

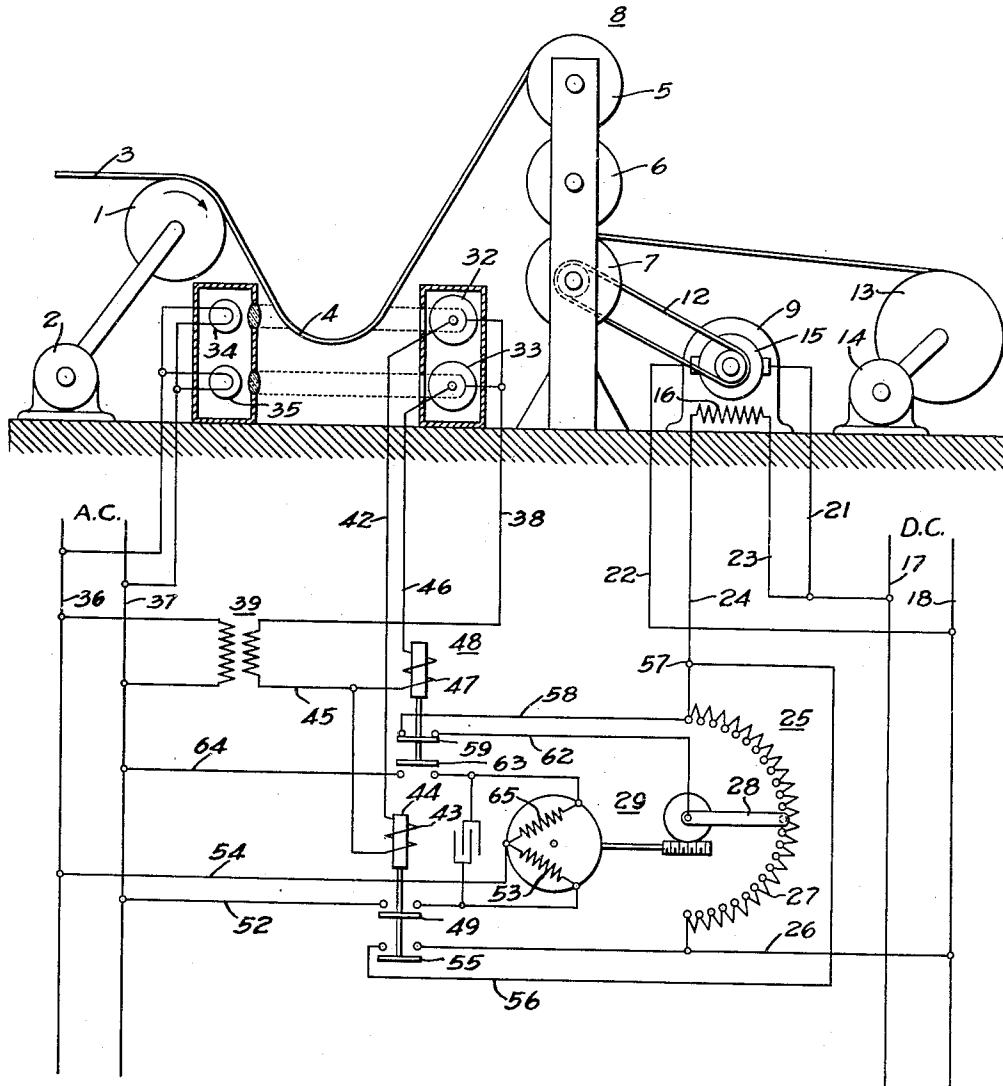
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SPEED REGULATOR

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WITNESSES:

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SPEED REGULATOR

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My invention relates to speed regulating systems, and particularly, to such systems that are adapted to be applied for controlling the loop or slack of sheet material as it comes from a manufacturing or processing machine during its passage to a stack of rolls or a reel.

In many industrial applications, such as the manufacture of paper or the passage of paper through a processing machine, it is desirable to permit a portion of the slack material to hang in the form of a loop prior to its passage to a stack of rolls for drying or calendering, or to a reel. It is, therefore, necessary to so regulate the speed of the rolls to which the material passes from the loop with respect to the machine from which the material is delivered, to permit a reasonable loop of slack material to be continuously maintained.

