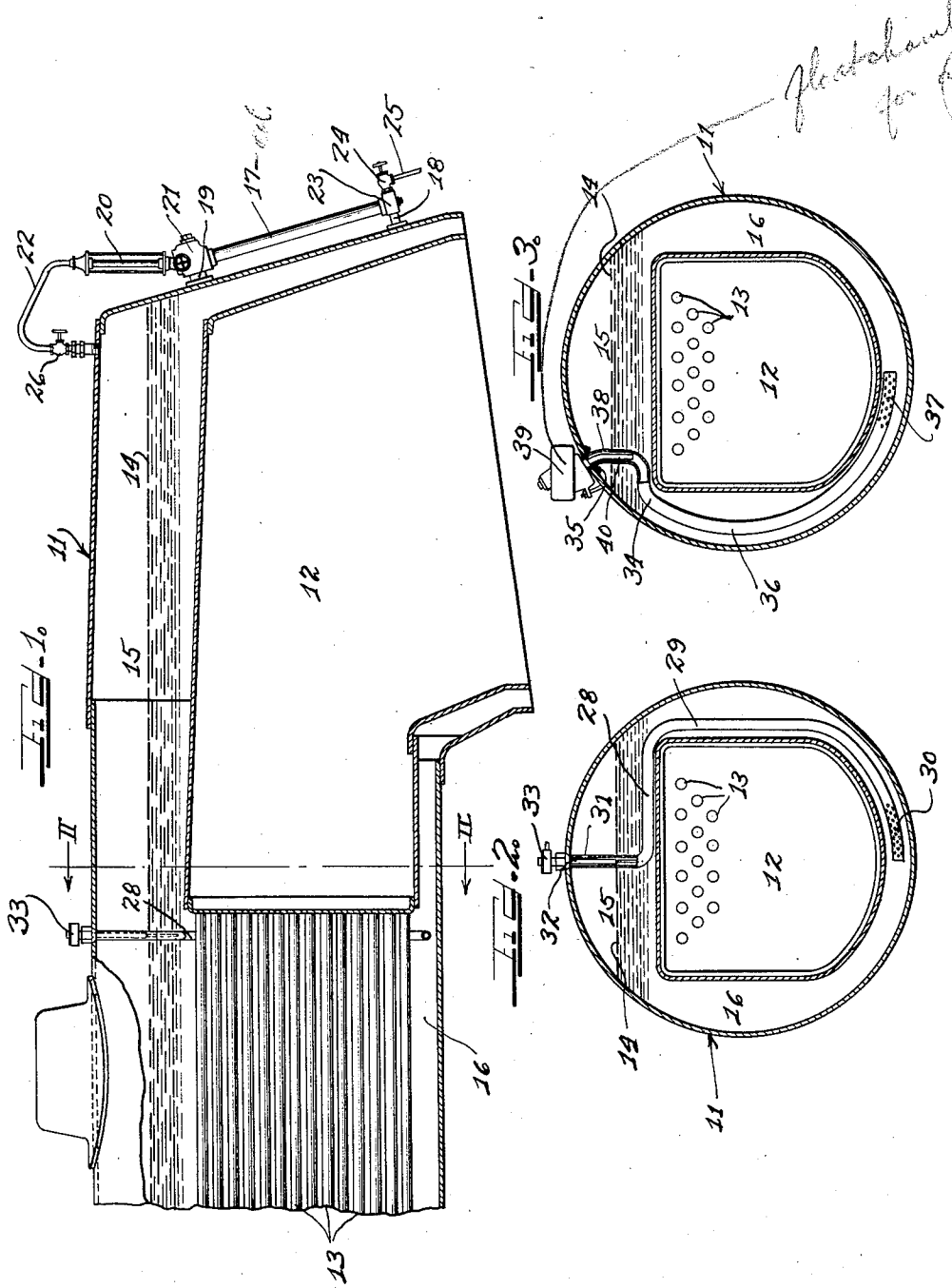
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Feb. 25, 1936. L. O. GUNDERSON 2,031,644

WATER LEVEL INDICATOR FOR STEAM BOILERS

Filed March 26, 1934 2 Sheets-Sheet 1



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Filed March 26, 1934 2 Sheets-Sheet 2

Fig. 4.

