An electrode boiler in which the electrodes are enclosed in a steam generating compartment surrounded by a control compartment, the boiler load being controlled by transfer of boiler water between the steam generating and control compartments and the feedwater supply being regulated by means responsive to the water level in the control compartment referred to as the controlled water level. The improvement of the boiler of the present invention includes the use of a float-operated feedwater regulator made responsive to a reference water level having a delayed response to the controlled water level. The delay is obtained by the use of a throttling device located in the water communication between the reference and the controlled water levels. The boiler water conductivity control means for boilers operated at low voltage includes an external piped circuit in which the conductivity measuring device is located and through which boiler water is made to flow by means of a hydraulic ejector located in the feedwater supply pipe. A conductivity control piping arrangement is also provided whereby the boiler water discharged for conductivity control is taken from the external piped circuit.

8 Claims, 2 Drawing Figures
FIG. 1
Fig. 2
LOW VOLTAGE ELECTRIC BOILERS

BACKGROUND OF INVENTION

Field of the Invention

The present invention relates to improvements in electrode boilers.

SUMMARY OF INVENTION

It is an object of the present invention to improve the feedwater regulation of electrode boilers and to provide an electrode boiler suitable for low voltage operation.

In accordance with the present invention, there is provided the improvement in an electrode boiler in which the electrodes are enclosed in a steam generating compartment surrounded by a control compartment, the boiler load being controlled by transfer of boiler water between the steam generating and control compartments and the feedwater supply being regulated by means responsive to the water level in the control compartment referred to as the controlled water level. The improvement comprises a float-operated feedwater regulator responsive to a reference water level and having a delayed response to the controlled water level. The delayed response is obtained by a throttling device located in the water flow path between the reference and controlled water levels. The improvement further comprises means for providing an electrode boiler suitable for low voltage operation.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will now be described in greater detail with particular reference to the accompanying Examples, in which:

FIG. 1 shows schematically and in sectional view a preferred embodiment of the low voltage electric boiler according to the present invention;

FIG. 2 shows schematically the boiler feed water make-up tank with associated apparatus.

DESCRIPTION OF PREFERRED EMBODIMENTS

A six-electrode boiler is illustrated schematically in FIG. 1, in which conventional parts of the boiler are not illustrated. A boiler shell 1 is divided into an upper steam outlet compartment and lower section by diaphragm plate 2. A cylindrical neutral wall 3 divides the lower section into the steam generating compartment, in which the electrodes are symmetrically arranged, and the outer control compartment. Steam is discharged from the top of the control compartment through throttling valve 11 to the feedwater heater 14, FIG. 2, at a constant adjustable rate. Best operation requires adjustment equal to about 1 percent of the boiler rated capacity. Boiler steam pressure controller 12 with control valve 13 varies the rate of admission of steam to the control compartment in response to boiler steam pressure variations, thereby providing proportional-speed floating action with WL2 (water level 2) serving as the final control element. There is also self-regulation. If the boiler steam pressure deviates from the set point of controller 12, the change in pressure causes WL2 to move in the direction tending to restore normal steam pressure. At times of decreasing load the self-regulation is further modulated by condensation of steam in the control compartment owing to water of a temperature lower than that of saturation rising from the bottom of the boiler.

FEEDWATER REGULATION

Feedwater controller 6, in response to WL3, functions to control the amount of water in the boiler required to provide storage water and steam space in the control compartment for transfer of water to or from the steam generating compartment to effect changes in boiler load.

As shown schematically, controller 6 has a control valve 7 directly float-operated, which goes through its full operating range of travel with moderate changes in the water level actuating the float.

Since the boiler steam pressure is maintained constant, the feedwater must be heated to saturation temperature as it enters the steam generating compartment. Normally about 10 percent of the boiler power input is used for this purpose. If valve 7 is fully closed about 10 percent of the boiler power input is therefore removed and if it fully opens the boiler power input is greatly increased, in either case with no change in the rate of steam generation. If the operation of valve 7 were directly responsive to momentary changes in WL3 the boiler operation would therefore be unstable. Throttling valve 8 is used to obtain a reference water level, WL4, which does not respond appreciably to momentary changes in WL3. Sediment remover 9 screens out suspended matter that might otherwise interfere with the throttling action.

The rate of change of WL4 is proportional to the difference between WL3 and WL4. For example, if the throttling position of valve 8 were such that WL4 approaches WL3 at the rate of 1 inch in 5 minutes when the difference between WL3 and WL4 is 1 inch, as this difference in level increases, the rate of change in WL4 increases proportionally. Consistent with A.S.M.E. terminology, the throttling action of valve 8 provides the feedwater controller with proportional adjustable-speed floating action.

CONDUCTIVITY CONTROL

The boiler is design for full load operation with water in the steam generating compartment of a given conductivity which is adjusted on start-up by adding a suitable salt solution to the boiler water through funnel 22 with valve 21 open to release air and maintain atmospheric boiler pressure. If the boiler were operated in a closed heating system having no leakage losses, no further adjustment of the conductivity would be required. There are, however, leakage losses of steam and condensate which are replaced with make-up water having a greater salt content and higher conductivity than the equivalent amount of leakage, thereby increasing the conductivity of the boiler feedwater and hence that of the boiler water. It is essential, however, that the boiler be designed for boiler water having a conductivity greater than that of the feedwater.

