

Nov. 3, 1931.

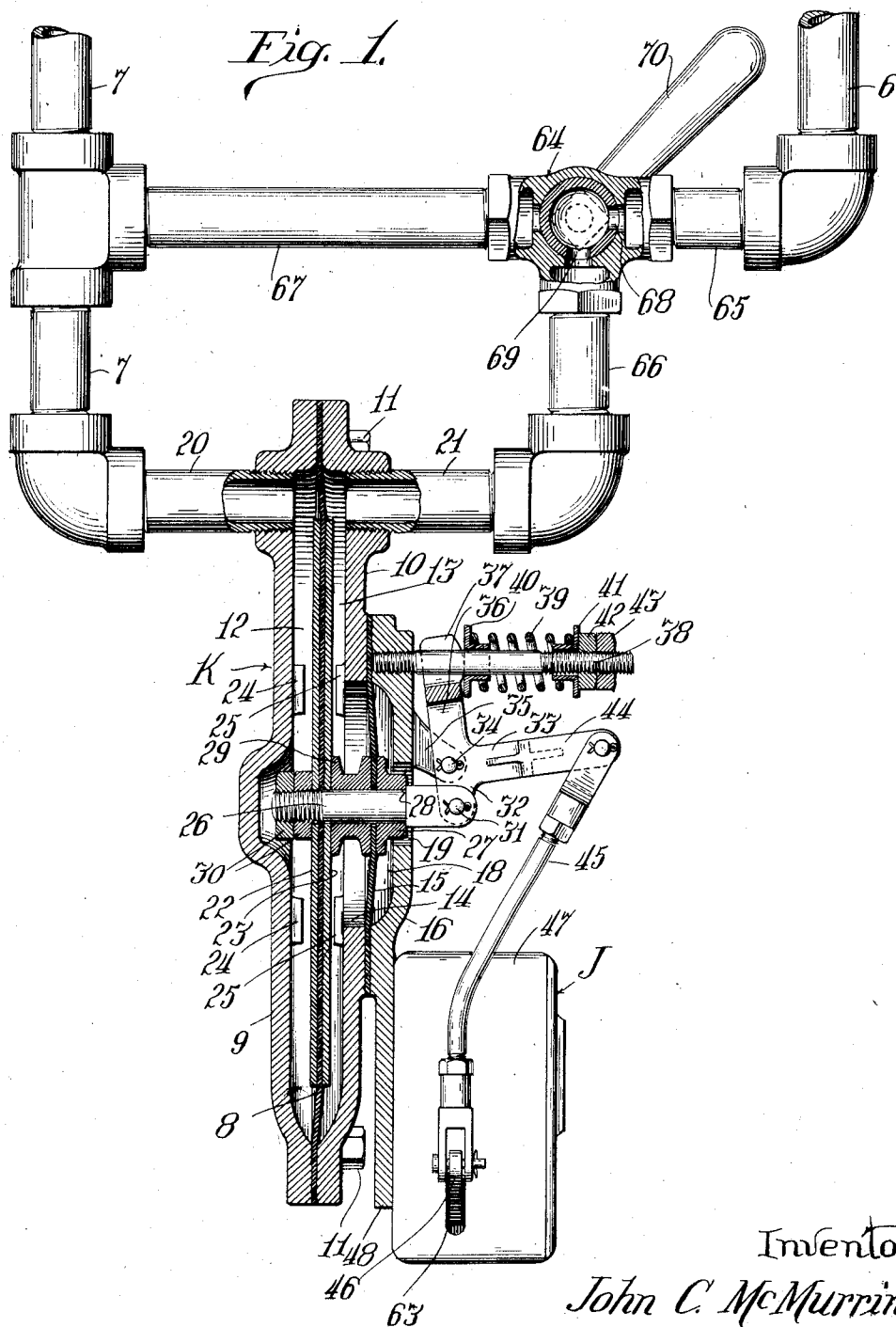
J. C. McMURRIN

1,829,807

DIFFERENTIAL CONTROLLER

Filed March 12, 1927

2 Sheets-Sheet 1



Inventor.

