

April 30, 1940.

H. S. TURNER

2,198,711

LIQUID LEVEL AND PRESSURE CONTROL

Original Filed Aug. 5, 1937

2 Sheets-Sheet 1

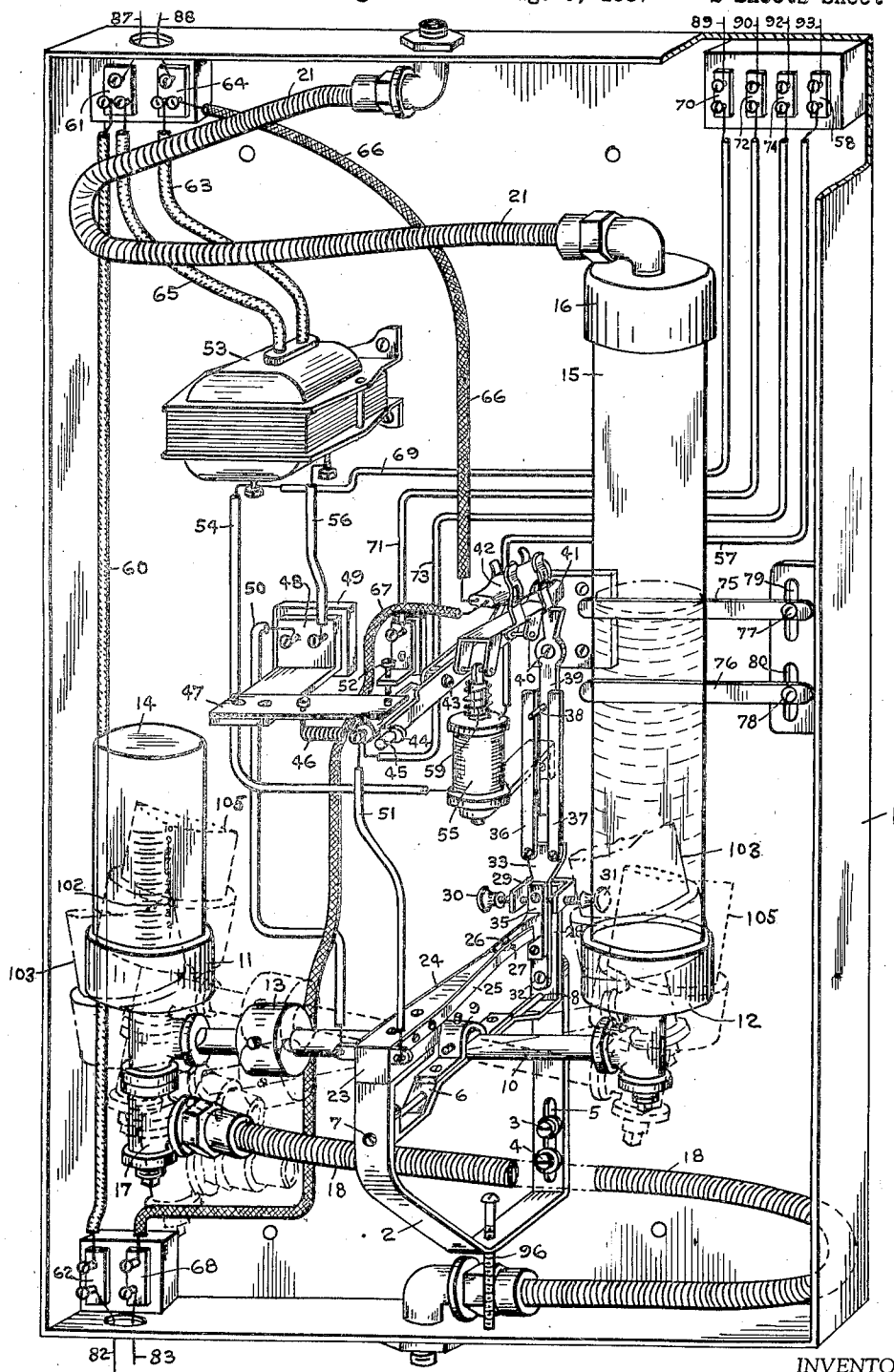


Fig. 1

BY

Hubert S. Turner

INVENTOR.

ATTORNEY.

