(No Model.)

2 Sheets—Sheet 1.

C. H. TWIST.

STEAM BOILER.

No. 384,943. Patented June 19, 1888.

Fig. 1.

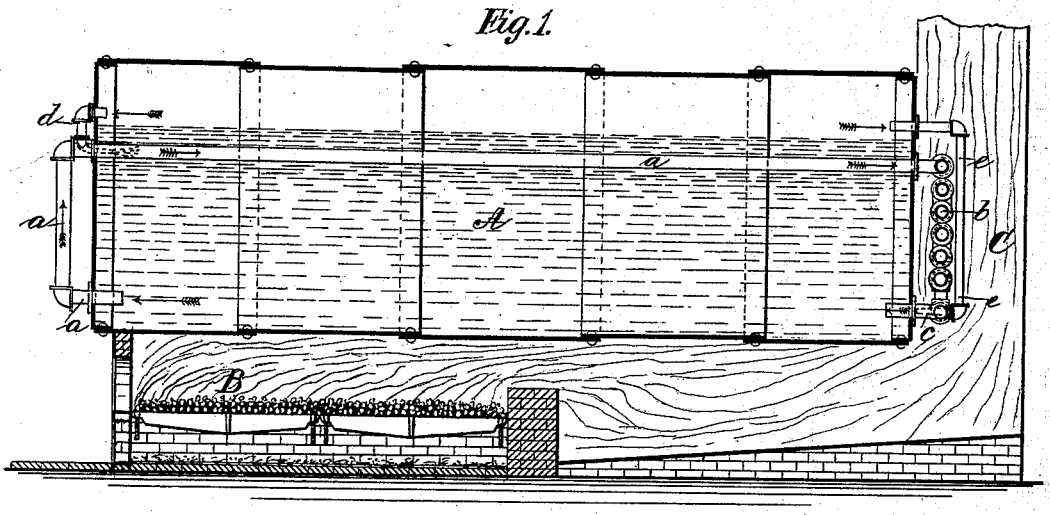


Fig. 2.

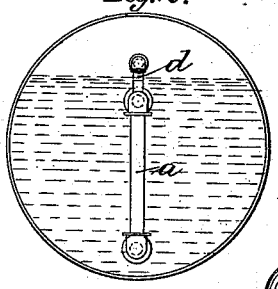


Fig. 3.

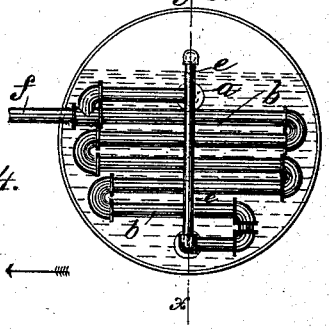
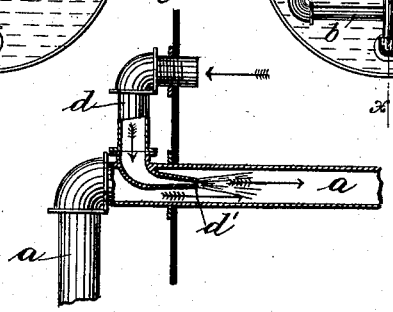


Fig. 4.



WITNESSES:
Edm. F. Tourtellotte.
Wallace H. Pearson.

INVENTOR
Charles H. Twist.
BY
Hubert A. Banning,
ATTORNEY

(No Model.) 2 Sheets—Sheet 2.

C. H. TWIST.

STEAM BOILER.

No. 384,943. Patented June 19, 1888.

Fig. 5.

