Since the reels **43—43** are transversely aligned, passage of wire **31** near the left flange of either reel occurs at the same time. The advancing wire **31** therefore, and thus the strand guide **48**, must be traversed a distance Y across the reel **43** and end up at the leftmost flange **47**.

If strand guide **48** is traveling to the right when the counting system **117** indicates that an additional 1000 feet of wire is needed to complete the almost full reel **43**, a signal on output **P1** of counter **117** energizes a solenoid **118** (FIG. **26**) to actuate the clutch **92** to drive the second drive screw **93** through driven shaft **67**, clutch **88** and shaft **91** to move the limit switch **103** toward the limit switch **112**. Since the relationship between drive screw **93** and sleeve **107** is identical to the relationship between drive screw **76** and sleeve **82**, the arm **106** is driven by drive screw **93** at the same rate of speed with which the arm **81** is driven by drive screw **76**. If, as shown, the distance between the guide rollers **87—87** on the support plate **78** to the left flange **47** of reel **43** is *X*, the strand guide **48** will continue to be moved to the right until it has traveled a distance

$$(Y-X)/2$$

when the actuator **113** on arm **81** engages the moving limit switch **103** to reverse drive screw **76**. The strand guide **48** is then moved to the left through a distance

$$(Y-X)/2+X$$

to a position immediately adjacent to the left flange **47**. At this time the strand guide **48** has traveled a total distance of

$$(Y-X)/2+(Y-X)/2+X$$

which is equal to *Y* from the time the clutch **92** was actuated by the counter **117**, representing substantially one complete layer of convolutions of wire **31** on the reel **43**. Since this layer of convolutions is assumed to equal 1000 feet, the occurrence of a completed reel takes place precisely adjacent to the leftmost reel flange **47**. At this time the counter **117** generates a signal on a second preset output **P2** thereof to initiate the snagging operation, described in detail below.

When the actuator **113** on the support arm **81** engages the moving limit switch **103**, the clutch **92** is deactuated to cease coupling the shaft **91** to the second drive screw **93** and a pneumatic cylinder **121**, having a movable piston **122** in engagement with the limit switch **103** is actuated to return the limit switch **103** to its normal position adjacent to the end support **77**. Since clutch **92** is disengaged, the actuating screw **93** is free to be rotated clockwise by the return movement of the movable limit switch **103** under the control of cylinder **121**.

As will become more apparent from the description below with respect to FIGS. **24**, **25** and **26**, cylinder **121** is actuated by a spring-return solenoid-operated control valve **123** under the control of a solenoid **124** energized each time limit switch **103** is actuated by switch actuator **113**. The actuation of cylinder **121**, however, is effective to move switch **103** only at those times when switch **103** is away from end support **77**.

If the first preset signal output **P1** is energized when the strand guide **48** is moving to the left, with the guide rollers **87—87** at a distance *X* from the left reel flange **47**, the clutch **92** is actuated to rotate the second drive screw **93** and move arm **106** and the limit switch **103**

thereon toward the limit switch **112** at the same rate of speed with which the support arm **81** and strand guide **48** is moved by drive screw **76**. In this case the strand guide **48** continues to travel to the left until the actuator **116** on support arm **81** engages the fixed limit switch **112** to reverse the direction of drive screw **76**. At this time the strand guide **48** and the moving limit switch **103** both have traveled a distance

$$X.$$

The strand guide **48**, thereafter, is caused to move to the right through a distance

$$(Y-X)/2$$

when the actuator **113** engages the moving limit switch **103** to cause the drive screw **76** to be reversed to reverse the direction of the strand guide **48** which then is driven to the left. As previously mentioned, the actuation of the moving limit switch **103** causes the clutch **92** to be deactuated to cease driving the second drive screw **93** and the cylinder **121** is actuated to return the limit switch **103** to its normal position adjacent to the end support **77**. The strand guide **48** continues moving to the left, until the wire **31** is in a position immediately adjacent to the leftmost flange **47** of reel **43**, traveling through a distance

$$(Y-X)/2$$

the total distance thus traveled by the strand guide **48** from the time the clutch **92** was actuated by the counter **117** is

$$X+(Y-X)/2+(Y-X)/2$$

which is equal to Y, representing substantially one complete layer of convolutions of wire **31** on the reel **43**. In this case, as in the one previously mentioned, the occurrence of the completed reel occurs when the path of the wire **31** is precisely adjacent to the leftmost flanges **47—47** of reels **43—43**. At this time a signal is generated on the second preset counter output P2 to initiate the operation of the snagger device **51**.

Thus it is seen that the distributor **36** may be controlled to insure that the path of the wire **31** being taken up is adjacent to the left flange **47** of the reel **43** adjacent to the snagger device **51** at the time of cutover.

B. Turret and Arbor Assembly

Referring to FIG. **15**, each arbor **42** includes a hub **126** secured to a hollow shaft **127** mounted for rotation in bearings **128—128** in a hub **129** and bearings **131** mounted in a sleeve **132**, both aligned with one another and formed in turret **37**. A reel **43** may be mounted on hub **126** with a bevelled interior face **133** of drum **46** in frictional engagement with a chamfered edge **136** of a flange **137** formed on the hollow shaft **127**.

A central hub **138** formed in the turret **37** is journaled in the sleeve bearing **38** disposed in the hub **41** on the frame **33**. Each end of the turret **37** is provided with a roller bearing **139** fastened to a plate **141** secured to each end of the turret **37**. Each bearing **139** is designed to perform one of two functions, dependent upon the position of the turret end associated therewith. The bearing **139** at the end of the turret **37** in the upper position engages a microswitch **142** when the turret is vertically aligned as shown in FIGS. **1** to **3**. Microswitch **142** controls a solenoid **143** (FIGS. **24** and **25**) which selectively operates a valve **146** to actuate a pneumatic cylinder **147** which causes a turret lock **148** (FIGS. **22** and **24**) to lock turret **37** from rotational movement and to disengage the driving means therefor. The bearing **139** in the lower position on vertically aligned turret **37** is received in a slot **151** on a support **152** secured to base plate **32** to prevent lateral movement or cambering of turret **37**.

A hollow shaft **153** is journaled in a set of bearings **156** mounted in central hub **138**. A pulley **157** keyed to hollow shaft **153** is drivably connected to a pulley **158** keyed to hollow shaft **127** through a timing belt **161**. Rotational movement of shaft **153** is imparted to arbor **42** through pulley **157**, pulley **158** and shaft **127**.

A solid shaft **162**, coaxial with shaft **153**, is journaled in bearings **164** mounted in hollow shaft **153**. A pulley **163** keyed to solid shaft **162** is drivably connected to a pulley **166** (FIG. **22**), similar to pulley **158** and keyed to the shaft **127** associated with the oppositely aligned arbor **42**, through a timing belt **167**. Rotational movement of shaft **162** is imparted to arbor **42** through pulley **163**, pulley **166** and shaft **127**.

C. Snagger Assembly

FIG. **15** shows a snagger support gear **171**, having circumferentially spaced teeth **172—172**, and mounted for rotation on bearings **173—173** on hub **129** of turret **37**. Gear **171** is formed with an eccentric peripheral bearing seat **176** having a circumferential surface canted with respect to the circumferential surface defined by the spaced teeth **172—172**. More specifically, the centerline or central axis of the bearing seat **176** on gear **171** intersects the central axis of the teeth **172—172** thereof at an approximate angle of 1° counterclockwise from horizontal reference in FIG. **15**. One gear **171** is associated with each arbor **42** but is not drivably connected thereto. Though each gear **171** is rotatable about an axis through its associated arbor **42**, and the central axis of bearing seat **176** on gear **171** generates a right circular conical locus about an axis through arbor **42**, the rotation of gear **171** is independent of the rotational movement of arbor **42**.

