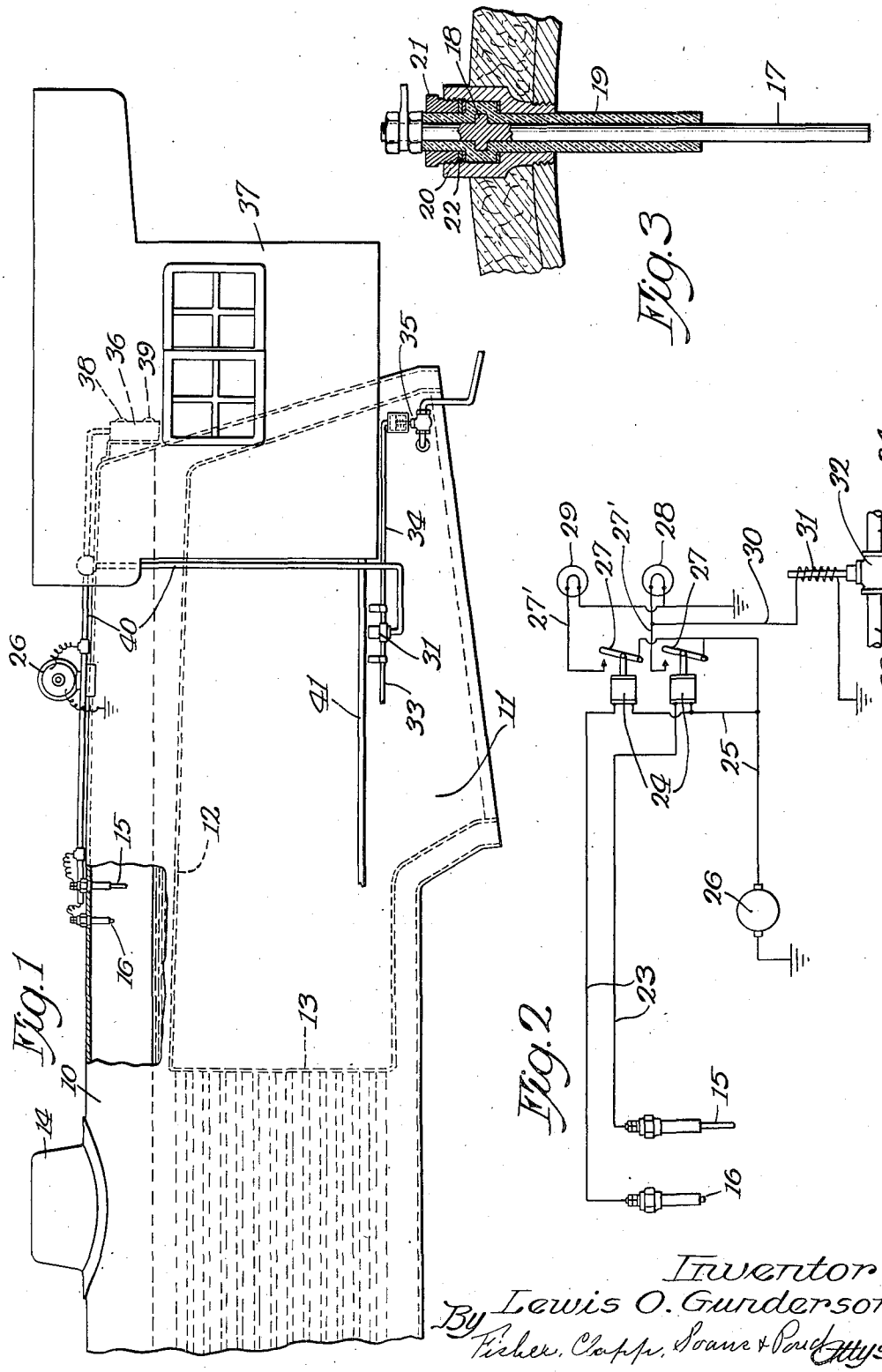
May 30, 1933. L. O. GUNDERSON 1,911,756

FOAM INDICATING AND FOAM CONTROL APPARATUS FOR STEAM BOILERS

Filed Sept. 23, 1931 2 Sheets-Sheet 1



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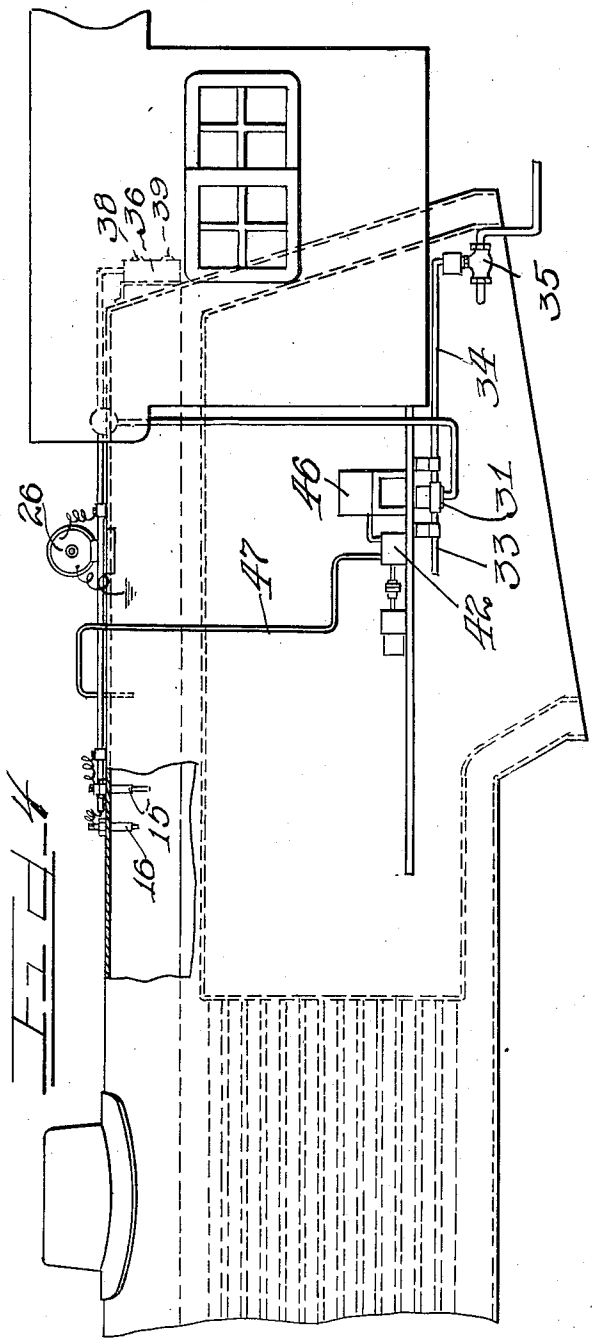

Fig. 1

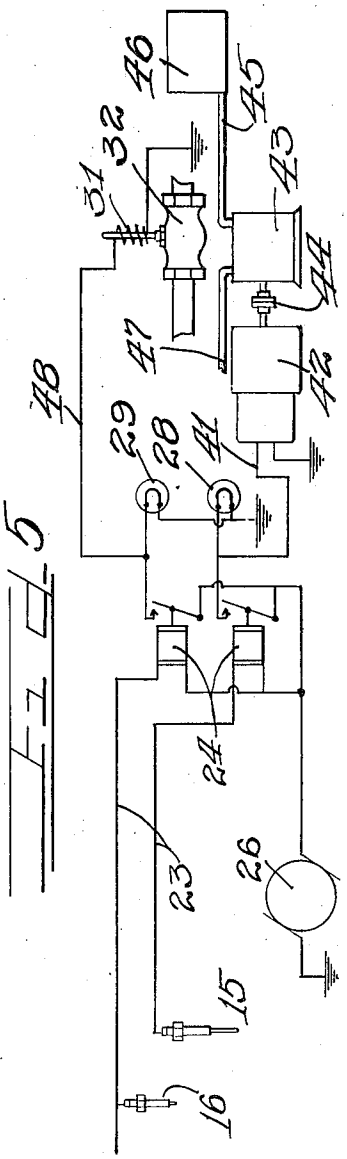

Fig. 5

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UNITED STATES PATENT OFFICE

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FOAM INDICATING AND FOAM CONTROL APPARATUS FOR STEAM BOILERS

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The invention relates to foam indicating apparatus for steam boilers, and seeks to provide reliable means for indicating the foaming condition of boiler water. A further object is to provide means arranged to automatically "blow-off" the boiler when required by the presence of foam.