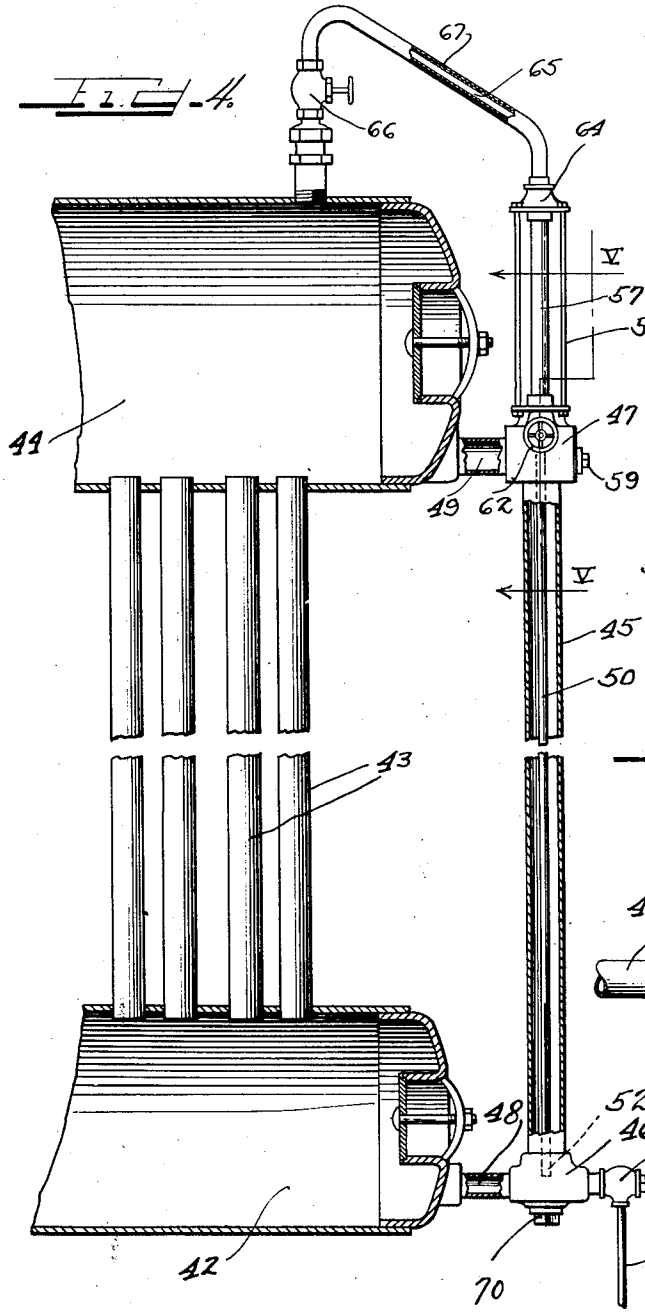


Fig. 5.

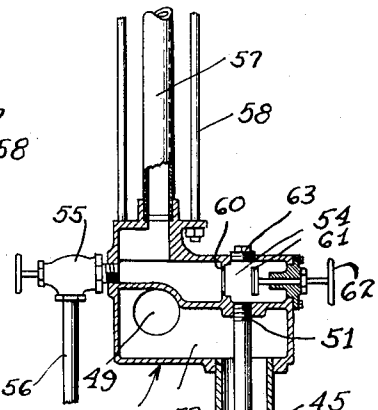
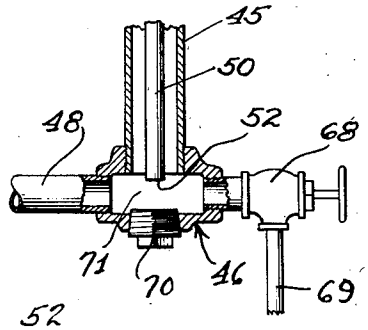


Fig. 6.



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2,031,644

UNITED STATES PATENT OFFICE

2,031,644

WATER LEVEL INDICATOR FOR STEAM BOILERS

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Application March 26, 1934, Serial No. 717,337

17 Claims. (Cl. 73—54)

This invention relates to improvements in apparatus for indicating the true water level or hydrostatic head in steam boilers at all times irrespective of the rate of steaming the boiler.

This application is a continuation-in-part of my application entitled "Water level indicator for steam boilers" Serial No. 634,836 filed September 26, 1932.

