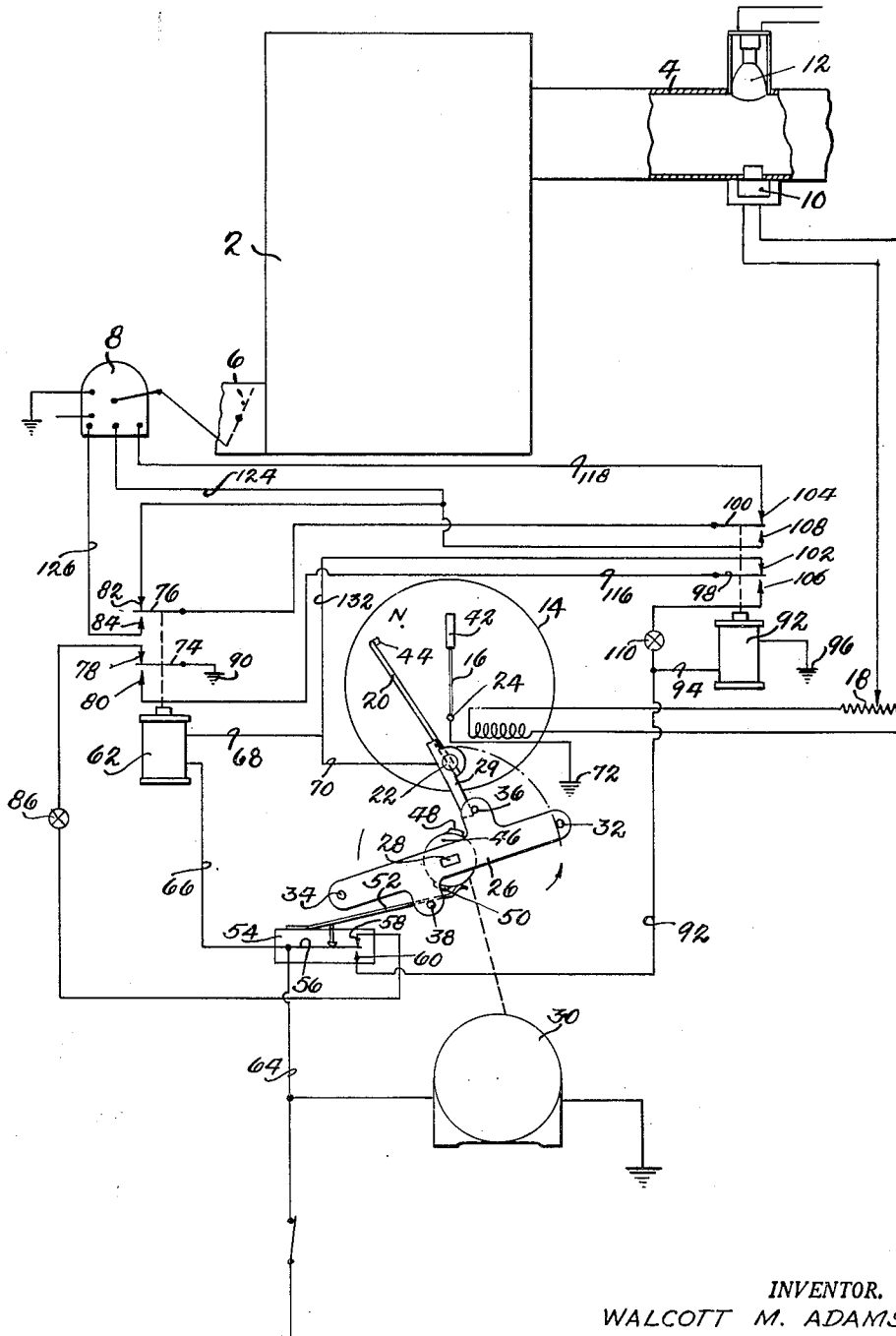


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W. M. ADAMS

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MECHANISM FOR VARYING THE SETTING OF AN OBJECT IN
ACCORDANCE WITH CONDITIONS AS ESTABLISHED
BY THE SETTING OF THE OBJECT
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INVENTOR.
WALCOTT M. ADAMS
BY *James G. Reineck*
ATTORNEY

UNITED STATES PATENT OFFICE

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MECHANISM FOR VARYING THE SETTING
OF AN OBJECT IN ACCORDANCE WITH
CONDITIONS AS ESTABLISHED BY THE
SETTING OF THE OBJECT

Walcott M. Adams, New York, N. Y.