It is an object of my invention to provide for transferring material from a delivery means to a receiving means with a slack loop and for so regulating the speed of the receiving means relative to the delivery means that the sag of the slack loop remains substantially the same at all times.

It is another object of my invention to provide for so controlling the operation of the receiving means with respect to the speed of the delivery means that the tension of the material which passes from the former to the latter is reduced to a minimum.

It is a further object of my invention to employ the slack loop between the delivery means and the receiving means for regulating the speed of the receiving means.

It is a still further object of my invention to incorporate in the system effective anti-hunting means for making adjustments in the amount of slack in the loop while adjusting the speed of the receiving means.

Referring to the drawing, the single figure illustrates one embodiment of my invention in which a machine represented by the roll 1 driven by a motor 2 delivers a sheet of material 3, such as paper or fabric which sags, forming a loop 4 between the machine 1 and a set of rolls 5, 6 and 7 which may be for drying or calendering the sheet and which are driven by section driving motor 9 by any suitable means, such as a belt 12, and from which the material passes to a reel 13 driven by a motor 14. The speeds of the motors 2 and 14 may be regulated in the usual way by means not here disclosed since they form no part of the present invention.

The section driving motor 9, as illustrated, is a direct-current motor having an armature wind-

ing 15 and a field winding 16 that are connected to be energized from direct-current supply conductors 17 and 18. The armature circuit extends from the conductor 17 through conductor 21, the motor armature 15 and conductor 22 to the supply conductor 18. The field winding circuit extends from the supply conductor 17 through conductor 23, the field winding 16, conductor 24, a motor operated rheostat 25 and conductor 26 to the supply conductor 18. The rheostat 25 comprises a resistor 27 and a movable contact member 28 that is operated by a pilot motor 29 in accordance with control mechanism governed by photo-tubes 32 and 33 mounted at different altitudes on one side of the loop 4 and adapted to receive beams of light from the light source 34 and 35, respectively, on the opposite side of the loop 4. The light sources 34 and 35 may be supplied with electrical energy from the alternating-current supply conductors 36 and 37.

The cathode terminals of the photo-tubes 32 and 33 are connected by means of a conductor 38 to one terminal of the secondary winding of a transformer 39, the primary winding of which is connected across the alternating-current supply conductors 36 and 37. The other terminal of the tube 32 is connected by a conductor 42 through the winding 43 of the relay 44 and by conductor 45 to the other terminal of the secondary winding of the transformer 39. The second terminal of the tube 33 is connected by conductor 46 through the winding 47 of the relay 48 and by conductor 45 to the second named terminal of the secondary winding of the transformer 39.

When the loops sags the amount indicated in the drawing, the beam of light between the light source 34 and the tube 32 is interrupted by the loop 4, thus maintaining the relay 44 in its de-energized or illustrated position, and the beam of light from the source 35 to the photo-tube 33 acts upon the photo-tube, thus maintaining the relay 48 energized and in its illustrated position, so that no power is supplied to the pilot motor 29 and the rheostat arm 28 remains in a stationary position.

If, for any reason, the motor 9 operates to drive section 8 comprising rolls 5, 6 and 7 faster than the machine represented by roll 1 is being driven, the slack in the loop 4 will be partially taken up until the sag in the loop is not sufficient to interrupt the beam of light from the source 34 to the photo-tube 32 and, as the tube 32 is illuminated, current flows from the transformer 39 through winding of the relay 44, actuating it to its circuit closing position. When

so actuated, the relay contact member 49 closes a circuit from the power circuit conductor 37 through conductor 52, the relay contact member 49, the motor field winding 53 and circuit conductor 54 to the supply conductor 36, thus operating the motor 29 to move the rheostat arm 28 in a clockwise direction to decrease the amount of the resistor 27 that is in circuit with the motor field winding 16, to thereby strengthen the field and cause the motor to decrease its speed. At the same time that the relay contact member 49 is actuated to its circuit closing position, the relay contact member 55 is also actuated to a circuit closing position, shunting the rheostat resistor 27 from the motor field winding circuit through conductor 26, relay contact member 55 and conductor 56 to junction point 57, so that temporarily, the energization of the motor field winding 16 is increased appreciably above the value corresponding to the position of the rheostat contact arm 28. This introduces a field forcing effect into the correction in the phase angle relation between the roll 1 and the rolls of the stack 8. It will be appreciated that this field forcing effect is necessary to re-introduce the amount of material in the sheet between the roll 1 and the stack 8 to bring the sag of the loop 4 to its desired position when the desired speed relation between the motors 9 and 2 is reestablished.