In the following description, the terms "true water level" and "static water level" are used to denote the plane which would represent the top surface of the water in the boiler provided that there was no active steaming therein or, in other words, with the water in a quiescent state.

The conventional sight glasses used on steam boilers are directly connected to the boiler by upper and lower legs communicating with the steam space and water space of the boiler respectively. It is known that the readings on these conventional sight glasses are erratic and do not conform with the actual static water level in the boiler. As a rule, the conventional sight glasses give abnormally high readings if the water within the boiler is chemically treated to overcome hardness.

Sometimes sight glasses are connected to individual water columns which have a lower leg connected to the water space and an upper end connected to the top of the steam space of the boiler. These sight glasses have been found to give erratic and unreliable indications of the actual static water level in the boiler but a slightly more correct reading is obtained because the lower leg of the water column is usually connected to the water space of the boiler somewhat lower down than the lower leg of sight glasses mounted directly on the boiler.

The lower down in the water space of the boiler that the lower leg of the water column is placed, the more accurate the sight reading will be until a point is reached below which no active steaming takes place. I have found that in most boilers there are interfering factors resulting in untrue water level indications in the sight glass if the lower leg of the customary water column is connected to, for example, a bottom drum of a Stirling type of boiler or to the mud ring of other types of boilers. In these instances when the boiler is steaming hard the water in the sight glass is sucked down and the readings become abnormally low and unreliable.

If the lower leg of the water column is located in a lower portion of the door sheet of a railway locomotive boiler the abnormally low readings become even more erratic when the throttle is opened and the boiler is steaming. During these times the water may be sucked entirely out of the bottom of the sight glass, showing no reading at all.

The cause of the abnormally low readings is the creation of a low pressure area throughout the lower confined portions of the boiler effected by the sudden rapid rising of steam bubbles directly above this area, caused when the steam is flowing rapidly from the boiler, as when the throttle of a locomotive boiler engine is opened. The buoyant steam bubbles displace the water around the upper portions of the hot fire box sheets or tubes so rapidly that a suction effect or reduced pressure area is created in the lower region, since the replacement water from the forward portion or top of the boiler is restricted in its flow by the narrow space between the sheets and back end wall of the boiler and by the frictional resistance in the circulation tubes, or in other more or less confined spaces of the various boiler structures.

Therefore, the conventional water column sight glass having a lower leg connected to the boiler below the region where active steam generation takes place will give erratic and unreliable readings because of the suction effect on the water in the column, which is proportional to the rate of steaming of the boiler.

In order to obtain a correct static water level reading, I have found that it is essential to provide a specially designed water column, the lower leg of which must be connected to the water space in the boiler at a point or plane below which no steaming takes place. The upper end of the column, as usual, is connected to the steam space. A sight glass, audible alarm or electrical indicating means may be used in connection with the water column to give visible indications of the actual water level.

I have designed a water column with special provisions to nullify the suction effect of the reduced pressure area and to also prevent the temporarily raised water in the boiler from affecting the reading of the indicator.

It is therefore an object of this invention to provide an apparatus for accurately indicating the true static water level in steam boilers.

Another object of this invention is to provide an improved water column for steam boiler water level indicators which is not affected by variations in the rate of steam production within the boiler.

A further object of this invention is to provide improvements in water level indicators which in-

sure accurate indications of the static water level within the boiler.

Another object of this invention is to provide a water column for water level sight glasses connected to steam boilers which is not influenced by the rate of steaming of the boiler.

Other and further objects of this invention will be apparent from the following description of the drawings which form a part of this disclosure.

On the drawings:

Figure 1 is a fragmentary sectional view, with parts in elevation, illustrating an embodiment of this invention.

Figure 2 is a cross-sectional view taken substantially along the line II—II of Figure 1.

Figure 3 is a cross-sectional view similar to Figure 2 but illustrating a modification of the water level indicating means.

Figure 4 is a fragmentary, broken, cross-sectional view, with parts in elevation, illustrating a modification of this invention applied to a Stirling type of boiler.

Figure 5 is an enlarged cross-sectional view taken substantially along the line V—V of Figure 4.

Figure 6 is an enlarged view of the lower end of the pipe shown in Figure 4.

