(No Model.)

G. E. HALL.

MEANS FOR PREVENTING BOILER EXPLOSIONS.

No. 303,841. Patented Aug. 19, 1884.

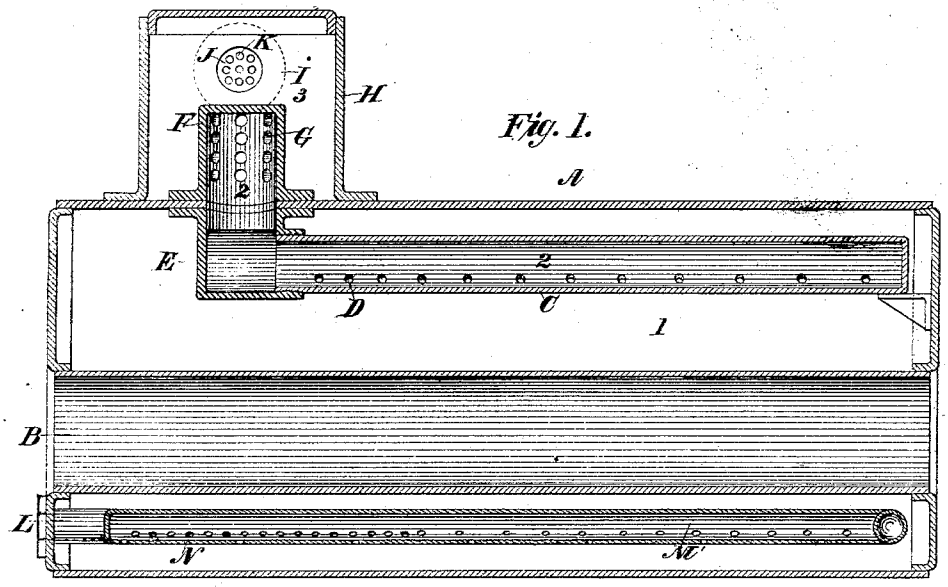


Fig. 1.

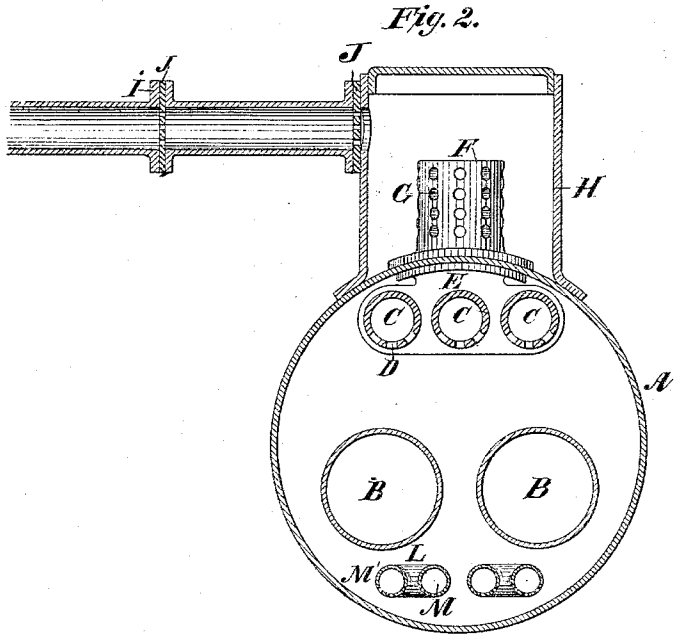


Fig. 2.

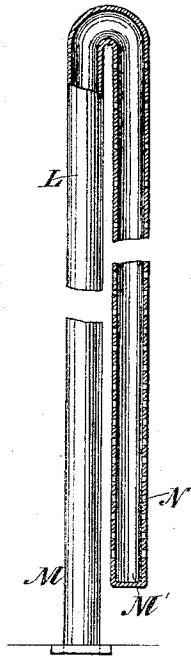


Fig. 3.

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MEANS FOR PREVENTING BOILER-EXPLOSIONS.

SPECIFICATION forming part of Letters Patent No. 303,841, dated August 19, 1884.

Application filed April 19, 1884. (No model.)

