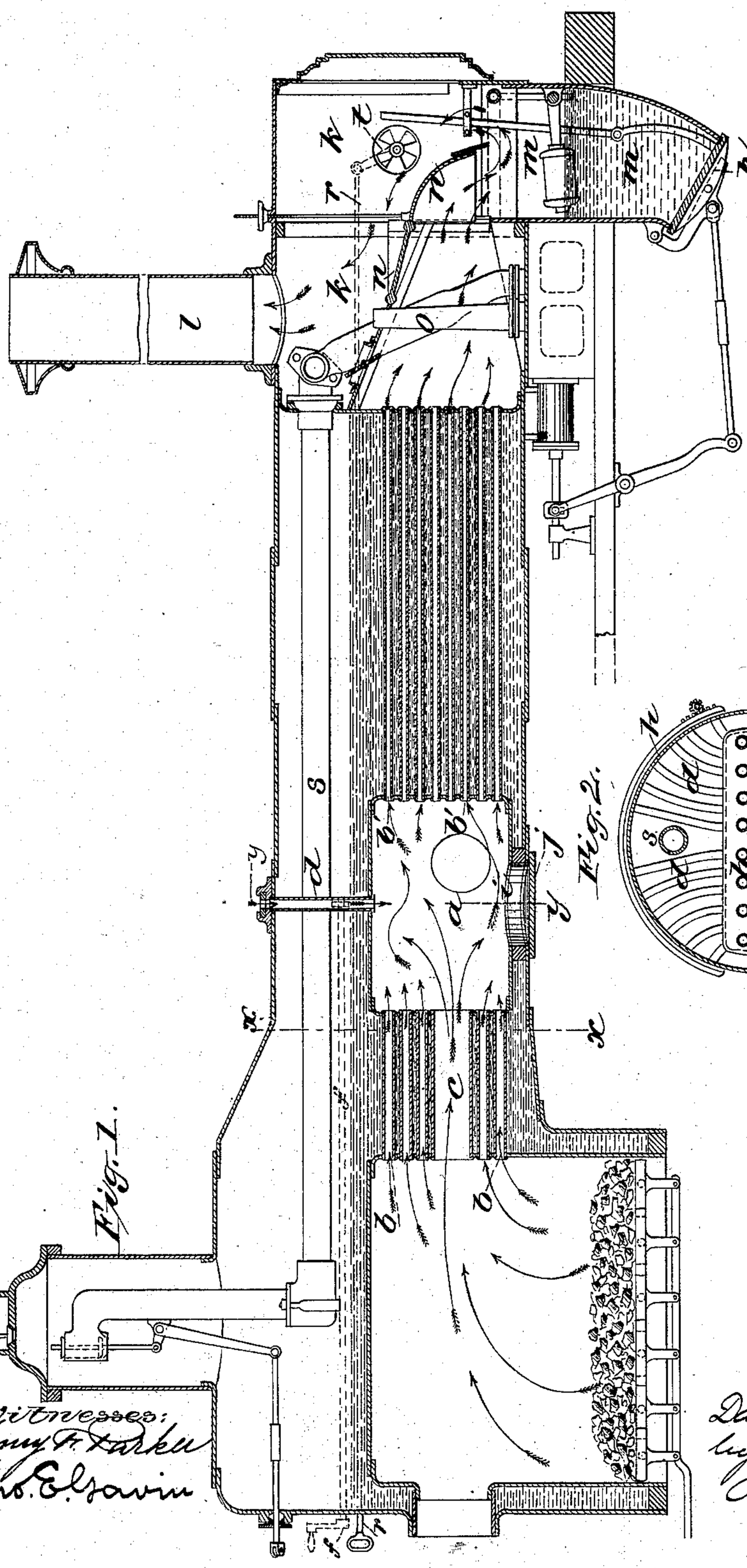
(No Model.)

D. GROESBECK.

STEAM BOILER.

No. 284,415. Patented Sept. 4, 1883.



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STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 284,415, dated September 4, 1883.

Application filed September 23, 1882. (No model.)

