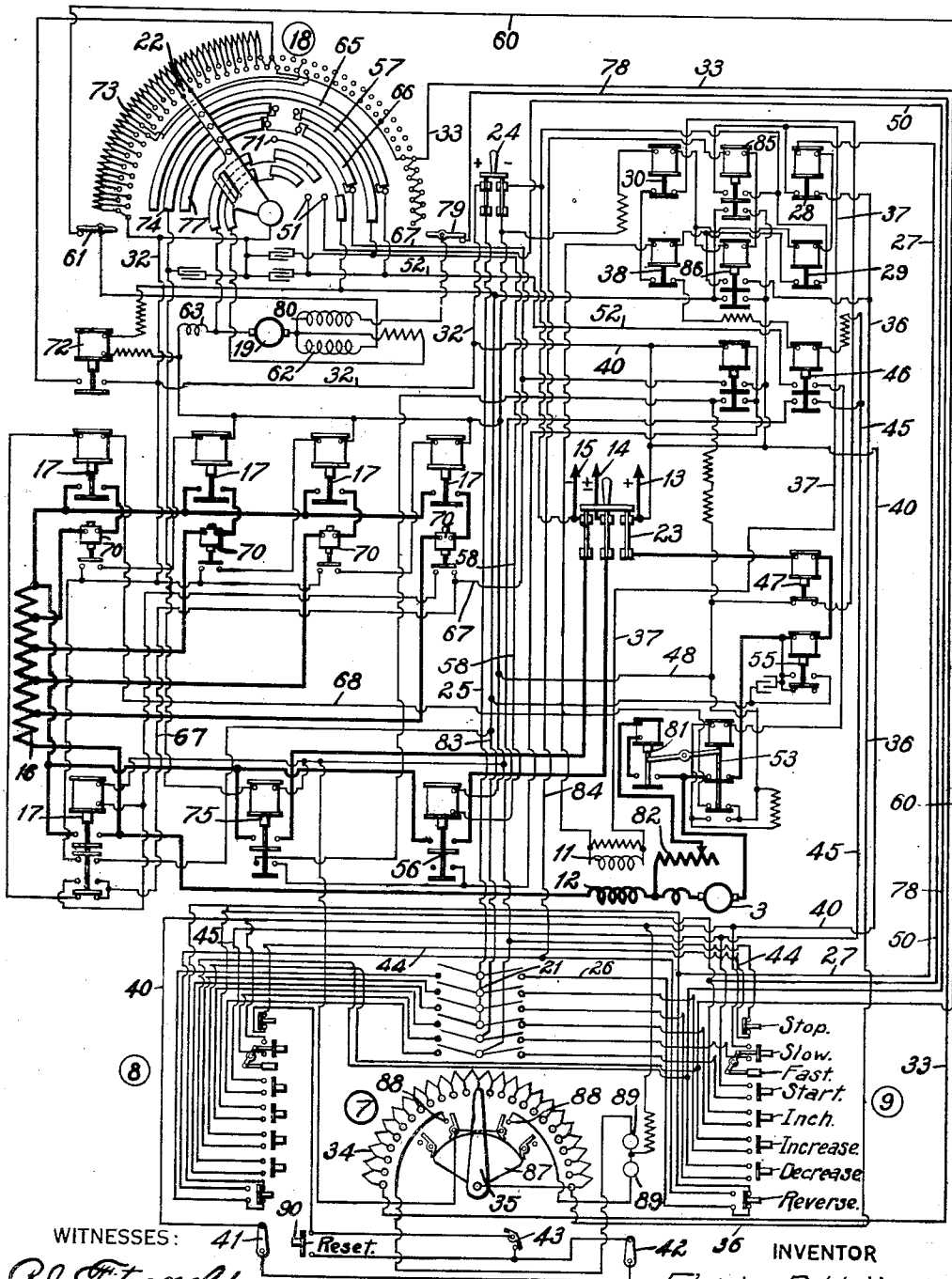


F. D. HALLOCK
ELECTRICAL SYSTEM.
APPLICATION FILED OCT. 14, 1916.

1,348,943.

Patented Aug. 10, 1920.
3 SHEETS—SHEET 1.



WITNESSES:
R. F. Fitzgerald.
J. P. Langley.

