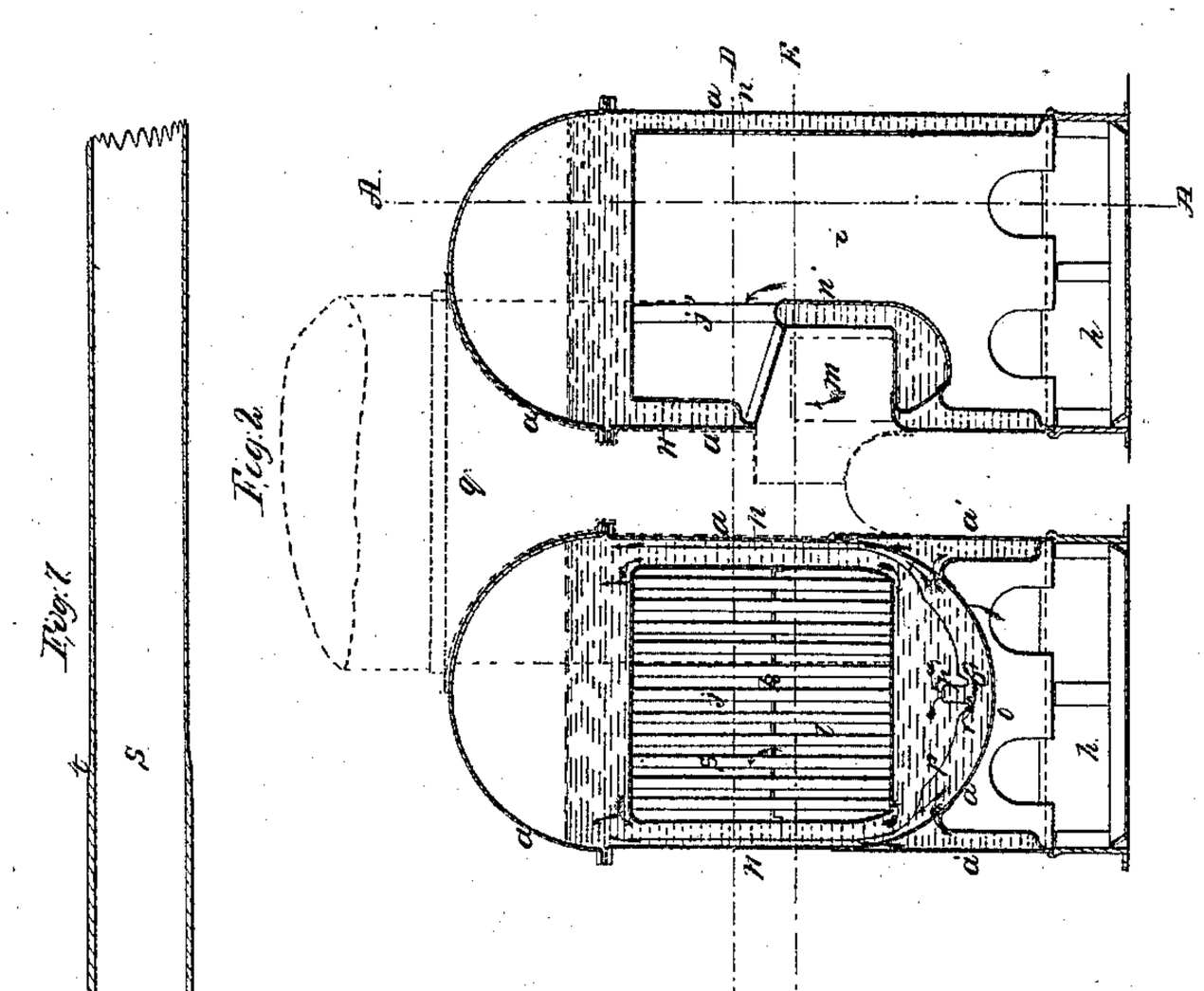
J. Montgomery,

Steam-Boiler Water-Tube.

No. 21,013. Patented July 27, 1858.



Witnesses:
Wm. H. Bishop
Joel B. Wilson

Inventor.
James Montgomery

UNITED STATES PATENT OFFICE.

JAMES MONTGOMERY, OF BROOKLYN, NEW YORK.

IMPROVEMENT IN GRATES FOR STEAM-BOILERS.

Specification forming part of Letters Patent No. **21,013**, dated July 27, 1858.

To all whom it may concern:

Be it known that I, JAMES MONTGOMERY, of Brooklyn, in the county of Kings, in the State of New York, have invented certain new and useful Improvements in Steam-Boilers; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a plan, with a portion of the rear part in section. Fig. 2 is a cross vertical section of two connected boilers, one taken at the line B B and the other at the line C C of Fig. 1. Fig. 3 is a longitudinal vertical section thereof taken at the line A A of Fig. 2. Fig. 4 is a horizontal section of a modification exhibiting two boilers connected back to back, with one in section to represent the internal arrangement of the flue-space; and Fig. 5, a longitudinal vertical section thereof, and Fig. 6 a cross vertical section with one half of the width taken at the line C C and the other at the line D D of Fig. 4; and Fig. 7 is a longitudinal section of one of the tubes on an enlarged scale.