As shown on the drawings:

Figures 1, 2 and 3 illustrate the adaptation of this invention together with various forms of water level indicating means to a locomotive boiler. The reference numeral 11 indicates a locomotive boiler, as a whole. The usual fire box is shown at 12 and the fire tubes at 13. The normal water level of the boiler is indicated at 14 defining thereabove the steam space 15 and therebelow the water space 16. The reference numeral 17 indicates a water column according to this invention having a lower leg 18 connected with the back head of a locomotive boiler and communicating with the water level between the back head and the fire box wall 12 at a point below which no steaming occurs. The upper end of the column 17 has a leg 19 communicating with the interior of the boiler through the back head thereof at a point approximating the normal position for the lower leg of conventional type sight glasses.

A sight glass 20 is connected with the water column 17 by means of a header connection 21 which will be more fully hereinafter described. The top of the sight glass 20 communicates through a tube 22 with the steam space 15 in the boiler at the top of the boiler 11.

The lower leg 18 communicates with the column 17 through a header connection 23. A blow-off valve 24 is connected to the header 23 for draining the column 17 through a drain line 25.

A valve 26 is inserted in the tube 22 for shutting off the steam connection with the sight glass when desired.

The water column and sight glass as secured to the back head of the locomotive boiler illustrates one form of my invention.

Another form of the invention is illustrated in Figures 1, 2 and 3 wherein the water column means are inserted in the boiler 11.

As shown in Figures 1 and 2, a tube 28 extends down into the boiler from the top thereof and is offset at 29 (Figure 2) so as to pass around the fire tubes 13. The tube 28 extends substantially into the bottom of the boiler beneath the tubes 13. The lower end of the tube 28 is perforated as shown at 30 (Figure 2) in order to give free access of the boiler water to the interior of the tube. The upper end of the tube is vented as shown at 31 so that the water in the tube is free to rise and fall in accordance with the static water level in the boiler. An electrode 32 having a connection 33 fits into the upper portion of the tube 28 and the lower end of the electrode 32 extends down to the hypothetical surface representing the static water level of the boiler. The electrode 32 is connected in an alarm circuit which is actuated when the water level in the boiler falls below the end of the electrode 32.

Figure 3 illustrates a further adaptation of this invention showing the use of a water column 34 similar to the tube 28 connected with an audible alarm 39 of any conventional type.

As shown in Figure 3, the tube 34 extends inwardly from an opening 35 in the top portion of the boiler shell. The tube is offset as at 36 to pass around the fire tubes 13 and extends to a point near the bottom of the boiler below which no active steam generation occurs. The tube 34 is perforated as shown at 37 so that the water in the boiler has free access to the interior of the tube. The tube 34 is also vented or perforated as shown at 38 so that the water level therein will indicate the true water level of the water in the boiler. Reference numeral 39 indicates a float chamber for an alarm whistle of any usual construction. The reference number 40 indicates a tube extending downward from the alarm whistle chamber which may contain a float device to open a valve when the water level drops below the level 14 and allow steam to pass through the chamber and actuate the whistle.

Figures 4, 5 and 6 illustrate the adaptation of one form of this invention to a Stirling type of boiler and show details of construction for the water column of this invention.

As shown in Figure 4 the reference numeral 42 indicates the lower or mud drum of a Stirling type boiler having water tubes 43 extending upwardly therefrom and communicating at their upper ends with a steam drum 44.

The water column of this invention is illustrated by the reference numeral 45 and has a bottom header 46 secured at the lower end thereof and a top header 47 secured at the top end. A lower leg 48 joins the header 46 with the mud drum 42 near the bottom thereof at a point below which no active generation of steam occurs. Likewise the header 47 is connected with the steam drum 44 by means of an upper leg 49 communicating with the interior of the steam drum at a point near the bottom thereof or immediately below the normal connection for a sight glass of the conventional type.

A tube 50 extends through the center of the column 45 in spaced relation from the inside wall thereof. The upper end of the tube 50 is secured in the header 47 as shown at 51 in Figure 5. The lower end of the tube 50 extends into the header 46 but terminates above the bottom thereof as shown at 52 in Figures 4 and 6.

As shown in Figure 5 the header 47 contains two passages 53 and 54 joining respectively the interior of the water column 45 with the boiler interior thru leg 49 and the interior of the tube 50 with a sight glass 57. The passageway 53 contains a plug opening 59 (Figure 4) in the end thereof to permit a cleaning of the interior of the passageway and the interior of the upper leg 49. The plug opening 59 is in lateral alignment with the interior of the upper leg 49.

