R. W. ANDREWS.

METHOD OF FEEDING WATER TO BOILERS.

APPLICATION FILED OCT. 19, 1914.

1,148,483. Patented July 27, 1915.

Fig. 1.

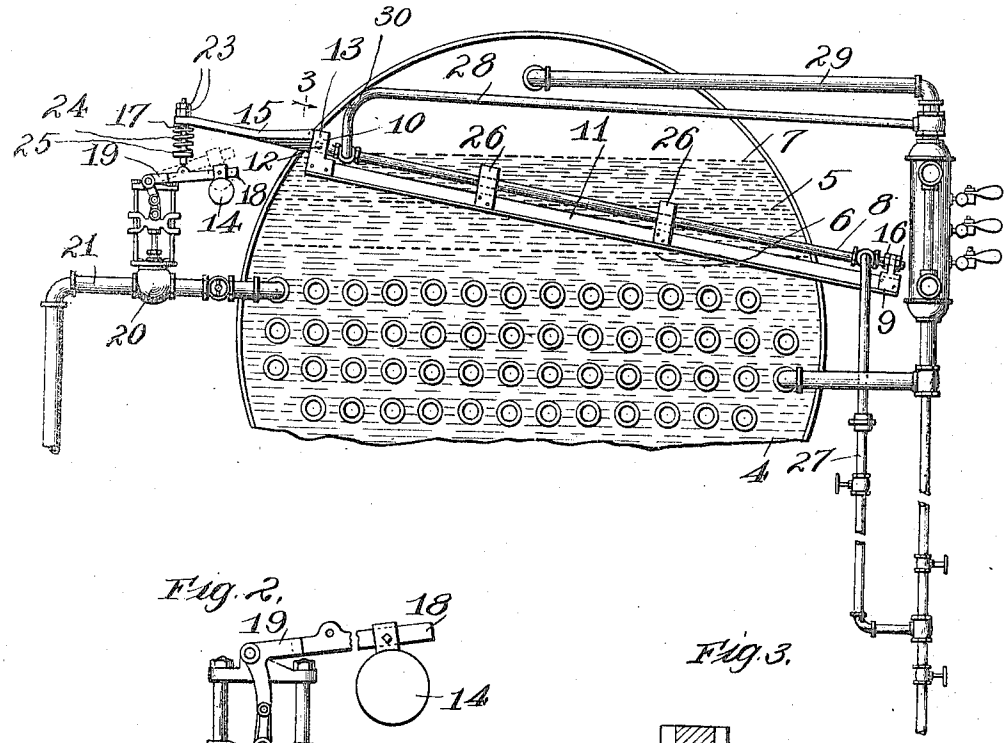


Fig. 2.

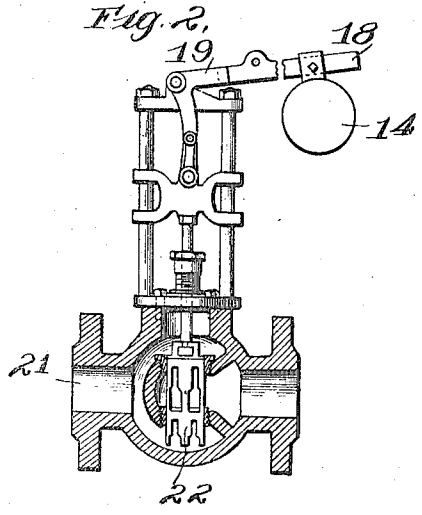
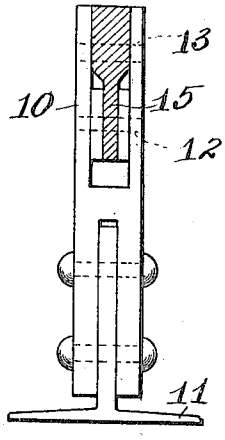


Fig. 3.



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UNITED STATES PATENT OFFICE.

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METHOD OF FEEDING WATER TO BOILERS.

1,148,483. Specification of Letters Patent. Patented July 27, 1915.

Original application filed October 3, 1913, Serial No. 793,159. Divided and this application filed October 19, 1914. Serial No. 867,337.

To all whom it may concern:

Be it known that I, ROGER W. ANDREWS, a citizen of the United States, residing at Lombard, in the county of Dupage and State of Illinois, have invented certain new and useful Improvements in Methods of Feeding Water to Boilers, of which the following is a specification.

This invention relates to methods of feeding water to boilers, and this application is a division of my application Serial No. 793,159, filed October 3, 1913, for boiler feed-water regulators.

The object of the invention is to provide a method for feeding water to boilers, particularly those used for steam power purposes, in such a manner as to increase the economy of operation and the power capacity of the boiler and furnace.