To all whom it may concern:

Be it known that I, GEORGE EVELYN HALL, of the city, county, and State of New York, have invented a new and Improved Means for Preventing Boiler-Explosions, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

When the temperature of any liquid is raised to a certain point, it boils or passes off in a state of vapor, and the temperature of the liquid remains constant until the whole is vaporized. This temperature varies with the character of the liquid, and also with the pressure of the atmosphere, or, as in steam-boilers or other closed vessels, with the pressure of the vapor on the surface of the liquid. Water under the normal pressure of the atmosphere boils at 212° Fahrenheit. Under a pressure of sixty pounds to the square inch, a temperature of 307° Fahrenheit is required to make it boil; under one hundred and twenty pounds, 350° Fahrenheit, and so on, every increase of pressure requiring a consequent increase of temperature to maintain the boiling-point. It is a well-known fact that if the pressure on the surface of a highly-heated liquid—such as water contained in a steam-boiler or other closed vessel—is from any cause removed the water will no longer remain in the form of water, but all or a large proportion of it will be instantly converted into steam. The expansive or acting force of the steam so produced will depend upon the volume of water present, its temperature, and the amount of pressure which has been removed. Very many conditions occur in practice which act to lessen or decrease the pressure acting on the surface of the water in the boiler. The most common way is by opening the throttle or safety valve and allowing the steam to pass off freely. Now, if the flow of steam which is moving with great velocity be suddenly stopped by closing either the throttle or the safety valve, a very powerful back-thrust or percussion is transmitted through and by the steam upon the body of the steam within the boiler, tending to compress it, not upon the surface of the water, but upon itself, and thereby removing the pressure from the surface of the water. As a result, the superheated water will burst into steam with great violence. At such a moment the water is unusually disturbed, which also facilitates the disengagement of additional steam. The great volume of steam thus set at liberty acts with a force entirely beyond that which the boiler is calculated to withstand, and as a consequence a terrific explosion ensues. The result would be the same whether the pressure upon the superheated water had been removed by exhaustion or condensation of the steam. Thus, if a large body of cold water be delivered into a boiler when the engine which receives its steam from the boiler is at rest, or if the engine be stopped immediately after the boiler has been filled and then suddenly started, the concussive action of the steam above described and the agitated or violent motion of the water within the boiler will suddenly bring to the surface and project into the steam-space and steam a large quantity of water considerably below the temperature of the water previously in the boiler, and condensation will as suddenly take place, causing an explosion in the manner already explained. In case of extremely low water, or by reason of an unusual motion of the boiler—as by the pitching of a ship—if cold water be injected into the steam-space, a like condensation of the steam will occur, producing a similar result. When the boiler is steaming to its full capacity, the heat applied to the outer surface of the shell or to the inner surface of the several flues or tubes, or, in general, to the heated surface and transmitted to the water, generates steam so rapidly along those surfaces and causes it to rise in such torrents through the water above that the presence of bubbles of steam and the active motion thereof lifts the water above its ordinary level, and if the throttle-opening is large the water will rise in a cone-shaped mass under that opening, and is often carried to the cylinder of a steam-engine, giving what is known as "wet steam."

The majority of boilers, when doing their best, will throw up particles of water into the steam-space in the violent ebullition which accompanies a disengagement of steam. Any sudden diminution in the pressure on the surface of the water results in a generation of

steam not only along the several heating-surfaces, but also throughout its mass, which tends to increase the percussive effect of the great mass of steam and water thus thrown violently against the interior of the shell, the force of which is sufficient to produce a rupture and the consequent explosion. When working under ordinary conditions, the interior of the shell is subject to a constant hammering action, which occurs by the fluctuations in pressure, due to the intermittent relief of pressure by induction of steam into the cylinder of the steam-engine. At the commencement of each stroke the steam-valve is opened, and the steam flows from the boiler by an appropriate pipe into the cylinder of the engine. When the stroke is partially completed, the valve closes, and no more steam is used during the balance of the stroke. Thus the pressure in the steam-space of the boiler is alternately lowered and raised, and is accompanied by a similar raising and lowering of the mass of water. The percussive action thus described tends to strain and weaken the shell of the boiler, often giving rise to cracks, seams, and leakage.

My invention, which is based upon the theory above set forth, relates and has for its object to prevent the sudden changes in the pressure to which the water in the boiler is subjected under the various exigencies of practice, and thus prevents steam-boiler explosions.

It consists of certain details of construction, as hereinafter more fully set forth, by which one or more barriers of metal or other suitable material are interposed in the path of the steam in its passage from the surface of the water to the steam-space, or from the steam-space to the point where it is to be applied, each barrier having a large number of openings or perforations of sufficient aggregate area to allow the steam to flow into the steam-space or from the boiler with the requisite freedom, and so arranged as to check the back-thrust or percussion of the steam, and thus prevent fluctuations in the pressure acting on the surface of the water in the boiler. By means of the large number of perforations or openings in the interposed barriers the force is distributed or broken up, and the steam included between the barriers acts in the manner of steam-cushions. The position of the barriers, which are preferably so designed that the sum of the areas shall be equal to or slightly greater than the area of the pipe or combined areas of pipes by which the steam leaves the boiler, is preferably arranged in such a manner that there shall be considerable steam-space between each, and thus the back-thrust or percussive force, which in ordinary boilers acts with such tremendous force, is, by means of the interposed barriers, gradually weakened from one to the other, so that before reaching the surface of the water in the boiler the percussive or compressing effect will be entirely destroyed. This arrangement will eliminate many of the objections, as above described, and which tend to produce uneven and varying pressures in the boiler, and at the same time the construction adopted allows the ordinary arrangement and action of the safety-valve subject to the maximum pressure.