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My invention relates to mechanism for varying the setting of an object in accordance with conditions as established by the setting of the object adapted to control any function where the effect can be indicated electrically, pneumatically, hydraulically or by gravity.

More specifically my invention provides control mechanism so constructed and arranged as to be automatic in operation, in that any departure from normal will be indicated and instrumentalities will be set into operation to restore conditions to normal, the speed of correction being proportional to deviation, with no dead zone and with no shift in control point.

As an illustration of one application of my invention and for clarity of description, but not by way of limitation I will describe my invention as applied to boiler or furnace air flow control.

The single figure of the drawing is a diagram illustrating an air flow control embodying my invention.

Referring to the drawings in detail, 2 designates a boiler equipped with damper 6, which in the illustration hereinafter described is the object the setting of which is to be varied. This damper is adapted to be rotated in one direction or the other toward opened or closed position by a geared down reversible damper motor 8.

10 designates a light-responsive element such as a photo-electric cell positioned in an opening provided for that purpose in the flue 4, while the exciter lamp 12 for the cell is positioned in an opening in the flue 4 diametrically opposite the cell. By this arrangement the denser the haze in the flue gases the smaller is the amount of light falling upon the light-responsive element 10, and the clearer the haze in the flue gases the greater is the amount of light falling upon 10.

14 designates an indicator, herein shown as a microammeter, the movable element or needle of which is designated 16. This indicator is connected electrically to the light-responsive element 10 so that the needle 16 indicates haze conditions in the flue 4.

18 is a potentiometer for adjusting the current passing through the winding of indicator 14 to provide for initial setting of the equipment so that when desired haze conditions exist in flue 4 the needle 16 will stand at the neutral or control point N on the scale of the indicator. As will be brought out hereinafter, the position of the neutral point N on the indicator dial varies with different installations.

The indicator 14 is equipped also with a driven

element or striker 20 which is pivoted at 22, which is offset with respect to the pivot 24 of the needle 16 as will be seen from the drawings.

The striker 20 is moved back and forth across the face of indicator 14 by striker-actuating bar 26 which is pivoted at 28 and driven by constantly rotating motor 30.

The striker-actuating bar is provided with two pins 32 and 34, one at each extremity of the bar. These pins are equidistant from the axis of rotation 28 of the bar and are adapted to engage a cam 29 which is attached to the striker and extends above and below the pivotal point 22 thereof. The striker actuating bar is also provided with pins 36 and 38 intermediate the pins 32 and 34 set equidistant from axis of rotation 28, but nearer this axis than the pins 32 and 34. The pins 36 and 38 are adapted to engage the cam 29 of the striker below the pivotal point 22 thereof.

From the description thus far given it will be seen that with the striker actuating bar 26 rotating in the direction of the arrows on the drawings, the pins carried by the bar will engage the cam 29 in the following order: 36, 32, 38 and 34. By reason of the fact that the pins 36 and 38 engage the cam 29 below the pivot 22 of the striker, and the pins 32 and 34 engage this cam above the pivot 22, the striker will be swung back and forth across the dial of the indicator 14. It will be understood that this operation is continuous, the circuit of the motor 30 always being closed.

The tip of the indicator needle 16 is equipped with a metal sleeve 42 while the tip of the striker 20 is equipped with a permanent magnet 44. Consequently as the striker sweeps across the indicator it will carry the needle with it. Under certain conditions the striker and needle carry current, and by providing the magnetic arrangement just referred to, chattering of the two members and arcing are prevented. By offsetting the pivots for the striker and indicator the striker magnet moves upwardly of the needle 45 at either side of central position. This provides a wiping action and a more certain contact between striker and needle, and also a means for disengaging the magnetic contact at the end of the back stroke as the magnet slides off the sleeve 42 allowing the needle to swing free.

The object of this arrangement, as will appear more fully hereinafter is to effect operation of the motor 8, in one direction or the other, when the needle 16 of the indicator is in other than neutral or normal position. When the indicator

needle stands at neutral N, flue conditions are normal and member 6 should not be adjusted. Any other position of the needle indicates either an abnormal or subnormal condition, the flue gases being either too dense or too clear, requiring that the damper be moved toward opened position or closed position as the case may be.

