April 20, 1943. L. O. REICHELT ET AL 2,317,113

CONTROL SYSTEM FOR MACHINES

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FIG. 1

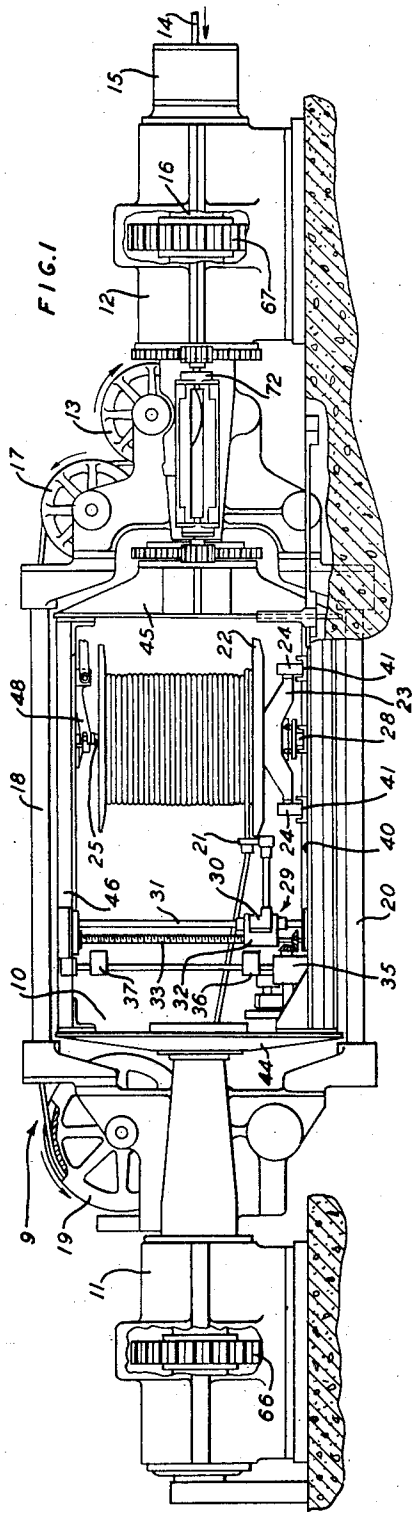
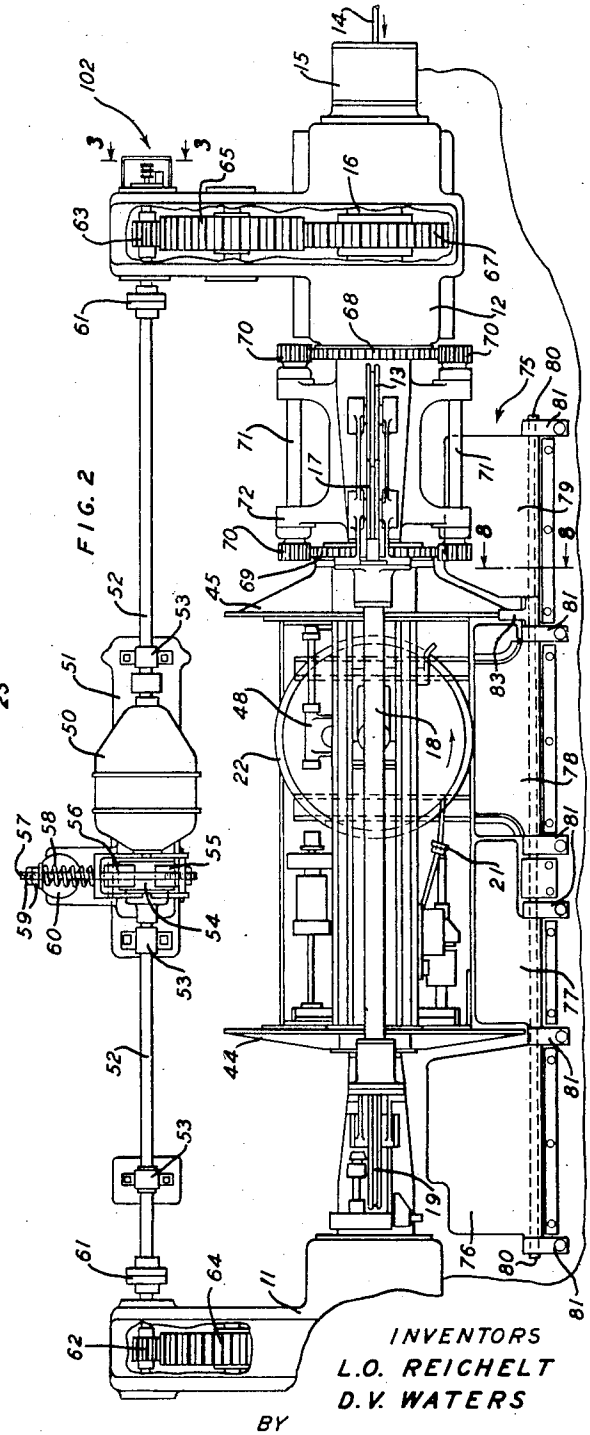