Snagger support **53** is rotatably mounted on bearings **177—177** mounted on the eccentric bearing seat **176** of gear **171**. Snagger support **53** therefore assumes a canted orientation with respect to a plane normal to the central axis of arbor **42** and the central axis of turret **37**. More specifically, the principal plane of snagger support **53** is tilted counterclockwise at an angle of approximately 1° from a vertical reference in FIG. **15**.

One end of snagger support **53** is formed with an opening **178** for receiving the snagger **52**. An opposite end of snagger support **53** is formed with a slot **181** for receiving a weight **182** fastened therein to counterbalance the snagger **52**. A roller **183** rotatably mounted on a peripheral section of the flange **137** on shaft **127** extends into an aperture **186** formed in snagger support **53**. Rotation of hollow shaft **127** causes roller **183** to bear against an adjacent edge of the aperture **186** to rotate snagger support **53** with the arbor **42**. As previously mentioned, the snagger support **53** rotates with arbor **42** and at an angle with respect to the axis thereof to oscillate the snagger **52** toward the reel **43** on arbor **42** when snagger **52** is below a horizontal plane through

the axis of arbor 42 and away from reel 43 when the snagger 52 is above a horizontal plane through the axis of arbor 42.

In order to maintain the canted orientation of the snagger device 51, the central axis of the bearing seat 176 on gear 171 must be maintained at a constant angle to a horizontal reference plane; otherwise a 180° rotation of the turret 37 will position the gear 171 in an inverted position from that shown in FIG. 15 with the result that the orbiting snagger 52 will oscillate toward the reel 43 on arbor 42 when the snagger 52 is in a position above a horizontal plane through the axis of arbor 42. The occurrence of the foregoing condition would create the risk of interference with or re-snagging of the wire 31 being distributed onto the reel 43 at a time subsequent to cutover. To prevent the foregoing condition from occurring, the apparatus must be arranged such that for each increment of rotation of the turret 37, gear 171 must be rotated an equal increment in the opposite direction to compensate for the rotation of turret 37. Stated otherwise, each gear 171 must be arranged for resultant translation movement with respect to the remainder of the apparatus. The compensation for each gear 171 is accomplished by connecting a sun gear 187 (FIGS. 15 and 22), fixedly secured to frame 33, to each gear 171 through a planetary gear 188 and a connecting gear 191 mounted on a shaft 192 extending through and journaled in the sides of turret 37. The gears 187, 188, 191 and 171 are arranged to provide a 1:1 ratio between gears 187 and 171.

As seen most clearly in FIG. 22, any rotary movement of turret 37 about central axis C will cause planetary gears 188—188 to undergo epicycloidal movement with respect to sun gear 187, thus rotating connecting gears 191—191 and the snagger support gears 171—171 connected thereto. Thus for every increment of rotation of turret 37 about central axis C, there is a corresponding increment of rotation in the opposite direction of gears 171—171 to keep the snagger devices 51—51 properly canted with respect to arbors 42—42 and reels 43—43 thereon.

The structure of each snagger 52 is illustrated in FIGS. 16 and 17. The snagger 52 includes a block 193 and a clamp 196, pivotally secured to the block 193 by a partially threaded shoulder screw 197 fastened in a threaded aperture 198 formed in a bevelled surface 201 formed on block 193. The block 193 is formed on its underside with a pair of spaced retaining members 202—202 each formed with an aperture 203 therethrough for receiving a pivot pin 206 which supports a pivot element 207. The pivot element 207 is normally biased clockwise by a torsion spring 208 with one end of the element 207 in abutting engagement with the underside of block 193. As shown in FIG. 18, block 193 is also formed with a bore 211 for receiving a compression spring 212 and a threaded counterbore 213 for receiving a removable stop 216 threaded therein and engaging spring 212. A slot 217 is formed in the underside of the block 193 communicating with the bore 211 for receiving a pin 218 press-fitted therein.

Referring once again to FIGS. 16 and 17, one end of the block 193 is formed with a laterally projecting, semiarcuate gripping jaw 221 having a series of serrations 222 formed on the arcuate portion thereof. The clamp 196 is formed with a corresponding semiarcuate gripping jaw 223 having a relatively smooth arcuate surface. When the snagger 52 is not being revolved, the clamp 196 assumes an offset, pivoted position clockwise about the axis of screw 197 in the direction of arrow 226 shown in FIG. 17. When the snagger 52 is being revolved due to rotation of the snagger support 53, centrifugal force causes the clamp 196 to pivot counterclockwise in the direction of arrow 227 until a pin 228 mounted therein engages an arcuate notch 231 in the block 193 to prevent further pivoting. At this time the jaws 221 and 223 are aligned to form a strand-receiving opening 232.

The snagger 52 is constructed to be moved into the path of the wire 31 to receive it in opening 232 to grip the wire 31 securely between the jaws 221 and 223. When it is desired to remove the wire 31 from the snagger 52, it is merely necessary to remove the reel 43 upon which the wire is wound by sliding the reel off of the arbor 42 supporting the reel. Removal of the reel will cause a force to be exerted on the wire 31, as shown in phantom in FIG. 17, to separate the jaws 221 and 223 to pull the wire 31 free from the opening 232 between the jaws and around the smooth arcuate surface of the jaw 223. Thus the snagger 52 is provided with a self-cleaning capability which automatically releases the gripped section of the wire 31 without operator assistance in the release operation.

Referring to FIG. 18, each snagger 52 is slidably disposed in bearings 233—233 mounted in the opening 178 formed in the snagger support 53. The snagger 52 is normally biased into a retracted position within the support 53 by the action of the spring 121 against pin 218 which has a shank portion 236 disposed in a bore 237 formed in support 53. The pivot element 207, aided by torsion spring 208, normally abuts a steel roll 238 to lock the snagger 52 in its retracted position.

An arcuate cam lever 241 (FIGS. 18 and 19) is one of a pair thereof, pivotally mounted at each end of the turret 37 by a pivot pin 242. The opposite end of the lever 241 is formed with bifurcations 243—243 for receiving a revolvable eccentric disc 246. As shown in FIG. 19, the disc 246 is secured eccentrically to a shaft 247 coupled to a linkage member 248 connected to a movable armature 251 of a solenoid 252 by a connecting rod 253. The solenoid 253 may be secured to the inside wall of turret 37. A tension spring 254 disposed between the solenoid 252 and a stop 255 on rod 253 normally acts to bias the rod 253 upward and to the left (FIG. 19) to pivot linkage member. The solenoid 252, associated with each snagger device 51, may be energized selectively to rotate shaft 247 partially about its axis to rotate eccentric disc 246, to pivot the lever 241 about pin 242. When the solenoid 252 is de-energized the lever 241 is automatically returned to its normal unpivoted position by the action of spring 254.

During normal operation when the snagger support 53 is rotated, it passes, for a portion of its path, adjacent to the cam lever 241. As shown in FIGS. 18 and 19, a detent member 256, having a flanged end 257, is rotatably supported in the snagger support 53. The lower part of the flanged end 257 is spaced from the arcuate surface of lever 241 when the snagger support 53 passes adjacent to lever 241. When the counting system 117 generates a signal on output P2 thereof indicating

that an amount of wire representative of a full reel thereof has been taken up onto the active reel **43**, the solenoid **252** is energized to pivot the lever **241** to engage flanged end **257** of the revolving detent member **256**. Upon engagement with the pivoted lever **241**, the detent member **256** partially rotates causing a pin **258**, biased by a compression spring **261** into an arcuate notch **262** formed in detent member **256**, to move upward within a bore **263** in the snagger support **53** against the action of spring **261** into engagement with pivot element **207** to move it against the action of torsion spring **208** out of abutting engagement with the roll **238** to unlock or trigger the snagger **51**.

