(No Model.) 2 Sheets—Sheet 1.

C. C. PECK.

STEAM BOILER.

No. 590,073. Patented Sept. 14, 1897.

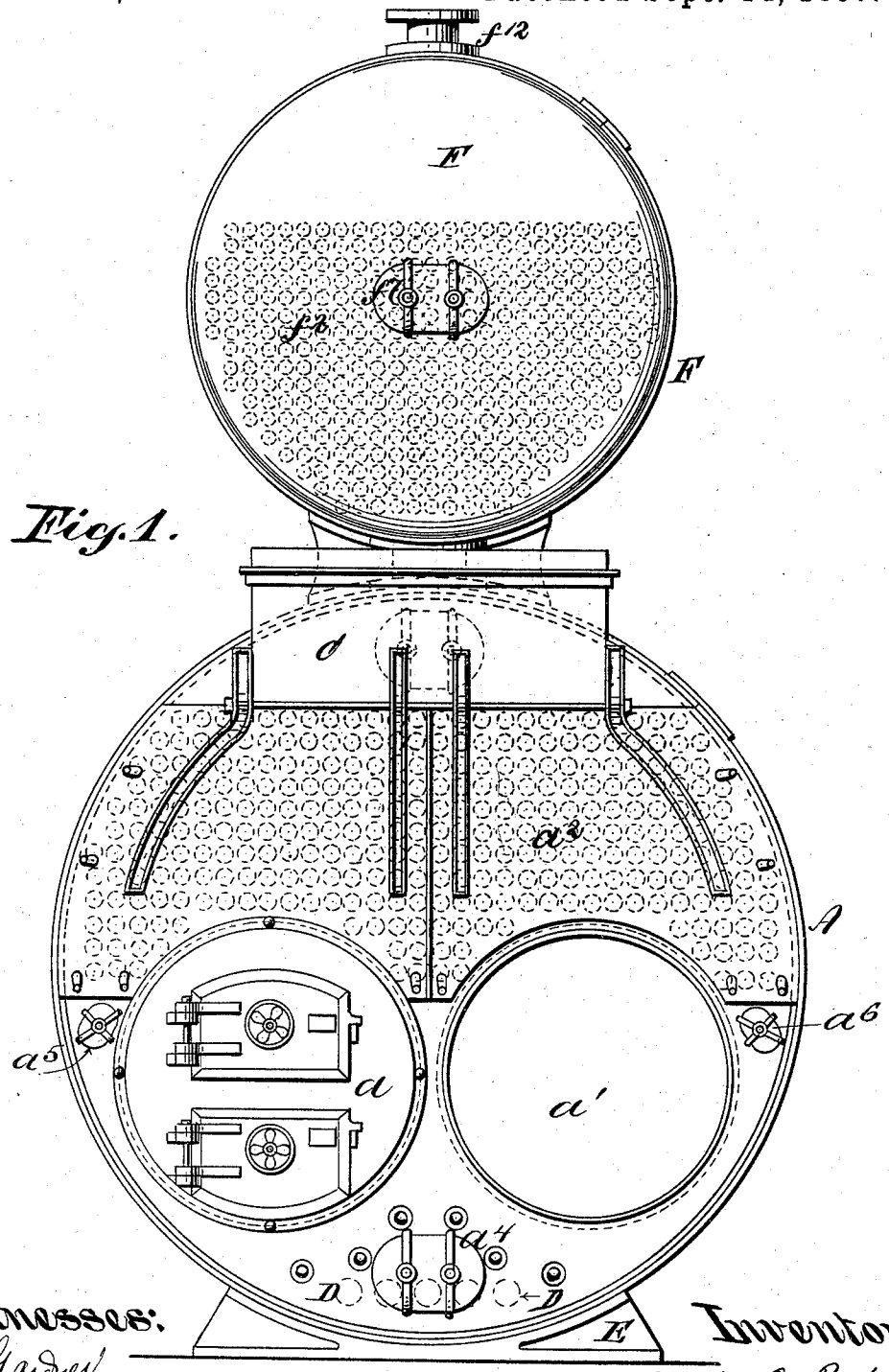


Fig. 1.

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Inventor:
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 2 Sheets—Sheet 2.

