Dec. 11, 1945. J. Z. LINSENMEYER ET AL 2,390,799

CONTROL SYSTEM

Filed June 9, 1944

Fig. 1.

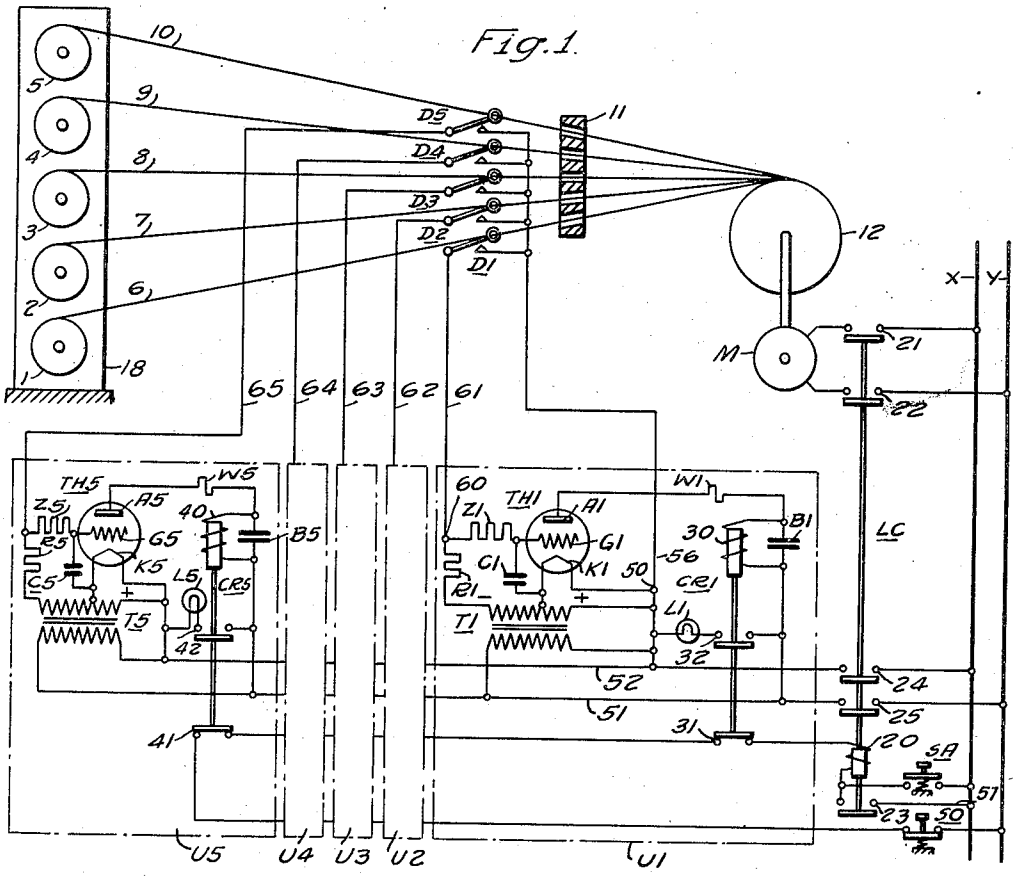
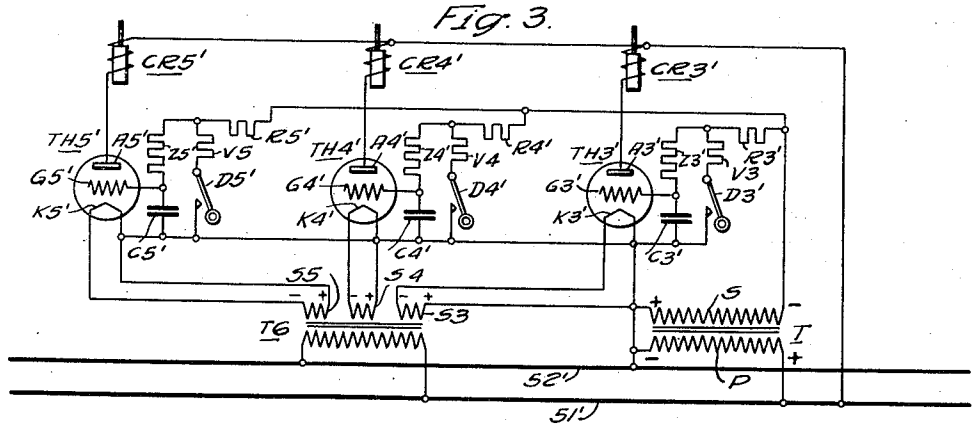


Fig. 3.