The efficiency of the furnace of a boiler depends more or less upon the rate of combustion of the coal; at a certain rate the efficiency, so far as the combustion is concerned, will be at a maximum; if this rate is increased or decreased there will be more or less falling off in the efficiency. In case of boilers carrying variable loads, however, in order to meet the requirements of a heavier load, ordinarily the rate of combustion is increased. By my method of feeding the boiler this increase in the rate of combustion may be more or less eliminated. Ordinarily the need of increased combustion is due partly to the increased amount of steam that must be supplied to the load, and partly to the increased amount of water that must be supplied to the boiler and then heated in maintaining constant the level in the boiler. If now in some dependable manner, such as by the use of the apparatus hereinafter described, the flow of water into the boiler when the heavy load occurs is made somewhat less than the outflow in the form of steam, the fire burden is proportionately decreased, so that the rate of increase of combustion may be less or may be entirely eliminated. Thus my method of feeding boilers consists, in part, in feeding the water as the load is increasing so that the increase in inflow will lag behind the increase in outflow, and hence less heat energy is required to heat the incoming water. If, however, the inflow to the boiler is less than the outflow, necessarily the water level in the boiler will descend, and hence the margin of safety between the normal water level and the minimum permissible water level is decreased. For this, and other reasons, in the past, it has been thought unwise to allow the water level to vary. Another reason for this is that so long as the water level remains substantially constant the water tender is assured that nothing abnormal is occurring. But if the tender finds the level sinking, it becomes necessary for him to determine whether it is due to some abnormal condition so as to be a source of danger, or whether it is a mere normal variation due to the heavy load. Hence, the effort has been in the past to maintain as constant as possible the water level in the boiler. By my method of feeding, however, these dangers and inconveniences from variations in water level are decreased or eliminated. My method is to allow the water to descend only when a heavier load occurs and to allow the descent to continue only until a minimum permissible limit is reached, no matter how heavy or long continued the load may be; and to do this in an entirely safe and dependable manner so that the margin of safety hereinabove referred to may be materially decreased without increasing the actual hazards incident to the boiler use. Further, irregularities or variations in the rate of combustion are necessary not only because of the variations in the load on the boiler, but also because of variations in the feed of water to the boiler. Necessarily if an increased amount of water is being fed to the boiler, even though the steam load is constant, an increased rate of combustion is necessary to maintain constant the steam pressure. Hence, another object of my method of feeding the water is to eliminate irregularities in the feed and to maintain constant at all times the feed when the load itself becomes constant. In general, then, the method consists in producing a continuous and constant flow of water into the boiler so long as the load is constant; in causing the change in inflow to lag behind the change in outflow when the load is increasing, but to gradually become equal to the outflow when the load becomes constant no matter what the load may be; so that for every different

load, so long as the load is constant, a different constant water level corresponding to the particular load is maintained. On the other hand, as the load lightens, the outflow decreases, but the change in inflow again lags behind the change in outflow, whether the load lightens from the maximum or the normal or any intermediate load, and again as the load becomes constant, a constant level corresponding to the load is soon reached. By this method heat energy is stored in the boiler during decreasing and light loads for use during increasing and heavy loads; and by carrying out this method in a definite unvarying and dependable manner the hazards incident to boiler use are decreased rather than increased.

In carrying out my method of supplying water to boilers, various means may be used. I prefer, however, the apparatus illustrated by the accompanying drawings, in which—

Figure 1 is an elevation partly in section of a boiler and a feed water regulator by means of which my method may be carried out; Fig. 2 is a section of the special form of feed water valve used in connection with the regulator; and Fig. 3 is a section of a portion of the regulator along the line 3 of Fig. 1.

In the drawings, the boiler is indicated by the reference number 4. The normal or average water level in the boiler is indicated by the dotted line 5, the minimum permissible water level is indicated by the dotted line 6, and the maximum permissible water level by the dotted line 7. The feed water regulator in this instance comprises an expansion tube 8 mounted on the supports 9 and 10, which are fixed in any suitable manner to the T-base 11. The base 11 is supported in any suitable manner in such a way as to bring the central portion of the expansion tube 8 in substantially the same horizontal plane as the normal water level in the boiler; the lower end of the expansion tube at about the same elevation as the minimum permissible water level, and the upper end of the expansion tube at about the same level as the maximum permissible water level.

Pivoted to the upper end of the support 10 by means of the pin 13, or in any other suitable manner, is a lever 15. The upper end of the expansion tube 8 is pivoted at the point 12 to the short arm of the lever 15; and connected to the outer end of the long arm of the lever is any suitable member such as a rod 17, which supports a long arm 18 of a second lever 19. The lever 19 is adapted to operate the feed water valve 20 of the supply pipe 21. Pressure may be applied to the water in the supply pipe in any suitable manner. A weight 14 eliminates at all times any loose play in the connection between the expansion tube 8 and the lever 19, and also causes the valve to operate, when allowed to do so, by the contraction of the expansion tube 8.

