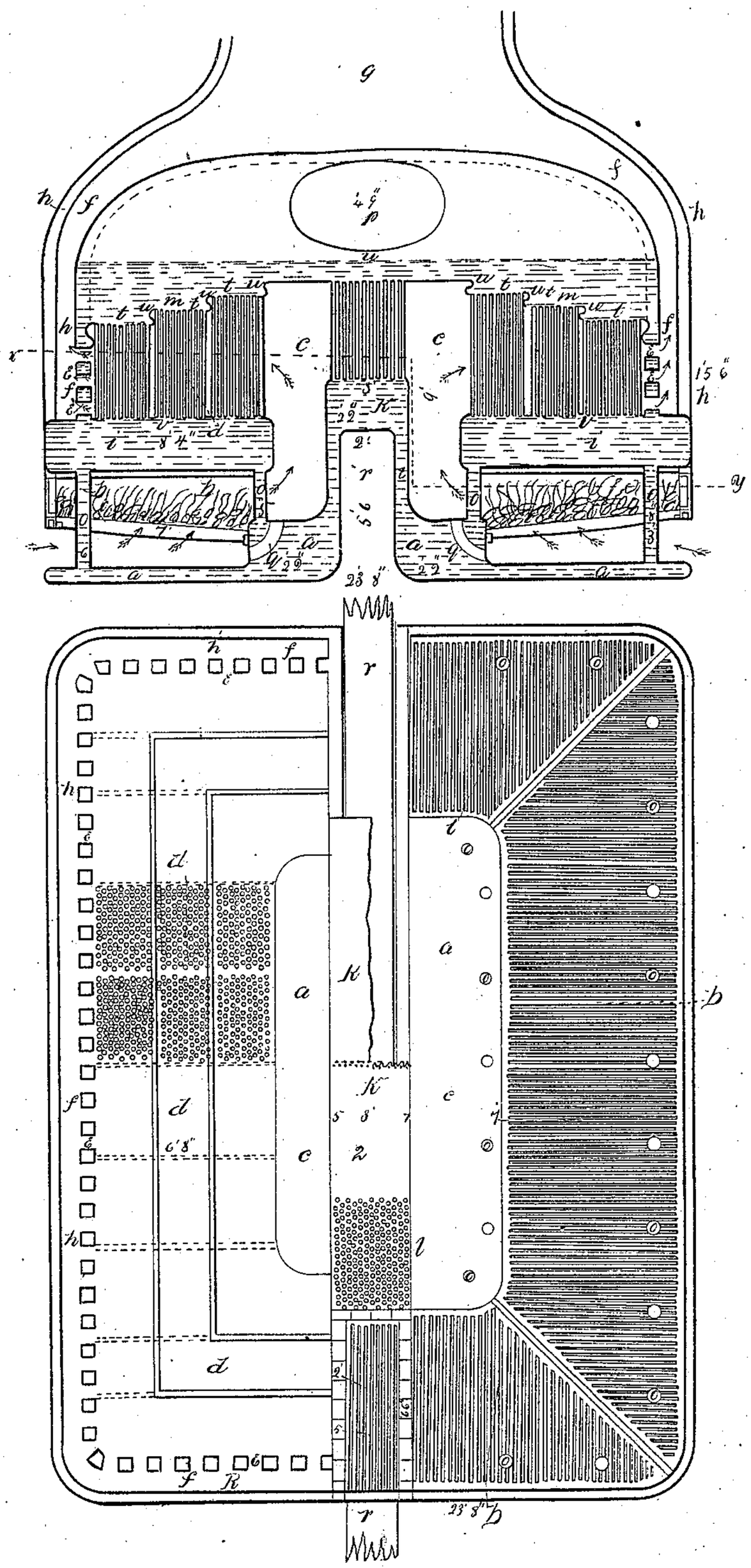
2 Sheets - Sheet 1.

J. A. Roebling,

Steam-Boiler Fire-Box.

No. 12,032. Patented Dec. 5, 1854.