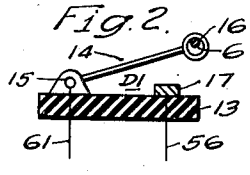


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Fig. 2.



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CONTROL SYSTEM

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6 Claims. (Cl. 28—51)

Our invention is related to that of our copending application Serial No. 492,964, filed June 30, 1943, now Patent No. 2,352,647, dated July 4, 1944, for Fault-responsive control systems for strand working machines, and concerns automatic cutoff controls for spooling, warping, stranding, weaving and the like strand working machines, and more particularly to machines provided with so-called drop-wire switches.

In textile or wire fabricating machines, a number of strand elements, such as threads or wires, are as a rule taken from supply or storage reels and, after passing through some processing operation, are eventually wound up on a beam, spool or drum. Occasionally, one or several of the strands may break, and it is then necessary to stop the machine immediately and to eliminate the fault.

Drop-wire switches may be used in order to provide an automatic cutoff control, a separate switch being provided for each of the threads or strands. Each dropwire switch has a hinged eyelet traversed by the thread and thereby kept against its bias from touching a stationary contact. When the thread breaks, the eyelet is released and the wire drops onto the stationary contact thereby closing the energizing circuit of a relay. The relay, usually a sensitive low voltage relay of the electromagnetic type, is then effective to stop the drive motor of the machine.

According to the invention, we consider the known drop-wire controls of strand working machines to represent a compromise which necessarily limits the operating qualities of the machines as regards sensitivity and reliability of control. Under customary operating conditions, the stationary contacts and drop wires of the drop-wire switches are apt to become covered with fluff, dust or dirt, especially after long periods of undisturbed operation. As a result, the electric contact established upon the occurrence of a break is unreliable and apt to have a high contact resistance, so that the relay may fail to operate properly. To be sure, this source of trouble is partly avoided when using drop-wire switches of relatively high biasing force and contact pressure, but this requires a relatively heavy construction of the drop wires which is apt to impose undue strain on the threads, thus creating another source of disturbance. The remedy of using contactors of extreme sensitivity is imperfect as regards the elimination of unreliable control impulses and represent also a complication with respect to adjustment and maintenance, especially in view of the high operating speeds preferred in modern strand working machines.

It is an object of our invention to provide an automatic cutout control for the electric drive of strand working machines in which, though drop-wire switches or the like fault-responsive means are used for transmitting a control impulse to an electromagnetic cutoff relay, a reliable pick-up of the control impulses by the relay and a safe and immediate stopping of the machine drive is secured even with imperfect or transient contact engagements and regardless of the energy requirements and time constants of the relay operation.

It is also an object of the invention to permit, in cutout controls of the type mentioned, the use of simple and sturdy electromagnetic relays, regardless of any misproportion of their current and voltage requirements and time constant to the condition of the primary control impulses transmitted by the drop-wires or other fault-responsive contact means of the machine to be controlled.

According to our invention, in order to achieve these objects, we provide an electronic discharge tube, for instance a gaseous tube known under the name "Thyratron," between the primary impulse transmitter and the cutout relay so that the control impulse serves merely to "fire" the tube, while the anode or plate circuit of the tube, which remains conductive after the firing moment, is connected to the relay and energizes it until the cutoff operation is completed.

According to another feature of the invention, we also provide interlock means between the plate circuit and the circuit controlled by the relay, so that the tube is automatically deenergized upon completion of the relay or cutout operation. Thus, the control circuit places itself into its initial condition once the control function is fully performed.

