April 23, 1935. C. WILHJELM 1,999,027

AUTOMATIC CONTROL SYSTEM

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Fig. 1.

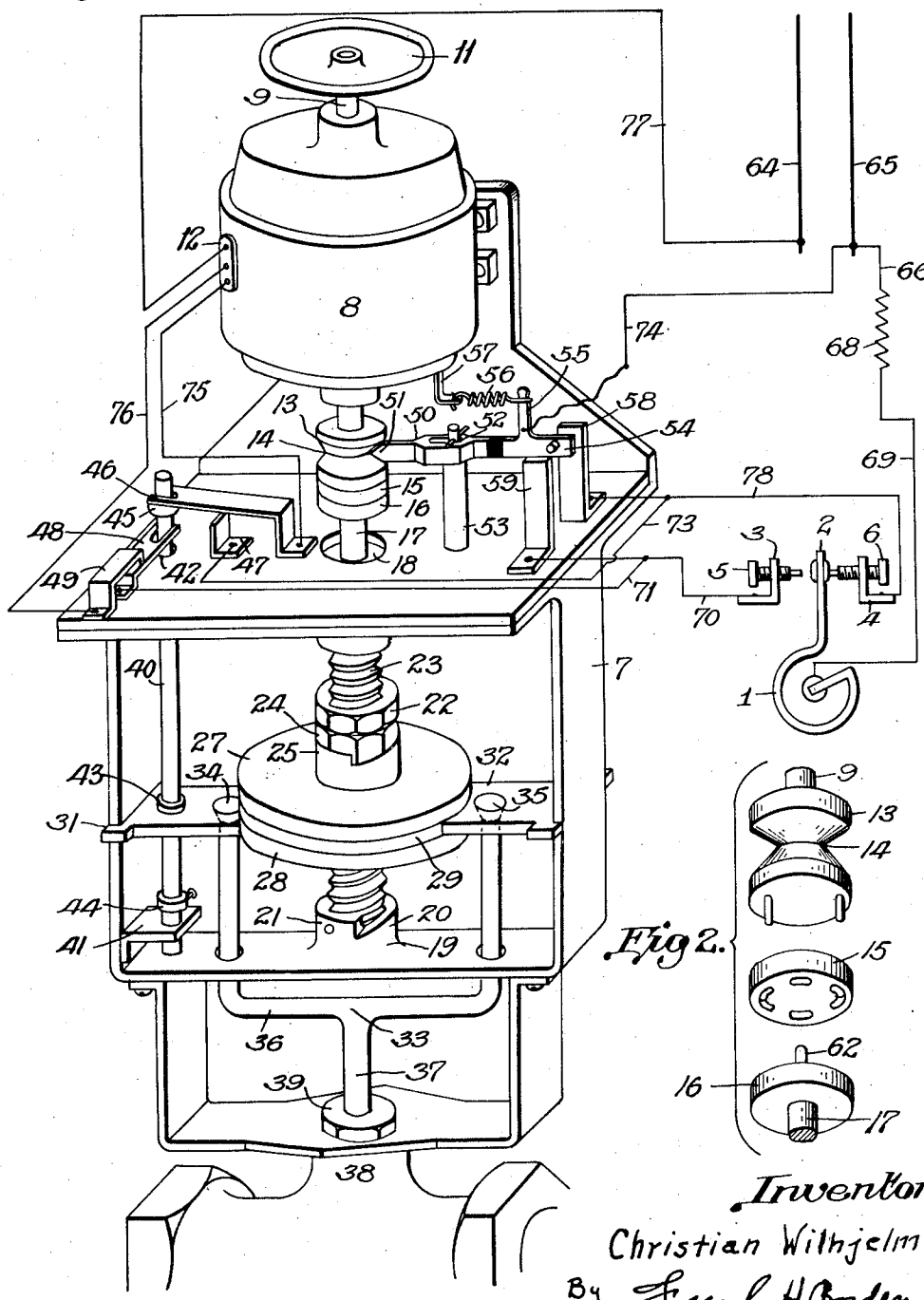


Fig 2.