A centrifugal force component acts to drive the unlocked snagger **52** slidably outward from the support **53** into an extended position to grip, sever and clamp a section of the wire **31** at a portion thereof adjacent to the leftmost flanges **47—47** of reels **43—43** when the extended snagger **52** is revolved into position between the supported take-up reels. Thereafter the wire **31** is wound onto the upper empty take-up reel associated with the extended snagger **52**, which continues to revolve in its extended position, retaining the gripped wire **31** therein. The wire **31** is retained in the snagger **52** until the reel **43** associated therewith is removed from its arbor **42** at which time the absence of centrifugal force allows the clamp **196** to assume its offset, pivoted position to facilitate removal of the section of the wire **31** held between the jaws **221** and **223** as previously described. The absence of centrifugal force also permits the snagger **52** to be self-retracted into the snagger support **53** by the spring **212** to cause the pivot member **207** to ride back over the roll **238** to assume the initial locked position shown in FIG. **18**. Thus the triggering mechanism for each snagger device **51** is automatically reset when its associated arbor **42** stops rotating.

D. Reel Locking Assembly

FIG. **15**, taken in conjunction with FIGS. **20** and **21**, illustrates the arrangement and operation of the three reel locking mechanisms **266—266** associated with each arbor **42** for releasably retaining a reel **43** thereon. An elongated member or shaft **267** having a head **268** formed on one end thereof is slidably disposed axially within the hollow shaft **127** and the hub **126** of the arbor **42**. A yoke **271** on a piston **272** connected to a pneumatic cylinder **273** mounted in the frame **33** is designed to receive the head **268** on the shaft **267** associated with the arbor **42** positioned adjacent to the base **32** whenever the turret **37** is rotated to interchange the vertical positions of the aligned arbors **42—42**. The shaft **267** is formed along an intermediate section thereof with three circumferentially spaced longitudinal slots **276—276**, one of which is shown in FIGS. **15** and **21**. A roller **277** is mounted in an intermediate portion of each slot **276**.

Each hub **126** is formed with three circumferentially spaced cavities **278—278** therein, each of which communicates with the hollow interior thereof. The locking mechanisms **266—266** are freely or floatably disposed within cavities **278—278** but are confined therein by the walls thereof to prevent substantial longitudinal and lateral movement. Each of a pair of aligned apertures **281** and **282** formed in the periphery of hub **126** communicates with each cavity **278**. Each locking mechanism **266** cooperates with an associated roller **277** in the slot **276** of shaft **267** to lock and release a reel **43** on an arbor **42** at selected times during the handling thereof.

Each mechanism **266** includes an arm **283** having first and second arcuate cam surfaces **286** and **287**, respectively, and a shoulder **288** formed thereon. When the reel **43** is locked to the arbor **42**, a roller **277** in shaft **267** engages cam surface **286**. Arm **283** is pivotally connected to a yoke **291** by a pivot pin **292**. The shoulder **288** projects into the aperture **281** and engages a lug **293** on hub **126**. A clamping block **296** having bevelled surfaces **297** and **298** on a projection **301** thereof extending through aperture **282**, is coupled to yoke **291** by a pin **302** threaded therein. Pin **302** extends through a bore **303** in block **296**, and is formed with a head **306** disposed in a counterbore **307** for retaining a plurality of washer-type springs **308—308** therein. The threaded end of pin **302** is prevented from becoming unthreaded from yoke **291** by a set screw **311**.

As illustrated in FIG. **15**, with the shaft **267** positioned as shown, wherein a slot **276** in shaft **267** is offset from a cavity **278** in hub **126**, a reel **43** may be clamped onto arbor **42** with the bevelled surfaces **133—133** on drum **46** of the reel **43** retained between the bevelled surface **136** of hollow shaft **127** and surfaces **297—297** of clamping blocks **296—296** respectively. This clamping action is accomplished by the rollers **277—277** acting against cam surfaces **286—286** of arms **283—283** pushing arms **283—283** downward into a locked position, urging shoulders **288—288** against lugs **293—293**, and the leading peripheral portion of shaft **267** acting against the clamping blocks **296—296**. This action is aided by the elastic force exerted by springs **308-308** which tend to urge clamping blocks **296—296** leftward resiliently to retain reel **43** on arbor **42** and to compensate for variances in reel hub lengths.

When it is desired to remove the reel **43** from the arbor **42**, the pneumatic cylinder **273** is actuated to slide shaft **267** axially to the right until each slot **276** is moved from its offset position with respect to each cavity **291** to a position subtending the cavity **291** as shown in FIG. **21**. As the shaft **267** is moved to the right, each roller **277** moves from engagement with an aligned cam surface **286** horizontally, unlocking arm **283**. Each unlocked arm **283** pivots about pin **292** moving the cam surface **287** into engagement with roller **277**. When slot **276** ultimately clears the clamping block **296**, the latter is permitted to be pivoted about pin **292** upwardly into slot **276**. It is of minor consequence whether or not the clamping block **296** actually pivots upwardly since if it does not, the only force which prohibits removal of the reel **43** slidably to the right is the weight of the adjacent portions of clamping blocks **296—296** which are small when compared to the weight of the reel **43** especially if the reel is wound with a full accumulation of strand thereon.

E. Drive System

Referring to FIG. **22**, the drive system for the take-up apparatus **30** is shown. A hydraulic dashpot or motor **313** drives the turret **37** through a gear **314**, mounted on an output shaft **315**, which engages a gear **316** secured to the hub **138** on the turret **37**. The ratio of gear **314** to gear **316** is chosen to such that gear **316**,

and therefore the turret 37, rotates 180° for a 270° rotation of gear 314 by motor 313. Motor 313 is mounted on a plate 317 secured to a rocker arm 318 controlled by a face cam 319 of turret lock 148. As discussed in detail below in connection with the pneumatic system of FIG. 24, the turret lock 148 may be actuated to bolt-lock the turret 37 from movement and to disengage gear 314 from gear 316 after the positions of the reels 43–43 are interchanged.

Each arbor 42 and its associated snagger device 51 is driven independently by one of a pair of identical electrically energized speed-controlled motors 320 and 321. As explained in more detail in connection with the hydraulic system of FIG. 23, the motors 320 and 321 are coupled to a pair of pumps 322 and 323, respectively, to vary the speed of distributor motor 62 in accordance with the speed of the motor driving the reel taking up the wire 31 to control the rate of distribution of the wire 31 onto the reels 43—43.

The motor 320 drives the arbor 42, shown in the upper vertical position on turret 37, through a pulley 326 keyed to solid shaft 162 and coupled to a pulley 327 on an output shaft 328 of motor 320 through a timing belt 331. As previously explained, rotation of shaft 162 drives the hollow shaft 127 secured to upper arbor 42 through pulley 163 on shaft 162 and pulley 166 on shaft 127, drivably coupled to one another by timing belt 167.

The motor 321 drives the arbor 42, shown in the lower vertical position on turret 37, through a pulley 332 on a motor output shaft 333 coupled to a pulley 336 keyed to hollow shaft 153 by a timing belt 337 to drive shaft 127 secured to lower arbor 42 through pulley 157 on shaft 153 and pulley 158 on shaft 127, drivably coupled to one another by timing belt 161.

As previously mentioned, every increment of rotation of turret 37 about central axis C by the energization of motor 313 produces a similar opposite increment of rotation of snagger support gears 171—171, through sun gear 187, planetary gears 188—188 and connecting gears 191—191, to compensate gears 171—171 for the rotation of the turret 37 to keep snagger devices 51—51 properly oriented with respect to their associated arbors 42—42 and the reels 43—43 thereon.

Further, as previously mentioned, the distributor 36 is operated by a reversibly driven hydraulic motor 62, under the control of reel motors 320 and 321 and pumps 322 and 323. Motor 62 is directly coupled to drive screw 76 and is selectively coupled to drive screw 93 through clutches 88, 89 and 92.