To all whom it may concern:

Be it known that I, DAVID GROESBECK, of New York city, county and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

My invention relates more especially to boilers of the locomotive type and for locomotive-engines, but may also be applied to upright boilers and to those of a stationary kind.

The object of my invention is to produce a more perfect combustion in the furnace, and to insure the perfect consumption of the smoke and gases during their passage through the flues or tubes of the boiler, and thus prevent the discharge of unconsumed or imperfectly-consumed gases from the stack, so as to obviate the serious waste of fuel, which usually occurs from this cause, as well as the discharge of foul odors which results therefrom.

To this end the main feature of my invention consists in an intermediate expansion or combustion chamber provided with inlets to admit igniting-flames from the furnace and fresh air from the atmosphere, and arranged within the boiler in the line of the flues, one section of which discharge into the same from the furnace while the other section lead therefrom to the smoke arch and stack. In this chamber the flame and gases from the furnace, together with the additional fresh air, reverberate, mix, and burn perfectly, and the hot perfectly-consumed gases resulting from this combustion then pass through the remaining portion of the flues at a high temperature, and are discharged through the smoke arch and stack without waste of fuel, as hereinafter fully set forth.

In the drawings annexed I have shown my invention embodied in the boiler of a locomotive-engine, as the invention is more especially designed and adapted therefor; but it will be understood that it may be readily applied to any other form of boiler for which it may be found suitable without requiring to illustrate each form.

Figure 1 presents a longitudinal section of a locomotive-boiler provided with my improvements, and Fig. 2 is a cross-section thereof on line *x x*, looking toward the right or front end.

In the ordinary locomotive-boiler, as is well known, the fire-box is necessarily very large and deep, to contain a large mass of fuel, which is almost constantly kept in a high state of activity, in order to produce the rapid generation of steam required in a locomotive-engine. Large volumes of gases are hence constantly given off from this mass of fuel, which are drawn rapidly through the tubes or flues by the powerful draft of the exhaust-jets. Now, these tubes are very long and narrow, and are, of course, constantly surrounded by water whose temperature is never much over 300° Fahrenheit, while the temperature of a flame of complete combustion, for which the tubes are supposed to be conductors, is vastly greater than this—say over 1000°. The tubes are hence always cold, compared to a flame temperature, and will chill and extinguish a flame, for it is well known that a flame cannot exist below a certain temperature, and if subjected to a cooling influence to bring it below this temperature it will become extinguished. It is therefore believed, in fact it is generally admitted by locomotive engineers, that flaming combustion does not or cannot exist to any material extent in the flues of the present type of locomotive-boilers, for these flues are long and narrow and continuous from furnace to smoke-arch, and hence present too large a cool metallic surface, compared to their capacity to permit flaming combustion to exist. Besides this, no means are provided for admitting fresh air in the tubes to keep alive any flames that might otherwise exist therein, which flames, it is generally admitted, become extinguished in the tubes at about eighteen inches from the furnace, which is due to the combined effect of suffocation for want of air and the cooling influence of the narrow water-surrounded tubes. The result, therefore, is that such fuel-gases as may flow into the tubes from the furnace pass through them without flashing into combustion, and hence in their journey act simply as vehicles or connectors of whatever heat they possessed when they left the furnace, instead of becoming positive generators of heat by flam-

ing combustion during their onflow through the boiler. In this unconsumed state these gases are discharged at the stack, which not only causes a great waste of fuel, but is also believed to be the chief cause of the foul odors frequently emitted from the stacks of locomotives. This action is of course greatest when the fire is fresh, or before the coal has been much coked, when the generation of gases from the coal is very great, a portion only of which is consumed in the furnace, while a very large remainder always escapes unconsumed through the flues. A proof of this theory is found in the blue lambent flames which are frequently seen to issue from or hover over the stacks of locomotives when momentarily at rest or under low action, which is the carbonic-oxide gas which has passed through the flues unconsumed, and which becomes ignited when it contacts with the air at the mouth of the stack.