FIG. 2



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FIG. 3

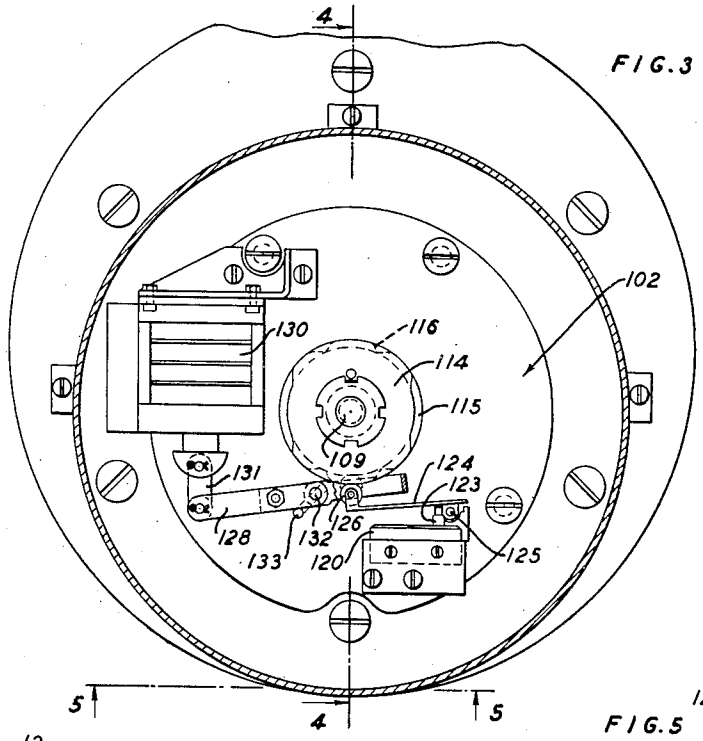


FIG. 4

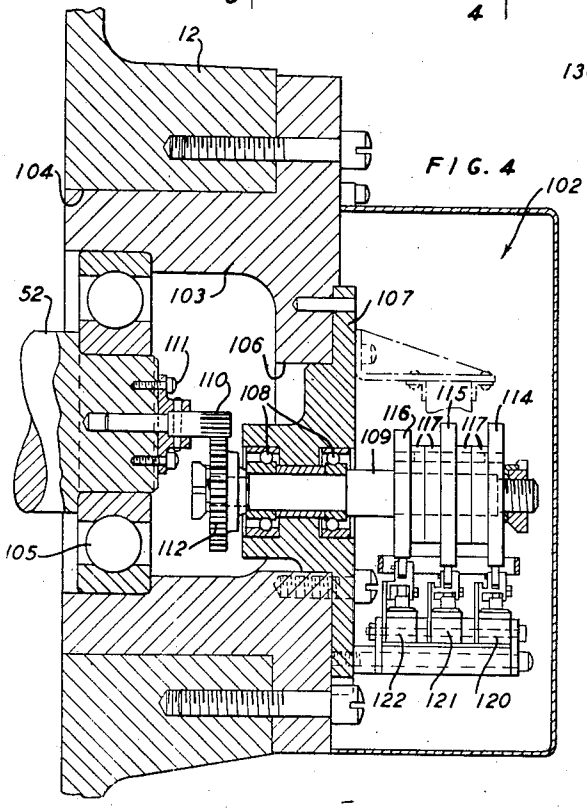


FIG. 5

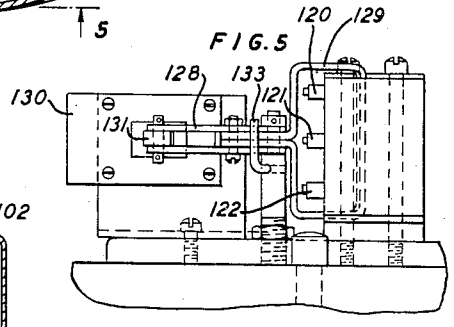
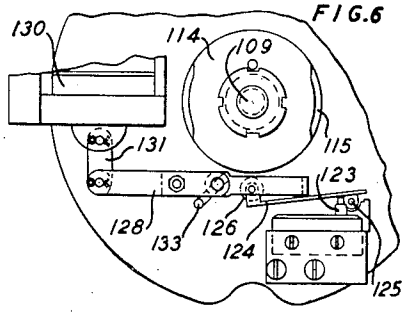


FIG. 6



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FIG. 7

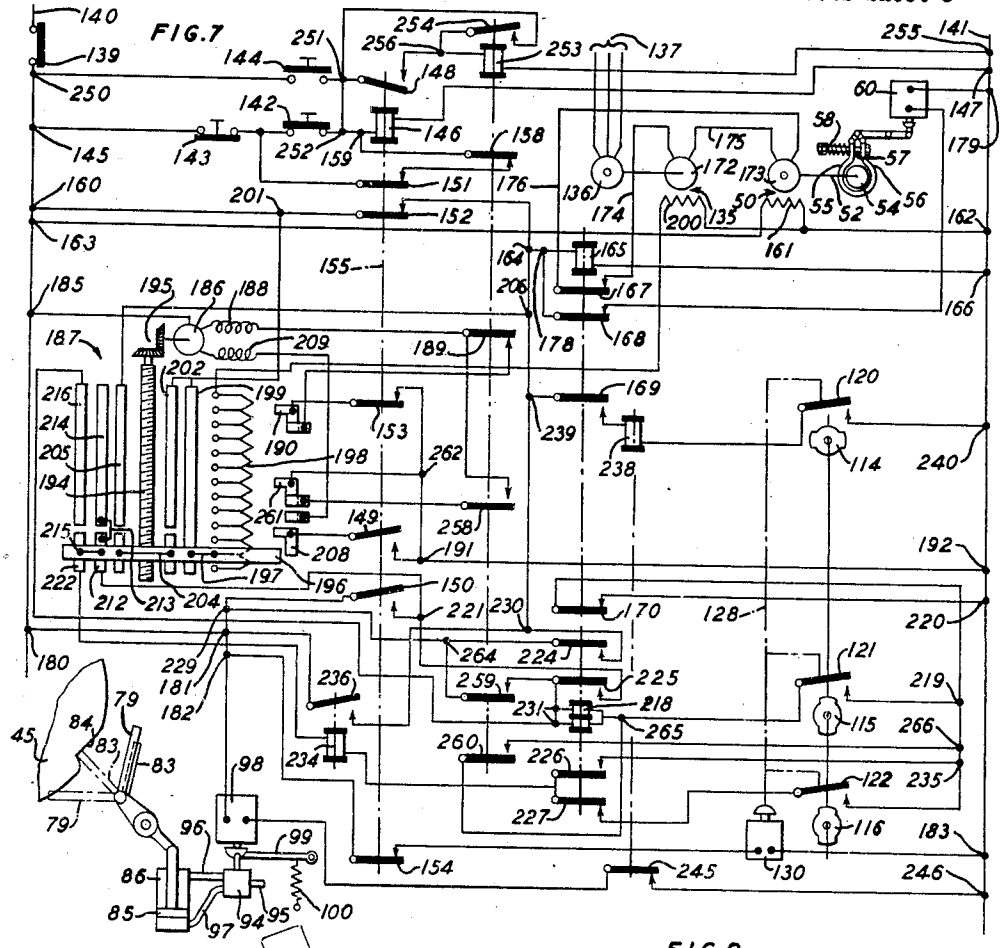


FIG. 8

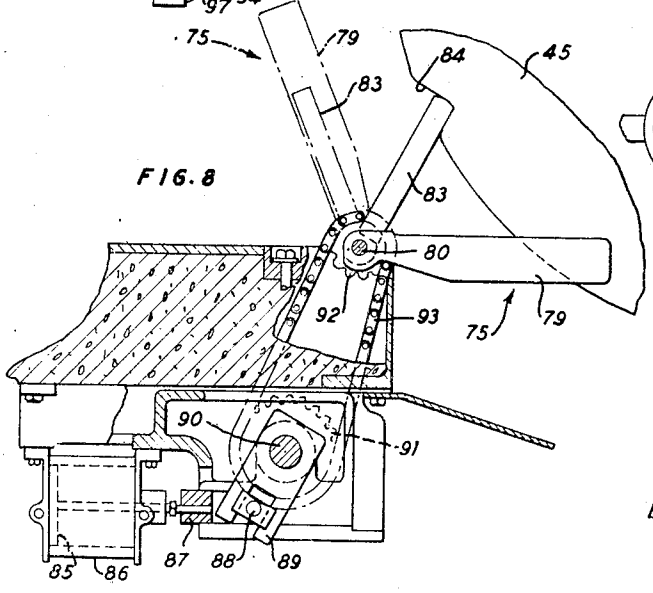


FIG. 9

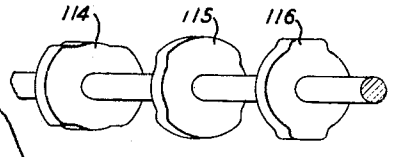
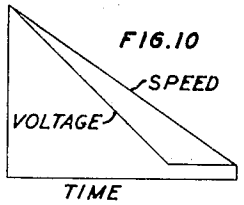


FIG. 10



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2,317,113

CONTROL SYSTEM FOR MACHINES

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Application July 31, 1941, Serial No. 404,886

22 Claims. (Cl. 57—58)

This invention relates to control systems for machines, and more particularly to a control system for machines commonly called "stranders" for combining strands by intertwisting them into cables such as may be used in mechanical arts and in the electrical communication arts.