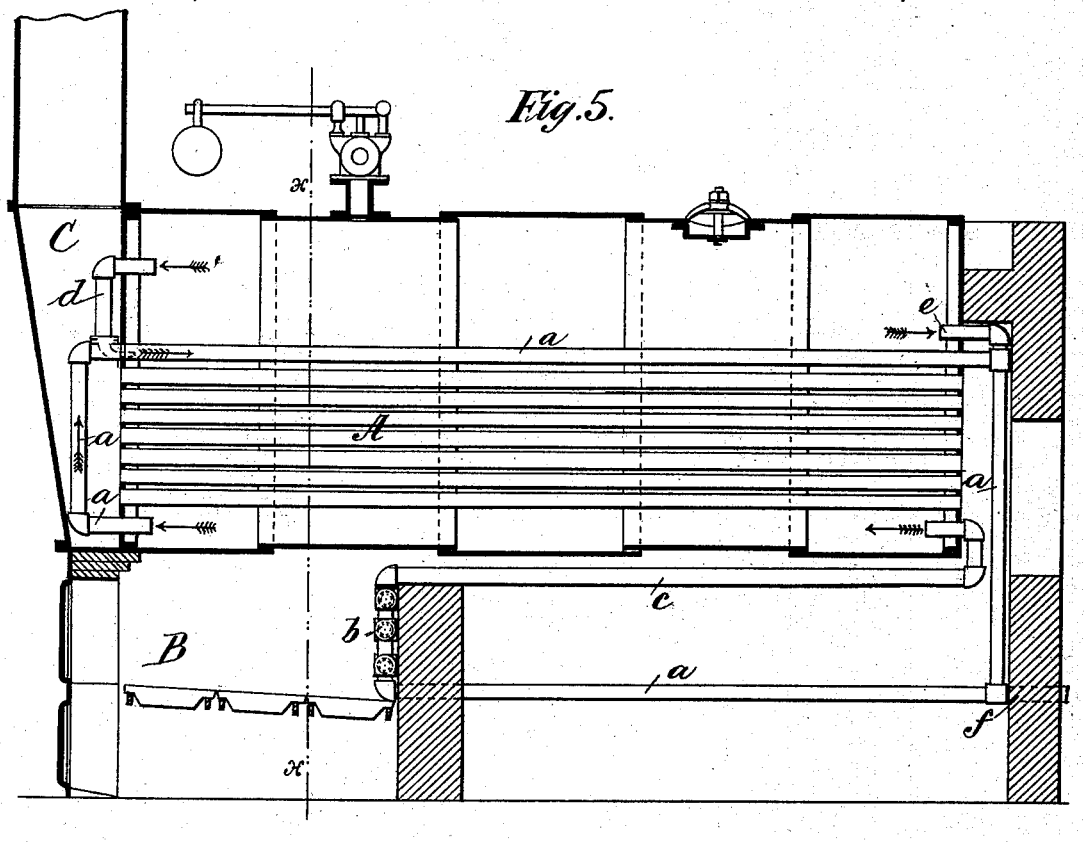
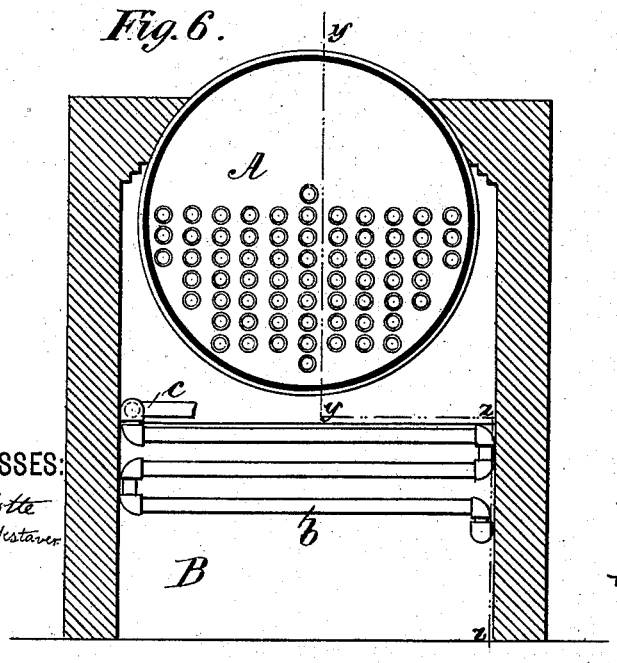


Fig. 6.



WITNESSES:
C. F. Fourtellotte
Wm. B. Bookstaver

INVENTOR
Charles H. Twist.
BY
Hibbard & Banning
ATTORNEY

UNITED STATES PATENT OFFICE.

CHARLES H. TWIST, OF NEW YORK, N. Y.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 384,943, dated June 19, 1888.