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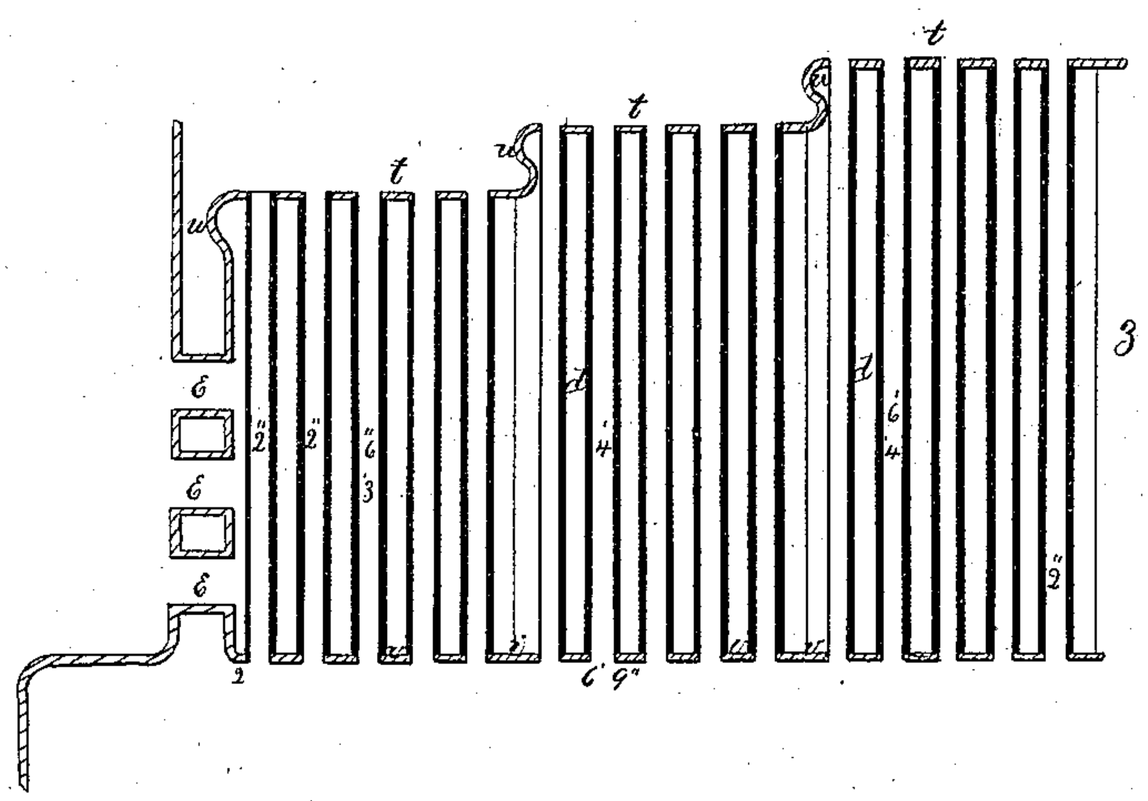

UNITED STATES PATENT OFFICE.

JOHN A. ROEBLING, OF TRENTON, NEW JERSEY.

IMPROVEMENT IN STEAM-BOILERS.

Specification forming part of Letters Patent No. **12,032**, dated December 5, 1854.

To all whom it may concern:

Be it known that I, JOHN A. ROEBLING, of Trenton, in the county of Mercer and State of New Jersey, have invented certain new and useful Improvements in Steam-Boilers for Marine and other Engines and for other Purposes; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1, Plate 1, shows a transverse vertical section taken through the center of a marine steam-boiler constructed according to my invention. Fig. 2, Plate 1, shows a horizontal section of the same, of which that half on the left side is taken through the tubular space and the half on the right through the furnace, as indicated by the red line *x y* in Fig. 1. Fig. 1, Plate 2, shows a partial longitudinal section of the keelson and of one of the furnaces above the keelson. Fig. 2, Plate 2, shows the plan of the tube-sheet forming the top of the tubular space on a larger scale than the other figures. Fig. 3, Plate 2, is a vertical section of the tubular space corresponding with Fig. 2.

Similar letters of reference indicate corresponding parts in the several figures.

