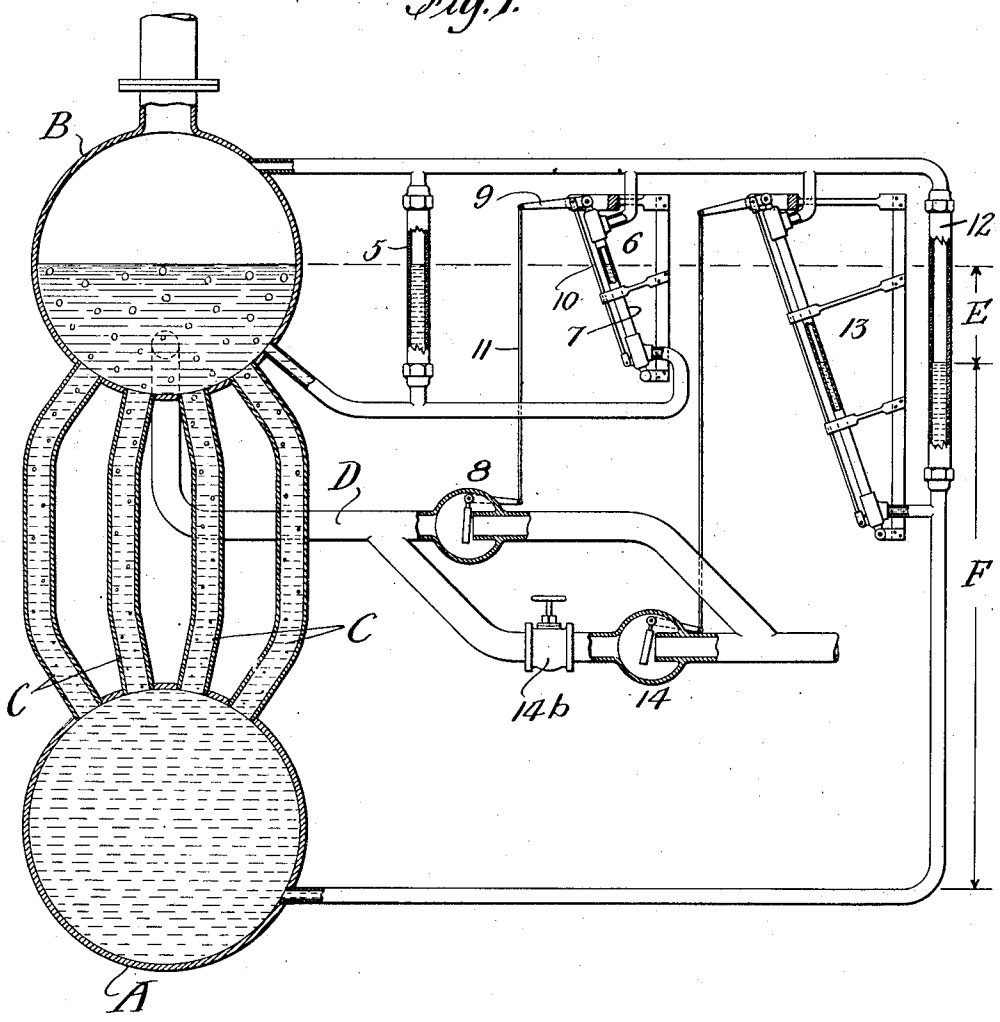
Nov. 8, 1932. W. L. DE BAUFRE 1,887,147

REGULATING SYSTEM FOR HIGH CAPACITY BOILERS

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Fig. 1.