Application filed August 28, 1886. Renewed November 28, 1887. Serial No. 256,295. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. TWIST, of the city of New York, in the county and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is such a full, clear, concise, and exact description as will enable others skilled in the art to which my invention appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

The object of my invention is to increase the efficiency of steam-boilers by utilizing the waste heat that now goes up the smoke-stack; to prevent the unequal contraction and expansion that now exists in steam-boilers, thereby rendering the boilers less liable to rupture or explode and adding to the life and usefulness of the boilers, and to prevent to a great extent the formation of injurious scale or sediment on the boiler plates, flues, or tubes.

It is a well-known fact that the greatest damage inflicted on a steam-boiler is caused by the unequal expansion and contraction of the plates, flues, and tubes. The unequal expansion and contraction of the boiler-shell cause a shearing motion, which often cuts the rivets to such an extent that they break off, thus occasioning leaks and a weakening of the boiler.

Not only that, the unequal strains to which the boiler is continually subjected have a tendency to elongate certain portions more than other parts, and as the weakest part of a boiler-shell is where the plates are joined together by rivets, the unequal strains produce the shearing above mentioned, besides warping or drawing the boiler-plates from their original position, which causes the boiler to leak at the seams and makes it very difficult to repair, as one plate may be found to be longer than the plate to which it is attached.

In an extended and varied experience with steam-boilers, covering a period of twenty years, I have often found the above to be the case, and in many instances the plates would have to be replaced with new ones on account of their great elongation and the inability of the boiler-makers to effect a tight joint with them.

The unequal contraction and expansion of a steam-boiler are produced by several causes, among which is the injection of cold feed-water into the hot boiler. In stationary boilers, however, that is often overcome by heating the feed-water before it enters the boiler, the waste steam from the exhaust of the engines being utilized to do the heating. Another cause, and probably the greatest, is the unequal distribution of the heat from the furnace-fire over or along the surface of the boiler, the boiler being the hottest at the end nearest the fire, which is herein termed the "front" end, and the coldest at the end farthest from the fire, which I term the "rear" or "back" end. Then, again, the plates at the bottom of the boiler, which come in direct contact with the fire, are subjected to greater heat than those at the top, which are generally exposed to the air, or covered with a non-conducting material.

The greatest strains from contraction and expansion, and when the most damage is done to the boiler, are when the fire is first made to raise steam, or when the fire is drawn to allow the boiler to cool off for the purpose of repairs or for cleaning. In the first instance the damage is generally caused through ignorance or carelessness on the part of the operator in allowing the boiler to get hot too fast and in not having a sufficient quantity of water in the boiler, his object being to raise steam in as short a time as possible. In the second instance the damage is caused by letting the boiler cool off too suddenly, it being the practice in many places to draw the fires, blow off the steam and hot water, and then inject cold water into the boiler, instead of letting the boiler cool off gradually and naturally.

Another source of damage and danger to a steam-boiler is the depositing on the plates and tubes of scale and mud, caused by the use of impure water, the foreign matter being separated from the water by the action of the heat. In a plain cylinder-boiler the scale is deposited on the bottom and sides of the boiler, and, owing to the construction of the boiler, it is easily cleaned, while in a tubular boiler the sediment is deposited on the bottom of the boiler and around the flues or tubes. A heavy or thick deposit of scale on the plates or flues of steam-boilers is injurious to the boiler, inasmuch as the water cannot circulate beneath the scale and reach the metal, which is thus left unprotected from the action of the fire

and soon burns out unless the scale is removed. In some parts of the United States the water is so pregnant with solid matter—such as alkalies, gypsum, &c.—that the water-spaces between the tubes in the boiler are frequently entirely stopped up with scale, which can only be removed by taking the tubes out, and this is a very expensive operation.

To secure a more perfect combustion of the fuel used in the making of steam and to utilize the waste gases that escape up the chimney has been the study of the users of steam for many years. Many devices have been resorted to with varying success; but with the best appliances and under the most favorable circumstances not over sixty to seventy-five per cent. of the fuel is actually utilized, the balance escaping in the form of gases at a temperature of from 300° to 800° Fahrenheit, (according to the kind of boiler and draft used,) and causing a loss to the consumer of twenty-five to forty per cent. of the actual heat produced, besides the extra labor that is necessary to handle the fuel. With the steam-boilers in common use, under ordinary circumstances, the waste amounts to fully fifty per cent. The objects of my invention I accomplish by utilizing a portion of the waste heat to heat the feed-water before it enters the boiler; also by utilizing the waste heat, when not used in heating feed-water, to increase the capacity and efficiency of the boiler by creating a perfect circulation through the entire length of the boiler, thereby keeping the water at a more uniform temperature and making the boiler less liable to uneven contraction and expansion, and also, by heating the feed-water before it enters the boiler, to cause the solid matter in the water to be deposited at or near the place where the water enters the boiler, where it can be collected in an ordinary mud-drum and blown out of the boiler at the pleasure of the engineer.

