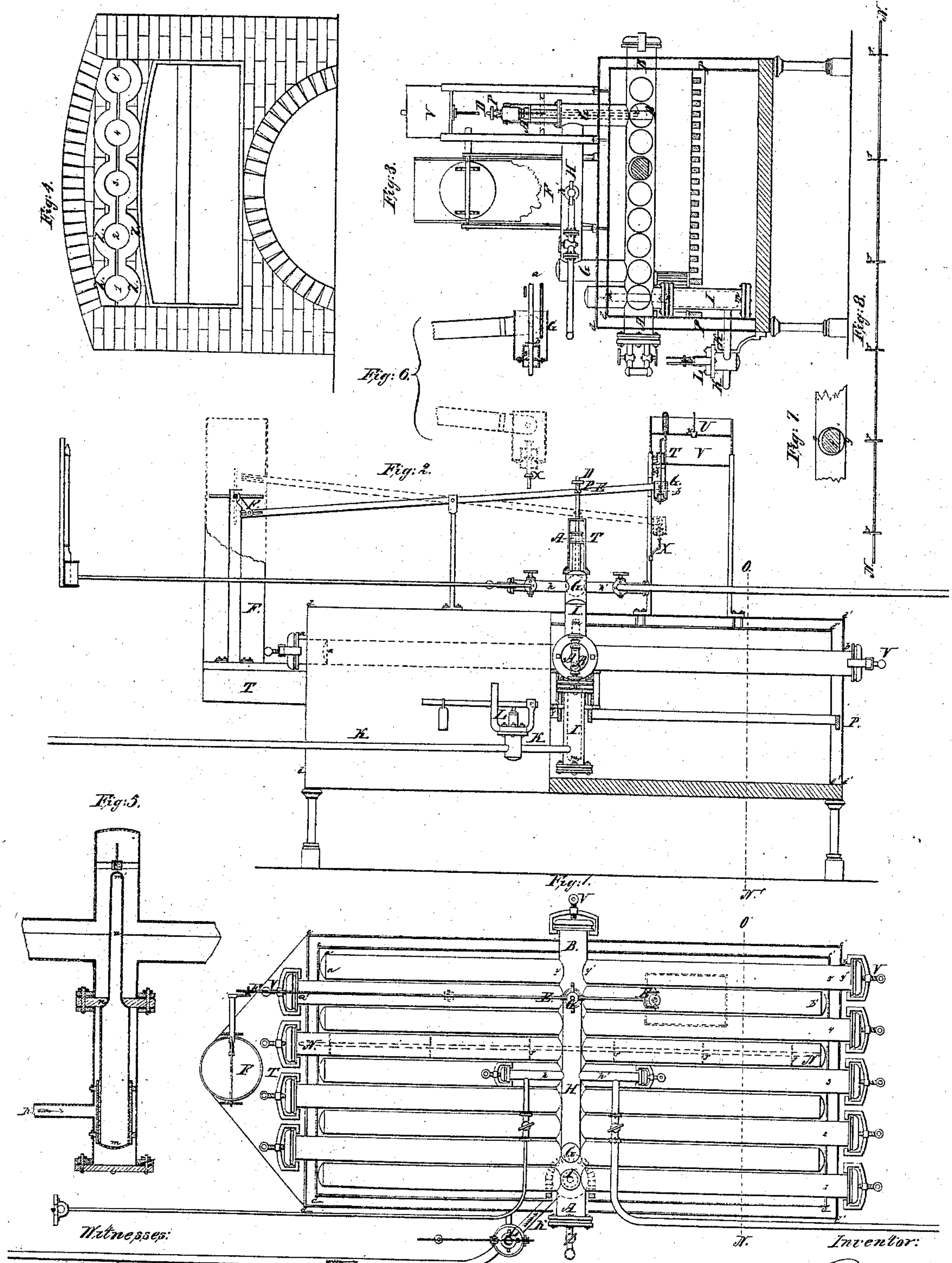
G. H. Moreau,

Steam-Boiler Water-Tube.

No. 3,415. Patented Jan. 26, 1844.



Witnesses:

Inventor:

UNITED STATES PATENT OFFICE.

GABRIEL H. MOREAU, OF PARIS, FRANCE.

IMPROVEMENT IN STEAM-GENERATORS.

Specification forming part of Letters Patent No. **3,415**, dated January 26, 1844.

