

April 16, 1929.

A. M. GOODWIN

1,709,616

REGULATING SYSTEM

Original Filed Nov. 6, 1925

2 Sheets-Sheet 1

Fig. 1.

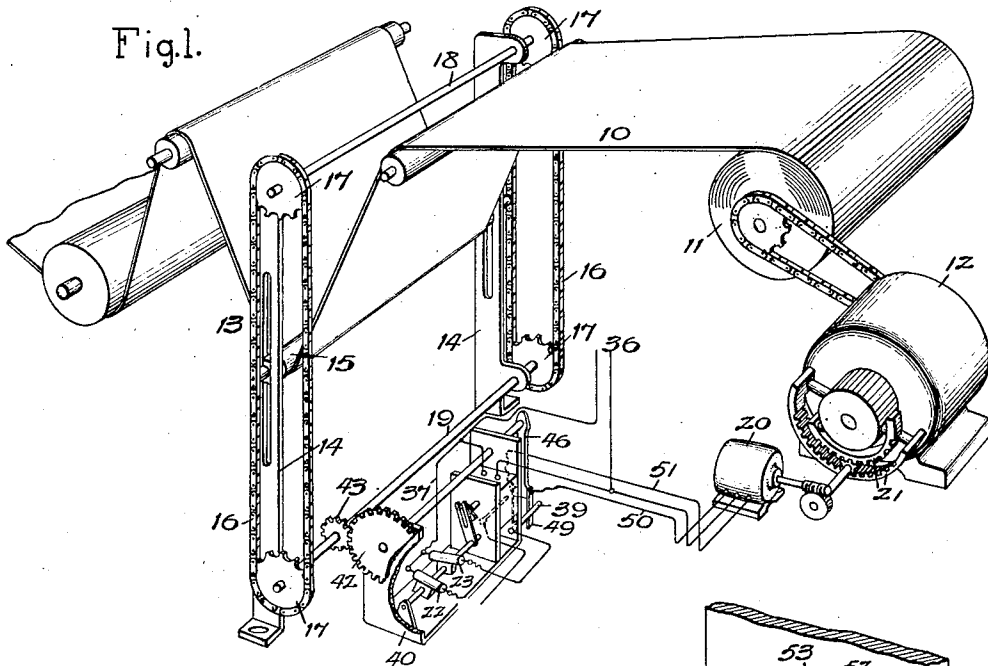
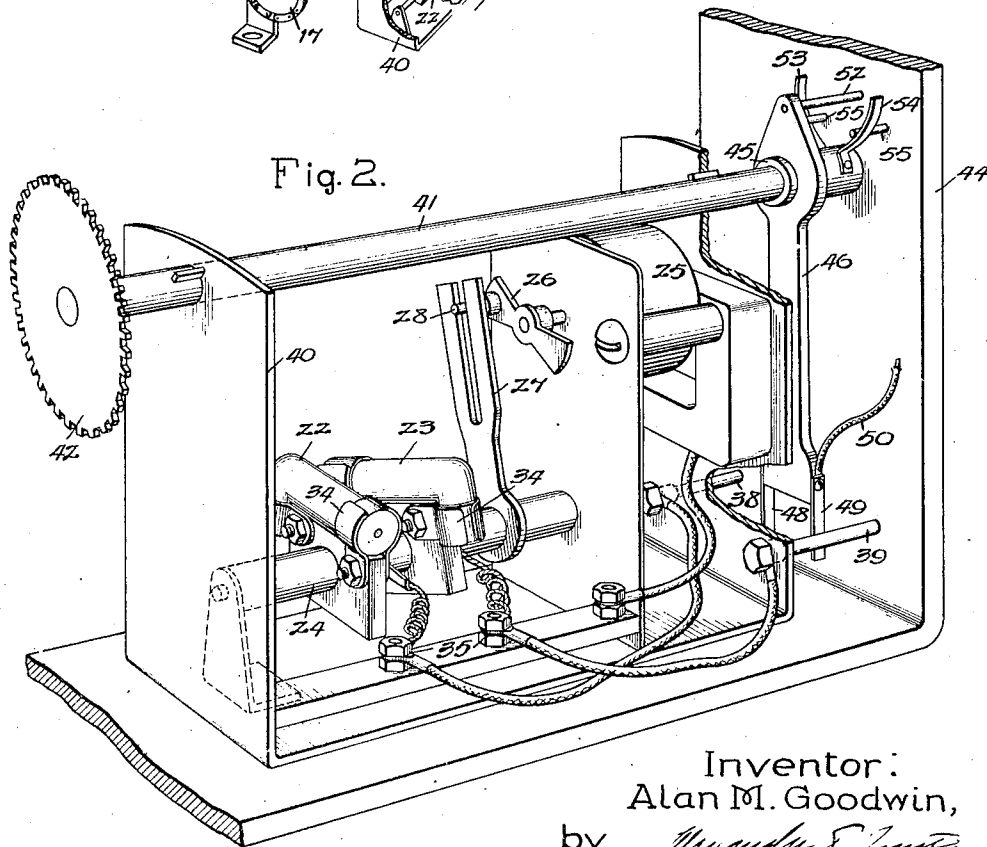