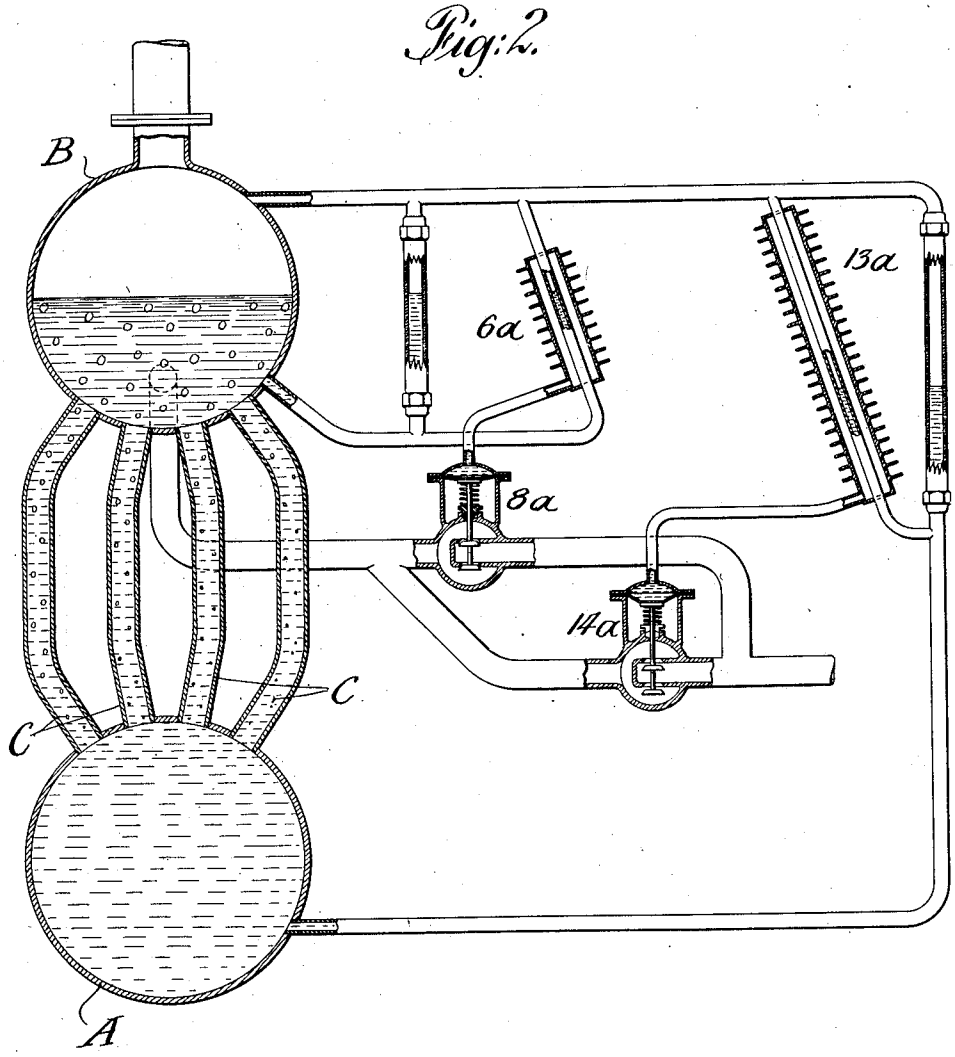
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REGULATING SYSTEM FOR HIGH CAPACITY BOILERS

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Fig. 2.



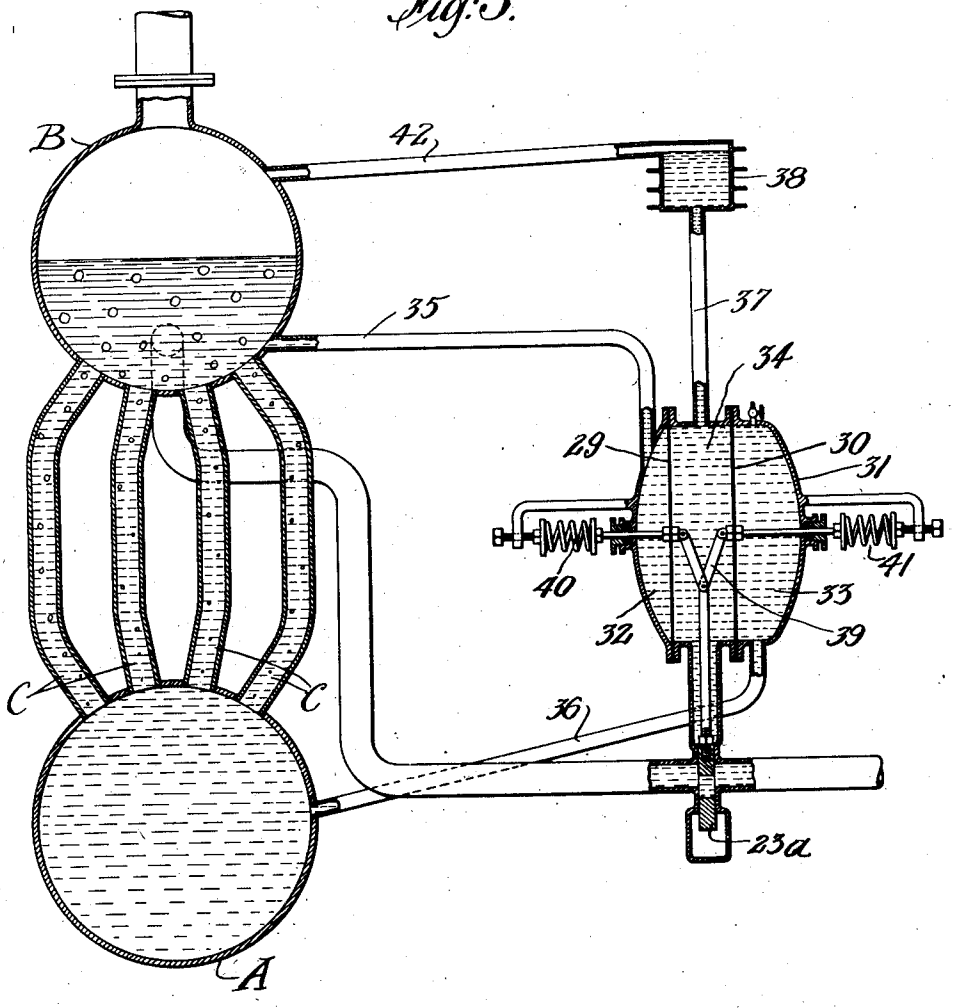
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REGULATING SYSTEM FOR HIGH CAPACITY BOILERS

