Feb. 14, 1961 C. E. HAUER 2,971,711

APPARATUS FOR REELING STRAND

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FIG. 3 (FIG. 4 | FIG. 6)

FIG. 2 (FIG. 4 | FIG. 5)

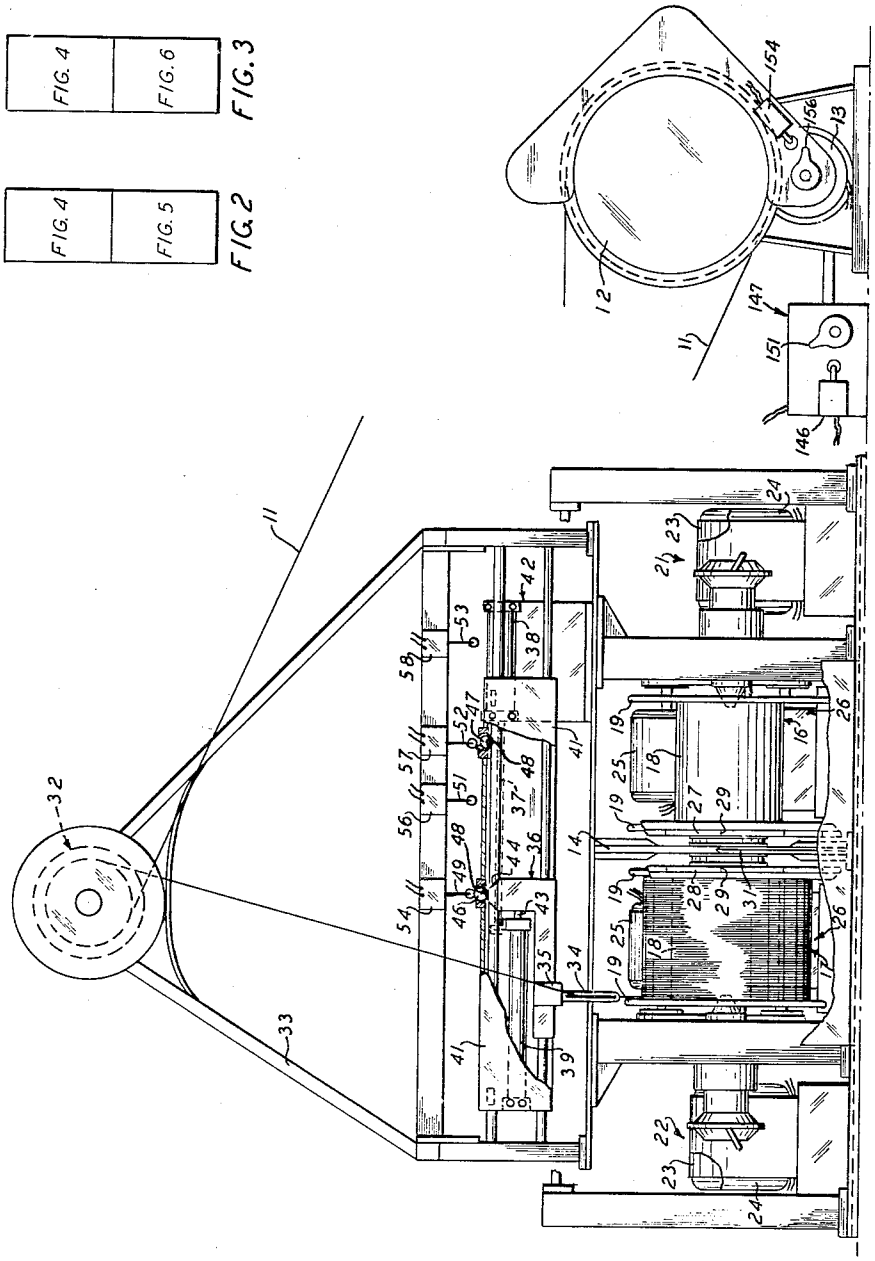


FIG. 1

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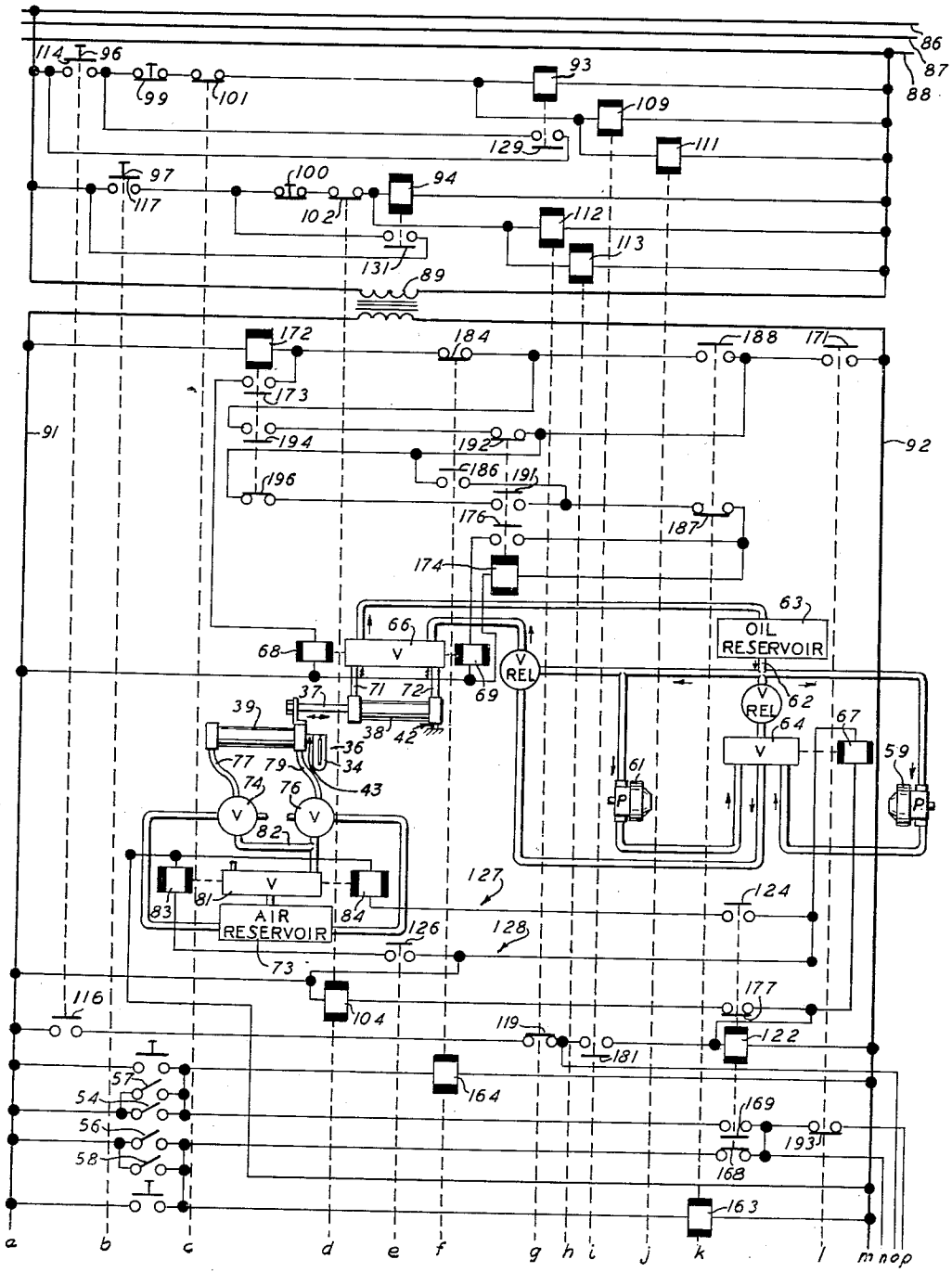