John C. McMurrin

By *Barnett & Truman*
Attorneys

Nov. 3, 1931.

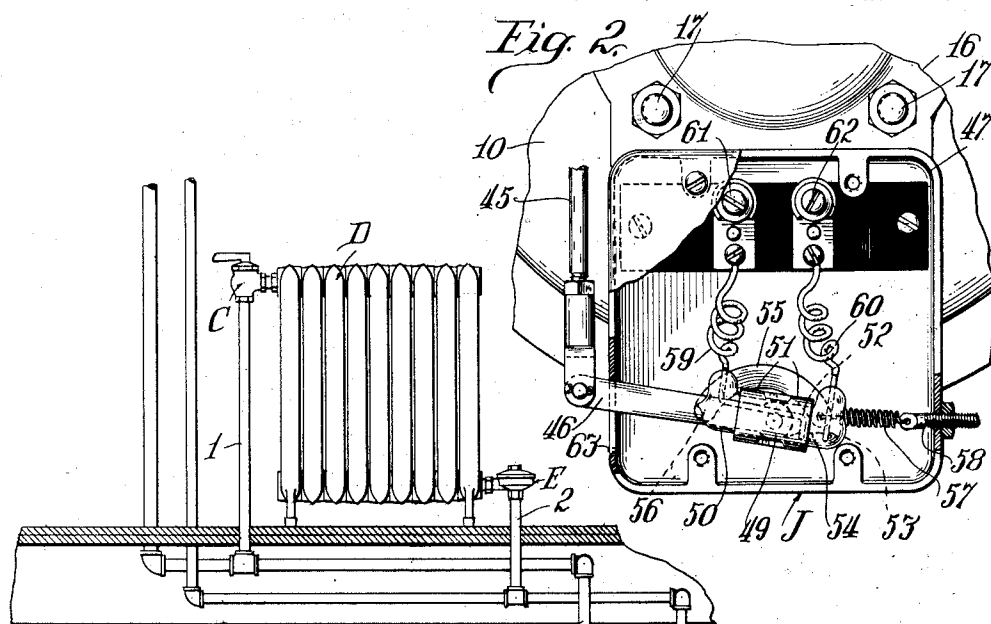
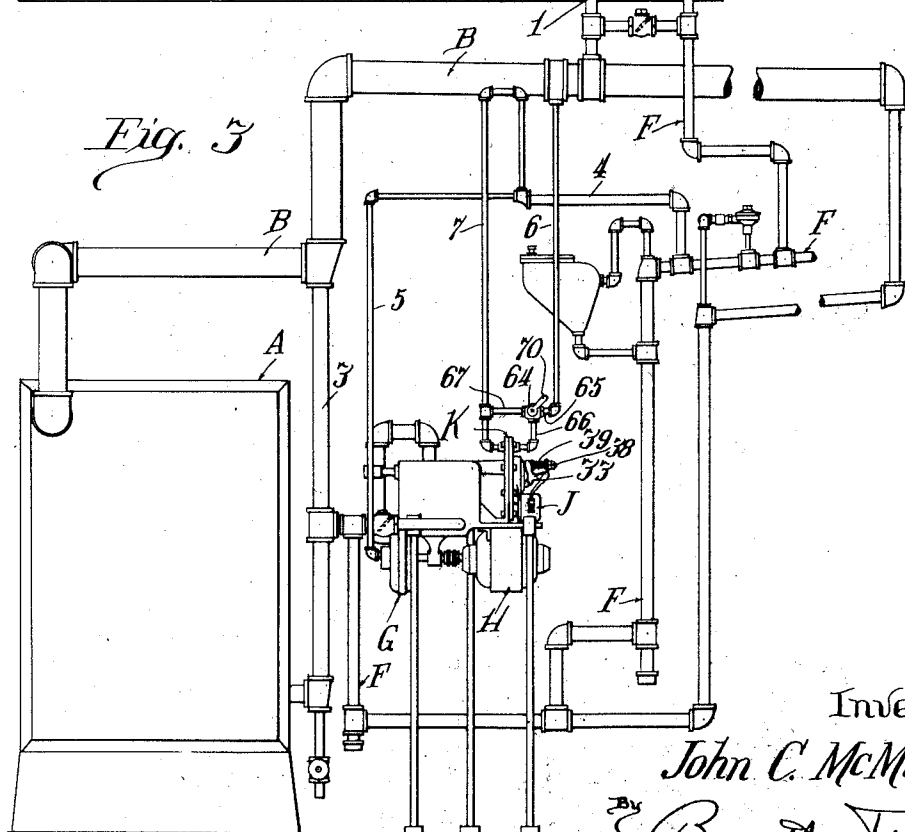
J. C. McMURRIN