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The passageway 54 is provided with a valve seat 60 for receiving thereagainst the plunger end 61 of a valve 62. This arrangement permits shutting off of the connection between the tube 50 and sight glass 57. A plug opening 63 is also provided in the top of the header 47 to permit a cleaning of the tube 50.

The upper end of the sight glass 57 terminates in a connection 64 communicating with a tube or pipe 65 leading to the steam space in the top of the steam boiler 44. The pipe 65 is provided with a valve 66 and is preferably lagged as shown at 67 to prevent condensation of the steam.

The lower header 46 as shown in Figures 4 and 6 is adapted to receive therein a blow-off valve 68 connecting the interior of the header with a drain pipe 69 and permitting a drainage of the columns 45 and 50. The bottom of the header 46 also contains an opening for receiving a plug 70 to permit a cleaning of the interior passageway 71 of the header and also to permit a cleaning of the tubes 45 and 50.

The lower leg 48 is formed with a smaller inside diameter than the upper leg 49. It is desirable to have the opening in the upper leg at least 25% greater in diameter than the opening in the lower leg to prevent any reduced pressure existing inside the boiler adjacent leg 48 from exerting any such effect in chamber 46 and tube 50. Any tendency toward reduced pressure in chamber 46 is therefore instantly and continually neutralized by the free flow of water and steam from the upper portion of the boiler thru column 45 and leg 49. The water column tube 45 should preferably have an inside cross-sectional area at least equal to the sum of the corresponding areas of the inside bore of the upper leg 49 and outside cross-section of tube 50.

The inner tube 50 should have a bore at least as great as the bore of the sight glass. To decrease likelihood of stoppage within the tube 50 it may be preferable to have about a 50% greater cross-sectional area therein than the cross-sectional area of the sight glass.

The tube 50 should extend downwardly to a plane below which active steaming in the mud drum does not occur. At the same time the end 52 of the tube 50 should not be influenced by the circulation of water through the column 45 into the lower leg 48. It is necessary to so position the end of the tube to prevent a Venturi action on the water within the tube.

From the above description it should be understood that the water column 45 receives water circulating between the mud drum and the steam drum. Since the lower leg of the water column is below the level at which active steaming takes place and since the lower leg 48 is smaller than the upper leg 49, circulation from the steam boiler downward to the mud drum will not be of a sufficient velocity to suck water in the tube 50 down out of its end 52.

Since the water in the steam drum is maintained above the upper leg 49 of the water column 45, it follows that the water in the tube 50 will rise into the sight glass 57. With the lower end of the tube 52 in communication with a point at which no active steaming takes place and with the upper end of the sight glass in communication with the steam chamber of the steam drum it is evident that an accurate reading of the true water level or static water level in the boiler should be obtained in the sight glass, irrespective of the displacement or buoying up of water by steam bubbles from one portion of the boiler to another.

However, due to condensation of steam in the sight glass 57 and in the steam pipe 65 it is reasonable to assume that sooner or later the sight glass and tube 50 will be filled with relatively pure condensed water, or distilled water. This pure distilled water may have a lower density than the boiler water and, as a consequence, the reading in the glass may be somewhat higher than the static water level in the boiler. When the boiler is highly concentrated with salts from hard water or added chemicals, it becomes necessary to blow out the glass 57 by opening the valve 55 and permitting the boiler water to replace the condensed water before taking the reading in the glass. If desired, the valve 55 may be automatic and set to open at regular intervals. To decrease the steam condensation in the sight glass the steam pipe 65 is thoroughly lagged as shown at 67.

In some instances it may be desirable to have the tube 50 somewhat shorter than shown in Figures 4 and 6. If the cross-sectional area of the lower leg 48 is made a smaller fractional part of the cross-sectional area of the upper leg 49, the tube 50 may be shortened but, in no event, should it be shortened to terminate above the level of non-steaming area in the boiler because of potential errors.

While the sight-glass means for taking the water level reading have been shown in Figures 1, 4 and 5 it should be understood that any reading means may be used, such as for example the electric means shown in Figure 2 or the audible alarm means shown in Figure 3.