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2 Sheets-Sheet 2

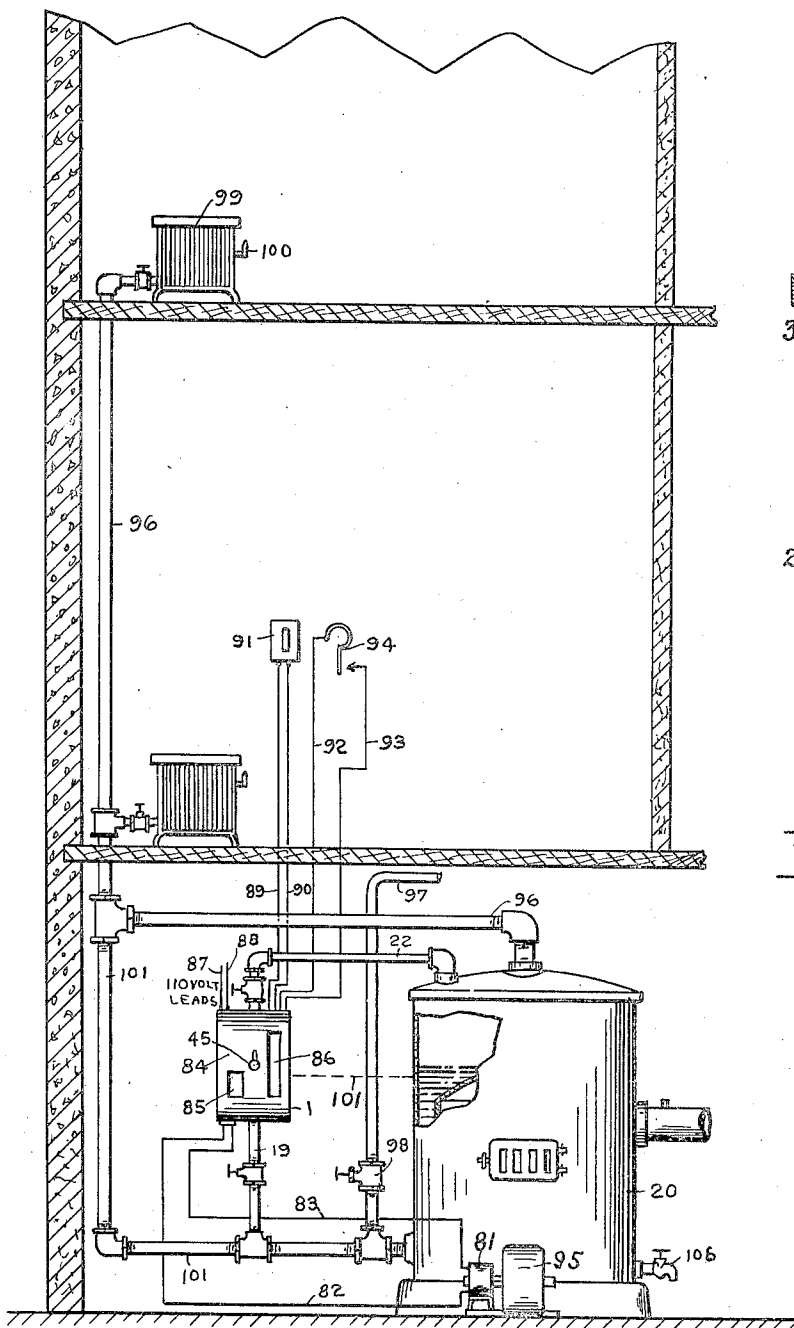


Fig. 2

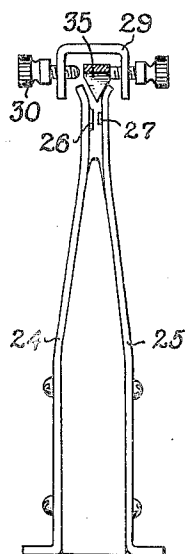


Fig. 3

INVENTOR.
Hubert S. Turner

BY

ATTORNEY.

UNITED STATES PATENT OFFICE

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LIQUID LEVEL AND PRESSURE CONTROL

Hubert S. Turner, Brooklyn, N. Y.

Refiled for abandoned application Serial No. 157,547, August 5, 1937. This application September 10, 1938, Serial No. 229,393

22 Claims. (Cl. 237—9)

The control device of the present invention is an improvement on and modification of the one disclosed in my co-pending application, Serial No. 86,999, filed June 24, 1936. This application is refiled for the abandoned application filed August 5, 1937, Serial No. 157,547.

Heretofore it has been customary to regulate the fuel combustion in a steam boiler by means of a device operated by the steam pressure developed in the boiler; the combustion being diminished or completely cut off, whenever the steam pressure in the boiler has reached a predetermined point.