1,829,807

DIFFERENTIAL CONTROLLER

Filed March 12, 1927.

2 Sheets-Sheet 2



Inventor.
John C. McMurrin
By *Barnett & Truman*
Attorneys.

UNITED STATES PATENT OFFICE

JOHN C. McMURRIN, OF MARSHALLTOWN, IOWA, ASSIGNOR TO C. A. DUNHAM COMPANY,
OF MARSHALLTOWN, IOWA, A CORPORATION OF IOWA

DIFFERENTIAL CONTROLLER

Application filed March 12, 1927. Serial No. 174,994.

This invention relates to a pressure operated controller adapted to maintain a substantially constant difference in pressure between two spaces. More specifically, the device is used to control the difference in pressure existing between two pipe lines by starting and stopping the means provided for changing the pressures in these pipes.

For example, in a vacuum steam heating system, it is desirable to vary the pressure of the steam supplied to the radiators, in order to correspondingly vary the temperature of the steam and the heat given out by the radiators, and at the same time it is desirable to maintain a substantially constant pressure difference between the supply and return mains so that the steam will always tend to flow through the radiators. In such a system, the improved differential pressure controller forming the subject matter of the present invention is used to stop and start the motor which drives the vacuum-producing means which acts to change the pressure under which the steam is supplied to the radiators. The controller is connected with the supply and return mains and operates to maintain a substantially constant pressure difference between these mains.

Briefly described, the invention comprises a casing in which are mounted two flexible diaphragms in such a manner as to divide the casing into three separate pressure chambers. One of these chambers is connected with the relatively low pressure main, one with the relatively high pressure main, and one is open to the atmosphere. The central portions of the diaphragms are secured in spaced relation to a stem, which is connected through a system of levers with the snap-switch controlling the operating motor which drives the pressure changing means.

The principal object of this invention is to provide an improved differential pressure controller operating and constructed as briefly described hereinabove, and as described more in detail in the specification which follows:

Another object is to provide such a controller which has no stuffing box or other packed joint between relatively moving parts.

The pressure chambers are permanently sealed so that there will be no leakage.

Another object is to provide such a controller which automatically ceases to operate, and shuts off the vacuum producing means, when a predetermined maximum vacuum has been attained.

Another object is to provide valved connections for such a controller whereby it may be operated as an ordinary vacuum switch, the differential feature being temporarily thrown out of service.

Other objects and advantages of this invention will be apparent from the following detailed description of one approved form of the apparatus.

In the accompanying drawings:

Fig. 1 is an elevation of the controlling assembly, the pressure controller unit itself being shown in central vertical section.

Fig. 2 is an elevation of the switch, and the lower portion of the controller, looking from the right at the lower portion of Fig. 1. The cover plate of the switch box has been broken away to disclose the switch mechanism.

Fig. 3 is an elevation of a portion of a vacuum steam heating system, to illustrate the use of this improved pressure controller.