The water level reading shown in the sight glass or other indicating means will not fluctuate due to variations in steam load or rate of evaporation, as is common in present water level indicating means. When the steam is rapidly withdrawn from the boiler the rate of evaporation of the water therein is increased resulting in increased circulation of water and as pointed out above causing a reduced pressure area in the lower portion of the boiler. This normally creates a suction effect through the lower leg 48 of the water column, but, because of the free and unrestricted flow of water into the column from the larger upper leg 49 the suction effect is immediately neutralized. Thus the suction effect cannot be transmitted to the tube 50 which communicates with the sight glass and therefore the reading in the glass is not disturbed.

Since there is no "solid" water or undisturbed water in the upper portion of the boiler the suction in the lower portion thereof through the lower leg 48 causes a mixture of water and bubbles to enter into the column 45 through the upper leg 49. At a very high steaming rate the solid water level in the column 45 may be reduced many inches below the level of the upper leg 49 without in any way affecting the column of water in the tube 50.

My apparatus is also readily adapted to indicate the density of the water in the boiler by merely allowing the column 50 and the sight glass 57 to fill with distilled water. The reading in the sight glass will then be higher than the reading obtained when the water tube 50 is blown down and filled with boiler water. The difference of the two readings is an accurate measure of the difference in density of the boiler water and distilled water. If desired, two units of the apparatus may be used side by side to indicate density at one reading. In that case, one of the units

will have the lagging removed from the steam pipe 65 and need not be equipped with a blow down valve 55. The difference in level readings of the two glasses after blowing down the one of the units indicates the density of the boiler water.

Having now described my invention, I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the prior art.

I claim:

1. Apparatus for indicating the static water level in steam boilers in operation which comprises a pipe in spaced relation from said boiler, an upper leg connecting the top of said pipe with the boiler at a point near the top of the boiler immediately below the normal water level therein, a lower leg of smaller flow capacity than said upper leg connecting the lower end of said pipe with the boiler at a point below the level of active steam formation therein, a tube extending through said pipe and terminating above the lower leg connection thereon and visible means connected to said tube for indicating the height of water in the boiler.

2. Apparatus for indicating the static water level in steam boilers which comprises a pipe in spaced relation from said boiler, a lower leg connecting the end of said pipe with a point near the bottom of said boiler below which active steam formation can not occur, a larger upper leg connecting the top of said pipe with the boiler at a point near the top thereof below the water level therein, a tube extending through said pipe terminating in spaced relation from the bottom leg connection thereof, and a visible water level indicator vented to the steam space of the boiler in communication with the top of said tube.

3. Apparatus for indicating the true water level in steam boilers which comprises a pipe, a lower leg on said pipe with restricted flow capacity in communication with a steam boiler at a point below the level of active steam formation therein, a connection providing an unrestricted flow of boiler water from near the top of the boiler to the top of said pipe, a tube extending through said pipe terminating in spaced relation from the bottom thereof, and a water level indicating means secured to said tube, said lower leg pipe connection being restricted in size to prevent too rapid downward circulation of water through the pipe when the boiler is steaming hard.

4. Static water level indicating means for steam boilers comprising a pipe, a lower header for the bottom of said pipe, an upper header for the top of said pipe, a lower leg joining the lower header with the interior of the boiler at a point below which no active steam formation occurs therein, an upper leg joining the upper header with the boiler at a point slightly below the normal level of the water therein, said upper leg having a larger inside diameter than said lower leg to prevent a too rapid downward circulation of water through the pipe, a tube extending into said pipe having a free end in spaced relation from the lower header, water level indicating means in communication with said tube, means in said header for permitting a cleaning and draining of the tube and pipe and blow-off means in said upper header for draining the tube.

5. Static water level indicating apparatus for steam boilers comprising a pipe having a lower connection in communication with the steam boiler at a point below the level of active steam formation therein and a larger upper connection in communication with the boiler near the top water level therein, said connections permitting a predetermined flow of boiler water through the pipe, a tube in said pipe having a free lower end spaced from the bottom thereof and a sight glass vented to the steam space of the boiler in communication with the top of said tube.