The location of the upper end of the expansion tube 8, with reference to the fulcrum 13 of the lever 15, may be adjusted by means of nuts 16; and the relation of the position of the valve piston 22 to the outer end of the long arm of the lever 15 may be adjusted by means of nuts 23. If, for any reason, the weight 14 should not be sufficiently heavy to actuate the piston 22 of the valve 20 when the tube 8 contracts, the long arm of the lever 15 will press downward on the spring 24, which is supported by a collar 25 fixed to the rod 17, and this pressure will assist the weight in operating the valve. Braces 26 fixed to the base prevent buckling of the expansion tube.

A consideration of the apparatus described will show that as the expansion tube expands the outer end of the long arm of the lever 15 will be raised, the weighted arm of the lever 19 will be raised, and the valve 20 will be opened. The lower end of the expansion tube 8 is connected to the boiler below the minimum permissible water level of the boiler by means of the pipe 27; and the upper end of the expansion tube is connected to the boiler at or above the maximum permissible water level by means of the pipes 28 and 29; so that water from the boiler can pass freely into the lower end of the expansion tube, and steam from the boiler can pass freely into the upper end of the expansion tube. As a consequence of this manner of connecting tube 8 to the boiler, the elevation of the water in the tube will depend upon the elevation of the water in the boiler; and the upper end of the tube which contains steam will be at the same temperature as the steam in the boiler, while the lower end of the tube which contains water will be at a lower temperature. Even though the water when it enters the tube may be of substantially the same temperature as the steam, yet it will rapidly radiate heat and cool to a lower temperature; and as there is no material interchange of the water in the tube and in the boiler, the water in the tube will necessarily be substantially at all times somewhat materially lower in temperature than the water or the steam in the boiler. The inclination of pipe 28 downward from the bend 30 to the pipe 29 allows the condensed water in pipe 28 to flow into the boiler instead of into the tube 8, and thus prevents undue heating of the water in the tube. Now, it is evident that under these circumstances, as the water level in the boiler lowers, the water in the tube will be correspondingly replaced by steam, a greater length of the tube will become of the temperature of the steam, and the tube will expand. The valve 20 will then be opened

farther than before and more water will pass into the boiler, offsetting more or less the tendency of the water level in the boiler to sink. On the other hand if the load is light, less steam being used, the water level in the boiler will tend to rise, the tube will receive more water, will become cooler, and will contract; the valve then will be closed more than before and the supply of water will be diminished. So that the tendency of the water in the boiler to rise will also diminish. There will thus be a tendency to maintain uniform the elevation of the water level. However, by the use of a short expansion tube, or a tube with low coefficient of thermal expansion, or by a suitable valve opening, or by a proper adjustment of the connections between the tube and the valve, the variations in the valve opening due to changes in lengths of the expansion tube may be sufficiently slight, so that in case of a heavy load on the boiler the inflow of water will be less than the consumption of water, and the water in the boiler will sink. On the other hand, by such means, in case of a light load the inflow may be made greater than the consumption of water and the water will rise.

In order to more fully control the flow of water to the boiler and cause it to vary more definitely with reference to the variations in load, so as to more properly relate the supply of water to the needs of the boiler, a balanced valve may be used with the regulator. By the use of such a valve the pressure tending to open the valve will always equal the pressure tending to close the valve, and its operation will be more sensitive. I have discovered also that a differential valve is sometimes desirable; that is, one in which the rate of opening of the valve varies differently from the rate of motion of the valve piston; also that it is sometimes desirable to use a valve such as may be called a graduated valve; that is, one in which the variations in the openings are by steps or graduated. By the use of the differential valve, the rate of variation of the flow may be unlike the rate of movement of the valve, so that the feed may be adapted to various conditions which may exist. By the use of the graduated valve, when desired, the valve ports may be such that the openings increase very rapidly about the time that the water reaches the minimum safe limit, so as to make it impossible for the water to sink below the danger line.

By the use of this regulator, it will be found that not only is there a continuous feed to the boiler at all times when the boiler is under load, but instead of the variations in feed being coincident and equal to the variations in steam requirements, there is a predetermined amount of lag in the variations in feed which relieves the boiler at times of heavy loads and allows the storage of heat energy during periods of light loads. The arrangement is also such that in case of a very light load or no load, the feed valve will be nearly or entirely closed, and when heavy loads are long continued or excessive the inflow becomes equal to the outflow, and sufficient water is thereby insured. In fact, at any time when the load becomes constant, whether light, heavy or intermediate, the level will become constant at a point depending upon the amount of load, each load on the boiler having its corresponding water level. By this method it will be seen that not only may the fire be maintained more constant but also the capacity of the boiler may be materially increased.