Where a boiler supplies steam to an engine, any tendency of the boiler to "foam"—that is, to have foam and froth entrained with the steam—is very objectionable, since water carried over with the steam impairs the lubrication of the engine and is likely to cause considerable damage or even a serious accident. Particularly in the operation of steam railway locomotives, wide variation of load to which they are subject, is liable to cause foaming and it is necessary to guard against foaming conditions in the boiler in order to avoid costly delays. In accordance with present practice, the boiler is blown-off at more or less frequent intervals to reduce the concentration of dissolved and suspended matter in the boiler water to prevent foaming. But since the engineer in charge has no means at present of knowing when the condition in the boiler is such that it is liable to foam, too frequent and excessive blowing is usually resorted to in order to play safe, and this practice is extremely wasteful of heat and fuel.

Attempts have been made to ascertain the point at which a boiler is liable to foam by determining the concentration of alkali salts by measuring the electrical conductivity of the boiler water and in other ways. But conductivity measurements have been found to be unsatisfactory and inaccurate. Furthermore, the concentration of the salts in the boiler water is only one of the factors affecting the foaming condition. Thus, the formation of foam in the steam boiler is affected not only by the concentration of dissolved salts, but also by suspended solids and by the presence of organic and colloidal matter in the water. It is also affected by the design of the boiler, the boiler pressure and the rate of evaporation and by variations in the load or steam demands.

The present invention provides means for indicating the formation of foam on the surface of the water in the boiler before it has accumulated to such an extent that it is liable to pass out of the steam outlet. I have found by experiment that the thickness of the foam layer on the water increases as a rule with the concentration of dissolved salts and other foam stabilizing material in suspension, other factors being constant, until finally the foam becomes so stable or long lasting that the foam level gradually rises in the steam space until the foam reaches the steam outlet where it is entrained with the steam. Also, by locating insulated electrodes in suitable positions in the steam space of the boiler and above the water level, I have found that, when foam develops and rises into the steam space, it will form electrolytic conductance for an electric current between two electrode points or between the electrodes and the boiler metal, and this current can be utilized directly to actuate a signal such as a small electric lamp, or preferably through the medium of a relay switch to operate any suitable signal and/or automatic devices for reducing the foam.

In this way, the operator or engineer is notified that the foaming condition of the boiler is such that there is danger of water being entrained with the steam and that the boiler should be blown-down to reduce the concentration of foam stabilizing material in the water. Also, and as preferred, the electric current thus developed can be employed for effecting the automatic operation of a blow-off valve for reducing the concentration of foam stabilizing materials. Furthermore, if desired, the electric current thus developed can be employed to automatically operate a feeding device, whereby a suitable chemical or material, such as an anti-foam compound, can be added to the boiler water when and as needed to alleviate any foaming condition, thus effecting economy and efficiency in its use.

The application of the present invention to a locomotive boiler is hereinafter described in detail and is illustrated in the accompanying drawings, and the invention

is more particularly defined in the appended claims.

In the drawings:—

Fig. 1 is a side elevation of a portion of the locomotive boiler to which the present invention is applied.

Fig. 2 is a diagram of the electric circuits.

Fig. 3 is a detail view partially in section of one of the electrodes.

Figure 4 is a side elevational view of a portion of a locomotive boiler, showing the application of a modified form of the present invention, part being broken away to show details of the apparatus.

Figure 5 is a diagram of the electric circuit of the modified form of invention shown in Figure 4.

The locomotive boiler 10 shown in the drawings is provided with the usual fire box 11 having a crown sheet 12 and back flue sheet 13, the latter, as usual being located adjacent but in rear of the steam dome 14 through which the steam passes from the boiler.

In accordance with the preferred arrangement, two insulated electrodes 15 and 16 are located in the top of the boiler shell to depend down into the steam space with their lower ends at different distances above the water level. When applied to a locomotive boiler, the electrodes are preferably located above the forward end of the fire box as shown, with the lower end of the electrode 15 approximately 13 or 14 inches above the crown sheet, or about 7 or 8 inches above the average or normal water level in the boiler. This electrode is arranged to actuate a signal when it is desirable to blow down the boiler to avoid foaming in case there is any sudden increase in the steam demand. The lower end of the electrode 16 is 4 or 5 inches below the top of the boiler and about 14 or 15 inches above the average water level. It is designed to give an indication when it is imperative that blowing of the boiler should be effected in order to prevent passage of moisture through the steam dome and steam outlet.