The bar 26, hereinabove referred to as the striker-actuating bar, has a function other than actuating the striker arm 20. As will be seen from the drawing a cam 46 is mounted on the axis of rotation of the bar. This cam is provided with rises 48 and 50 set 180° apart. The cam is adjustably mounted to permit of initial setting to suit varying conditions. Extending into the path of the rises 48 and 50 of the cam, so as to be depressed thereby as the cam rotates, is the free end of a switch-actuating spring-arm 52. The other end of this switch-actuating arm is anchored adjacent a switch 54 comprising a spring-contact arm 56 and cooperating fixed contacts 58 and 60. The contact arm 56 is arranged to deflect itself into engagement with a fixed contact 58 when the switch-actuating arm 52 is riding upon either of the two dwells of the cam 46, and to be deflected by the arm 52 into engagement with a fixed contact 60 when the switch-actuating arm 52 is deflected by either of the two cam rises 48 and 50.

62 designates a control relay the circuit to the coil of which is adapted to be closed when the striker 20 is in engagement with the indicator needle 16.

The relay 62 controls two spring switch arms 74 and 76. With the relay-deenergized these switch arms spring into engagement with fixed contacts 78 and 82, respectively. Energizing of the relay coil pulls these arms out of engagement with the contacts mentioned and into engagement with the fixed contacts 80 and 84, respectively.

I find it desirable under some conditions to employ signal lamps with my control, one of which is shown at 86 and one function of the relay 62 is to control the circuit of this lamp.

92 designates another relay the circuit of which is closed when the arm 56 of switch 54 is closed on contact 60 due to depression of switch-actuating arm 52 by cam 46.

This relay when energized is adapted to actuate spring switch blades 98 and 100 into engagement with fixed contacts 106 and 108, respectively.

With the relay de-energized these blades engage fixed contacts 102 and 104, respectively.

110 designates another signal lamp which may be employed, the circuit of this lamp being closed when switch arms 74 and 98 are in engagement with contacts 80 and 106, respectively due to both relays 62 and 92 being energized.

The relays 62 and 92 have a further and more important function, namely to control the direction of rotation of the reversible damper motor 8.

Normal

Let it be assumed first of all that proper haze conditions exist in the flue 4. In other words normal conditions exist, in which event the indicator needle 16 will stand at neutral point N and while the striker 20 is moving back and forth across the dial of the indicator because of the constantly rotating motor 30, there should be no operation of the damper-control motor 8 nor should either of the lamps 86 and 110 be energized.

Under assumed conditions, with indicator needle at N, as the striker 20 starts on its movement to the right as viewed in the drawing, the rise 50 of cam 46 will depress the spring arm 52 to close switch arm 56 on fixed contact 60, which closes the circuit to the relay 92. This circuit may be traced from current source, conductor 64, switch arm 56, contact 60, conductors 92 and 94, relay 92 to ground 96. The circuit of the lamp 86 is open at contact 58 of switch 54, and that of lamp 110 is open at contact 80 of the switch controlled by relay 62, the circuit of this relay being open at tip of striker arm 44 and also open at contact 102 of the switch controlled by relay 92. The motor lead 118 of motor 8 is open at contact 104 of the relay 92, and the lead 126 of the motor 8 is open at contact 84 of the relay 62.

By the time the striker has moved into position to pick up the indicator needle 16 at N, the rise 50 of cam 46 has moved away from arm 56 allowing switch arm 56 to move out of engagement with contact 60 to open the circuit of relay 92, the switch arm 56 moving into engagement with fixed contact 58 so that a circuit is closed to lamp 86 through conductor 88 only as far as contact 78 which contact is open by action of relay 62 whose circuit is closed by contact of the striker 20 with the needle 16. This relay circuit may be traced by way of conductors 64 and 66, relay 62, conductors 68 and 70, striker arm 20 and indicator needle 16 to ground 72. Again there is no movement of motor 8, because common motor lead 124 is open at contact 82 of relay 62 and at contact 108 of relay 92.

When the relay 92 was de-energized and relay 62 was energized as just described, a holding circuit was established for the relay 62, which may be traced from current supply source conductors 64 and 66, relay 62, conductors 68, 132, contact 102, and switch blade 98 of relay 92, conductor 116, contact 80 and switch blade 74 of relay 62 to ground 90.