In the manufacture of cables the strands of which the cable is to be formed are usually drawn from supply reels mounted for rotation, the strands being guided over suitable sheaves and through a common hollow guide of a flier unit and thence to a take-up reel. The flier unit is rotated at a speed relative to the linear speed of the group of strands to form a desired twist in the group prior to the strands reaching the take-up reel. In many instances, for example in forming telephone cables, the take-up reel is quite large and is of considerable weight, particularly after the cable formed of the intertwisted strands has been wound thereon. Such a reel, therefore, is mounted upon a truck having a vertical shaft, both of which accompany the reel into a take-up unit in the flier unit, and during the operation of the machine the flier unit also must be of sufficiently heavy and durable structure to support the take-up unit, the reel and its truck. In such machines it is advantageous to stop the flier unit at a point where the take-up reel and its truck will be free for removal from their unit. Due, however, to the momentum of the flier unit it is not possible to stop the unit immediately upon opening the circuit to a driving motor in the unit.

An object of the invention is to provide a control system for machines having driven parts, and more particularly a simple, efficient and highly practical control system for stopping the parts at a definite position when the diminishing momentum of the parts will permit.

With this and other objects in view, one embodiment of the invention comprises a control system for machines, for example a machine for forming cable including a flier unit driven by a main motor at a given maximum speed to intertwist strands into a cable which is wound upon a take-up reel about which the flier travels, the control system controlling the running of the main motor and thus the flier unit, as well as the starting and stopping thereof, the stopping process causing deceleration in the speed of the flier unit to a given minimum speed and the location of the flier unit at a definite position before the stopping is rendered effective.

Other objects and advantages will be apparent from the following detailed description when taken in conjunction with the accompanying drawings, wherein

Fig. 1 is a side elevational view of the apparatus selected to illustrate the invention;

Fig. 2 is a top plan view of the apparatus, portions thereof being broken away;

Fig. 3 is an enlarged detailed sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is a fragmentary detailed view taken substantially along the line 5—5 of Fig. 3;

Fig. 6 is a fragmentary detailed view of the mechanism shown in Fig. 3, illustrating parts thereof in another position;

Fig. 7 is a wiring diagram illustrating the electrical circuits and the associated parts of the apparatus which the circuits control;

Fig. 8 is an enlarged fragmentary sectional view taken along the line 8—8 of Fig. 2;

Fig. 9 illustrates the contours of the respective cams shown in Figs. 3, 4 and 6, and

Fig. 10 is a diagram illustrating the relationship between the drop in voltage and the drop in speed of rotation of the flier unit in preparing the apparatus for stopping.

Referring now to the drawings, attention is first directed to Figs. 1 and 2, which illustrate a cable forming apparatus embodying the invention. This apparatus includes a flier unit and a take-up unit, respectively indicated generally at 9 and 10, supported on a common axis but by separate concentrically disposed shafts carried by suitable bearings in spaced housings 11 and 12. A detailed description of all parts of the apparatus is not believed necessary for a clear understanding of the invention, as the general principles of a strander are well known. In general the flier unit includes an idler sheave 13 which receives a group 14 of strands from individual supply sheaves (not shown), the group of strands passing through a hollow guide 15 and through a suitable hollow shaft 16, of the flier unit, in the housing 12. The idler sheave 13 in receiving the group of strands, directs the group to another idler sheave 17 which raises the group to a point where it may pass through a tubular guide 18 of the flier unit, being received by another idler sheave 19 upon leaving the guide. A similar tubular member 20 is disposed diametrically opposite the tubular guide 18 to counterbalance the flier unit. The group of strands upon leaving the idler sheave 19, passes through a distributor guide 21, at which time the group of

strands may be termed a cable as the intertwisting operation thereof has been completed.

From the guide 21 the cable is wound upon a take-up reel 22, the latter being disposed upon a truck 23 having supporting rollers 24 as well as a vertical shaft 25. The shaft 25 of the truck is rotatably supported and removably fixed to the reel by any suitable means (not shown) to cause rotation of the reel during rotation of the flier unit. Means, indicated at 26, operatively connects the shaft 25 with a suitable driving means which may include the driving means for the flier unit 9 to cause rotation of the take-up reel at a predetermined and desired variable speed.

During rotation of the reel the guide 21 is moved relative to the reel by a distributor mechanism, indicated generally at 29, to distribute the convolutions of the cable uniformly on the reel. The distributor mechanism may include a support 30 for the guide 21, the support being movable on a rod 31 and having a nut-like portion 32 for a screw 33, the latter being driven alternately in opposite directions through a suitable power means, indicated at 35, controlled by limit switches 36 and 37. As illustrated in Fig. 1, the take-up unit has a platform 40 upon which are mounted channel-like tracks 41 in which the supporting rollers 24 of the truck 23 may travel in placing an empty take-up reel in the take-up unit and removing the take-up reel therefrom, when filled. In the present embodiment platform 40 is positioned in a plane parallel with the floor upon which the housings 11 and 12 are mounted, thus a pit is required in the floor through which the flier may travel about the take-up unit. This makes possible the movement of the take-up reel in a common plane parallel with the floor in the loading and unloading of the reel relative to the flier unit. The take-up unit comprises spaced heads 44 and 45, and connecting members, including the platform 40 at one position and member 46 at a diametrically opposed position, the latter including means, indicated generally at 48, to removably hold the shaft 25 for rotation but against lateral displacement in addition to means to support the upper ends of the members of the distributing mechanism.

In general the power for driving the flier unit as well as the take-up reel and the distributor unit, include a main motor 50 mounted upon a suitable bracket 51 and having a main shaft 52 extending in both directions therefrom. The shaft 52 is supported by suitable bearings 53 and has a brake drum 54 mounted thereon and fixed thereto adjacent one side of the motor. Brake shoes 55 and 56 are of suitable structures and contours to conform to the brake drum and to create a frictional force thereon to stop rotation of the shaft 52, when applied. A detailed structure of the brake shoes is not shown but they may be arcuate in general contour, connected by separate pivots or a common pivot at their lower ends while either one or both of their upper ends may be operatively connected to a spring rod 57 upon which a spring 58 is disposed to apply its force, through the rod, to the brake shoes to actuate the brake shoes. The force of the spring applied to the brake shoes is variable through the adjustment of nuts 59 on the rod 57. A solenoid 60 is operatively connected to the rod 57, as schematically illustrated at Fig. 7, to actuate the rod against the force of the spring 58 to hold the brake shoes away from the brake drum when the solenoid is energized.

Although in actual structure the shaft 52 has couplings 61 at each end thereof which connect the shaft to other shafts, for the purpose of illustration let it be assumed that the ends of the shaft 52 extend into the housings 11 and 12 through suitable bearings and have pinions 62 and 63 mounted thereon. The driving connections at each end of the shaft 52 are identical, there being intermediate gears 64 and 65 operatively connecting their respective pinions 62 and 63 with driven gears 66 and 67 respectively. The driven gear 66 in the housing 11 is mounted upon a shaft of the flier unit 9 and thus causes rotation of the flier unit. The gear 67 in the housing 12, however, is mounted upon the hollow shaft 16, this shaft supporting the adjacent end of the flier unit 9. A gear 68, mounted upon the stationary housing 12, is one of a set of planetary gears including a gear 69 mounted on the head 45 of the take-up unit 10, the gears 68 and 69 being operatively joined by pairs of smaller gears 70 fixedly mounted upon shafts 71, the latter being rotatably supported by a spider 72 which is a part of the flier unit 9. Therefore, through the driving mechanism including the motor 50 and the shaft 52, the flier unit 9 is rotated and through this same power means, due to the interpositioning of the planetary gears 68, 69 and 70, the take-up unit 10 is held against rotation.