Fig. 2.



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Fig. 4.

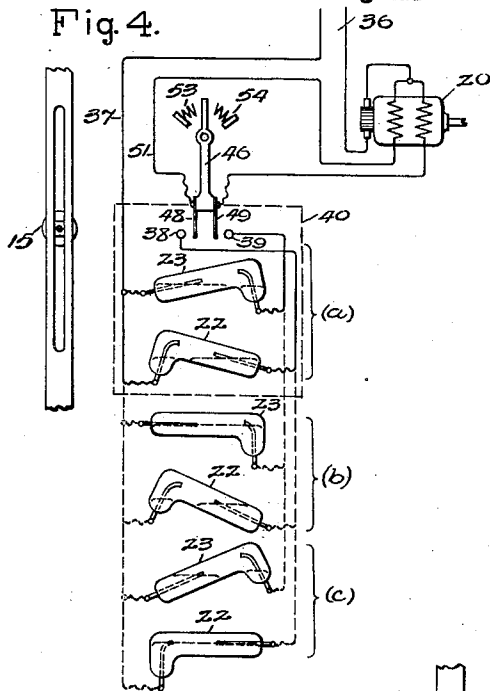


Fig. 3.

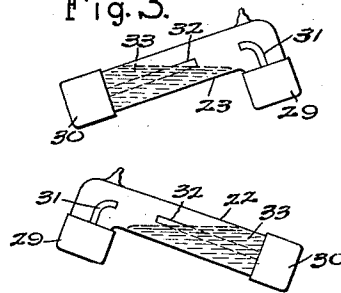


Fig. 6.

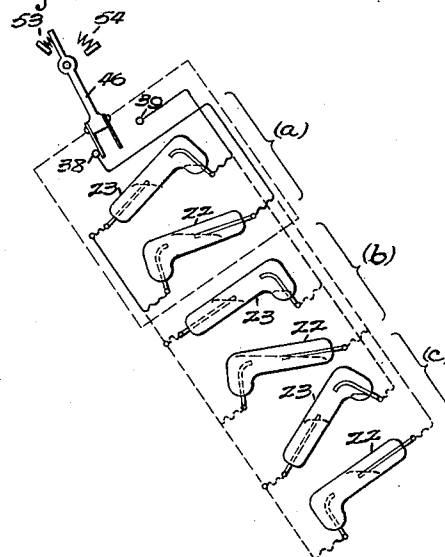
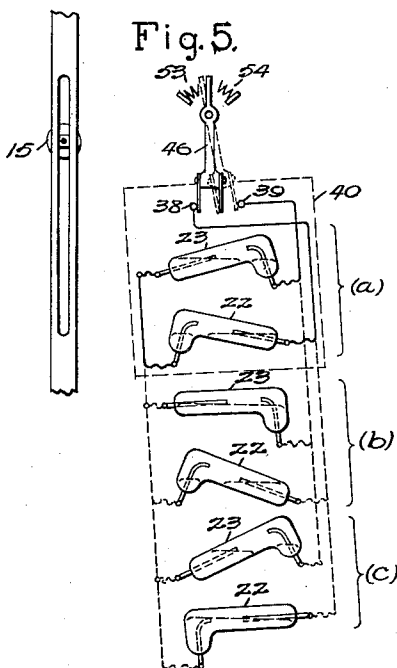


Fig. 5.