The same letters indicate like parts in all the figures.

In the construction of tubular steam-boilers serious difficulty has been experienced in obtaining a sufficient proportional extent of manageable grate-surface. It is well known that if too thick a layer of coal is placed on the grate much of the heat will be absorbed in distilling the upper portion of the layer of coal, much of the combustible matter escaping in the form of carbureted hydrogen and carbonic oxide, the heat evolved from the combustion of the coal nearest the grate effecting the distillation of carbureted hydrogen from the coal above, while the oxygen of the blast or draft is consumed before it can reach these to inflame them, and the carbonic acid produced by the complete combustion of the lower part of the charge in passing up through the upper part takes up an additional charge of carbon, thereby forming carbonic oxide, which escapes from the furnace with a large portion of unconsumed carbon, heat being absorbed instead of being evolved by the change of carbonic acid into carbonic oxide. From these well-known facts all experienced engineers direct the coal to be charged in thin layers as the only economical mode of management; but as steam-boiler furnaces have been heretofore constructed a sufficient amount of fire cannot be made because of the limited extent of grate-surface in proportion to the large amount of evaporating-surface presented by the tubes and because of the supposed impossibility of increasing the amount of fuel without thereby inducing the waste from the causes first named. The only way in which an increased evolution of heat could be produced would be to enlarge the extent of grate-surface; but no mode of effecting this practically in large boilers has heretofore been known, because if the length of grate be too great the stoker cannot reach the rear end of the charge for efficient management, and it is only by an increase of length that a greater extent of grate-surface can be obtained, as the utmost width has already been given. I have, however, succeeded in obtaining a material extent of grate-surface in the direction of the length of the boiler to overcome the difficulties above pointed out without the inconveniences above stated; and to this end my invention consists in combining the series of vertical water-tubes and the flue-space among the said tubes and communicating with the fire-chamber at one end, as hereinafter described, the extending of the grate along the entire length of the boiler, or nearly so, with a fire-door at each end, whereby I am enabled to obtain practically the required extent of grate-surface with all the facilities of managing or stoking the fire, while at the same time the fire on that part of the grate nearest the flue-space leading to and among the tubes can be so managed by keeping thereon a thin charge of incandescent coals as to supply through that portion of the charge the required quantity of highly-heated uncombined oxygen to consume the combustible gases evolved from the charge of coal on the other portion of the grate farthest from the flue-space leading to and among the water-tubes; the stoking being so arranged as to supply the fresh charges of coal on the grate farthest from the said flue-space and the incandescent coals being gradually transferred to the other end of the said grate.

In the accompanying drawings, *a* represents the outer shell of the boiler, made with parallel vertical sides and a semi-cylindrical top

and bottom; and *b* the front and *c* the back grate, which, if desired, may be separated by a cross-bridge running across the entire breadth of the fire-chamber and placed about midway between the front and back end of the boiler, but not represented. For the better-protection of this bridge (if one be used) against the action of the heat it is made hollow, the two ends communicating with the water-legs for the free circulation of the water through it. There is a fire-door *f* in front and another *g* at the rear end, the one *f* to give access for the management of the fire on the grate in front of the bridge, and the other *g* to give access to the fire on the grate back of the bridge, so that the stokers can have ready access to the whole length of the grate-surface of the largest boilers. Below the grate there is an ash-pit *h*, extending the whole length and breadth of the boiler.

In the boilers represented in Figs. 1, 2, and 3 the products of combustion from the fire-chamber pass up in a vertical flue-space *i* at one of the rear angles of the boilers, and thence into a horizontal flue-space *j* toward the front, thence turn down around the front edge of a diaphragm or plate *k* into a return-flue space *l*, under the said diaphragm to the rear end of the boilers, and out into the stack through the other rear angle of the boiler at *m*. The flue-spaces *j* and *l* are not the whole width of the boiler, but there is a water-space *n* on each side communicating with the water above and below the flues. Numerous vertical water-tubes are placed in the flue-spaces, and extending from the top plate of the upper flue to the bottom plate of the lower flue to establish a free communication between the water above and below the flues, and by reason of the arrangement of the flues the products of combustion in passing up to and along the upper flue circulate among and around the said tubes, acting on the outside of the upper half of their length, and in returning through the lower flue act in like manner on the lower half of their length, so that the upper part of the length of the tubes will be more intensely heated than the lower, thus favoring the upward circulation of the water through the said tubes, the circulation of the water being downward in the water-spaces outside of the flues to supply water to the lower ends of the said tubes.

To prevent the steam generated on the crown-sheet *o* of the furnace from passing directly up to the lower end of the tubes, which would have a tendency to check the supply of water to that end of the tubes, a shield-plate *p* is interposed. This plate inclines upward on each side from the middle, and then extends vertically up into the waterways *n* on each side about midway between the side plates of the flues and the outer shell of the boiler, so that all the steam which is generated on the crown-sheet of the furnace is deflected laterally on each side and rises between the vertical parts of this plate and the outer shell of the boiler, leaving the other portion of the said water-ways free for the downward circulation to supply the lower end of the tubes.