FIG. 4

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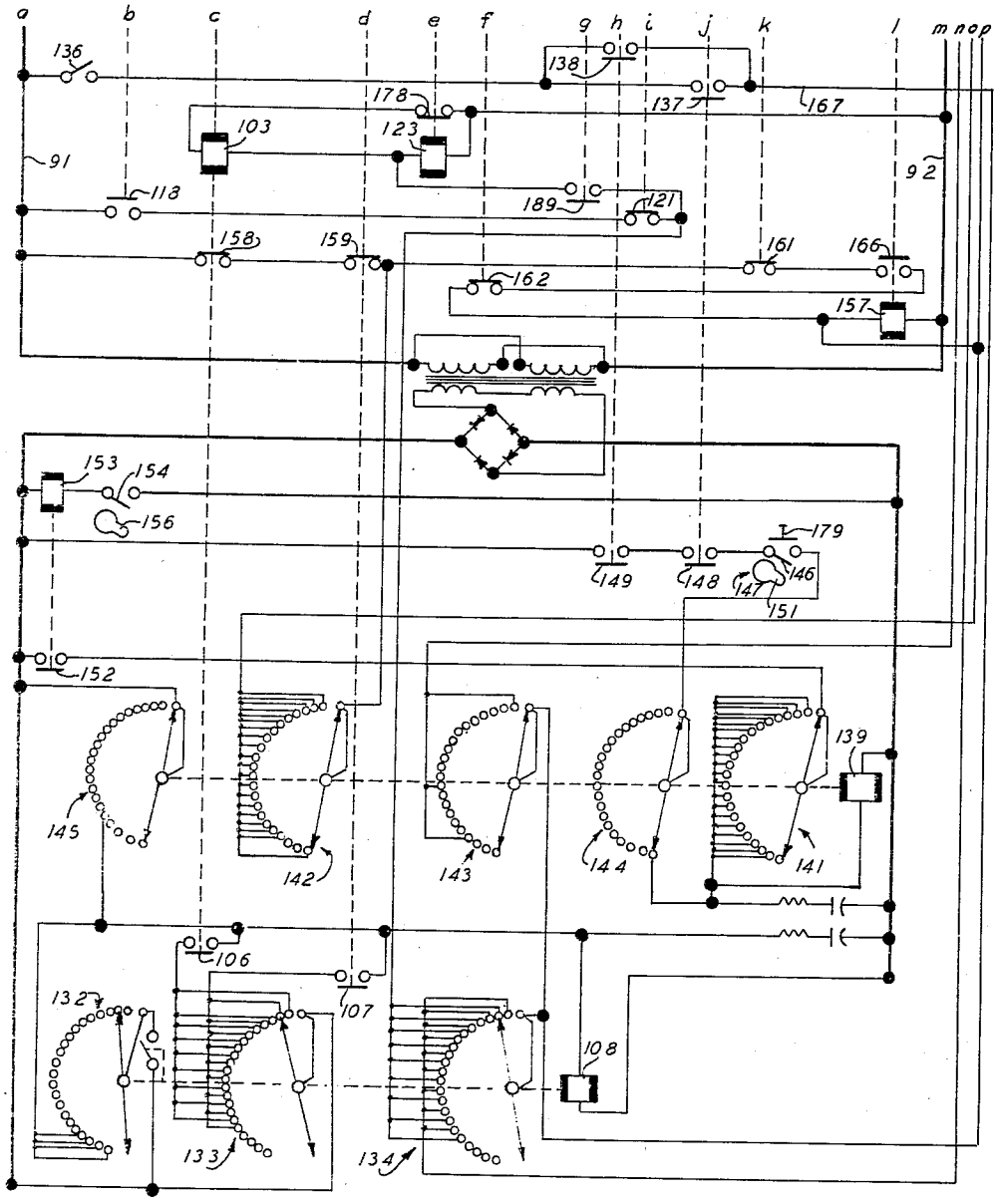


FIG. 5

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APPARATUS FOR REELING STRAND

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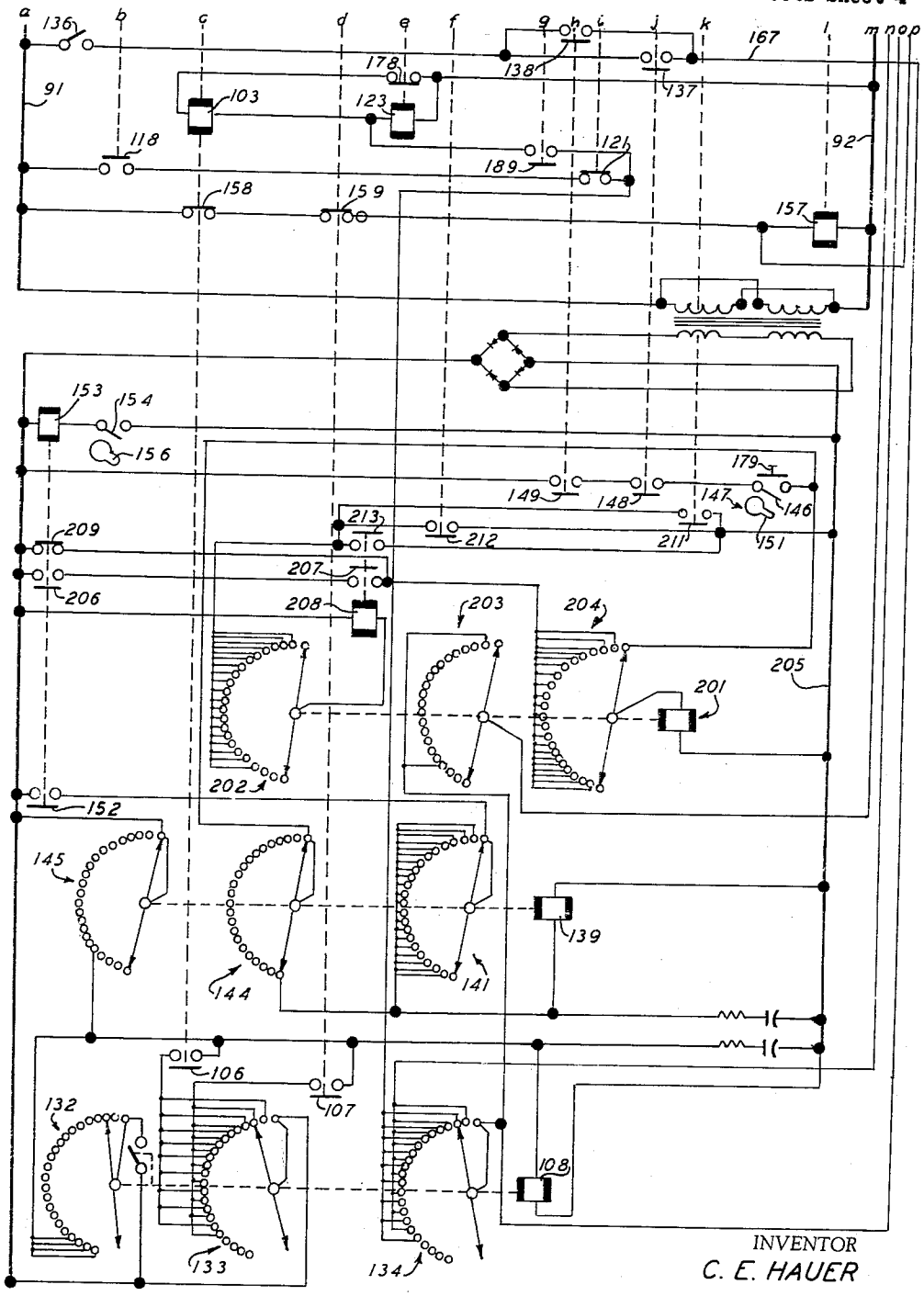


FIG. 6

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2,971,711

APPARATUS FOR REELING STRAND

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Filed Dec. 31, 1958, Ser. No. 784,193

8 Claims. (Cl. 242—25)

This invention relates to apparatus for reeling strand and, more particularly, to apparatus for controlling strand take-up apparatus for winding strand material on successive reels, which may continue uninterruptedly as the strand material is being transferred from a full reel to an empty reel.

In the manufacture of plastic insulated wire, the finished insulated wire is directed continuously from an extruder at a substantially constant linear speed. In order that the extrusion operation may continue without interruption or disturbance, it is a common practice to employ strand reeling apparatus having two reels where predetermined lengths of finished insulated wire are wound on successive or alternate reels.

When a predetermined length of insulated wire strand has been wound upon a take-up reel, the strand is transferred to an empty reel without interrupting the advancement of the strand and the connecting strand extending between the two reels is severed automatically. The tension in the strand as it is wound upon the take-up reels must remain substantially constant at a predetermined value throughout the operation and, further, it is desirable that the strand be distributed uniformly to lay successive convolutions of the strand side by side throughout the width of the reel drum.

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

Another object of the present invention is to provide new and improved electrical control systems for continuously running take-up apparatus for strand material.

A further object of the present invention is the improvement of reeling apparatus which are provided with means for transferring automatically a strand which is being wound upon a take-up reel which has become filled to an empty reel without stopping the reeling apparatus

A further object of the present invention is to provide new and improved apparatus for controlling the distribution of the strand for a period just prior to and during which the strand is transferred from the full reel to an empty reel.

A still further object of the present invention is to provide new, improved and simplified means for controlling reeling apparatus whereby the reeling apparatus can be operated with greater speed and better efficiency.

