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FOAM INHIBITOR APPARATUS FOR BOILERS

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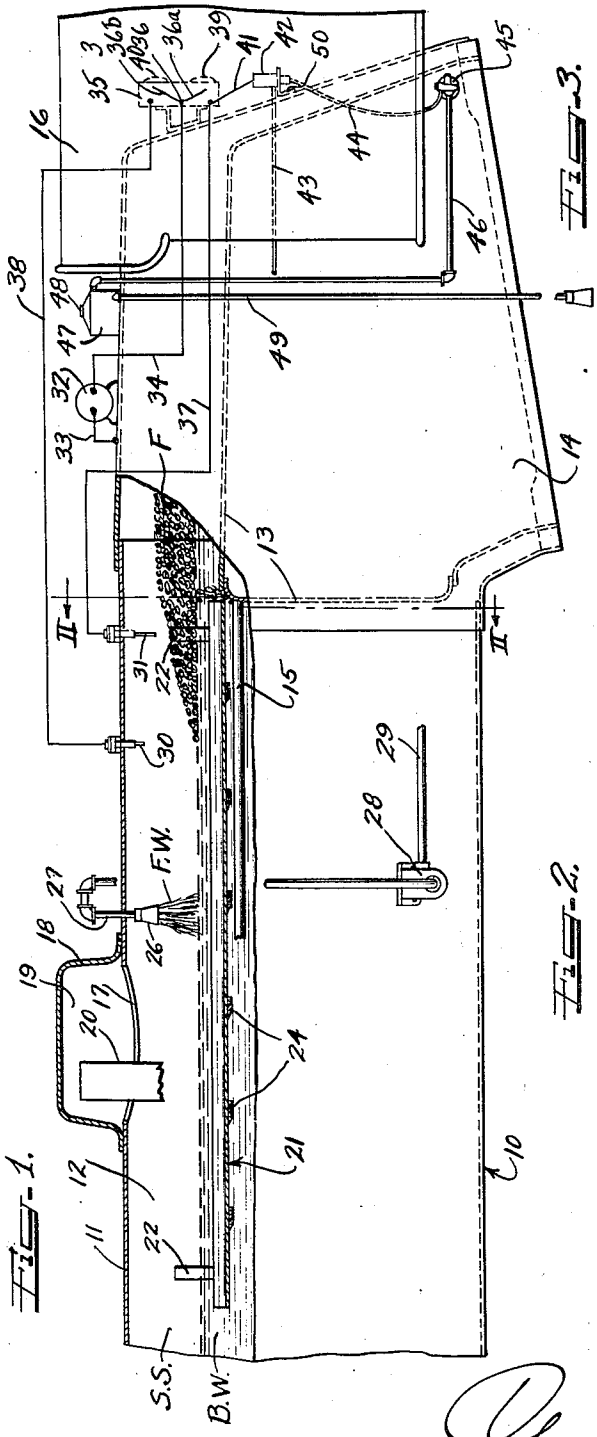



Fig. 1.

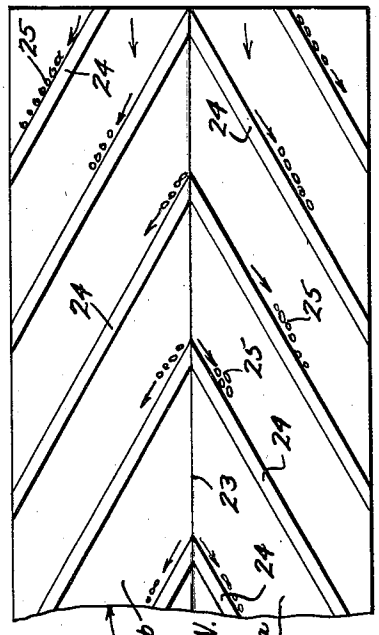


Fig. 3.

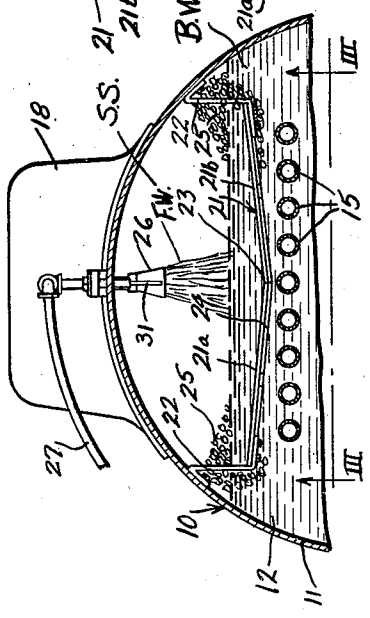



Fig. 2.