Referring first to the steam heating system shown in Fig. 3, A is the boiler which supplies steam through supply main B, riser 1 and inlet valve C to the radiator D. Air and condensate pass out through thermostatic trap E and pipe 2 into the return main F. The condensates flow from return main F into pipe 3 and thence back into the boiler. The pump or other suction producing mechanism G withdraws air from the return main F through the pipes 4 and 5, thus reducing the pressure throughout the system, as desired. Pump G is driven by the motor H, controlled by the snap-switch J. The differential pressure controller indicated at K operates the switch J. The controller K is connected by pipes 6 and 7 with the supply main B and return main F, respectively.

The controller K will now be described in detail, referring more particularly to Fig. 1. A circular flexible diaphragm 8 has its edge portions clamped between a pair of substan-

tially circular casing members 9 and 10, secured together at their peripheries by a plurality of bolts 11. The casing members 9 and 10 are dished away from one another so as to form shallow pressure chambers 12 and 13 at opposite sides of the diaphragm 8. The central portion of casing member 10 is cut away at 14 this opening being closed by a smaller circular flexible diaphragm 15, the periphery of which is clamped against casing member 10 by means of a third casing member 16 secured to member 10 by a plurality of bolts or screws 17. Casing member 16 partially encloses a pressure chamber 18 at the outside of diaphragm 15, this chamber 18 being open to the atmosphere through the central aperture 19 in casing 16.

Pipe 20 leading from chamber 12 connects with the relatively low pressure pipe 7 leading to the return main F. Similarly pipe 21 leading from relatively high pressure chamber 13 connects with the pipe 6 leading to the supply main B. Reinforcing plates 22 and 23 cover the central portion of diaphragm 8, and the movements of this diaphragm under the influence of pressure differences are limited by the bosses 24 and 25 projecting inwardly from the casing members 9 and 10, respectively.

A stem 26 projects through central apertures in the diaphragms 8 and 15. A clamping collar 27 is positioned on stem 26 between a shoulder 28 on the stem and one face of the diaphragm 15. A spacing collar 29 is mounted on the stem 26 between the two diaphragms, and nuts 30 threaded on the free end of the stem serve to clamp the assembly rigidly together. The collars 27 and 29, and nuts 30 secure the diaphragms in spaced parallel relation upon the stem 26, and also seal the joints between these members so as to prevent the passage of fluids along the stem between chambers 12, 13 and 18.

The opposite end of stem 26 is pivoted at 31 to a short arm 32 of the bell crank lever 33, pivoted at 34 between lugs 35 projecting outwardly from casing member 16. An oppositely extending, longer arm 36 of the bell crank 33 has a forked end 37 which slidably embraces a bolt 38 mounted in the upper portion of casing member 16. A compression spring 39, mounted about the bolt 38, is confined between the slidable collar or washer 40, which bears against the forked end 37 of the bell crank, and a similar washer 41 which bears against the adjusting nut 42 and lock nut 43 mounted on the end of bolt 38. Obviously, the compression of the spring 39 may be adjusted by changing the position of nuts 42 and 43 on the bolt 38. A third arm 44 of bell crank 33 is connected by link 45 with the free end of the operating lever 46 of the control switch J.

This switch J is housed in a casing 47 mounted in any suitable manner on a down-

wardly projecting extension 48 of the casing member 16. This switch J may be of any approved type involving a quick throw or snap mechanism for quickly making and breaking the control circuit. In the preferred example here shown (see Fig. 2), switch J is of the mercury contact type. Lever 46 is pivoted within the casing at 49 and carries the sealed glass tube 50 which projects equally at opposite sides of the pivot 49 and is secured to lever 46 by clip 51. A pair of contacts 52 and 53 are sealed into the tube and project downwardly in spaced relation near one end of the tube so that when the lever 46 and tube 50 are inclined to the position shown in Fig. 2, a globule of mercury 54 contained within the tube will run to this end and connect the contacts 52 and 53. When tube 50 is inclined in the opposite direction, the mercury will run to the opposite end of the tube and break the circuit between contacts 52 and 53. A curved link 55 has one end pivoted to lever 46 at 56. A tension spring 57 is secured between the other end of link 55 and an anchoring bolt 58 secured in housing 47. Flexible wires 59 and 60 electrically connect the contacts 52 and 53 with the binding posts 61 and 62, from which leads extend to the motor H, or to the starting mechanism therefor.