Experience has shown that such a steam pressure control, for a heating boiler, is faulty in many respects and especially when used with a single pipe steam heating system, which vents the air within the system by means of air valves located on the steam radiators and pipes. In the case of the latter system, a comparatively high steam pressure is required to force the air out of the heating system through the air valves, within a reasonable time; though a comparatively low steam pressure is all that is required to maintain the same system steam saturated, once the air has been expelled.

On this account, the combustion regulators heretofore used, are usually set at a steam pressure that will expel the air and insure steam saturation within the desired time interval. Obviously this is an uneconomical method of heating, inasmuch as the high air expelling steam pressure is in effect during the entire period when heating is taking place and the extra fuel needed to maintain any steam pressure above the saturation point of the heating system, is out of all proportion to the slight increase in heating effect of the higher pressure steam.

In the present invention means are provided automatically to provide exactly the correct steam pressure to remove the air from any given system, in any required time, and then check the consumption of fuel to the minimum needed to maintain the entire heating system barely steam saturated and free from air, irrespective of what the actual steam pressure may be. Experience has shown that as long as the pressure within the heating system, after steam saturation is obtained, is but slightly above atmospheric, thereby preventing the inflow of air through the air valves, the greatest economy of fuel is obtained.

Taking advantage of the principles involved, I have been able to utilize my steam saturation control for also functioning as a high water cut-

off, as a low water cut-off, as a steam pressure gauge and as a water level gauge, without any additions thereto.

In the drawings herewith, which are a part hereof:

Figure 1 represents a perspective view of one form of the invention;

Figure 2 represents diagrammatically a cross-section of a building with the device controlling the boiler, and

Figure 3 is an enlarged fragmentary view on the line 3—3 of Fig. 1.

Referring to Fig. 1, a base 1 is provided, which may be as shown or of any other desired form. Bracket 2 is rigidly fastened to base 1 by screws 3 and 4, which pass through slot 5 in bracket 2. A cradle 6 is pivoted at 7 and 8 in the two arms of bracket 2 and turns freely on these pivots. Rigidly supported on cradle 6, by clamp 9, is a hollow pipe 10 which terminates in fittings 11 and 12. A counterweight 13 is adapted to slide along pipe 10 and is fastened thereto by a set screw.

The lower and open end of a hollow glass vessel 14 is sealed in fitting 11. Similarly sealed in fitting 12, is a glass tube 15 which is also sealed in fitting 16 at its upper end. Connected to fitting 11 is a plugged T 17 and fastened in the side outlet thereof is a flexible hose 18, which may be of metal, rubber or other suitable material. The pipe 10 establishes communication between the vessel 14 and tube 15 through the fittings 11 and 12. Hose 18 is preferably formed in a loop, as shown, in order to obtain greater flexibility and is connected by pipe 19 (Figure 2) below the low water level of boiler 20. Similarly connected to fitting 16 is flexible hose 21, which is preferably looped, as shown in order to obtain greater flexibility and is connected by pipe 22 (Figure 2) above the normal water line of boiler 20.

Fastened to a lug of bracket 2 is insulating block 23, which supports electric contact springs 24 and 25, to which are fastened at their free ends electric contacts 26 and 27. Fastened to an upward extending projection 28 at the rear of cradle 6, is adjusting screw bracket 29, which supports adjusting screws 30 and 31. Held within this bracket by pivot 32 is circuit opener 33, which moves freely on its pivot. An insulating block 35 is fastened to 33 and engages the free ends of springs 24 and 25. Circuit opener 33 has two adjustable prongs 36 and 37 which pass over pin 38 attached to trip 39. Pivot 40 supports trip 39 and the latter turns freely

thereon. Resting on the top of trip 39 is mercury switch holder 41 which clasps mercury switch 42. Pivot 43 supports holder 41 and the latter turns freely thereon. An extension 44 of holder 41 terminates in resetting button 45.

One end of heating coil 46 is fastened to bi-metallic strip 47, which is fastened to bracket 48, mounted on insulating block 49. Wire 50 connects the coil electrically to spring 24. The other end of heating coil 46 is connected electrically to spring 25 by wire 51. An adjustable electrical contact 52 is adapted to engage a contact on the free end of strip 47, when the latter is warped upward by heat from heating coil 46.

A purely conventional operative means is shown electrically connected to the device, which can be made to control any other form of operative means desired. Transformer 53 has its left secondary terminal connected by wire 54 to the lower terminal of solenoid 55 and its right secondary terminal connected by wire 56 to bracket 48. The upper terminal of solenoid 55 is connected by wire 57 to terminal 58.