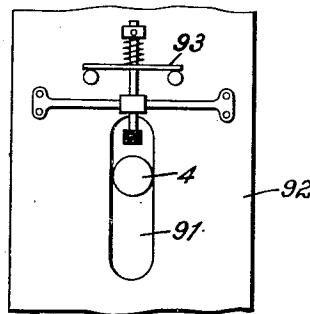
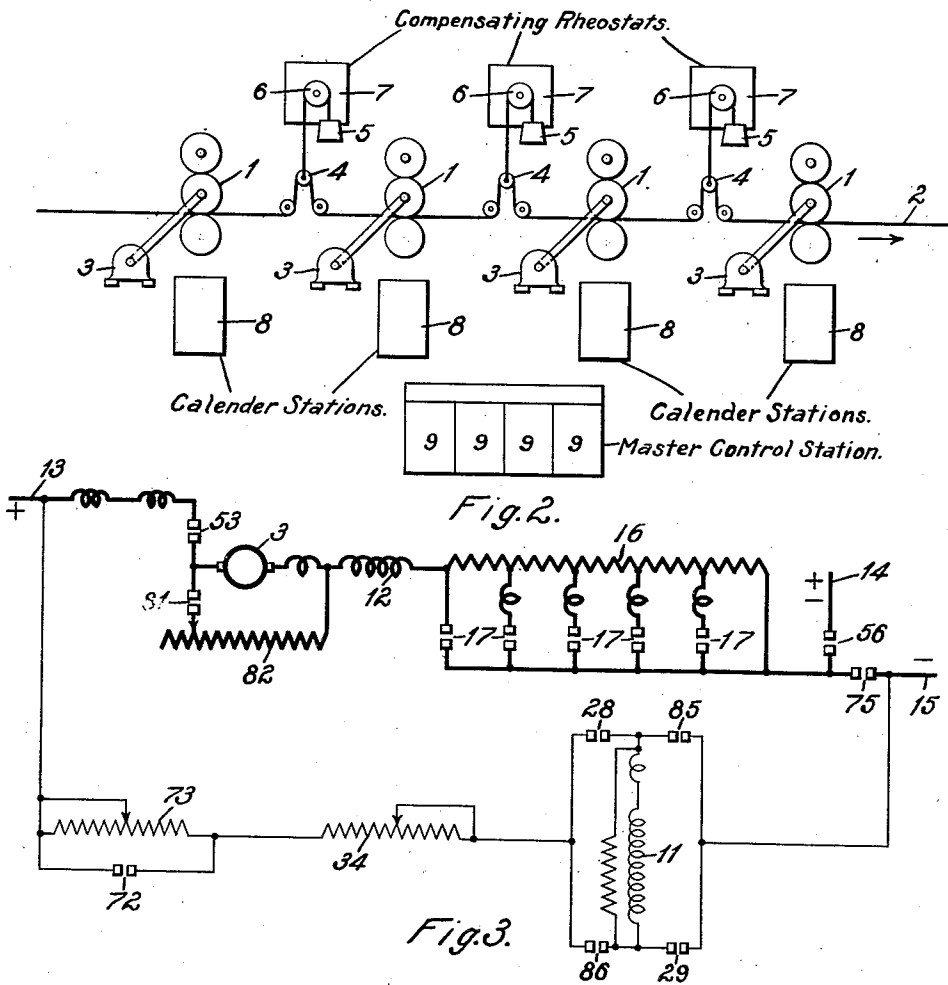
Fig. 1.

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3 SHEETS—SHEET 3.