F. Control Systems

Referring to FIGS. 23, 24, 25 and 26, the hydraulic control system, the pneumatic control system and the electrical control system, respectively, for the take-up apparatus 30 are shown.

As illustrated in FIG. 23, a hydraulic system for controlling the distributor motor 62 includes a reservoir 339 containing hydraulic fluid at atmospheric pressure. Fluid is pumped from reservoir 339, containing hydraulic fluid at atmospheric pressure, through a supply line 340 connected to the reel-motor-driven fluid pumps 322 and 323 through a pair of spring-centered, double-solenoid operated valves 341 and 342 under the control of two sets of solenoids 343 and 344 and 345 and 346, respectively, to the motor 62. Pumps 322 and 323 and valve 341 determine the speed of motor 62, while valve 342 determines the direction of rotation of motor 62. Though both valve 341 and valve 342 are shown in their spring-centered neutral positions, it should be understood that one solenoid associated with each valve will be energized when the take-up apparatus 30 is being operated.

When either solenoid 343 or solenoid 344 is energized, valve 341 is operated to direct fluid to motor 62 through a high fluid pressure line 347 and valve 342. Solenoids 343 and 344 are alternately operated in response to the cutover signal represented by the pulse on output P2 of counter 117.

Solenoids 345 and 346 are operated upon the actuation of control limit switches 112 and 103, respectively, by the movement of strand guide 48, to direct fluid reversibly to motor 62 to reverse the direction of drive screw 76 and strand guide 48. Fluid is returned to the reservoir 339 through a pressure regulator 338 which insures smooth operation of motor 62 and a filter 348 both connected in a return line 349.

As illustrated in FIG. 24, pressurized air for the pneumatic control system is directed from an air supply 350 through a four-way, spring return, solenoid-operated valve 351 operated by a solenoid 352, to a supply line 353. As mentioned previously, the movable limit switch return cylinder 121 is controlled through a four-way, spring return, solenoid-operated valve 123, operated by the solenoid 124 to direct air from the supply line 353 to cylinder 121 to force piston 122 outward to move arm 106, and switch 103 thereon, to its normal position abutting the stop 111 on end support 77 of the distributor 36.

The driving means for the turret motor 313 includes a four-way, spring-return, solenoid-operated valve 354 operated by a solenoid 355 to direct air from supply line 353 to a first air-oil tank 356 where the air pressure forces oil from the tank 356 into the left side of the motor 313 to rotate a vane 357 therein 270°. The vane 357 is coupled to shaft 315 to rotate gear 314 through an angle of 270°, thereby rotating gear 316 on hub 138 and the turret 37 through an angle of 180°, to interchange the positions of the reels 43—43 (FIG. 22). Oil exists from the right side of motor 313 and passes through a cam-controlled valve 358 into a second air-oil tank 359. The vane 357 in motor 313 is coupled to a cam 360 which rotates therewith to move a cam follower 361 on valve 358 to close valve 358 gradually as the turret 37 completes the latter portion of its 180° rotation. This is necessary to insure a controlled rotation of the turret 37 since the weight of the full reel in the upper position on turret 37 might otherwise cause the turret 37 to whip around too quickly after its initial movement creating the risk of damage to or misalignment of the apparatus due to the stresses involved.

As previously mentioned, operation of the turret lock 148, discussed in detail below, causes the gears 314 and 316 to disengage to permit motor 313 to be reset upon the de-energization of solenoid 355, operating valve 354 to direct air into tank 359, forcing oil through a one-way check valve 361 into the right side of motor 313 to move vane 357 back to its original position. The oil then exits the left side of motor 313 and enters the tank 356 to await the next cycle of operation.

The turret lock 148 is controlled by the four-way, spring-return, solenoid-operated valve 146 under the control of solenoid 143. When solenoid 143 is energized, valve 146 is operated to direct air from line 353 into cylinder 147 to retract a piston 362, partially rotating face cam 319 which is coupled thereto. The face cam 319 is formed on opposite sides with a pair of complementary cam slots 363 and 364 for receiving a pair of cam followers 365 and 366, respectively. The cam follower 365 is coupled to a bolt 367 (FIG. 22) while the cam follower 366 is coupled to the rocker arm 318. Each of the cam slots 363 and 364 are formed for approximately half their lengths with arcuate portions having a center of curvature which coincides with the center of face cam 319.

During the first half of the movement of face cam 319, the cam follower 365 is moved outwardly to move bolt 367 into a notch 368 in the hub 138 to lock the turret 37 from movement, while the cam follower 366 rides in the slot 364 without movement. During the second half of the movement of face cam 319, the cam follower 365 rides in the slot 363 without further movement, holding bolt 367 in locked position while the cam follower 366 is moved inwardly to pivot rocker arm 318 and plate 317 connected thereto to disengage gear 314 on motor 313 from gear 316 on hub 138, thus allowing motor 313 to be reset.

The reel locking and unlocking cylinder 273 is actuated through a four-way, spring-return, solenoid-operated valve 369 under the control of a solenoid 370, shown energized, selectively to lock the locking mechanisms 266—266 in the arbor 42 aligned with the cylinder 273.

As shown in FIGS. 25 and 26 arranged as shown in FIG. 27, power is supplied to the electrical system from a suitable 220 volt 60hz source of E.M.F. connected at terminals 371—371 to lines 372 and 373 and through a suitable step-down transformer 374 to lines 375 and 376. The solenoid 352 for operating valve 351 to direct air to the pneumatic control system of FIG. 24 may be energized by an operator closing a switch 377 which connects solenoid 352 across lines 375 and 376.

Connected across lines 375 and 376 are a pair of motor starting relays 381 and 382 in series with a pair of push-button start switches 383 and 386 and a pair of emergency-stop push-button switches 387 and 388, respectively. When one of the motor start buttons 383 or 386 is depressed, the associated relay 381 and 382 is energized to close a contact 391 or 392 connecting a reel driving motor 320 or 321, respectively, across lines 372 and 373 to energize the associated motor. Energization of motor start relay 381 or 382 also closes a contact 393 or 396, respectively, to complete a holding circuit for keeping relay 381 or 382 energized to permit the operator to release either depressed motor start button without stopping its associated motor.

Both motor 320 and motor 321 are provided with suitable speed-control systems (not shown) to match the constant linear speed of the advanced wire 31 by reducing the rotational speed of each arbor 42 as the winding diameter of reel 43 thereon increases. The speed-control systems may be, for example, of the type disclosed in Hauck et al. U. S. Pat. No. 3,408,013, assigned to the assignee of the present invention.

Closure of microswitch 142 by the bearing 139 on turret 37 in the upper position energizes the solenoid 143 through a normally closed contact 397 of a relay 398 to operate a valve 146 to actuate cylinder 147 to engage the turret lock 148.

The counting system includes a follower sheave 401 in rolling contact with the advancing wire 31. Sheave 401 is mechanically coupled to and drives a pulse generator 402 which indicates the length of wire advanced past sheave 401 by feeding pulses to counter 117, for example, one pulse for every 2 feet of wire advanced. As previously mentioned, counter 117 is provided with two preset outputs P1 and P2.

A pulse is generated on output P1 of the counter 117 when the total number of pulses from the pulse generator 402 is representative of a total length of wire 31 wound upon a reel 43 equal to a predetermined length of wire less than the desired length of wire on a full reel. For example, if it is desired to have 26,000 feet of 24 gauge insulated wire on each reel, preset output P1 may be adjusted to render an output pulse when the total number of pulses fed to counter 117 indicates that 25,000 feet, or 1000 feet less than the desired amount of wire has been taken up by the active reel 43.

Similarly, a pulse is generated on output P2 of the counter 117 when the total number of pulses fed to counter 117 from the pulse generator 402 is representative of a total length of wire 31 wound upon a reel 43 equal to the desired amount. In the chosen example, an output pulse would be rendered on output P2 when the total number of pulses fed to counter 117 indicates that 26,000 feet of insulated wire has been taken up on the active reel 43.

