No. 610,969. Patented Sept. 20, 1898.

E. D. MEIER & H. G. TIDEMANN.

BOILER.

(Application filed Mar. 14, 1898.)

(No Model.)

Fig. 1.

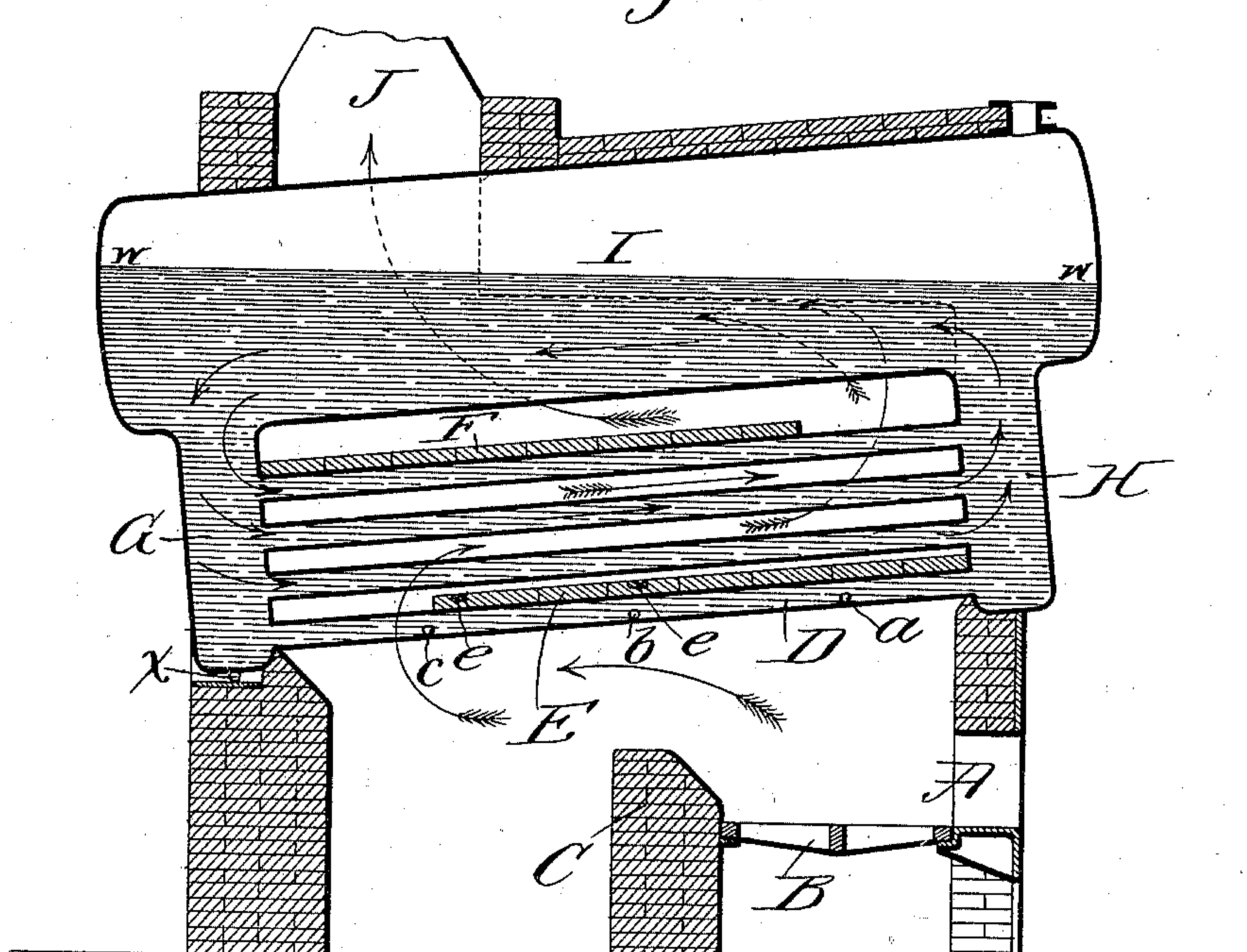
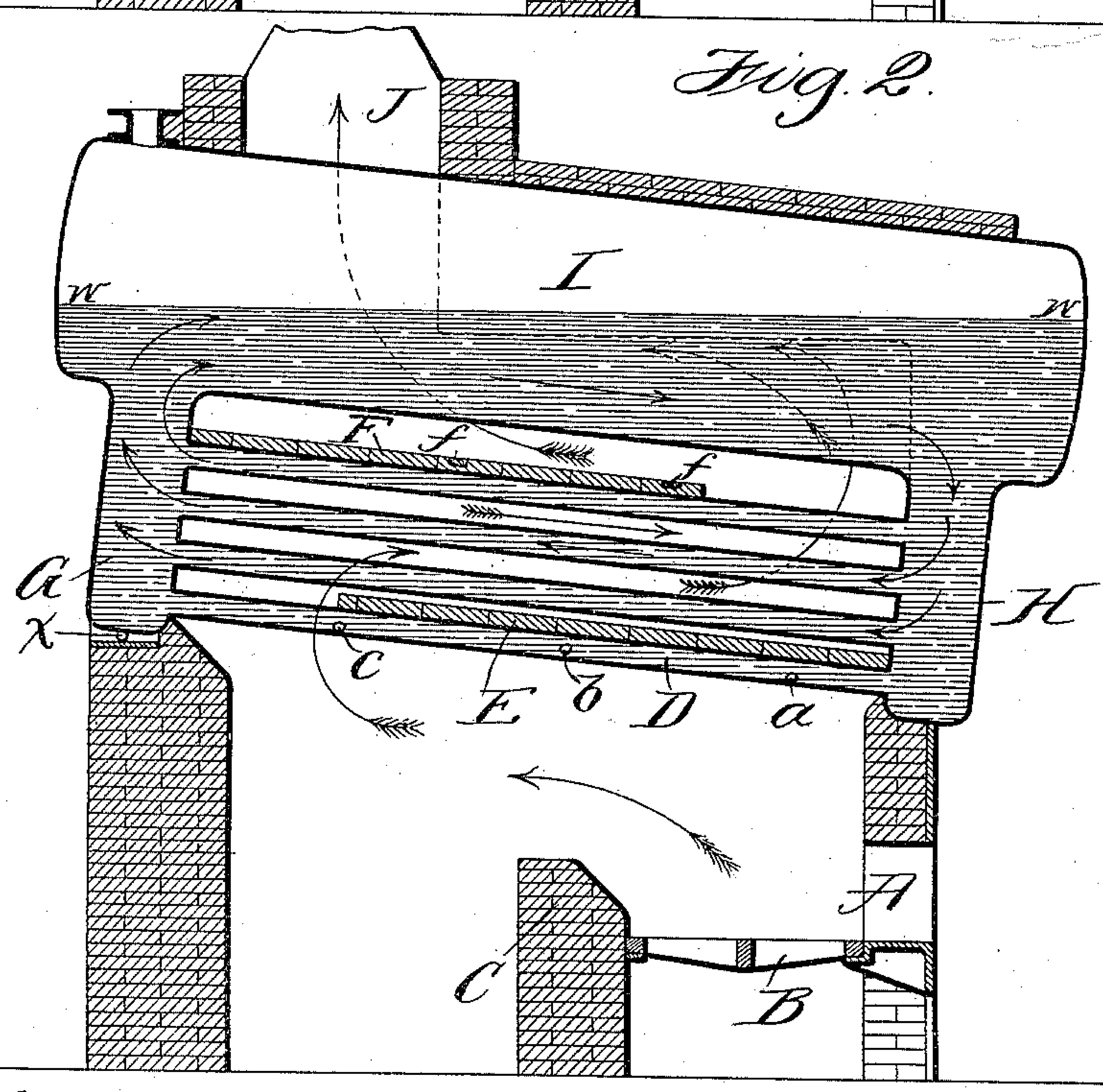


Fig. 2.



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UNITED STATES PATENT OFFICE.