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AUTOMATIC CONTROL SYSTEM

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4 Claims. (Cl. 192—141)

The general object of this invention is to provide an improved mechanism for operating automatically any kind of valve damper and the like, simply by alternate making of two very faint electric contacts made by thermostats, their equivalents or any other type of electric contact maker—automatic or hand operated.

There are numerous such devices on the market at this time, but they all have several or all of the draw-backs here enumerated: That the current required to function them is too great for the light contacts in the actuating instruments or switch and therefore intermediate relays are required, that if the thermostat contacts do not make firmly and long enough the operation of the mechanism becomes intermittent, causing the destructive sparking at the actuating contacts, unless special holding-in relays are used. That their reliability is questionable because the greatest power is required when starting the operation just when little or no power is available. This is very undesirable as it so happens that valves and dampers as a general rule, take considerably more power to lift off the closed position than it does to bring them into that same position, also a general defect is that in practice it is almost impossible to get any of the devices now on the market to operate fast and then stop at definite fixed limits, regardless of differences that always will exist in the power required for a given operation. The invention here described overcomes all these major defects with present day devices in this same category and it has numerous other advantages of importance all of which will be disclosed in the description below:

In the accompanying drawing, forming part of this description Fig. 1 represents a diagrammatic perspective of one purely illustrative form of the invention.

Fig. 2 represents a perspective view of the clutch parts forming a connection between the driving motor and the driven parts.

In the drawing Fig. 1 is a complete disclosure of my invention. For the purpose of simplicity, a simple coiled piece of thermostatic metal is shown as the actuating member operating between two fixed contacts. This is a standard, well-known commercial article and no further explanation should be required as to its function in the combination. Any other substitute for this device should be construed as a mere equivalent.

I have elected to use a reversible series wound electric motor as the power transmitter. In this description it is a motor having a double set of field windings so that it can readily be reversed in rotation by sending the current in through one or the other field. No attempt is made to describe the details of this motor as it is a well known commercial article. Any other power generator substituted for this motor should be considered its equivalent in this invention.

As the operated element in this combination I have shown a simple standard globe type valve, having an inlet and an outlet and a movable valve member operative by the device described below. This valve is not further described in detail and may be substituted with any device whatsoever requiring to be moved within definite limits in response to the closing of alternate electric circuits without carrying the combination outside of the bounds of the spirit of the invention or the scope of the claims set forth.

For the purpose of the explanation, the different parts in the drawing are numbered from 1 and up as follows: 1 is a bi-metallic piece of metal that will move left in a dropping temperature and right in a rising temperature. 2 is a double contact of suitable contact metal at the end of part 1. 3 and 4 are contact brackets carrying respectively contact screws 5 and 6. 7 is a suitable metal frame designed to form a support for all the parts of the operating mechanism. Where electric contacts and wires are supported by the frame 7, suitable insulation is provided for. 8 is the motor frame containing all the standard electric motor parts not shown except for the shaft 9. The motor is clamped to the frame 7 with screws right and left. The motor shaft 9 extends above the motor and on it is fastened a handle 11, for the purpose of operating the device by hand. There is a hole in the motor frame 12 through which the electric wires pass. The motor shaft extends through the bottom end of the motor frame and on it is fastened a round disc, the outer face of this disc being shaped as a V groove 14. This disc 13, the leather washer 15 and the disc 16 forms a flexible drive connection to the shaft 17 shown in detail in Fig. 2. The shaft 17 extends through a bearing 18 in frame 7; the lower end of the shaft 17 terminates in this bearing. That section of shaft 17 in between bearing 18 and 19 is threaded. On the lower end of this threaded section is a special bushing 20, firmly pinned to the shaft 17. This bushing is cut with a notch on its upper face. On the upper section of the threaded part of shaft 17 are two nuts 22 and 23, cut with the same thread as shaft 17. Nut 22 has a notch 24 on its under face, similar to the notch 21 in collar 20. The nut 22 only serves as a convenient means of locking nut 24 in place on shaft 17, without marking up the thread of the shaft with set screw marks or the like. In between the collar 20 and the nut 22 is a special nut 25. Both ends of this special nut have a notch, equal to the notch 21 and 24. Only the upper notch is shown in the drawing numbered 26 and it is shown engaging the nut 24. It is evident that if the shaft