Preferably, as shown in detail in Fig. 3, each electrode comprises a metal conducting rod 17 having an integral flange 18 adjacent its upper end, the rod, except at its upper and lower ends, and the flange being enclosed in a shell of molded insulation 19, preferably bakelite. The electrode extends through a stuffing box 20 threaded into the boiler shell and a gland nut 21 threaded into the box secures it in place, packing 22 being provided to form a steam-tight joint.

As shown in the diagram in Fig. 2, the electrodes 15 and 16 are connected by conductors 23 to a pair of relays or sensitive solenoid coils 24, the other terminals of which are connected by a conductor 25 to one of the terminals of a source of current 26 which has its other terminal grounded on the boiler shell. If desired, the source of current 26 may be the turbo-generator which usually forms part of the equipment of a locomotive and generally furnishes a 32-volt current, or a 6-volt battery may be provided. As the foam accumulates and rises in the steam space, it will contact first with the electrode 15, thereby energizing the circuit including said electrode 15 and causing the blow-off valve, through the operation of the air valve 32, to open and discharge concentrated boiler water from the steam boiler. Then, if due to excessive steam demand or evaporation, the foam continues to accumulate and develop, in spite of the blowing-off operation, so that the foam finally touches electrode 16, the foam closes the circuit including said electrode 16, thereby causing the lamp 29 to light and serve as a signal to the engineer in charge of the operation of the boiler. Upon the operation of the lamp 29, the engineer can then take such steps as are necessary, such as reducing the rate of steam withdrawal from the boiler to cause the foam to subside and thus prevent its entrainment with the steam.

Due to the high resistance of foam and its variable characteristics, a solenoid relay is preferably used to actuate the signaling devices and the blow-off valve.

Where a 6-volt battery is used, a solenoid coil of 500 ohms resistance and approximately 150 ampere turns of wire is satisfactory. Where the 32-volt current from the turbo-generator is employed, each coil is preferably of 3300 ohms resistance and has approximately 125 ampere turns. As the foam surrounds the electrodes, about ten milliamperes of current will flow through the corresponding relay or solenoid to thereby actuate its switch 27. It will be understood that the above-mentioned values may be varied within wide limits to meet various conditions.

The relay switches are connected to the source of current 26 and their back contacts are connected by conductors 27′ to corresponding signals which are preferably in the form of lamps 28 and 29. The other terminals of the lamps are grounded on the boiler shell. Preferably also, the relay switch associated with the lamp 28 is connected by the conductors 30 to a solenoid coil 31, the other terminal of which is grounded. This solenoid, when energized, serves to open a valve 32 which is normally held in closed position by the boiler pressure. If desired, the valve 32 may serve as a blow-off valve for the boiler, but in the form shown, it is interposed in an air supply pipe 33 leading from the main air drum on the locomotive. When the valve 32 is opened, air under pressure flows through the

pipe 34 to open an air operated blow-off valve 35.

The relays 24 and lamps 28 and 29 are preferably located in a suitable casing 36 arranged within the engineer's cab 37. Lamp 28 is arranged to illuminate a yellow bull's eye 38 to indicate the presence of considerable foam, and the lamp 29 is arranged to illuminate a red bull's eye 39 to indicate that the accumulation of foam has reached the danger zone. The conductors are arranged in suitable conduits 40 as shown in Fig. 1, and solenoid 31 and air valve 32 may be mounted on the boiler below the running board 41 or at any other convenient location. The blow-off valve 35 is arranged adjacent the mud ring at the rear end of the boiler to facilitate removal of sludge and mud settling out of circulation at this point.

With the improved apparatus, notwithstanding the widely varying conditions and factors which affect the formation of foam, the engineer or operator will be notified when it is desirable to blow-off the boiler, and will also be notified when the foam reaches the danger zone so that he may blow-down the boiler before any moisture is carried into the engine cylinder. Also, in the preferred arrangement, the blowing of the boiler is automatically controlled. Obviously, the improvement may be applied to other types of boilers and changes may be made in the details set forth without departure from the scope of the invention as defined in the appended claims.