The upper part of the plunger of solenoid 55 is encircled by the coiled spring 59 and is fastened by a pivot connection to the front part of holder 41, so that this end is held higher than the back end which rests on trip 39 and consequently the mercury in switch 42 is normally kept away from its contacts.

Wire 60 connects terminal 61 to terminal 62. Wire 63 connects terminal 64 to one terminal of the primary of transformer 53 and the other terminal is connected by wire 65 to terminal 61. Wire 66 connects terminal 64 to one terminal of mercury switch 42, the other terminal being connected by wire 67 to terminal 68. Wire 69 connects wire 54 to terminal 70; wire 71 connects contact 52 to terminal 72; wire 73 connects wire 51 to terminal 74.

Adjustable sighting bands 75 and 76 are adapted to be tightened in correct position by means of screws 77 and 78, which travel in slots 79 and 80.

Referring to Figure 2, motor 81 is connected by wires 82 and 83 to terminals 62 and 68. A cover 84 is adapted to be fastened over base 1. Glass windows 85 and 86 allow vessel 14 and tube 15 to be inspected. Resetting button 45 projects through a slot in this cover. Terminals 61 and 64 are connected by wires 87 and 88 to the 110 or 220 volt house leads. Terminals 70 and 72 are connected by wires 89 and 90 to buzzer 91. Terminals 74 and 58 are connected by wires 92 and 93 to thermostat 94.

The operation of the device will now be explained. It is well known in the art that the most efficient operating level for steam boiler water is just covering the crown sheet of the combustion chamber. However, the water is usually kept much higher than that due to the danger of uncovering the crown sheet as the water lowers when steam is produced or on account of small water leakages. As the present invention provides means for reducing or cutting off combustion, if the boiler water gets too low, the preferred way of installing the device is as follows: Base 1 is fastened to the boiler or contiguous thereto, at such a height that the center of tube 15, when in a vertical position, is level with the minimum height of water it is deemed safe to have in boiler 20 when the heating system is steam saturated. After the base is fastened and pipes 19 and 22 connected to hoses 18

and 21, adjusting screws 4 and 5 are loosened and bracket 2 lowered or raised to bring the desired operating water level of boiler 20 accurately to the center of tube 15, when counterweight 13 is so adjusted that the tube is held vertical. Screw 96, which passes through bracket 2, is then tightened against the lower flange of base 1, to prevent any slippage and screws 3 and 4 are tightened. The set-screw of counterweight 13 is then loosened and the weight is placed as far to the right as it will go, the water rising in tube 15 to the height of the water in boiler 20, due to the connection of pipe 19 to the bottom of the boiler and due to the venting of the air in tube 15 through pipe 22 above the water level of boiler 20. Sighting band 76 is normally adjusted so that its upper edge is just equal to the correct water level when tube 15 is vertical.

The contacts of thermostat 94 are then closed and a circuit is closed over the following path: Thermostat 94, wire 93, terminal 58, wire 57, solenoid 55, wire 54, secondary of transformer 53, wires 56 and 50, contact spring 24, contacts 26 and 27, contact 25, wires 51 and 73, terminal 74, wire 92, completing the circuit through thermostat 94. Solenoid 55 attracts its plunger, which tilts the contact end of mercury switch 42 downward. This establishes a circuit over the following path: Mercury switch 42, wire 67, terminal 68, wire 83, motor 81, wire 82, terminal 62, wire 60, terminal 61, wire 87 to the source of electricity, wire 88, terminal 64, wire 66, completing the circuit through mercury switch 42. This causes motor 81 to operate blower fan 95 to which it is connected. As blower fan 95 forces air into the combustion chamber of boiler 20, the consequent increase in combustion chamber temperature causes the boiler water to produce steam and this causes the boiler water to slowly lower, as the steam is disseminated through the heating system by way of pipe 96. To counteract this effect water is allowed to enter boiler 20 from house main 97, by opening valve 98, so that the starting water level in tube 15 is strictly maintained level with sighting band 76.

This process continues until steam radiator 99, which would usually be the radiator at a point farthest from the boiler, has had all the air expelled from it through air valve 100 and is consequently steam saturated. This can readily be determined by removing air valve 100 and noting when live steam, free from air mixture, is visible in the air valve opening. As in some installations a radiator nearer the boiler may be slower in reaching its steam saturation point, it is advisable to check all such radiators in the heating system. The water level in tube 15 is then brought exactly up to band 76 and valve 98 is closed. The contacts of thermostat 94 are then opened, solenoid 55 releases its plunger, mercury switch 42 resumes its normal position tilted backward and the circuit is opened through motor 81. The blower fan stops, combustion is diminished, the boiler water stops producing steam and the steam disseminated throughout the heating system condenses and runs back to the boiler through return pipe 101. When the entire system has cooled off and all the water is back in the boiler, sighting band 76 is adjusted so that its upper edge is just equal to the water level at that time.