When the speeds of the motors 9 and 2 are in correspondence and the loop 4 extends downwardly to its desired or illustrated position, the beam of light from the source 34 to photo-tube 32 is again interrupted, thus deenergizing the relay 44 and permitting it to drop to its lower or illustrated position to interrupt the operation of the motor 29, and to interrupt the circuit through conductor 56 in shunt relation to the rheostat 25. The circuit from the field winding 16 is then again completed from conductor 24, through conductor 58, the contact member 59 of the relay 48, conductor 62, rheostat arm 28, the lower portion of the resistor 27, and the conductor 26, to the supply conductor 18.

If the motor 9 slows down appreciably with respect to the motor 2 thus causing the material from the loop 4 to be taken up by the stack of rolls 8 more slowly than delivered by the machine represented by the roll 1, so that the sag in the loop 4 becomes great enough to interrupt the light beam from the light source 35 to the photo-tube 33, the circuit through the winding of the relay 48 will be interrupted permitting it to drop to its lower position. In dropping to its lower position the relay contact member 59 interrupts the circuit through conductors 58 and 62 in shunt relation to the portion of the resistor 27 through the rheostat arm 28 and the conductor 24, thus inserting the whole of the resistor 27 in the field winding circuit to effect a sudden increase in the speed of the motor 9. At the same time the relay contact member 63 closes a circuit from the circuit conductor 37 through conductor 54, the relay contact member 63, the motor winding 55, and conductor 54 to supply conductor 36 to so operate the motor 29 as to move the arm 28 in a counter-clockwise direction to increase the resistance in the motor field winding circuit and increase the speed of the motor 9. When the speed of the rolls in the stack 8 is sufficient to raise the loop 4 to permit the light beam from the source 35 to strike the photo-tube 33, the relay 48 will be again energized and actuated to its upper or illustrated position, thus interrupting

the circuit through the relay contact member 63 for driving the pilot motor 29, and, at the same time, reestablishing the shunt circuit through the relay contact member 59 to cause the motor to slow down to a speed determined by the position of the rheostat arm 28.

The field forcing effect caused by interrupting the circuit in shunt relation to the upper portion of the rheostat resistor 27 through the relay contact member 59 while operating the motor 29 in a direction to decrease the excitation of the field winding 16 and cause an increase in the speed of the motor 9 may cause a sufficient temporary increase in the motor speed to raise the loop 4 out of the light beam from the source 35 to the photo-tube 33 prior to the completion of the corrective action of the rheostat arm 28 necessary to bring the speed of the motor 9 in complete accord with the speed of the motor 2, so that the loop 4 again moves gradually downwardly to interrupt the light beam from the source 35 to the tube 33 to effect a similar operation of the motor 29 to effect a further corrective step. It will be appreciated that the successive corrective steps will be shorter in duration of time the nearer the speed of the motor 9 becomes to its desired speed to match the speed of the delivering machine 1 necessary to maintain the loop 4 in a fixed position.

It will be appreciated that the means effective to cause a relatively abrupt change in the speed of the motor 9 while the pilot motor 29 is in operation to effect a correction in the setting of the rheostat 25 permits the re-adjustment of the loop 4 to its desired position at the time the correction in the speed of the motor 9 is effected. The cumulative error in the speeds of the roll 1 and the stack of rolls 8 is thus corrected so that an over-correction in the speed of the motor 9 is not required to bring the loop 4 to its desired position, which over-correction, if permitted, would result in a hunting action in the motor speed alternately above and below the desired speed.

Many modifications in the arrangement of circuits and apparatus may be effected without departing from the spirit of my invention, and I do not wish to be limited otherwise than by the scope of the appended claims.

I claim as my invention:

1. In a regulating system, in combination, means for delivering flexible sheet material, means for receiving said material, the relative positions of said delivering and said receiving means being such that the material is free to sag as it passes from the former to the latter, a motor having a field winding for driving said receiving means, a variable resistor connected in circuit with said field winding, an auxiliary motor for actuating said resistor, means including a plurality of radiation responsive devices and associated radiation sources for controlling the operation of said auxiliary motor, the energization of said devices being controlled by the sag of the material as it passes from the delivering means to the receiving means, and means for eliminating the cumulative error in the sag during operation of said auxiliary motor.