To all whom it may concern:

Be it known that I, GABRIEL HIPPOLYTE MOREAU, of the city of Paris, in the Kingdom of France, have invented a new and Improved Mode of Reduced Boiler Applied to Steam-Engines; and I do hereby declare that the following is a full and exact description thereof.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

Various systems of generators have been tested with horizontal, vertical, and inclined tubes, everything leaving more or less to desire. Either the steam drives the water from those tubes or a regular feeding becomes impossible, or one obtains not steam enough or the expense of the combustible is doubled. However, it must always have seemed strange and even absurd to use immense boilers containing ten or twelve thousand times more water than every piston-stroke consumes, while every piston-stroke introduces as much as it consumes. What is then that enormous reservoir of water for? It serves chiefly, first, to fill up sufficiently the boiler, which must necessarily be of a great capacity, since it must offer a vast heating-surface and that no portion of that surface ought to be dry without the greatest danger; second, to make less sensible the momentary variations in the progress of the fire, for a large quantity of water, much less than a small one, acquires superior tension by an excess of fire, and a reduction of elasticity by a reduction of the fire; third, to remove all importance of slight variations of the level in the boiler, and consequently to those of the feeding. In fact, its surface at the water-gage being very much extended, one conceives that, should the feeding cease entirely, one should have still time to perceive the lowering of the level, the engine needing to work pretty long to lower the level of two centimeters, for instance. (One centimeter is about half an English inch.)

Those are, without speaking of the difficulties of cleaning and others, the chief reasons for the use of those large and enormously heavy boilers, requiring excessive expenses for the establishing, a very long time to heat, and the continual risks of the frightful ravages of an explosion.

To replace those boilers by tubulous apparatus containing but a small quantity of water, it is necessary to find means to realize indispensable conditions. There must be, among the rest, first, sufficient surface for the heating; second, regular feeding without the possibility of having neither more nor less water than is necessary for the constant gage in spite of the variations more or less unavoidable in the expenditure of steam; third, surface of water-gage nearly as extended as in an ordinary boiler, and whose gage can only lower slowly if the feeding fails or diminishes; fourth, the certainty that the steam cannot drive the water from that apparatus more than from an ordinary boiler; fifth, horizontal and warranted communications of the tubes common both for water and steam; sixth, easiness of cleaning; seventh, means by which the excess of tension of the steam moderates the fire instantaneously, for if the fire then continued with a certain intensity the tension should soon rise by one or several atmospheres, or, the valve opening, there should be a spending without any advantage. It is true that if all the difficulties were reduced to that seventh condition the apparatus should present besides so many advantages that one could remedy it by a greater attention in the managing of the fire and by the choice of an intelligent and experimented fireman; but it is not so, and the other conditions are of the utmost necessity. It is therefore obvious that by realizing these conditions immense advantages should realize with them. Among the number, the apparatus would cost but about the fourth part of the price of a boiler; the space it would occupy would be much less; its weight would be twenty to forty times less; some minutes only would be required to heat; there would be no explosion, and, besides, all should be limited in the tearing of some tubes without any other misfortune. Theoretical and experimental inquiries have led me to resolve the problem by a system of tubes conveniently disposed.

Tubes may be disposed in many ways. Many ways also may make them communicate between each other, &c. The good one differs perhaps but very little from all the others materially; but one must have applied one's self with perseverance to such inquiries to understand what pains, time, and expense are necessary to discern those decisive differences, the more difficult to recognize as they strike the eyes the least, by reason of their little apparent but material importance. After having uselessly sought to modify the several known tubular systems, obtaining nothing satisfactory with them, I concluded that I had begun the wrong way, and that it was better for me to choose my starting-point anew. I thought that a flat boiler having only ten or twelve centimeters in depth—that is to say, between its upper and lower parts—though receiving but very little water, should present a great heating-surface, a great surface of gage, little weight, &c.; that the solidity, on the contrary, was alone much less. I also perceived that in principle one would preserve that form, and that it should be sufficient to supply the boiler, to fill the same space by a certain number of tubes of about ten or twelve centimeters, for instance. I place tubes horizontally on the same plan parallel to each other and almost in contact to a score of centimeters, or about seven or eight English inches above the grate of the furnace. The means of communication among each other should deviate the least possible from the flat boiler I have just spoken of. The tubes and orifices of communication will then have their axes in the plane of the axis of the tubes composing the system. These communications should have the greatest diameter possible; as great as that of the tubes of the system will be the best. Any means of communicating above, under, or at length out of the plane of the axes has inconveniences, and it is necessary, as I have said it, that the same communication of the tubes with each other be common both to water and steam. Attached to the principle of the flat boiler and representing it the most simple possible, I place the tubes, as I have said, on the same horizontal plane. To place some higher or some lower or to make more than one row, or to gather them, as it were, in a pile, is running to numerous inconveniences. Above the general plane of the axes one can admit but tubes for steam and not at all for water. One must also renounce the idea of feeding the apparatus by the upper part. It is necessary to cause the water to enter from below. The feeding must be made very regular. The water must arrive there having already a temperature equal to that which is already within. One must be very careful not to give too much thickness to the metal with which the tubes are made, the indispensable thickness in the large boilers being one of the principal causes of their bursting. For tubes of twelve centimeters, or about five English inches in diameter, the thickness of a millimeter (or about a twenty-fourth part of an inch) and a half is more than sufficient, the tube resisting thus to a pressure of about fifty atmospheres. I confine myself to these preliminary remarks. They seemed to me necessary to a better understanding of the apparatus. The remainder will follow from the description I am to make of it.