Apparatus for taking up a continuously advancing strand upon successive take-up reels embodying certain features of the present inventions, may include means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for detecting the length of strand remaining to be taken up on the take-up reel, and means for insuring that the distribution of the strand is directed toward the inside flange of the reel when a predetermined length of strand remains to be taken up on the reel. Means are provided for reversing the distribution of strand if the distribution of the strand is directed away from the inside flange of the reel when a predetermined length of the strand remains to be taken up on the reel, regardless of the position to which the distribution of the strand is being directed just prior to the time when the predetermined length of the strand remains to be taken up on the reel. Means are also provided for transferring the distribution of the strand from a position adjacent to the inside flange of the reel to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

Other objects and features of the invention will be more readily understood from the following detailed descriptions of specific embodiments thereof, when read in conjunction with the accompanying drawings, in which:

Fig. 1 is a fragmental, front elevation of a take-up apparatus embodying certain principles of the present invention;

Fig. 2 is a diagrammatic view showing how Figs. 4 and 5 are arranged to form one embodiment of an electrical circuit embodying certain principles of the present invention;

Fig. 3 is a diagrammatic view showing how Figs. 4 and 6 are arranged to form an alternative embodiment of the electrical circuit;

Figs. 4 and 5, combined, constitute a schematic representation of portions of one embodiment of the electrical control circuit and a hydraulic and pneumatic system forming part of the take-up apparatus, and

Fig. 6, in combination with Fig. 4, constitutes a schematic representation of portions of an alternative embodiment of the electrical control circuit and the hydraulic and pneumatic system forming part of the take-up apparatus.

Referring now to the drawings, there is shown in Fig. 1, strand reeling apparatus for taking up a strand 11 without interruption. The strand 11 may be, for example, an insulated wire, delivered at a substantially constant rate from an insulating machine (not shown) by a conventional strand-advancing capstan 12 driven by a motor 13 or other appropriate means.

The strand reeling apparatus comprises a flat, rigid, support member 14 located centrally between a right take-up reel, designated generally by the numeral 16, and a left take-up reel, designated generally by the numeral 17. The take-up reels 16 and 17 are identical in construction and are positioned side by side as shown in Fig. 1 for axial rotation about a common axis. The take-up reels 16 and 17 are of a conventional design and each includes a cylindrical winding drum 18 and a pair of flange-like reel heads 19—19 secured fixedly at opposite ends of the winding drum 18. The reels 16 and 17 are driven rotatably by electric motor drive units, designated generally by the numerals 21 and 22, respectively. The drive units 21 and 22 each include two direct-current machines 23 and 24 connected operably to each other and to an alternating current motor 25 through a plurality of gears and shafts (not shown) in a transmission, designated generally by the numeral 26. Suitable electrical control means (portions of which are not shown), are provided for stopping, starting and controlling the machines 23 and 24 and the motor 25 of the drive units 21 and 22, independently. The portions of the circuit controlling the drive units 21 and 22 which are not disclosed in the present application are substantially identical to those disclosed in a copending application, Serial No. 656,978, filed May 3, 1957, by T. T. Bunch. The structural features of the present take-up apparatus are substantially identical to those disclosed in the above-identified application of which the present methods and apparatus are modifications thereof.

Mounted between the central support member 14 and the adjacent reel heads 19—19 of the take-up reels 16 and 17, respectively, are a pair of snagger wheels 27 and 28. Each of the snagger wheels 27 and 28 is provided

with a series of peripheral, tangentially-projecting fingers 29—29, which function to catch the strand 11 when the latter is transferred from one of the take-up reels 16 and 17 to the other during a cutover operation. A stationary, vertically positioned cutter 31 is mounted on the front surface of the central support member 14 and is designed to sever the strand 11 when a portion thereof is engaged and extends between the fingers 29—29 on the snagger wheels 27 and 28 during the cutover operation.

The strand 11, as it advances toward the take-up reels 16 or 17, advances from the capstan 12 around a freely rotatable guide sheave, designated generally by the numeral 32, positioned on the top of an inverted, V-shaped frame 33 near the center of the take-up apparatus with the right-hand side thereof tangent to the longitudinal axis of the center support member 14. From the guide sheave 32, the strand 11 is directed downwardly into a slot of a forwardly projecting slotted guide 34 mounted at the lower end of a depending distributor arm 35. The guide 34 directs the stand 11 to one or the other of the take-up reels 16 and 17.

The distributor arm 35 forms a portion of a movable distributor carriage, designated generally by the numeral 36. The distributor carriage 36 is shown connected operably to the outer, free end of a movable piston rod 37 of a hydraulically-actuated distributor cylinder 38 which is actuatable to reciprocate the distributor carriage 36 transversely with respect to the take-up reels 16 and 17 alternately so as to distribute the strand 11 across the winding drums 18—18 of the take-up reels. The free end of the rod 37 is secured rigidly to a pneumatically-actuated stepping or indexing cylinder 39 (Fig. 4) at the right-hand end thereof as viewed in Figs. 1 and 4. The opposite end of the cylinder 39 is secured to a hood member 41 by appropriate means. The distributor cylinder 38 is secured rigidly to the frame of the apparatus by means of a support member, designated generally by the numeral 42. The rod 37 of the cylinder 38 is secured to the hood member 41 and the cylinder 39 so as to reciprocate the cylinder 39 and the hood 41. The distributor carriage 36 is secured fixedly to the outer, free end of a movable piston rod 43 of the cylinder 39 which is designed to index the distributor carriage 36 alternately from a left-hand operating position to a right-hand operating position and vice versa.

The distributor carriage 36 is shown in Fig. 1 in its left-hand operating position, in which operating position it operates to distribute the continuously advancing strand 11 upon the take-up reel 17. The distributor carriage 36 is provided with a cam member 44 designed to actuate alternately ball members 46 and 47 which are secured for limited movement in apertures 48—48 in the hood 41. The distributor carriage 36 carries the cam 44 designed to move the ball member 46 or 47 so it extends above the surface of the hood 41 a sufficient amount, in turn, to actuate alternately spring-biased plungers 49 and 51 or 52 and 53 of sensitive limit switches 54 and 56 or 57 and 58, respectively. When the piston rod 43 of the indexing cylinder 39 is fully retracted to the left, as viewed in Fig. 1, the cam 44 is in engagement with the ball 46 to operate the limit switches 54 and 56. Conversely, if the piston rod 43 of the indexing cylinder 39 were fully extended to the right, as viewed in Fig. 1, the cam 44 would be in engagement with the ball 47 to operate the limit switches 57 and 58.

Referring now to Fig. 4, there is shown in a portion thereof, a schematic representation of a combined hydraulic and pneumatic system forming a portion of the strand reeling apparatus. This system includes a pair of constant displacement, rotary, hydraulic pumps 59 and 61 which are driven by the drive units 21 and 22, respectively (Fig. 1), at speeds proportional to the rotational speeds of their respective take-up reels 16 and 17. The intake ports of both hydraulic pumps 59 and 61 are connected directly to a common supply line 62, which, in turn, communicates directly with a reservoir 63 containing a hydraulic fluid at atmospheric pressure.

A four-way, solenoid-operated, spring-return valve 64 is connected to the discharge ports of the hydraulic pumps 59 and 61 so that, normally the hydraulic fluid discharged from the hydraulic pump 61 is bypassed and returned to the reservoir 63 through the valve 64, to the supply line 62, while normally the valve 64 prevents the return of the hydraulic fluid discharged by the hydraulic pump 59 to the reservoir 63, and the hydraulic fluid from the latter pump flows to a four-way, spring-centered, double solenoid-operated distributor reversing valve 66. However, when solenoid 67 of the valve 64 is energized, the hydraulic fluid discharged from the pump 61 is directed to the distributor reversing valve 66, whereas the hydraulic fluid discharged by the hydraulic pump 59 is returned to the reservoir 63 through the valve 64.

The distributor reversing valve 66 normally is in its central position, and in this position directs fluid from the pump 59 or 61 back to the reservoir 63. The distributor reversing valve 66 is designed to control the direction of flow of the hydraulic fluid supplied by either of the hydraulic pumps 59 and 61 to the distributor cylinder 38 when actuated by solenoid 68 or 69. One end of the distributor cylinder 38 is connected to a corresponding port of the distributor reversing valve 66 by means of a line 71 and, similarly, the opposite end of the cylinder 38 is connected to another port on the distributor reversing valve 66 by a line 72.

The distributor reversing valve 66 is controlled by the two solenoids 68 and 69 which are energized alternately. When the solenoid 69 is energized, the valve 66 is operated to supply hydraulic fluid under pressure from either the hydraulic pump 59 or the hydraulic pump 61 to the left-hand end of the distributor cylinder 38, as viewed in Fig. 1, to move the piston rod 37 and attached distributor carriage 36 to the right. Conversely, when the solenoid 68 is energized, the distributor carriage 36 is caused to move to the left.