Now, by referring to Fig. 1, it will be noted that according to my invention I do not make the flues continuous; but I construct the boiler with an intermediate combustion-chamber, *a*, within the water-space in the course of the flues between the furnace and the smoke-arch. This combustion-chamber is of course made of a strong metallic shell, similar to the rest of the boiler, and is preferably inclosed within the first cylindrical section of the boiler, as seen in Fig. 1, and is of nearly a semi-cylindrical shape in cross-section, as shown in Fig. 2, its curved portion being concentric with the shell of the boiler, while its flat top part is placed somewhat below the water-line, so that the chamber is entirely surrounded by the water of the boiler. The combustion-chamber, as will be readily noted, is placed much nearer to the furnace than to the smoke-arch, so that the flues are divided into two sections leading into and discharging from the chamber. The first section of tubes, *b b*, are therefore short, and extend from the tube-sheet of the furnace to the rear wall or tube-sheet of the combustion-chamber, and their opposite ends are of course tightly expanded in the respective sheets. The second section of tubes, *b' b'*, are long, and extend from the front wall or tube-sheet of the combustion-chamber to the front tube-sheet of the boiler in the smoke-arch. Now, the long tubes *b'* are preferably made much narrower than the short tubes *b*, which latter are about one-third larger in area than the long tubes. Besides having the first or short tubes *b* wider than the last tubes *b'*, I also extend a large tube or cylinder, *c*, from the furnace to the combustion-chamber, in about the center of the group of short tubes *b*, which tube *c* is large enough to always conduct a column of flame into the middle of the combustion-chamber when the furnace is in action, which will always serve to ignite any mixture of air and gas that may form in the chamber. It will therefore be now understood that when the locomotive is in action the draft through the combustion-chamber will be relatively much slower than the draft through the boiler-flues, and that hence the gases drawn from the furnace into the combustion-chamber through the short tubes *b* will be checked in their speed, and have an opportunity to expand and reverberate in this chamber, and will thus become thoroughly mixed and then ignited by the volume of free flame which will issue into the chamber through the large tube *c*, so that a secondary or complete combustion will thus be established in the combustion-chamber. The chamber will thus become filled with a reverberating mass of flame, which, being located at nearly the middle of the water-space in the boiler, will greatly increase the steaming-power thereof, while all the hot exhausted gases from this combustion, which will be at a much higher temperature than in the flues of common boilers, will then flow out of the combustion-chamber through the final tubes *b'*, thereby imparting their contained heat thereto, and these gases will be finally discharged in a spent condition from the stack, and in a clearly consumed and odorless state. This improvement, therefore, results not only in a great economy of fuel, but materially increases the steaming-power of the boiler, distributes the heat more uniformly through the length of the boiler, forms a smoke-consuming and gas-burning furnace, and avoids the emission of the foul odors heretofore so objectionable, and thus constitutes an important improvement.

In order to render the combustion of the gases in the chamber *a* certain and perfect, it is provided with inlets for admitting fresh air thereto, which inlets are preferably in the form of the tubes *d d*, extending from the shell of the boiler on the top to the top sheet of the chamber *a*, as well shown in Figs. 1, 2, and 3. These tubes thus pass through the steam-space, and will therefore be kept quite hot, and will hence heat the air effectually in its passage through them, and then discharge this air in hot jets, in the manner of a blow-pipe or hot blast, down into the middle of the chamber *a*, where it will unite with the hot imperfectly-consumed gases from the furnace, and thus render their combustion perfect, and thereby result in the generation of a large quantity of heat within the middle of the boiler, which has been heretofore lost. If desired, the air-inlets might open through the sides or through the bottom of the boiler and combustion-chamber, thus passing through the water-space; but I prefer to have the inlets extending through the steam-space, as shown, as the heating effect on the air is better in this arrangement. The air-inlets, however, might open on the front end of the smoke-arch, and the air-heating tubes pass from thence through the smoke-arch, and thence extend to the combustion-chamber, so that the air would be heated by the waste gases in the smoke-arch, which would form a desirable arrangement; but I do not confine myself to any special arrangement of the air-inlets.