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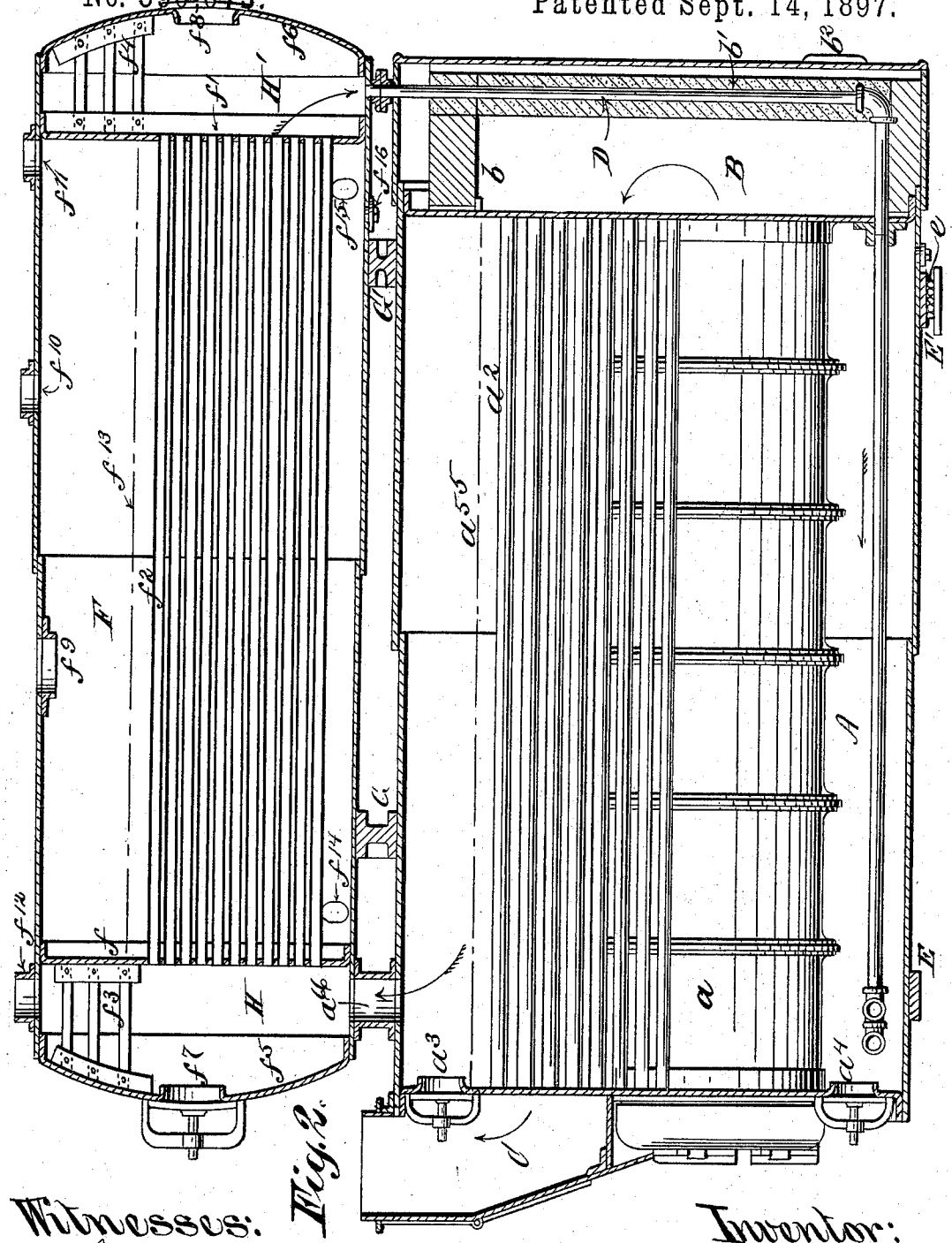


Fig. 2.

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UNITED STATES PATENT OFFICE.

CASSIUS C. PECK, OF ROCHESTER, NEW YORK.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 590,073, dated September 14, 1897.

Application filed August 26, 1896. Serial No. 603,951. (No model.)

To all whom it may concern:

Be it known that I, CASSIUS C. PECK, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification sufficient to enable others skilled in the art to which the invention appertains to make and use the same.

My invention is applicable to nearly all classes of boilers—that is to say, to shell-boilers both externally and internally fired and both vertical and horizontal and also to both horizontal and vertical water-tube boilers—but the invention is shown only as applied to an internally-fired shell-boiler, as its application to the numerous types and designs of boilers in use is only a matter of proper proportions to suit each style of boiler, the method of operation remaining unchanged.

