

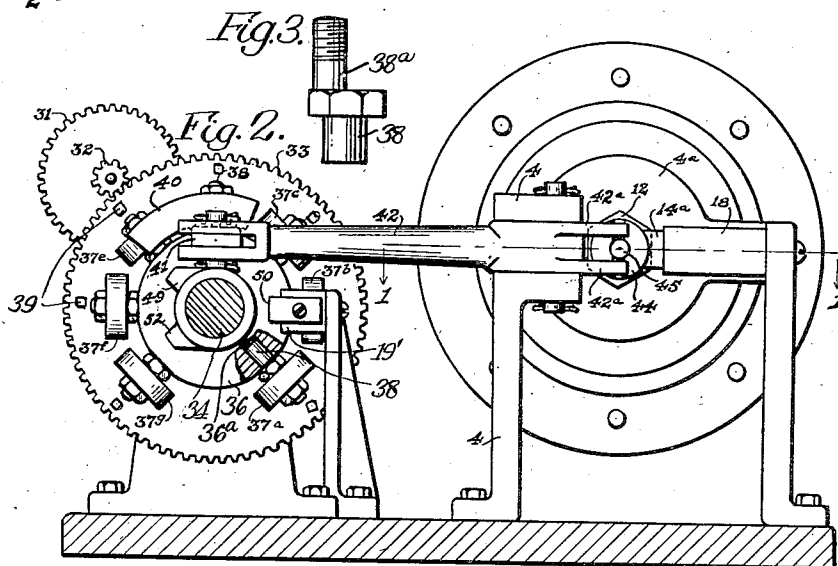
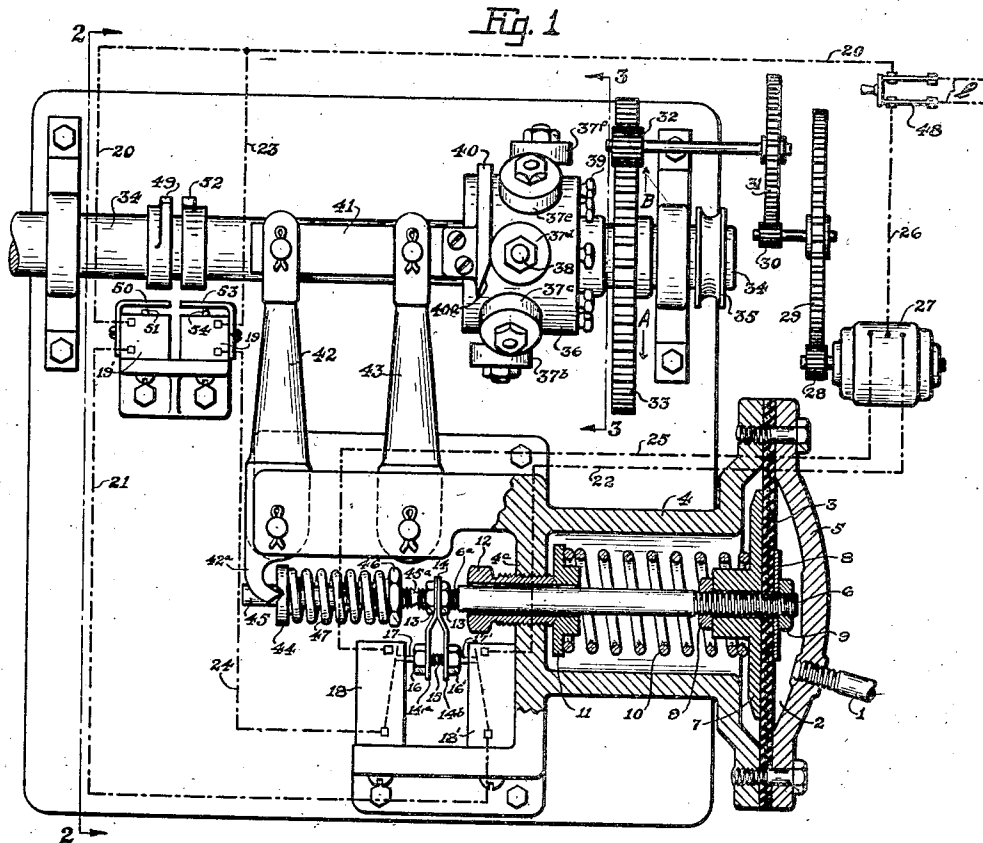
Sept. 8, 1936.

S. S. WEEKS

2,053,885

PRESSURE ACTUATED CONTROL APPARATUS

Filed Dec. 13, 1934



SHIRLEY S. WEEKS

INVENTOR.

BY *Harry Dexter Beck*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,053,885

PRESSURE-ACTUATED CONTROL
APPARATUS

Shirley S. Weeks, Providence, R. I.