Counterweight 13 is then adjusted so that tube 15 is balanced by vessel 14 and is held vertical with the water at the level mentioned. At the same time that the water was lowering in tube

15, it was rising in vessel 14, due to the production of steam pressure in the system. As vessel 14 is closed at its top there is no escape for the air contained therein and consequently this air is compressed by the steam pressure developed and the water rises to a height in direct ratio to the pressure developed. This pressure is indicated on scale markings 102 on vessel 14. Normally, when counterweight 13 is properly adjusted, the weight of this water in vessel 14 assists in the tilting of cradle 6, but at present no such effect is produced.

After counterweight 13 has been adjusted, the contacts of thermostat 94 are again closed and the heating system saturated with steam, which will be shown now by the water level in tube 15 lowering down to sighting band 76. This lowering of the water lessens the weight on the right side of pivots 7 and 8 and the rising of the water in vessel 14, due to the steam pressure developed, has increased the weight on the left side and cradle 6 is unbalanced and tilts downward on the left and upwards on the right, as shown by dot and dash lines 103. Adjusting screw 31 is now adjusted so that it forces insulating block 35 of circuit opener 33 against contact spring 24 sufficiently to open contacts 26 and 27, the long point of insulating block 23 assisting in the break. This at once opens the traced circuit through solenoid 55 and the blower fan 95 is at once stopped.

As soon as the steam in the heating system begins to condense and return to the boiler in the form of water, the lowering steam pressure in vessel 14, which is concurrent with the steam condensation, allows the air compressed in the upper part of vessel 14 to force out the water therein. This increases the weight on the right side of pivots 7 and 8 and decreases the weight on the left side and causes cradle 6 to partly resume its normal position, even though the water level in tube 15 may still be in the vicinity of sighting band 76. Adjusting screw 30 is then so manipulated that it forces insulating block 35 sufficiently to the right so that contact spring 24 reengages contact spring 25. Bracket 29 is wide enough so that circuit opener 33 can be given sufficient play sidewise to cause contact springs 24 and 25 to engage each other only when all the water has come back to the boiler, when the steam pressure has been lowered to nothing, when the steam pressure has fallen to any desired point, when a part only of the water has returned to the boiler, or by any combination of these factors.

Governed by thermostat 94, the process will now be repeated as long as there is a demand for heat. In subsequent, immediate operations, however, as the water level in tube 15 will remain in the vicinity of sighting band 76, cradle 6 will tilt and open the solenoid circuit with but a slight steam pressure, which will represent that actually required in the particular heating system to maintain steam saturation in all the radiators.

In each operation the correct steam pressure for prompt expulsion of whatever air may have entered the heating system, will be automatically provided; as the more air that has entered, the more water must have returned to the boiler and consequently the higher will be the steam pressure allowed to expel the air, as this pressure is increased by an increase in the amount of water in tube 15.

If at any time after first starting, when the water in tube 15 is in the vicinity of sighting band

75, very quick steaming produces a high enough pressure to make it advisable to shut off combustion, then the additional weight in vessel 14 overbalances whatever weight there may be in tube 15 and cradle 6 tilts to the left and the solenoid circuit is opened.

Assuming that it takes water in vessel 14 up to the five pound scale marking, to tilt cradle 6 when the water in tube 15 is level with sighting band 75 and one-half pound when the water is level with sighting band 76: then when starting with a cold heating system, five pounds will be the maximum allowable steam pressure at the start, which will be progressively lowered to the one-half pound point as steam saturation of the heating system is approached. The rapidity of this lowering of the water will depend on inside and outside temperature, which governs the rapidity of steam condensation in the heating system. On a cold day, the condensate will return to the boiler faster than on a warm day and consequently the allowable steam pressure will be greater on the cold day as the water level in tube 15 will drop slower. This is at it should be as the heating system will then reach its saturation point faster.

When adjusted, as described, and once the air is expelled from the heating system and until thermostat 94 is satisfied, cradle 6 will be tilted and the solenoid circuit opened and closed so as to just maintain the heating system steam saturated, the actual steam pressure being only that necessary to overcome pipe and radiator friction and produce a radiator pressure just above atmospheric, thereby preventing ingress of air through the air valves.