17 is turned clockwise with nut 22 locked in place, the nut 25 must rotate with the shaft. If, however, the shaft 17 is rotated counter clockwise and the nut 25 is retarded in its free rotation, it will move downward, until its under notch not shown engages notch 21, in which position the nut 25 will be compelled to rotate with the shaft 17 in counter clockwise direction so long as shaft 17 continues to move in that direction. On nut 25 is permanently fastened two discs 27 and 28. There is a space between these two discs into which is fitted a washer 29 having its thickness somewhat less than the space between these two discs, the center hole of the washer slightly larger than the diameter of nut 25. The washer 29 has two guiding supports 31 and 32 which by engaging the sides of frame 7 prevent it from rotating with the nut 25 and only permits up and down motion of 29.

A fork shaped member 33 has its two ends riveted to either side of washer 29 respectively at 34 and 35. At 36 this fork shaped member 33 is fastened to the valve stem 37 which operates the valve seat in valve 38. The valve 38 is clamped in permanent position to frame 7 by nut 39.

A shaft 40 is supported by a bearing at 41 and 42. This shaft has two bushings 43 and 44 that can be adjusted up and down by set screws to suit the travel of 31. The shaft 40 terminates in bearing 41 at its lower end, but extends through bearing 42 with its upper end. On this upper end is fastened an insulated collar 45. The operating relationship here being that the two collars 43 and 44 are set slightly short of the up and down travel of washer 29 so that at either extreme position, the position of the collars 43 and 44 will push the shaft 40 a small distance up or down respectively. This up or down motion will be transmitted through shaft 40 to the insulated collar 45 and in the up movement the collar 45 will engage the flexible contact 46 and break its contact with contact bracket 47; normally these two contacts will be together. At the extreme down movement, collar 45 will engage contact arm 48 and break its normal contact with contact bracket 49.

Going back to disc 13 on the lower part of the motor shaft, there is a switch member 50 engaging the V-groove 14 by its V-shaped end at 51. This switch arm has an elongated hole 52 by means of which it is supported and guided by the stud 53. This switch arm 50 carries an insulated double contact 54 at its outer end, it also has an extension 55, which serves as a support for the spring 56 fastened to the motor 8 by means of the insulated bracket 57. This spring holds the V-shaped end 51 of switch arm 50 against the V in disc 13 with a permanent tension, this being possible on account of the elongated hole 52. Right and left movement of the switch arm 50 is restricted by the two contact brackets 58 and 59. The operation of this assembly is as follows: If the motor shaft 9 moves in an anti-clockwise direction, the V—51 on the switch arm 50 will jam in the V—14 on disc 13, resulting in a clockwise movement of the left end of arm 50, until its right end hits contact bracket 59. It is evident that so long as the anti-clockwise movement of shaft 9 continues and while this movement stops, the spring 56 maintains switch arm 50 in engagement with contact bracket 59. If, however, now the shaft 9 is rotated in a clockwise direction, the V at 51 on switch arm 50 will again jam in the V on disc 13 and be carried back to the position shown in the drawing while the outer end of the arm 50 will flop over against contact bracket 58 and remain there while the clockwise movement of shaft 9 continues and until a motion in a counter-clockwise direction of shaft 9 takes place.