EDWARD D. MEIER AND HENRY G. TIDEMANN, OF ST. LOUIS, MISSOURI.

BOILER.

SPECIFICATION forming part of Letters Patent No. 610,969, dated September 20, 1898.

Application filed March 14, 1898. Serial No. 673,747. (No model.)

To all whom it may concern:

Be it known that we, EDWARD D. MEIER and HENRY G. TIDEMANN, citizens of the United States, residing at St. Louis, State of Missouri, have made a certain new and useful Improvement in Boilers, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical longitudinal sectional view illustrating the position of the water-tubes relative to the furnace now most generally employed, and Fig. 2 is a view illustrating a boiler whose tubes are arranged relative to the furnace according to this present invention.

This invention relates to a new and useful improvement in steam generators or boilers, the object being to so arrange the water-tubes and boiler generally relative to the fire-box or furnace, or vice versa, as to render the boiler most efficient.

In the drawings we have shown a subhorizontal water-tube boiler to illustrate the old practice and also to demonstrate our invention. It will be noted that the type of boiler does not necessarily have to be exactly that illustrated, as other types could be used.

In using the term "subhorizontal water-tube boiler" we desire to be understood as meaning those boilers in which the inclination of the upper tubes in the main bank or banks is less than forty-five degrees. In such a subhorizontal water-tube boiler it has heretofore been the universal practice to place the grate or furnace under the higher ends of the tubes. We are not aware of a single instance in which this method has been departed from. The reason for placing the furnace under the higher ends of the tubes may be attributed to the desire on the part of most boiler-manufacturers to have the flames or products of combustion directed against the tube-surfaces practically at right angles, and this is most easily accomplished when the grate is placed under the higher ends of the tubes which are inclined upwardly toward the front. This invention, however, consists in reversing this arrangement and placing the grate, and consequently the furnace, under the lower ends of the tubes.

In the drawings we have shown a well-known type of boiler, known as the "Heine Safety-Boiler," in which A indicates the fire-door; B, the grate-bars; C, the bridge-wall; D, the boiler-tubes; E, the lower curtain or tiling; F, the upper curtain or tiling; G, the rear water-leg or header; H, the front water-leg or header; I, the drum; J, the stack, and W W the water-line.

In Fig. 1 the tiling forming the lower curtain E is held in position by anchor-bars *e*.

In Fig. 2 the same letters of reference refer to corresponding parts, with the exception that the upper curtain F may be held in position by anchor-bars *f*, while the anchor-bars for the lower curtain E are omitted, they being unnecessary, due to the inclination of the tubes illustrated in this figure.

In Fig. 1 the boiler is used in the usual manner, with the grate under the higher ends of the tubes. It will be observed in this arrangement that there is a smaller head of water for the upper ends of the tubes directly over the grate than there is for the lower ends of the tubes or at the rear end of the boiler. Owing to the well-known direction of circulation in the tubes of boilers arranged as shown in Fig. 1 it is clear that when the boiler is steaming freely no solid water remains in the upper ends of the tubes, the solid water being replaced by a mixture of steam and water, while at the lower end the solid water is entering from the rear water-leg or header, such circulation being indicated by the featherless arrows. In the furnace proper the radiant heat of burning fuel is reflected directly against the tubes and is added to the heat from the burning gases, so that the heating-surface of the upper ends of the tubes which are over the furnace proper is taxed more than any other portion of the boiler, and therefore this surface receives a greater amount and more direct heat than any other. By reason of the presence of the steam and water in this portion of the tubes, the amount of steam preponderating, the tubes are less protected on the inside than at the lower end, where solid water is entering.