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Patented Apr. 16, 1929.

1,709,616

UNITED STATES PATENT OFFICE.

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REGULATING SYSTEM.

Application filed November 6, 1925, Serial No. 67,463. Renewed March 3, 1923.

My invention relates to a system of automatic regulation and it is particularly useful as an automatic speed regulator for electric motors and it will be described as such. One
5 object of my invention is to provide a regulator for automatically maintaining a desired operating relation between two pieces of machinery or between two segregated parts of the same machine. For example, in the textile industry the roll which receives the finished fabric must be rotated at a speed proportioned to the rate at which the fabric is produced and at the same time its speed must be compensated for the gradually increasing diameter of the roll.

Another object of my invention is to provide a regulating system of the character above indicated which is exceptionally free from hunting.

10 In carrying my invention into effect I make use of liquid conductor switch operated control circuits leading to the speed changing or other regulating device. The liquid conductor commonly used for switching purposes is mercury. However, any other good
15 liquid conductor which has the ability to come back to a liquid level after the vessel in which it is contained is tipped from one position to another will answer the purpose, this being the characteristic which I make use of in the carrying out my invention. Since the characteristics of mercury switches and their use are well known, I will mention this type of liquid conductor switch in the description of my invention. The mercury
20 switch or switches are of the tilting type and are preferably tilted back and forth periodically by means of a constant speed motor. Ordinarily this would simply open and close the control circuit periodically. However, the platform upon which the mercury tube switches are mounted is arranged to be bodily tipped in one direction or the other by an automatic gauging device depending upon the direction and extent of regulation desired so as to alter the periodic switching operation performed by the constant speed motor from a limit where a switch does not close at all through a range
25 where the duration of closure is gradually increased to a limit in the other direction where it remains closed all of the time. Two such mercury tube switches may be employed with their circuit closing ends reversed so
30 that as the duration of closure of one switch

is increased the duration of closure of the other switch is decreased and vice versa and these switches may be arranged so that over a central range neither switch closes.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of the invention reference is made in the following description to the accompanying drawing in which
35 Fig. 1 represents a perspective view of the essential parts of the invention as applied in the textile industry to regulate the speed of the motor which rolls up the finished product; Fig. 2 shows the details of construction
40 of the mercury tube contacting apparatus; Fig. 3 shows the type of mercury tube switches used and their approximate relative positions with respect to each other when used with the particular installation herein
45 described and Figs. 4, 5 and 6 show different operative conditions of the apparatus.

Referring to Fig. 1—10 represents a strip of finished cloth as it comes from the textile mill. It is wound on the roll 11 which is driven by an electric motor 12. The cloth passes through what is known in the industry as a tenter frame 13 which serves the double purpose of keeping the cloth smooth and taut and regulating the speed of motor 12. The
50 tenter frame consists of the spaced vertical guides 14 for supporting the weighted roller 15 which is allowed to move up and down in the frame to keep the cloth taut, the cloth supporting the weighted roller as represented. Chains 16 are attached to the end bearings of the roller and pass over sprocket wheels 17 at the tops and bottoms of the guides. The two top wheels and the two bottom wheels are secured to shafts 18 and 19 respectively so as to keep the roll properly aligned. It will be evident that if the motor 12 operates too slowly, roll 15 will be gradually lowered and that if motor 12 operates too fast, roll 15 will be raised rotating the
55 shafts 18 and 19 accordingly.

Motor 12 is here represented as an alternating current commutator motor of a type adapted to have its speed changed by shifting the brushes with respect to the commutator. I have represented a reversible pilot motor 20 suitably geared to the brush yokes 21 of motor 12 for shifting the brushes and it will be understood that when the pilot motor operates in one direction the brushes of

motor 12 are shifted to raise its speed and when the pilot motor operates in the reverse direction the speed of motor 12 is lowered. The motor 20 is arranged to be energized for one direction of rotation through a mercury switch 22 and for the opposite direction through a mercury switch 23. The operation of the mercury tube switches is controlled in accordance with the vertical position of roll 15 to vary the speed of motor 12 in a manner to maintain roll 15 near a central position in the vertical guides 14.