The opposing ends of the indexing cylinder 39 are supplied from an air reservoir 73 through pilot-operated, three-way valves 74 and 76. The valves 74 and 76 are connected to opposite ends of the indexing cylinder 39 by means of flexible lines 77 and 79, respectively. If there is no pilot pressure supplied by a valve 81, the valve 74 connects the left-hand end of the indexing cylinder 39 directly to the air reservoir 73 so that the piston rod 43 is in its extended, right-hand position, and the valve 76 connects the opposite end of the indexing cylinder 39 to exhaust at atmospheric pressure. However, when a pilot line 82 is connected to the air reservoir 73 through the three-way, double-solenoid operated valve 81, the valves 74 and 76 are actuated so that the left-hand end of the indexing cylinder 39 is connected to exhaust through the valve 74 and the opposite end of the indexing cylinder 39 is connected to the air reservoir 73 by the valve 76 so that the piston rod 43 is held in the left-hand, retracted position, as shown in Fig. 1.

The valve 81 is provided with two solenoids 83 and 84 designed to be energized alternately. When the solenoid 83 is energized, the pilot line 82 is connected to exhaust through the valve 81 to hold the distributor carriage 36 in the right-hand position or index the distributor carriage 36 to the right-hand position if it is not already in the right-hand position. When the solenoid 84 is energized, the pilot line 82 is connected to the air reservoir 73 through the valve 81 to actuate the valves 74 and 76 which holds the distributor carriage 36 in the left-hand position or indexes the distributor carriage 36 to the left-hand position if it is not already there.

Referring now to combined Figs. 4 and 5, there is shown an electrical circuit for controlling the operation of the reeling apparatus. The electrical circuit includes three bus lines 86, 87 and 88 supplying electrical power from a suitable 440 volt, 3 phase, 60 cycle source of

E.M.F. (not shown) to the primary of a transformer **89**, the secondary of which is connected to bus bars **91** and **92**. Connected across the bus lines **86** and **88** is a pair of motor-starting relays **93** and **94** (Fig. 4). Connected in series with the relays **93** and **94** are start buttons **96** and **97**, respectively. When one of the start buttons **96** or **97** is depressed, the associated relay **93** or **94** is energized resulting in the energization of the associated motor **25** of the drive units **22** or **21**, respectively.

The motor-starting relay **93** or **94** is energized by depressing the start button **96** or **97**, respectively, and is energized through a normally-closed emergency stop button **99** or **100** and a normally-closed, time-to-close contact **101** or **102** associated with a relay **103** or **104**, respectively. If neither drive unit **22** nor **21** had been running previously, neither relays **109** and **111** nor relays **112** and **113**, connected in parallel with the respective motor-starting relay **93** or **94**, would be energized when the relay **93** and associated relays **109** and **111** or relay **94** and associated relays **112** and **113** were energized. Therefore, when contact **181** or **189** is closed as a result of the energization of relay **109** or **112**, normally-closed contacts **119** and **121** would be closed to complete a circuit to the respective relays **104** and **103**. The energization of the relay **103** or **104** will close a normally-open contact **106** or **107**, respectively, which tends to complete a circuit to the solenoid of a stepping relay **108**.

Each of the start buttons **96** and **97** is provided with two contacts **114** and **116**, and **117** and **118**, respectively, and depending upon which of the buttons **96** or **97** is pressed first, the strand **11** will be taken up on the reel **17** or **16** associated with their respective drive units **22** or **21** if properly connected thereto. If the distributor **36** is in the right-reel position when the left-start button **96** is depressed, the distributor **36** will index to the left. If the distributor **36** is in the left-reel position at the time the start button **96** is depressed, it will stay in that position.

If either of the drive units **21** or **22** associated with the reel **16** or **17**, respectively, is energized already, the relay **112** or **109** will be energized and normally-closed contact **119** or **121**, respectively, associated therewith will be open. If the contact **119** or **121** is open, it will prevent a relay **122** or **123** from being energized to close a normally-open, time-to-close contact **124** or **126** associated therewith and thus prevent an associated distributor indexing circuit, designated generally by the numeral **127** or **128**, from being energized as a result of depressing the start button **96** or **97** and closing the contact **116** or **118**, respectively. When either the start relay **93** or **94** is energized, it closes a contact **129** or **131**, respectively, associated therewith in a respective holding circuit to hold the associated relay **93** or **94** energized and permit the operator to release the normally-open start button **96** or **97** without causing the associated motor **25** to stop.

The relay **108** may include three arcuate-shaped banks **132** to **134**, inclusive, of contacts. The circuit to the solenoid of the relay **108** is completed if the contacts of bank **133** of relay **108** are in the proper position. If relay **108** does become energized and then deenergized, it steps to such a position as to create a circuit through bank **134** of relay **108** parallel to that which was established by the depressing of the start button **96** or **97**. This parallel circuit then acts to hold the relays **122** or **123** energized. This is so because, a capstan relay (not shown) is energized to close a normally-open contact **136** whenever the capstan **12** is running. Also, either relay **111** or **113** is energized and a normally-open contact **137** or **138**, respectively, is closed when one of the take-up drive units **22** or **21** is running.

When the relay **122** or **123** is energized, it closes the normally-open contact **124** or **126**, which passes a current to the solenoid **84** or **83**, respectively, of the pneumatic valve **81** which causes the distributor **36** to be positioned at the reel **17** or **16**, respectively, that is being driven by the drive unit **22** or **21** which is energized.

The coil of a relay **139**, which relay is similar to relay **108**, except that it comprises five contact banks, designated generally by the numerals **141** to **145**, inclusive, is energized when a circuit is completed through its own contact on bank **144**. The circuit containing the contact on bank **144** is closed initially from a switch **146** actuated by a counter, designated generally by the numeral **147**, and through both normally-open contacts **148** and **149**, of the relays **111** and **113**. The coils of the relays **111** and **113** are energized when their respective drive units **22** and **21** are running. The switch **146** is closed by a cam **151** at the end of a predetermined count by the counter **147**. The counter **147** is a predetermined counter which has selector switches thereon to enable it to be set so that it will close the switch **146** after a preselected number of feet of the strand **11** has been fed to the take-up reel by the capstan **12**. The counter **147** is geared to the capstan **12** and actuated thereby to measure the length of the strand **11** fed to the take-up apparatus thereby. The closing and opening of the counter switch **146** therefore will cause the relay **139** to move off its normal position.

The coil of relay **139** also has a circuit connected through each of the rest of its contacts on bank **141** of relay **139**, and through a normally-open contact **152** of a relay **153**. The relay **153** is energized through a normally-open switch **154** which is closed by a cam **156** actuated by the capstan **12** once each time any desired predetermined length (e.g. ten feet) of strand **11** that the capstan **12** feeds to the take-up apparatus. Therefore, when relay **139** is off its initial position, it advances one step for every ten feet of travel of the pitch surface of the capstan **12** until it returns to its initial position. The reason for choosing the specific ten foot length of strand **11** is that with the specific length of the reels **16** and **17**, and the specific diameter of the strand, one layer of convolutions of the strand **11** on a substantially full reel contains approximately 220 feet of the strand **11**. Since the stepping relay **139** is stepped twenty-two times, it is desirable to have the relay step once for each ten feet so that the remaining length of strand **11** will have been wound on the reel when the relay steps past its twenty-second contact.

It should be noted that the ratio between the frequency of actuation of the switch **154** by the cam **156** and the speed of revolution of the capstan **12** could be any desired relation to insure that the desired length of strand **11** is fed to the take-up reel **16** or **17** during each period of time the relay **139** steps from one contact to another. The cam **156** could be connected to and driven by the capstan **12** by any well known variable type, positive connections.

The coil of a relay **157** is connected across the lines **91** and **92** through a series connection consisting of a pair of normally-closed, instantaneous contacts **158** and **159** of the relays **103** and **104**, respectively, and the bank **142** of relay **139**. In parallel with the bank **142** of the relay **139** are normally-closed, instantaneous contacts **161** and **162** of relays **163** and **164**, respectively, and a normally-open, instantaneous contact **166** of the relay **157**. Therefore, after the bank **142** of the relay **139** has advanced through its first nineteen steps, its part of the circuit containing the coil of the relay **157** is open.

During this period, each time the bank **143** of the relay **139** is stepped to either contact **1**, **13** or **19**, the direction of travel of the distributor **36** is continued or changed, as the case may be, so that it is advancing toward the inside flange **19** of the reel **16** or **17** on which the strand **11** is being taken up, which is in a direction toward the opposite reel **16** or **17**, as a result of the actuation of the relay **163** or relay **164**. The relay **163** or relay **164** is energized from line **91** and through contact **136**, contact **137** or **138**, a line **167**, bank **143**, and a

contact 168 or 169 of the relay 122. Therefore, if the circuits are functioning properly, the last occasion upon which the relay 163 or 164 is actuated will be when the relay 139 has stepped past the nineteenth contact on bank 142. When this takes place the circuit including the coil of relay 157 is broken and its own holding contact 166 is opened and a contact 171 is opened dropping the distributor control portion out of the circuit.