It is well known that steam is not nearly as good a conductor of heat as water and besides has less capacity for heat than water, and therefore this mixture of steam and water in the upper ends of the tubes cannot as readily receive the maximum heat to which it is subjected, cannot protect the metal of the tubes, and cannot utilize the heat as well as the solid water in the lower ends of the tubes. Experiment and experience alike have demonstrated that when the heated gases of combustion are made to travel in an approximately horizontal direction along the tubes by means of the approximately horizontal diaphragm or curtain of tiling E the flames or gases hug the tube-surfaces and lick all around more closely than when they are made to travel between the tubes at approximately right angles. When the tubes are inclined as shown in Fig. 1, it is difficult to maintain the tiling forming the curtain E in position, and recourse must be had to anchor bars or rods for holding the tiles to the side walls or securing the tiles to the front header or water-leg.

By reference to Fig. 2 it will be seen that there is a larger head of water on that portion of the tubes directly above the fire, and therefore that portion of the tubes will be almost entirely filled with solid water, the water entering at their front ends and circulating in the direction of the featherless arrows. This tube-surface directly over the fire which receives the solid water is more exposed to heat, is better protected by its contents, and is in a condition to absorb the heat more readily than that shown in Fig. 1. The tiling forming the diaphragm or curtain E, once placed in position, will remain without recourse to anchor bars or rods. This tiling can be made entirely independent of the side walls, and if it should move slightly out of place by reason of the difference of expansion and contraction in heating or cooling its tendency will be to return to its original position. This tendency of the tiling to return to its normal position is less important in stationary boilers than in marine boilers, in which latter the rolling, pitching, and shaking of the vessel form a disturbing element, rendering this feature of a natural return to its original position or its tendency to return to its proper position of prime importance.

A certain amount of free space, determined by experience, is necessary above the fuel-bed of any boiler and between the tubes of the lower row and tiling and the top of the bridge-wall in order to allow the gases of combustion liberated from the fuel to expand and pass out of the furnace into the combustion-chamber. By reference to Fig. 2 it will be seen that this result is better and more advantageously accomplished here than by the construction shown in Fig. 1. To illustrate this feature, it will be obvious that at the forward portion of the grate there will be less gas than at the rear end of the grate, where the total quantity of liberated gas from the fuel-bed has to pass off through a given area, and therefore as long as the distance between the fuel-bed and the lower row of tubes is sufficient just at the bridge-wall it can be materially lessened toward the front.

The construction illustrated in Fig. 2 permits of a lower front than the construction shown in Fig. 1 and affords a greater flue area for the combustible gases above the bed of fuel and above the bridge-wall than the usual plan, as exemplified in Fig. 1.

Many arrangements may work passably in problems of combustion and heat transference when the working limits are low. In modern practice, on land as at sea, the tendency is to push every factor to the extreme limit consistent with safety and economy. Matters which may seem trivial and escape attention where work is light may become of great importance when nearing the upper limits. Besides, at such upper limits a number of small factors would accumulate to create trouble or even danger, which factors would or may be ignored in lighter service. Among these is the question of the relative direction of the circulation of the water in the tubes and of the heated gases outside. It will be noted in Fig. 1 that the direction of the heated gases is opposed to the trend of the water circulation in the lowest row of tubes, while in Fig. 2 they are practically parallel. To illustrate the advantage of having the direction of circulation of the water in sympathy with that of the gases of combustion in the lowest row of tubes, we will assume that the first bubble of steam in the arrangement shown in Fig. 1 is evolved in a tube of the lower row at *a*, a second at *b*, and a third at *c*. It will be noted that each succeeding bubble takes away some of the force which is impelling the first bubble forward and upward, because the space occupied by the generated steam being greater than the water which it supersedes will detract that much pressure from the head of water at the lower ends of the tubes; but if these bubbles travel in the direction of the products of combustion, as in the arrangement shown in Fig. 2, and solid water is entering to replace the space formerly occupied by the moving or circulating bubbles, the probability of a more vigorous circulation is apparent.

It is well known that the greatest point of danger in burning the heating-surface of the boiler is just above the bridge-wall, where the contraction of the flame into the narrowest space is necessary. A glance at the drawings will show that in Fig. 1 the danger to the heating-surface is greater from this source than in Fig. 2, because in the latter the area opens out toward the rear and therefore eases this condition, while in Fig. 1 the reverse is the case.