According to a further feature of the invention, the gaseous discharge tube is provided with a potentiometric grid circuit which has points of different polarity, relative to the tube cathode, connected with the fault-responsive impulse transmitting means, so that the occurrence of an impulse has the effect of changing the grid polarity thereby determining the firing moment of the tube.

These and other objects and features of the invention will be apparent from the following description of the embodiments illustrated in the drawing in which:

Figure 1 is a diagrammatic showing of those

parts of a textile machine which are essential in connection with the present invention, and represents also the circuit diagram of an electric control system for automatically stopping the drive of the textile machine, upon the occurrence of strand failure, in accordance with the above-stated objects and features of the invention;

Fig. 2 is a schematic illustration of one of the drop-wire switches used in the machine according to Fig. 1; and

Fig. 3 is the circuit diagram of a modified embodiment of a fault-responsive control system according to the invention.

Referring to Figure 1, the illustrated machine has a plurality of storage reels, such as those denoted by 1, 2, 3, 4 and 5, which are mounted on the frame or supporting structure 18 of the machine. The strands or threads 6, 7, 8, 9 and 10, respectively, pass through an eyeboard 11 to a beam, drum or spool, depending upon the particular kind of machine involved. During the passage from the eyeboard to the beam 12, the threads may be subjected to a fabricating operation, such as weaving, knitting or twisting, so that the material wound up on beam 12 represents a final or fabricated material. In other machines, for instance in a wrapper, the threads or strands are merely placed on the beam 12 without other fabricating operation than arranging them in proper order for a subsequent fabricating step.

In order to indicate a strand break, a drop-wire switch is allotted to each of the threads, such as the switches denoted by D1, D2, D3, D4 and D5. Each of these switches is designed in accordance with the example of switch D1 shown in Fig. 2. According to Fig. 2, an insulating base plate 13 is attached to the supporting structure of the machine and serves as a support for several or all of the drop-wire switches. A wire 14 is pivotally mounted at 14 and carries an eye or loop 16. The wire 14 is biased, preferably only by its gravity, toward a stationary contact 17 which is attached to the insulating base 13. The wire 14 of switch D1 is connected by a lead 61 with relay control means to be described in the following. Similar leads 62, 63, 64 and 65 are provided for the other switches D2 through D5, respectively. As will be pointed out in the following, several drop-wire switches may be electrically connected, so that the operation of any one of them will act on the same relay-control means. Therefore, contact 17 may consist of a bar which passes underneath a plurality of drop wires, so that it can be engaged by any one of them in order to close an electric contact. When the strand working machine is in operating condition, the strands traverse the eyes of the drop-wire switches and thereby keep the drop wires in raised position, as illustrated in Fig. 2. Hence, the electric contact between the drop wires and the contact bar 17 is normally interrupted.

Reverting to Fig. 1, the beam 12 is driven by an electric motor M energized from current supply mains X and Y. The connection of these mains to the motor is controlled by a line contactor LC whose operating coil 20 operates two main contacts 21 and 22, a self-sealing contact 23 and two control contacts 24 and 25. Coil 20 is connected with main X through a starting switch SA, for instance of the push button type. However, its energization is also controlled by a group of control units, such as those denoted by U1, U2, U3, U4 and U5. Each of these control units is allotted to one of the drop-wire switches, respectively, and includes an electromagnetic control relay and a Thyratron or the like discharge tube.

Referring to control unit U1, the appertaining control relay CR1 has a control coil 30 for actuating a main contact 31 and a signal contact 32. The other control units are similarly equipped. For instance, relay CR5 of unit U5 has its coil 40 acting on a main contact 41 and a signal contact 42.

The energizing circuit of coil 20 of line contactor LC extends in series through main contacts 31 and 41 as well as through the corresponding (not illustrated) contacts of the corresponding other control relays, and this circuit includes also a normally closed stop switch or push button SO.