6. Apparatus of the class described comprising a pipe extending vertically in spaced relation from a steam boiler, a lower leg on said pipe communicating with the boiler at a point below which no active steaming occurs, an upper leg on said pipe having at least a 25% greater flow capacity than said lower leg communicating with the boiler immediately below the normal water level therein, a tube extending into said pipe having a free end terminating near the bottom thereof and communicating at its top end with a sight glass vented to the steam space of the boiler.

7. Apparatus for indicating the static water level of steam boilers in operation which comprises a tube in communication with the interior of a steam boiler at a point below the level of active formation of steam therein and at a point near the top thereof, and means for indicating the level of water within the tube including an electrode extending into the upper end of said tube at least to the normal level of the water therein.

8. Apparatus for indicating the static water level of steam boilers in operation which comprises a tube for insertion wholly within said boiler having a lower end opening below the level of active steam generation in the boiler in a location not subject to reduced pressure resulting from the operation of the boiler, and having an upper end opening into the steam space of the boiler, and an indicating device extending into the upper end of said tube and actuated by the water therein when the water varies from its normal level.

9. Apparatus for indicating the static head of water within locomotive steam boilers comprising a tube for insertion wholly within said boiler adjacent the fire tubes thereof having a lower open end terminating at a point below the level of active steam generation and an upper end vented to the steam space, and means for indicating the level of the water within said tube including an electrode extending into the upper end of said tube at least to the normal level of the water therein.

10. Apparatus for indicating the true water level in steam boilers which comprises, in combination with a steam boiler, a tube for receiving water from the boiler having a lower open end in communication with the interior of the boiler at a point below the level of active steam generation therein, a second tube within said first mentioned tube surrounded by the water therein and having a lower open end below the level of active steam generation in the boiler, means connected with the first tube to prevent reduced pressures formed in this level of the boiler from creating a suction effect upon water in the second tube and a water level indicating device connected with the second tube.

11. In an apparatus for indicating the true water level in steam boilers, in combination with a steam boiler, a pipe having a lower end communicating with the boiler below the level of active steam formation therein and having an upper end communicating with the boiler near the top

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thereof, a tube within said pipe having a lower open end communicating with the water in the pipe at a point below the level of active steam generation in the boiler, a restricted orifice in the bottom of said pipe to regulate the flow of boiler water through the pipe and a water level indicating device communicating with said tube.

12. Apparatus for indicating the static level of water in steam boilers in operation which comprises a tube in communication with the boiler at a point below the active steam formation therein in a location not subjected to reduced pressure resulting from the operation of the boiler and also at a point near the top of the boiler, and a water level indicating means communicating with said tube.

13. Apparatus for indicating the static water level of steam boilers in operation which comprises a tube having a lower end in communication with the boiler at a point in the boiler below the level of active steam generation in a location not subjected to reduced pressure resulting from operation of the boiler and having an upper end in communication with the steam space of the boiler and means communicating with said tube at the upper end thereof to indicate the level of water in the tube.

14. Apparatus for indicating the static head of water within steam boilers comprising a tube for insertion wholly within a boiler having a lower open end terminating at a point below the level of active steam generation in a location not subject to reduced pressure resulting from the operation of the boiler and an upper end vented to the steam space and means for indicating the level of water within said tube including an electrode extending into the upper end of said tube to the minimum safe water level in the boiler.

15. In combination with a steam boiler, means for indicating the static level of the water therein comprising a tube wholly within said boiler having a lower open end below the level of active steam generation in a relatively quiescent water area and having an upper end opening to the steam space and an indicating device extending into the upper end of said tube and actuated by the water therein falling below a predetermined minimum safe level.

16. Apparatus for indicating the static water level of steam boilers in operation which comprises a tube for insertion wholly within said boiler having a lower open end terminating at a point below the level of active steam generation in the boiler in a location not subjected to reduced pressure resulting from the operation of the boiler and an indicating means extending into the upper end of said tube, the upper end of said tube also communicating with the steam space of the boiler.

17. Apparatus for indicating the static level of water in steam boilers in operation which comprises a tube in communication with the boiler at a point below the active steam formation therein in a location not subjected to reduced pressure resulting from the operation of the boiler, and also at a point near the top of the boiler, a second tube having a free lower end extending into said first mentioned tube at least to the normal level of the water therein and an audible alarm communicating with such said second tube and adapted to be actuated by steam pressure within the boiler when the level of the water in the first mentioned tube falls below the free end of said second tube.

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