Application December 13, 1934, Serial No. 757,304

2 Claims. (Cl. 236—26)

This invention relates to improvements in pressure-actuated control apparatus. It is herein particularly described in its application to a boiler installation where it is desired to exercise automatic control of the agencies affecting the fire conditions by means responsive to changes in the steam pressure of the boiler. In its broader aspects the invention is adaptable to the control of any fluid subject to pressure changes.

5 An object of the invention is to provide improved apparatus of the so-called step action type having the advantageous exactitude of adjustment of fire controlling factors characteristic of such step action, but having further the capacity of employing as many steps as may be desired with exceedingly small increments between consecutive steps, thus making possible much closer regulation than heretofore. This improved result is obtained, according to my invention, by apparatus of marked simplicity, small size and long life, easy to install and adjust.

It is a feature of the invention that the change of pressure which actuates the control is imposed upon a diaphragm normally in balance, as it were, or subjected to equal forces on both sides. This enables a highly sensitive element to be employed and insures alertly responsive action to a relatively small change in pressure. Moreover, the apparatus is so constructed and arranged that whenever the diaphragm is flexed the resulting operation promptly reestablishes the balance of forces acting on the diaphragm, thus enabling it to resume its unflexed or most sensitive position. And this is so regardless of the particular step in the range of action whereat the apparatus is awaiting a change of pressure. The enhanced sensitivity, the provision for exact and nice adjustment, and the exceptional simplicity of the mechanism, result in control apparatus capable of rendering a most satisfactory performance.

The accompanying drawing shows the best mode in which I have contemplated applying the principles of my invention, but these are to be taken as merely illustrative because it is intended that the patent shall cover by suitable expression in the appended claims whatever features of patentable novelty exist in the invention as a whole.

In the accompanying drawing:

Figure 1 is a plan, partly in section as on line 1—1 of Figure 2, of apparatus illustrative of my invention;

Figure 2 is a side elevation, viewed as on line 2—2 of Figure 1; and

Figure 3 is an elevation of a detail.

Referring more particularly to the drawing,

the actuating pressure is conducted by a pipe 1 from a source such as the boiler system of a power plant to a chamber 2 where it is applied to a diaphragm 3. The latter may be made of highly sensitive material since, as will presently appear, the forces acting upon its opposite sides are normally in balance, and its responsive flexures are occasioned by comparatively small deviations from the normal counterbalanced condition. The edge of the diaphragm is tightly clamped between a suitably shaped frame member 4 and a cover 5, and its center is secured to a stem 6 between a backing plate 7 and a face plate 8 by nuts 9. A coiled spring 10 seats at one end on the backing plate 7 and at its other end seats against a collar 11 which in turn rests upon a hollow adjusting screw 12 threaded into a portion 4a of the frame member 4. The stem 6 passes freely through both the collar and the adjusting screw and beyond them is provided with a reduced threaded portion 6a to which, by means of nuts 13, is secured an arm 14 preferably made up of two strips 14a and 14b of resilient material.

The separated ends of these strips carry a short threaded rod 15 on which are provided adjusting nuts 16, 16' each of which is arranged to engage respectively an operating plunger 17, 17' of a sensitive electric switch 18, 18' such as a Burgess micro switch. A movement of only a few thousandths of an inch will alter the setting of such switches. They are here indicated diagrammatically as of the type tending to remain open and each is electrically connected in series with a similar sensitive switch 19, 19' which normally stands closed. Both sets of switches control an electric circuit, represented diagrammatically by dot-and-dash lines 20, 21, 22, 23, 24, 25 and 26, which connect the power lines 1 and switches with a reversible motor 27. This motor, by suitable gearing, 28, 29, 30, 31 and 32, also shown somewhat diagrammatically, is connected to a gear on what is hereinafter termed a control shaft 34. This shaft carries an element 35 which may be connected by any suitable means (not shown) with the dampers governing the air flow through a boiler system and with valves or other agencies which regulate the feed of fuel to the combustion chamber.

Mounted on the control shaft 34 is a cam element 36 comprising a hub and a series of adjustable cam faces disposed therearound. Each such cam face is herein shown as a roller 37 mounted on a sort of crank shaft 38a (see Figure 3) which is provided eccentrically on a main shaft 55

or shank 38. These shanks are inserted in radially disposed sockets 36a distributed around the hub circumferentially and disposed progressively along the hub, that is, axially or longitudinally thereof, to define a helix around the hub. Each roller may be adjusted axially with respect to the axis of the hub, or the shaft 34, by merely rotating its supporting shaft 38 in its socket in the hub and when positioned as desired each shaft may be locked by a set screw 39 against inadvertent displacement. Each roller, of which there is here shown a series numbered 37a, 37b, 37c, 37d, 37e, 37f and 37g, represents one step of the step action control and since each roller is individually adjustable, the apparatus can be nicely adjusted at each step without altering or disturbing the adjustment of any other step.