Although I have shown and described particular means for carrying out my method for supplying water to boilers, yet many other means may be used for the purpose. It is necessary only to have means which are so affected by variations in the water level in the boiler as to cause in a dependable manner, predetermined variations in the means supplying water to the boiler, so that the variations in the amount of water supplied shall lag behind the variations in the level, in accordance with my method. I have particularly specified how this lag may be produced in case of the apparatus which I prefer, but the same result may also be obtained with any suitable apparatus by increasing the length or decreasing the size of the water pipe 27. The longer or the smaller this pipe, the greater the length of time required for variations in water level in the boiler to cause corresponding variations in the feed-water regulating apparatus. So that by the use of a pipe of this nature operatively connecting the water level in the boiler with the mechanism which is to be used in carrying out the method, the lag may be controlled as desired. Also, as a part of my method, in case of such material increase in load as to tend to exhaust the steam supply, or such decrease in load as to cause dangerous steam pressure in the boiler, I decrease temporarily the flow of water when the load increases, and increase temporarily the flow when the load decreases. By having the operating mechanism affected directly by the water level in the manner described, this result is produced as follows: When a heavy increase in load comes suddenly upon the boiler, there follows a corresponding decrease in steam pressure in the boiler and hence an increase in water level due to the intrained steam in the water expanding, together with submerged water flashing into steam because of the reduced pressure. Hence there is thus a corresponding increase in elevation of the water in the thermostatic tube, and c

corresponding closing down of the valve; all of which is temporary due to the fact that the increased outflow of steam quickly lowers the water in the boiler and reverses the operation of the mechanism. Conversely, in case of a sudden decrease in load and a consequent increase in pressure, there is a temporary forcing down of the water level and hence a temporary increasing of the water feed which tends to cool down the boiler contents and opposes increase in pressure. This also allows more constant fire, decreases hazard, and increases the boiler capacity. And this occurs whenever there is a sudden change in load whatever the water level may be at that time.

I claim as my invention:

1. A method of feeding water to boilers consisting in causing the inflow to be continuous at all times and to exceed the outflow when the outflow is decreasing, to substantially equal the outflow when the outflow is normal, and to be less than the outflow when the outflow is increasing, and in causing the inflow to become equal to the outflow when the outflow above normal is excessive or long continued.

2. A method of feeding water to boilers consisting in causing the inflow to substantially equal the outflow while the load is constant, and in causing the rate of change of the inflow to lag behind the rate of change of the outflow while the outflow varies.

3. A method of feeding water to boilers consisting in causing the inflow to substantially equal the outflow while the load is constant, in causing the rate of change of the inflow to lag behind the rate of change of the outflow while the outflow varies, and in causing the relation of the inflow to the outflow to be always the same under similar load conditions.

4. A method of feeding water to boilers consisting in causing the water level to have at all times a definite and predetermined relation to the load on the boiler, that relation consisting in part in the water level varying inversely as the load on the boiler varies, and consisting further in the water level becoming constant at an elevation corresponding to the particular load on the boiler when the load becomes constant.

5. A method of feeding water to boilers consisting in causing the water level to first vary directly as the load varies when the change in load occurs, in causing the water level to then vary inversely as the load continues to vary, and in causing the water level finally to become constant when the load becomes constant.

6. A method of feeding water to boilers consisting in causing the water level to have a definite and predetermined relation to the load on the boiler, in causing each load on the boiler to produce a corresponding water level, but in limiting the possible variation in water level within certain predetermined limits irrespective of the load upon the boiler.

7. A method of feeding water to a boiler consisting in varying the level of water in the boiler directly as the load when sudden material changes in load occur, then, as the change in load continues, in varying the level inversely as the load, and finally, as the load becomes constant, in causing the water level to remain constant.

8. A method of feeding water to boilers consisting in causing the inflow to substantially equal the outflow while the load is constant, but in causing the change in rate of inflow to lag behind the change in rate of the outflow when the rate of outflow varies.

9. A method of feeding water to boilers consisting in causing the inflow to substantially equal the outflow while the load is constant; in causing changes in rate of inflow to lag behind changes in rate of outflow; in causing the rate of inflow to vary temporarily inversely as the rate of outflow when a change in rate of outflow occurs; and in then causing the rate of change of the inflow to lag behind the rate of change of the outflow while the rate of outflow varies.

In testimony whereof, I hereunto set my hand in the presence of two witnesses.

ROGER W. ANDREWS.

In the presence of—

LANNA LONG,

MARGARET H. MANN.