In the drawings, Figure 1 is a longitudinal vertical section of a stationary boiler, A, taken on the line *x x* of Fig. 3, showing one arrangement of the pipes and connections which I employ in conjunction with the boiler, and this figure shows, also, the fire-box B and the course taken by the products of combustion under the boiler and into the smoke-box C, from whence they pass up through and out of the smoke-pipe, the upper part of which is not shown. Fig. 2 is a front view of the boiler-cylinder and the connections at the end nearest the fire, while Fig. 3 is a view of the rear end of the boiler-cylinder, and showing the pipe and coil connections at that end, which are located within the smoke-box; and Fig. 4 is an enlarged side view, partly in section, of the steam-connection *d*, combined with the water-pipe *a*, which parts are also shown in Figs. 1 and 2. Fig. 5 is a vertical longitudinal section, taken on lines *y y z z* of Fig. 6, of a stationary tubular boiler equipped with my improvement; and Fig. 6 is a transverse section thereof, taken on the line *x x* of Fig. 5.

In the drawings, A represents the boiler, B the fire-box, and C the smoke-box.

a is an open pipe (shown as being made of several pieces, but which need not be so made) extending from a point near the bottom of the boiler up to a point a short distance below the water-line, and through the water to the rear end of the boiler and into the smoke-box, where it opens into a coil, *b*, located where it will be heated by the fire, as in the smoke-box C, or where it will be in contact with the fire, as shown in Fig. 1, or in the fire-box B, as shown in Figs. 5 and 6, such coil being made to empty into the lower part of the boiler by means of a pipe or extension, *c*. At the front end of the boiler is a steam-pipe, *d*, which has an open end within the boiler above the water-line, in order that it may take the live steam, and this pipe communicates with the water-pipe *a* and may have a small end or steam-jet, *d'*, so that more force will be imparted to the steam when it enters the pipe *a*. A similar steam-pipe, *e*, passes out of the rear end of the boiler and enters the return-pipe *c*, but may enter the coil *b* instead of this return-pipe, and this steam-pipe may also be provided with a jet at that point, if desired. The connection *f* is to permit the feed-water to enter the coil *b*, in order that the feed-water may be heated in its passage to the boiler both by mingling with the hot waters in the coil *b* and also by reason of the heat imparted to the coil *b* by the products of combustion within the smoke-box or heat from the fire-box. The course of circulation is indicated by the arrows.

The coil of pipe *b* is placed in the smoke-box in such a manner as to be surrounded by the waste heat, but not to interfere with the draft. This coil, having a direct communication with the boiler, becomes, as it were, a part of the boiler, and on filling the boiler with cold water the coil and the pipe *a* are also filled, provided that they do not extend above the water-line of the boiler. The pipe *a* can be run through the boiler, as shown, and I prefer to have it so; but this arrangement of the pipe is not essential, as it may be made to extend along on the outside of the boiler, or it can be arranged wholly within the boiler; but, whether as shown or otherwise located, it may be placed at any desired height not above the water-line unless steam-jets are used in connection with it, as hereinafter described. So also the form of the water-containing receptacle or conduit within the smoke-box (shown as the coil *b*) may be varied.