The output P1 of counter 117 is coupled to a first toggle or flip-flop 403 having complementary d.c. voltage level outputs 404 and 406 through a relay 407. Output 404 of flip-flop 403 is coupled to the enabling input of a gate 408 serially connected to a relay 409 having a contact 411 which closes when relay 409 is energized to energize motor starting relay 392 to energize motor 321. Output 406 of flip-flop 403 is coupled to the enabling input of a gate 412 serially connected to a relay 413 having a contact 416 which closes when relay 413 is energized to energize motor starting relay 381 to energize motor 320. The flip-flop 403 responds to pulses at its input 417 by changing the state of the output voltage levels at outputs 404 and 406. Thus, flip-flop 403 changes state after each received pulse generated on output P1 of counter 117. Each of the gates 408 and 412 is designed to respond to a high d.c. voltage level from the flip-flop output associated therewith.

When an output pulse is generated on counter output P1, a contact 414 of relay 407 closes momentarily to connect the gates 408 and 412 to line 375. When either gate 408 or 412 is enabled by a high d.c. voltage level on its associated flip-flop output, a circuit is completed across lines 375 and 376 to energize a relay 418 and the relay 398. When relay 418 is energized, a contact 422 thereof is closed to energize the clutch-actuating solenoid 118 and a relay 424, closing a make contact 425 thereof, to establish a holding circuit for solenoid 118 through a break contact 426 of a clutch-release relay 427. Solenoid 118, when energized, actuates clutch 92 to drive the second drive screw 93, moving the arm 106, and the limit switch 103 thereon, away from its normal position adjacent to the right end support 77

toward the fixed limit switch **112** (FIG. **12**), moving piston **122** into the air cylinder **121**. When limit switch **103** is subsequently closed by actuator **113** carried by support arm **81**, the clutch-release relay **427** and solenoid **124** are energized. When relay **427** is energized, the normally closed contact **426** thereof opens to de-energize clutch solenoid **118** to disengage clutch **92** so that the drive screw **93** is no longer being driven. Energization of solenoid **124** operates valve **123** which actuates cylinder **121** to move piston **122** to the right to return the arm **106** to its position adjacent to end support **77**.

When relay **398** is energized, a contact **431** thereon closes to energize solenoid **355** and a relay **432**. Energization of solenoid **355** operates valve **354** to force oil from air-oil tank **356** into turret motor **313** to rotate vane **357** clockwise (FIG. **24**) 270° to rotate turret **37** through gears **314** and **316** through an angle of 180° to interchange the positions of the arbors **42—42**. Energization of relay **432** closes a make contact **433** to set up a holding circuit therefor through a break contact **434** of relay **436**. Contact **397** of relay **398** opens to de-energize solenoid **143** to permit valve **146** to reverse the fluid through cylinder **147** to unlock the turret **37**.

When contact **397** is opened, the relay **436** de-energizes to close contact **434**, completing the holding circuit for relay **432**. As the turret **37** rotates to interchange the positions of the reels **43—43**, the bearing **139** associated with the upper reel moves out of engagement with microswitch **142** opening the latter. When the bearing **139** associated with the now-revolving lower reel subsequently engages microswitch **142**, relay **436** is energized to open the holding circuit for relay **432** to de-energize relay **432** and solenoid **355** to cease driving the turret motor **313**. At this time solenoid **143** is again energized to operate valve **146** to actuate turret lock **148**.

The output P2 of counter **117** is coupled through a relay **437** to a second flip-flop **438** having complementary d.c. voltage level outputs **439** and **441** coupled to the enabling inputs of a gate **442** and a gate **443**, respectively. The operation of flip-flop **438** and gates **442** and **443** by a pulse on output P2 of counter **117** is identical in all respects to the operation of the flip-flop **403** and the gates **408** and **412** at counter output P1. Each of the gates **442** and **443** is designed to respond to a high d.c. voltage output level from the flip-flop output associated therewith.

When a pulse is generated on counter output P2 a contact **444** of relay **437** momentarily closes and a high d.c. voltage level on output **439** enables gate **442** to energize a relay **446**, a relay **447** and the solenoid **252** associated with the snagger device **51** adjacent to the arbor **42** driven by the motor **321**.

Energization of relay **446** closes a made contact **448** thereof and opens a break contact **451** thereof. Closure of contact **448** energizes solenoid **343** to operate valve **341** to direct fluid from pump **323**, driven by motor **321**, to distributor motor **62**, through valve **342**, to control the rate thereof. The solenoid **343** is held operated by a holding circuit through a contact **452** on a relay **453** which is also energized upon closure of contact **448**. Solenoid **344** is simultaneously de-energized since the opening of contact **451** of relay **446** causes a relay **454** to become de-energized, opening a holding circuit therefor through a contact **455**. Energization of relay **447** opens a break contact **456** to open the circuit to motor start relay **381**, opening contact **391** thereof to cease supplying current to reel motor **320**. Energization of the snagger solenoid **252**, associated with the snagger device **51** adjacent to the arbor **42** driven by motor **321**, pivots the lever **241** associated therewith to trigger the associated snagger **52**.

Similarly, a high d.c. voltage level on output **441** of flip-flop **438** enables the gate **443** to energize a relay **457**, a relay **458** and the solenoid **252** associated with the snagger device **51** adjacent to the arbor **42** driven by the motor **320**.

Energization of relay **457** opens a break contact **461** and closes a make contact **462** thereof. When contact **461** opens, solenoid **343** and relay **453** are de-energized, opening the holding circuit through contact **452**. Closure of contact **462** energizes solenoid **344** and relay **454** through contact **451** of relay **446**. Solenoid **344** and relay **454** are held energized through holding contact **455**. As previously mentioned, the energized solenoid **344** operates valve **341** to direct fluid from pump **322**, driven by motor **320**, to distributor motor **62**, through valve **342**, to control the rate thereof. Energization of relay **458** opens a break contact **461** to open the circuit to motor start relay **382**, opening contact **392** thereof to cease supplying current to reel motor **321**. Energization of the snagger solenoid **252**, associated with the snagger device **51** adjacent to the arbor **42** driven by motor **320**, pivots the lever **241** associated therewith to trigger the associated snagger **52**.

Closure of fixed limit switch **112** by actuator **116** on support arm **81** energizes a relay **462** which closes a contact **463** thereof to establish a holding circuit therefor through a break contact **466** of relay **467**. A contact **468** of relay **462** closes to energize distributor solenoid **345** to operate valve **342** to direct fluid through distributor motor **62** to rotate drive screw **76** in a first direction to move the support arm **81** and the strand guide **48** to the right (FIG. **12**). A contact **471** of relay **462** opens to open a holding circuit for the relay **467**. When the actuator **113** on arm **81** closes movable limit switch **103**, the relay **467** is energized to open break contact **466** thereof to open the holding circuit for relay **462** to de-energize relay **462**, closing contact **471** thereof to set up the holding circuit for relay **467**. Contact **472** of relay **467** closes to complete the holding circuit therefor and contact **473** closes to energize distributor solenoid **346**. When the distributor solenoid **346** is energized the valve **342** is operated to reverse the direction of rotation of motor **62** to drive screw **76** in a second reverse direction to move the support arm **81** and the strand guide **48** to the left.

The unlocking of the normally locked reel locking mechanisms **266—266** is controlled by an operator closing a switch **476** which energizes the solenoid **370** to operate valve **369** to reverse the fluid in cylinder **273** to move piston **272** therein and the shaft **267** to the right, as shown in FIG. **21**, to permit the clamping members **301—301** to pivot upward so that a full reel **43** can be removed and replaced with an empty reel. If automatic loading and unloading facilities are utilized with the apparatus **30**, the unlocking of the reel locks would also be automatic, the solenoid **370** being energized in response to the operating signal for the unloading facility.