Referring to Fig. 2, it is seen that the mercury tube switching mechanism comprises a shaft 24 upon which the mercury tubes 22 and 23 are mounted, a constant speed motor 25 and mechanical connection between the motor 25 and shaft 24, whereby rotation of the motor causes the oscillation of the shaft in a manner to tilt the switches 22 and 23 back and forth. This mechanical connection consists of a crank arm 26 driven by the motor 25 and a slotted lever 27 secured to shaft 24. A pin 28 in arm 26 fits into the slot in lever 27 and as the crank rotates the pin 28 slides in the slot and at the same time moves the lever 27 back and forth through an angle corresponding to the angle through which the mercury tube switches are tilted thereby. The details of the tubes themselves are shown in Fig. 3 where it is seen that conducting caps 29 and 30 are provided on the opposite ends of the tubes which are electrically connected to internal electrodes 31 and 32, and the tubes contain a liquid conductor 33 such as mercury. The caps of the tubes are adapted to be clasped by conducting clips 34 suitably supported on the shaft 24, and these clips are connected by flexible conductors to suitable binding posts 35, part of which are shown in Fig. 2. One end of the tubes will be permanently electrically connected to one side of a source of supply 36 as by conductor 37 of Fig. 1. The other end of the tubes will preferably be connected to binding posts 38 and 39 as best shown in Fig. 2. The constant speed electric motor 25 will be permanently connected to the source of supply 36 when the device is in operation.

The switch mechanism just described is mounted on a framework 40 which is keyed to a shaft 41, which shaft carries a gear wheel 42 meshing with a pinion 43 on the shaft 19 of the tenter frame. The shaft 41 is supported in a stationary framework 44 which may constitute a housing for the switch mechanism. It will thus appear that as the roll 15 moves up and down in the tenter frame the entire switch mechanism on frame 40 will be rotated with the horizontal shaft 41. The vertical position of frame 40 shown in the drawing corresponds to the central position of the roll 15.

Mounted on the stationary bearing housing 45 in the stationary framework 44 through

which the shaft 41 passes is a frictional contact arm 46, having contacts 48 and 49 which play between and cooperate with contacts 38 and 39 in the movable framework 40. Contact 49 is connected through conductor 50 to the pilot motor 20 and when this circuit is closed in the tube 23 and at contacts 39—49 the pilot motor circuit is completed to operate the motor in a direction to adjust the brushes of motor 12 to raise its speed. Contact 48 is connected through a conductor 51 to the pilot motor 20 and when this circuit is closed in the tube 22 and at contacts 38—48 the pilot motor circuit is completed to operate the motor in the reverse direction to lower the speed of motor 12.

The friction arm 46 is provided with a pin 52 which cooperates with spring fingers 53 and 54 at the extremities of its movement and which resist the extreme movements of arm 46. Thus if arm 46 is moved in a clockwise direction by the corresponding movement of contact 39 up to a point where pin 52 just comes in contact with spring finger 54 and then contact 39 recedes slightly the arm 46 will remain stationary due to friction and the contacts 39—49 will open. However, if the arm 46 is moved beyond this position such that spring arm 54 is put under tension by pin 52 this tension by pin 52 will cause contact 49 to follow contact 39 back when it recedes so as to maintain the contacts closed until the spring arm is stopped by a stationary pin 55, after which no further movement of arm 46 will take place until it is again moved by one or the other of contacts 38 or 39.

The operation of the apparatus will be better understood by referring to Figs. 4, 5 and 6, where different operating conditions of the apparatus are represented. In Fig. 4 the roll 15, the friction contact arm 46 and the frame 40 shown in dotted lines are represented in their central positions. In this figure and in Figs. 5 and 6, (a) represents the central position of the mercury tubes with respect to the frame 40, (b) represents the condition of the switches as tilted to the right, and (c) as tilted to the left by the constant speed motor 25 from the mid position represented at (a).

In Fig. 4 it is seen that in the central position at (a) neither tube 22 nor 23 closes the circuit, at (b) tube 23 is closed and at (c) tube 22 is closed. However, with the roll 15 and arm 46 in the central positions the circuits are open at contacts 38 and 39 so that no regulation occurs.

