R. Rafael,

Steam-Boiler Fire-Box.

No. 54,205. Patented Apr. 24, 1866.

Fig. 1.

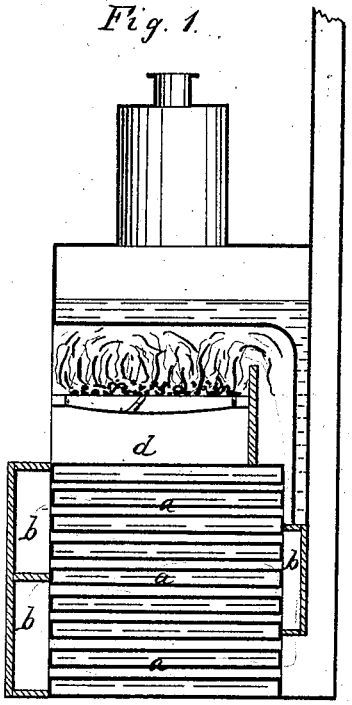


Fig. 3.

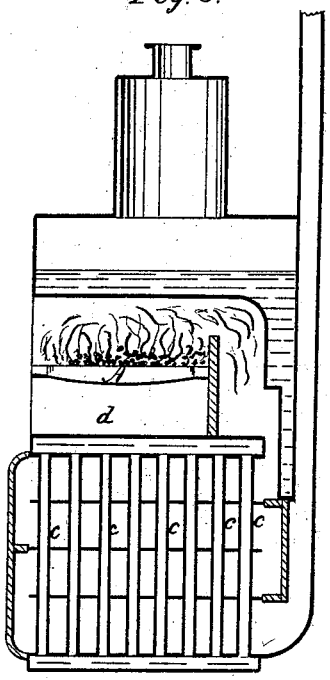


Fig. 2.

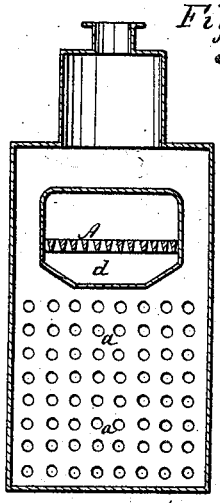
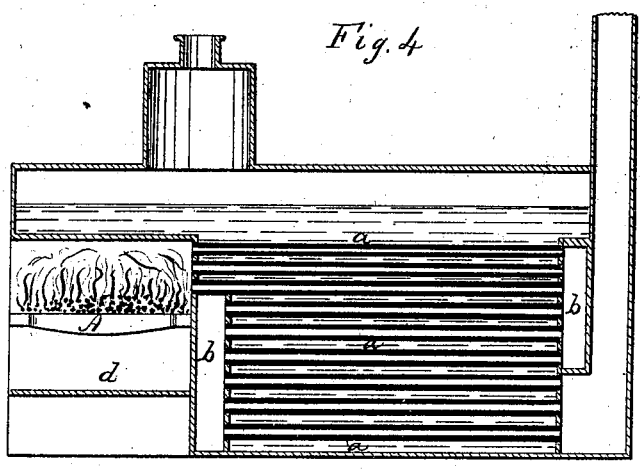


Fig. 4



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UNITED STATES PATENT OFFICE.

R. RAFAEL, OF NEW YORK, N. Y.

IMPROVEMENT IN STEAM-GENERATORS.

Specification forming part of Letters Patent No. **54,205**, dated April 24, 1866.

To all whom it may concern:

Be it known that I, R. RAFAEL, of the city, county, and State of New York, have invented a new and Improved Steam-Boiler; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a longitudinal vertical section of this invention. Fig. 2 is a transverse vertical section of the same. Fig. 3 is a longitudinal section of a modification of the same. Fig. 4 is a similar view of another modification of the same.

Similar letters of reference indicate like parts.

This invention consists in placing the furnace or fire-place of a steam-boiler at or near the top of the same in such a manner as to have there the highest heat, causing at the same time the hot gases to descend toward the bottom of the boiler, either in a zigzag direction or otherwise. By these means different degrees of heat are produced in the water, the highest degrees being always on the top and the lowest at the bottom of the boiler, and consequently no circulation of the water will take place, as in ordinary boilers, whether the water is made to pass through the tubes or outside of them, and whether those tubes are placed horizontal, vertical, or in any other convenient position; and, furthermore, the heated gases being brought in contact with water of gradually-decreasing temperature, will be deprived of all their heat, or nearly so, before they are allowed to escape through the chimney.