In loading or unloading the take-up reel the flier unit 9 must be stopped in a position so that the tubular guide 18 and the tubular member 20 lie in a vertical plane, otherwise either the guide 18 or the tubular member 20 would interfere therewith. When in this position, for example the position indicated in Fig. 1, an apron, indicated generally at 75 but having sections 76, 77, 78 and 79, may be moved from a position indicated by dot and dash lines in Fig. 8 to a position indicated in solid lines in this figure. These positions may be termed up and down positions, referring to the respective positions they are in when the flier is running and when the flier is stopped. The sections of the apron 75 are mounted upon a common shaft 80 journalled in bearings 81 at the ends of the outer sections and between the sections, the sections being fixed to the shaft so as to be moved in unison when the shaft is rotated. A latch 83 is also mounted on the shaft 80 but is free to rotate limited distances thereon governed by the adjacent section 79. In other words, the latch 83 and the section 79 of the apron 75 may have interfitting portions which will cause the latch to move from the dot and dash lined position shown in Fig. 8 with the apron until it reaches the solid line position shown in this figure, where it will remain, allowing the apron to continue to its down position. The purpose of the latch 83 is to enter a notch 84 in the periphery of the head 45 of the take-up unit 10, to hold the take-up unit against rotation during the process of removing a full reel and the placing of an empty reel therein.

The mechanism controlling the apron 75 with its various sections and the latch 83 includes a piston 85 in a cylinder 86, the piston being movable in the cylinder to move a slide 87, the latter being operatively connected at 88 to a rocker arm 89. The arm 89 is fixed to a shaft 90 upon which is mounted a sprocket wheel 91, the latter being connected to a sprocket wheel 92 through a chain 93. The sprocket wheel 92 is fixed to the shaft 80 and through actuation of the piston and its associated mechanism the shaft 80 is alternately rocked to move the apron and the latch

from one position to another. The piston 85 is controlled by a valve 94 (Fig. 7) to alternately supply a fluid under pressure from a supply line 95 through fluid lines 96 and 97 to opposite ends of the cylinder 86. The valve 94 is controlled by a solenoid 98 to move the valve into one position when the solenoid is energized, a lever 99 under the constant force of a spring 100 causing movement of the valve in the opposite direction when the solenoid is deenergized.

Attention is now directed to Figs. 2 to 6 inclusive, which illustrate the cam control unit 102 that exercises an important part in the functioning of the machine, particularly the stopping thereof at a definite time interval, in addition to the controlling of the apron and the latch 83. Attention is drawn to Fig. 2 merely to illustrate the location of this unit upon the housing 12 and its operative connection with the shaft 52. Referring now to Fig. 4, it will be observed that a bearing supporting sleeve 103 is disposed in an aperture 104 of the housing 12, supporting a bearing 105 for the adjacent end of the shaft 52. The sleeve 103 is apertured at 106 to receive a bearing bracket 107, the latter supporting bearings 108 for a cam shaft 109. A pinion 110 is fixed to the shaft 52 by suitable means, indicated at 111, and is operatively connected to the cam shaft 109 through a gear 112, the latter being mounted on the inner end of the cam shaft. Cams 114, 115 and 116 are mounted upon the cam shaft 109 at spaced positions controlled by spacing members 117. The contours of the cams 114, 115 and 116 are illustrated in Fig. 9, this illustration setting forth also the relationship of the high points of the cams. The connection of the cams to the main shaft 52 through the pinion 110 and the gear 112, causes rotation of the cams at the same speed as the flier unit 9. High points of certain of the cams follow the tubular guide 18 and the tubular member 20 of the flier so as to effect stopping of the flier at a definite position, as will hereinafter be described.

Switches 120, 121 and 122 are positioned to be actuated by the cams 114, 115 and 116 respectively. These switches all have plungers 123 of the spring controlled type and cam levers 124 pivoted at 125 and positioned to actuate the plungers when the high portions of the cams ride upon rollers 126 carried by the free ends of the levers. Due to the fact that the unit 102 functions only when the apparatus is being prepared to stop, means is provided to hold the cam levers 124 of the switches out of engagement with the cams during the general running of the machine. This is brought about through a lever 128 having an end 129 formed into a loop to extend over all of the cam levers 124 yet permitting engagement of the cams with the rollers 126 when the cam levers are freed by the lever 128. The lever 128 is shown in its inoperative position, free of the cam levers 124, in Fig. 3 and in its operative position, holding the cam levers away from the cams, in Fig. 6. The energization of a solenoid 130 actuates the lever 128, through a link 131, about a pivot 132. A stop 133 controls the positioning of the lever 128 when the solenoid is deenergized.

Attention is now directed to Fig. 7, which in the upper right hand corner illustrates schematically the main motor 50, the shaft 52 and the brake mechanism including the solenoid 60. The main motor 50 is under the control of a generator 135, the latter being driven by a constant speed motor 136 receiving its power from lines 137. The control system includes lead lines 140 and 141 from a source of electrical energy not shown, a switch 139 in line 140 conditioning the control system for functioning when closed. There are three manually controlled switches, namely a start switch 142, a stop switch 143 and a jogging switch 144. The jogging switch is not used during the general operation of the machine, its purpose being hereinafter described. The control system, as illustrated, is in a condition immediately following the closing of the switch 139 and the start switch 142, which completes the circuit from line 140 at connection 145, through the closed stop and start switches 143 and 142, respectively, and through a relay 146 to line 141 at connection 147. The closing of this circuit energizes the relay 146 to open contacts 148, 149 and 150 and close contacts 151, 152, 153 and 154. These contacts are in general alignment, as indicated by the dot and dash lines 155, meaning that they are all operated from the same relay. The closing of the contact 151 will complete an interlocking circuit about the relay 146 from line 140 at connection 145, through switches 143, contact 151, a normally closed contact 158, a connection 159, through relay 146, to line 141 at 147. A circuit is completed through the field 161 of the main motor 50 from line 140 at connection 163 to line 141 at 162 when the switch 139 is closed. The closing of the contact 152 completes a circuit from line 140 at 160 through contact 152, connection 164, through relay 165 to line 141 at connection 166. The energization of this relay closes contacts 167, 168 and 170, opening at the same time contact 169. In closing the contact 167, armature 172 of the generator 135 and armature 173 of the main motor 50 are placed in series through conductor 174 leading from the contact to one side of the armature 172, a conductor 175 leading from the other side of the armature 172 to one side of the armature 173 and a line 176 leading from the other side of the armature 173 back to the contact. The closing of the contact 168 closes a circuit through the solenoid 60, to operate the solenoid against the force of the spring 58 to hold the brake shoes 55 and 56 in open position free of the drum 54, removing the braking force from the drum and thus from the main motor 50. This circuit may be traced from connection 160 of line 140, through contact 152, connections 164 and 178, contact 168, through the solenoid 60, to the line 141 at connection 179.

Returning now to the contact 154, this contact completes a circuit from line 140 at connection 180, through connections 181 and 182, contact 154, solenoid 130, to line 141 at connection 183. When the solenoid 130 is energized the lever 128 is actuated to hold the cam levers 124 (Figs. 3 and 6) out of engagement with the cams 114, 115 and 116. The dotted lines leading from the core of the solenoid 130 bear the same reference numeral 128 representing the lever for controlling the cam levers 124.