If for any reason it is desired to increase the restoration steam pressure, this can be done by moving counterweight 13 to the right or by lowering bracket 2. In either case it will then take more water in vessel 14 to tilt cradle 6, and consequently this will entail a higher steam pressure.

As well as operating as a steam saturation control, a low water cut-off for the steam boiler is also provided. Should the water in boiler 20 lower to a certain point below sighting band 76, which can be to the crown sheet, as shown by dotted line 101 in Figure 2; the weight of tube 15 is reduced more than it is when steam saturation takes place. This unbalances cradle 6, without any raising of water in vessel 14, and it tilts, opening the solenoid circuit as described.

A high water cut-off is also provided, as should the water in tube 15 rise to a certain point above the level of sighting band 75, then the extra weight added to the tube 15 overcomes the balancing effect of counterweight 13 and cradle 6 tilts downward on the right of pivots 7 and 8 and assumes a position approximately as shown by dotted lines 105. Insulating block 35 of circuit opener 33 is forced against contact spring 25 and it is separated from spring 24, which opens the solenoid circuit.

Just as vessel 14, with scale markings 102, serves as a steam pressure gauge, so tube 15 also serves as a water level gauge, making these two common adjuncts to every steam boiler unnecessary, when my steam saturation control is used.

Optional with the device is an alarm which produces a signal whenever the solenoid circuit is opened by either high or low water, but not when opened by the described steam saturation of the heating system. The two terminals of the high resistance heating coil 46 are connected to contact springs 24 and 25 by wires 50 and 51.

This constitutes a short-circuit for heating coil 46 except when springs 24 and 25 are disengaged. Due to the high resistance of coil 46, solenoid 55 does not receive sufficient current to maintain its plunger attracted, but coil 46 does receive sufficient current to generate heat, whenever this short-circuit is removed. This heat is sufficient to warp bimetallic strip 47 upwards and the contact on its free end engages contact 52 after a definite time interval, which can be varied by the adjustment of contact 52. This time interval is made slightly longer than the maximum time it takes cradle 6 to resume its normal position after steam saturation of the heating system. Hence, whenever contacts 26 and 27 remain open for a longer period than that represented by steam saturation, which will be caused by either high or low water, a circuit is closed over the following path: Buzzer 91, wire 89, terminal 70, wire 69, secondary of transformer 53, wire 56, bracket 48, strip 47 and contact on end thereof, contact 52, wire 71, terminal 72, wire 90, completing the circuit through buzzer 91 and sounding an audible signal. A signal light or any other signal, can, of course, be substituted for the buzzer.

A main line circuit breaker is also optional with the device and is of particular use when the boiler combustion means comprises a more complex lay-out than that shown in the drawings. The description hereinbefore given has been limited to the opening and closing of the circuit through solenoid 55, which will usually be a low-voltage circuit. When so desired, an additional safeguard against too high steam pressure and high or low water is provided, which becomes operative only after a predetermined additional rise in steam pressure or rise or fall of boiler water, than that required to open contacts 26 and 27. Prongs 36 and 37 of circuit opener 33 are so adjusted that they do not force pin 38 to the left or right sufficiently to cause the top of trip 39 to clear the bottom of mercury switch holder 41, until the desired additional tilt has been given to cradle 6 than is required to open contacts 26 and 27. However, when trip 39 does clear the bottom of holder 41, either to the right or left, holder 41 falls downward on pivots 43 and tilts mercury switch 42 backward, opening its contacts and the circuit through motor 81, even though solenoid 55 should have its plunger attracted. The falling of holder 41 backward, moves extension 44 upward, forcing the free end of bimetallic strip 47 upward and engaging its contact with contact 52; hence, the alarm is sounded without waiting for the described time interval to elapse.

Whenever holder 41 falls, trip 39 cannot resume its normal, vertical position and circuit opener 33 cannot close contacts 26 and 27 until resetting button 45 has been manually depressed, thereby releasing trip 39. Hence, the solenoid circuit is held open at contacts 26 and 27, regardless of whether a normal steam or water condition is later on produced or not. Neither can holder 41 be reset on trip 39 until the normal balance of cradle 6 has been brought about by the reduction of the higher steam pressure or the restoration of the normal water level in tube 15 by opening valve 98 or draining off excess water through valve 106, as until this balance is restored, the top of trip 39 will not return to its normal position under the rear end of holder 41.

This secondary safety cut-off is of great advantage particularly in the larger boiler installations, where a serious leak might quickly empty

the boiler or where water injectors are used, which at times flood the boiler. It is also of particular advantage where boiler controls are used comprising various instrumentalities, some of which may not function quickly enough, in case of an emergency, as it furnishes a means of instantly cutting off the main current source of such instrumentalities.