3. Operation

With the take-up apparatus **30** having the turret **37** positioned to orient the reels **43—43** as shown in FIGS. **1** to **3**, with the reel in the upper position on turret **37** drivably connected to motor **320**, and the leading end of wire **31** being gripped by a snagger **52**, an operator depresses the reel motor start push button **383** and closes air supply switch **377** (FIG. **25**).

Depression of push button **383** energizes motor start relay **381** through contact **456** of relay **447** and emergency-stop push-button switch **387**, closing contact **391** to energize reel drive motor **320** and contact **393** to hold relay **381** energized. Energized motor **320** rotates to drive the reel **43** in the upper position on turret **37** through pulleys **326** and **327**, shaft **162**, pulleys **163** and **166** and the shaft **127** associated with upper reel **43** (FIG. **22**). The rotary movement of motor **320** is imparted to pump **322** to supply hydraulic fluid from reservoir **339** to control the rate of distributor motor **62** through valve **341**, operated by energized solenoid **343** (FIG. **23**).

Closure of switch **377** energizes solenoid **352**, operating valve **351** to direct air from air supply **350** to the pneumatic system of FIG. **24**.

Assuming that the strand guide **48** is in its leftmost position as shown in FIG. **12** with actuator **116** on arm **81** engaging the fixed limit switch **112**, relay **462** will be energized closing contact **468** thereon, energizing solenoid **345** to operate valve **356** to direct fluid through distributor motor **62** to rotate drive screw **76** and move arm **81** and strand guide **48** thereon to the right. As the strand guide **48** moves to the right, the insulated wire **31** is advanced at a constant linear speed from an extruding process through guide rollers **87—87** and onto the winding surface of the rotating take-up reel **43** where the wire **31** is coiled thereon. Upon reaching the rightmost flange **47** of reel **43**, actuator **113** on arm **81** engages and closes limit switch **103**. Closure of limit switch **103** energizes relays **427** and **467**. Energization of relay **427** opens contact **426** thereof which has no effect at this time since it is in electrical series with normally open contact **422** of relay **418**. Energization of relay **467** closes contacts **472** and **473** thereof and opens contact **466** to open the holding circuit for relay **462**. Since limit switch **112** is open at this time, relay **462** de-energizes opening contact **468** to de-energize solenoid **345** to permit valve **342** to be neutralized momentarily in its spring-centered position, and closing contact **471** to complete the holding circuit for relay **467** through contact **472** thereof. Solenoid **346** is energized through now-closed contact **473** of relay **467** to operate valve **342** to reverse the direction of distributor motor **62** to reverse drive screw **76**, driving strand guide **48** to the left.

The strand guide **48** continues to be reciprocated to guide the wire **31** between the flanges **47—47** of the upper take-up reel **43** under the control of limit switches **112** and **103** and distributor motor **62** to distribute superimposed layers of convolutions of insulated wire **31** upon the winding drum **46** of the upper take-up reel **43**. When pulse generator **402** has fed a total number of pulses to counter **117** representative of an amount of accumulated wire on upper reel **43** equal to a predetermined amount of wire less than the amount of wire desired to make a full reel, a pulse is generated on preset output **P1** of counter **117**.

The output pulse on preset output **P1** of counter **117** changes the state of flip-flop **403** to establish a high d.c. voltage level on output **404** to enable gate **408**. The output pulse on **P1** also energizes relay **407** to close momentarily contact **414** to energize relay **409**, clutch relay **418** and turret relay **398**. Energization of relay **409** closes contact **411** to energize motor start relay **382** which closes contact **396** in the holding circuit therefor and closes contact **392** to energize the other reel drive motor **321** which rotates the empty reel, which occupies the lower position on turret **37**, through pulleys **332** and **336**, shaft **153**, pulleys **157** and **158** and the shaft **127** associated with the lower reel **43** (FIG. **22**). Energization of relay **418** closes contact **422**, energizing relay **424** which holds energized through now-closed contact **425** thereof energizing clutch solenoid **118** to engage clutch **92** and rotate the second drive screw **93** through shaft **67** and one of the clutches **88** or **89** depending upon the direction of drive screw **76** (FIGS. **12** and **22**). Rotation of drive screw **93** causes arm **106** and switch **103** to move to the left along drive screw **93** toward limit switch **112**, driving piston **122** to the left into cylinder **121**.

Energization of relay **398** closes contact **431** energizing relay **432**, closing contact **433** thereof to set up a holding circuit therefor through contact **434** of relay **436**, energized through closed microswitch **142**, and energizing solenoid **355**. Contact **397** of relay **398** opens to de-energize solenoid **143** which operates valve **146** to deactuate the turret lock **148** (FIGS. **22** and **24**). Relay **436** is also de-energized by the opening of contact **397** to close contact **434** to establish the holding circuit for relay **432** and solenoid **355**. Energization of solenoid **355** operates valve **354** to actuate turret motor **313** to rotate turret **37** and revolve the arbors **42—42** and the reels **43—43** thereon. When turret **37** has rotated 180°, now-open microswitch **142** is closed by the bearing **139** at the end of the turret **37** which has been rotated from the lower position adjacent to the base **32** to the upper position. Upon closure of microswitch **142**, relay **436** is energized to break the holding circuit for relay **432** to de-energize solenoid **355** to operate valve **354** to reset the vane **357** of turret motor **313**. At this time the solenoid **143** is again energized to operate valve **146** to lock turret **37** from movement and disengage gears **314** and **316**. The reel **43** taking up the wire **31** is now in the lower position on turret **37**. The empty reel **43** now occupies the upper position on turret **37** and is being driven by motor **321** as the wire **31** is advanced past the empty reel toward the full reel.

When the moving limit switch **103** is subsequently engaged by the actuator **113** on arm **81**, relays **427** and **467** and solenoid **124** are energized. Energization of relay **427** opens contact **426** to de-energize clutch solenoid **118** to disengage clutch **92** to cease driving drive screw **93**. Relay **424** in series with solenoid **423** is also de-energized to open contact **425** in the holding circuit for solenoid **118**. Energization of solenoid **124** operates valve **123** to actuate piston **122** of cylinder **121** to move arm **106** to its normal position adjacent end support **77**.

As mentioned previously, the energization of relay **467** causes distributor solenoid **345** to be de-energized and causes distributor solenoid **346** to be energized to operate valve **356** to reverse distributor motor **62** to

rotate drive screw 76 to move the strand guide 48 toward the left flange 47 of the empty reel 43 adjacent to the snagger device 51 associated therewith. At this time an output pulse is generated on preset output P2 of counter 117.

The output pulse generated on counter output P2 energizes relay 437 to close contact 444 and changes the state of the flip-flop 438 to generate a high voltage level on output 439 to enable gate 442 energizing snagger solenoid 252 and relays 446 and 447 through contact 444. The energization of the solenoid 252 pivots cam lever 241, associated with the empty reel 43, to rotate flange 257 of detent member 256 causing pin 258 to move pivot member 207 on snagger 52 upward to ride over roll 238. At this time centrifugal force thrusts the snagger 52 outwardly to catch and sever the wire 31 therein and remain in an extended or triggered position. The advancing wire 31 is now wound upon the empty reel in the upper position of turret 37.

Energization of relay 446 opens contact 451 to de-energize solenoid 344 and relay 454 breaking the holding circuit therefor through contact 455. When solenoid 344 is de-energized, valve 341 (FIG. 23) is momentarily rendered neutral. Contact 448 of relay 446 closes to energize solenoid 343 and relay 453, closing contact 452 to complete the holding circuit therefor. When solenoid 343 is energized, valve 341 is operated to direct fluid to distributor motor 62 from reservoir 339 through pump 323 driven by the motor 321 which drives the arbor 42 in the upper position on turret 37 to increase the distribution rate of the wire 31 on the newly positioned reel 43 now taking up the wire 31.