2. In a regulating system, in combination, means for delivering material, means for receiving said material, means for causing said material to have more than one direction of travel as it passes from the former to the latter, means for driving said receiving means and means for regulating the speed of said driving means in

accordance with the speed at which said material is being delivered thereto, said means being responsive to a predetermined sag of said material, and means operative during a regulating action for correcting the cumulative error in the material between said delivering and receiving means.

3. In a regulating system, in combination, means for delivering material, means for receiving said material, the relative positions of said delivering and said receiving means being such that the material is free to sag as it passes from the former to the latter, and means including a plurality of radiation responsive devices for maintaining the sag between an upper and a lower limit, and means operative during operation of the last named means for correcting the cumulative error in the material between said delivering and receiving means.

4. In a regulating system, in combination, means for delivering material, means for receiving said material, the relative positions of said delivering and receiving means being such that the material is free to sag as it passes from the former to the latter, driving means for said receiving means, means including a radiation responsive device for decreasing the speed of the driving means when the sag is less than a predetermined value, means including a second radiation responsive device for increasing the speed of the driving means when the sag is more than a predetermined value, and means operative during a speed variation for correcting the cumulative error in the material between said delivering and receiving means.

5. In a regulating system, in combination, means for delivering material, constant speed driving means therefor, means for receiving said material, means for causing the said material to have more than one direction of travel as it passes from the former to the latter means, variable speed driving means for driving said receiving means at substantially the speed of said constant speed driving means, means including photo-electric means responsive to the position of said material for varying the speed of said variable speed driving means, and means operative during a speed variation for eliminating the cumulative error in the position of said material.

6. In a regulating system, in combination, means for delivering flexible sheet material, means for receiving said material, the relative positions of said delivering and said receiving means being such that the material is free to sag as it passes from the former to the latter, a motor for driving said receiving means having a field winding, a variable resistor connected in circuit with said field winding, a pilot motor for actuating said resistor, and means including a plurality of radiation responsive devices at different elevations and associated light sources for controlling the operation of said pilot motor, said radiation responsive devices being responsive to the sag of the material as it passes from the delivering means to the receiving means, said higher radiation responsive device being effective when ex-

posed to its associated light source to cause operation of said pilot motor to decrease the resistance in said field winding circuit and to remove said variable resistor from the regulating motor field circuit during operation of said pilot motor, said other radiation responsive device being effective when its associated light source is interrupted to cause operation of said pilot motor in a direction to increase the resistance in said field winding circuit and to insert said variable resistor in said motor field winding circuit during operation of said pilot motor.

7. In a regulating system, in combination, means for delivering material, means for receiving said material, the relative positions of said delivering and receiving means being such that the material is free to sag as it passes from the former to the latter, driving means for said receiving means, means for decreasing the speed of the driving means when the sag is less than a predetermined value, means for increasing the speed of the driving means when the sag is more than a predetermined value, and means operated during a speed variation for correcting the cumulative error in the material between said delivering and receiving means.

8. In a regulating system, in combination, means for delivering material, constant speed driving means therefor, means for receiving said material, means for causing the said material to have more than one direction of travel as it passes from the former to the latter means, variable speed driving means for driving said receiving means at substantially the speed of said constant speed driving means, means responsive to the position of said material for varying the speed of said variable speed driving means, and means operated during a speed variation for eliminating the cumulative error in the position of said material.

9. In a regulating system, in combination, means for delivering flexible sheet material, means for receiving said material, the relative positions of said delivering and said receiving means being such that the material is free to sag as it passes from the former to the latter, a motor for driving said receiving means having a field winding, a variable resistor connected in circuit with said field winding, a pilot for actuating said resistor, and means including devices at different elevations for controlling the operation of said pilot motor, said device being responsive to the sag of the material as it passes from the delivering means to the receiving means, said higher device being effective to cause operation of said pilot motor to decrease the resistance in said field winding circuit and to remove said variable resistor from the regulating motor field circuit during operation of said pilot motor, said other device being effective to cause operation of said pilot motor in a direction to increase the resistance in said field winding circuit and to insert said variable resistor in said motor field winding circuit during operation of said pilot motor.

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