In many boiler installations the return water comes back so slowly to the boiler that the water often gets temporarily too low for safe operation. This condition is provided for by the double low and high water cut-off described, as the combustion in boiler 20 is reduced by this temporarily low water and increased again when the water level becomes normal; but in case of a leak or other serious water loss, combustion is cut off until manual attention has been given to the control.

Whenever the water in tube 15 is higher or lower than sighting bands 75 or 76, but not high or low enough to cause contacts 26 and 27 to open, then more or less steam pressure will be required to open them than normally, as there will be more or less weight on the right side of pivots 7 and 8. This is as it should be, as the higher the water in any boiler, the less space for steam is available and consequently a higher pressure will be required and steam will be produced slower; the lower the water, the more space for steam is available, which will be produced faster and consequently, the less pressure will be required. Sighting bands 75 and 76 furnish convenient means for checking the proper water level in boiler 20. Band 75 is used if the heating system is cold and band 76 if it is steam saturated.

By loosening the set screws of clamp 9, pipe 10 can be shifted to the right or left, thereby increasing or decreasing the balancing effect of counterweight 13.

If the utilization of vessel 14 and tube 15 as steam and water level gauges is not desired, they may be made of a substance other than glass. In such a case the initial adjustment of tube 15 is made by bringing the water in the boiler to the desired point when steam saturation is obtained in the heating system and then merely balancing tube 15 in a vertical position, by means of counterweight 13, when the system is cold.

While I have shown a thermostat 91 as governing the device, a manually operated switch, or other circuit closing device may be substituted therefor.

The plugged openings at the bottoms of fittings 12 and 17, are to facilitate cleaning of vessel 14 and tube 15.

While in the drawings, I have selected for disclosure a one pipe steam heating system, as that is the most common form, it will be understood that my device is equally applicable to a two pipe or a vacuum system, as it is also to any vessel containing any liquid whose level and internal pressure varies.

I claim:

1. A device of the character described comprising a boiler, a pivoted member, a tube supported by one end of said member, a closed vessel supported by the other end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, and means controlled by said pivoted member for regulating the supply of heat to said boiler.

2. A device of the character described comprising a boiler, a closed vessel directly connected at its lower end to the lower portion of said boiler, a second closed vessel directly connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessels for oppositely directed vertical movement in response to variations in liquid contents thereof, and means responsive to movement of said supporting means for controlling the supply of heat to said boiler.

3. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessels for oppositely directed vertical movement in response to variations in liquid contents thereof, means for regulating the supply of heat to said boiler, a switch controlling said regulating means and operated by limited movement of said vessels, a second means for opening said switch upon greater movement of said vessels, and means for locking said switch in open position after being opened by said second means.

4. A device of the character described comprising a boiler, a pivoted member, a tube supported by one end of said member, a closed vessel supported by the other end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, electrical means including a switch for controlling the supply of heat to said boiler, means normally holding said switch in open position, and electrical means responsive to movement of said member for closing and releasing said switch.

5. A device of the character described comprising a boiler, a closed vessel directly connected at its lower end to the lower portion of said boiler, a second closed vessel directly connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessels for oppositely directed vertical movement in response to variations in liquid contents thereof, electrical means including a switch for controlling the supply of heat to said boiler, means normally holding said switch in open position, and electrical means responsive to movement of said supporting means for closing and releasing said switch.

6. A device of the character described comprising a boiler, a pivoted member, a tube supported by one end of said member, a closed vessel supported by the other end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, means for regulating the supply of heat to said boiler, a switch controlling said regulating means and operated by limited movement of said pivoted member, a second means for opening said switch upon greater movement of said pivoted member, and means for locking said switch in open position after being opened by said second means.

7. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said

vessels for oppositely directed vertical movement in response to variations in liquid contents thereof, electrical means including a normally open switch for controlling the supply of heat to said boiler, means responsive to limited movement of said vessels for closing and releasing said switch, and means responsive to additional movement of said vessels to render said last-named means inoperative and maintain said switch in open position.

8. A device of the character described comprising a boiler, a pivoted member, a tube supported by one end of said member, a closed vessel supported by the other end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, electrical means including a normally open switch for controlling the supply of heat to said boiler, means responsive to limited movement of said pivoted member for closing and releasing said switch, and means responsive to additional movement of said member to render said last-named means inoperative and maintain said switch in open position.