With the members of this switch in the positions shown in Fig. 2, lever 46 may be gradually moved downward until it just passes a horizontal position, this movement placing the spring 57 under added tension. As the horizontal plane is passed, the point of attachment 56 of link 55 will pass below the pivot 49 of lever 46 and the spring 57 will then suddenly snap the parts to a downwardly inclined position corresponding to but opposite to the position illustrated in Fig. 2. Suitable stops are provided to limit the swinging movement of lever 46 in each direction. As here shown, this is done by the ends of a solt 63 in housing 47 through which lever 46 extends. This sudden tilting of the tube 50 will cause the mercury globule 54 to run to the other end of the tube and abruptly break the circuit. In exactly the same manner lever 46 may be gradually elevated until it just passes a horizontal position, after which it will suddenly be snapped upwardly by the spring 57 and the mercury globule 54 will run back to the position shown in Fig. 2 and again complete the circuit.

Again referring to Fig. 1, the three-way valve 64 is connected by pipe 65 with pipe 6, and by pipe 66 with pipe 21 leading to chamber 13. A third pipe connection 67 extends from the three-way valve to the pipe 7 which leads to chamber 12 of the controller. With the three way valve in the position shown in Fig. 1, communication is established from pipe 6 through pipe 65, ports 68 and 69 of the rotatable valve member, to pipes 66 and 21

leading to chamber 13. At this time communication is cut off between the valve and pipe 67. By means of valve handle 70 the rotatable valve member may be turned so as to bring ports 69 and 68 into communication with pipes 67 and 66, and cut off the pipe 65. In this case communication will be established between pipe 7 and chamber 13 through the pipe 67, three-way valve 64, and pipes 66 and 21. Under normal operation, the three-way valve will be in the position shown in Fig. 1 so that chamber 12 of the controller is in communication with the pipe 7 leading to the return main F, and chamber 13 is in communication with the pipe 6 leading to the supply main B.

In the position shown in the drawings, diaphragm 8 has been moved to the right against the stops 25 by the pressure of spring 39 acting through the bell crank 33 and stem 26. At the same time a force is tending to move the diaphragms to the left, against the action of spring 39, this force being equal to the difference in the pressures existing in chambers 12 and 13 multiplied by the exposed area of diaphragm 8, plus the difference between atmospheric pressure and the pressure in chamber 13 multiplied by the exposed area of diaphragm 15. With the parts in the positions shown, the switch is closed and the motor H is operating so that the pressure is being gradually diminished (that is the vacuum is being increased) in the chamber 12. This will gradually increase the difference in pressures existing between chambers 12 and 13, and spring 39 is so adjusted that when this pressure differential reaches the desired amount, for example, one or two pounds per square inch, the forces acting to move the diaphragms to the left will overbalance the force of spring 39 and diaphragm 8 will move over against the stops 24. This will lower switch lever 46 and break the control circuit so that the vacuum producing mechanism will cease to function. With the vacuum pump out of operation, the pressure in chamber 12 will gradually build up, and the pressure difference between chambers 12 and 13 will gradually decrease, until the spring 39 is again able to throw the parts back to the position illustrated in the drawings, which results in the closing of switch J and the vacuum producing means is again placed in operation. It will be seen that the opening or closing of switch J is dependent upon the difference in pressure existing between chambers 12 and 13 and not upon the absolute pressure or degree of vacuum in either of these chambers. However, as the vacuum existing in supply main B, and hence in chamber 13 is increased, that is the pressure in chamber 13 is decreased, the pressure difference acting on the smaller diaphragm 15 is increased since atmospheric pressure is constant. Therefore a smaller

difference in pressure acting on the larger diaphragm 8 will be sufficient when added to the pressure acting on the small diaphragm 15, to throw the switch J to closed position. When a certain maximum vacuum has been attained in the chamber 13 (depending upon the adjustment of spring 39), the pressure acting on the small diaphragm 15 will be sufficient to operate the switch regardless of the pressure difference, if any, acting on the larger diaphragm 8. This will shut off the vacuum-producing mechanism, so that there is a maximum limit established for the vacuum in the supply main B.