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## FOAM INHIBITOR APPARATUS FOR BOILERS

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8 Claims. (Cl. 122—459)

This invention relates to the elimination of a sustained level of light water or foam in the vicinity of the steam outlet of an operating steam boiler.

More specifically the invention relates to a foam inhibitor plate mounted flatwise in a locomotive boiler to extend from near the fire box of the boiler to a point well beyond the steam dome and at a level above the flues of the locomotive but beneath the normal water level therein. The plate is mounted in spaced relation from the boiler shell so that it defines a localized non-steam-generating course in full communication around the entire perimeter thereof with the main body of boiler water in the boiler.

While the invention will be hereinafter specifically described in connection with locomotive boilers, it should be understood that this is only an example of one use of the invention and that the foam inhibiting apparatus can be used in any type of steam boiler.

According to this invention a metal plate is horizontally mounted above the rear ends of the flues in a locomotive. The plate extends forwardly from the locomotive fire box to a point well beyond the steam dome or steam outlet of the boiler. The edges of the plate are spaced from the boiler shell so that the top of the plate is in full communication with the main body of boiler water. The plate is mounted at a level in the boiler slightly beneath the normal water level and serves to define a somewhat insulated non-steam-generating course along the top of the main body of boiler water.

Since the hottest part of a locomotive boiler is around and over the fire box, water will flow over the plate in a forward direction under the steam dome or outlet. Steam bubbles generated under the plate cannot rise into any foam or light water on the top of the boiler water in the vicinity of the steam outlet because the same must travel under the plate to the edges thereof where they will collapse in the non-steam-generating area above the plate.

Likewise, bubbles emerging from the fire box end of the boiler will flow forwardly over the plate and will collapse after traveling a short distance along the non-steam-generating area. As a result, the steam space of the boiler above the plate will be retained substantially free from light water or foam development between the fire box and the steam dome. The plate impedes the rising of steam bubbles formed therebeneath and a feature of this invention includes the directing of these bubbles to the side edges of the plate away from the non-steam-generating zone formed above the plate. The bubbles thus must travel along a longer path before they are released at points spaced from the steam outlet. This increased travel depresses foam development and has the same effect as permitting the bubbles to rise an appreciable amount into the steam space before spilling into a trough having an inlet above the water level in the boiler.

Since the plate keeps the steam space clear for passage of steam from the fire box end of the boiler, where most steam is developed, to the steam dome, no high steam velocities are created tending to entrain foam or moisture therein as it passes to the steam outlet.

Another feature of the invention includes the spraying of feed water or make-up water into the boiler at a point above the plate where it can be readily commingled with the water flowing forwardly over the plate.

If desired, according to the invention, the boiler can be blown down automatically whenever foam development on top of the plate reaches a predetermined level.

It is, then, an object of the invention to inhibit foam in operating steam boilers by mounting a plate flatwise in a boiler adjacent the steam space thereof but below the normal water level therein.

Another object of the invention is to provide a foam inhibitor plate in a steam boiler of the locomotive type capable of effectively preventing the rise of steam bubbles into foam formation on the boiler water in the vicinity of the steam outlet from the boiler.

Still another object of the invention is to provide a localized non-steam-generating course in the vicinity of the steam outlet of a boiler that is in full communication with the main body of boiler water around the entire perimeter thereof.

A further object of the invention is to inhibit foam and moisture entrainment in steam leaving a locomotive boiler by means of a comparatively flat plate mounted horizontally in the boiler just below the normal water level therein and extending from the fire box to a point beyond the steam outlet with the edges of the plate spaced from the boiler shell.

Other and further objects of the invention will be apparent from the following detailed description of the annexed sheet of drawings, which discloses a preferred embodiment of the invention in a locomotive boiler.

On the drawing:

Figure 1 is a fragmentary side elevational view,

with parts broken away and shown in vertical cross section, of a locomotive boiler equipped with a foam inhibitor plate, automatic blow-off devices, and feed water spray device according to this invention.

Figure 2 is a fragmentary vertical cross-sectional view, with parts shown in elevation, taken along the line II—II of Figure 1.