In Fig. 5 the roll 15 is raised somewhat from a central position so that the frame 40 and the mercury tube switch mechanism are tilted in the manner shown such that contact is made between the arm 46 and contact 38, the arm 46 still being in its central position as shown in full lines. The condition of the switches 22 and 23 in the three positions (a),

(b), and (c) are the same as in Fig. 4, but it will be noticed that switch 23 just closes at the extremity of its oscillation at (b). Thus the duration of closure of switch 23 has decreased while that of switch 22 has increased, it being almost closed at the central position (a) of the oscillation.

The control circuit of pilot motor 20 being closed periodically, by switch 22, condition (c), and at contacts 38 and 48, the motor now begins to shift the brushes of the main motor in a direction to lower its speed to a limited extent at each closure of switch 22. Ordinarily a few such closures will be sufficient to cause the roll 15 to stop rising and just as soon as the slightest lowering occurs frame 46 will be rotated to the left so as to open the control circuit at 38. Let us assume, however, that the speed of motor 12 continues to be too low and that roll 15 continues to rise. The duration of contact in tube 22 will increase, thereby increasing the regulation until the condition represented in Fig. 6 is reached. It is seen that the circuit of tube 22 now remains closed all the time while that of tube 23 remains open all the time. The arm 46 has been rotated from its central position against spring 53 and has placed the spring under tension to some extent. The pilot motor 20 is thus energized continuously and the regulation is a maximum which is essential since the roll 15 has risen to near the top of the frame. The speed of motor 12 is thus materially increased and the roll 15 starts to descend. Spring 53 causes the arm 46 to follow contact 38, thus maintaining the control circuit closed until the dangerous condition of roll 15 has been corrected. As the roll 15 descends and spring 53 reaches its limit of travel, as explained in connection with Fig. 2, it leaves the friction arm 46 in some such position as shown in dotted lines in Fig. 5. Frame 40 immediately causes contact 38 to move away from the contact on the friction arm 46 and the control circuit is broken. Finally contact is made at 39, as shown in the dotted line position of arm 46, in Fig. 5. The tube 23 condition (b) just closes the control circuit at the extremity of its oscillation and starts the regulation in the opposite direction to increase the speed of motor 12. It will be noticed that now the regulation is started even before the roll reaches its central position in descending and as the frame 46 rotates to the left the regulation is gradually increased due to the increasing duration of closure of tube 23. This is what is desired because after an extreme regulation in one direction it is desirable to anticipate the reverse regulation which will eventually become necessary and apply it in gradually increasing amounts until the speed has been corrected and the arm 46 has been brought back near a central position. Ordinarily the speed will be corrected in this way

before the maximum reverse regulation becomes necessary so that instead of strong hunting action which tends to persist first in one direction and then in the other the apparatus tends to damp the hunting action until only a very slow creeping of the roll up and down near the center of the frame exists.

It will thus be observed that there is a range of movement of the roll 15 where no regulation takes place, that outside of these limits the regulation is gradually applied in increasing amounts to a maximum and that after an excessive regulation in either direction the necessary reverse regulation is anticipated and applied in time to bring the apparatus back to a normal regulating condition.

In certain cases where the regulating requirements are not exacting it may be feasible to omit the friction arm 46 altogether, and have the mercury tube switch circuits led directly to the pilot motor or other regulating device.

While the invention has been described as a speed regulator it will occur to those skilled in the art that the regulator has novel features which may be utilized in various instances where exacting regulating requirements are essential, and consequently I do not wish to limit my invention to speed regulators, nor do I wish to limit my invention to the particular arrangement of the parts herein described and illustrated, but seek Letters Patent carrying claims commensurate with the scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a regulating system, a regulator the action of which is dependent upon the closure of an electric circuit, a tiltably mounted liquid conductor switch in such circuit, means for continuously tilting said switch in opposite directions to open and close the circuit thereat, and means responsive to a condition to be regulated for bodily varying the position of said switch so as to relatively vary the open and closed periods of said switch.