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Fig. 3.



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1,887,147

UNITED STATES PATENT OFFICE

WILLIAM L. DE BAUFRE, OF ORANGE, NEW JERSEY, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

REGULATING SYSTEM FOR HIGH CAPACITY BOILERS

Application filed January 28, 1929. Serial No. 335,448.

This invention relates to the regulation of feed water supply to boilers to ensure adequate supply of water in the boiler under all operating conditions and is especially useful in high capacity installations operated at high rating, such, for example, as installations where there is a large amount of evaporating surface subject to radiant heat.

The nature, objects, and advantages of my invention will be understood from the following.

In boilers operating at very high ratings, such as those of the steam generator type, there is a tendency for undesirable fluctuations to occur in steam pressure and steam generation due to the fact that the weight of water contained in the boiler is small relative to the rate at which it is evaporated. Large fluctuations of water level in the steam drum occur which have been difficult to control, even with automatic feed water regulators.

In known automatic feed water regulators in which a single regulator is employed connected to the steam drum of the boiler in the manner of the usual boiler gage glass, there are wide and violent fluctuations in the rate of feed which accentuate the pressure fluctuations caused by sudden changes in the demand for steam. This is so because in such devices the rate of feed is almost, if not completely, shut off by the rise in the water level in the steam drum with a sudden increase in the demand for steam. Then as the water level begins to drop, the opening of the feed valve by the regulator causes an inflow of cold water which absorbs heat and thereby causes a further drop in level and a further increase in feed. As a consequence, the regulator control over-runs the normal position corresponding to the steam demand. When the water level starts to rise by reason of the excess feed, the cutting down of the cold feed accentuates the rise. It will be seen, therefore, that this action causes fluctuations in the feed which produce troublesome variations in the steam pressure and water level in boilers working at high ratings.

One of the objects of my invention is to overcome such difficulties and to ensure adequate and proper supply of feed water to the boiler.

How the foregoing together with such other objects and advantages as may hereinafter appear or are incident to my invention are realized is illustrated in preferred form in the accompanying drawings wherein

Fig. 1 is a more or less diagrammatic sectional elevation thru a boiler illustrating the application of a feed water regulating system constructed in accordance with one form of my invention; and

Figs. 2 and 3 are similar views illustrating other forms of my invention.

My invention proceeds upon the following:—

A boiler gage glass connected in the usual manner to the steam drum of a boiler indicates the water level within the steam drum. If the bottom connection to the gage glass be made to a lower point in the boiler, however, the gage glass will show a lower water level than corresponds to the level within the steam drum. This is due to the fact that the level within any gage glass is the surface of solid water in one leg of a U-tube, while the boiler drums, tubes, etc., form the other leg containing a mixture of steam and water. In other words the said one leg contains a head of solid water equivalent to the head of mixture of steam and water in the other leg. To balance the column of steam and water within the boiler requires a shorter column of solid water within the gage glass and connections. The difference is affected by the inertial and frictional resistance to circulation within the boiler and by the difference between the temperature within the boiler and in the gage glass connections. In any given case, the difference between the levels indicated by the ordinary gage glass and the gage glass connected much below the water level, is roughly proportional to the rate of steam generation at any given steam pressure. A reduction in steam pressure increases the difference in levels due to the greater volume of the steam bubbles produced, thus decreasing the density of the mixture within the boiler and increasing the resistance to circulation therein. If the new

gage glass be connected to the lowermost drum or header, its water level above that point will be a measure of the total weight of water contained in the boiler irrespective of the rate of steam generation and steam pressure except as affected by circulation resistance.