When the relay 157 was deenergized it opened the normally-open, instantaneous contact 171 which deenergized a relay 172, which in turn, opened a normally-open contact 173 to deenergize the solenoid 68, or it deenergized a relay 174 which opened up a normally-open contact 176 to deenergize the solenoid 69 which allows the valve 66 associated with the distributing cylinder 38 to assume its neutral position and divert all fluid flow from the cylinder 38, thus causing the distributor 36 to dwell near the inside flange if it is not time for the cutover to occur. The cutover is always initiated when the distributor 36 is near the inner flange 19 of the reel 16 or 17.

After this, the only way that the relay 157 can be reenergized is after bank 142 of the relay 139 has returned to its normal position. However, when bank 145 of relay 139 reaches a position where the contact thereof is closed the relay 108 will be energized. When the relay 108 is deenergized, it will step to its next position, which in turn, will cause either relay 103 or relay 104 to be energized through bank 134 of relay 108 and the normally-closed contact 158 or 159, respectively, thereof holding off reenergizing of the relay 157 until after the cutover from one reel 16 or 17 to the other has taken place.

Another action performed by the relay 103 or 104 is to deenergize the drive units 22 or 21 driving the reel 17 or 16 which has been in use and allowing the reel 17 or 16 to drift to provide slack in the strand 11 to permit a cutover from one reel to the other to take place without introducing excessive stresses therein. The reel 16 or 17 coasts to a stop as a result of the inherent friction in transmission 26 in the drive unit 21 or 22.

The relays 122 and 123 are in parallel with the relays 104 and 103, respectively, and are energized simultaneously. After a time delay, the relay 122 or 123 closes the normally-open, time-to-close contact 124 or 126 which results in the energization of solenoid 84 or 83 which actuates the cutover valve 81, which in turn results in the distributor 36 being indexed to the new reel position.

Simultaneously, a normally-closed, time-to-close contact 177 or 178 of relay 122 or 123 breaks the circuit energizing the coil of the relay 104 or 103. The relay 103 or 104 is deenergized and the contact 101 or 102 closes so that the drive unit 22 or 21 which was deenergized by relay 103 or 104 can be restarted by again depressing the start button 96 or 97.

The speed of the distributor 36 is adjusted to the proportional length of the strand 11 being taken up since the speed of the distributor 36 is responsive to the speed of the reel 16 or 17 which has a preselected speed. The speed of the distributor 36 is going to depend on the speed of the reel 16 or 17 and if the machine is slowed down for some reason or other then the distributor 36 will slow down a proportional amount and thus the same number of feet (220 feet) of the strand 11 will be fed to the take-up reel 16 or 17 for each traverse of the distributor 36, assuming that the diameters of the strand and winding surface are the same in each case.

The signal for a cutover is received by the control circuit through the actuation of a reset button 179 or the counter switch 146 when the distributor 36 is in transit, and the distributor 36 will be directed immediately toward the inside flange 19, regardless of the direction of travel at that time. The travel of the distributor 36 toward the inside flange 19 will be continued until the distributor 36 has arrived at the inside flange 19 or the limit of the travel of the distributor 36 in that direction under normal circumstances, and will be then reversed unless the relay 157 has been deenergized to allow the contact 171 to open up and drop the distributor control portion out of the circuit, as described previously. If this has happened then the remaining amount of the strand 11 will be piled up at the inside flange 19 of the reel 16 or 17. If the distributor 36 is reversed and is moving toward the outside flange 19, the distributor 36 will be reversed when contact 13 or 19 on bank 143 has been closed which will cause the distributor 36 to be directed toward the inside flange 19 or the opposite reel 16 or 17. Each time contact 1, 13 or 19 on bank 143 of relay 139 are closed and thus progressively smaller amounts of the strand 11 remains to be taken up on the partially filled reel 16 or 17, the distributor 36 will be directed toward the opposite reel if it is not already moving in that direction.

Operation

After it has been decided which take-up reel will be used first, the machine is started by energizing the direct-current machines 23 and 24 and the motor 25 associated with the drive unit 21 or 22 of that reel.

Assuming that the distributor 36 is positioned over the right take-up reel 16 and it is desirable to use the left take-up reel 17 first, the start button 96 associated with the left reel 17 will be depressed by the operator which will cause the relays 93, 109 and 111 to be energized.

The energization of the relay 93 will close the normally-open contact 129 to form a holding circuit for the relays 93, 109 and 111 across the contact 114 of the start button 96, so that the start button 96 may be released subsequently, and also will energize the machines 23 and 24 and the motor 25 associated therewith. The energization of the relay 109 closes the normally-open contact 181 and opens the normally-closed contact 121. The opening of the normally-closed contact 121 prevents the closure of the contacts 117 and 118 of start button 97 from causing the distributor 36 to index to the right reel 16. The closure of the instantaneous contact 181 results in the energization of the relay 122 and the solenoid 67 of the pump bypass valve 64 since the contact 119 associated with the relay 112 is closed when the right-reel drive unit 21 is deenergized. At this time the start button 96 may be released.

The energization of the relay 111 closes the normally-open instantaneous contacts 148 and 137. The energization of relay 122 opens the normally-closed instantaneous contact 168, and closes the normally-open instantaneous contact 169 and the normally-open, time-to-close contact 124. The closure of the normally-open, time-to-close contact 124 results in the energization of the solenoid 84. Energization of the solenoid 84 results in the indexing of the distributor 36 to the left-reel position from the right-reel position. The strand reeling apparatus is now operating so that the machines 23 and 24 and the motor 25 of drive unit 22 are energized and the left take-up reel 17 is in the process of being filled with strand 11. The right drive unit 21 is assumed to be deenergized at this time, but the right take-up reel 16 is mounted in the apparatus. The piston rod 43 of the indexing cylinder 39 is in its fully retracted, left-hand position.

As the strand 11 advances continuously, the distributor carriage 36 is reciprocated to distribute the convolutions of the strand 11 in uniform layers upon the winding drum 18 or winding surface of the left take-up reel 17. At this time the reciprocation of the piston rod 37 of the distributing cylinder 38 is controlled by the ball 46 which the cam 44 causes to operate the limit switches 54 and 56 alternately.

When the limit switch 54 is operated by the ball 46, the contact thereof closes to energize the relay 164 which opens a normally-closed contact 184 to deenergize the solenoid 68 and closes a contact 186 resulting in the energization of the relay 174 to close and hold closed the

contact 176 resulting in the energization of the solenoid 69 of the distributor reversing valve 66, thereby reversing the direction of flow of the hydraulic fluid in the lines 71 and 72. The hydraulic fluid now enters the left-hand end of the distributing cylinder 38 and causes other fluid to exit from the right-hand end thereof so that the distributor carriage 36 is moved to the right at a speed proportional to the rotational speed of the left-hand drive unit 22.

The movement of the distributor carriage 36 is reversed again when the ball 46 operates the limit switch 56 since the operation of the latter results in the energization of the relay 163 to open a normally-closed contact 187 to deenergize the solenoid 69 and to close a normally-open contact 188 to energize the relay 172, thus in turn, closes and holds closed the contact 173 to energize the solenoid 68 of the distributor reversing valve 66 to reverse the distributor 36. In this manner, the distribution of the strand 11 continues throughout the normal reeling of the strand 11 upon the take-up reel 17.

Prior to the initiation of a cutover operation, the operator depresses a right reel start button 97 which energizes relays 112, 113 and 94 which starts the idle reel 16 and brings it slightly above its required peripheral drum speed. The energization of the relay 94 will close the normally-open contact 131 to form a holding circuit for the relays 112, 113 and 94 across the start button 97, so that the start button 97 may be released subsequenly, and also causes the right reel drive unit 21 to be energized by energizing the machines 23 and 24 and the motor 25 associated therewith.

The energization of the relay 112 also closes the normally-open contact 189 and opens the normally-closed contact 119. The opening of the normally-closed contact 119 prevents the closure of the contacts 114 and 116 of the start button 96 from later causing the distributor 36 to index to the left reel 17. The closure of the instantaneous contact 189 would result in the energization of the relays 123 and 103 but for the fact that contact 121 associated with relay 109 is always open when the drive unit 22 is energized and bank number 134 of relay 108 is not at this time in the proper position to pass current to the relays 123 and 103 from the line 91. The energization of the relay 113 closes the normally-open, instantaneous contacts 149 and 138.

The machine is now ready for a cutover to take place, and since both of the reels 16 and 17 are running, the relays 111 and 113 are energized and the associated contacts 148, 137, 149, and 138 are closed. The switch 146 may be closed by the associated counter 147, or the reset button 179 on the counter may be depressed by the operator, and the relay 139 will be energized through the bank 144 thereof which is in its normal position. This will result in the relay 139 being stepped to the next position when deenergized at the time switch 146 is opened, or the operator releases the reset button 179. When the relay 139 is stepped off its normal position, the relay 139 may be energized and deenergized by the actuation of the normally-open contact 152, when the relay 153 associated therewith is energized and deenergized with each ten-foot travel of the pitch surface of the capstan 12.