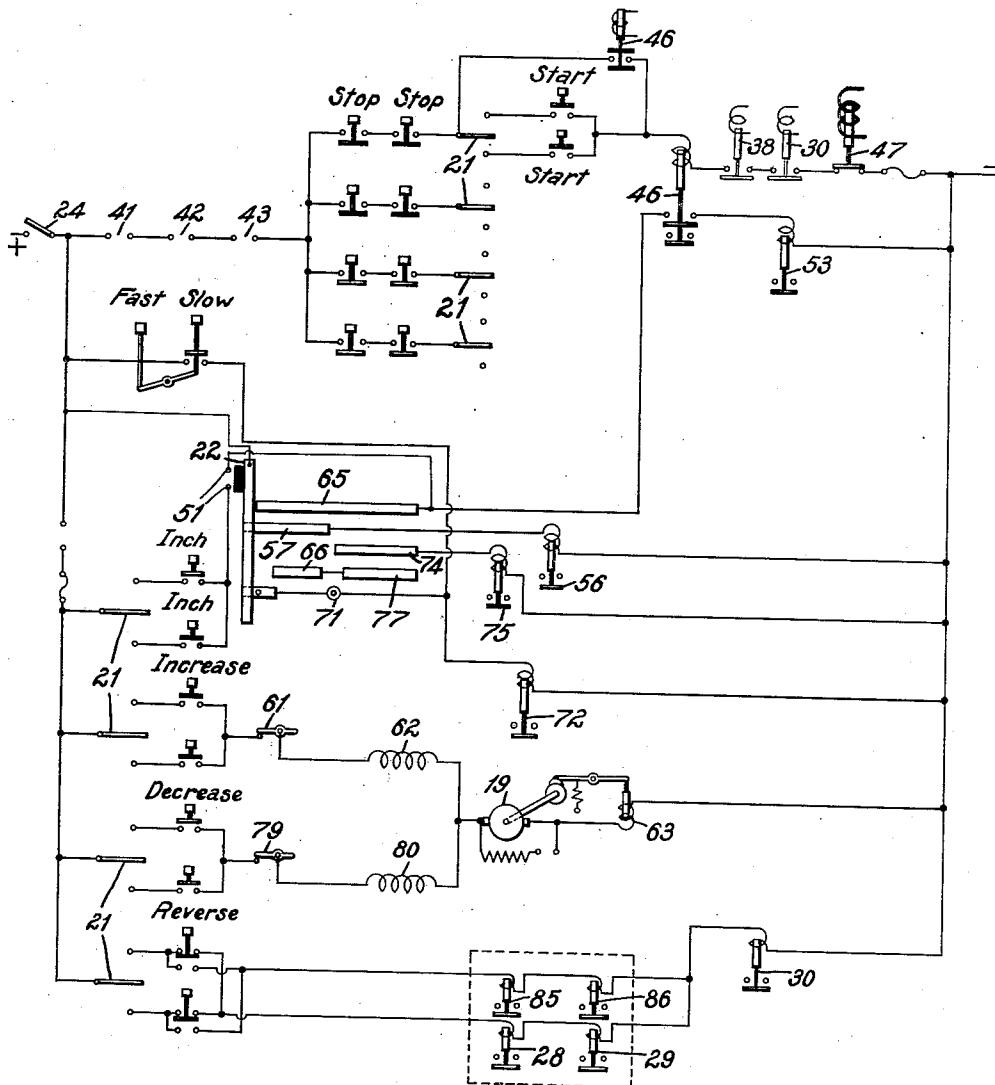


Fig. 5.

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UNITED STATES PATENT OFFICE.

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ELECTRICAL SYSTEM.

1,348,943.

Specification of Letters Patent. Patented Aug. 10, 1920.

Application filed October 14, 1916. Serial No. 125,637.

To all whom it may concern:

Be it known that I, FLETCHER D. HALLOCK, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electrical Systems, of which the following is a specification.

My invention relates to electrical systems and particularly to such systems as are employed in connection with machines embodying a series of rolls for successively treating sheets of fabric or other material.

My invention has for one of its objects to provide an arrangement that is simple in construction and automatic in operation to control the relative speeds of motors for driving rolls that are arranged in series.

A second object of my invention is to provide a system whereby the independently controlled motors for driving rolls that are arranged to successively treat sheet material may be controlled by manually operable means located at a central point and whereby signals may be operated for indicating the necessary adjustments of the speeds of the respective driving motors.

Another object of my invention is to provide an arrangement whereby the relative speeds of the respective driving motors for a series of rolls are controlled in accordance with the length of material between the several pairs of rolls.

Machines for treating fabric or other sheet material such as, for example, calendar rolls for the manufacture of fabric embodying rubber, usually comprise series of rolls that are provided with independent driving motors. A movably mounted idler roll, which is placed between each pair of main rolls, is connected to some suitable tensioning device in order to maintain the length of the loop of material passing over the idler roll within predetermined limits.

In the operation of such machines, it is essential that the several driving motors operate at substantially the same speed in order to maintain satisfactory operating conditions. Otherwise, the material travels through one pair of rolls faster than through an adjacent pair of rolls and the result is either to increase or to decrease the length of the loop of material between the rolls.

In case the forward motor is operated at the faster speed, the tension upon the material between the rolls is increased to such degree that the fabric may be torn.

According to the present invention, I provide an arrangement in which the speed of each of the motors for driving the several rolls is automatically controlled in accordance with the position of the idler roll over which the material passes before reaching the roll. This arrangement comprises what may be termed a compensating rheostat that is operatively connected to the idler roll and is actuated to increase or decrease the speed of the corresponding motor according as the length of the loop of material passing over the idler roll is increased or decreased. The rheostat comprises a resistor that is permanently in series with the shunt field-magnet winding of the motor, the effective portion of the resistor being varied as stated above. This arrangement regulates the relative speeds of the motors within certain limits.

I provide, also, manually operable means, preferably in the form of push-button stations, for controlling each of the driving motors. A controlling station of this character may be located adjacent to each of the rolls. A similar push-button station for each of the motors for producing the same effects upon the operation of the motors as those of the individual stations mentioned above may be located at a central point to constitute a master control station. By means of this arrangement, a single operator is enabled to adjust the speed of any of the motors.

In order that the attendant may be notified of the approach of the idler roll to an extremity of its path of movement in either direction, signal lamps are provided which indicate the motor, the speed of which differs from that of the other motors, and which notify the operator of the direction in which the speed of the motor should be changed. The signal devices are operated either by the idler rolls directly or through the movable arms of the compensating rheostats when the arms are near the ends of their respective paths of movement to vary the excitation of the motor field-magnet windings. The signal devices, which are prefer-

ably electric lamps, notify the operator that the lengths of the loops of material between the rolls are approaching their maximum or their minimum limit, as the case may be, and the proper adjustments of the speeds of the motors may be made before the idler rolls assume such positions that damage to the fabric may result. The motors may be brought to rest simultaneously by automatic means controlled by the idler rolls or by manually operable means.

The details of my invention are described in connection with the accompanying drawings, in which Figure 1 is a diagrammatic view of circuits and apparatus illustrating my invention as applied to a single driving motor. Fig. 2 is a diagrammatic representation of a series of rolls that are adapted to be controlled in accordance with my invention. Fig. 3 is a diagrammatic view of a schematic arrangement of the main circuits of one of the driving motors. Fig. 4 is a view of a portion of one of the idlers and a switching mechanism controlled by it. Fig. 5 is a diagrammatic view of a schematic arrangement of the control circuits for one of the driving motors.