The boiler here represented is thirty-two feet long, twenty-three feet eight inches wide, and fifteen feet six inches high, designed for a steamship of sixteen-hundred-horse power, or three thousand tons burden. It is therefore the largest size that may ever be wanted. Two such, placed fore and aft, will supply steam for three-thousand-two-hundred-horse power. The aggregate grate-surface of the single boiler is five hundred and forty-five feet; heating-surface, nineteen thousand feet—equivalent in efficiency to the four boilers of the steamship *Arctic*, of the Collins line.

a a a form the base of the boiler, a water-table of six inches depth at the outside, increased in the center to a height of two feet two inches. Here a second bench is formed which leaves underneath a clear opening the whole length of the boiler of three feet wide and five feet six inches high for the inclosure of a strong keelson. It is, however, preferable in place of this large center keelson to substitute a number of small ones and distribute them under the base *a*. The smaller keelsons may be strengthened by iron plates or be made of iron altogether. The latter arrangement will admit of a more simple and effective and also cheaper construction of the boiler. The part of the boiler marked *r* and *k* will then be omitted and the bottom will be entirely smooth, and by omitting the center tubes (marked *l*) the central fire-chamber (marked *c*) will be enlarged.

b b b are the furnaces surrounding the center on all sides, and forming, if not interrupted by a center keelson, one single vast furnace of seven feet length of fire-bars running all around the boiler, therefore occupying its whole area, except the central space, (marked *c c*.) This feature is one of the most valuable of the plan and entirely novel. In most marine boilers there are a number of small narrow boxes surrounded by water-spaces, which serve as furnaces, and in order to increase the furnace-room a double tier of such small furnaces is generally resorted to, forming two rooms above each other, as is the case in the Collins and most other marine boilers. This arrangement of two stories of furnaces is very inconvenient and objectionable in every respect. It not only adds greatly to the cost of constructing and keeping in repair such boilers, but the tending of the fires is rendered much more difficult. Again, by the separation of furnaces, we can never obtain that degree of economical consumption which is absolutely necessary, and for the simple reason that no perfect combustion can take place in a narrow iron box surrounded by water, which keeps the walls cool and the temperature of the furnace low by abstracting its heat. Perfect combustion can only take place under the influence of a high and concentrated heat, and this heat can only be generated in a furnace entirely free from absorbing obstructions.

c c c is a space of seven feet wide by sixteen feet long and nine feet high, entirely free and empty where no deep center keelson interferes, occupying the center of the boiler and surrounded by the furnace. I call this space the "central" fire-chamber. Its use will be more fully explained hereinafter.

d d d is the space occupied by the tubes which connect the upper and lower water-spaces, and through which the water circu-

lates. This arrangement constitutes another important feature of my boiler not to be met in other plans, and which admits of the greatest amount of heating-surface that is at all practicable in a given space. The horizontal area occupied by the tubes is nearly equal to the area of the furnace, and this is the correct proportion for a marine or any other good boiler where small tubes are used and economy of space is an object. The tubes are two inches in diameter and arranged in three different groups differing in length, being, respectively, three feet six inches, four feet, and four feet six inches. The object of this will be hereinafter more fully explained.

E E E E are flues through which the draft escapes into the smoke-jacket *f*. They are either round or square openings inserted in the water-space which surrounds the tube-space, and are arranged in two or three or more tiers above each other. Their position is clearly indicated in Fig. 2, Plate 1.

f f f f is the smoke-jacket surrounding the whole boiler. It forms the communication between the tube-space and the chimney *g*, which occupies the center above the boiler.

h h is a double case filled with a non-conducting substance, as sand or ashes, and inclosing the smoke-jacket and chimney. In place of this case a steam-jacket may be substituted and of larger dimensions where more steam-room is wanted.

i i is the water-space above the furnace, its top *v* forming the bottom sheet for the tubes. It is two feet deep, so that workmen can get inside to fasten the ends of the tubes. There are man-holes inside the space *c c* as well as outside.

k is a water-space above the center keelson where such is adopted.

l are tubes above the keelson, and which extend only as far as the fire-chamber *c c*. As was remarked above, this deep center keelson should be omitted, if possible. In this case the tubes *l* are also to be omitted.

m m is the corrugated top plate, which covers the tube-space and central fire-chamber, and is constructed in offsets or tiers *t t*, connected by corrugated steps *u u*.

n n indicate a lining of fire-brick under the roof of the furnace. Large square brick may be suspended to the roof by screw-bolts, whose heads form dovetails and are inserted in the bricks; or the brick may be attached and secured in any other convenient manner.

o o o are hollow columns or water-pipes about six inches in diameter, which rest on the base *a a* and support the upper part of the boiler and form a water-communication between without much obstructing the furnace.

p indicates an opening for a steam-pipe; *r*, center keelson.

s s are two separate furnaces surrounded by fire-brick walls above the center keelson where such is adopted. Where this keelson does not interfere, these two separate furnaces are omitted, and the large furnace is continued clear around.

q q indicate small pipes passing from the ash-pit through *a* to *c* for the admission of air when soft coal is burned.