Figure 3 is a fragmentary bottom plan view of the foam inhibitor plate, taken along the line III—III of Figure 2.

As shown on the drawing:

In Figures 1 and 2, the reference numeral **10** designates generally a locomotive having the usual boiler shell **11** defining a boiler course **12**. Plates **13** are mounted inside of the boiler shell **11** to define a fire box **14** at the rear end of the boiler. Fire tubes **15** extend from the fire box **14** through the boiler course **12** beneath the surface of the boiler water B. W. therein. The normal level of the boiler water B. W. is, as usual, maintained above the top plate **13** of the fire box **14**. A steam space S. S. is thus provided in the top of the boiler course **12** above the boiler water B. W.

The usual engineer's cab **16** is mounted around the rear end of the boiler.

The boiler shell **11** has an opening **17** in the top thereof enclosed with a cover **18** providing the usual steam dome **19** above the top of the boiler. The steam dome **19** is spaced forwardly of the fire box **14** as shown in Figure 1.

A steam outlet pipe or dry pipe **20** extends upwardly into the steam dome **19** and has the open top end thereof spaced beneath the top of the cover **18**. The dry pipe usually extends forwardly along the boiler course **12** to the superheater equipment, operating cylinders, and the like appurtenances of the locomotive for supplying steam thereto.

According to this invention an elongated imperforate metal plate **21** is suspended flatwise in the boiler course **12** by means of straps **22** secured inside of the boiler shell **11**. The plate **21**, as shown in Figures 1 and 2, is suspended above the fire tubes **15** but beneath the level of the boiler water B. W. The plate is preferably mounted about level with the top of the fire box **14** and extends from the fire box to a point beyond the steam dome **19** as shown in Figure 1.

As shown in Figure 2, the plate **21** has the side edges thereof parallel with the sides of the boiler shell and in spaced relation therefrom. A space of from six inches to one foot between the edges of the plate and the boiler shell is desirable. Since the opening **17** in the top of the boiler is in the longitudinal center of the boiler shell, the plate **21** will thus be disposed beneath this opening and will extend therebeyond in all directions as shown in Figures 1 and 2.

The plate **21** is preferably slightly sloped down toward a central longitudinal line **23** thereof so as to provide two inclined leg portions **21***a* and **21***b* from the depressed center line **23** to the edges of the plate. The leg portions should preferably slope about 2 to 3° from the horizontal.

Lateral baffles **24** are secured along the underside of the plate in the form of chevrons with the pointed ends or vortices facing the fire box **14** and with the sides thereof slanting outward to the sides of the plate at an obtuse angle.

The baffles will serve to direct steam bubbles **25** generated under the plate toward the edges of the plate where they can rise to the top of the boiler water B. W. as shown in Figures 2 and 3. This will prevent formation of steam pockets beneath the plate. The baffles are preferably quite shallow as indicated in Figures 1 and 2, so that they will not interfere with the normal circulation of water in the boiler at points spaced below the plate.

Since the hottest portion of the boiler course is adjacent and above the fire box **14**, the normal flow of water in the boiler is toward the front end of the locomotive. Since the plate **21** is about on the same plane with the top of the fire box, water flowing forwardly from the top of the fire box passes over the plate. The water area on top of the plate is a non-steam-generating zone since it is somewhat insulated from the fire tubes of the boiler.

Because foam F or light water develops first in the hottest portion of the boiler this light water and foam will likewise flow forwardly over the plate and will rapidly collapse into solid water after having traveled a short distance in the non-steam-generating area. Steam bubbles are prevented from rising into any mass of foam formation on the boiler water and a sustained level of light water or foam in the boiler in the vicinity of the steam dome is prevented. The bubbles emerging from the fire box to flow over the plate collapse after traveling a short distance and likewise the bubbles emerging from the sides of the plate collapse, so that the steam space in the boiler is retained substantially free from light water and foam between the fire box and the steam dome. The steam space is thus kept clear for flow of steam to the steam dome and high steam velocities are avoided such as would normally tend to entrain foam or moisture.

As indicated in Figure 1, a foam level is not maintained above the plate **21** in the vicinity of the steam zone because the foam developed at the fire box end of the boiler collapses after it travels a short distance over the plate. As also shown in Figure 2 the steam bubbles developed under the plate are directed to the sides thereof by means of the baffles and will collapse on top of the boiler water at the sides of the plate.