The striker will continue to carry the needle across the indicator dial to the end of the travel of the striker at the right hand end of the dial, at which point the striker is disengaged from the pin 36 or 38 as the case may be. Immediately the pin 32 or 34 engages the striker to return it to its original position to the left of the indicator dial, the indicator needle, due to magnet 44 is carried back across the indicator dial to a point beyond the scale, when, due to the different axes of the needle and striker, the magnet slides upward off the sleeve 42 allowing the needle to swing free. The relays remain in their described position, relay 62 energized and relay 92 de-energized until the striker arm returns to its starting position and depresses the switch-actuating spring arm 52.

The holding circuit above referred to serves two purposes. One function is to reduce to a minimum the arc between the striker and needle as they separate.

The other function of this holding circuit is to ensure that the circuit of the motor 8 will remain open after the needle and striker separate near the end of the back swing and to reset the relays simultaneously at the beginning of the next cycle without placing current on the motor 8.

Abnormal

Let us assume now that the indicator needle 16 is to the right of neutral N. Under this condition

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the haze in flue 4 is too dense, abnormal, so that it is desired to move the damper toward opened position and energize lamp 86 as the striker starts on its movement to the right, the rise of cam 46 will depress the spring arm 52 to close switch arm 56 on fixed contact 58, which closes the circuit to relay 92, by way of conductor 64, switch arm 56, contact 60, conductors 92 and 94, relay 92 to ground 96. This will break the contact of switch blade 98 with contact 102 thus breaking the holding circuit for the relay 62 at contact 80 and switch blade 74. There is no action of motor 8 at this moment in that motor lead 118 is broken at contact 104 and switch blade 100 of the switch controlled by the relay 92, which is now energized, while motor lead 126 is open at switch blade 76 and contact 84 of the switch controlled by relay 62. There are no lamps energized because circuit of lamp 86 is open at the contact 58 and switch blade 56 of the switch 54 and the circuit of lamp 110 is open at contact 80 and blade 74 of the switch controlled by relay 62. As soon as the striker passes the neutral point N on the indicator dial the riser of cam 46 will ride off the spring arm 52 permitting switch arm 56 of switch 54 to return into engagement with fixed contact 58, so that a circuit is now closed to the lamp 86. The circuit to relay 92 is broken at contact 60 and switch blade 56 of switch 54. The opening circuit of motor 8 is closed, at contact 104 and blade 100 of the switch controlled by relay 92 and at contact 32 and 76 of the switch controlled by relay 62, both relays at this moment being de-energized. This condition continues until the striker picks up the indicator needle. At this instant a circuit is closed to the relay 62, by way of conductors 64, 66, through the relay, conductors 68, 70, striker 20, indicator needle 16 to ground 72. This opens the circuit of lamp 86 and opens the circuit of the motor 8 at switch arm 76 and contact 82 of the switch controlled by relay 62.

This condition will continue until the striker has swung all the way across the dial of the indicator and back to its original position, and the needle of the indicator has returned to proper indicating position, it being seen that the holding circuit of the relay 62 is still maintained so that relay 62 remains energized even though the striker and indicator needle are no longer engaged.

After the striker has moved all the way across the indicator and returned to its initial position and the indicator needle has been released to return to indicating position, the cycle of operation just described will be repeated, assuming that haze conditions are still abnormal. On the other hand, should haze conditions during this cycle have been restored to normal, then the cycle of operation will be that above described under normal haze conditions.

It should be noted at this point that the motor 8 does not operate continuously under abnormal haze conditions, from the time that the needle 16 moves to position indicating abnormal haze conditions until the needle returns to neutral position indicating normal haze conditions. On the contrary, the motor 8 is operated intermittently, actually only during the time it takes for the striker to move from the neutral point N until it engages the indicator needle. This time varies of course depending upon the degree of abnormal density of the haze in the flue. The denser the haze the more the needle 16 is deflected and the longer the time required for the striker to engage the needle. This feature is of importance in

that it provides a movement of motor 8 for each cycle of operation which is proportional to the deviation of the needle 16, that is, the net speed of motor 8 (movement per unit of time) is proportional to deviation of 16. This avoids too much movement or overadjustment of the damper. For example, suppose that under the abnormal haze conditions assumed the circuit of the motor 8 remained closed throughout the time the indicator needle was off the neutral point. Under these circumstances it might very well be that the damper would have been opened to its maximum, whereas but a slight movement toward closed position would be required. In that case haze conditions would be subnormal, necessitating movement of the damper toward closed position, so that there would be constant overrunning of the motor 8, first in one direction and then the other, the net result of which would be that the damper never would be properly set. By arranging the control so that the damper is moved at a net speed proportional to deviation of the indicator needle this over-adjustment is avoided. It will be appreciated also that there is necessarily a lag between movement of the damper and a change in flue conditions, and that by arranging the control as described I overcome this lag, in that in effect I move the damper slightly toward open position and then wait until this effects a change in the desired direction in the haze conditions in the flue, before moving the damper further, which further movement, as a matter of fact, may or may not be necessary.