Referring particularly to Fig. 2, several sets of rolls 1 are arranged in series to treat fabric or other sheet material, indicated at 2, that passes through the rolls. Each of the sets of rolls is driven by an electric motor 3 which is mechanically connected to the rolls in any suitable manner. A movably mounted idler roll 4 is placed between each pair of main rolls or calenders for the purpose of maintaining a substantially uniform tension upon the fabric.

The tensions exerted by the idler rolls are determined by the weights of the idler rolls or by weights 5 that are connected to the idler rolls by chains or ropes passing over pulleys 6. Each of the pulleys 6 is operatively connected to a rheostat 7 which may be termed a compensating rheostat by reason of the fact that it adjusts the speed of one of the driving motors 3 in order to compensate for the difference between the speeds of the motors for driving adjacent sets of rolls. One less idler roll and one less compensating rheostat are employed than the number of motors.

Each of the motors 3 is adapted to be controlled, also, by manually operable means, preferably having the form of push-button switches, one set or station 8 of which is located adjacent to the motor or the roll driven by it. The push-button station above referred to may be termed, for convenience, a calender station. A similar push-button station 9 for controlling each of the motors is located at a central point which may be termed a master control station. By means of the arrangement above described, each of the motors may be controlled from the cal-

ender station or it may be governed in the same manner from the master control station. A single operator is thus enabled to adjust the speeds of the motors in accordance with operating conditions.

Reference may now be had to Fig. 1, in which the circuits for controlling one of the driving motors is diagrammatically illustrated. The motor, the armature of which is indicated at 3, has a shunt field-magnet winding 11 and a series field-magnet winding 12. The motor is supplied with energy from line conductors 13, 14 and 15 of a three-wire system. A sectional starting resistor 16 is controlled by a series of progressively actuated electromagnetic switches 17.

The motor circuits are controlled by a master switch 18 that is controlled by a pilot motor 19. The speed of the motor 3, which is controlled in accordance with the position of the movable arm of the master switch 18, is adjusted by means of push-button switches, one station 8 of which corresponds to the calender station described in connection with Fig. 2. A similar station 9 for producing like effects upon the speed of the main motor is adapted to be connected in circuit in accordance with the position of a double-throw switch 21. The effects produced upon the operation of the main motor by the corresponding push-button switches of the respective stations are indicated by appropriate legends.

By means of the switch 21, which may be termed a transfer switch, either the calender station 8 or the master control station 9 may be rendered ineffective to control the motor. If all of the several transfer switches 21 are actuated to corresponding positions, the motors may be controlled only from the master control stations or from the calender stations, according to the positions of the switches. A compensating rheostat 7 is arranged to automatically control the excitation of the shunt field-magnet winding 11 of the motor 3 within predetermined limits.

It may be assumed that the movable arm 22 of the master switch 18 occupies its inoperative position which is at the end of its path of movement in a clockwise direction. It may be assumed, further, that a manually operable line switch 23 and a control switch 24 have been closed. It may be assumed, for example, that the transfer switch 21 has been operated to connect the master-control station 9 in circuit and that the calender station 8 is inoperative.

A circuit is completed by the closing of the above switches which extends from the positive side of control switch 24 through conductor 25, switch 21, conductor 26, "reverse" button, conductor 27, actuating coils of field-reversing switches 28 and 29 and actuating coil of field-protective relay 30 to the negative side of switch 24.

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The switches 28 and 29 are closed to complete the shunt field circuit of the motor which extends from the positive side of control switch 24 through conductor 32, movable arm 22, conductor 33, resistor 34 and movable arm 35 of compensating rheostat 7, conductor 36, relay 28, conductor 37, shunt field-magnet winding 11, actuating coil of field-protective relay 38, and relay 29, to the negative side of switch 24. The shunt field-magnet winding 11 of the motor is energized by the circuit above described for operation of the motor in the forward direction.

The push-button switch designated "start" is then closed to complete a circuit which extends from the positive side of control switch 24 through conductor 40, emergency switch 41 of calender station 8, emergency switch 42 of master-control station 9, limit switch 43, "stop" push-button switch of station 8, conductor 44, "stop" push-button of station 9, switch 21, "start" push-button switch of station 9, conductor 45, actuating coil of no-voltage relay 46, relays 38 and 30, overload relay 47, and conductor 48, to the negative side of switch 24.

When the no-voltage relay 46 is closed, the motor 3 may be operated for short periods during the process of making up or threading the fabric through the rolls. An interlock connected to the no-voltage relay 46 completes a holding circuit for its actuating coil in shunt relation to the push-button switch designated "start." This circuit extends from the positive side of the control switch 24 through the "stop" push-buttons, as described above, then, shunting the switch 21 and the "start" push-button, through the interlock connected to the no-voltage relay 46, then through the actuating coil of the relay 46 to the negative side of the switch 24, as before described. The push-button switch designated "inch" completes a circuit which extends from the positive side of control switch 24, through conductor 25, switch 21, "inch" button, conductor 50, contact members 51, which are bridged by the switch arm 22 in its normal "off" position, conductor 52, no-voltage relay 46, actuating coil of line switch 53, and conductor 48 to the negative side of switch 24.