My invention also relates to the means employed for insuring that the feed-water supplied to the boiler shall be always delivered at its lower portion and out of possible contact with the steam-spaces and steam; and it consists in providing a longitudinally-arranged pipe or pipes bent upon itself or themselves, to form parallel arms, one of which arms is perforated with a large number of small holes, or is provided with a large number of jet-pipes arranged in or along the under surface of the parallel arm, the distribution of the holes or jets being such that the larger number are located immediately over that portion of the bottom plates of the boiler which are immediately over or which act as the roof of the fire-box. By this means I am enabled, first, to partially heat the feed-water by its passage through the non-perforated arm, and to insure a uniform distribution throughout the water in the boiler, and thus render the presence of any large body of cold water in the boiler impossible. This arrangement also enables me to keep the lower surface of the boiler free from deposits or incrustations which usually form thereon, and are compacted by the consequent hammering or percussive action, as previously described, the action of the jets of water being to wash the lower surface of the boiler, and to stir up and distribute any earthy deposits which may form thereon. It also acts to increase the circulation of the water, and the earthy matter will either be kept in solution or deposited by the upward flow of the water and steam on the sides or upper part of the shell, where it can do no harm.

In the accompanying drawings, forming a part of this specification, similar letters of reference indicate like parts, in which—

Figure 1 is a central longitudinal section. Fig. 2 is a cross-section on the line $x\ x$ of Fig. 1. Fig. 3 is a view, partially in horizontal section, of the tube for supplying the feed-water.

In the drawings are shown one form or embodiment of my invention, in which A represents a steam-boiler, which may be of any approved design, and provided with fire-flues B B. C C C are tubes or pipes arranged parallel to each other, and provided with openings or perforations D, which may be of any number, and are preferably so arranged and designed that the aggregate area of the openings shall be equal to or slightly greater than the area of the pipe or opening through which the steam is conveyed from the boiler. The tubes C are each closed at one end, the said closed end resting upon proper supports, bolted or otherwise attached to the end of the boiler. The tubes are in no wise attached to said sup-

port, merely resting thereon, so as to allow a certain longitudinal motion, due to their expansion and contraction. The other end of each tube is connected to a hollow casting, E, or multiple elbow attached to the upper shell of the boiler, and which connects by a circular opening made in the shell with a tube-shaped inner drum, F, arranged on the top thereof, the said drum being provided with the openings or perforations G, as shown in the drawings.

H is the dome, to one side of which is attached the exit or steam pipe I, corresponding in its internal diameter to the orifice made in the side of the dome.

J J are the barrier-plates, having the perforations K therein, and interposed between the dome and the exit-pipe, and arranged between the lengths of the exit-pipe at previously-determined distances.

L is the feed-pipe, formed of the two tubes M M', arranged longitudinally along the lower portion of the boiler and parallel to each other, and joined together at one end to form a continuous sinuous passage. The tube M is attached to the end of the boiler, so as to be brought in contact with the pipe from the source of water-supply. The point where the tubes are joined together is adapted to rest upon any suitable support, thus allowing for the expansion and contraction. The parallel tube M', by which the water is distributed, is provided with a large number of openings or jet-orifices, N, on its lower surface, and so arranged to distribute the streams of water upon the lower surface of the boiler. I prefer to locate the greatest number of openings or orifices over that portion of the boiler under which the fire-box is located, and the number and size of said openings or orifices should be such that the sum of their areas shall be equal or greater than the area of the passage through which the water is conveyed to the boiler.

The steam-space in the upper portion of the boiler constitutes what I term a "first" chamber, and is marked 1.

The combined space in the interior of the tubes C, casting E, and inner dome, F, constitute what I call a "second" or "pipe" chamber, and is marked 2.

The space between the domes F and H constitute the third chamber or dome-chamber, and is marked 3. This latter may communicate directly with the steam-valve of an engine, and be subject to all the fluctuations of pressure due to the intermittent consumption of the steam; or I may interpose the barrier-plates J, which, if used, constitute independent steam-spaces between each pair of plates. As such barrier-plates are not essential to the invention, I will describe the invention without them.