The inner division of the vertical flue-space *i* is double to form a water-leg *n'*, but as the products of combustion in passing over the upper edge thereof to get into the upper horizontal flue-space *j* will impart a very intense heat to this water-leg, particularly to the upper edge thereof, which might be injurious, if not dangerous. I connect the upper part of this water-leg with the upper part of the boiler above the flue-space *j* by vertical water-tubes *j'*, which afford a free circulation of the water through this water-leg, and thereby protect it against any injurious action of the heat. The space between these tubes affords the required space for the passage of the products of combustion.

The water-legs *a'* each side of the furnace are formed each of two plates connected together by their lower edge, one riveted to the vertical side of the boiler and the other to the semi-cylindrical bottom, being suitably curved for that purpose, and that part of the bottom of the boiler which is within the water-legs is cut through with long slots in the direction of the circumference for the free circulation of water into and out of the legs, as indicated by arrows in Fig. 2.

The shield-plate *p* may be turned in the middle under the tubes, as represented at *p'*, and pierced with holes for the downward passage of water and these holes protected by a second shield-plate *o'* below, so that the water from above may pass through and get below, and at the same time the steam generated on the crown-sheet will be deflected and made to pass up through the side water-legs *n n*.

In Fig. 2 there are two boilers represented side by side, the flues of both discharging into a common stack *q*.

The red arrows indicate the direction of the draft.

In Figs. 4, 5, and 6 the boilers are arranged so that they can be connected in pairs by their back ends, leaving sufficient space below the central stack for stoking the fire on the back grate of both boilers through the back fire-doors.

The flue-spaces of each boiler, with their congeries of water-tubes, are divided into two compartments by a vertical water-way *r r*. The vertical flue-space *i*, leading from the fire-chamber into the upper horizontal flues *j j*, is located at the back end and in the middle of the width of the boilers, and there are two flue-spaces *m* leading to the stack, one for each flue, one on each side of the vertical flue *i*. The products of combustion from the fire-chamber rise in the flue-space *i*, are separated by the central water-way *r r*, and pass horizontally through the two flues *j j* to the front end, where they pass around the front end of

the diaphragm *k* and back in the two flues *l l* to the exit-flues *m*, leading to the stack. In this construction the central stack, which joins the rear end of the two boilers, is constructed separately, so as to fit into the rear end of the two boilers, which mode of construction facilitates the transportation of the boilers, as they can be transported separately and put up by simply pushing the rear end of each boiler into the casing of the central stack. The bore of the water-tubes *s* is of equal diameter from end to end, as represented in Fig. 7 on an enlarged scale, and the outer surface is also of equal diameter from the upper end to within a few inches of the lower end, where the diameter is increased, as at *t*, to increase the thickness of metal for the reason already described.

In Figs. 4, 5, and 6 the crown-sheet of the furnace is represented of a different form, as the boilers may be with any one or all of my said improvements, although the best results will be obtained when all of my said improvements are used in connection.

The best mode of managing the fires in my improved furnace is to charge the coal on the front grate, and when it has reached the incandescent state—that is, after it has been thoroughly coked—to transfer a portion of it in that state into the back grate, leaving a sufficient quantity on the front grate to ignite a fresh charge of coal, and so on, gradually transferring and charging, which transfer can be readily effected by pushing the coals as the combustion proceeds by the stokers in front toward the middle or the fire-bridge, if one be used, and the stokers at the rear drawing the coals onto the back grate. In this way a very intense heat from coked coal will be maintained on the back grate, and as the coals on this back grate have been previously distilled the blast or draft will supply more oxygen than will be consumed by passing through the charge, but which will be intensely heated in so passing through the fire, and hence will be in the best condition to inflame the combustible gases evolved from the coals on the front grate as they pass over the back grate toward the flues. Thus a most perfect combustion of the inflammable matter will be effected and in a manner which will give out the greatest amount of heat for the coals consumed.

I am aware that boilers have been constructed in the manner of two horizontal tubular boilers placed back to back with one smoke-box common to both and with the grates of the two connected so as to appear as one grate for the two series of flue-tubes and with a door at each end; but this mode of construction does not present the mode of operation which I have invented and claim as my invention, for each half of the grate belongs to and acts in connection with its appropriate set of flue-tubes as in two separate boilers, and the products of combustion from the coals on one end of the grate cannot be made to pass over the other end of the grate.

What I claim as my invention, and desire to secure by Letters Patent, is—

Combining with a boiler formed with a series of vertical water-tubes, and the flue-space among the said tubes communicating with the fire-chamber at one end only, substantially as described, a grate made the whole or nearly the whole length of the boiler and with a fire-door at each end, substantially as and for the purpose specified.

JAMES MONTGOMERY.

Witnesses:

WM. H. BISHOP,

WM. SELLERS.