The tube TH1 of unit U1 has its anode A1 connected through a resistor W1 with one terminal of coil 30 of control relay CR1. The cathode K1 is connected through a lead 56 with the interconnected contacts of the drop-wire switches, i. e. with the contact bar 17 in the example shown in Fig. 2. The control grid G1 of tube TH1 is connected through a resistor Z1 with a lead 61 attached to the other contact of the appertaining drop-wire switch D1. A resistor R1 is connected between grid resistor Z1 and the secondary of a transformer T1. This secondary is tapped so that part of its winding serves to provide the cathode K1 with heating current. The primary of transformer T1 is connected across two supply leads 51 and 52 which are connected with mains X and Y under control by contacts 24 and 25 of line contactor LC. One terminal of the transformer secondary is also connected with lead 52. Consequently, when control contacts 24 and 25 are closed, the plate circuit of tube TH1 extends from anode A1 through resistor W1 and relay coil 30 to lead 51 and thence through contact 25 to main Y; while the cathode K1 is in connection with main X through lead 52 and control contact 24. The connections are so chosen that the terminals of the transformer secondaries have the polarities indicated by + and — during the conductive voltage phase. The grid G1 is normally at a sufficiently negative potential relative to the cathode K1 to block the flow of current through the tube. When the thread or strand 6 breaks, thereby releasing the drop wire of switch D1, leads 56 and 61 are connected with each other. As a result, a short circuit is established between points 50 and 60 of the potentiometric resistance arrangement of the tube circuit. Consequently, point 60 of the resistance arrangement assumes now the positive polarity of the cathode K1. This has the effect of placing firing potential on grid G1, so that the arc discharge in tube TH1 is ignited. The current now flowing through the tube energizes coil 30 of control relay CR1.

The control relay and tube circuits of the other control units are of similar design and function. Thus, the anode A5 of tube TH5 is connected through resistor W5 with coil 40 of relay CR5. The grid G5 is connected through resistor Z5 with a lead 65 attached to the drop-wire switch D5. The cathode K5 is connected to the secondary of a transformer T5 as well as with the leads 52 and 56 connected to the common contact (17 in Fig. 2) of the drop-wire switches. A resistor R5 is inserted between grid resistor Z5 and the secondary of transformer T5.

The capacitors C1, C5, and B1, B5 are of auxiliary nature and serve to improve the operating conditions of the tubes and control relays.

The signal contacts 32 and 42 are connected with signal lamps L1 and L5, respectively, which are lighted when the appertaining control relay is energized, in order to indicate to the attendant which of the drop-wire switches has closed. This facilitates finding the broken thread.

The system, as a whole, operates as follows:

Fig. 1 shows the circuit elements in inoperative condition with all threads 6, 7, 8, 9 and 10 in good working order. For starting the drive motor M, button SA is depressed by the operator. This closes the energizing circuit of contact coil 20 from main X through SA, 20, 31, etc., 41, SO, Y. The line contactor LC closes its contacts and thereby energizes the motor through contacts 21 and 22. The closure of contact 23 establishes a self-sealing circuit for coil 20 through lead 57. Hence, the coil remains energized when starting button SA is released and returns to its interrupting position. The textile machine is now in operation. In order to stop it, the button SO is actuated. This interrupts the circuit of coil 20 and causes the line contactor LC to disconnect the motor and to interrupt its self-sealing circuit. Consequently, the machine remains stopped upon release of the stop button SO.

When a thread breaks while the machine is in operation, the corresponding drop-wire switch, for instance switch D1, closes its contact and, as explained above, controls the discharge tube TH1 to energize coil 30 of control relay CR1. Due to the amplifying effect involved in the electronic control circuit, only a slight voltage impulse and a negligible current flow is necessary to cause firing of the tube, and the tube will then continue to remain in operation, independent of any irregularity in grid voltage. The current flowing in the plate circuit of the tube and effective in the coil of the control relay is of a magnitude and voltage determined by the operating requirements of the relay and virtually independent of the energy or operating conditions of the primary grid impulse. Consequently, the system secures a proper energization of the control relay immediately upon occurrence of a strand break, even if the contact established in the drop-wire switch is impaired by moisture or dust and too unreliable for a direct control of an electromagnetic relay or contactor. Likewise, the duration of the control impulse is of no concern as regards the performance of the control operation.

The energization of the control relay thus effected interrupts the coil circuit of the line contactor LC and thus causes it to disconnect the drive motor M at contacts 21 and 22 in the same manner as if the stop button SO had been depressed by the operator. At the same time, the contact 32 of relay CR1 lights the signal lamp L1.