Figure 1 presents the plan of the apparatus; Fig. 2, the elevation of the side of M, and Fig. 3 the profile on the lines N O of Fig. 1 and N′ O′ of Fig. 2.

The same letters refer to the same parts in the three figures.

A B is a horizontal tube forming the communication between the nine other tubes, which are perpendicular to it. Each of these is composed of two ends. Thus a b is composed of the ends d y y' y'', attached to the transversal tube A B, soldered and riveted in those junctions for more solidity. The axes of all these tubes are in the same horizontal plane. The tube A B is of a diameter a little larger than the others, so that the nine other tubes representing the boiler have between them communications of a greater diameter than the diameter of the tubes. It is to be understood that according to the dimensions of the apparatus it will be possible to use two or more transversal tubes A B. The anterior end A carries an index of the gage by means of a glass pipe in the ordinary way. It is understood that one can adapt cocks to it to shut off in case the glass pipes should break or when required to clean them. Each of these tubes a b a' b' has one of its ends closed permanently and the other by a cover shutting by means of bridles and bolts; or, still better, as is seen, by means of a single pressing-screw V V, in order to open and shut more quickly for cleaning or for other motives. One sees, also, that the ends closed or fixed, as a, do not go so far. They leave thus the necessary place for the shutting of the others and can be in the furnace, while the others project without, the sides of the furnace being indicated by the lines c c d d and c' c' d' d'. As to A, it projects outside, as may be seen by the lines d d and d' d', indicating the side.

The following is the method of regulating the draft of the chimney:

C D is a cylindrical rod loaded with a weight P, regulated to the tension one wishes to have, passing through a stuffing-box A T, and extending in a tube A′ B′, soldered to the apparatus and extending almost to the bottom in water, so that the pressure of steam will cause the water to ascend into the tube. That water presses the rod C D from the lower part to the upper. When the tension overcomes the load, the rod will ascend and will act on the lever E H F, which will shut by the end F′ the register of the chimney. The tension diminishing, the load will cause the rod to come down again and open anew the register. The rod will come down only when the tension is less than to make it ascend, and the difference may be of one-third and even one-half an atmosphere during some instants. This difference can be overcome in the following manner: The lever E F′ extends to E′ and there is provided with a vase G′, shown in vertical profile here to exhibit the inside part, in which is a little valve, with the rod S opening from the lower part to the upper at the bottom of the vase. In the present position the excess of tension of the steam is supposed to have made the rod C D ascend and shut the register of the chimney. Thus the vase G′ must have ascended, and the button *b* of the rod S has pushed from the lower part to the upper the rod *b a* of the clapper of a valve *e*, placed in the bottom of a larger superior vase V. This vase is on the principle of an intermittent fountain tightly shut. It admits air but by the tube T′. When the valve *e* is opened, the water runs from the larger vase into the little one, till it comes to stop the lower extremity of the tube T′, which plunges into it, and thus stops the flow of water. The increase of weight which produces this water makes the rod C D come down as soon as the tension of the steam begins to diminish. The lever and the little vase will take the position indicated by the dotted draft and the chimney opens. The lower end of the rod of the clapper-valve of the little vase meets the obstacle X, and the valve is opened. This vase gets empty, ready to reascend when the same circumstance occurs. The larger vase V is shut at the upper part by a conical cork *y*, having a rod by which one lifts it up when one wishes to let the water pass into the vase V from the receiver U. The cork *y* excludes the air.