The operation of my device is as follows: Steam is generated from the surface of the water in the boiler is collected from the steam-space and passes through the perforations D in the tubes or pipes C, and is conveyed thereby to the inner dome, passing thence through the openings or perforations G, formed in the sides thereof, and into the cavity of the dome H, and from the dome through a suitable pipe, in which perforated barrier-plates may or may not be used, to the steam engine or apparatus where the same is to be utilized. Strong pulsations or alterations of pressure occurring in the outer dome-chamber, owing to causes as previously described, result in drawing steam with fluctuating force, which depends upon the amount of steam drawn from the dome-chamber through the perforations G in the inner dome; but the expansion in the pipe-chamber of the steam contained therein reduces the violence of the pulsations or fluctuations in the pressure. These reduced fluctuations in pressure are transmitted through the perforations D into the steam-chamber of the boiler proper. These successive transmissions reduce the concussive effect, so as to be practically inappreciable to the boiler, or, if at all appreciable, act to reduce the pressure to such a small extent that the consequent generation of steam will not be sufficient in amount to act with destructive effect. Thus the boiler generates its steam under an approximately-steady pressure.

It will thus be seen that the steam is prevented from rushing in a solid body into the dome-space, and also that impulses transmitted from the interior of the boiler have their force broken and distributed by the interposed perforated barriers and the cushioning of the steam upon itself, and likewise the force concussive or otherwise acting from the dome-chamber inward has its force similarly distributed and broken. The functions of the barriers are then, first, to prevent any immediate or violent generation of steam when the pressure is suddenly removed from the surface of the highly-heated water in the boiler, and yet while so acting to allow the steam to flow freely under ordinary conditions of pressure to supply the demand made upon the boiler; and, secondly, to break and distribute the percussive action from without inward, caused by the intermittent action of the piston or the sudden closing of the engine-valve supplied by the boiler, or by the sudden closing of a safety-valve attached to the boiler itself, the steam in the chambers indicated acting as steam-cushions to arrest the percussive force before it reaches the surface of the water.

I attach considerable importance to the first barrier being in the forms of pipes or tubes C, which present a large extent of surface, in which the perforations D can be formed, as described, without obstructing the ordinary access to the boiler for cleaning, repairs, &c., and without interfering in any degree with the action of the safety-valve.

In putting my invention into practice I do not limit myself to any particular construc-

tion of boiler, nor to any particular number or size of the barrier-plates, nor to the number of barriers which I may interpose.

Modifications may be made in the forms and proportions, provided, however, that in making any changes or modifications the sum of the area of the perforations made in any of the barriers shall be equal to or slightly greater than the area of the pipe or combined areas of pipes or area of safety-valve conveying the steam from the boiler.

In adding my invention to old boilers having a dome it is only necessary to remove the dome and to introduce the parts, as described, make the connections, and replace the dome, no alterations being required to the boiler itself.

I do not limit myself to the use of the barrier-plates J, interposed between lengths of the steam-pipe, which act as a conduit from the boiler, in combination with the other portions of the device, as described. Said barriers may be used alone and can be applied to any pipe or any style of boiler. In case, however, said perforated barrier-plates are used alone, I consider it preferable to increase the size of the steam-pipe.

Many modifications of the device can be employed, depending upon the different conditions arising in practice.

To the means, as herein described, for injecting the feed-water I make no claim in the present application, as the same is fully shown, described, and claimed in the application made by request of the Patent Office as a division of the present application, and filed by me June 21, 1884.

No claim is made in this application to the method herein set forth of preventing explosions in steam-boilers, as it may form the subject-matter of a separate application.

I claim as my invention—

1. A steam-boiler having two or more barriers dividing the water-space from the dome-space, and one or more barriers arranged within the pipe leading from the dome-space to the cylinder of a steam-engine, the sum of the areas of the openings in any of the said barriers being equal to or greater than the opening through which the steam is led from the boiler by the safety-valve orifice, or from the dome-space to the cylinder, substantially as described.

2. The combination, with a steam-boiler, of two or more perforated tubes arranged in the upper part of said boiler and suitably connected to a second perforated chamber within the steam-dome, substantially as described.

3. In a steam-boiler, the combination of two or more perforated tubes arranged in the upper part of said boiler, a second perforated chamber within the steam-dome, and the feed-water pipe or pipes located and perforated substantially as described.

4. The combination, with a steam-boiler, of two or more perforated tubes arranged in the upper part of said boiler, a second perforated chamber within the steam-dome, a pipe or pipes for conveying the steam from the boiler, and perforated barrier-plates within the conveying pipe or pipes, all arranged to operate substantially as described.

5. The shell A, dome H, and casting C, in combination with each other and with a perforated inner dome, F, and perforated barrier-pipes C, arranged to operate substantially as and for the purpose set forth.

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