The main object of my invention is to improve boiler efficiency and at the same time to increase safety and durability. Dryness of steam, uniformity of steam production, and convenience in cleaning are also objects sought and obtained. These several results are accomplished by and my invention consists, primarily, in generating steam in a secondary generating-chamber wholly by the condensation of steam from a primary boiler, said steam from the primary boiler being brought directly in contact with metallic surfaces extending through the water in said secondary generating-chamber, and the resulting water of condensation being returned directly to the primary boiler, and, secondarily, in the special features of construction and arrangement of parts hereinafter set forth. Said chamber contains a sufficient amount of water-covered condensing-surface to condense the boiler-steam as fast as the latter is formed. Evaporation is therefore produced in the chamber approximately equal to the amount of boiler-steam condensed. This secondary evaporation is used for power or heating, while the water of condensation formed from boiler-steam returns by gravity to the boiler and is constantly reëvaporated. As steam is taken from the secondary chamber water is correspondingly forced in, as in feeding an ordinary boiler. By this arrangement the boiler or lower chamber is constantly automatically fed by the gravity-return of its own condensed steam and the heating-surfaces of the interior remain continuously clean. As the upper chamber is the source of supply of steam withdrawn for power or heating uses, it follows that solid matter precipitated from the feed-water for this chamber will be deposited therein. These solids can be more conveniently removed than in case of ordinary boilers, where fire-heated metal surfaces receive the deposits, both because the secondary chamber can be made more accessible than in the ordinary boiler and more especially because the deposits from feed-water remain in a softer condition, so that they can be washed out with a hose. The conditions for making dry steam in the secondary chamber are much better than in an ordinary boiler, as will be shown in describing the operation of the boiler.

The type of boiler selected for showing the operation of the invention is an internally-fired shell-boiler, similar in design to the well-known Scotch boiler, except that there is a brick-lined combustion-chamber at the rear, adapting it to stationary use instead of the water-leg construction required for marine use.

In the accompanying drawings, Figure I is a front end elevation of the boiler and secondary chamber, the furnace-doors, &c., on one side being omitted. Fig. II is a central longitudinal sectional elevation of the boiler with attached secondary chamber.

A is the boiler, having two internal furnaces a a', extending from front through the whole length of boiler to combustion-chamber B, the furnaces being the same length as fire-tubes a^2. The course of gases is indicated by unfeathered arrows, being through the furnaces from the grates located at front end to combustion-chamber B, thence returning through tubes a^2 to smoke-box C, whence they escape to chimney.

Chamber B is lined on sides and rear with fire-bricks b and asbestos b', and there is a cleaning-door b^2 located on one side of the vertical pipe D. The boiler is supported on cradles E E', one of which is usually provided with rollers e to allow for the slight move-

ment caused by expansion and contraction of boiler-shell under changes of temperature. Manholes a^3 a^4 and hand-holes a^5 a^6 provide for access to interior of boiler.

Secondary chamber F is supported on cradles G G', which rest on the shell of boiler A. In tube-sheets f f' are fixed tubes f^2, which serve as condensing-surface for steam proceeding from boiler A and as heating-surface for production of steam in chamber F. The tube-sheets are riveted to the shell of chamber F, so as to make steam-tight joints. The portion of sheets f f' not supported by tubes is stayed by braces f^3 f^4, which are riveted at one end to the exterior heads f^5 f^6, and at the other end to the tube-sheets. Heads f^5 f^6 are provided with manholes f^7 f^8 to give access to the compartments H H'. One or both heads f^5 f^6 may also be provided with hand-holes for convenience in case of removal of defective or worn-out tubes. A manhole f^9 provides access to the central compartment F.

f^{10} is a nozzle for attaching one or more safety-valves, and f^{11} is the steam-delivery nozzle.

f^{12} is a safety-valve nozzle for the protection of boiler A.

The water-line is shown at a^{55} in boiler A and at f^{13} in chamber F. Two hand-holes f^{14} f^{15}, or four or more, and one blow-off f^{16} provide for cleaning out from the bottom. Pipe D, which carries the water of condensation from pipes f^2 down through combustion-chamber B and delivers it into boiler A, is of sufficient length to extend several times the length of the boiler in order to assist in heating and circulating the body of water under the furnaces.