If desired, the water-way passes through a cock adapted at the bottom of a little box Z, placed below the receiver, soldered to the vase V. One will open that cock at the degree which one will please. The rod of the clapper passes through the bottom of the said box, a hole being made for that purpose, as the escape of some drops of water is of no consequence.

Let us suppose the excess of tension takes place even forty-eight times within twenty-four hours, and that at every time the little vase G′ exhausts half a liter of water it will be sufficient to pour at once twenty-four liters of water into the larger vase to have it supplied for twenty-four hours of working, which is absolutely insignificant. It is obvious that one may change the position of the lever, together with its length, and dispose the system as one pleases. Also, if one wishes to push the steam out of the boiler without causing it to pass through the cylinder, one must establish a valve or a cock for its cleansing.

Fig. 6 represents the vase G on a larger scale.

It is pretended that percarbureted-hydrogen gas can accumulate and detonize in the vent-hole. If the register of the chimney is closed, however, I see no danger in it; but for all safety one has but to make an opening down the chimney and shut it with a shutter opening without, remaining free and ready to open at the least internal pressure.

G G′ are vertical tubes united in communication by H, bearing the tube *h* for the manometer and *h′* for the taking of steam.

I is a vertical tube placed on the upper part of the boiler, with a corresponding tube I′ below it in the same axis. The feeding-water comes in I′, and from this in all the horizontal system by the pipe K K′.

L is a valve for the escape of the overflowing water. In I I′ is a floater, represented by the dotted lines *m m′*. This floater shuts and opens the communication in *n*.

Fig. 4 presents the profile of that part of the apparatus, with the same letters for indication. The specific gravity of the floater is such that it sinks into the water up to the line *u*. It is obvious that as soon as the water-gage will be to that height in the whole apparatus the opening in *n* will be shut, and no water will be permitted to come in, since it comes under and is inclined to force the floater up to the opening *n*. The water which is pushed by the feed-pump escapes through the valve L a little more loaded than the rod C D, before described. As soon as the level begins to lower, the floater goes down and the water comes in.

It will be necessary to provide guides for the floater, that it may always move vertically and at the same time to present an obstacle to the water which arrives by K and could make it deviate from its vertical position.

I I′ is in the interior of the furnace, except the upper end, which can surmount the arch indicated by the line *d d′*, Fig. 2, and *d c*, Fig. 3, as also H G G′. As to the lower part I′, it is in the fire-place and ash-pan P P′, Fig. 2, and P′ P″, Fig. 3, which are the elevation and profile of the grate. This grate has an opening for I′, which is, besides, preserved from the contact of the coals by a vertical screen. The arch gets warm, undoubtedly, but much less than should be thought at first. The tubes being as near as possible and the vent-hole T, whence departs the chimney F, being low enough besides, the radiation of the vault cannot surpass the radiation of an ordinary boiler.

I have already said that the dotted lines *c c c′ c′* and *d d d′ d′*, Fig. 1, marked the sides of the furnace, beyond which project the capped ends. I add that the metal of the tube must not be in contact with the masonry.

Fig. 4 represents the external front of the masonry on the side of the ends not permanently closed. The openings 1 2 3 4 5 are to receive the tubes 1 2 3 4 5 of Fig. 1.

The circular zones Z Z are filled with sheet-iron, which is alone in contact with the tubes, the masonry stopping at a certain distance. It is sufficient to place at the exterior part of the masonry bands of sheet-iron, stoutly fixed to the iron of the furnace and bearing the cuts which form the openings 1 2 3 4 5. One places the apparatus on the lower band cut, then one places the upper band.

The upper part of the furnace may be movable at pleasure by substituting sheet-iron for masonry—in that case double vault and double sides, as I have said. Sheet-iron is to be preferred to masonry, independently of its lightness, because of the little space it occupies and the economy of establishing; it presents but a reservoir of caloric, which gets cold almost as soon as it is heated, and the means which act on the fire by shutting the chimney produces its effect more quickly.

For the navigation on sea the great agitation to which the ship is exposed requires the employment of a means to prevent the water of the tubes to obey quickly the motions, and to direct it according to the inclination toward one of the ends of the apparatus, leaving the other dry, let us cause the rod to pass through the centers of several metallic disks; let us fix them to that rod, leaving intervals between them, their planes being parallel to each other and perpendicular to the very rod; let us introduce a rod thus supplied with disks or washers in each horizontal tube of the system in order to avoid this inconvenience.

