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MOTOR CONTROL SYSTEM

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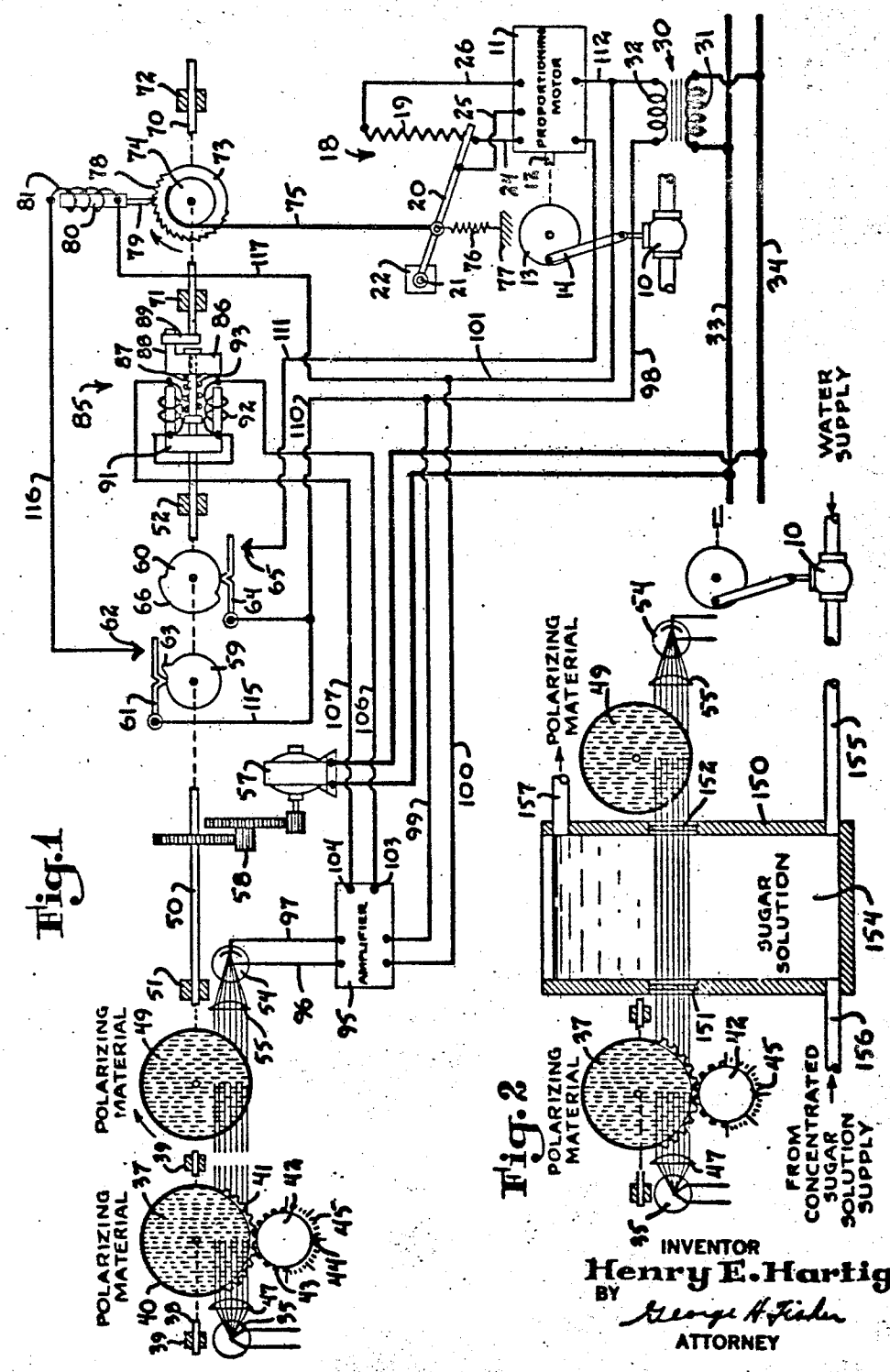


Fig. 1

Fig. 2

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MOTOR CONTROL SYSTEM

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6 Claims. (Cl. 250—41.5)

The present invention is concerned with a motor control system, more particularly with one in which the motor is used to position an object remotely located from the controller.

An object of the present invention is to provide a system for remotely positioning an object in which a light beam is polarized with a predetermined angle of polarization and in which means responsive to the angle of polarization of the light is effective to control the positioned object.