2. In a regulating system, a liquid conductor switch and means for continuously tilting said switch back and forth towards open and closed positions, a supporting structure for said switch and tilting means, and means responsive to a condition to be regulated for bodily turning said structure to vary the duration of closure of said switch.

3. In a regulating system, a liquid conductor switch and means for continuously tilting said switch back and forth toward open and closed positions, a supporting structure for said switch mounted to rotate on an axis parallel to the axis about which said switch is tilted, and means responsive to a condition to be regulated for rotating said structure from a position where the switch

remains open all of the time to a position where it remains closed all of the time and vice versa.

4. In a regulating system, a pivoted support carrying a shaft, the axis of rotation of said support and shaft being parallel, means for continuously oscillating said shaft on said support, a pair of liquid conductor switches secured to said shaft in such a way that as the shaft is oscillated back and forth one switch is moved toward a closed position while the other is moved toward an open position, and vice versa, and means responsive to opposite regulating requirements for respectively rotating said support in opposite directions.

5. In a regulating system, a pivoted support carrying a shaft, the axis of rotation of said support and shaft being parallel and horizontal, a constant speed motor on said support for oscillating said shaft, a pair of liquid conductor switches tilted back and forth with the oscillations of said shaft toward open and closed positions, regulating circuits controlled by said switches, and means responsive to opposite regulating requirements for respectively rotating said support in opposite directions.

6. In a regulating system, a pivoted support carrying a pair of liquid conductor switches which are pivoted on said support parallel to the axis of rotation of said support, means for continuously tilting said switches back and forth on said support toward open and closed positions, regulating circuits controlled by said switches, means responsive to opposite regulating requirements for rotating said support in opposite directions, contacts in series with said switches, and means dependent upon the rotation of said support for controlling said contacts.

7. In a regulating system, a pivoted support carrying a pair of liquid conductor switches which are pivoted thereon on an axis parallel to the axis of rotation of said support, means on said support for continuously tilting said switches back and forth toward open and closed positions, regulating circuits controlled by said switches, means responsive to opposite regulating requirements for rotating said support in opposite directions, contacts in series with said switches, and means responsive to the opposite rotations of said support for closing and opening said contacts, said means and contacts being arranged so that both contacts are normally open when regulation is not required and one or the other contact is maintained closed for extreme regulating requirements.

8. In a regulating system, a pivoted support, a pair of liquid conductor switches tiltably mounted on said support on an axis

parallel to the axis of rotation of said support, means for continuously tilting said switches back and forth toward open and closed positions, an electric regulator arranged to be alternately energized through said switches for opposite regulating requirements, means for rotating said support in opposite directions from a central position in proportion to such regulating requirements, contacts in series with said electric regulator and said switches carried by said support, and a frictionally pivoted arm provided with contacts cooperating with the contacts of the support, said arm being arranged to be rotated by the movement of said support towards one or the other set of cooperating contacts, the contacts on said support being spaced differently from the contacts on said arm and arranged so that a lost motion space exists between the opposite driving connections formed by said contacts where no contact is made.

9. In a regulating system, an electric regulator having separate energizing circuits for opposite regulating operations thereof, a liquid conductor switch in each circuit, said switches being tiltably mounted such that as one switch is tilted toward a closed position, the other is tilted toward an open position, means for continuously tilting said switches toward open and closed positions, and means responsive to opposite regulating requirements for progressively increasing the duration of closure of one switch and progressively decreasing the duration of closure of the other switch in proportion to such requirements and in the proper direction to produce corrective regulation.

10. In a regulating system, an electric regulator having separate energizing circuits for opposite regulating operations thereof, a liquid conductor switch in each circuit, said switches being tiltably mounted such that as one switch is tilted toward a closed position, the other is tilted toward an open position, means for continuously tilting said switches back and forth toward open and closed positions, means responsive to opposite regulating requirements for progressively increasing the duration of closure of one switch and progressively decreasing the duration of closure of the other switch in proportion to such requirements and in the proper direction to produce corrective regulation, other contacts in series with each regulating circuit, and means dependent upon regulating conditions for opening said circuits to prevent overregulation and closing said circuits again when corrective regulation is required.

In witness whereof, I have hereunto set my hand this 2nd day of November, 1925.

ALAN M. GOODWIN.