Attention is now directed to contact 153, which when closed completes a circuit from line 140 at connection 185, through an armature 186 of a motor driven rheostat, indicated generally at 187, through an upper field 188, a normally closed contact 189 and upper limit switch 190, the contact 153, through a connection 191 to line 141 at connection 192. When this circuit is completed the motor driven rheostat begins operation in one direction, causing rotation of its driving screw 194 through gears 195 to move a

crossbar 196 upwardly. The crossbar 196 has brushes 197 connecting contact buttons of a tapped resistance 198 to a conductor bar 199. The resistance 198 is in series with a field 200 of the generator 135, this circuit being traced from line 140 at connection 160, through connection 201, conductor bar 199, brushes 197, resistance 198, through field 200 to line 141 at 162. This connection places the resistance 198 and the field 200 of the generator in parallel with the field 161 of the main motor 50. Therefore, as the crossbar 196 of the motor driven rheostat moves upwardly, the resistance in series with the field 200 of the generator 135 is reduced, affecting an increase in the voltage output of the generator and thus an increase in the speed of the main motor 50. This operation continues, reducing the resistance in series with the generator field until the main motor is driven at a predetermined maximum speed, at which time the motor driven rheostat will be stopped through the opening of the limit switch 190 through the engagement of the crossbar 196 therewith. This opens the circuit through the armature 186 and the upper field 188 of the motor driven rheostat, holding the crossbar 196 at that position, causing the main motor to drive at the predetermined speed.

With the circuits thus far described, let it be assumed that the machine is equipped with an empty take-up reel 22, that the reel has been secured in place by the mechanism 46, operatively connected, through the shaft 25, to the connecting line 28 to cause driving of the reel, and that the ends of a group of strands 14 have been threaded through the machine, that is through the hollow shaft 16 over the sheaves 13 and 17, through the tubular guide 18, around the sheave 19 and through the distributor guide 21, and secured to the reel. When this has been accomplished, the start switch 142 may be closed, completing the circuits previously described. The completion of these circuits will immediately energize the solenoid 60 to release the brake mechanism, energize the main motor 50 through the generator 135 controlled by the motor driven rheostat 187 to gradually build up speed of rotation of the flier from a stop position to a full running speed. The flier is thus rotated through the shaft 52 of the main motor 50, the pinion 62, the intermediate gear 64 and the gear 66 which directly rotates the flier unit 9, to bring about a twist in the strands between the sheave 13 and a point in advance of the machine, and a further twist therein between the sheave 19 and the distributor guide 21. The take-up unit during this rotation of the flier, is held against rotation through the planetary gears 68, 69 and 70, the gear 68 being stationary, its associated gears 70 governing the rotation of the gears 70 associated with the gear 69 to effect holding the latter with the take-up unit stationary during rotation of the flier unit. This action continues until it is desired to stop the machine.

Due to the momentum of the flier unit, it is impossible to stop the machine immediately. Furthermore, it is important that the machine be stopped when the flier unit is in either one of two positions, these positions being when either tubular guide 18 or the tubular member 20 is at the extreme top position, the purpose of this being, as heretofore described, to allow removal of the full reel and the replacing thereof with an empty reel. Therefore, to stop the machine the stop switch 143 is moved into open position. This immediately breaks the circuit through the relay 146, resulting in the closing of contacts 148, 149 and 150 and the opening of contacts 151, 152, 153 and 154. The relay 165, however, remains locked in through a circuit from line 140 at connection 160, through connection 201, conductor bar 202, brushes 204 of the crossbar 196, conductor bar 205, connections 206 and 164, through relay 165 to line 141 at 166. Therefore, the circuits to the generator 135, the motor 50 and the brake controlling solenoid 60 remain closed, the speed of the motor 50 being decreased, however, by regenerative braking resulting from a decreasing voltage output of the generator due to an increase in the resistance 198 to the circuit of the generator field 200. This is brought about by the driving of the motor driven rheostat in the opposite direction.

The closing of the contact 149, through the deenergization of the relay 146, completes a circuit through a limit switch 208, which was moved into closed position during the upward travel of the crossbar 196. This circuit may be traced from line 140 at connection 185, through the armature 186, a lower field 209, the limit switch 208 now in closed position, contact 149, to line 141 at 192. The field 209 reverses the direction of the motor and the travel of the screw 194, moving the crossbar 196 downwardly to the position shown in Fig. 7, where it will have opened limit switch 208, stopping the motor at a position where the maximum resistance will be introduced into the generator field to reduce the speed of the motor 50 to a minimum.

Again attention is directed to the fact that the momentum of the flier unit prevents it from slowing down at the rate at which the voltage to the main motor may be reduced. This is illustrated in the diagram illustrated in Fig. 10, where the bottom line represents time from a point where the stop switch is opened, a point in the vertical plane thereof indicating the beginning of the drop in "voltage" to the main motor and the drop in "speed" of the flier unit. As illustrated, the drop in voltage is greater than the drop in speed of the flier unit; thus it is not practical to stop the flier unit at the time the voltage has been reduced to a minimum. It is, therefore, advisable to continue the rotation of the flier unit holding the brake mechanism inoperative until the speed of the flier has also reached a predetermined minimum speed where the brake can be applied to immediately stop the flier unit without damage thereto.

Returning now to the stopping of the machine, the stop switch has been pressed, deenergizing the relay 146, the relay 165 being locked in and a circuit being completed through the lowering or reversing field 209 of the rheostat 187 starting downward movement of the crossbar 196. The opening of the contact 151 opens the interlocking circuit to the relay 146. The opening of the contact 153 opens the circuit through the upper limit switch 190, while the opening of the contact 154 opens the circuit to the solenoid 130, deenergizing the solenoid to allow the lever 128 to free the cam levers 124 for movement into engagement with their respective cams. The closing of the contact 149 completes the circuit through the lower series field 209 of the motor driving the rheostat as previously described. The completion of this circuit causes operation of the motor driven rheostat 187 in the opposite direction, that is a direction causing downward movement of the crossbar 196, until the circuit

is broken through the engagement of the crossbar with the lower limit switch. During this downward movement with the crossbar of the rheostat, the value of the resistance 198 into the generator field 200 is increased, effecting a decrease in the generating voltage to the main motor field 161, resulting in the decrease in speed of the main motor from a predetermined maximum speed to a predetermined minimum speed. The minimum speed of the motor does not follow the reduction in speed of the flier unit, as illustrated in Fig. 10. Therefore, the circuits to the motor remain complete until the speed of the flier has been reduced accordingly.

The closing of the contact 150 completes the circuit during the downward travel of the crossbar 196 from line 140 at connection 180, through connection 181, contact 150, a short conductor bar 212, which is electrically connected as at 213, to a longer conductor bar 214 similar in length to the conductor bars 202 and 205, through brushes 215, another conductor bar 216, through a relay 218, switch 121, when closed, through a connection 219, contact 170 to line 141 at connection 220. The relay 218 is of the quick closing, slow opening type and will, therefore, be completed at the next intermittent closing interval of the switch 121 controlled by the movement of the cam 115 associated therewith.

As heretofore described, the cams 114, 115 and 116 rotate at the same speed as the flier unit 9. In other words, for each revolution of the flier unit the cams pass through one revolution. It is, therefore, apparent that the circuits for controlling the brake-controlled solenoid 60 and the apron-operated solenoid 98 are conditioned for closing as soon as the stop switch 143 is pressed, but these circuits remain under the control of the cams and the time relay 218, until the flier is slowed down to a desired minimum speed.