Subnormal

Now let it be assumed that the indicator needle 16 is to the left of neutral N, indicating too clear or subnormal conditions in the flue 4. Under these conditions it is desired to move the damper 6 toward closed position and to energize the lamp 110.

The striker starts to the right and switch arm 56 is depressed into engagement with contact 60, so that a circuit is closed to relay 92 and the holding circuit to relay 62 is opened. Consequently neither lamp at this moment is energized, and both leads of the motor 8 are open so that there is no motor action.

When the striker has swung into engagement with the indicator needle, relay 62 will be energized. At this instant both relays 62 and 92 are energized. With both relays energized, and striker arm and indicator needle in engagement, and both to the left of neutral N, a circuit is closed to the lamp 110 and the circuit of motor 8 is closed in a direction to rotate the motor to the right to move the damper toward closed position. This condition exists until the striker arm and the indicator needle reach neutral N. At this point the circuit of relay 92 is opened, the circuit of the motor 8 is open and the circuit of lamp 110 is open. Therefore the motor stops and there are no lamps lighted.

This condition will continue to the end of the striker swing and throughout its return. If flue conditions are still subnormal this cycle will be repeated until flue conditions have been restored to normal.

It will be appreciated that under subnormal conditions I avoid over adjustment of the damper with all its attendant disadvantages, as already explained in connection with abnormal conditions.

It will be apparent from all of the foregoing that I have provided mechanism for controlling

the setting of an object in accordance with certain indicated conditions. In the illustration described this object is a damper and the indicated conditions are the haze conditions in a flue. It is to be distinctly understood that application to boiler or furnace air flow is purely illustrative. Obviously my invention is equally applicable to air conditioning equipment, wherein it may be desired to introduce some foreign material into the air being supplied to a room. Then again this same control is useful for controlling the pressure in a vessel by controlling the fire, in which event the lamp and cell hereinabove referred to could be dispensed with and the pressure indicated electrically or by a pneumatic gage. The same control could be employed in heat treating processes where operation of the control mechanism could be initiated by thermocouple. My control is useful for controlling the rate of flow of a liquid or gas into a reservoir or receiver to maintain a desired level or pressure therein as indicated by a suitable indicator.

These applications of my control all come within the scope of my invention. In all cases there is required an indicator of some sort for indicating desired conditions and the condition existing at any instant, and in all cases there is an object which must be adjusted to restore conditions to normal, and in all cases when the indicator indicates any condition other than normal, instrumentalities will be set into operation to vary the setting of the object to be adjusted.

It is to be understood furthermore that changes may be made in the details of construction and arrangement of parts hereinabove described within the purview of my invention.

What I claim is:

1. In mechanism of the class described including an object the setting of which is to be varied, the combination of an indicating device having a movable element the position of which varies with respect to a neutral point on the indicating device with changes in condition as established by the setting of the object, an intermittently operated electric motor for varying the setting of said object, an oscillatable striker adapted intermittently to engage said movable element, a rotating actuator for oscillating said striker, a double throw switch comprising a spring arm for closing the switch in one direction, a cam carried by said actuator and adapted intermittently to engage said spring arm for closing said switch in the opposite direction, a relay the circuit of which is closed when said actuator is moving the said striker toward the movable element of the indicating device and said cam is holding the double throw switch closed, a second relay, a holding circuit therefor, a switch in said holding circuit which opens upon closure of the circuit of the first mentioned relay, further movement of said actuator sufficient to move the striker past the neutral point of the indicating device rotating said cam out of contact with the arm of the double throw switch permitting the switch to close in the opposite direction, whereby upon the striker passing the neutral point both relays will be de-energized, a pair of motor control switches closable upon de-energization of said relays to close the motor circuit to alter the setting of the object in a direction to restore conditions to normal, and a circuit for the second mentioned relay adapted to be closed when the striker moves still further into contact with the movable element of the indicating device, whereby said relay will open the motor circuit, thereby to provide a

movement of said motor proportional to the deviation of the movable element of the indicating device.