In lieu of the blow-off valve 35, if desired, there may be substituted a pump or other suitable device, which may also be controlled by the solenoid 31 as shown in Figure 1, for injecting into the boiler a suitable anti-foam compound or material, as will later be described.

My invention also contemplates the use of an anti-foam injecting device. In this case, the relay which is associated with the lamp 28 is connected by conductors 41 to a motor 42, the other terminal of which is grounded. The motor 42 drives a pump 43 through a shaft connection 44. The intake side of the pump 43 is connected by a pipe line 45 to a reservoir 46 in which the anti-foam material is stored. The exhaust side of the pump 43 is connected by a pipe line 47 to the steam space of the boiler. As will be seen in Figure 4, the pipe line 47 passes through the top of the boiler 10 and terminates above the normal boiler level in the boiler.

When this anti-foam device is used, it is preferable to have the relay switch associated with the lamp 29 connected by a lead 48 to the solenoid coil 31 to operate a blow off valve as previously described. In this embodiment of my invention, when the foaming of the water is of sufficient intensity to cause the foam to contact the lower electrode thereby closing primary circuit, the pump 42 is operated through the relay to feed the anti-foam material from the reservoir 46 into the boiler tube to counteract the foaming propensity of the water therein. If for any reason, the foaming increases in spite of the effect of the anti-foam material, the foam will upon contacting the upper electrode close that circuit and operate the valve 32, thus blowing off the impurities and sediment from the boiler.

It will be obvious that I may use more than two electrodes so as to operate various combinations of signals and foam relieving devices.

I claim as my invention:

1. In combination with a steam boiler, an insulated electrode located in the steam space of the boiler above the water level therein, an electric circuit closed by the contact of foam with said electrode, and means actuated by said circuit for injecting a substance into the boiler to cause subsidence of the foam.

2. In combination with a steam boiler, an insulated electrode located in the steam space of the boiler above the water level therein, an electric circuit closed by the contact of foam with said electrode, a blow-off valve for the boiler for changing the concentration of the boiler water, and means for operating said valve arranged to be actuated by said circuit, substantially as described.

3. In a system of the class described, the combination with a steam boiler, a blow-off valve for the boiler, an insulated electrode in the steam space of the boiler and above the water level therein, and electrically actuated devices connected in circuit with said electrode and energized by the rise in the foam level in the boiler into contact with said electrode for operating the blow-off valve for reducing the concentration of solids in the boiler water, irrespective of the water level, substantially as described.

4. In combination with a steam boiler, an insulated electrode located in the steam space of the boiler above the water level therein, an electric circuit closed by the contact of foam with said electrode, and means actuated by said circuit for subsiding the foam within said boiler.

5. A combination as defined in claim 4 wherein said foam-releiving means comprises a blow-off valve for reducing the concentration of the solids in the boiler water.

6. In a system of the class described, the combination with a steam boiler, of at least two insulated electrodes having terminals at different levels in the steam space of the boiler and above the water level, electric circuits closed by the contact of foam with said electrodes, means operated by the circuit of one of said electrodes for injecting anti-foam material into said boiler, and

means operated by the circuit of another of said electrodes for blowing-off said boiler.

7. In combination with a steam boiler, an insulated electrode located in the steam space of the boiler above the water level therein, an electric circuit closed by the contact of foam with said electrode, and means actuated by said circuit for reducing the concentration of solids in the boiler water irrespective of the water level.

8. In combination with a steam boiler, an insulated electrode located in the steam space of the boiler above the normal water level therein, an electric circuit adapted to be closed by contact of foam with said electrode, means actuatable by energization of said circuit for subsiding the foam within said boiler and signal means in parallel with said first means to indicate the state of said circuit.

9. In combination with a steam boiler of a locomotive, an insulated electrode dependent from the boiler shell into the steam space above the crown sheet and terminating above the normal water level therein, an electric circuit adapted to be closed by contact of foam with said electrode, means actuatable by the closing of said circuit for blowing off the boiler and signal means in parallel with said first means and illuminated during the blowing-off operation.

10. In combination with a steam boiler, at least two insulated electrodes having terminals at different levels in the steam space of the boiler and above the normal water level, electric circuits adapted respectively to be closed by contact of foam with said electrode terminals, means actuatable upon energization of one of said circuits to relieve the foaming condition of said boiler and a signal device in each electrode circuit for indicating the state of each circuit.

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