Further objects of the present invention will be apparent from a consideration of the accompanying specification, claims, and drawing of which

Figure 1 is a schematic view of one form of my motor control system, and in which

Figure 2 shows a portion of a specific application of the control system.

Referring to the drawing for a more detailed explanation, there is shown in Figure 1, in schematic form, the motor control system forming the subject of the present invention. While it is to be understood that the particular invention is not limited to any particular object to be positioned, this object has been shown in the drawing as a valve indicated by the reference numeral 10. This valve is variably positioned by a proportioning motor generally indicated by the reference numeral 11. The motor drives the valve through a shaft 12 to which is secured a crank disc 13. A link 14 is eccentrically connected to the crank disc 13 and is also connected to the stem of valve 10. Associated with the proportioning motor 11 is a control potentiometer, generally indicated by the reference numeral 18. This control potentiometer comprises a resistance 19 and a contact arm 20 which is adapted to slidably engage resistance 19. The contact arm is pivotally mounted at 21 to a suitable support 22. The potentiometer 18 is connected through conductors 24, 25, and 26 to the proportioning motor 11. The proportioning motor 11 may be of any suitable type wherein the motor assumes a position corresponding to the position of the controller. Thus when power is supplied to the motor 11, the motor always assumes a position corresponding to the position of the potentiometer arm 20. Such an arrangement is shown in the patent to D. G. Taylor No. 2,028,110, issued January 14, 1936.

A step-down transformer 30 is used to supply power for operation of the motor 11 and for operation of the motor control system generally. This transformer comprises a line voltage primary 31 and a low voltage secondary 32. The line voltage primary 31 is connected to line wires 33 and 34 leading to a suitable source of power (not shown).

As indicated by the objects, the control system of the present invention acts through the variation of the angle of polarization of a beam of light. Any suitable source of light may be used. In the present instance an electric lamp 35 is employed, the lamp being energized by any suitable source of power (not shown). Mounted in the path of the rays from the electric lamp is a disc of polarizing material, indicated by the reference character 37. This disc is mounted upon a shaft 38 which is supported in bearings 39. The disc 37 may be of any suitable polarizing material, preferably of the substance known commercially as "Polaroid," which has the property of polarizing any light which is transmitted therethrough. The angle of the plane of polarization can be readily varied by rotating the disc. In order to rotate the disc 37, the same is mounted in a rim 40 which is provided with teeth 41 on its under surface. Cooperating with the teeth 41 is a knob 42 which is provided with teeth 43 around the upper portion of its periphery. Knob 42 is provided with a pointer 44 which cooperates with a scale 45. It will be readily understood that by rotation of the knob 42 the angular position of the polarizing disc 37 may be varied and in consequence the angle of polarization is accordingly varied. The pointer 44 and scale 45 provide a convenient means of indicating the degree of angularity of the polarized disc 37. It is to be understood that the scale 45 may be calibrated to any suitable units depending upon the specific application of the system. Thus if valve 10 is employed in a heating system, wherein it controls the flow of steam or other similar heating fluid, the scale 45 may be calibrated in terms of steam flow, or in some instances, in terms of degrees of temperature.

Interposed between the disc 37 of polarizing material and the source of light 35 is a lens 47 which serves to direct the rays along substantially parallel lines through the disc 37. In this manner, the diversion of the light rays is decreased. Located adjacent to the object to be positioned is a receiving disc 49 of polarizing material, preferably of the same type as used in disc 37. This disc is secured to a shaft 50 which is supported in bearings 51 and 52. The disc 49 is disposed in the path of the light rays which have passed through the polarizing disc 37. Also mounted in the path of the light rays

after they have passed through the second polarizing disc 49 is a photoelectric cell 54. Interposed between the disc 49 and the electric cell 54 is a lens 55 which serves to converge the light rays upon the photo-electric cell.