Energization of relay 447 opens contact 456 thereof to de-energize motor relay 381 which causes contact 391 thereof to open the supply circuit to motor 320 to stop the latter from rotating the now-full reel 43 in the lower position on turret 37. The operator may now close switch 476 to energize solenoid 370 to operate valve 369 to actuate cylinder 273 to move piston 272 and shaft 267 to the right, as shown in FIG. 21 to permit the locking mechanisms 226—226 to release the reel 43 from the lower arbor.

The operator or an automatic unloading apparatus may then act to pull the full reel 43 from the arbor 42 associated therewith, pulling the wire 31 from the jaws 221 and 223 of snagger 52. A new empty reel may be loaded onto the arbor 42 and the solenoid 270 may be de-energized to permit valve 369 to be positioned to retract piston 272 into cylinder 273, moving the shaft 267 into locking engagement with the reel locking mechanisms 266—266 in hub 126.

Upon the subsequent generation of a pulse on output P1 of counter 117, indicating that a predetermined amount of strand less that desired to make a full reel has been taken up on the formerly empty reel, relay 407 is again energized to close contact 414 and flip-flop 403 is caused to change state, this time generating a high voltage level on output 406 to enable gate 412. When gate 412 is enabled relays 413, 418 and 398 are energized through contact 414. Energization of relay 413 closes contact 416 thereof to energize motor relay 381 which closes contact 391 to energize reel motor 320 which rotates the new empty reel 43 in the lower position on turret 37. The relays 418 and 398 operate as previously explained to unlock the turret 37, rotate the turret 180°, stop,lock, disengage and reset the turret drive motor 313, and cause the distributor to direct the advancing wire 31 past the left flange 47 of the empty reel 43 now in the upper position on turret 37.

At this time a pulse is again generated on the counter output P2 to energize relay 437, closing contact 444 thereof and changing the state of flip-flop 438, this time generating a high voltage level on output 441 to enable gate 443. When gate 443 is enabled, solenoid 252 and relays 457 and 458 are energized through contact 444. Energization of the solenoid 252, associated with the empty reel 43 triggers the snagger 52 associated with the empty reel 43 in the upper position on turret 37, to catch, sever and grip the wire 31 to begin winding the wire 31 thereon.

Energization of relay 457 opens contact 461 to de-energize solenoid 343 and the relay 353, breaking the holding circuit therefor through contact 452. When solenoid 343 is de-energized, valve 341 (FIG. 23) is momentarily rendered neutral. Contact 462 of relay 457 closes to energize solenoid 344 and relay 454, closing contact 455 to complete the holding circuit therefor. When solenoid 344 is energized, valve 341 is operated to direct fluid to distributor motor 62 from reservoir 339 through pump 322, driven by the motor 320, which drives the arbor 42 in the upper position on turret 37 to increase the distribution rate of the wire 31 on the newly positioned reel 43 now taking up the wire 31. Energization of relay 458 opens contact 461 thereof to de-energize motor relay 382 opening contact 392 thereof to cease supplying electrical energy to the motor 321 driving the full reel 43 now in the lower position on turret 37 to stop the reel 43. Once again the full reel may be unlocked, removed and replaced either by an operator or suitable automatic apparatus.

The apparatus will thereafter continuously operate as described above, with each full reel 43 being removed and replaced with an empty reel in the lower position on turret 37.

It will be understood that the above-described arrangements are simply illustrative of the applications 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 without departing from the spirit and scope thereof.

What is claimed is:

1. A method of taking up a continuously advancing strand onto first and second transversely aligned take-up reels having winding surfaces defined between the ends thereof and mounted for rotation about spaced, parallel axes, which comprises the steps of:

driving the first reel;

distributing the advancing strand onto the first reel by guiding the strand back and fourth across the defined winding surface thereof to wind successive layers of convolutions of strand thereon;

driving the second reel;

interchanging the positions of the reels to position the second reel along the path of the strand being distributed onto the first reel;

altering the distribution of strand onto the first reel in a predetermined sequence by guiding a predetermined length of the advancing strand, representative of a final layer of convolutions of strand on the first reel back and forth onto a part of the winding

surface of the first reel, less than the defined winding surface, the end of said sequence occurring when the path of the strand is adjacent to predetermined end of the second reel, and

transferring the distributed strand from the first reel to the second reel at a time coincident with the end of said sequence.

2. A method of taking up a continuously advancing strand as set forth in claim 1, including the additional step of:

revolving an actuable snagger adjacent to one end of the second take-up reel about the axis of said second reel in a planar path at an angle with plane normal to the axes of the reels, and wherein the predetermined sequence of distribution of strand and the transfer thereof from the first reel to the second reel includes:

detecting a first predetermined amount of strand distributed onto the first reel;

altering the path of the distributed strand to position the path of the strand adjacent to the ends of the reels and near the snagger;

detecting a second predetermined amount of strand on the first reel, and

actuating the snagger when the second predetermined amount of strand is detected to grip and sever a section of strand in the path between the reels to wind the strand onto the second reel.

3. A method of reeling strand material continuously onto successive take-up reels in accordance with claim 2, which includes the additional step of:

maintaining the angle of the planar path of the snagger when the positions of the take-up reels are interchanged.

4. In an apparatus for reeling strand continuously onto successive take-up reels,

an arm rotatable about a central axis;

a pair of cantilevered arbors, each supported at one end of said arm and rotatable about an axis parallel to said central axis, for rotatably supporting a pair of take-up reels;

means for rotating said arm selectively about said central axis;

driving means for rotating each of said arbors independently of one another;

a pair of snagger devices, each mounted adjacent to the supported end of one of said arbors and rotatable therewith, for snagging an advancing strand;

means for orienting each of said snagger devices to position its principal plane at a predetermined angle with respect to a plane normal to the axes of said arbors, and

means for maintaining the principal planes of said snagger devices at said predetermined angle with respect to said normal plane when said arm is rotated.

5. An apparatus for taking up a continuously advancing strand onto first and second transversely aligned take-up reels having winding surfaces defined between the ends thereof and mounted for rotation about spaced, parallel axes, comprising:

means for driving the first reel;

means for distributing the advancing strand onto the first reel by guiding the strand back and forth across the defined winding surface thereof to wind successive layers of convolutions of strand thereon;

means for driving the second reel;

means for interchanging the positions of the reels to position the second reel along the path of the strand being distributed onto the first reel;

means for altering the distribution of the strand onto the first reel in a predetermined sequence by guiding a predetermined length of the advancing strand, representative of a final layer of convolutions of strand on the first reel back and forth onto a part of the winding surface of the first reel, less than the defined winding surface, the end of said sequence occurring when the path of the strand is adjacent to a predetermined end of the second reel, and

means for transferring the distributed strand from the first reel to the second reel at a time coincident with the end of said sequence.