Referring now to Fig. 1 of the drawings, I have illustrated a simple form of boiler comprising a mud drum A, a steam and water drum B and a plurality of tubes C connecting the drums. Feed water is supplied to the steam and water drum B by means of the feed pipe D.

An ordinary gage glass 5 is provided for the drum B with which is associated a regulator 6 of the expansion type comprising in general a metallic expansion tube 7 which operates a valve 8 thru the medium of the lever 9 pivoted on the fixed rod 10 and connected at one end to the tube 7 and at its other end to the valve connecting link 11. The amount of steam and water in the tube 7 governs its expansion and contraction and as it expands or contracts the valve is opened or closed as the case may be.

A second gage glass 12 is connected between the steam space of the drum B and the lower part of the mud drum A and a regulator 13 similar to the regulator 6 is associated therewith which regulator operates a valve 14.

It is to be observed that the weight of the mixture of steam and water in the drum B governs the level of water in the gauge glass 5 and regulator 6 just as much as the weight of the mixture of steam and water in the entire boiler governs the level of water in gauge glass 12 and regulator 13. In neither case does the gauge glass give an absolutely correct indication of the actual level of the water in the boiler. The error, however, is generally proportional to the height of the particular column of mixed steam and water to which the gauge is connected. The height of this column in drum B is so small that for all practical purposes in this art the indication of the gauge glass 5 is accepted as correct, and it is known in the art as a level indicator.

For the same reason the response of regulator 6 to changes in water level in the steam drum B is considered sufficiently accurate to give a practical control of feed water supply thereby.

In other words, a gauge glass or regulator of the type shown in Fig. 1, if connected on one side to the steam space of the boiler and on the other side to a point slightly below the normal water level of the boiler, will respond to changes in weight of water above the lowest point of connection. Considered as an accurate index of the level of the water in the steam drum neither would be absolutely correct, but the percentage of error is so small that for all practical purposes the gauge glass and regulator are accepted as reflecting the level of water in the steam drum.

The distance E between the levels in the gage glasses 5 and 12 is a measure of the rate of steam generation while the distance F is roughly proportional to the weight of water contained in the boiler. Of course, with no steam generation, the level in 12 will be the same as the level in 5.

The valves 8 and 14 are located in the feed line and as here shown the valve 8 is in one branch of the feed line and the valve 14 in another.

It will be clear from the foregoing that the valve 8 is operated by the regulator 6 and the valve 14 from the regulator 13. The latter valve with its regulator is adjusted to feed water at a somewhat lower rate than that of steam generation and the deficiency is made up by regulator 6 and its valve to maintain the desired level within the steam drum B.

Under steady steam generation, then, regulator 13 will admit through valve 14 from 50 to 90 per cent., say 75 per cent. of the feed water required, and regulator 6 will admit through valve 8 the additional 25 per cent. necessary. Should the demand for steam gradually increase, the water level in steam drum B will fall and the total amount of water within the boiler becomes less. The levels in both 5 and 12 will fall, resulting in an increase in feed by both regulators.

Should the steam pressure slowly decrease with the same rate of steam generation, there will be a tendency for the level to rise in gage glass 5 due to the less dense mixture in the boiler caused by the lower steam density. Regulator 6 will thereupon slightly close valve 8, reducing the feed rate. The amount of water contained in the boiler will become less, causing a drop in the level of gage glass 12 and the regulator 13 will slightly open valve 14. The system will settle down with a somewhat increased portion of the feed water passing through valve 14 and a somewhat lesser portion through valve 8 with the level in the steam drum slightly lower.