The water under the steam dome is thus always maintained as solid water and since the water area above the plate receives the collapsed foam and light water it contains high concentrations of electrolytes and alkalies.

The feed water F. W. is sprayed into the boiler from a spray head **26** suspended in the steam space of the boiler from a feed pipe **27** projecting through the top of the boiler shell. The spray of feed water F. W. ejected by the spray head **26** is impacted downwardly on top of the water in the non-steam-generating zone above the plate **21** at a point where the foam and light water have collapsed. As shown in Figures 1 and 2, the spray head **26** is thus positioned spaced from the rear of the steam dome **19** and above the longitudinal center of the plate **21**.

The sprayed feed water intimately mixes with the water flowing over the plate and is rapidly heated by this water. A preheating of the feed water is effected before the same enters the main body of boiler water B. W. Likewise, since the water flowing above the plate contains a high concentration of electrolytes and alkalies, the feed water, being intimately mixed therewith, will effect a precipitation of scale forming ingredients. At the same time the water hardening ingredients of the feed water are sludged to effect a flocculation thereof.

The intimate mixing of the feed water with

the highly concentrated water in the boiler will effect a rapid transition of the pH value of the feed water to an increased pH value thereby minimizing chances for adsorption of organic substances on dispersed matter in the water. This minimized adsorption reduces foaming tendency of the water finally supplied to the main body of boiler water and inhibits formation of surface active substances. The feed water is thus preconditioned.

If the feed water contains colloidal oil incorporated therein from the feed water heaters, exhaust steam injectors, pumps or other appurtenances, the concentrated water above the plate 21 will effect a "salting out" of the oil. This is caused by the electrolytes in the concentrated water. The oil will be simultaneously adsorbed or agglomerated in the flocculated alkaline compounds or precipitates being formed and is thus removed.

The feed water is supplied to the spray head 26 through the pipe line 27 from a pump 28 mounted on the outside of the boiler. The pump 28 is fed from the pipe line 29 communicating with the water tank of the locomotive tender. Injectors, or other appurtenances, can be embodied in the line 29.

As shown in Figure 1, a short electrode 30 projects through the top of the boiler shell 11 into the steam space of the boiler above the plate 21 at a point where the foam from the rear end of the boiler and the sides of the plate reaches a collapsed condition as shown in Figure 1.

A longer electrode 31 projects from the top of the boiler toward the plate 21 near the rear end of the plate. This long electrode terminates below the short electrode 30 and is adapted to be contacted by foam F flowing over the plate 21. The electrodes 30 and 31 are electrically insulated from the boiler shell 11.

A source of electric current such as a generator 32 is mounted on the locomotive and has one terminal thereof grounded on the boiler shell through a wire 33. The other terminal of the generator is connected through a wire 34 with a foam meter box 35 mounted in the engineer's cab and having a multiple relay 36 therein. The wire 34 communicates with the relay 36 and the relay has one arm 36*a* thereof adapted to establish contact with a wire 37 leading to the long electrode 31. The other arm 36*b* of the relay is adapted to make contact with a wire 38 from the short electrode 30. Signal lamps 39 and 40 are also provided in the box 35.

When foam rises to a level sufficiently high to contact the electrode 31, the electrode will be grounded through the foam to the boiler shell and an electrical circuit will be established through the wires 34 and 37 to close the relay arm 36*a*, light the lamp 39 and energize a wire 41 leading to a solenoid-operated air valve 42. The air valve 42 receives compressed air through a supply line 43 and, when opened, supplies this air through a tube 44 to a sludge blow-off valve 45 communicating with the lower portion of the boiler. The valve 45 discharges into a pipe line 46 communicating with a steam separator 47 mounted on top of the boiler. Steam is flashed from the water entering the separator through the steam outlet 48 in the top of the separator while the water is drained with harmless force to the road bed through the drain line 49. The solenoid in the air valve 42 is grounded on the boiler shell through a wire 50 as shown, to complete the circuit when the relay arm 36*a* is closed.

Thus when foam reaches a predetermined level above the rear end of the plate 21, the boiler is automatically blown down. When the foam rises to a higher level and travels further forward in the boiler into contact with the short electrode 30, a circuit is established to close the relay arm 36*b* and light the top lamp 40 thereby indicating to the engineer that the boiler should be manually blown down. If desired, a top blow off can be used in place of the bottom blow off 45.