6. An apparatus for continuously reeling strand material onto first and second rotatable reeling elements, which comprises:

a vertically disposed turret mounted for rotation about horizontal central axis;

first and second transversely aligned arbors, rotatably cantilevered at opposite ends of said turret for rotation about spaced horizontal axes for receiving the first and second reeling elements;

first and second rotatable snagger supports;

means mounting said snagger supports at a canted angle at the cantilevered ends of said arbors to position the principle planes of said supports at an angle with respect to a vertical plane;

a pair of snaggers;

means slidably mounted each of said snaggers in said snagger supports for movement from a retracted position within said supports to an extended position partially without said supports and extending radially outward of the ends of the reeling elements adjacent to said turret;

resilient means associated with each of said snaggers for urging said snaggers into said retracted positions within said supports;

releasable means for locking each of said snaggers into said retracted positions;

distributing means transversely aligned with said arbors and the reeling elements thereon and being vertically spaced from said turret adjacent to said first arbor for guiding an advancing strand back and forth across the winding surface of the first reeling element;

means for driving said distributing means to guide an advancing strand back and forth across the winding surface of the first reeling element;

means for driving said first arbor and a first of said snagger supports thereon in synchronism therewith to rotate the first reeling element to take up the distributed strand and to rotate said support to revolve said first retracted snagger therein about the axis of said first arbor in an annular path to oscillate said first snagger toward and away from the adjacent end of said first reeling element for alternate halves of the orbiting cycle of said first snagger;

means for detecting first and second accumulations of strand on said first reeling element;

first means responsive to the detection of said first accumulation of strand on said first reeling element for driving said turret to rotate said turret 180° to interchange the positions of said arbors and the reeling elements thereon to interpose the second reeling element between said distributing means and the first reeling element along the path of the strand to the first reeling element;

second means responsive to the detection of said first accumulation of strand for driving said second arbor and said snagger support thereon in synchronism therewith to rotate the second reeling element and said support to revolve said second retracted snagger therein about the axis of said second arbor in an annular path to oscillate said second snagger toward and away from the adjacent end of the second reeling element for alternate halves of the orbiting cycle of said second snagger;

third means responsive to the detection of said first accumulation of strand for altering the operation of said distributing means to distribute a length of strand equivalent to the difference between said first and second accumulations thereof in a predetermined sequence onto part of the winding surface of the first reeling element wherein the end of said sequence occurs when the strand is adjacent to the ends of the reeling elements adjacent to said orbiting snaggers, and

means responsive to the detection of said second accumulation of strand on the first reeling element for releasing said releasable means to unlock said revolving second snagger to permit centrifugal force to thrust said second snagger partially without said second snagger support against the urging of said resilient means associated therewith to grip and sever the strand adjacent to the end of the second reeling element associated with said second snagger to wind the strand onto the second reeling element.

7. An apparatus for continuously reeling strand material as set forth in claim **6**, wherein the difference between said first and second accumulations of strand is equal to the length of strand in the final layer of convolutions thereof on the first reeling element.

8. A method of gripping an advancing strand, comprising the steps of:

revolving a snagger about a first axis in an annular path having an axis intersecting said first axis at an angle to oscillate the snagger between a pair of spaced planes perpendicular to said first axis, and

imparting relative movement between the advancing strand and said snagger to position said strand in a path between said spaced planes intersecting the path of the revolving snagger whereby the snagger intercepts and grips the strand.

9. A method of gripping an advancing strand as set forth in claim **8**, wherein the imparting of the relative movement between the strand and said snagger includes the steps of:

guiding the advancing strand in a path past said revolving snagger, and

imparting translational movement to the revolving snagger selectively to intersect the path of the advancing strand to cause the snagger to intercept and grip the strand.

10. A method of snagging an advancing strand guided in a path past a take-up element and in proximity to the periphery thereof, which comprises the steps of:

revolving a snagger about a longitudinal axis through the take-up element in a first annular path having an axis canted with respect to the axis of the take-up element to oscillate the snagger between first and second spaced planes perpendicular to the axis of the take-up element and adjacent to an end thereof;

directing the guided strand transversely of the take-up element until it is adjacent to said planes, and

imparting translational movement selectively to the revolving snagger to move the snagger into a second annular path parallel to said first path intersecting the path of the strand to cause the snagger to intercept, grip and sever the strand to initiate the winding of the strand onto the take-up element.

11. A method of snagging an advancing strand in accordance with claim **10**, including the additional step of:

maintaining the snagger in the second annular path while it continues to revolve.

12. A method of effecting the transfer of a moving strand from a first driven reel to a second driven reel aligned transversely with said first reel, comprising the steps of:

guiding the strand onto the first reel past the second reel along a predetermined straight path generally tangent to the periphery of the second reel;

traversing the guided strand back and forth along the periphery of said reels between first and second planar limits normal to the axes thereof;

driving a revolvable snagger about the axis of the second reel in a circular path adjacent to and at an angle with the first planar limit, and

translating the circular path of the snagger selectively to intersect the first planar limit between said reels to catch, sever and grip the strand when it is adjacent to the first planar limit to wind the strand around the second reel.

13. Apparatus for gripping an advancing strand, comprising:

a snagger mounted for revolution about a first axis in an annular path having an axis intersecting said first axis at an angle;

means driving said snagger for oscillating said snagger between a pair of spaced parallel planes perpendicular to said first axis, and

means for imparting relative movement between the advancing strand and said snagger to position the strand in a path between said spaced planes intersecting the path of the revolving snagger whereby said snagger intercepts and grips the strand.

14. Apparatus for gripping an advancing strand as set forth in claim **13**, wherein said relative movement imparting means includes:

means for guiding the advancing strand in a path past said revolving snagger, and

selectively operable means for imparting translational movement to said revolving snagger to cause said snagger to intersect the path of said advancing strand and to intercept and grip said strand.

15. An apparatus for snagging an advancing strand guided in a path past a take-up element and in proximity to the periphery thereof, which comprises:

a snagger mounted for revolution about a longitudinal axis through the take-up element in a first annular path having an axis canted with respect to the axis of the take-up element;

means for driving said snagger to oscillate said snagger between first and second spaced planes perpendicular to the axis of the take-up element and adjacent to an end thereof;

means for directing the guided strand transversely of the take-up element until it is adjacent to said planes, and

means for imparting translational movement selectively to said revolving snagger to move said snagger into a second annular path, parallel to said first path, to intersect the path of the strand to intercept, grip, sever and retain the strand therein to initiate the winding of the strand onto the take-up element.

16. A snagging device for a continuous take-up unit wherein a continuously advancing strand is distributed in superimposed layers of convolutions onto the winding surface of a take-up reel rotating about an axis, which comprises:

a support member adjacent to the take-up reel and rotatable about an axis intersecting an axis spaced from and parallel to the axis of said reel at an angle;

a snagger clamp slidably mounted in said support member and having a body formed with a gripping surface and a block loosely mounted on said body;

resilient means urging said clamp into said support in a nonwire intercepting position;

releasable means for holding said clamp in said nonintercepting position, and

means responsive to a predetermined amount of strand material accumulated on said take-up reel for releasing said releasable means to permit said clamp to slide out of said support under the influence of centrifugal force into a wire-intercepting position.

17. An apparatus for transferring a moving strand being taken up by a first driven reel from the first reel to a second driven reel aligned transversely with the first reel, which comprises:

means for guiding the strand onto the first reel past the second reel along a predetermined straight path generally tangent to the periphery of the second reel;

means for traversing the guided strand back and forth along the periphery of the reels between first and second planar limits normal to the axes thereof;

a snagger mounted for revolution about the axis of the second reel adjacent to the first planar limit;

means for driving said snagger to revolve said snagger in a circular path adjacent to and at an angle with the first planar limit, and

means for translating the circular path of said snagger selectively to intersect the first planar limit between the reels to catch, sever and grip the strand when it is adjacent to the first planar limit to wind the strand around the second reel.

18. A device for snagging an advancing strand, which comprises:

a block formed with an arcuate wire-gripping jaw having coarse serrations formed thereon;

a clamp formed with an arcuate wire-gripping jaw;

means for securing said clamp loosely to said block with said jaws spaced apart and said clamp pivoted to an offset position with respect to said block;

a support rotatable about an axis;

means slidably mounting said block within said support;

means resiliently urging said block into a retracted position within said support;

locking means mounted on said support for holding said block in said retracted position;

detent means mounted in said support, coupled to said locking means and being resiliently movable from a first position to a second position for unlocking said locking means;

a lever pivotally mounted adjacent to said support and said detent means during a portion of the rotary movement of said support, and

means actuable to pivot said lever for engaging and moving said detent means to unlock said locking means to permit said block to be extended from said retracted position by centrifugal force against the urging of said resilient means, centrifugal force acting also to pivot said clamp from its offset position to align said gripping jaws for snagging engagement with the advancing strand.

* * * * *