The operation is as follows: Steam being raised in boiler A the vapor rises as fast as formed through neck a^{66} into compartment H of chamber F, and thence passes into tubes f^2, where it is condensed by the cooler water outside said tubes. Chamber F is set on a slight inclination toward the rear in order that the water of condensation may flow toward compartment H' and there collect into pipe D, which serves the double purpose of returning the water of condensation to boiler A and of remedying the universal difficulty of internally-fired boilers of lack of circulation at bottom or under the furnaces. Arrows feathered on one side show the course taken by the steam and water of condensation. As the supply of water to boiler A is constant and in exact proportion to the weight of steam which passes out of it, the water-line can be carried within a very few inches of the tube-line without danger of burning tubes; also the water-line in chamber F can be carried closer to the tube-line than usual without risk of damage to the structure, for even if the water-line should get below the tube-line no harm would result other than the loss of the use of surface not submerged. When the boiler is first started, no steam-pressure of any amount is formed in chamber F until sufficient steam has been condensed in pipes f^2 to heat the water surrounding the tubes to about 212° Fahrenheit. Neither is there any perceptible pressure above the atmosphere in boiler A during this period of heating water to boiling-point. As the temperature of water is increased above the boiling-point and vapor-pressure accumulates it also correspondingly increases in A, the pressure in the latter being higher in inverse ratio to the amount of tube-surface in F—that is to say, the greater the amount of tube-surface in F the less will be the difference of temperature (and pressure) between the water in A and F necessary for transferring a given amount of heat in a given time. As it is desirable to have as little difference as possible between the steam-pressure carried in A and in F, the condensing heating-surface in the latter should be liberal in amount, say equal to the fire-heated surfaces in A. With this proportion a few pounds difference in pressure will be sufficient when the steam-pressure in F is maintained at not over one hundred pounds, and somewhat greater difference as the working pressure in F is increased. Also the difference of pressure is increased in direct proportion to increase of demand for steam from F. Thus if more steam is being drawn from F than corresponds with rated capacity the pressure in A will have to be increased above the normal amount in order to transfer a sufficient number of heat units to the water-surrounding tubes f^2 to keep up the extra draft on F. Conversely, when the requirement for steam is less than the rating of the boiler structure the difference in pressure between A and F will be less than the normal or rating difference. If demand for steam suddenly ceases entirely, A and F will show almost the same pressure. Also differences in pressure will vary in proportion to the degree of cleanness of the exterior surfaces of tubes f^2, the efficiency of these heat-transferring surfaces decreasing in ratio with accumulation of solid matter precipitated from the surrounding water. As steam from A is pretty evenly distributed through tubes f^2, the evolution of steam-bubbles in the water surrounding the tubes does not differ greatly for the whole length of tubes. Hence the surface of the water is not greatly agitated by the escaping bubbles, as it would be if an excessive number rose to the surface in one comparatively small spot. The best of conditions are therefore secured for producing steam free from entrainment of moisture.

The advantages secured by this system of double evaporation are:

First. The fire-heated surfaces of the boiler are maintained in a constantly clean condition. This not only insures continuous maximum efficiency, but also adds greatly to the safety and durability of the boiler structure. The heating-surfaces can never be burned, and either too low or too high water in the

fire-heated portion of the boiler can never occur.

Second. The driest steam compatible with a steam-reservoir in contact with water-surface is secured.

Third. The fire-heated portion of the boiler never requires cleaning if the slight waste of water which occurs be supplied with pure water, and the secondary chamber can be more easily cleaned than an ordinary boiler.

Fourth. In a boiler of any given steam-making capacity the fire-heated portion does not require to be so large as where the steam for general use is obtained from a boiler structure designed for a single evaporation.

I do not confine myself to the form of steam-boiler shown and described, as the invention is equally applicable to brick-set shell-boilers. In the case of under-fired shell-boilers the pipe D may be only a short pipe connecting the two shells. In case of horizontal water-tube boilers the usual combined steam and water drum can be reduced in size and the secondary chamber F mounted above and connected with the drum by two necks. On account of inconvenience of erection and management I do not consider the invention so well adapted to the vertical type of either shell or water-tube boilers as to the horizontal forms.

In order to reduce first cost or height, one secondary chamber may be connected to two boilers.