The closing of line switch 53 completes the armature circuit of the motor 3 which extends from line conductor 13 through switch 23, actuating coil of overload relay 47, actuating coil of field-accelerating relay 55, line switch 53, armature 3, series field-magnet winding 12, starting resistor 16, and line switch 56, to line conductor 14. Line switch 56 is normally closed, when the switch arm 22 occupies its "off" position, by means of a circuit extending from the arm 22, which is connected to the positive side of switch 24, through contact segment

57, conductor 58, actuating coil of switch 56 to the negative side of switch 24.

The armature circuit of the motor is closed only while the "inch" button is held in its closed position. The motor operates slowly by reason of the fact that the entire starting resistor 16 is in circuit and the shunt field-magnet winding is fully energized.

When the fabric has been started through the rolls and the system is ready for normal operation, the push-button switch designated "increase" is actuated to complete a circuit which extends from the positive side of switch 21 through "increase" button, conductor 60, limit switch 61, field-magnet winding 62 and armature of pilot motor 19, and brake coil 63 to the negative side of switch 24. The pilot motor then actuates the switch arm 22 in a counter-clockwise direction to effect the completion of the armature circuit of the driving motor 3 independently of the operation of the "inch" button.

When the switch arm 22 engages a contact segment 65, a circuit is completed which extends from the switch arm 22, which is connected to the positive side of the control circuit, through contact segment 65, conductor 52, no-voltage relay 46, actuating coil of line switch 53 and conductor 48 to the negative side of switch 24. The armature circuit of the motor is then completed, as traced above in connection with the operation of the "inch" button. A circuit is next completed which extends from the switch arm 22 through contact segment 66, conductor 67, interlock of accelerating switch 17 located below the resistor 16, actuating coil of accelerating switch 17 located immediately above the resistor 16, conductor 68 and interlock of line switch 53, to the negative side of switch 24.

The closing of the accelerating switch 17, the circuit for the actuating coil of which is traced above, completes a shunt circuit for one section of the resistor 16. The closing of the accelerating switch also permits the closing of a relay 70 that is mechanically connected thereto when the current traversing the series actuating coil of the relay 70 falls to a predetermined value. The closing of each of the relays 70 completes a circuit for the actuating coil of the succeeding accelerating switch to close, and the several switches close automatically in order to completely shunt the resistor 16 when the current traversing the several relay coils 70 falls successively to predetermined values.

When the last accelerating switch 17 closes, the circuits of the actuating coils of the other accelerating switches are opened and the corresponding switches drop to their open positions. When the arm 22 moves to such position that it no longer engages the contact segment 66, the circuit of the actuat-

ing coil of the accelerating switch located below the resistor 16 is opened, and the entire resistor 16 is inserted in circuit with the motor armature in preparation for the transfer of the motor connections to a circuit of higher voltage.

When the movable arm 22 of the master switch 18 has rotated through an angle of slightly less than 90° , the circuit of the actuating coil of line switch 56 is broken at contact segment 57 and the switch 56 opens to momentarily interrupt the armature circuit. When the arm 22 is in an approximately upright position, it engages a contact member 71 to complete a circuit through the actuating coil of a relay 72 which closes a shunt circuit for the resistor 73 and thereby insures a strong field during the period of changing from the low-voltage connection to the high-voltage connection.

When the arm 22 engages a contact segment 74, a circuit is completed which extends from the arm 22 through contact segment 74 and actuating coil of line switch 75 to the negative side of switch 24. The switch 75 then closes to connect the armature circuit of the motor to line conductor 15. The motor is now connected across line conductors 13 and 15, and the applied electromotive force is accordingly doubled.

When the arm 22 engages a contact segment 77, the circuit of the actuating coil of the first switch 17 to close is again completed in the same manner as that described in connection with the engagement of contact segment 66. The several accelerating switches operate automatically and in order to again shunt the resistor 16. The circuit of the actuating coil of relay 72 is broken at contact member 71 and the relay opens to permit the weakening of the field by the gradual inserting of field resistor 73 by the arm 22.

During the acceleration of the motor by weakening its field, the relay 55, which is of the well-known fluttering type, controls the circuit of the actuating coil of relay 72 and causes the latter to shunt the resistor 73 when the current traversing the actuating coil of relay 55 exceeds a predetermined value. The operation of the relays 55 and 72 thus prevents the acceleration of the motor at an abnormal rate. The motor then operates at its normal speed.

When it is desired to decrease the speed of the motor for any reason, the push button designated "decrease" is closed to complete a circuit for the pilot motor, which extends from the positive side of switch 21 through "decrease" button, conductor 78, limit switch 79, field-magnet winding 80 and armature of pilot motor 19 and brake coil 63 to the negative side of switch 24. The pilot motor 19 then actuates the arm 22 in a clockwise direction to gradually

shunt the resistor 73 in series with the shunt field-magnet winding 11 to decrease the speed of the motor 3.

If the arm 22 continues its movement beyond the point at which connections are made for effecting the transfer of the motor circuit from one voltage connection to the other, the resistor 16 will be inserted in circuit with the motor and the relay 72 will be closed to insure a strong field during the transition period. The several operations occur in the reverse order to that described above in connection with the acceleration of the motor.