It should be understood that the foam inhibitor plate of this invention need not be used in connection with automatic blow off apparatus. Since, however, it is in full communication with the boiler water and forms somewhat of a localized water area thereabove having the foam producing substances concentrated therein, it is well adapted for use in combination with automatic blow down equipment.

In difficult operating periods when water must be conserved and the boiler cannot be blown down even though foam development reaches undesirable levels, the plate 21 of this invention will prevent entrainment of foam with the steam entering the dry pipe 20. The plate actually protects the dry pipe from moisture or light water because it inhibits foam formation in the vicinity of the steam dome.

The collapsing of enhanced amounts of foam and light water in the area on top of the plate 21 can be readily taken care of since the additional quantities of solid water thus produced are immediately recirculated back to the main body of boiler water. Flooded conditions over the plate are thus prevented.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted herein otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a steam boiler having a steam outlet in the top thereof, a steam space for supplying steam to the outlet and a water space beneath the steam space, the improvement which comprises an imperforate foam inhibitor plate mounted flatwise in the water space of the boiler under the steam outlet and adjacent to the steam space of the boiler to define an elongated non-steam-generating course extending in the direction of major water flow in the boiler and submerged in the water space around the perimeter of the plate.

2. In a locomotive boiler including a boiler shell defining an elongated boiler course, a fire box in one end of the boiler shell, and a steam dome on top of the boiler shell in communication with the boiler course in spaced relation from the fire box, the improvement which comprises an imperforate foam inhibitor plate extending flatwise along the boiler course and under the steam dome from a point adjacent the fire box to a point forward of the steam dome and at a level beneath the normal water level in the boiler to submerge the plate in the boiler water, said plate being in spaced relation from the boiler shell to define a localized non-steam-generating water area thereabove in full communication with the main body of boiler water around the entire perimeter thereof.

3. In a steam boiler having a water space, a steam space and a steam outlet communicating with the top of the steam space, the improvement which comprises an imperforate foam inhibitor plate submerged in the water space and extending in the direction of major water flow in the boiler beneath the steam outlet, said plate having a depressed longitudinal central portion and legs sloping upwardly from said central portion into spaced relation from the boiler shell, and means for rigidly holding said plate in the water space of the boiler.

4. A foam inhibitor plate for steam boilers comprising a metal sheet adapted to be suspended in the water space of a boiler and having slightly inclined portions extending from a longitudinal center line thereof, and spaced baffles secured on the bottom of the sheet diverging from said longitudinal center line to the sides of the sheet.

5. A foam inhibitor device for steam boilers comprising a substantially flat imperforate plate, and chevron-shaped shallow baffles secured on the bottom of the plate in spaced relation, said baffles having the convergent ends thereof aligned along the longitudinal center of the plate.

6. In a locomotive boiler including a boiler shell defining an elongated boiler course, a fire box in said shell adapted to be surrounded by water in said boiler course, fire tubes extending forwardly from said fire box through the boiler course, and a steam dome on the top of said shell forwardly of the fire box, the improvement which comprises a foam inhibitor plate suspended flatwise from the boiler shell in the boiler course at a level beneath the normal water level in the boiler, said plate extending from a point in closely spaced relation to the first box to a point forwardly of the steam dome and being spaced from the boiler shell to be in full communication with the main body of boiler water around the entire perimeter thereof, and a spray feed water device suspended from the top of the boiler shell above said plate to impact feed water on top of the water flowing over the plate intermediate the ends of the plate.

7. The method of controlling a steam boiler which comprises flowing light water and foam from the hottest portion of the boiler along a non-steam generating area submerged in the boiler water and extending beneath the steam outlet to collapse the foam and light water before it reaches the outlet, and diverting steam bubbles in the boiler water under said area to points spaced from the outlet and thereby maintain a clear steam channel for flow of steam to the outlet.

8. The method of controlling a steam boiler which comprises flowing boiler water and any foam and light water developed thereon from the hottest portion of the boiler along a non-steam generating area submerged in the boiler water and extending beneath the steam outlet to collapse the foam and light water before it reaches the steam outlet and to prevent generation of additional foam and light water from the thus flowing boiler water, diverting steam bubbles in the boiler water under said area to points spaced from the outlet for maintaining a clear steam channel for flow of steam to the outlet, and introducing feed water into the non-steam generating area in accordance with the requirements of the boiler.

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