The dotted lines N *r r r r r r* N′ indicate the rod in place with its disks, Fig. 1. The disks will clog the too quick circulation of the water without preventing it entirely. Instead of being perfectly circular and to have a diameter equal to that of the tube, they should have the form represented by *f*, Fig. 7, *g g* being the vertical section of the tube—that is to say, the disks should be of a diameter a little smaller, and a little segment will be taken from them to allow a certain liberty of circulation in its lower parts. This little apparatus can easily be taken by one of its ends to introduce it into the tube and to remove it. These disks may serve to sweep off the gravel which gets in the tubes. In order to avoid too sensible an accumulation of water in the apparatus on the side where the ship would be inclined by the wind, one may discompose an apparatus in several parts, each of which having but two or three tubes. One may also in the direction of the length of the apparatus (which must always be the direction of the length of the ship) make the apparatus itself bear upon two pivots in a manner analogous to the suspension of a cradle.

I will finish this description in observing that I have thought useless to occupy myself about the means of repairing the apparatus in case any tube should burst. In fact, when we make an ordinary boiler we do not care about the means to repair it if it bursts. Then a boiler costs much dearer and resists not so much as the tubes we are speaking of. There is no need then to create difficulties gratuitously. The essential is to establish well the apparatus and to try it with the hydraulic press under a strong pressure, even ten times what it is to bear, in order to be sure that the soldering, joints, &c., present no flow. For these essays the floater *m m′*, Fig. 2, should not be in place unless it be dropped down. otherwise, it would prevent the water from filling the apparatus. It should be laid in one of the horizontal tubes. The spray will show whether it will itself resist the pressure. We must observe that the same pressure that would rend the tubes of the boiler would leave the floater entire, as the tubes receive the strain of the hydraulic press in the inside of their curvatures, which tends to separate their molecules, while the contrary effect is produced for the floater, which receives that strain on the exterior part, and that will resist because of its diameter, which is not so large as that of the tubes of the boiler, even if we supposed less thickness to its metal.

If one wishes to have a greater steam-reservoir, one can multiply the vertical-tubes in making them communicate with each other by others joining them, as the example is to be seen in the drawings, where the steam-pipe *h′* is seen.

In establishing engines it is very rare when one does not make some change, and often without perceiving that one can hurt the mother idea the principle. It should then be well remarked; that all the tubes composing this boiler have their axes in the same horizontal plane; that the diameter of the communications is not less; that it is even greater than that of the tubes of the apparatus; that these communications are common both at once to the water and steam; that the water-gage is at once in the tubes and in the communications; that above the plane of the boiler there are but tubes to serve as a reservoir or a dome, and which may be multiplied according to necessity. It should also be observed that the feeding-tube or of injection brings the water from underneath; that this water coming in the horizontal apparatus is at a temperature at least equal to that within; that for the constancy of the water-gage the floater becomes a regulating-valve, which opens and shuts an orifice always covered by water, since it is several centimeters below the gage; that the water is maintained in the total length of the tubes by disks placed perpendicular to their axis; that that apparatus, though containing twenty and even forty times less water than an ordinary boiler, presents as much and more heated surface and gage; and to end this recapitulation we shall direct the attention on the means which unites all the conditions of economy, and which suppresses the safety-valves, as they become useless, because of the impossibility of danger.

It is well understood that one may establish several of these apparatus according to the wants and localities, either on the same or on different planes, but always horizontal. The communications between these apparatus are established by upper tubes to concur to the same end and being to contain but steam. Every apparatus will receive its alimentation as I have explained. A single pump can be sufficient for all, the injecting-tube being ramified for that purpose according to the number of the apparatus, which will have each its regulating-valve with floater, as it has been said.

I claim—

1. Making the generator of a series of small horizontal tubes all on the same plane, in combination with and opening into a tube of greater diameter placed at right angles with them, or nearly so, the opening or connection between each tube in the series, and the larger tube being equal, or nearly so, to the diameter of the tubes in the series, so that the communications between the tubes of the series shall be common for the water and steam.

2. Regulating the feeding of the water into the boiler by a floating valve in the feed-pipe, the specific gravity of which shall cause it to close the aperture in the feed-pipe when the water reaches the proper level, as herein described.

3. Preventing the rush of water from one side of a series of tubes to the other in marine and other locomotive boilers by means of a partition-disk placed in the tubes, as herein described.

4. Regulating the intensity of heat in the furnace, and thereby regulating the generation of steam by the pressure of steam acting on a piston connected with the damper which regulates the draft of the chimney, in combination with the means herein described for overcoming the friction of the moving parts in reopening the damper when the pressure is reduced, substantially as herein described.

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