The above description of the construction of my boiler will enable its operation to be readily understood. The grand and novel features are the arrangement of the furnace all around the boiler, thus producing a large grate-surface, the central fire-chamber, *c c*, the occupation of nearly the whole area of the boiler by tubes, the peculiar effect this has upon the draft in connection with the distribution of the exit-flues E E, the corrugated steps of the top sheet of the tube-space, and the brick lining of the furnace-roof. All these points have a most important bearing on the efficiency of this boiler—so much so that its economical working and great capacity for supplying steam will surpass any other marine boiler now in use in this country or in Europe.

The great importance of unobstructed furnace-room has already been dwelt upon. This is rendered more evident when we compare combustion as carried on in a steam-boiler furnace with that of a puddling or heating furnace. The high degree of heat obtained in the latter cannot be reached in the former on account of the fast abstraction of heat by the surrounding walls. The effect of an absorbing-roof is particularly objectionable, and for this reason I insist upon a fire-brick lining, which, when glazed over by the strong heat, will reflect it and materially perfect the process of combustion in place of injuring it. The object of any furnace should be to render combustion perfect, and this can only be done under the influence of a high concentrative action. When thus the fuel is perfectly consumed and but little unconsumed atmospheric air remains left, the intense heat is then allowed to escape in a blaze and spread among the forest of tubes to be by them absorbed.

The central fire-chamber, *c c*, serves as a receptacle of the united product of the furnace, which rushes in with great force, and by its impetus will cause a thorough mixing of the unconsumed air and the gases, and thus more fully elaborate the process of combustion. This is further improved by the liberty afforded to the blaze and flame to expand and ascend to the roof, which is nine feet high.

It is a well-ascertained fact that flame will be more fully developed and more positive in its action the more room it has to expand and elongate. From this central fire-chamber the heat now will spread all around among the tubes. Those immediately surrounding the chamber will be the most effective absorbers; but as the area of the tube-space becomes greatly enlarged toward the circumference the draft will rapidly diminish in proportion, and thus allow the reduced heat to

move slowly and become totally absorbed, or nearly so, before the unconsumed gases reach the escape-flues E E E. This whole arrangement is quite the reverse of the common mode of providing for a uniform draft from the grate to the chimney. The upper tier of the escape-flues E E E may be partly or altogether stopped by inserting fire-brick. A few experiments and a little experience will teach the best mode of regulating the draft so as to produce the best result. Where artificial draft is needed, as is the case when hard coal is consumed, it may be produced either by fan-blast, supplying a large pipe underneath and in front of the ash-pit, or by an exhausting-fan in the chimney. The latter mode appears to be the best. The strength of this boiler will be much increased by the addition to the top (inside) of ribs, which are shown dotted in Fig. 1 of Plate 1, and indicated by the letters *q' q'*. To these ribs stays may be attached to connect with the sheet *m*. The stays, as well as the ribs, may correspond with the rivets of the sheets *m*, so as not to interfere with the insertion of the tubes. The top *q'* may be constructed like cells, ribs running both ways and forming cells, and these may be most effectually connected by stay-rods with the sheets *m*.

It will be noticed that there is ample room for inserting or removing the tubes through the sheets *m*, the steps favoring this work. There is also good opportunity for cleaning the boiler, all the upper parts, where incrustations or settlement can take place in consequence of the intense heat, being accessible. The water in the base is out of the reach of fire and will not cause hard sediment to be deposited.

The construction of the upper tube-sheet, *m*, in tiers or offsets *t t*, descending from the center of the boiler toward the circumference, prevents the upper ends of the tubes being left uncovered by water by the rolling or careening of the vessel, besides which it enables provision to be made for the unequal expansion and contraction of the tubes consequent upon the difference in the intensity of the heat of the tube-space *d* near the fire-chamber and near the exterior circumference to be provided for by corrugating the steps *u*, which unite the several tiers or offsets.

The construction of this boiler will be less expensive than that of the Collins boilers.

What I claim as new, and wish to secure by Letters Patent, is—

The arrangement of the extended grate-surface, elaborating or central combustion-chamber, *c c*, the tube-sheets *v* and *t*, and the tubular water-surface between the said sheets, substantially as herein set forth.

JOHN A. ROEBLING.

Witnesses:
MARCUS ADAMS,
I. W. FISHER.