As the cam element revolves with the control shaft 34 the several adjustable rollers successively engage an arcuate arm 40 on the end of a bar 41 carried by a pair of levers 42, 43 pivotally mounted on the frame 4. One of these levers has a pair of short arms 42a which bear on a sleeve 44 slidable on a rod 45 whose pointed end 45a rests in a tapered hole in the end of the diaphragm stem 6. This rod 45 is threaded near its pointed end and engaged thereon is a sleeve nut 46 between which and the slidable sleeve 44 is another coiled spring 47. Accordingly the positioning of the lever 42 determines the compression of the spring 47 and the force imposed by it upon the sleeve nut 46 and thence by way of the rod 45 and stem 6 upon the diaphragm.

To illustrate the operation of my improved apparatus let it be assumed that the normal steam pressure to be carried on the boiler system is to be substantially 100 pounds per square inch. Assume further, for example, that the effective area of the diaphragm is twelve square inches. Under such assumptions the total pressure or force exerted on the right side of the diaphragm is 1200 pounds. To initially adjust the apparatus for this pressure, the hand switch 48 is first thrown out and, with the cam element 36 preferably set as shown in Figure 1, that is, with the median roller 37d of the series in contact with the arcuate arm 40, the springs 10 and 47 are adjusted to establish a balanced condition of forces acting on the diaphragm.

The larger spring 10 should be of considerable strength so that when its force is imposed upon the left side of the diaphragm the greater portion of the actuating pressure will be opposed. For example, let the adjusting screw 12 be turned until spring 10 is exerting approximately a force of 1170 pounds on the backing plate 7. The sleeve nut 46 is next turned until the force exerted by spring 47 counterbalances the remainder of the actuating pressure. The total force now acting on the left side of the diaphragm is equal and in opposition to the pressure on its right side. Thus the normal counterbalanced condition is established with the diaphragm unflexed and in its most sensitive position as shown in Figure 1.

The nuts 13 on the reduced portion of the diaphragm stem may now be adjusted to position the arm 14 so that its resilient ends 14a, 14b are midway between the plungers 17 and 17' of the sensitive switches 18 and 18' respectively. The nuts 16, 16' may be utilized for the refinement of this adjustment. The manual switch 48 is now closed and the apparatus is ready to assume automatic control of the fire affecting agencies, it being understood, of course, that with the roller 37d in contact with the arm 40, the position of element

35 and the corresponding settings of the air and fuel regulating agencies are such as to maintain a steam pressure of 100 pounds so long as the demand on the boiler remains unchanged.

If this demand should increase, however, the resulting effect will be a drop in the steam pressure. Since the forces acting on the diaphragm are in balance, a relatively small reduction in the steam pressure, for example a half pound or even less, will be sufficient to affect a response by the diaphragm. The latter will flex to the right a slight amount but still sufficient to cause the resilient end 14b of the arm 14 to move plunger 17' a few thousandths of an inch and thereby close switch 18'. This establishes the circuit through wire 20, switch 19' (normally closed) wire 21, switch 18', wire 22, motor 27 and wire 26. The motor is accordingly rotated and causes rotation of gear 33 and shaft 34 in the direction indicated by the arrow A. This will open up the fuel regulators and dampers and bring about an increase in the fire conditions to produce additional steam to satisfy the increased demand.

As the shaft 34 rotates, roller 37d rides along the arm 40 and off its tapered end 40a, thus allowing the arm to move toward the right and into engagement with roller 37e. Simultaneously with the movement of the bar 41, lever 42 is swung clockwise. The leftwise swing of its short arms 42a releases the compression on spring 47 and correspondingly decreases the force exerted by this spring on the diaphragm. If this reduction is sufficient to offset the reduction in steam pressure caused by the increased demand on the boiler, the diaphragm is again under balanced conditions and will return to its unflexed position. This will move arm 14 and its end 14b so as to permit switch 18' to open and thus break the circuit through the motor. The latter will promptly stop, such slight overrun as may occur being negligible inasmuch as the roller then in contact with the arm 40 can roll along its flat face.

If the reduction in force of the spring 47 is not enough to effect a counterbalanced condition on the diaphragm, the latter remains flexed until the step of the apparatus is reached at which the opposing forces acting on the diaphragm are brought into balance. Thereupon, as already described, the diaphragm is restored to its initial unflexed condition with the forces acting upon it in balanced relation. To prevent any damage to the apparatus, as where an extreme reduction in steam pressure might occur, a cam 49 is provided on shaft 34 which in due course engages a resilient arm 50 and forces it against plunger 51 of switch 19' to cause the latter to open and break the energizing circuit through the motor. This stops further operation of the apparatus in this direction but still leaves all the elements in position to respond in the reverse direction upon restoration of the steam pressure within the operative range of the device. Incidentally, no harm is done to the sensitive diaphragm since the end of its stem 6 brings up against the cover 5 after a very short movement.