Conductivity controller 15 with conductivity cell 16 and valve 19 function to limit the rise in boiler water conductivity. When it rises above the set point of the controller, valve 19 opens to discharge boiler water which is replaced with feedwater of a lower conductivity, thus reducing the boiler water conductivity to normal. Conductivity cell 16 in pipe fitting 17 measures the conductivity of boiler water circulated through an external piped circuit by hydraulic ejector 10 which
also serves to give the feed-water entering the boiler sufficient velocity to reach the steam generating compartment, thus preventing a greater than normal portion of it going directly towards the conductivity cell. The bleed water is preferably taken, as shown, from the external piped circuit. Valve 18 is throttled to limit the rate of bleed and check valve 20 prevents reverse flow.

LOW LIMIT OF BOILER LOAD

If, during light loads, the water level is allowed to make and break circuit with the electrode tips, sparking or flashing occurs of sufficient intensity to cause electrode wastage. In a preferred embodiment, to prevent this operating condition, standpipe 4 is provided which serves to obtain a low limit of water level and the electrode tips are designed to obtain at this level a boiler load of between 2 and 3 percent of the boiler rated capacity.

RETENTION OF GROUND CURRENTS

Preferably, a ring conductor 5, passing under the tips of the electrodes, is mechanically and electrically connected with the bottom of neutral wall 3 by means of support bars 5a to limit the amount of stray electrode current reaching the bottom of the boiler where it tends to cause pitting.

The preferred embodiments of the present invention have been described in detail. Various modifications can be made without departing from the spirit of the invention.

Apart from the obvious modifications to the basic design of the electrode boiler such as, for example, the use of a different number of electrodes or the enclosure of all electrodes in a single shell, which can be cylindrical or made with lobes each partially surrounding an electrode. More specifically departures from the herein described invention can be made as follows:

Throttling valve 8 can be replaced with an orifice of predetermined size. Also, each one or both of parts 8 and 9 can be made integral parts of controller 6.

An electrode boiler constructed in accordance with the present invention has many advantages over boilers of the prior art.

The most essential advantages resides in the performance of said boiler in a manner to achieve the most economical operation, particularly in the heating of all electric buildings having power contracts based on the maximum or billing demand. The electrode boiler of this invention will take any load between 2 percent and 125 percent of its rated capacity, whereas, at any instant the load taken by an immersion heater boiler must be a multiple of the unit heaters of which the boiler is composed. Owing to on-off operation of unit heaters, in response to maximum demand control means, the immersion heater boiler requires a much greater billing demand for the same heating load as measured in KWh.

The arrangement of conductivity control apparatus has the advantage that the conductivity of the boiler water discharged for conductivity control is continuously and closely measured so that the conductivity controller can stop the process the instant the boiler water conductivity is returned to normal.

It will be understood that various modifications in addition to those abovementioned can be made to the specific embodiments described without departing from the spirit of the claims.

1. In an electrode boiler in which the electrodes are enclosed in a steam generating compartment surrounded by a control compartment, the boiler load being controlled by transfer of boiler water between the said steam generating and control compartments and the feedwater supply being regulated by means responsive to the water level in the control compartment referred to as the controlled water level, the improvement comprising a float-operated feedwater regulator responsive to a reference water level having a delayed response to the said controlled water level, said delayed response being obtained by a throttling device located in a water flow path between the said reference and controlled water levels.

2. An apparatus as claimed in claim 7, in which the said throttling device is a valve having means for adjusting the time required for said reference water level to correspond to a change in the water level in said control compartment.

3. A low voltage electrode boiler as claimed in claim 1, further comprising boiler water conductivity control means including an external piped circuit in which a conductivity measuring device is located and which boiler water is made to flow by means of a hydraulic ejector located in the feedwater supply pipe, one end of the said external piped circuit being connected with the hydraulic ejector and the other end with the boiler, preferably at the level of the bottom of the said steam generating compartment.

4. A low voltage electrode boiler as claimed in claim 3, further comprising conductivity control piping connected to said external piped circuit whereby boiler water is discharged for conductivity control.

5. A low voltage electrode boiler as claimed in claim 1, further comprising low limit water level control means including a stand pipe having its lower end connected with the said steam generating compartment at a level above the tips of the electrodes and its upper end extended into the top of the said control compartment, the controlled low limit of water level and electrode tip configuration being made to obtain a minimum boiler load of between 2 and 3 percent of full load.

6. A low voltage electrode boiler as claimed in claim 3, further comprising low limit water level control means including a stand pipe having its lower end connected with the said steam generating compartment at a level above the tips of the electrodes and its upper end extended into the top of the said control compartment, the controlled low limit of water level and electrode tip configuration being made to obtain a minimum boiler load of between 2 and 3 percent of full load.

7. A low voltage electrode boiler as claimed in claim 1, wherein a ring conductor is secured to the steam generating compartment wall under the tips of the electrodes whereby to conduct stray currents from said electrode tips to said generating compartment wall.

8. A low voltage electrode boiler as claimed in claim 3, wherein a ring conductor is secured to the steam generating compartment wall under the tips of the electrodes whereby to conduct stray currents from said electrode tips to said generating compartment wall.

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