Attention here is directed to the fact that when the motor-operated rheostat 187 has completed its operation, moving the crossbar 196 in its lowermost position, where the lower limit switch 208 is broken, the brushes 197 maintain the circuit closed through the generator field 200 introducing the maximum resistance thereto. The brushes 204 have moved free of the conductor bars 202 and 205 and the brushes 215 have moved free of the conductor bars 214 and 216. The brushes 215, however, in this position electrically connect the short conductor bar 212 with the conductor bar 222, when the brushes 204 leave the conductor bars 202 and 205.

As stated hereinbefore, the relay 218 is of the quick closing, slow opening type of time relay. In other words, when the switch 121 is allowed to close during the actuation of the cam 115, the relay 218 will be energized, and although the circuit will be broken through the continued rotation of the cam opening the switch, the repeated intermittent closing of the switch will maintain the relay energized until the speed of rotation of the cam 115 has been reduced so that the time interval in which the switch is held open equals the time interval of deenergization of the relay. Assuming, therefore, that the relay 218 is energized immediately after the opening of the stop switch 143 and at a time when the machine, including the flier unit 9 and the cams 114, 115 and 116, is rotated at the decreasing speed but at a speed faster than the operation of the relay 218, the relay 218 will remain closed to thus hold closed contacts 224, 225 and 226 and hold open a contact 227.

The closing of contact 224 forms an interlocking circuit through the relay 165 which may be traced from line 140 at connection 180, through connections 181 and 229, contact 224, connections 230 and 164, through the relay 165 to line 141 at 166.

The closing of the contact 225 forms an interlocking circuit through the relay 218 which may be traced from line 140 at connection 180, through connection 181, contact 150, connection 221, contact 225, connections 231, relay 218, switch 121, when closed, connection 219, contact 170, to line 141 at connection 220.

The contact 226 conditions a circuit for completion when the crossbar 196 of the motor driven rheostat 187 has moved to its lowermost position, this circuit being traced from line 140 at 180, through connection 181, contact 150, connection 221, conductor bar 212, brushes 215, conductor bar 222, through a relay 234, contact 226, connection 235, contact 170, to line 141 at 220.

The energization of the relay 234 will complete a circuit when the relay is energized to close its contact 236, which circuit may be traced from line 140 at 180, through connection 181, contact 236, connections 230 and 164, through relay 165 to line 141 at 166. This is the third interlocking circuit for the relay 165 to maintain it energized while other circuits have been opened, rendering the previous interlocking circuits for this relay ineffective. The relay 234 also conditions a circuit for a relay 238 which controls the solenoid 98 of the apron-operated mechanism. This circuit when completed may be traced from line 140 at 180, through connection 181, contact 236, connection 230, through a connection 239, contact 169, when closed, relay 238, switch 120, when closed, to line 141 at 240.

Returning now to the contact 227 of relay 218, attention is directed to the fact that this contact and the contact 226 are of the overlapping type, meaning that during the energization or deenergization of the relay 218 one contact is made before the other contact is opened. The contact 227 remains open during the energization of the relay 218 but when closed completes a circuit including the relay 234, which is substantially the same as the circuit completed through the relay by the contact 226 excepting that in the circuit with the contact 227 the switch 122 is present and is under the control of its cam 116.

Let it be assumed that the stop switch 143 has been pressed, effecting a continuous driving of the machine, particularly to flier unit, yet at a decreasing speed, during which time the brake mechanism is held inoperative through the energization of the solenoid 60, and during this decreasing speed of rotation of the flier the cams 114, 115 and 116 rotate in synchronism therewith, the relay 218 having been energized at the beginning of this decrease in speed and maintained energized through the repeated closing of the switch 121 while the time operating feature of the relay 218 maintains the associated circuits linked with the contacts 224, 225 and 226 closed until after the voltage output of the generator 135 has been reduced to a minimum, effecting, through regenerative braking, the reduction in speed of the main motor 50 to a minimum through the lowering of the crossbar 196 of the motor driven rheostat to its lowermost position and held there through the opening of the limit

switch 208. When the speed of rotation of the flier 9 and its associated cams 114, 115 and 116 has been reduced to a predetermined minimum speed, the formation of the cam 115 at either one of its diametrically opposed high portions will engage the switch 121 to hold it open a length of time sufficient for the relay 213 to open, at which time the contacts 224, 225 and 226 will be opened and contact 227 will be closed. The contact 224 functioned to form an interlocking circuit in the relay 165, but subsequent to its functioning another interlocking circuit was formed through the energization of the relay 234 and the closing of its contact 236. Therefore, the relay 165 remains energized although the contact 224 is open. The contact 225 provides an interlocking circuit around the relay 213, this circuit being broken, however, through the opening of the switch 121. The relay 234, whose circuit has been completed previously by the contact 226, is maintained energized through the closing of the contact 227. However, after the cam 115 first opens its switch 121, the cam 116, which has smaller high portions than those of the cam 115, will cause opening of its switch 122 at the exact time when the tubular guide 18 and tubular member 20 of the flier are in a common vertical plane, either one or the other being disposed on the top of the cycle of rotation of the flier. It will be apparent, by viewing the contours of the cams 115 and 116 in Figs. 7 and 9, that these cams rotate in unison on a common shaft so that the high portions of the cam 115 will cause opening of the switch 121 prior to the high portions of the cam 116 opening the switch 122. Therefore, the repeated opening of the switch 122 will not affect the circuit including the contact 227 until after the switch 121 has been opened and at a definite period thereafter. The cam 116 will open the switch 122, opening the circuit including the relay 234 to deenergize the relay, resulting in the opening of the contact 236 and the breaking of the locking circuit through the relay 165.

The relay 165 then becomes deenergized, resulting in the opening of the contacts 167 and 168 and the closing of the contact 169. The opening of the contact 167 opens the circuit including armatures of the motor 50 and the generator 135, while the opening of the contact 168 opens the circuit to the solenoid 60, denergizing the solenoid and allowing the spring 58 to function in actuating the brake mechanism, forcing the brake shoes 55 and 56 into intimate engagement with the brake drum 54, stopping rotation of the shaft 52, and thus stopping rotation of the motor 50 and the flier unit 9. The action which takes place after the opening of the switch 122 is substantially instantaneous, effecting stopping of the flier unit at a definite position.

The closing of the contact 169 completes the circuit through the relay 238 upon the next closing of the switch 120, resulting in the opening of contact 245 in a circuit including the solenoid 98. This circuit may be traced from line 140 at connection 180, through connection 181, solenoid 98, contact 245, to line 141 at 246. This circuit was completed upon energization of the relay 165 at the beginning of the operation of the machine to energize the solenoid 98, to operate the valve 94 and effect actuation of the piston 85 and its associated mechanism to move the apron 75 and the latch 83 into their upper positions and to hold them thus until the circuit through the solenoid 98 is opened. At this time, that is immediately after the flier unit has been stopped, this circuit is opened, deenergizing the solenoid 98 and rendering the spring 100 effective to actuate the valve to another position and to cause fluid under pressure to actuate the piston 85 and through the associated mechanism to move the apron 75 into the lower position and move the latch 83 into the notch 84 of the head 45.