The closure of the switch 154 energizes the relay 153 to actuate the contact 152 which energizes and deenergizes the relay 139 through the bank 141 to step it until it moves to its normal position and at that time the closure of the contact 152 has no affect on the stepping relay 139, since the bank 141 thereof is not connected to the normal position as is bank 144. Thus, the relay 139 remains stationary in the normal position until it receives a signal from the counter switch 146 or the reset button 179. When the signal is received by the relay 139 and it steps to close the first contact on the bank 143 thereof circuits through the normally-open, instantaneous contact 169 of relay 122, which give a sense of the station occupied by the distributor 36, operate to energize the coil of relay 164. The energization of the relay 164 opens the normally-closed, instantaneous contacts 184 and 162, and closes the normally-open, instantaneous contact 186.

The closure of the contact 186 causes the relay 174 to be energized which closes normally-open contacts 191 and 176 and opens normally-closed contact 192. The closure of the contact 176 results in the energization of the solenoid 69 which actuates the valve 66 causing the distributor 36 to be reversed and directed toward the inside flange 19 adjacent to the opposite reel 16. The operation of these circuits is always such that the distributor 36 is driven in the direction of the inside flange 19 adjacent to the opposite reel if it is not already moving in that direction at the time the contact 1, 13 or 19 on bank 143 of relay 139 is closed. It is obivous that any of many different combinations of contacts on bank 143 of the relay 139 could be utilized for this purpose.

The coil of the relay 157 is connected across the lines 91 and 92 through normally-closed, instantaneous contacts 158 and 159 of relays 103 and 104, respectively, and in series with the bank 142 of relay 139. In parallel with the bank 142 of the relay 139, are normally-closed, instantaneous contacts 161 and 162 of relays 163 and 164, respectively, and the normally-open, instantaneous contact 166 of the relay 157. Therefore, after the bank 142 of relay 139 has advanced through its first nineteen steps, its part of the circuit is open. This permits the coil of the relay 157 to be deenergized to open the normally-open, instantaneous contact 171 during part of the cutover cycle by the energization of either relay 163 or 164, but only after bank 142 of relay 139 has advanced past its first nineteen steps and one hundred and ninety feet of the remaining 220 feet of the strand 11 has been fed into the reel 17.

At this time the solenoid 69 has been energized and is in the process of causing the direction of the distributor 36 to be reversed causing the distributor to continue to advance towards the opposite reel 16 or dwell at the inside flange 19.

When the coil of the relay 139 completes a circuit from the contact of the reset button 179 through the contact on bank 144 of the relay 139, which is closed normally, the relay 139 will be energized and deenergized to move off its normal position. The coil of the relay 139 also has a circuit connected through each of the rest of its contacts on bank 141 thereof and through the normally-open contact 152 of the relay 153 which closes once for each ten feet of strand 11 that the capstan 12 feeds to the take-up apparatus. Therefore, when the relay 139 is off its normal position, it is advanced one step for each ten feet of travel of the peripheral surface of the capstan 12. At such time as the relay 139 has stepped to the eighteenth position, the contact on bank 145 thereof will close resulting in the energization of the relay 108. When the relay 139 steps to the nineteenth contact thereof the contact on bank 143 thereof opens, deenergizing and causing the relay 108 to step to the next position which is an even numbered position, thus resulting in the energization of relays 123 and 103 from line 167 through bank 134.

The energization of the relay 123 opens the normally-closed, instantaneous contact 178 and closes a normally-open, time-to-close contact 126, which is adjusted to control the timing of the cutover. The closure of contact 126 causes the solenoid 83 of the valve 81 to be energized after a predetermined time interval.

The closure of the contact on bank 134 of relay 108 which resulted in the energization of relay 103 caused the normally-closed, instantaneous contact 158, which is in series with the coil of relay 157, to be opened which causes the relay 157 to be deenergized momentarily resulting in the opening of the normally-open, in-

stantaneous contact 166, 171, and closure of a normally-closed, time-to-open contact 193.

Having the contact 158 closed at the same time as the now-closed contact 159 of the relay 104 causes the relay 157 to be energized to close the contact 166 and open the contact 193 when the relay 139 returns to its normal position. Since the contact 193 is a time-to-open contact, the relay 163 is assured of being energized through the contacts 158 and 159, through the bank 142 of relay 139 and the normally-closed contact 168 of the relay 122. The energization of the relay 163 results in the closing of the contact 188, which in turn, results in the relay 172 and thus the solenoid 68 being energized.

The deenergization of the relay 103 resulted in the opening of a normally-closed, time-to-close contact 101 resulting in the deenergization of the relays 109, 111 and 93 which causes the machines 23 and 24 and the motor 25 of the left-reel drive unit 22 to be deenergized and allowed to coast to provide slack in the strand 11 to permit a cutover to the right reel 16 without introducing excessive stresses in the strand 11 during the cutover. The left-reel drive unit 22 will then coast to a stop as a result of the inherent friction therein.

Energization of the relay 123, which closed the contact 126 after a time delay, caused the solenoid 83 of the valve 81 to be energized, and the opening of the contact 124 caused the solenoid 84 of the valve 81 to be deenergized. With the solenoid 83 energized, the valve 81 is connected so as to exhaust the pilot line 82 and, accordingly, the left-hand end of the indexing cylinder 38 is connected to the air reservoir 73 so that the piston rod 43 thereof is thrown rapidly to the right carrying with it the distributor carriage 36 and the cam 44, and thus the distributor 36 is indexed to the right reel 16.

It will be noted that the distributor control portion of the circuit will be energized through bank 143 of relay 139 when the relay 139 is positioned on contacts 1, 13 and 19 thereof during the distribution of the last 220 feet of the strand 11 on the reel being filled in preparation for a cutover from one reel to the other. The 220 feet is substantially equivalent to one layer of convolutions of the specific sized strand 11 wound on the specific sized reel when the reel is substantially full. When the contacts 1, 13 and 19 on bank 143 of relay 139 are closed, a circuit is completed from line 91, through contacts 136 and 138 or 137, through a portion of line 167, through the bank 143 through contact 168 or 169, depending on the reel adjacent to which the distributor 36 is positioned at that instant, through the coil of the relay 163 or 164 and to the line 92.

It should be noted that the contact 168 will be closed if the distributor 36 is positioned adjacent to the right reel 16 and that the contact 169 will be closed if the distributor 36 is positioned adjacent to the left reel 17. Therefore, if the distributor 36 is positioned adjacent to the right reel 16 and it is desirable to index to the left reel 17, contact 168 is closed and relay 163 will be energized each time the contacts 1, 13 or 19 on bank 143 is closed, if such is not energized already, which results in the distributor 36 being directed always toward the left reel 17 or inside flange 19 of the right reel 16.

However, if the distributor 36 is positioned adjacent to the left reel 17, contact 169 is closed and the relay 164 will be energized each time the contact 1, 13 or 19 on bank 143 is closed which, in turn, will result in the distributor 36 being directed always toward the right reel 16 or inside flange 19 of the left reel 17.

This results in the distributor 36 always being directed toward the inside flange 19 of the reel 16 or 17 onto which the strand 11 is being distributed prior to the cutover operation each time that the contacts 1, 13 or 19 of bank 143 is closed and thus when successive predetermined lengths of progressively smaller amounts of the strand 11 remains to be taken up on the partially filled reel 16 or 17.

Further, it should be noted that the distributor 36 is always reversed when it arrives at the inside flange 19 of the reel 16 or 17 during the distribution of the first 190 feet of the remaining 220 feet of strand 11, but if the distributor 36 arrives at the flange 19 of the reel 16 or 17 during the reeling of the remaining 30 feet of strand 11, the distributor will dwell at the flange 19 and pile the strand 11 up adjacent to the flange 19. This happens because when the relay 139 steps off of the nineteenth contact or bank 142, the relay 157 is deenergized and contact 171 is opened up to disconnect the distributor control portion of the circuit from the remaining circuit, so that the closure of the limit switches 54, 56, 57 and 58 no longer affects the movement of the distributor 36.

As the strand 11 is transferred from the full take-up reel 17 to the empty take-up reel 16, one of the fingers 29—29 on each of the rotating snagger wheels 27 and 28 catch a portion of the strand 11 and cooperate to carry it against the cutter 31, whereby the strand 11 is severed and the new leading end thereof is attached to the snagger wheel 27 and wound on the winding drum 18 of the empty take-up reel 16. Thus, the reeling of the strand 11 commences on the winding drum 18 of the empty take-up reel 16.

Now that the cutover operation is completed, the reeling operation on the take-up reel 16 proceeds in the normal manner previously described in connection with the take-up reel 17. The take-up reel 17 is stopped subsequently by the inherent friction of the drive unit 22. The full reel 17 is removed fom the apparatus and is replaced by another empty take-up reel 17. Thereafter, when the take-up reel 16 is nearly full, the drive unit 22 is again energized to rotate the empty take-up reel 17 as previously described and apparatus again is in readiness for the next cutover operation to take place.