Supposing there should be a sudden increase in the demand for steam. This would almost immediately result in a drop in steam pressure with increased steam generation at the expense of the stored up heat in the water and boiler parts. The steam thus generated throughout the boiler would displace water, forcing it into the steam drum B and the level in the steam drum would almost immediately rise. Regulator 6 would shut off the flow through valve 8 more or less completely. Regulator 13 would respond but slowly, to open valve 14 as the water contained in the boiler became less due to the increased demand and to the decrease in the

supply through 8. The level within the steam drum would soon feel the effect of the decreased supply relative to the steam demand, and as it lowered regulator 6 would gradually open until at a level in the steam drum very near its previous height the increased demand would be met by the increased flow through valves 8 and 14.

The regulator 13 is not directly affected by a sudden increase in the rate of steam generation, but only indirectly and to a secondary extent by the drop in pressure accompanying the increased demand. It acts to increase slowly the rate of feed with a sudden increase in steam demand, rather than suddenly shutting off the feed as explained hereinbefore in connection with the operation of known single regulators. It therefore provides a steadying action in proportion to the percentage of the feed controlled by it.

A throttle valve 14*b* may be employed to control the limit of feed.

In Fig. 2 I have illustrated a system similar to that just described with a difference appearing in the type of regulator and valve employed, the former being indicated by reference characters 6*a* and 13*a* and the latter by 8*a* and 14*a*.

In Fig. 3 I have shown a form of my invention in which the feed valve 23*a* is controlled by the action of two spaced diaphragms 29 and 30 located in the casing 31 and dividing it into two end chambers 32 and 33 and an intermediate chamber 34. The end chamber 32 communicates with the water space of the steam and water drum B thru means of a connection 35, the end chamber 33 communicates with the mud drum A thru means of the connection 36 and the intermediate chamber 34 communicates with the steam space of the drum B thru means of the connection 37. The connection 37 is provided with a vessel 38 at its highest point, which vessel is provided with cooling fins to insure condensation of any steam entering from the steam drum. Thus the pressure in the intermediate chamber 34 will always be substantially constant and equal to the head of water from the center of the diaphragm to the bottom of the portion 42 of the connection 37 which drains the vessel 38 back to the drum B.

It will thus be seen that the movement of the diaphragm 30 is roughly proportional to the total weight of water in the boiler and the movement of the diaphragm 29 varies with variations in the weight of water in the steam drum B. For reasons above pointed out, variations of weight of water through the steam drum B above the point of connection of line 35 are for practical purposes a sufficiently accurate index of the level of water in the steam drum B, and movement of diaphragm 29 may therefore also be said to vary with variations of level of water in the steam drum B. The two diaphragms 29 and 30 are connected through toggle lever means 39 to the valve 23*a* and are separately adjustable by means of springs 40 and 41, respectively. A small leakage around the feed valve 23*a* keeps the vessel 38 filled with water to the overflow portion 42 of the connection 37, the overflow returning to the drum B.

From the foregoing, it will be seen that I have provided a method and apparatus for automatically controlling the rate of feed water supply to a boiler in proportion to the total weight of water contained therein, as well as in accordance with the variation of level in the steam drum which enables more steady operation of boiler installations when producing very high rates of steam generation.

I claim:—

1. The method of controlling the water level in a boiler by regulating the water supply thereto which comprises supplying part of the feed water in accordance with the weight of water in the boiler irrespective of the water level therein, thru the medium of feed water supply control means responsive to the head of solid water equivalent to the mixture in the boiler, and part in accordance with control means responsive to the level of the water in the boiler.

2. In a system for controlling the water level and water supply in a boiler, means responsive to the level of water in the boiler for controlling feed water supply thereto, and means controlling feed water supply thereto responsive to the level of a column of water which in turn is responsive to the total weight of mixed steam and water in substantially the entire boiler.

3. In a system for controlling the water level and water supply in a boiler, a feed water supply line, and means controlling the rate of feed thru said line including a valve, means responsive to the level of water in the boiler for actuating said valve, a second valve, and means responsive to the total head of steam and water mixture in the boiler for actuating said second valve.

4. In a system for controlling the water level and water supply in a boiler, a pair of valves for controlling the feed, means responsive to the level of water in the boiler for operating one of the valves and means responsive to the total head of steam and water mixture in the boiler for operating the other valve.

5. In a system for controlling water supply in a boiler, a pair of valves for controlling the feed, means responsive to the level of water in the boiler for operating one of the valves and means responsive to the total head of mixed steam and water in the boiler for operating the other valve, the normal setting of said valves being such that the

valve operated by the last mentioned means admits more water than the other valve.