2. In mechanism of the class described including an object the setting of which is to be varied, the combination of an indicating device having a movable element the position of which varies with respect to a neutral point on the indicating device with changes in conditions as established by the setting of the object, electrically operated means for varying the setting of said object, an oscillatable striker adapted intermittently to engage said movable element, a constantly rotating actuator for oscillating said striker, a double throw switch adapted to close automatically in one direction, a cam carried by said actuator adapted intermittently to close said switch in the opposite direction, a relay whose circuit is closed when the actuator is moving the striker toward the movable element of the indicating device and the said cam is holding the double throw switch closed, a second relay, a switch in the circuit of said relay which opens upon closing of the circuit of the first relay, said cam being so disposed relatively to the double throw switch that upon further movement of the actuator sufficient to move the striker past the neutral point of the indicating device the cam will have moved away from the double throw switch to permit the latter to close automatically in the opposite direction, to break the circuit of the first relay, a pair of switches closable upon the said de-energization of both relays to close the circuit of said electrically operated means to alter the setting of the object in a direction to restore conditions to normal, and a circuit for the second mentioned relay closed by contact of the striker with the movable element of the indicating device to open the circuit of the electrically operated means, thereby providing for operation of the electrically operated means which is directly proportional to the deviation of the movable element of the indicating device with respect to the neutral point of the indicating device.

3. In mechanism of the class described including an object the setting of which is to be varied, the combination of an indicating device having a movable element which moves to one side of a neutral point on the indicating device when conditions as determined by the setting of the object are abnormal and to the other side of said neutral point when conditions are subnormal, electrically operated means for varying the setting of said object, an oscillatable striker adapted intermittently to engage said movable element, an actuator for the striker, a double throw switch self-closing in one direction, a cam carried by the actuator adapted intermittently to close the said switch in the opposite direction, a relay, the circuit to which is closed when the striker is at the subnormal side of the neutral point and said cam is holding the double throw switch closed, a second relay, a circuit for the second relay adapted to be closed when the striker and said movable element are in contact at the subnormal side of the said neutral point, a pair of switches closable upon the energization of both relays to close the circuit of the said electrically operated means with the striker and movable element at the subnormal side of the neutral point, and both relays are energized, said cam moving into inoperative position with respect to the said double throw switch when the striker and movable element have

moved to the neutral point to open the circuit of the first relay to open the switch controlled thereby and open the circuit of the electrically operated means.

4. Control mechanism comprising a reversible motor; a pivoted indicating element, indicating when the motor is to be operated; an oscillatable pivoted striker element, adapted intermittently to engage the indicating element to effect pivotal movement of the two elements as a unit; a circuit for said motor; contact mechanism in said circuit closed by engagement of said two elements, to close said motor circuit; a magnet carried by one element, the other element having a metal area, the magnet and metal area contacting when the two elements are engaged to prevent chattering and arcing, the pivots of the two elements being offset relatively so that, with the two elements engaged, a wiping action is provided between the two to improve the contact between the indicating element and the striker.

5. Control mechanism comprising a reversible motor; a pivoted indicating element, indicating when operation of the motor is desired; an oscillatable pivoted striker element, adapted intermittently to engage the indicating element to effect pivotal movement of the two elements as a unit; a circuit for said motor; contact mechanism in said circuit closed by engagement of said two elements, to close said motor circuit; and a constantly rotating motor for oscillating said striker element.

6. Control mechanism comprising, in combination, a reversible motor; a pivoted indicating element, indicating when the motor is to be operated and in which direction; a pivoted striker arm; a continuously running motor; an arm driven thereby and intermittently engaging the

striker arm, to oscillate the same into intermittent engagement with the indicating element; a circuit for said reversible motor; contact mechanism in said circuit closed by contacting of the striker element with the indicating element, with the latter at one side of a neutral position, thereby to close said motor circuit for one direction of rotation of the reversible motor; contact mechanism in said motor circuit controlled by said rotating arm for opening said motor circuit when the striker arm and indicating element have reached said neutral position; another circuit for said motor, to effect rotation of the same in the opposite direction; contact mechanism in this second circuit controlled by said arm, to close said second circuit when the indicating element is at the side of neutral position opposite to that first mentioned and with the striker moving to neutral position; and a relay, the circuit of which includes the striker arm and indicating element for opening the said second circuit of the reversible motor when the striker arm has moved past neutral position into engagement with the indicating element.

WALCOTT M. ADAMS.

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