Fig. 2 shows the clutch assembly between the motor shaft 9 and the shaft 17. The disc 13 has in addition to the V-groove 14, two pins 60 and 61. These pins are placed at 180° to each other. The same is the case with the two pins 62 and 63 on disc 16. The leather washer 15 has four elongated holes at 90° angle to each other, so that when assembled as shown in Fig. 1, the two pins on disc 13 fit two opposite holes in the leather washer and the two pins on disc 16 fit into the two remaining holes in the leather washer, thereby establishing a flexible shaft power transmission from the motor to the valve operating mechanism. This is not an entirely new method of flexible power transmission except for the elongated holes that permit a few degrees movement of the motor shaft, before it begins to transmit power and gets a load to pull. This lost motion in the clutch should be large enough to permit the disc 13 to rotate sufficiently to throw switch 50 into its opposite direction before it begins to move the mechanical parts of this device as well as the valve. The advantages of this feature will be further explained below.

The electrical wiring as shown in Fig. 1 consists of a pair of supply wires, a connection from line 65 to thermostat 1 through resistor 68 wire 69. There is a connection from contact bracket 3 through wire 70 to contact bracket 59. There is also a wire 71 connecting bracket 59 to contact 48. Contact bracket 4 is connected to contact bracket 58 by wire 78 and bracket 58 connects to contact 47 by wire 73. Wire 74 connects switch arm 50 to line 65. Contact 49 is connected through wire 76 to the motor field that will run the motor in a counter clockwise direction, looking down on the motor. The contact 46 is connected to the field that will run the motor in a clockwise direction through wire 75. To complete either of the two circuits through the motor, wire 77 runs from the one side of the motor armature to line 64.

The operation is as follows: If the temperature increases where thermostat 1 is located, it will move left and make contact 2 and contact screw 5, thereby establishing the following electric circuit:

Line 65 wire resistor 68 wire 69, thermostat 1, contact 2, contact screw 5, bracket 3, wire 70 wire 71 contact 48 to contact 49, as these contacts are free to close, then further through wire 76 through one motor field the motor armature and then through wire 77 back to other line 64. This circuit is reduced in strength by the resistor 68 and is just strong enough to turn the motor shaft in a counter clockwise direction but not strong enough to pull the rest of the apparatus, however, due to the elongated holes in the leather washer 15, this faint current will move the shaft a fraction of a turn. In so doing the V-shaped part of switch arm 50 will grip in the groove of disc 13 and be carried with it until the opopsite end of the switch arm 50 snaps over against contact 59. As this takes place, another circuit is established from line 65 to line 74 switch arm 50 contact 54 bracket 59 wire 71, contacts 48, 49 and wire 76 through motor line 77 and back to line 64, exactly like the first explained circuit, except that this new addition to the circuit short circuits the resistor 68 and the thermostat con-

tacts, thereby performing two functions of importance as follows:

First shorting out of the thermostat contacts 2 and 5 eliminates any continued sparking at these contacts after the first light touch that caused enough current to pass to shaft switch arm 50. Second, the resistor 68 which is in the circuit to cut down the current through the contacts, when shorted out will permit the full current to pass through the motor, thereby causing further movement of the motor beyond the lost motion in the leather disc 15 at full power. This further movement at full power of the motor will transmit the counter-clockwise movement to shaft 17 and in so doing the nut 25 will get a downward movement and clamp its upper disc 27 against the washer 29, thereby transmitting the downward motion to the valve stem 37 through the fork 33. The more power it requires to move the valve stem, the more friction there will exist between the disc 27 and the washer 29 within the friction capacity of these surfaces. As this whole assembly from nut 25 to valve stem 37 moves downward, the adjustments should be made so that arm 31 hits collar 44 slightly before or just when the nut 25 engages notch 21 on collar 20 at the bottom. As the nut 25, hits notch 21 the nut and discs 27 and 28 are forced to turn with the shaft 17, stopping any further downward movement of these parts and all the above mentioned parts connected with them and consequently the valve stem will not be forced even the slightest amount further, regardless of the further running or drifting of the motor and shaft 17. The pushing down of 31 on collar 44 results in a downward movement of shaft 40 which in turn shifts the insulated collar 45 down against contact 48, thereby breaking the established circuit through these contacts so that the motor will stop its counter-clockwise movement; at the same time it releases contact 46 so it makes contact with 47, thereby putting the mechanism in position to be operated into its other position, the position in which it is shown in Fig. 1.