I am aware that it has been proposed to dry steam from a primary boiler in a secondary chamber by means of products of combustion passing through flues in said secondary chamber, and also to heat feed-water in a similar manner, as in Patent No. 474,385, also that it has been proposed to generate steam in a secondary chamber in direct contact with the water in a primary boiler, as in Patent No. 413,284; but these patents do not disclose the essential features of my invention, which consist, primarily, in generating steam in a secondary generating-chamber wholly by the condensation of steam from the primary boiler brought directly in contact with metallic surfaces extending through the water in said secondary generating-chamber and in returning the resulting water of condensation directly to the primary boiler.

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

1. The combination with a primary boiler in which steam is generated by direct contact of water with metal surfaces exposed to the fire, of a secondary steam-generator constructed to receive steam directly from said primary boiler and to condense it in tubes passing through water in a secondary generating-chamber, whereby the water in said secondary steam-generating chamber is heated wholly by steam from said primary boiler, together with means for returning the water of condensation from said secondary steam-generator to said primary boiler, substantially in the manner and for the purpose described.

2. The combination with a primary boiler in which steam is generated by direct contact of water with metallic surfaces exposed to the fire, of a secondary steam-generator the water-line in which is above that in said primary boiler, said secondary steam-generator being constructed to receive the steam directly from said primary boiler and to condense it in tubes passing through water in a secondary generating-chamber, whereby the water in said secondary steam-generating chamber is heated wholly by steam from said primary boiler, together with means for returning the water of condensation from said secondary steam-generator to the said primary boiler by gravity, substantially in the manner and for the purpose described.

3. The combination with a boiler in which steam is generated by direct contact of water with metal surfaces exposed to the fire, of a secondary steam-generator the water-line in which is above that in the primary boiler, said secondary generator being provided with the compartment H, for receiving the steam from the primary boiler, with the condensing-tubes f, and generating-chamber F, with the compartment H′, for receiving the condensation from the tubes f^2, and with pipe D, for conveying the water of condensation to the bottom of the primary boiler, substantially in the manner and for the purpose described.

4. The combination with a boiler in which steam is generated by direct contact of water with metal surfaces exposed to the fire, of a secondary steam-generator the water-line in which is above that in the primary boiler, said secondary steam-generator consisting of the compartment H, for receiving the steam from the primary boiler, of condensing-tubes f^2, passing through the generating-chamber F, and of the compartment H′, for receiving the condensation from the tubes f^2, and returning the same to the primary boiler, substantially in the manner and for the purpose described.

5. The combination with a primary boiler in which steam is generated by direct contact of water with metallic surfaces exposed to the fire, of a secondary steam-generator the water-line in which is above that in the primary boiler, said secondary steam-generator consisting of the steam-receiving compartment H, formed with a manhole f^7, the secondary generating-chamber F, the condensing-tubes f^2, passing through said secondary generating-chamber F, the condensation-receiving compartment H′, formed with a manhole, and means for returning the water of condensation from said compartment H′, to the primary boiler, substantially in the manner and for the purpose described.

6. The combination with a primary boiler in which steam is generated by direct contact of water with metallic surfaces exposed to the

fire, of a secondary steam-generator the water-line in which is above that in the primary boiler, said secondary steam-generator consisting of the steam-receiving compartment H, the secondary generating-chamber F, formed with a manhole, the condensing-flues f^2, passing through said secondary condensing-chamber, the condensation-receiving compartment H′, and means for returning the water of condensation from said compartment H′, to the primary boiler, substantially in the manner and for the purpose described.

7. The combination with a primary boiler in which steam is generated by direct contact of water with metallic surfaces exposed to the fire, of the steam passage or neck a^{66}, the steam-receiving compartment H, provided with the manhole a^7, the secondary generating-chamber F, formed with a manhole f^9, the condensing-tubes f^2, passing through said secondary condensing-chamber, the condensation-receiving compartment H′, provided with the manhole f^8, and the pipe D, for conveying the water of condensation from said chamber H′, to the primary boiler substantially in the manner and for the purpose described.

8. The combination of an internally-fired shell-boiler A, having the combustion-chamber B, return-flues a^2, and steam-neck a^{66}, and a secondary steam-generator above said primary boiler, said secondary generator consisting of the steam-receiving compartment H, into which the steam-neck a^{66}, opens, the secondary generating-chamber F, the condensing-flues f^2, passing through said secondary condensing-chamber, the compartment H′, for receiving the water of condensation from said tubes f^2, and means for returning the water of condensation from said compartment H′, to the primary boiler A, substantially in the manner and for the purpose described.

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