As is well known, a member of polarizing material will pass polarized light only when it is disposed in an angular position corresponding to the plane of polarization of the light. This action is quite critical. If a disc of polarizing material is held in front of a polarized light beam, the light will not pass through the disc of polarizing material to any substantial degree until the angular position of the disc almost identically coincides with the angle of polarization of the light, under which condition the light will be transmitted through the polarizing disc with almost full intensity. Referring to the specific apparatus, it will be clear that substantially no light will be received by the photo-electric cell 54 until the angular position of disc 49 substantially coincides with the angular position of disc 37. In order to change the angular position of disc 49, the shaft 50 is driven by a motor 57 through a reduction gear train 58. The shaft 50 and consequently the disc 49 is rotated continuously in the direction of the arrow adjacent disc 49. Also secured upon shaft 50 are a pair of switch cams 59 and 60. Cam 59 is adapted to cooperate with a switch blade 61 which, in turn, is adapted to be moved into engagement with a contact 62. The cam 59 is provided with a toe portion 63 which upon engaging the cam follower of switch blade 61 causes the same to move into engagement with contact 62. The cam 60 is adapted to cooperate with switch blade 64, which in turn is adapted to engage a contact 65. The cam 60 is provided with an elongated raised portion 66 which upon engaging the cam follower of switch blade 64 causes the same to be moved into engagement with contact 65 against the bias of blade 64.

Driven by shaft 50, at certain times in the operation of the system, is a second shaft 70, which shaft is supported by suitable bearings 71 and 72. Secured to shaft 70 is a disc 73 which has secured thereto a pulley member 74. Secured to the pulley member 74 is a cable or other similar device 75, which is secured at its lower end to the potentiometer arm 20. A spring 76 is also secured to arm 20, being secured at its lower end to a rigid support 77. When shaft 70 is rotated in a clockwise direction, the cable 75 is wound up on pulley 74 and moves arm 20 upwardly along the resistance 19 against the biasing action of spring 76. Located along the outer periphery of disc 73 are ratchet teeth 78 which cooperate with a pawl member 79 secured to a solenoid core 80. Cooperating with the solenoid core 80 is a solenoid winding 81, which when energized moves core 80 and consequently pawl member 79 out of engagement with the ratchet teeth 78. As will be more apparent from the accompanying description, the switch consisting of switch blades 61 and 62 controls the energization of solenoid 81.

As indicated earlier the shaft 50 is operative during certain portions of the operation to drive shaft 70. A magnetic clutch, generally indicated by the reference character 85, serves to control the connection between the shafts 50 and 70. This clutch consists of a collar member 86 which is slidably secured to shaft 50. The collar 86 is held against rotation on shaft 50 by a spline 87. Collar 86 is provided with a projecting arm 88 which is adapted to engage an arm 89 secured to and projecting from shaft 70. Controlling the position of collar 86, which is of magnetic material, is an electromagnet consisting of a core 91 and a winding 92. When the electromagnet is energized, the collar 86 is drawn towards the left into engagement with the core 91, so as to cause arm 88 to be moved out of the path of arm 89. When the electromagnet is deenergized, a spring 93 is effective to move collar 86 towards the right so that arm 88 is in the path of arm 89.

The energization of the electromagnet 91 is controlled by the photo-electric cell 54 through a suitable amplifier 95. The photo-electric cell is connected to the amplifier by conductors 96 and 97. Power is supplied to the amplifier 95 from the secondary 32 through conductors 98, 99, 100, and 101. The output terminals 103 and 104 of the amplifier 95 are connected to the electromagnet winding 92 by conductors 106 and 107. It will be understood that whenever the angular positions of discs 37 and 49 coincide, light will be received by photo-electric cell 54, which when amplified causes the energization of the electromagnet and consequent disengagement of the clutch 85.

The switch consisting of switch blades 64 and 65 controls the energization of the proportioning motor 11. During certain periods of the operation, power is supplied to the proportioning motor and when this is done, the position taken by the motor is determined by the then position of arm 20. During the times that the switch blade 64 is separated from contact 65, thus removing power from the proportioning motor 11, the position of arm 20 of potentiometer 18 has no effect on the proportioning motor 11 and the valve 10 remains in the position to which it was last moved by the motor.

Operation of Figure 1 species

The various elements in this system are shown in the position they occupy at the beginning of the cycle wherein shaft 70 is rotated by shaft 50. In this position the clutch 85 is engaged, the solenoid winding 81 is deenergized so that pawl 79 engages the ratchet teeth 78, and switch 64 is disengaged from contact 65 so that no power is supplied to the proportioning motor 11. The rotation of shaft 50 in a clockwise direction, under these circumstances, will cause a clockwise rotation of shaft 70 and a clockwise rotation of disc 73. This rotation of disc 73 is effective to wind the cable 75 upon the pulley 74 and to move arm 20 upwardly of the resistance as previously explained. All during this movement of arm 20, it exerts no control whatsoever over proportioning motor 11 due to de-energization of the latter. When the disc 49 reaches a position corresponding to that of disc 37 so that the light polarized by disc 37 is able to pass through disc 49, the photo-electric cell 54 is illuminated and the current passed thereby is amplified through amplifier 95 to cause energization of the electromagnet winding 92 so as to disengage the clutch 85. Although this disengagement of clutch 85 continues only so long as the photo-electric cell 54 is illuminated, it will continue sufficiently long to allow arm 88 to pass the arm 89. In view of the fact that the pawl 79 prevents reverse rotation of shaft 70, the position of shaft 70 will remain fixed until solenoid winding 81 is energized. Consequently, in spite of the fact that collar 86 is subsequently allowed to move back to the right upon deenergization of the electromagnet, the rotation of shaft 50 will have no effect upon the