The motor may be brought to rest by the opening of either of the "stop" buttons of stations 8 and 9 or either of the emergency switches 41 and 42, all of these switches being connected in series circuit relation. As will be later described, the "stop" buttons of each control station and the emergency switches of the several control stations are all connected in series, and the opening of any of these latter switches operates to stop all of the motors simultaneously. Since the "stop" switches and the emergency switches are in series with the push-button switches designated "start," the opening of a "stop" switch opens the circuit of the actuating coil of no-voltage relay 46. As above described, the relay 46 controls the circuit of the actuating coil of line switch 53, and the latter is accordingly opened. A local dynamic braking circuit for the motor armature is established by a switch 81 that is mechanically connected to the switch 53. The dynamic braking circuit comprises the motor armature, a holding coil for the switch 81 and a resistor 82.

If it should be desired to momentarily decrease the speed of the motor, the push-button switch designated "slow" is actuated to complete a circuit for the relay 72 which extends from the positive side of switch 24 through conductor 40, "slow" button, switch 21, conductor 83 and actuating coil of relay 72, to the negative side of switch 24. The relay 72 completes a shunt circuit for the resistor 73 and the motor operates at slow speed. The actuation of the push-button designated "fast" establishes normal operating conditions of the motor.

When it is desired to reverse the direction of the driving motor, the "reverse" button is actuated to open the circuit of field-reversing relays 28 and 29 and to complete a circuit which extends from the positive side of switch 21, through "reverse" button, conductor 84, actuating coils of field-reversing relays 85 and 86 and actuating coil of field-protective relay 30, to the negative side of switch 24.

Reverse operation of the driving motor will occur only in case of abnormal conditions with respect to the rolls and the

fabric and will usually be necessary for a comparatively short period. In view of these conditions, the relays 85 and 86 are provided with interlocks for completing the circuit of the actuating coil of relay 72 while they are in their closed positions. This arrangement insures that the motor operates at slow speed when it rotates in the reverse direction.

10 If it should occur that, during the normal operation of the series of rolls, the speed of one of the motors varies from that of the motor for driving the roll immediately preceding in the system, the length of the loop of material between the pair of rolls will be varied. The position of the idler roll is changed in accordance with the change in length of material, and the movable arm 35 of the corresponding compensating rheostat 7 is actuated to either increase or diminish the amount of the resistor 34 that is permanently connected in series with the shunt field-magnet winding 11.

25 If the variation in speed is comparatively small, it may be corrected by the automatic operation of the compensating rheostat, and no adjustment by the operator is necessary. If, however, the arm 35 approaches the limit of its movement in either direction, a cam 87 that is connected to the rheostat arm 35 permits a switch 88 controlled thereby to close a circuit for a signal lamp 89.

30 If, for example, the arm 35 be actuated by the corresponding weight 5, in a clockwise direction, to insert resistance in series with the field-magnet winding of the motor to increase its speed, and the arm and cam 87 reach predetermined points at which the switch 88 to the left of the arm 35, as viewed in Fig. 1, is permitted to close, the lamp 89 that is adjacent to the "increase" button is energized to warn the operator that the master switch 18 must be adjusted for an increased speed of the driving motor.

45 Should the operator fail to make the proper adjustments, and the rheostat arm continues its movement, the limit switch 43, which is in series with the "stop" push-button switches and emergency switches, is opened by the cam 87 to effect the stopping of the motor 3 and all of the other motors, as described above in connection with the stop switches and emergency switches. The limit switch may be shunted by means of a reset switch 90 in order to complete the control circuits after the motors have been brought to rest.

60 A schematic arrangement of the control circuits is diagrammatically illustrated in Fig. 5. It will be noted that the "stop" push-button switches of the several stations are arranged in parallel relation to each other and in series relation to the emergency switches that may be located either at the control stations or upon the frames of the

rolls, as desired. For convenience, only one of each of the switches 41, 42 and 43 is illustrated. The several control stations are otherwise entirely independent of each other.

70 If it is desired, each of the idler rolls 4 may be arranged to operate an emergency switch for stopping all of the motors in the same manner as that described above in connection with the limit switch 43 that is opened by the compensating rheostat when the idler roll reaches its predetermined position. This arrangement is desirable in case the compensating rheostat is omitted and the several driving motors are controlled entirely by manually operable means.

85 In the arrangement illustrated in Fig. 4, an idler roll 4 is arranged to move vertically in a slot 91 with which a frame member 92 is provided. A switch 93, which may correspond in function to the limit switch 43, shown in Fig. 1, is opened by the idler roll 4 when the latter reaches a predetermined position. The rolls are thus stopped before the idler roll reaches the end of its path of movement and the tension upon the fabric becomes abnormal.

95 A system constructed in accordance with my invention possesses a number of desirable operating characteristics. Under normal operating conditions, the relative speeds of the several driving motors are controlled automatically and a uniform tension is maintained upon the fabric passing through the rolls. The resistance of the compensating rheostat is of low value compared with that of the master switch, the compensating rheostat being adapted to adjust differences of speed within the limits of inherent regulation of the motor. Thus, the amount of resistance in the field circuit of any motor, at any time during its normal operation, is relatively small.