The great waste of fuel in the operation of steam-engines is not owing simply to the imperfection of the engine itself, but in a much greater measure to the imperfection of the boilers. If the quantity of heat in the furnace be computed, it will be found that but a very small portion of it enters the boiler to produce steam, the greatest part escaping up the chimney being wasted into the open atmosphere. This great waste of heat is well known to all engineers, and it can be easily demonstrated that the same cannot be avoided in steam-boilers as at present constructed. Whatever be their peculiar arrangements, their principle is invariably this: To have within them a body of water which will be in ebullition with as even a temperature as possible throughout the entire boiler.

The many devices for the better distribution of heat and the most complete circulation of the heated gases and of the water have no other object than the equalization of the temperature in every part of the boiler, and if this equalization is obtained, and at the same time the greatest possible heating-surface, the best possible result is thought to be effected. The fallacy of this principle will be apparent from a brief analysis of the phenomena which takes place in the boiler, bearing always in mind the law of the equilibrium of temperatures, according to which a circulating gas will impart heat to the body through which it circulates provided its temperature is higher than that of said body; but it will absorb heat from said body if its temperature be lower.

The boiler being full of water and the fire lighted in the furnace, the hot gases issuing from the fire begin to circulate, and as the temperature of the water and the iron surrounding it is so much lower than that of the gases the heat, in its tendency for an equilibrium, parts from the gases and enters the iron and the water. In this state of the case if the heating-surface of the boiler were sufficiently large, the whole heat generated in the furnace would be absorbed by the water, and the gases at their point of exit in the chimney would be found comparatively cold. But this would last only one moment. The heat from the gases passing into the iron and the water would raise their temperature gradually, and just in proportion as this temperature would increase the passage of heat from the gases to the water would diminish, such passage being possible only as long as the temperature of the gases exceeds that of the water. As the difference in the temperature of the gases and of the water diminishes the passage of the heat from the gases into the water diminishes in the same proportion; and if a thermometer be placed at the point where the gases leave the boiler and enter the chimney, it will be found that their temperature, instead of being almost cold, as at the beginning of the operation, has increased just in proportion to that of the water in the boiler. This process continues, but at every successive moment the temperature of the wa-

ter being higher and higher, and the difference between said temperature and that of the water being less and less, the passage of heat from the gases to the water diminishes, and the temperature of the gases escaping up the chimney increases precisely in the same ratio. After a certain time the water will reach the highest temperature which it can possibly attain, and if it is supposed that in order to impart to the water said highest temperature the gases generated in the furnace must have a temperature of 1200°; and if after the water has reached its highest temperature the temperature of the gases is suddenly reduced to 900°, (by the introduction of fresh fuel or from some other cause,) it is evident that the temperature of the water will also be reduced in proportion, because in that case the gases, instead of imparting heat to the water, take away from it until the equilibrium is restored. During this process of restoring the equilibrium all the heat generated in the furnace, plus all the heat extracted by the heated gases, runs up the chimney and is a mere waste.

These disadvantages are overcome by the construction of my steam-boiler, in which all circulation of the water is avoided, and the fire-grate A is so situated that the heated gases, on emanating therefrom, will first come in contact with the upper or hottest stratum of water, and then gradually descend, so as to meet strata of water of gradually-decreasing temperature.

The boiler may either be arranged as shown in Figs. 1, 2, and 4, where the heat passes through a series of return-flues which are surrounded by water, or the tubes may be filled with water and the heated gases circulate in a zigzag course round their external surface.

When return-flues *a* are used, as shown in Figs. 1 and 4, said flues terminate in jackets or compartments *b*, or if the water is contained in a series of tubes, *e*, as shown in Fig. 3, said tubes are placed in a vertical position in the heating-chamber, which is provided with a series of horizontal zigzag partitions, so that the heated gases are compelled to travel in a zig-zig course from the fire-place down to the bottom of the boiler, whence the same are allowed to escape into the chimney.

By this arrangement the greatest possible amount of the heat generated in the furnace is transferred to the water, for as this heat gradually diminishes in its passage from the furnace to the chimney, so as to mark a constantly-descending scale, in the same manner the water in the boiler has an equally descending scale of still lower degrees, the coldest water being at the bottom, and the hottest in the upper, part of the boiler, next to the fire-place.

By referring to Fig. 2 it will be noticed the ash-pit *d* has an inverted conical or arched form to allow the steam to pass up to the steam-chamber above with the greatest possible freedom.

I claim as new and desire to secure by Letters Patent—

The herein-described arrangement of the furnace in the upper part of the boiler, and the succession of horizontal flues, whereby the products of combustion are conducted in a zig-zag course to the bottom of the boiler, and there discharged into the chimney, as explained.

The above specification of my invention signed by me this 12th day of June, 1865.

R. RAFAEL.

Witnesses:
WM. T. MCNAMARA,
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