Since both of the reels 16 and 17 are running, the relays 111 and 113 are energized and associated contacts 148, 137, 149 and 138 are closed. The counter actuates the switch 146 and the relay 139 will be energized through bank 144 thereof which is in its normal position, since the relay 139 always is returned to its normal position by the repeated actuation of the relay 153 through the repeated closure of the switch 154 by the capstan 12. Simultaneously, when the first contact on the bank 143 of relay 139 is closed, circuits through the normally-closed, instantaneous contact 168 of the relay 122, which indicates the station occupied by the distributor 36, operates to energize the coil of the relay 163.

When the relay 163 is energized it closes the normally-open, instantaneous contact 188 and opens the normally-closed, instantaneous contacts 161 and 187. The closure of the contact 188 causes the relay 172 to be energized, which in turn, closes normally-open contacts 173 and 194 and opens a normally-closed contact 196. The closure of the contact 173 results in the energization of the solenoid 68 which actuates the valve 66 resulting in the distributor 36 being driven towards the reel 17.

The coil of the relay 157 is connected across the lines 91 and 92 through the normally-closed contacts 158 and 159 of the relays 103 and 104, respectively, and in series with the contacts of bank 142 of the relay 139. In parallel with the contacts of bank 142 of the relay 139 are the normally-closed, instantaneous contacts 161 and 162 of the relays 163 and 164, respectively, and the normally-open, instantaneous contact 166 of the relay 157. Therefore, after the bank 142 of the relay 139 has advanced through its first nineteen steps, its part of the circuit is opened, as previously described.

When this takes place, a circuit including the coil of the relay 157 is broken, which deenergizes the relay 157, opens the holding contact 166 and opens the normally-open, instantaneous contact 171 which deenergizes the

relay 174 and stops the distributor 36. After this has happened, the only time that the relay 157 can be re-energized is after the bank 142 of the relay 139 has returned to its normal position.

When a circuit is made and broken by the contact 146 of the counter 147 through the contact on bank 144 of the relay 139 to the coil thereof, the relay 139 will be energized and deenergized to move off its normal position. The coil of the relay 139 also has a circuit connected through each of the rest of its contacts on the bank 141 thereof and through the normally-open contact 152 of the relay 153 which closes once for each ten feet of strand 11 that the capstan 12 feeds to the take-up apparatus. Therefore, when the relay 139 is off its normal position it is advanced one step for each ten feet of travel of the peripheral surface of the capstan 12 until it is returned to its normal position.

At such time as the relay 139 is stepped to the eighteenth position, the contact on bank 145 thereof will close resulting in the energization of the relay 108, which is deenergized when the relay 139 steps to the nineteenth position thereof, and causes the relay 108 to step to the next position which is an odd numbered position, thus, resulting in the energization of the relays 122 and 104 through the bank 134 of the relay 108. The energization of the relay 122 opens the normally-closed, instantaneous contact 168, and closes the normally-open, instantaneous contact 169 and the normally-open, time-to-close contact 124.

The closure of the contact 124 causes the solenoid 84 of the valve 81 to be energized after a predetermined time interval. The closure of the contact on the bank 134 of the relay 108, which resulted in the energization of the relay 104, caused the normally-closed, instantaneous contact 159, which is in series with the coil of the relay 157, to be opened which caused the relay 157 to be deenergized momentarily resulting in the opening of the normally-open, instantaneous contacts 166 and 171 so that the distributor 36 may be held stationary during approximately thirty feet of travel of the strand 11.

The energization of the relay 122 opens the normally-closed, time-to-open contact 177 resulting in the de-energization of the relay 104. However, when the relay 104 is energized, the normally-closed time-to-close contact 102 is opened resulting in the deenergization of the relays 112, 113, and 94 which causes the right-reel drive unit 21 to be deenergized and allowed to coast to provide slack in the strand 11 to permit a cutover to the left reel 17 without introducing excessive stresses in the strand 11 during the cutover. The right-reel drive unit 21 will then coast to a stop as a result of the inherent friction therein.

The energization of the relay 122 opened the normally-closed, instantaneous contact 168 and closed the normally-open, instantaneous contact 169 and also closed the normally-open, time-to-close contact 124 to energize the solenoid 84 of the valve 81. The solenoid 83 of the valve 81 was deenergized as a result of the opening of the contact of bank 134 of the relay 108. With the solenoid 84 energized, the valve 81 is connected so as to exhaust the pilot line 82 and accordingly, the right-hand end of the indexed cylinder 39 is connected to the air reservoir 73 so that the piston rod 43 thereof is thrown rapidly to the left carrying the distributor 36 and the cam 44 to the left and thus indexing the distributor 36 to the left reel 17.

Now that the cutover operation is completed, the reeling operation on the take-up reel 17 proceeds in the normal manner as previously described. The take-up reel 16 is stopped subsequently by the inherent friction of the drive unit 21. The filled reel 16 is then removed from the apparatus and is replaced by another empty take-up reel 16. Thereafter, when the take-up reel 17 is nearly full, the drive unit 21 is again energized to rotate the empty take-up reel 16 as previously described. The apparatus is then in readiness for another cutover operation.

Alternative embodiment of control circuit

The above-described circuit may be modified to eliminate the possibility of small amounts of strand 11 being piled up adjacent to the inside flange 19 of the full take-up reel 16 or 17 and yet cause the distributor 36 to be indexed from a position adjacent to the inside flange 19 of the full take-up reel to an empty reel during a cutover operation. To prevent any dwell of the distributor 36 adjacent to the inside flange 19, which may occur in the first-described embodiment, it is necessary to prevent contact 171 from opening during the time in which the last predetermined length (220 feet) of strand 11, which is equivalent to one full layer of convolutions of strand on the full reel. This may be accomplished if contacts 161, 162 and 166 and bank 142 of relay 134 are removed by connecting one side of contact 159 directly to one side of relay 157 and one side of contact 193.

Further, means must be provided to insure that the distributor 36 is always positioned adjacent to the inside flange 19 of the full reel 16 or 17 when the desired length of strand 11 has been taken up on the full take-up reel. This may be accomplished by adding a stepping relay, designated generally by the numeral 201 (Fig. 6), similar to stepping relays 108 and 139, having three banks 202, 203, and 204. The bank 203 which has contacts 1 and 19 thereof connected in parallel may be substituted for bank 143. Contact 1 of bank 203 is utilized to insure that the distributor 36 is directed toward the inside flange 19 when a desired predetermined length of the strand 11, equivalent to one full layer of convolutions of the strand, remains to be taken up on the full reel 16 or 17. Contact 19 of bank 203 is utilized to insure that the distributor 36 is always directed toward the inside flange 19 when a lesser predetermined length of strand 11 remains to be taken up on the full reel 16 or 17, preferably a length equivalent to that which will form a partial layer of convolutions from a position on the winding surface of the full reel 16 or 17 to which the distributor 36 is directing the strand 11 at that instant to the inside flange 19.

The latter results may be accomplished by connecting the brushes of the bank 204 of relay 201 between the bank 144 of relay 139 and the switch 146, and at the same time connecting the solenoid of relay 201 between the brushes of bank 204 and a bus 205. Contacts 1 to 21, inclusive, of bank 204 are connected together and in series with a normally-open contact 206 of relay 153 and a normally open contact 207 of a relay 208 which are connected in series with each other and in parallel with a normally-closed contact 209 of the relay 153.

The solenoid of relay 208 is connected ot the brushes of bank 202 of relay 201. Contacts 1 to 19, inclusive, of bank 202 of relay 201 are connected to the bus 205 through a normally-open contact 211 of the relay 163, a normally-open contact 212 of relay 164 and a normally-open contact 213 of relay 208 all of which are connected in parallel with each other. The relay 208 should be a timing relay with the contacts 207 and 213 thereof being time-to-open contacts so that the contacts 207 and 213 will remain closed during each short interval of time that the relay 208 is deenergized when relay 201 is stepped from one contact to another on bank 202.

The alternative embodiment of the control circuit is identical to the first embodiment except for the above-described modifications which are all illustrated on Fig. 6 of the drawings.

When the alternative embodiment of the control circuit illustrated on the combined Figs. 4 and 6 of the drawings is utilized in the take-up apparatus, the operation of the take-up apparatus will be essentially the same as described above for the other embodiment except as follows. When the signal for cutover is received by

the control circuit through the actuation of the reset button 179 or the counter switch 146 at the end of a predetermined count by the counter 147, the relay 139 and the relay 201 will be energized. When the button 179 is released or the switch 146 opens by the continued movement of the cam 151, the solenoids of the relays 139 and 201 are deenergized which cause them to move off their normal position to contact 1. The closure of contact 1 on bank 203 will cause the distributor 36 to be directed immediately toward the inside flange 19, regardless of the direction of travel of the distributor 36 at that time. The travel of the distributor 36 will continue toward the inside flange 19 until the distributor 36 has arrived at the inside flange 19 or the limit of travel of the distributor 36 in that direction under normal circumstances, and will then be reversed by the actuation of solenoid 68 or 69 by relay 163 or 164, respectively, as a result of the closure of limit switches 56 or 58, or 54 or 57, respectively, depending on which reel the strand 11 is being taken up on at the time.