If now the medium of flow through the valve 38 has caused the condition to change so that the thermostat 1 makes contact between 2 and 6, the electric circuit will be established as follows: from line 65 resistor 68 wire 69 thermostat 1 contact 2 and 6 bracket 4 wire 78 wire 73 contact 47, 46 wire 75 through clockwise motor field, motor armature wire 77 back to line 64. This faint current limited by resistor 68 as before is just enough to operate the motor slightly clockwise in its free motion permitted by the elongated holes in leather disc 15. This slight motion will swing switch 50 back into the position shown in Fig. 1 in which position it completes the circuit line 65, wire 74 contact arm 54 contact bracket 58 and wire 73, whereby a short cut around the resistor 68 and theremostat 1 again is established so that full power is available through the motor to turn the shaft 17 in a clockwise direction. This motion will cause the nut 25 to shift upward pressing disc 28 against the washer 29, causing friction which prevents its rotation with shaft 21 so long as the upward movement continues. In this upward motion of the nut, all of the parts 29 to the shaft 37 will follow upward as they did in the downward movement described above. As the motor continues operation, the nut 25 eventually reaches the upper limits established by notch 24. As nut 25 hits notch 24, it is forced to rotate with the shaft 17 and any further upward motion of it and the valve operating parts attached to it is stopped. Just a little before this happens, however, the arm 31 hits collar 43 and moves shaft 40 upward which in turn lifts collar 45 and which then lifts contact 46 from its connection with contact 47 thus breaking the circuit through them that caused the clockwise movement of the motor. In lifting contact 46, collar 45 releases contact 48 so it will close contact with contact 49, thus placing the equipment back in the position shown in Fig. 1 in which position it is ready for an impulse to close the valve.

I have above clearly described the elements comprising this invention and their different functions as well as the advantages derived from this novel combination. This has all been done in a specific manner for simplicity in explanation but in practice I intend to utilize the features of this invention with freedom in the use of equivalent elements for parts or combination of parts here shown and described.

What I claim as my invention is:—

1. A control system comprising a power supply, a mechanism operable from said power supply in alternate directions, means for transforming such motion into rotary motion, a threaded shaft operated by said rotary motion, bearing supports for said rotary shaft, a nut on the shaft, frictional means for restricting the rotary motion of said nut when the threaded shaft revolves whereby the nut will move longitudinally with the shaft, a controllable member operably connected to said nut whereby the longitudinal movement of the nut causes said member to move and means overcoming the frictional means and causing rotary motion of the nut operative when the predetermined limit has been reached whereby the nut ceases to move longitudinally with the shaft and the controllable member stops at a predetermined limit.

2. A control system comprising a power supply, a mechanism operable from said power supply in alternate directions, a translatory member to be controlled by said mechanism, a mechanical limiting means between said mechanism and said member to be controlled whereby further motion of the member to be controlled is prevented while the mechanism continues indefinitely to function without being subjected to additional strain.

3. A control system comprising a power supply, a mechanism operable from said power supply in alternate direction, a translatory member to be controlled by said mechanism, a friction limiting device between said mechanism and said member to be controlled and means independent of the member to be controlled for making the friction limiting device function when the desired movement of the member to be controlled has been attained.

4. A control system comprising a rotatable threaded shaft, means arranged for selectively rotating the shaft in either direction, a controlled device having a part reciprocable substantially parallel with the long axis of the shaft, means defining longitudinally spaced limits of motion for said part, means threadably engaging the shaft and non-rotatable on the shaft between said limits, said means arranged for rotation with said shaft when either limit is reached by said part, whereby continuation of rotation of the shaft is ineffectual to move said part after said limit has been reached.

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