position of shaft 70 until arm 88 again engages arm 89, which will be at the end of the cycle.

After the shaft 50 has completed substantially 180° of rotation, the cam follower of switch 64 engages the raised portion 66 of cam 60 causing switch blade 64 to be moved into engagement with contact 65. When this takes place, the power is supplied to proportioning motor 11 through the following circuit: from secondary 32 through conductors 98 and 110, switch blade 64, contact 65, conductor 111, motor 11, and conductor 112 to the other terminal of secondary 32. As soon as power is supplied to the motor in this manner, the motor starts to move to assume the position corresponding to the position of arm 20, if it does not already assume such a position. The raised portion 66 of cam 60 extends throughout over 120° of the cam surface and the speed of rotation of cam 60 is sufficiently slow so that during the time required for the cam 60 to move through this amount of its rotation, the motor 11 is able to move valve 10 to the position corresponding to a position of arm 20.

Shortly after the cam follower of switch blade 64 passes off the raised portion 66 of cam 60, the toe 63 of cam 59 engages the cam follower of switch blade 61 and causes the latter to engage contact 62. When this happens, an energizing circuit is established to solenoid winding 81 as follows: from secondary 32 through conductors 98, 110, and 115, switch blade 61, contact 62, conductor 116, solenoid winding 81 and conductors 117 and 101 to the other terminal of secondary 32. As soon as this circuit is established, the winding 81 is energized, which as previously explained, causes pawl 79 to be moved upwardly out of engagement with the ratchet teeth 78. When this occurs spring 76 is effective to rotate disc 74 and consequently shaft 70 in a counterclockwise direction, at the same time moving potentiometer arm 20 downwardly. This downward movement continues until arm 89 engages shaft 88. After sufficient time has elapsed to permit the return of disc 73 to the starting position, switch 61 moves out of engagement with the toe portion 63 of cam 59 so as to separate from contact 62 and open the circuit to solenoid winding 81. When this occurs the elements are again in the position shown in the drawing, whereupon the cycle is repeated.

It is to be understood that the knob 42 is actuated whenever it is desired to change the position of valve 10. By changing the position of knob 42, the angular position of disc 37 is changed. This in turn results in a change in the angular position of disc 49 at which light is passed to the photo-electric cell 54 to effect the disengagement of clutch 85 and to thus terminate adjustment of arm 20. This system is a particularly desirable one wherever it is necessary to have the controller in a position relative to the controlled object wherein it is undesirable or impracticable to run wires of any kind. The system has the advantage over other systems based solely upon the intensity of a light beam transmitted to a photo-electric cell that the operation is not affected by small variations either in the intensity of the source of light or in the loss of intensity in transmission through the intermediate medium.

Species of Figure 2

In Figure 2 there is shown an application of the present system wherein it finds particular utility. In the arrangement of Figure 2, the system is used for maintaining constant the concentration of a sugar solution. It is well known that a sugar solution has the property of rotating the plane of polarization of polarized light passed therethrough. By transmitting the light polarized by disc 37 through a sugar solution and causing the position of a controlled valve to be varied in accordance with the amount of rotation of the plane of polarization of the light and its passage through the sugar solution, it is possible by employing the valve to control the concentration of the sugar solution to maintain a substantially constant concentration. The similar elements of the apparatus have been indicated by corresponding reference numerals in the two figures. In this species as in the preceding species, a lamp 35 constitutes the source of light and the light furnished thereby is passed through a lens 47 to disc 37 of suitable polarizing material such as "Polaroid." A knob 42 is similarly provided for adjusting the angular position of the polarized disc 37. In this case, the scale 45 with which the pointer 44 of knob 42 cooperates, is calibrated in units of concentration of the sugar solution.