110 In case the speed of one or more of the motors varies from the speeds of the other motors to such degree that the automatic means are insufficient to compensate for the variation, the operator is automatically warned that adjustments must be made in order to prevent damage to the fabric. The system is automatic also to effect the stopping of all of the rolls quickly and safely by the opening of the motor circuits and by the use of dynamic braking means. It is practically impossible to injure the fabric by reason of abnormal conditions with respect to the driving mechanism for the rolls. The above and other advantages will be apparent to those skilled in the art to which my invention is related.

I claim as my invention:

1. The combination with a pair of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between said

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rolls, of signaling means controlled by said idler roll for indicating a difference in the speeds of said motors.

2. The combination with a pair of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between said rolls, of signaling means comprising a lamp circuit controlled by said idler roll for indicating a difference in the speeds of said motors.

3. The combination with a series of rolls for sheet material, and a means between the rolls of each pair for maintaining uniform tension upon said material, of a driving motor for each of said rolls and signaling means controlled by said maintaining means for indicating differences between the speeds of motors for driving adjacent rolls.

4. The combination with a pair of rolls for sheet material, a driving motor for each of said rolls, and an idler roll movably mounted for maintaining a substantially uniform tension upon said material, of signaling means operable in accordance with the position of said idler roll for indicating the relative speeds of said motors.

5. The combination with a series of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between the rolls of each pair, of means for adjusting the speed of each of said motors independently of the other, and signaling means adjacent said adjusting means and controlled by said idler rolls for indicating necessary adjustments.

6. The combination with a series of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between the rolls of each pair, of means for adjusting the speed of each of said motors independently of the others, and means comprising signal lamps adjacent said adjusting means and controlled by said idler rolls for indicating necessary adjustments.

7. The combination with a series of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between the rolls of each pair, of means for adjusting the speed of each of said motors independently of the others, and means comprising signal lamps adjacent said adjusting means and controlled by said idler rolls for indicating such motors as differ in speed from the other motors.

8. The combination with a series of rolls for sheet material, a driving motor for each of said rolls, and an idler roll between the rolls of each pair, of means for adjusting the speed of each of said motors independently of the others, and means comprising signal lamps adjacent said adjusting means and controlled by said idler rolls for indicating such motors as differ in speed from the other motors and the proper adjustment to correct such differences.

9. The combination with a pair of rolls for sheet material, independent driving means for each of said rolls, and an idler roll for maintaining a substantially uniform tension upon the material between the rolls, of signaling means for indicating the approach of the idler roll to the ends of its path of movement.

10. The combination with a pair of rolls for sheet material, independent driving means for each of said rolls, and a movably-mounted idler roll between said rolls for maintaining a substantially uniform tension upon said material, of signal lamps operable when said idler roll occupies predetermined positions for indicating necessary adjustments of the speed of one of said driving means.

11. The combination with a pair of rolls for sheet material, separate driving means for each of said rolls, and an idler roll between said rolls for maintaining a substantially constant tension upon said material, of means for adjusting the speed of one of said driving means in accordance with the position of said idler roll and for effecting the stopping of both of said driving means when the idler roll reaches a predetermined position.

12. The combination with a plurality of rolls for sheet material, separate electric motors for each of said rolls, and an idler roll between each pair of said rolls for maintaining a substantially constant tension upon said material, of means for adjusting the speed of certain of said electric motors in accordance with the positions of the idler rolls, and means controlled by said idler rolls for indicating, at a remote point, the approach of said idler rolls to predetermined positions by reason of abnormal slack in said sheet material.

13. The combination with a pair of rolls for sheet material, independent driving means for each of said rolls, and an idler roll between said rolls for maintaining a substantially constant tension upon said material, of means for effecting the stopping of all of said driving means when said idler roll reaches a predetermined position.

14. The combination with a pair of rolls for sheet material and an electric motor for driving each of said rolls, of a member movable in accordance with the length of material between said rolls, and signal devices operated by said member in accordance with its position to indicate abnormal conditions.

15. The combination with a pair of rolls for sheet material, an electric motor for driving each of said rolls, and a member movable in accordance with the length of material between said rolls, of means controlled by said member for regulating the speed of one of said motors and for operating signals for indicating the arrival of

said movable member at a predetermined point in its path of movement.

16. The combination with a pair of rolls for sheet material, an electric motor for driving each of said rolls, and a member movable in accordance with the length of material between said rolls, of means controlled by said member for regulating the speed of one of said motors, for operating signals and for effecting the stopping of said motors under predetermined conditions.

17. The combination with a plurality of rolls for sheet material, an electric motor for driving each of said rolls, and members movable in accordance with the lengths of material between said rolls, of rheostats controlled by said members for governing the speed of said motors, and means for stopping all of said motors when one of said members occupies a predetermined position.

18. The combination with a pair of rolls for sheet material, an electric motor for driving each of said rolls, and a member movable in accordance with the length of material between said rolls, of a rheostat controlled by said member for governing the speed of one of said motors, said member also and indicating signals operated by said movable member at a predetermined point in its path of movement.