Upon a lessening of the demand on the boiler, with characteristic increase in the steam pressure, the diaphragm is flexed to the left thereby moving arm 14 and its resilient end 14a to effect closure of switch 18. This establishes the circuit through wires 20 and 23, switch 19, wire 24, switch 18, wire 25, motor 27 and wire 26. This causes rotation of the motor and gear 33 in the reverse direction indicated by arrow B. As shaft

34 likewise revolves, roller 37c will engage the tapered end 40a of arm 40 and cause the latter to shift to the left, thus swinging lever 42 counterclockwise to increase the compression of spring 47. If the force thus added to the left side of the diaphragm is sufficient to counterbalance the slight increase of steam pressure which caused the flexing of the diaphragm, the latter will be restored to its unflexed position, switch 18 will be opened and the action of the controller arrested. If the corresponding new setting of the fire affecting agencies is such as to make the steam production correspond with the reduced demand, no further change occurs. But otherwise, the controller continues through its successive steps until the desired balance is attained. Here again, to prevent undue operation of the apparatus, another cam 52 on shaft 34 coacts with resilient arm 53 to depress plunger 54 and open switch 19 to stop the motor. In this instance the backing plate 7 bottoms on the internal shoulder of the frame member 4 and saves the diaphragm from any excessive flexure. But the elements are still in position to respond in a reverse direction to a restoration of the pressure within the range of the apparatus.

It will be noted that the pressure responsive element, the diaphragm 3, is normally in its unflexed position where it is most sensitive to pressure changes. When flexed in response to some change, the apparatus at once goes into operation and promptly restores the diaphragm to its original position. And since it is normally acted upon by counterbalanced forces, it is alertly responsive to a pressure change and this continues true and to the same degree regardless of what the actual pressure condition is within the range of the apparatus.

While the disclosure has assumed an operative pressure of 100 pounds, it is, of course, understood that any pressure may be accommodated by selecting springs of the proper characteristics. And although particularly described in its application to a boiler installation the use of the improved apparatus is not so limited because it may readily be adapted for controlling the pressure in gas making plants, annealing or blast furnaces, and other instances where the fluid whose pressure is to be controlled may be applied to the responsive element of the apparatus.

I claim:

1. Pressure actuated control apparatus comprising, in combination, a diaphragm subjected on one side to an actuating pressure; an adjustably mounted spring arranged to exert a force on the opposite side of said diaphragm to counterbalance the greater portion of said pressure force; a stem connected to said diaphragm; a movable arm associated with said stem so as to be moved thereby in accordance with the move-

ment of said stem due to the flexing of said diaphragm upon change of said actuating pressure; an electric switch arranged to be closed by movement of said arm; an electric circuit controlled by said switch; an electric motor connected to said circuit; a rotatable cam connected to said motor so that upon energization of the motor said cam is rotated; a lever arranged to be swung by rotation of said cam; a second spring arranged to be flexed by said lever and to exert a force against the actuating pressure on the diaphragm; the aforesaid elements being constructed and organized so that upon a change in the actuating pressure said stem is moved to effect closure of the switch and energization of the motor, thereby causing rotation of the cam and a consequent change in the effective force of said second spring to counterbalance said pressure change and thereby return said stem to its initial position to bring about the opening of said switch.

2. Pressure actuated control apparatus comprising, in combination, a pressure responsive element subjected on one side to an actuating pressure; a spring arranged to exert a force against the opposite side of said element to counterbalance the greater portion of said pressure force; a second spring arranged to exert a force against the said opposite side of said element to counterbalance the remainder of said pressure force; an arm arranged to move in accordance with the movement of said element in response to changes of said pressure; a pair of electric switches arranged to be actuated selectively by movement of said arm; electric circuits controlled by said switches; a reversible electric motor connected with said circuits, and adapted to be rotated in one direction upon the actuation of one of said switches and in the other direction by actuation of the other of said switches; a rotatable cam connected with said motor and arranged to be rotated in accordance with the rotation of the motor; and a lever arranged to be swung by said cam and thereby alter the effective force of said second spring; the said elements being organized so that upon an increase in the actuating pressure on said pressure responsive element, the arm moves to effect closure of the switch which brings about an increase in the effective force of the second spring to counterbalance the increase of pressure, and so that upon a decrease in said pressure the arm moves to effect closure of the switch which brings about a decrease in the effective force of said second spring to counterbalance the decrease in said pressure; the said arm being moved by the said changes in the effective force of said second spring to open the switch whose closing effected the operation of said motor.

SHIRLEY S. WEEKS. 60