9. A device of the character described comprising a boiler, a pivoted member, a tube supported by one end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, electrical means including a switch for controlling the supply of heat to said boiler, means normally holding said switch in open position, electrical means responsive to limited movement of said member for closing and releasing said switch, and means responsive to additional movement of said pivoted member to render said last-named means inoperative and maintain said switch in open position.

10. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessel and tube for oppositely directed vertical movement in response to variations in liquid contents thereof, electrical means including a switch for controlling the supply of heat to said boiler, means normally holding said switch in open position, electrical means responsive to limited movement of said vessels for closing and releasing said switch, and means responsive to additional movement of said vessels to render said last-named means inoperative and maintain said switch in open position.

11. A device according to claim 4, characterized by a thermostat responsive to air temperature controlling the electrical means for closing and releasing said switch.

12. A device according to claim 5 characterized by a thermostat responsive to air temperature controlling the electrical means for closing and releasing said switch.

13. A device according to claim 9 characterized by a thermostat responsive to air temperature controlling the electrical means for closing and releasing said switch.

14. A device according to claim 10, characterized by a thermostat responsive to air temperature controlling the electrical means for closing and releasing said switch.

15. A device of the character described comprising a boiler, a closed vessel connected to the

lower portion of said boiler, a substantially vertical tube connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessel and tube for oppositely directed vertical movement in response to variation in the liquid contents thereof, electrical means including a switch for controlling the supply of heat to said boiler, resilient means normally holding said switch in open position, electro-magnetic means for moving said switch into closed position, a pair of contacts in series with said electromagnetic means normally biased into engagement, and means responsive to movement of said vessel and tube for effecting relative movement of said contacts.

16. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessels for oppositely directed vertical movement in response to variation in the liquid contents thereof, electrical means including a switch for controlling the supply of heat to said boiler, resilient means normally holding said switch in open position, electro-magnetic means for moving said switch into closed position, a pair of contacts in series with said electro-magnetic means normally biased into engagement, and means responsive to limited movement of said vessels for effecting relative movement of said contacts, and a member supporting said switch and movable in response to additional movement of said vessel and tube to release said switch to open position.

17. A device according to the character described in claim 15 characterized by a pivoted member supporting said vessels at opposite ends thereof.

18. A device according to the character described in claim 16 characterized by a pivoted member supporting said vessel at one end and said tube at the other end.

19. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessel and tube for oppositely directed vertical movement in response to variations in the liquid contents thereof, means for regulating the supply of heat to said boiler including a mercury switch, an unbalanced pivoted member, a stop normally holding said pivoted member in said horizontal position, a lever pivoted to said member and supporting said mercury switch, resilient means normally holding said lever in switch-open position, electro-magnetic means

responsive to limited movement of said vessels for moving said lever into switch-closed position, and means responsive to additional movement of said vessels for disengaging said stop from said pivoted member thereby resulting in movement of said pivoted member and lever into the switch-open position.

20. A device of the character described comprising a boiler, a closed vessel connected to the lower portion of said boiler, a second closed vessel connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means supporting said vessel and tube for oppositely directed vertical movement in response to variations in the liquid contents thereof, means for regulating the supply of heat to said boiler including a mercury switch, an unbalanced pivoted member, a stop normally holding said pivoted member in said horizontal position, a lever pivoted to said member and supporting said mercury switch, resilient means normally holding said lever in switch-open position, electro-magnetic means for moving said lever into switch-closed position, contacts in series with said electro-magnetic means for controlling energization thereof, means responsive to limited movement of said vessels for effecting movement of said contacts into and out of engagement, and means responsive to additional movement of said vessels for disengaging said stop from said pivoted member thereby resulting in movement of said pivoted member and stop into switch-open position.

21. A device of the character described comprising a boiler, a pivoted member movable between two positions, a tube supported by one end of said member, a closed vessel supported by the other end of said member, means connecting said vessel and the lower end of said tube to the lower portion of said boiler and connecting the upper end of said tube to the upper portion of said boiler, heat supply means for said boiler, and means effective upon movement of said member into either of said two positions to render said heat supply means inoperative.

22. A device of the character described comprising a closed vessel directly connected at its lower end to the lower portion of said boiler, a second closed vessel directly connected at its lower end to the lower portion of said boiler and at its upper end to the upper portion of said boiler, means movable between two positions and supporting said vessels for oppositely directed vertical movement in response to variation in the liquid contents thereof, heat supply means for said boiler, and means effective upon movement of said member into either of said two positions to render said heat supply means inoperative.

HUBERT S. TURNER.