The action produced by the connection of these parts with a steam-boiler will be as follows: After the boiler is filled with water to the desired height, in the ordinary manner, the fire is then built under it and the process of making steam commences, and when the water in the boiler becomes heated currents are established or formed by the water flowing upward and away from the source of the greatest heat, while the colder water flows toward the most heated part to replace the other

and in its turn becomes heated, and thus the action of the water produced by the heat is continued. The direction of the currents will be upward and from the fire on the surface and downward and toward the fire in the lower part of the boiler. The water at the front end of the boiler will of course boil sooner and be hotter than the water which is farthest from the fire. As the water becomes heated the hot water in the front end rises, and a portion of it will flow up through the pipe *a* and force the cold water that is in the pipe through the coil *b*, which will thus be made to empty its cold water into the boiler through the connection *c*. In this manner the circulation is started throughout the entire length of the boiler, and the cold water at the back end is forced forward to replace the hot water at the front end and to make room for the hot water that is being forced through the coil and into the back end through the connection *c*. The circulation thus begun is continued so long as the water is kept heated. The water is thus kept at an even temperature, or nearly so, at all points in the boiler, and consequently the contraction and expansion of the plates and tubes are accordingly rendered even or uniform.

In order to give increased velocity to the circulation when required, I make use of one or more steam pipes or jets, *d* and *e*, which are inserted into the water-circulating pipes at such points as may be found desirable. In the drawings I show two such steam-jets entering the water-pipes at the front and rear ends of the boiler; but different boilers may require the steam pipes or jets at other points, while some boilers need only the circulation that is made by the use of the water-pipes. I prefer the steam-jets made as shown in Fig. 4 of the drawings, which is a section of a jet made on the same principle as an injector; but this form is not essential, although desirable. By using the steam-jets in connection with the water-pipes I make it much easier to feed the boiler, as the feed-water is taken up by the circulation and carried along with it into the boiler, being heated as it passes through the coil, thus allowing no cold water to enter the boiler.

By using steam-jets to increase the velocity of the circulation the pipe *a* may be raised to the top of the boiler, as the steam from the jets will raise the water to that height with the assistance of the hot-water pressure from the boiler, a small jet of steam only being necessary. If too much steam were used, it would not condense in the hot water and a back-pressure would be formed.

The pipe *a* may be inside of the boiler, if convenient, in which case the extension of the same beyond the front end may be dispensed with altogether, provided a proper connection is made with the coil *b*, and, if desired, two or more similar pipes and coils may be used.

I have shown one feed-water connection; but two or more may be made, if required or desired. The connection *f* permits the feed-water to enter the coil *b*, and this assists the heating of the feed-water before it enters the boiler.

I do not confine myself to the use of the appliance in the form shown in the drawings, for the same may be varied in many respects, and different makes and kinds of boilers will require variations from the form of the appliances shown in the drawings; but I do confine myself to the same general arrangement, in order that I may accomplish the object of my invention which I have described.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A means for increasing the efficiency of a steam-boiler, consisting of a pipe located within said boiler and extending from end to end thereof, in combination with one or more steam pipes or jets having communication therewith, said first-mentioned pipe being adapted to receive water and steam from said boiler at or near one end thereof and to discharge the same at or near the opposite end, substantially as and for the purpose set forth.

2. A means for increasing the efficiency of a steam-boiler, consisting of one or more circulation-pipes combined therewith and adapted to receive water therefrom at or near the front or fire-box end thereof, said pipe or pipes extending to the rear or colder end of the boiler and communicating with a conduit opening into such rear end, in combination with one or more steam pipes or jets having communication with the said circulation pipe or pipes or with said conduit, whereby the water and steam entering the said circulation pipe or pipes are discharged into the rear or colder end of the boiler and the circulation increased, substantially as and for the purpose set forth.

3. A means for increasing the efficiency of a steam-boiler, consisting of one or more coils or conduits disposed to be heated by the fire, and a feed-water pipe communicating with said coil, in combination with one or more pipes adapted to bring water from the boiler, one or more steam pipes or jets made to enter said water-pipe or said conduit, and a return-pipe for discharging the water from said conduit into the boiler, the whole being arranged substantially as and for the purpose set forth.

4. A means for increasing the efficiency of a steam-boiler, consisting of the pipe *a*, coil *b*, and return-pipe *c*, the same being arranged in the manner shown and described, for the purpose set forth.

5. A means for increasing the efficiency of a steam-boiler, consisting of the pipe *a*, coil *b*, and return-pipe *c*, arranged as described, in combination with the steam-pipes *d* and *e*, substantially as and for the purpose set forth.

CHAS. H. TWIST.

Witnesses:
EDW. F. TOURTELLOTTE,
HUBERT A. BANNING.