The above description relates to the normal operation of the device in response to the pressure difference existing between the supply and return sides of the heating system. In case it is desired to operate the controller as an ordinary vacuum switch, that is to establish a certain desired maximum pressure difference between atmospheric pressure and the vacuum existing in the return line, the three-way valve 64 is moved so as to establish communication between pipes 66 and 67 and cut off communication with the pipe 6 leading to the supply main B. Both sides of the larger diaphragm 8 will now be placed in communication with pipe 7 leading to the return main so that the pressures will always be equalized in the chambers 12 and 13 and diaphragm 8 will be inoperative to move the stem 26. The controller is now operated entirely by the smaller diaphragm 15 which is subject to atmospheric pressure on one side and the vacuum of the return main which now exists in chamber 13. When a certain maximum vacuum is obtained, this pressure difference will be sufficient to operate bell-crank 33 against the action of spring 39 and close the switch J.

Since when used on a heating system, the pipes 6 and 7 will gradually become filled with water of condensation, but will not fill at equal rates, these pipes 6 and 7 as well as the chambers 12 and 13 should be originally filled with water. For this reason it is important that the vertical legs of the pipes 6 and 7 should be of equal height (as shown in Fig. 3) so that the water pressure head at each side of diaphragm 8 will be the same.

While this pressure controller has been designed especially for use in connection with a differential vacuum heating system, it will be apparent that it might be equally useful in other systems or mechanisms wherein a desired pressure difference is to be maintained between two spaces regardless of the absolute pressures therein.

I claim:

1. In a steam heating system, a differential pressure controller comprising a casing, a flexible diaphragm dividing the casing into two separate chambers, a second smaller flexible diaphragm forming a portion of the outer

5 wall of one chamber, a relatively high pressure pipe leading to one chamber, a relatively low pressure pipe leading to the other chamber, a three-way valve in the high pressure pipe, a branch pipe leading from this valve to the other pipe, and a stem connecting the diaphragms and projecting outside of the casing.

10 2. In a steam heating system, a differential pressure controller comprising a casing, a flexible diaphragm dividing the casing into two separate chambers, a second smaller flexible diaphragm forming a portion of the outer wall of one chamber, a relatively high pressure pipe leading to one chamber, a relative-
15 ly low pressure pipe leading to the other chamber, a three-way valve in the high pressure pipe, a branch pipe leading from this valve to the other pipe, a stem connecting
20 the diaphragms and projecting outside of the casing, and an adjustable pressure means connected with the stem for resisting the movement thereof in response to the pressure forces within the casing acting on the
25 diaphragms.

3. In a steam heating system, a differential pressure controller comprising a casing, a flexible diaphragm dividing the casing into two separate chambers, a second smaller flexible
30 diaphragm forming a portion of the outer wall of one chamber, a relatively high pressure pipe leading to one chamber, a relatively low pressure pipe leading to the other chamber, branch pipe connections including
35 a valve, whereby the low pressure pipe may be connected with both chambers and the high pressure pipe disconnected, and a stem connecting the diaphragms and projecting outside the casing.

4. In a steam heating system, a differential pressure controller comprising a casing, a flexible diaphragm dividing the casing into two separate chambers, a second smaller flexible
45 diaphragm forming a portion of the outer wall of one chamber, a relatively high pressure pipe leading to one chamber, a relatively low pressure pipe leading to the other chamber, branch pipe connections including a
50 valve, whereby the low pressure pipe may be connected with both chambers and the high pressure pipe disconnected, a stem connecting the diaphragm and projecting outside the casing, and an adjustable pressure means
55 connected with the stem for resisting the movement thereof in response to the pressure forces within the casing acting on the diaphragms.

JOHN C. McMURRIN.