Another advantageous feature in the arrangement shown in Fig. 2 resides in the tendency of the heat to linger around the highest ends of the tubes when the products of combustion turn, as indicated by the feathered arrows, and move forward. The heat is here held by the tiles forming the curtain F. Again, when the products of combustion turn upward after passing the full length of the tubes and move rearwardly toward the stack the gases have a free and unobstructed passage above the upper tiling on their way to the chimney or breeching after having given full benefit to more than one-half of the boiler-shell which exposes the largest body of water to contact with the heat, the direction of the movement of the products of combustion here being in opposition to the circulation of the water in drum I, while the reverse is the case in Fig. 1. As the hottest gases from the combustion-chamber contact with the tubes at their highest point, the steam-bubbles will pass direct to the rear water-leg, and thence to the surface, finding here the lowest hydrostatic pressure. The solid water filling up from the front is cooler and heavier and causes a rapid circulation. The cool water in the tubes above the lower row traveling opposite the current of the hot gases forms a counter-current so much desired in good boiler practice, giving a sure and unobstructed circulation in the boiler. In the new arrangement there is a better result produced by the contact of the hot gases with the tube-sheet of the rear water-leg which is struck by the hottest gases, thus forming steam-bubbles inside the water-leg, which will pass directly upward with the current from the tubes, making this water-leg a very effective heating-surface and giving also room for the steam-bubbles. This is not true of the construction shown in Fig. 1, where the hottest gases strike the rear water-leg, and when steam-bubbles are formed, there being a greater hydrostatic pressure at this end of the boiler than at the higher end of the tubes, the steam-bubbles, instead of rising directly to the surface, will be compelled by the circulating water to travel forwardly the length of the tubes and pass into the front water-leg, where they may rise to the surface. Thus it will be seen that while the counter-current in the lower row of tubes in Fig. 1 is a disadvantage said counter-current in the upper nest of tubes in Fig. 2 is beneficial in that as the greatest amount of steam is generated therein at the rear or highest ends of the tubes said steam is quickly available when it rises to the surface, and therefore it requires comparatively but a short time in which to get up steam.

Another feature of advantage due to the position of the boiler shown in Fig. 2 is its natural tendency to return to its normal position in cooling, which is assisted by the inclination of the rear water-leg where it rests on roller x, while the reverse is the case with relation to Fig. 1.

It is obvious that many minor changes in the construction, arrangement, and combination of the several parts of this boiler can be made and substituted for those herein shown and described without in the least departing from the nature and principle of this invention.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The herein-described arrangement of a subhorizontal water-tube boiler, said boiler comprising a drum, front and back water-legs, opening directly into the drum, and water-tubes opening at their ends into the water-legs, said water-tubes being inclined upwardly and rearwardly, the lower ends of said tubes being over the fire-box where the greatest heat exists, whereby, when steam is formed in said tubes, it travels rearwardly through the tubes, and passes upwardly through the rear water-leg and directly into the drum, substantially as described.

2. The herein-described arrangement of a subhorizontal water-tube boiler, said boiler comprising a longitudinally-arranged drum I, front and back water-legs G and H, which open directly into the ends of the drum, and longitudinally-disposed water-tubes D which open into the water-legs, said water-tubes being inclined upwardly and rearwardly, thereby locating the lower ends of the tubes over the fire-box, the hydrostatic pressure being greater at the front end of the boiler, forcing the water circulation rearwardly in the tubes, and forwardly in the drum, said water circulation being counter to the direction of movement of the products of combustion, with the exception of the circulation of the water in the lowest set of tubes which is parallel with that of the movement of the products of combustion, whereby, when bubbles are evolved in the tubes, they pass rearwardly through the tubes, whose inclination assists such action, and upwardly through the rear water-leg, flashing into steam at the rear end of drum I, where the hydrostatic pressure is smallest, substantially as described.

In testimony whereof we have hereunto affixed our signatures, in the presence of two witnesses, this 10th day of March, 1898.

EDWARD D. MEIER.
HENRY G. TIDEMANN.

Witnesses:
F. R. CORNWALL,
WM. A. SCOTT.