When the distributor reaches the inside flange 19 and relay 163 or 164 is energized, contact 211 or 212, respectively, is closed resulting in the relay 208 being energized causing closure of the normally-open, holding contact 213, connected in parallel with contacts 211 and 212 and in series with the bank 202 of the relay 201 and the solenoid of its own relay 208. The energization of the relay 208 also resulted in the closure of the normally-open contact 207 connected in series with the contact 206 of relay 153, and in parallel with the contact 209 of relay 153. Prior to this time, the relays 139 and 201 would be advanced in unison, however the closure of contact 207 would result in stepping relay 201 being advanced twice each time relay 153 is energized and deenergized by switch 154, which is twice the rate at which relay 139 is being advanced. Since the distributor 36 is travelling toward the outside flange of the take-up reel 16 or 17, on which the strand 11 is being taken up, and the relay 201 is advancing at twice the rate of relay 139, the nineteenth contact on bank 203 will be closed to complete a circuit through solenoid 68 or 69, depending on which reel is being used at the time, when one-half the length of the strand 11 remaining to be taken up when the distributor 36 was reversed at the inside flange 19 has been taken up, causing the distributor to be directed toward the inside flange 19.

At the instant the remaining length of the strand 11 has been taken up on one of the take-up reels, the relay 139 will step off from contact 18 to contact 19 on bank 145 resulting in relay 108 being actuated to cause the distributor 36 to be indexed from one reel to the other as described previously.

By utilizing the alternate embodiment of the electrical control circuit, the distributor 36 is always directed toward the inside flange when a predetermined length of strand 11 remains to be taken up on the full reel. The distributor is reversed when the distribution of the strand 11 arrives at the inside flange, is directed toward the outside flange, until one-half the then remaining length of strand is taken up, and is then directed toward the inside flange. In this manner, the initiation of the indexing of the distributor 36 from the full reel to the empty reel may occur when the distributor 36 is adjacent to the inside flange, which is desirable.

In either of the above-described embodiments, it may be desirable to change the position of the connections on the various banks of the stepping relays in order that the various predetermined lengths of strand may be varied. In that event, selective push-button switches may be utilized instead of actually physically moving the lead connected thereto.

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

What is claimed is:

1. Apparatus for reeling strand continuously onto successive take-up reels, which comprises a plurality of take-up reels, means for directing the distribution of the strand transversely back and forth across the winding surface of one of the take-up reels, means for detecting the length of the strand remaining to be taken up on the take-up reel, means for reversing the distribution of the strand if the distribution of the strand is directed away from the inside flange of the reel when a predetermined length of the strand remains to be taken up on the reel, this reversing to take place regardless of the position to which the distribution of the strand is being directed just prior to the time when the predetermined length of the strand remains to be taken up on the reel, means for reversing the distribution of the strand when the distribution of the strand reaches the inside flange of the reel, means for directing the distribution of the strand toward the outside flange when the distribution of the strand arrives at the inside flange until a predetermined fraction of the then remaining amount of strand has been taken up on the reel, means for directing the distribution of the strand toward the inside flange so that the length of the strand remaining to be taken up is taken up on the reel, and means for transferring the distribution of the strand to a succeeding reel from the inside flange of the reel when the remaining length of the strand has been taken up on the first-mentioned reel.

2. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for directing the distribution of the strand transversely back and forth across the winding surface of one of the take-up reels, means for detecting the length of the strand remaining to be taken up on the take-up reel, means for reversing the distribution of the strand if the distribution of the strand is directed away from the inside flange of the reel when a predetermined length of the strand remains to be taken up on the reel regardless of the position to which the distribution of the strand is being directed just prior to the time when the predetermined length of the strand remains to be taken up on the reel, and means for transferring the distribution of the strand from a position adjacent to the inside flange to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

3. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for initiating a cutover, means for indicating the length of the strand being taken up on the take-up reel, means responsive to the indicating means for insuring that the distributing means is directed toward the inside flange of the reel when a predetermined length of the strand remains to be taken up on the reel, means for always reversing the distributing means whenever the distribution of the strand reaches the inside flange, means responsive to the indicating means for causing the distributing means to be directed toward the outside flange until one-half of the then remaining length of the strand has been taken up and then reversing the distribution of the strand so that when the distribution of the strand arrives at the inside flange the predetermined length of the strand will have been taken up on the reel, and means for indexing the distributing means to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

4. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for detecting the length of the strand remaining to be taken up on the take-up reel, means responsive to the detecting

means for insuring that the distributing means is directed toward the inside flange of the reel when each of a plurality of predetermined lengths of the strand of progressively smaller amounts remain to be taken up on the reel, means for always reversing the distributing means whenever the distribution of the strand reaches the inside flange, and means for indexing the distributing means to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

5. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for directing the distribution of the strand transversely back and forth across the winding surface of one of the take-up reels, means for detecting the length of the strand remaining to be taken up on the take-up reel, means for reversing the distribution of the strand if the distribution of the strand is directed away from the inside flange of the reel when each of a plurality of successive predetermined lengths of the strand of progressively smaller amounts remains to be taken up on the reel regardless of the position to which the distribution of the strand is being directed just prior to the time when each of the predetermined lengths of the strand remains to be taken up on the reel, and means for transferring the distribution of the strand to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

6. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for initiating a cutover, means for indicating the length of the strand being taken up on the take-up reel, means responsive to the indicating means for insuring that the distributing means is directed toward the inside flange of the reel when each of a plurality of successive predetermined lengths of the strand of progressively smaller amounts remains to be taken up on the reel, means for always reversing the distributing means whenever the distribution of the strand reaches the inside flange and at least a relatively small length of the strand remains to be taken up on the reel, means for stopping the distributing means adjacent to the inside flange when the distribution of the strand arrives at the inside flange and less than the relatively small length of the strand remains to be taken up on the reel so that the length of the strand remaining to be taken up on the reel at that instant is piled up adjacent to the inside flange, and means for indexing the distributing means to a succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

7. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for initiating a transfer of the distribution of the strand to a succeeding reel, means for indicating the length of the strand remaining to be taken up on the take-up reel, means responsive to the indicating means for insuring that the distributing means is directed toward the inside flange of the reel when each of a plurality of successive predetermined lengths of the strand of progressively smaller amounts remains to be taken up on the reel regardless of the direction in which the distribution means is traveling just prior to the time when each of the plurality of successive predetermined lengths remains to be taken up on the reel, each of the progressively smaller amounts being at least as small as the length of the strand in the last complete layer of convolutions of the strand on the reel, means for always reversing the distributing means whenever the distribution of the strand reaches the inside flange and at least a relatively small length of the strand remains to be taken up on the reel, means for stopping the distributing means adjacent to the inside flange when the distribution of the strand arrives at the inside flange and less than the relatively small length of the strand remains to be taken up on the reel so that the length of the strand remaining to be taken up on the reel at that instant is piled up adjacent to the inside flange, and means for indexing the distributing means to the succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

8. Apparatus for reeling strand continuously onto successive take-up reels, which comprises means for distributing the strand transversely back and forth across the winding surface of one of the reels, means for initiating a transfer of the distribution of the strand to a succeeding take-up reel, means for indicating the length of the strand being taken up on the take-up reel, means responsive to the indicating means for insuring that the distributing means is directed toward the inside flange of the reel when a predetermined length of the strand remains to be taken up on the reel, means responsive to the indicating means for insuring that the distributing means is being directed toward the inside flange when a lesser predetermined length of the strand remains to be taken up on the reel, means responsive to the indicating means for insuring that the strand distributing means is being directed toward the inside flange when a still lesser predetermined length of the strand remains to be taken up on the reel, means for always reversing the distributing means whenever the distribution of the strand reaches the inside flange and at least the still lesser predetermined length of the strand remains to be taken up on the reel, means for stopping the distributing means adjacent to the inside flange when the distribution of the strand arrives at the inside flange and less than the still lesser predetermined length of the strand remains to be taken up on the reel so that the length of the strand remaining to be taken up on the reel at that instant is piled up adjacent to the inside flange, and means for indexing the distributing means to the succeeding reel when the remaining length of the strand has been taken up on the first-mentioned reel.

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UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 2,971,711 February 14, 1961

Charles E. Hauer

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 10, line 58, for "143" read -- 145 --; column 14, line 54, for "ot" read -- to --; column 17, line 4, for "remain" read -- remains --.

Signed and sealed this 1st day of August 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents