

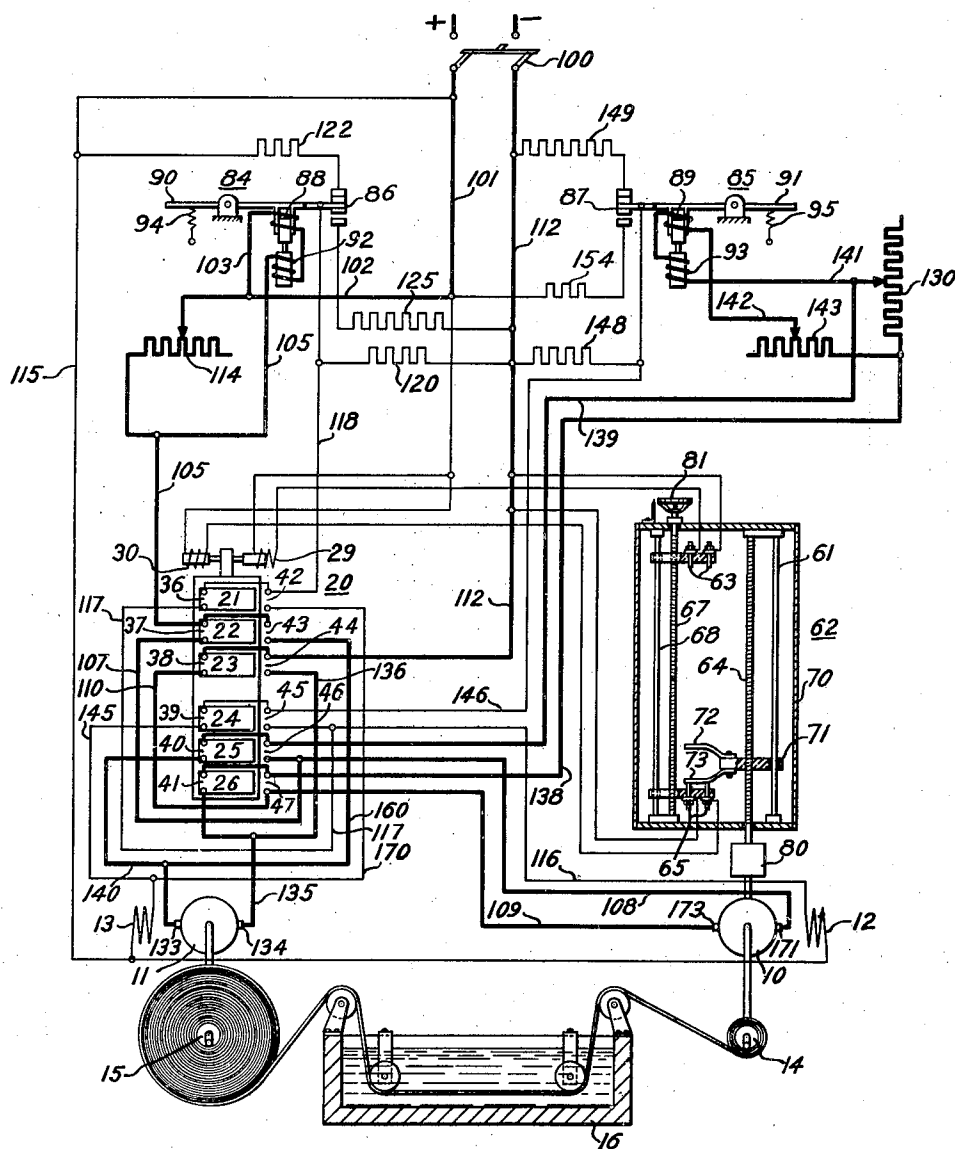
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MOTOR CONTROL SYSTEM

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MOTOR CONTROL SYSTEM

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My invention relates generally to motor control systems and more particularly to control systems for operating industrial motors.

Although my invention is capable of general application, it is particularly useful for controlling the speed and tension at which cloth is passed through a dyeing solution.

Briefly, the process of dyeing material comprises passing it through a bath of a dyeing solution as it is transferred from one roll to another. When the material has completely passed through the bath in one direction, the process is reversed, and then it is rewound upon the original roll. This cycle of operation is continued until the material has attained the proper shade. For the average class of work, it is usually necessary to pass the material through the dyeing solution eight to ten times before it attains the proper shade.

Thus, it is apparent that, as the diameters of the rolls of material change, the speed and tension at which the material passes through the solution changes, and, in consequence, the cloth is unevenly dyed.

It is an object of my invention to provide a control system that shall be simple and reliable and be readily and economically manufactured and installed.

A more specific object of my invention is to provide for transferring material from either of two rolls to the other at a constant speed and tension.

Another object of my invention is to provide for changing the direction of travel of the material, in accordance with any desired operating condition.

Another object of my invention is to provide for reversibly operating a pair of dynamo-electric machines as a motor and as a generator, and as a generator and as a motor, respectively, and for controlling the machines whereby the power delivered by the motor and the output developed by the generator are substantially constant.

Other objects of the invention will hereinafter become apparent.

For a fuller understanding of the nature and the objects of my invention, reference should be had to the following detailed de-

scription, taken in connection with the accompanying drawing, the single figure of which shows a diagrammatic view of a control system constructed in accordance with my invention.

Referring now to the drawing, the reference characters 10 and 11 designate a pair of dynamo-electric machines having field windings 12 and 13, respectively. The machines are connected, respectively, to a pair of spaced rolls 14 and 15 upon which the material is carried, as it passes through a dyeing solution contained in the receptacle 16. When the direction of the travel of the material is from the roll 15 to the roll 14, the machine 10 acts as a motor, and the machine 11 acts as a braking generator to provide the proper tension, and when the material is passing in the opposite direction, the machine 11 acts as a motor, and the machine 10 acts as a braking generator to provide the proper tension.

In order to provide for reversibly operating the pair of machines as a motor and as a generator, and as a generator and as a motor, respectively, a magnetically operated reversing switch 20 is utilized. As shown, the switch comprises a plurality of suitably mounted contact segments 21 to 26, inclusive, operated by a pair of electromagnets 29 and 30, and a plurality of a set of contact terminals 36 to 41, inclusive, and 42 to 47, inclusive, disposed on opposite sides of the contact segments.

The sets of contact terminals are so arranged and positioned that those disposed on the right of the contact segments are bridged when the electro-magnet 29 is actuated, and that those disposed on the left are bridged when the electro-magnet 30 is actuated. When the set of contacts on the left are bridged, the machine 10 acts as a motor and the machine 11 as a generator, and, when those on the right are bridged, the machine 11 acts as a motor and the machine 10 as a generator.

The electro-magnets 29 and 30 that actuate the reversing switch are energized by means of a limit switch 62 controlled by the angular displacement of the machine 10. In other

words, the electro-magnets are responsive to a predetermined travel of the material passing between the rolls 14 and 15. As shown, the limit switch comprises, generally, a pair of adjustable spaced contact members 63 and 65 carried by a threaded rod 67 and a guide rod 68 supported by a frame 70 and a traversing member 71 having spring contact fingers 72 and 73 that are disposed to bridge the spaced contact terminals 63 and 65, respectively. The traversing member is actuated by a threaded rod 64 carried by the frame 70 and driven by the machine 10 through a gear reduction unit 80. A guide rod 61, carried by the frame 70, is provided to extend through an opening in one end of the traversing member 71, in order to prevent it from turning as the threaded rod 64 rotates.

One end of threaded rod 67 is provided with right-hand threads and the other end with left-hand threads, whereby the distance between the spaced contact members 63 and 65 may be varied to accommodate the rolls of material of different sizes.

For the convenience of the operator, the operating dial 81 that is secured to the threaded rod 67 may be indexed or calibrated to represent rolls of material of definite sizes or a predetermined distance of travel of the material passing through the dyeing solution. Therefore, when the material travels a predetermined distance in one direction, as, for example, from the roll 14 to the roll 15, the spring contact finger 73 makes contact with the pair of spaced contact terminals 65 and completes the circuit for energizing the electro-magnet 30.

Operation of the reversing switch 20 changes the direction of the travel of the material and now the traversing member 71 gradually moves towards the pair of spaced contact terminals 63. Then, after a predetermined distance of travel of the cloth in the reverse direction, the spring contact finger 72 makes contact with the pair of spaced contact terminals 63 and completes the circuit for energizing the electro-magnet 29. This cycle of operation continues until the material attains the proper shade.

It is apparent that, as the material is transferred from the one roll to the other in the absence of special control equipment, the speed and tension will vary in accordance with the change in the diameters of the rolls of material. Therefore, I provide for varying the field strength of the machines, whereby the power delivered by the one acting as a motor and the power developed by the one acting as a generator, are substantially constant. In this manner, the speed at which the material passes through the dyeing solution is maintained substantially constant, because the speed of rotation of the machine acting as a motor is reduced in proportion to the increase in the diameter of the roll of

material driven thereby. Likewise, the tension of the cloth is maintained substantially constant because the torque required to rotate the machine that is acting as a generator is reduced in proportion to the decrease in the diameter of the roll of material driving the generator.

In order to vary the field strength of the machines, I provide for cutting in-and-out resistance units by utilizing a pair of relays 84 and 85 of the vibrating type. The relays are of the same general type and their construction is such that their operation is very sensitive.

The movable coils 88 and 89, carried by the pivotally mounted members 90 and 91, are disposed to move in a field of constant flux provided by the stationary coils 92 and 93. By this arrangement, the magnetic pull is constant and independent of the position of the movable coils, and, accordingly, the relays are very sensitive.

Sensitivity is defined as the change in pull per unit distance of travel of the vibrating contacts 86 and 87. In other words, a sensitive relay is one in which the difference between the pull-in force and the pull-out force is small, friction being assumed to be negligible.

Coil springs 94 and 95 are provided to oppose the magnetic pull of the coils. In the position shown, the relays are deenergized, and the springs are biasing the movable contacts against the upper contacts of the relays. For a more complete description and showing of a relay of the type utilized, reference may be had to Patent No. 1,684,151, W. Schaelchlin, issued September 11, 1928 and assigned to the assignee of this invention.

In explaining the operation of the control system, let it be assumed that the knife switch 100 is closed and that the limit switch has just operated to energize the electro-magnet 30. Therefore, the machine 10 is operating as a motor and the machine 11 as a generator. The circuit for energizing the armature of the machine 10 extends from positive side of the line, through conductors 101, 102 and 103, the coils 88 and 92 of the relay 84, conductor 105, the contact terminals 37—bridged by the contact segment 22—conductors 107 and 108, the armature of the machine 10, conductors 109 and 110, the contact terminals 38—bridged by the contact segment 23—, and to the negative side of the line through conductor 112. An adjustable resistor 114 for shunting the coils of the relay 84 is also connected between the conductors 103 and 105.

The circuit for energizing the field windings 12 of the machine 10 extends from the positive side of the line, through conductor 115, the field winding 12, conductors 116 and 117, the contact terminals 36—bridged by the contact segment 21—and conductor 118 and

resistor 120, to the negative side of the line through the conductor 112.

A circuit for shunting the field winding 12 extends from the conductor 115, through resistor 122 and the movable and upper contact of the relay 84 and to the conductor 118. When the coils of the relay 84 attract the movable contact against the lower contact, another circuit is established for connecting a resistor 125 in parallel with the resistor 120.

The operation of the relay 84 can be best understood by assuming that the diameter of the roll of material 14 is relatively small, and that the speed of the machine 10, which is now acting as a motor, is relatively high. As the diameter of the roll gradually increases, the current traversing the coils of the relay 84 gradually increases, and the coil-pull overcomes the spring-pull and draws the movable contact from the upper contact of the relay. This disconnects the shunting resistor 122, from the field 12 and causes the field current to increase. If the change in field current is too large, the armature current decreases, and, in consequence, the spring-pull overcomes the coil-pull, and, again biases the movable contact 86 against the upper contact. This re-establishes the shunting resistor 122 across the field winding 12, and, accordingly, decreases the field excitation and increases the armature current, which again causes the coil-pull to draw the movable contact from the upper contact of the relay.

The opening and reclosing of the movable contact 86 is very rapid and herein resides the utility of this type of relay since it is very sensitive. The speed at which the contact 86 vibrates is determined by the amount of shunting required to maintain the armature current constant.

If the armature current exceeds a certain amount the movable contact swings down against the lower contact of the relay and begins to vibrate against the lower contact member, thereby increasing the field excitation still more. This not only removes the shunting resistor 122 but also alternately connects the resistor 125 in parallel with resistor 120. Thus, the excitation is increased more and more as the diameter of the roll 14 increases. In this manner, the relay 84 operates to cause the motor 10 to deliver a substantially constant amount of power, regardless of the diameter of the roll of material 14. This means that the speed at which the material passes through the dyeing solution is maintained substantially constant. It is also apparent that the amount of power delivered by the motor 10 and, accordingly, the speed of travel of the material may be varied by adjusting the resistor 114 that shunts the coils of the relay 84.

While the machine 10 is operating as a motor, the machine 11 is operating as a brak-

ing generator to provide substantially constant tension on the material. The power developed by the generator 11 is dissipated through an adjustable load resistor 130 connected directly across the armature. This circuit extends from a terminal 134 of the generator, through conductors 135 and 136, the contact terminals 41—bridged by the contact segments 26—conductor 138, the load resistor 130, conductor 139, one of the contact terminals 46, the contact terminals 40—bridged by the contact segment 25—to the opposite terminal 133 of the generator through conductor 140.

The coils 89 and 93 of the relay 85 are connected in parallel with the resistor 130 through conductors 141 and 142 and an adjustable resistor 143. Therefore, the relay 85 is responsive to the voltage across the load resistor 130, which, in turn, is responsive to the power developed by the generator.

The circuit that energizes the field winding 13 extends from the positive side of the line, through the conductor 115, the field winding 13, conductor 145, the contact terminals 39—bridged by the contact segment 24—and conductor 146, to the negative side of the line through resistor 148.

Another circuit extends from the resistor 148, through conductor 146 and the movable and upper contacts of the relay 85. This connects a resistor 149 in parallel with the resistor 148 whenever the movable contact is biased against the upper contact of the relay. When the movable contact member 87 makes contact with the lower contact member of the relay, a shunting resistor 154 is connected across the field winding 13.

The operation of the relay 85 can be best understood by assuming that the diameter of the roll of material 15 is relatively large and that the speed at which the machine 11, is driven, is relatively low. As the diameter of the roll gradually decreases, the power developed by the generator will tend to increase, since the speed of rotation tends to increase. This increased amount of power causes the coil pull of the relay to overcome the spring pull and draw the movable contact from the upper contact of the relay. This disconnects the parallel resistor 149 and causes the field current to decrease. If the decrease in field current is too large, the generated armature current decreases, and, in consequence, the spring-pull overcomes the coil-pull and again biases the movable contact 87 against the upper contact. This re-establishes the resistor 149 across the resistor 148, and, accordingly, increases both the field excitation and the generated armature current, thereby causing the coil-pull to draw the movable contact from the upper contact. As explained in relation to the relay 84, the opening and closing of the movable contact member 87 is very rapid. The speed at which the contact 87

vibrates is determined by the amount of shunting required to maintain a constant generated current.

If the generated current exceeds a certain amount, the movable contact swings down against the lower contact member of the relay and begins to vibrate, thereby decreasing the field excitation still more. This not only removes the parallel resistor 149 from the resistor 148 but also alternately connects the resistor 154 in shunt with the field winding 13. Thus, the excitation is decreased more and more as the diameter of the roll 15 decreases. In this manner, the relay 85 operates to cause the braking generator 11 to develop a substantially constant amount of power, regardless of the diameter of the roll of material driving the generator. This means that the tension of the material that is passing through the dyeing solution is maintained substantially constant. It is also apparent that the power developed by the generator, and, accordingly, the degree of the tension of the material may be regulated by adjusting the resistors 130 and 143.

When the roll 15 is empty, the contact finger 72 of the traversing member bridges the pair of spaced contact terminals 63 and energizes the electromagnet 29 which actuates the reversing switch to the right. This causes the machine 11 to act as a motor and the machine 10 to act as a braking generator. Likewise, the reversing switch connects the relay 84 in circuit with the machine 11 and the relay 85 in circuit with the machine 10.

The circuit for energizing the armature of machine 11 extends from the positive side of the line, through the conductors 101, 102, and 103, the coils of the relay 84, conductor 105, the contact terminals 43—bridged by the contact segment 22—conductor 160, the armature of the machine 11, the conductors 135 and 136, the contact terminals 44—bridged by the contact segment 23 and, to the negative side of the line through conductor 112.

The circuit for energizing the field winding of the machine 11 extends from the positive side of the line, through conductor 115, the field winding 13, conductor 170, the contact terminals 42—bridged by the contact segment 21—to the movable contact 86 of the relay 84 and to the resistor 120 through conductor 118.

The operation of the machine 11, acting as a motor, is the same as that previously described for the machine 10 when it was acting as a motor. The armature of machine 10 is now connected to dissipate its generated power through the load resistor 130. This circuit extends from a terminal 171 of the machine 10, through conductor 108, the contact terminals 46—bridged by the contact segment 25—conductor 139, the load resistor 130, conductor 138, the contact

terminals 47—bridged by the contact segment 26, to the opposite terminal 173 of the machine through the conductor 109. The circuit for energizing the field winding 12 of the machine 10 extends from the positive side of the line, through conductor 115, the field winding 12, conductor 116, the contact terminals 45—bridged by the contact segment 24—to the movable contact 87 of the relay 85 and to the resistor 148 through conductor 146. The operation of the machine 10, acting as a generator, is the same as that previously described for the machine 11 when it was acting as a generator.

Therefore, I have disclosed a control system that provides for transferring material from either roll to the other at a constant speed and tension, and for changing the direction of the travel of the material in accordance with any desired operating condition.

Since certain changes may be made without departing from the scope of my invention, it is intended that all matters contained in the foregoing description and shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A control system for transferring material from either of two rotatively mounted members to the other comprising, in combination, a dynamo-electric machine connected to each member, means associated with the said machines for reversing the direction of the travel of the material, means responsive to the travel of the material for actuating said reversing means, and means associated with the same machines for transferring the material at a substantially constant speed and tension.

2. A control system for transferring material from either of two rotatively mounted members to the other comprising, in combination, a dynamo-electric machine connected to each member, means for reversibly operating the said machines as a motor and as a generator, and as a generator and as a motor, respectively, means associated with the generator for providing a substantially constant tension on the material as it is being transferred, and means associated with the motor for transferring the material at a substantially constant speed.

3. A control system comprising, in combination, a pair of dynamo-electric machines for transferring material from either of two rolls to the other, means for reversibly operating the said machines as a motor and as a generator, and as a generator and as a motor, respectively, means responsive to the angular displacement of one of said machines for operating said reversing means, and means associated with said machines for causing the generator to develop a substan-

tially constant output and the motor to deliver a substantially constant amount of power.

4. A control system comprising, in combination, a pair of dynamo-electric machines for transferring material from either of two rolls to the other, means for reversibly operating the said machines as a motor and as a generator, and as a generator and as a motor, respectively, means responsive to the travel of the material for operating said reversing means, a relay associated with the said machines through said reversing means, whereby the power delivered by the motor is maintained substantially constant, and a second relay associated with the said machines through said reversing means, whereby the output developed by the generator is maintained substantially constant.

5. A control system comprising, in combination, a pair of dynamo-electric machines for transferring material from either of two rolls to the other, a field winding for each machine, means for reversibly operating the said machines as a motor and as a generator, and as a generator and as a motor, respectively, means responsive to a predetermined travel of the material for operating said reversing means, a relay associated with the motor through said reversing means, said relay having a pair of contact members connected in circuit with the field winding of the motor, a cooperating movable contact member actuated in accordance with the power delivered by the motor for controlling the field winding, a second relay associated with the generator through said reversing means, said relay having a pair of contact members connected in circuit with the field winding of the generator, and a cooperating movable contact member actuated in accordance with the power developed by the generator for controlling the field winding.

6. A control system comprising, in combination, a dynamo-electric machine, means for operating the machine as a motor and as a generator, said means being responsive to a predetermined angular displacement of the machine, means associated with the machine, when acting as a motor, for causing it to deliver a substantially constant amount of power and means associated with the machine, when acting as a generator, for causing it to develop a substantially constant amount of power.

7. A motor-control system comprising, in combination, a dynamo-electric machine having a field winding, means for operating the machine as a motor and as a generator, said means being responsive to the angular displacement of the machine, a relay associated with the machine, when acting as a motor, said relay having a pair of contact members connected in circuit with the field winding, a cooperating movable contact member actu-

ated in accordance with the power delivered by the motor for controlling the field windings, a second relay associated with the machine, when acting as a generator, said relay having a pair of contact members connected in circuit with the field winding, and a cooperating movable contact member actuated in accordance with the power developed by the generator for controlling the field winding.

8. A control system for transferring material from either of two rotatively mounted members to the other comprising, in combination, a dynamo-electric machine connected to each member, means associated with the said machines for reversing the direction of the travel of the material, means responsive to the travel of the material for actuating said reversing means, means associated with the same machines for transferring the material at a substantially constant speed and tension, and means for varying the speed and tension of the material.

9. A control system comprising, in combination, a pair of dynamo-electric machines for transferring material from either of two rolls to the other, means for reversibly operating the said machines as a motor and as a generator, and as a generator and as a motor, respectively, means responsive to the travel of the material for operating said reversing means, a relay associated with the said machines through said reversing means, whereby the power delivered by the motor is maintained substantially constant, and a second relay associated with the said machines through said reversing means, whereby the output developed by the generator is maintained substantially constant, and means associated with the relays for varying the amount of power delivered by the motor and the power output developed by the generator.

10. A control system comprising, in combination, a dynamo-electric machine, means for operating the machine as a motor and as a generator, said means being responsive to a predetermined angular displacement of the machines, means associated with the machine, when acting as a motor, for causing it to deliver a substantially constant amount of power, means associated with the machine, when acting as a generator, for causing it to develop a substantially constant amount of power, and means for varying the amount of power delivered by the motor and the power output developed by the generator.

In testimony whereof, I have hereunto subscribed my name this 18th day of June, 1931.

WILLIAM H. LANDENBERGER.