19. The combination with a plurality of rolls for treating material successively, of means for regulating the speed of said rolls in accordance with the length of material between said rolls, and means for controlling said rolls individually or collectively.

20. The combination with a pair of rolls for treating material successively, and an electric motor for driving each of said rolls, of means for regulating the speed of one of said motors in accordance with the length of material between said rolls and for stopping said motors when the material between the rolls reaches a predetermined length.

21. The combination with a pair of rolls for treating material successively, and an electric motor for driving each of said rolls, of means for regulating the speed of one of said motors in accordance with the length of material between said rolls and for stopping said motors when the material between the rolls reaches a predetermined minimum length.

22. The combination with a pair of rolls for successively treating material, of means for automatically controlling the relative speeds of said rolls in accordance with the length of material between them, and means for indicating when said length reaches a predetermined value.

23. The combination with a plurality of rolls for sheet material and independent driving motors therefor having field-magnet windings, of a pair of resistors in circuit

with each of said windings, manually operable means for controlling one of said resistors, and automatic means actuated by said material for controlling the other resistor in accordance with relative speeds of adjacent rolls.

24. The combination with a plurality of rolls for sheet material and independent driving motors therefor having field-magnet windings, of a pair of resistors in circuit with each of said windings, manually operable means for controlling one of said resistors, and automatic means actuated by said material for controlling the other resistor in accordance with the relative speeds of adjacent rolls as measured by the length of material between said rolls.

25. The combination with a plurality of rolls for sheet material and independent driving motors therefor having field-magnet windings, of manually operable means for effecting a variation of the resistance of each of the field circuits within predetermined limits, and automatic means dependent upon relative speeds of adjacent rolls for varying the resistance of said circuits within relatively small limits.

26. The combination with a plurality of driving motors for effecting the actuation of sheet material and separate controlling means therefor, of a single means actuated by said material for rendering all of said controlling means inoperative and effecting the stopping of said motors.

27. The combination with a plurality of motors for effecting the actuation of sheet material and independent controlling means therefor, each of said means comprising a no-voltage release device, of a single means controlled by said material for simultaneously rendering all of said devices inoperative and effecting the stopping of said motors.

28. The combination with a plurality of motors for actuating sheet material or the like and independent controlling means therefor, each of said means comprising a no-voltage release device, of manually operable means and automatic means operatively connected to said motors and operable under predetermined conditions for simultaneously controlling the operation of said no-voltage release devices.

29. The combination with a plurality of motors for effecting the actuation of sheet material and independent controlling means therefor comprising line switches and no-voltage release devices for controlling each of said switches, and means for controlling said devices either independently or simultaneously.

30. The combination with a plurality of motors for effecting the actuation of a band of material and independent controlling means therefor comprising line switches and

no-voltage release devices for controlling each of said switches, manually operable means and automatic means operatively connected to said motors for controlling said devices simultaneously and manually operable means for controlling said devices independently of each other.

31. The combination with a plurality of motors for effecting the actuation of a body of material, of independent controlling means therefor, each of said controlling means comprising a push-button station adjacent to the corresponding motor and a similar push-button station located at a central point.

32. The combination with a plurality of motors for effecting the actuation of a body of material, of independent controlling means therefor, each of said controlling means comprising a push-button station adjacent to the corresponding motor and a similar push-button station located at a central point and means for selectively rendering either of said stations operative.

33. The combination with a plurality of motors for effecting the actuation of a body of material, of independent controlling means therefor, said controlling means comprising a separate push-button station adjacent to each of said motors and a master-control station comprising push-button stations corresponding to each of the separate stations.

34. The combination with a plurality of motors for effecting the actuation of a body of material, of independent controlling means therefor, said controlling means comprising a separate push-button station adjacent to each of said motors and a master-control station comprising push-button stations corresponding to each of the separate stations and double-throw switches for selectively rendering either of said stations operative.

35. The combination with a pair of rolls for treating material, of means for auto-

matically controlling the relative speeds of said rolls in accordance with the length of material between them, and a plurality of means for indicating when said length reaches any one of a plurality of predetermined values.

36. The combination with a pair of rotatable devices for treating material, a driving motor for each of said devices having a field-magnet winding, and an idler roll between said devices for engaging said material, of a resistor permanently connected in circuit with one of said windings, an arm for adjusting said resistor controlled by said idler roll, and a signal device for indicating a difference in the speeds of said motors, said arm serving also to control said signal device.

37. The combination with a plurality of motors for effecting the actuation of a body of material, of independent controlling means for each of said motors, means located at a central point for simultaneously controlling all of said motors, and means for indicating the desirability of operating said independent controlling means.

38. The combination with a plurality of motors for effecting the actuation of a body of material, of a switch for each of said motors for stopping each of said motors, and a second switch for each of said motors for stopping all of said motors.

39. The combination with a plurality of motors for effecting the actuation of a body of material, of a switch for each of said motors for stopping each of said motors, and a second switch for each of said motors for stopping all of said motors, said second switches being arranged in series and said first switches being arranged in parallel circuit in series relation with said second switches.

In testimony whereof I have hereunto subscribed my name this 4th day of October, 1916.

FLETCHER D. HALLOCK.