The machine is now in condition for the removal of the reel 22 and its supporting truck 23, providing the desired amount of cable has been intertwisted and wound thereon. A suitable counter (not shown) may be used to measure the cable wound on the reel. It may be desirable to add predetermined variable lengths to the cable on the reel by continuing the operation of the machine. Therefore, it would be advantageous to be able to run the machine at a slow speed while the operator watches the counter, and again stop the flier at the proper position and actuate the apron 75 together with the latch 83. This is made possible through a jogging mechanism or circuits including the jogging switch 144 of the instant release type, which must be manually held in place to maintain the associated circuits closed. The closing of the switch 144 completes the circuits through the relay 146, causing the relay to function as before described, the circuit being traced from line 140 at connection 250, through switch 144, connections 251 and 252, through the relay 146, to line 141 at 147. The relay 146 is of the slow closing, quick releasing type, making it possible for the completion of a circuit through the jogging relay 253 and its interlocking circuit controlled by its contact 254 prior to the energization of the relay 146 to open the contact 148. The circuit through the relay 253 may be traced from line 140 at connection 250, through the switch 144, connection 251, contact 148, relay 253, to line 141 at connection 255. The interlocking circuit for the relay 253 is traced from line 140 at 250 through switch 144, connection 251, contact 254, connection 256, relay 253, to line 141 at 255. This interlocking circuit being completed prior to the opening of the contact 148, the jogging relay remains energized during the holding of the switch 144 closed. The main purpose of the contact 148 is to render ineffective, operation of the relay 253 during the normal running of the machine, through the control of the start and stop switches 142 and 143 respectively.

The energization of the relay 146 will close various circuits to cause the machine to begin its operation in the same manner as previously described under the control of the start switch 142, except where certain of the circuits are removed through the energization of the jogging relay 253 and other circuits completed so that the machine will operate in the usual manner but at a slower rate of speed, causing actuation of the brake unit and the apron control mechanism and bringing into action the cams 114, 115 and 116 at a proper interval to stop the flier at a selected position.

In addition to the contact 254 of the interlocking circuit for the relay 253, this relay controls contacts 158 and 189 in addition to contacts 258, 259 and 260. When the relay 253 is energized the contacts 158 and 189 are opened, respectively opening the interlocking circuit for the relay 146 and the circuit controlled through the upper limit switch 190. The contact 258 closes to complete a circuit through a jogging

limit switch 261, which may be traced from line 140 at connection 185, through the armature 186 of the motor driven rheostat 187, the upper field 188 thereof, through contact 258, limit switch 261, connections 262 and 191, to line 141 at 192. The contacts 259 and 260, closed by the energization of the relay 253, complete a circuit through the relay 218, when the switch 121 is closed, the circuit being traced from line 140 at 180, connections 181, 229 and 264, contacts 259, connections 231, through relay 218, a connection 265, contact 260, connection 266, contact 170, which has been closed by the energization of the relay 165, to line 141 at 220.

It will, therefore, be apparent that upon pressing the switch 144 closed the brake mechanism controlled by the solenoid 60 will be released, the circuits through the armatures of the generator 135 and the main motor 50 will be completed and the main motor will be driven at a speed controlled by the motor driven rheostat. The motor driven rheostat will be operated to cause upward movement of the crossbar 196, closing the lower limit switch 208 to condition it for future functioning and continue to travel upwardly until the jogging limit switch 261 is open, at which time the circuit through the motor driven rheostat will be closed, holding the crossbar 196 at a position adjacent the limit switch 261, resulting in the controlling of the voltage of the generator and thus the speed of the main motor 50 driving the flier unit, the speed of the flier unit being slower than the required running speed.

When it is desirable to stop the machine the operator releases the switch 144, opening the circuits to the relays 146 and 253 but not affecting the relays 165 and 218 which have been locked in through their previously described circuits. The deenergization of the relay 146 will complete a circuit through the lower field 209 which is under the control of the lower limit switch 208, resulting in the driving of the rheostat to move the crossbar 196 downwardly until it is again in its lowermost position, at which time the motor driven rheostat will be stopped through the opening of the limit switch 208. Thus the stopping operation of the machine is repeated except that the stopping operation does not begin with the flier unit travelling at the high speed, it travelling, however, at a speed higher than that satisfactory for immediate stopping. Furthermore, the difference in the reducing voltage to the motor 50 and the reducing speed of the flier unit 9 is similar to the illustration in Fig. 10. Thus the relay 218, assisted by relays 234 and 165, falls under the control of the cams 114, 115 and 116 to function in stopping the flier unit when the speed thereof has been reduced to a desired minimum speed, allowing the cam 115 to close its switch 121 a length of time sufficient for the deenergization of the relay 218. When this has been accomplished the circuit controlled by the cam 116 will be completed through the contact 227 and the relay 234 and at a definite time thereafter this circuit will be opened through the action of the cam opening the switch 122. This results in the deenergization of the relay 165, opening the circuits to the generator 135 and the main motor 50 and rendering the brake mechanism effective through the deenergization of the solenoid 60. Immediately thereafter the switch 120 is closed through the action of the cam 115, resulting in the opening of the contact 245 to deenergize the solenoid 98, rendering the spring 100 effective to cause actuation of the valve 94 resulting in the moving of the apron 75 into its lower position and the latch 83 into engagement with the notch 84 of the head 45.

With the control system associated with the machine, it is possible, through the manual closing of a switch, to cause the apron 75 to move upwardly into an open or running position, and to remove the latch from the head 45 of the take-up unit, whose function has been to hold the take-up unit against rotation during the unloading of a full reel and the loading of an empty reel. Through the closing of the start switch the brake is removed from the drive shaft, and the generator, due to the decreasing resistance under the control of the motor driven rheostat 187, applies increased voltage to the field 161 of the main motor, increasing the speed of the motor to increase rotary speed of the flier unit until a predetermined maximum speed has been maintained, after which the motor of the rheostat is deenergized, holding the controlled resistance to the generator and maintaining the predetermind maximum speed. During this operation certain interlocking circuits are set up for the relays 146 and 165.

To stop the machine, that is to stop the flier unit at a definite position so that the reel may be removed and a new reel disposed in place in the take-up unit, electrical units automatically act upon opening of the stop switch 143 to reverse the action of the motor driven rheostat to add an increased resistance to the generator field, maintaining interlocking circuits to the relay 165 although the relay 146 has been deenergized, until after the voltage to the main motor has been reduced to a minimum and until the speed of the flier has also been reduced to a minimum. During this action of the rheostat in decreasing the speed of the main motor and effectively reducing the speed of the flier unit, the switches 120, 121 and 122 are free to be controlled by their cams and the relay 218 is brought into action through the assistance of the relays 234 and 165 to effectively stop the flier unit at a definite position after it has attained sufficiently slow speed. After this has been accomplished the brake mechanism automatically operates to cause stopping of the flier unit at the predetermined position and actuation of the apron controlling mechanism automatically to condition the machine for the removal of the full reel.

This same procedure may be carried out through the operation of the jogging switch 144, to cause running of the machine at a slower speed controlled by the limit switch 261 yet effecting the same automatic action of the brake mechanism and the apron controlling mechanism.

The embodiment of the invention herein disclosed is merely illustrative and may be widely modified and departed from in many ways without departing from the spirit and scope of the invention as pointed out in and limited solely by the appended claims.

What is claimed is:

1. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect actuation of the part at a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, a unit actuable with the part and at speeds variable with variations in

the speed of the part, and means under the control of the unit to cause stopping of the part at a given position after the actuation thereof has reached the said minimum speed.

2. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect actuation of the part at a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, a unit actuable with the part and at speeds variable with variations in the speed of the part, means under the control of the unit to cause stopping of the part at a given position in the operating cycle, and means influenced by the speed of the part to render the stopping means effective after the actuation of the part has reached the said minimum speed.

3. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect acceleration of the part to a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, a unit actuable with the part and at speeds variable with variations in the speed of the part, and means under the control of the unit while the part and unit are decelerating to cause stopping of the part at a given position after the part has reached the said minimum speed.

4. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect acceleration of the part to a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, means influenced by the speed of the part while decelerating to cause stopping of the part at a given position after the part has reached the said minimum speed, and auxiliary means affecting the first named means to effect acceleration of the part to a predetermined speed intermediate the said maximum and minimum speeds and causing a repetition in the functioning of the second and third named means.

5. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect actuation of the part at a predetermined running speed, a unit actuable in timed relation with the part to effect stopping of the part in a given position, means to effect deceleration of the part and unit to predetermined minimum speeds, and means to render the unit ineffective during the actuation of the part at the running speed and during the deceleration of the part and unit until after the said minimum speeds have been reached.

6. In a control system for a machine having a part driven through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, means to stop the part, a unit driven by the motor at speeds variable with those of the part, and means controlled by the unit to render the stopping means effective to stop the part after the said minimum speed of the part and unit have been reached.

7. In a control system for a machine having a part driven through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, means to stop the part, a unit driven by the motor at speeds variable with those of the part, means to render the stopping means ineffective during actuation of the part and until the said minimum speed of the part and unit have been reached, and means to render the last named means ineffective upon the part and unit reaching their minimum speeds.

8. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect actuation of the part at a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, means to stop the part comprising a stop mechanism actuable to stop the part, and an electrically operated time relay adapted to effect actuation of the stop mechanism only when the actuation of the part has reached the said minimum speed.

9. In a controlling system for a machine having a part actuable through operating cycles, in combination, means to effect actuation of the part at a predetermined maximum speed, means to effect deceleration of the part to a predetermined minimum speed, means to stop the part comprising a stop mechanism actuable to stop the part, an electrically operated time relay disposed in an electrical circuit, a switch disposed in the circuit, an element actuated in timed relation with the part to effect alternate opening and closing of the switch to repeatedly energize the relay until the time opening intervals of the switch and the relay have balanced, and means affected by the opening of the relay to render the stop mechanism effective.

10. In a control system for a machine having a part driven through operating cycles by an electric motor, in combination, means to cause application of an electrical energy to the motor to effect running of the motor at a predetermined speed to drive the part at a predetermined speed, means to cause a decrease in the electrical energy to a predetermined value in a given time to effect deceleration of the motor and part to predetermined minimum speeds and maintain the electrical energy at the said value until the part reaches the said minimum speed, and means driven by the part and adapted to cause stopping of the part after the part reaches the said minimum speed.

11. In a control system for a machine having a part driven through operating cycles by an electric motor, in combination, means to cause application of an electrical energy to the motor to effect running of the motor at a predetermined speed to drive the part at a predetermined speed, means to cause a decrease in the electrical energy to a predetermined value in a given time to effect deceleration of the motor to a predetermined minimum speed to cause deceleration of the part and maintain the electrical energy at the said value until the part reaches a given minimum speed, and means influenced by the speed of the part to stop the part at a given position after the part has reached the said minimum speed.

12. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, a rotatable element driven by the

motor in timed relation with the part, and means affected by the rotative speed of the element to cause stopping of the part when the said minimum speed thereof has been reached.

13. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, a rotatable element driven by the motor in timed relation with the part, and means affected by the rotative speed of the element to cause stopping of the part at a given position after the said minimum speed thereof has been reached.

14. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, a rotatable cam driven by the motor in timed relation with the part, a brake operable to stop rotation of the part, and means controlled by the cam to effect operation of the brake to stop the part at a definite position.

15. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, a cam rotated in timed relation with the part, a brake operable to stop rotation of the part, an electrical circuit opened and closed by and including a switch actuated by the cam, an electrical time controlled unit in the circuit energized by repeated closing of the circuit through the cam and the switch until the time limit for deenergization of the unit equals the time interval between closing intervals of the switch by the cam, and means affected by the deenergization of the unit to effect operation of the brake.

16. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a predetermined maximum speed to drive the part at a predetermined maximum speed, means to effect deceleration of the motor and the part to predetermined minimum speeds, a cam rotated in timed relation with the part, a brake operable to stop rotation of the part, an electrical circuit opened and closed by and including a switch actuated by the cam, an electrical time controlled unit in the circuit energized by repeated closing of the circuit through the cam and the switch until the time limit for deenergization of the unit equals the time interval between closing intervals of the switch by the cam, a second cam rotatable with the first mentioned cam, and a second circuit affected by the unit and including a switch actuated by the second cam after deenergization of the unit to effect operation of the brake to stop the part at a given position.

17. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a given speed to rotate the part at an operating speed, means to effect deceleration of the motor to effect deceleration of the part to a given minimum speed, a cam rotated by the motor in timed relation with the part, a switch actuated by the cam, a brake to stop the part, and electrical means controlled by the switch and the cam to render the brake effective to stop the part when the part has reached the said minimum speed.

18. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a given speed to rotate the part at an operating speed, means to effect deceleration of the motor to effect deceleration of the part to a given minimum speed, a cam rotated by the motor in timed relation with the part, a switch actuated by the cam, a brake to stop the part, means to hold the switch free of the cam during rotation of the part at the operating speed, and electrical means controlled by the switch and the cam to render the brake effective to stop the part when the part has reached the said minimum speed.

19. In a control system for a machine having a part rotatable through operating cycles by an electric motor, in combination, means to effect running of the motor at a given speed to rotate the part at an operating speed, means to effect deceleration of the motor to effect deceleration of the part to be given minimum speed, cams rotated by the motor in timed relation with the part, switches actuated by the cams, a brake to stop the part, electrical means controlled by one of the switches at a time controlled by its cam to effect operation of the brake to stop the part at a given position, and electrical means controlled by the other switch and its cam to render the first electrical means ineffective until deceleration of the part to the said minimum speed.

20. In a control system for a machine to be loaded with an article and having a part rotatable relative to the article, in combination, a platform actuable into and out of a loading position for use in loading and unloading the machine with articles, means to effect rotation of the part at a running speed, means to effect deceleration of the part to a predetermined minimum speed, means to stop the part at a given position after the reduction of the part to the minimum speed to condition the machine for the unloading of the article therefrom, and means to cause actuation of the platform out of loading position prior to the rotation of the part and actuation of the platform into loading position after stopping of the part.

21. In a control system for a machine to be loaded with an article and having a part rotatable relativet to the article, in combination, means to effect rotation of the part at a running speed, means to effect deceleration of the part to a predetermined minimum speed, means to stop the part at a given position after the reduction of the part to the minimum speed to condition the machine for the unloading of the article therefrom, and means to latch the machine against operation during the loading and unloading of the articles.

22. In a control system for a machine to be loaded with an article and having a part rotatable relative to the article, in combination, a platform actuable into and out of a loading position for use in loading and unloading the machine with articles, means to effect rotation of the part at a running speed, means to effect de-

celeration of the part to a predetermined minimum speed, means to stop the part at a given position after the reduction of the part to the minimum speed to condition the machine for the unloading of the article therefrom, means to cause actuation of the platform out of loading position prior to the rotation of the part and actuation of the platform into loading position after stopping of the part, and a latch actuable with the platform to hold the machine against operation during loading and unloading of the articles.

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