Since the other control relays and tube circuits of the system operate in parallel with the relay and tube circuits appertaining to switch D1, the break of any thread has the above-described effect of stopping the motor, except that a different signal lamp is lighted, thereby indicating the location of the fault.

While we have shown in Fig. 1 only a limited number of threads or strands, it will be obvious that the invention can be applied to any large number of threads or strands. It is, as a rule, preferable to group several threads or appertaining drop-wire switches together, so that the switches of this group act on a common control tube and relay, and actuate a common signal lamp. For instnce, if the textile machine has a number of threads arranged in horizontal rows, all drop-wire switches appertaining to a horizontal row may be connected with a single tube and control relay, so that the illumination of the indicator lamp, upon an automatic stopping of the machines, indicates merely the horizontal row in which the fault is to be looked for.

Instead of providing each individual tube and control relay combination with a separate transformer, it is also possible to reduce the number of transformers, for instance, in the manner exemplified by the embodiment shown in Fig. 3.

Fig. 3 is a straight-line circuit diagram which shows only part of the electronic portion of the control system, the appertaining drop-wire switches being denoted by D3', D4' and D5', and the appertaining control relays CR3', CR4' and CR5' being represented merely by their respective energizing coils. The textile machine, its electric drive motor and the appertaining line contactor are not shown in Fig. 3, because these elements may be the same as those represented in Fig. 1.

According to Fig. 3, each of the Thyratron tubes TH3', TH4' and TH5' has its anode A3', A4', or A5' connected through the energizing current of the appertaining control relay CR3', CR4' or CR5' with an alternating-current supply lead 51' which corresponds to the lead 51 according to Fig. 1. The cathodes K3', K4' and K5', respectively, are connected through a lead 53 with the other lead 52' of the alternating-current supply. A single transformer T, having its primary P connected across supply leads 51' and 52', serves for impressing by its secondary S the necessary potentiometer voltage across the cathode-grid connection of all control tubes of the system. The connection includes resistors R3', R4' and R5', respectively, and extends through another resistor V3, V4 or V5 and the appertaining drop-wire switch D3', D4' or D5'. The midpoint between resistor R3' and V3 is connected to a grid G3' through another resistor Z3'. Similar resistors Z4' and Z5', respectively, are provided in the circuits of grids G4' and G5'. A second transformer T6, connected across leads 51' and 52', has a separate secondary winding S3, S4 and S5 for each of the tubes TH3', TH4' and TH5', respectively, for providing the tube cathode with heating current. The secondary windings have the indicated polarities during the voltage phase in which the tubes are capable of carrying current when released by their grid control circuits. As in the embodiment described in connection with Fig. 1, the potential impressed in the grids G3', G4' and G5' is sufficiently negative, relative to the respective cathodes, to block the discharge as long as the appertaining drop-wire switches are open. The closing of any of these switches, due to strand failure in the textile machine, establishes a cross connection which places the grid on a positive potential relative to the cathode and causes firing of the appertaining tube.

It will be noted that in control systems of the type described above, the electronic sections of the control arrangement are interlocked with the line contactor, this interlock being established by passing the energizing circuit of the electronic tubes through the control or interlock contacts 24 or 25 of line contactor LC. As a result, the circuits of the Thyratrons and control relays are deenergized as long as the machine is inoperative and obtain their energization only when starting

the electric drive motor. Upon the occurrence of a strand break, the automatic disconnection of the drive motor has also the effect of deenergizing the tube circuits. As a result, the plate current established by the firing of the tubes ceases automatically when the desired cutoff effect of the machine drive is completed.

Due to the fact that the closing of the drop-wire switches serves merely for starting the operation of the control tubes, and since the subsequent energization of the electromagnetic control relays is independent of the duration or intensity of the primary control impulse and is terminated only after the machine has been stopped, it is possible to use various types of electromagnetic contactors as control relays, regardless of any misproportion of their operating and energy requirements to the energy condition or duration of the primary control impulse.

It will be understood from the foregoing by those skilled in the art that the invention permits various modifications and changes without departure from its gist and essential features, as set forth in the claims appended hereto.

We claim as our invention:

1. In a strand working machine, the combination of means for accommodating a plurality of strands, electric drive means arranged for simultaneously advancing said strands when operative, electromagnetic contact means having two sets of contacts of which one is connected with said electric drive means for controlling its operation, an electromagnetic relay connected with said contact means for controlling the operation of said sets of contacts, an electronic discharge tube having an anode circuit connected with said relay and a grid circuit for controlling said anode circuit, impulse transmitting means responsive to the occurrence of a strand break and connected to said grid circuit so as to provide the latter with voltage for controlling said tube to energize said relay when said transmitting means respond to a break, and means controlled by said other set of contacts for rendering said tube and relay ineffective when said drive means are stopped due to the control action of said one set of contacts.

2. In a strand working machine, the combination of means for accommodating a plurality of strands, electric drive means arranged for simultaneously advancing said strands when operative, electromagnetic contact means having two sets of contacts of which one is connected with said electric drive means for controlling its operation, an electromagnetic relay connected with said contact means for controlling the operation of said sets of contacts, a gaseous discharge tube having an anode circuit connected with said relay for energizing the latter when conductive and a grid circuit for controlling said anode circuit, drop-wire switch means for engaging one of said strands so as to transmit an electric impulse in response to the occurrence of a strand fault, said switch means being connected to said grid circuit so as to provide the latter with firing voltage for rendering said tube conductive by said impulse, and means controlled by said other set of contacts for rendering said tube and relay ineffective when said drive means are stopped due to the control action of said one set of contacts.

3. In a strand working machine, the combination of means for accommodating a plurality of strands, fabricating means for simultaneously operating said strands, an electric drive for actuating said fabricating means, a relay contactor for controlling said drive, drop-wire switch means for engaging one of said strands so as to transmit—in response to the occurrence of a strand failure—an electric impulse insufficient as compared with the energizing requirements for operating said relay, and a gaseous discharge tube having a grid circuit connected to said switch means so as to establish firing conditions upon occurrence of said impulse and an anode circuit connected with said relay for energizing the latter, and contact means controlled by said relay for deenergizing said anode circuit upon operation of said relay.

4. Electric control means for a strand working machine, comprising an electric drive motor, a cutoff contactor for stopping said motor, an electromagnetic relay for controlling said contactor, drop-wire switch means responsive to the occurrence of strand failure in said machine for producing an electric control impulse of insufficient energy as compared with that required for the normal operation of said relay, a gaseous discharge tube having a grid circuit connected to said switch means so as to establish firing conditions upon occurrence of said impulse and an anode circuit connected with said relay for actuating the latter when energized and fired, and means under control by said contactor for energizing said anode circuit, whereby said motor is stopped and said anode circuit deenergized by said contactor upon the occurrence of strand failure.

5. Electric control means for a strand working machine, comprising an electric drive, an electromagnetic relay for controlling said drive, drop-wire switch means responsive to the occurrence of strand failure in said machine for producing an electric control impulse of insufficient energy as compared with that required for the normal operation of said relay, a gaseous discharge tube having a grid circuit connected to said means so as to establish firing conditions upon occurrence of said impulse and an anode circuit connected with said relay for energizing the latter, and contact means controlled by said relay for deenergizing said anode circuit and relay upon operation of said relay in order to restore said tube and relay to initial operating conditions.

6. Electric control means for a strand working machine, comprising an electric drive, an electromagnetic relay for controlling said drive, drop-wire switch means responsive to the occurrence of strand failure in said machine, a gaseous discharge tube having a cathode, an anode, and a grid, and a potentiometric tube circuit connected to said cathode and grid and having two points of different polarity relative to that of said cathode connected across said switch means so that the potential of said grid is negative relative to said cathode when said switch means are open and becomes sufficiently positive for firing said tube when said switch means are closed in response to strand failure, said anode and cathode being connected to said relay for controlling it to cut off said motor when said tube is energized and fired, and means for energizing said tube under control by said relay so as to deenergize said tube upon a cutoff operation of said relay.

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