The sugar solution is contained in a receptacle 150 which is provided with windows 151 and 152. The polarized light transmitted through disc 37 passes through window 151, the sugar solution 154 in the receptacle 150, and the window 152 to the second polarized disc 49. When the angular position of disc 49 corresponds to the angle of the plane of the polarization of the light leaving the sugar solution, the light passes through disc 49 and lens 55 to the photo-electric cell 54. The valve 10, in this species, is employed to control the flow of water through a pipe 155 into a receptacle 150. A pipe 156 also leads into the receptacle 150, this pipe leading from a container of a relatively concentrated sugar solution. Connected to the upper end of container 150 is an outlet pipe 157 which serves to convey the sugar solution away to a suitable point of storage or utilization. The concentrated sugar flows through pipe 156 at a more or less uniform rate so that by suitable variation of the valve 10, which controls the flow of water to the solution, it is possible to vary the concentration of the solution 154.

In the operation of this system the knob 42 is turned to a point corresponding to the desired concentration of sugar. The apparatus is initially adjusted so that with this setting of knob 42 and consequently disc 37, the position assumed by valve 10, as a result of the control exerted thereon by disc 49 will be such that just enough water is passed to the container 150 to maintain the concentration of the sugar solution 154 at the desired value. As soon as the sugar solution changes in concentration, the angle of rotation of the plane of polarization caused by the light passing through this solution 154 will be changed so as to cause a corresponding change in the position of valve 10. This change in the position of valve 10 will cause more or less water, as needed, to be supplied to the solution 154 to restore the concentration to the desired value.

It will be seen that I have provided an apparatus for remotely controlling an object which is ideally adapted to the situation wherein the remotely controlled object is in a location where it is undesirable to extend wires to the controller and the controlled object. It will also be seen that this system has the advantage that it does not depend upon the intensity of a light beam but rather solely upon the rotation of the plane

of polarization which is unaffected by normal transmitting mediums such as air. It will further be seen that the system in question is ideally adapted to the control of the constituency of a medium which varies the angle of polarization of polarized light in accordance with the constituency thereof.

While I have shown a specific embodiment of my invention for the purpose of illustration, it is to be understood that the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In combination, an object to be positioned, motor means for positioning the same, a source of light, means for polarizing said light, means for varying the angle of polarization, and means responsive to the angle of polarization of said light for controlling said motor means and operative to cause the same to drive said object to a position proportional to the angle of polarization of the light.

2. In combination, an object to be positioned, motor means for positioning the same, a source of light, means for polarizing said light, means for varying the angle of polarization, means in the path of said polarized light capable of passing said light only when disposed at an angle corresponding to the angle of polarization of said light, means for changing the angular position of said last named means until it passes light, and means controlling said motor means to cause the same to drive said object to a position corresponding to the position of said means in the path of the polarized light.

3. In combination, an object to be positioned, motor means for positioning the same, a source of light, a member of polarizing material located in the path of said light, means for varying the angular position of said member, and means responsive to the angle of polarization of the light passing through said member for controlling said motor means and operative to cause the same to drive said object to a position proportional to the angular position of said member.

4. In combination, an object to be positioned, motor means for positioning the same, a source of light, a first member of polarizing material located in the path of said light, means for varying the angular position of said member, a second member of polarizing material located in the path of light polarized by said first member, means for changing the angular position of said last-named member until the polarized light is passed by said member, and means controlling said motor means to cause the same to drive said object to a position corresponding to the position of said second member of polarizable material.

5. In combination, an object to be positioned, motor means for positioning the same, a source of light, a member of polarizing material located in the path of said light, means for varying the angular position of said first member, a second member of polarizing material located in the path of the light polarized by said first member, means for changing the angular position of said last named member, a controller, means operatively connecting said controller and said last named member of polarizable material until the polarized light is passed by said member, means operative thereupon to render said connecting means ineffective, and means associated with said third mentioned means operative subsequent to the disconnection of said connecting means to cause said motor means to move said object to a position corresponding to the position of said controller.

6. In combination, an object to be positioned, motor means for positioning the same, a source of light, a member of polarizing material located in the path of said light, means for varying the angular position of said first member, a second member of polarizing material located in the path of the light polarized by said first member, means for continuously changing the angular position of said last named member, a controller, means effective to periodically operatively connect said controller and said last named member of polarizable material until the polarized light is passed by said member, means operative thereupon to render said connecting means ineffective, and means associated with said third mentioned means operative during periods following said periods of operative connection between said controller and said second named member of polarizable material to move said object to a position corresponding to the position of said controller.

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