6. In a system for controlling water supply in a boiler, valve means for controlling the rate of feed into the boiler, and means for operating said valve means including a casing, a pair of spaced diaphragms dividing said casing into two end chambers and an intermediate chamber, a connection establishing communication between the lower part of the boiler and one end chamber, a connection establishing communication between the boiler at a point slightly below the normal water level thereof and the other end chamber, a connection establishing communication between the steam space of the boiler and the intermediate chamber, a vessel in said last mentioned connection for condensing steam entering the connection from the steam space so as to maintain a head of solid water in said connection, and means connecting said diaphragms to said valve means.

7. In a system for controlling water supply in a boiler, valve means for controlling the rate of feed into the boiler, and means for operating said valve means including a casing, a pair of spaced diaphragms dividing said casing into two end chambers and an intermediate chamber, a connection establishing communication between the lower part of the boiler and one end chamber, a connection establishing communication between the boiler at a point slightly below the normal water level thereof and the other end chamber, a connection establishing communication between the steam space of the boiler and the intermediate chamber, a vessel in said last mentioned connection for condensing steam entering the connection from the steam space so as to maintain a head of solid water in said connection, and toggle means connecting said diaphragms to said valve means.

8. In a system for controlling water supply in a boiler, valve means for controlling the rate of feed into the boiler, and means for operating said valve means including a casing, a pair of spaced diaphragms dividing said casing into two end chambers and an intermediate chamber, a connection establishing communication between the lower part of the boiler and one end chamber, a connection establishing communication between the boiler at a point slightly below the normal water level thereof and the other end chamber, a connection establishing communication between the steam space of the boiler and the intermediate chamber, a vessel in said last mentioned connection for condensing steam entering the connection from the steam space so as to maintain a head of solid water in said connection, and means connecting said diaphragms to said valve means, together with means for adjusting the aforesaid valve means.

9. In a system for controlling water supply in a boiler, valve means for controlling the rate of feed into the boiler, and means for operating said valve means including a casing, a pair of spaced diaphragms dividing said casing into two end chambers and an intermediate chamber, a connection establishing communication between the lower part of the boiler and one end chamber, a connection establishing communication between the boiler at a point slightly below the normal water level thereof and the other end chamber, a connection establishing communication between the steam space of the boiler and the intermediate chamber, a vessel in said last mentioned connection for condensing steam entering the connection from the steam space so as to maintain a head of solid water in said connection, and means connecting said diaphragms to said valve means, together with means for adjusting the aforesaid valve means, and means associated with said diaphragms offering resistance to movement thereof.

10. In a system for controlling water supply in a boiler, valve means for controlling the rate of feed into the boiler, and means for operating said valve means including a casing, a pair of spaced diaphragms dividing said casing into two end chambers and an intermediate chamber, a connection establishing communication between the lower part of the boiler and one end chamber, a connection establishing communication between the boiler at a point slightly below the normal water level thereof and the other end chamber, a connection establishing communication between the steam space of the boiler and the intermediate chamber, a vessel in said last mentioned connection for condensing steam entering the connection from the steam space so as to maintain a head of solid water in said connection, and means connecting said diaphragms to said valve means, together with means for adjusting the aforesaid valve means, and adjustable means associated with said diaphragms offering resistance to movement thereof.

11. The method of controlling the water level in a boiler by controlling a supply of feed water substantially in accordance with the water level and concurrently controlling a supply of feed water in accordance with the weight of the mixture of steam and water in the boiler.

12. The method of controlling the water level in a boiler by controlling a portion of the supply of feed water in accordance with the weight of the mixture of steam and water in the boiler and controlling a substantially smaller portion substantially in accordance with the water level in the boiler.

13. The method of controlling the water

level in a boiler by regulating the water supply thereto, which comprises controlling a supply of water in accordance with the weight of water in substantially the entire boiler and concurrently controlling a supply of water substantially in accordance with the weight of water in the steam drum.

14. The method of controlling the water level in a boiler by regulating the water supply thereto, which comprises controlling a supply of water in accordance with the weight of water in substantially the entire boiler, and concurrently controlling a supply of water substantially in accordance with the weight of water above a point in the boiler slightly below the normal water level thereof.

15. The method of controlling the water level in a boiler by regulating the water supply thereto, which comprises controlling a supply of water in accordance with the weight of water above a point substantially at the lowest part of the boiler and concurrently controlling a supply of water substantially in accordance with the weight of water above a point in the boiler slightly below the normal water level thereof.

In testimony whereof, I have hereunto signed my name.

WILLIAM L. DE BAUFRE.