The mouths of the air-tubes *d d* are covered by a perforated plate, *h*, which moves in guides *e*, concentric with the shell of the boiler, and is provided with a suitable operating device reaching to the cab, whereby the engineer can readily shift the plate one way or the other, and thus open or close the air-inlets to any desired extent, so as to admit the desired quantity of air or exclude it altogether, according to circumstances—that is, when the fire is fresh and giving off large quantities of gases, considerable air may be admitted into the combustion-chamber to consume these gases; but when the fire is quite clear little or no air may be needed from the inlets, as sufficient may enter through the furnace-door and pass through the large tube *c* with the flame to render the combustion perfect in the chamber.

I prefer to operate the regulating-plate by a rotary shaft, *f*, extending out from the cab over the shell of the boiler, and provided with a pinion, *g*, on its outer end, which meshes with a segment of gear-teeth on the plate, as fully shown in Figs. 2 and 3.

Through the base of the combustion-chamber, and through the shell of the boiler, a manhole, *i*, is formed, provided with a suitable cover, *j*, by which access may be had to the interior of the chamber, when required, and also through which any accumulated cinders, &c., from the furnace may be removed.

I do not wish to infer that an intermediate reverberating-chamber in the course of the flues is in itself new, as a previous instance of this can be given; but in that instance the intermediate chamber was not provided with a large tube or conduit extending from the furnace and adapted to convey igniting-flames into the chamber in combination with inlets for admitting fresh air to render the combustion certain and perfect and means for regulating the opening of said inlet, which features form important elements of my improvement.

In Fig. 1, *k* indicates the smoke-arch, which is extended forwardly over the bumper-beam and beyond the stack *l*, in the same manner as shown in my aforesaid application, and is provided with spark-arresting devices, on the principle shown in the same application—that is, a large extinguishing-chamber or water-box, *m*, is arranged in the front end of the smoke-arch, and depends from the base of the same down between the fore wheels of the truck and behind the bumper-beam of the locomotive. Within the smoke-arch an inclined apron or spark-deflector, *n*, extends out from the tube-sheet over the flues, and its outer end is curved or turned downward to discharge directly down over the middle of the water-tank. The exhaust-nozzles *o* rise through the base of the smoke-arch and project up through the deflector *n*, and discharge above the same directly beneath the stack *l*. The deflector *n*, hence, compels the draft to take an indirect passage to the stack, and arrests all the sparks which may issue from the flues, and deflects them straight down into the water of the tank, where they are instantly extinguished and settle to and collect in the bottom of the tank, from which they may be removed, when required, by operating the dumping-door *p*. The draft, however, is not appreciably obstructed by the spark-deflector, but simply changed in its direction, owing to the free space between the mouth of the deflector and the water-level of the tank, and between the deflector and the front of the smoke-arch, which spaces are each equal to or greater than the area of the combined flues. These spark-arresting features, however, form no part of the present invention; but I would here call attention to the fact that the combustion-chamber *a* materially assists the action of the spark-arrester, as many of the sparks entering the chamber in an incandescent state from the furnace will be detained for a while therein, and will be whirled around in contact with the flame and gases from the furnace and hot air from the air-tubes *d*, and will thus be partially or entirely burned up, so that the amount of sparks finally discharged from the flues into the smoke-arch will be less in number and smaller in size, and will thus be more easily extinguished; besides, those detained by and burned in the chamber will conduce to the heating effect and economize the fuel, as will be readily appreciated.

I am aware that a combustion-chamber has been arranged in the furnace end of a boiler fed through a series of small short tubes from the furnace, with fresh-air inlets in the combustion-chamber to insure the combustion of gases conveyed by the small short tubes from the furnace into the chamber. I am also aware that a boiler has been planned with a combustion-chamber in the middle of the cylindrical body portion of the boiler, and fed by both small tubes and large tubes or flues from the furnace, but without fresh-air inlets in said chamber. I am not aware, however, that the particular combination and arrangement of features which I describe and claim have been used before, and which produce a materially improved result over the former constructions.

What I claim as my invention is—

1. The combination, in a tubular steam-boiler, with a combustion-chamber, *a*, located within the tubular body portion of the boiler, at or near the middle thereof, between furnace and smoke-arch, of a series of small tubes, *b*, and one large central tube, *c*, leading from the furnace into said chamber, and with fresh-air inlets opening into said chamber, arranged and operating substantially as and for the purpose set forth.

2. A tubular steam-boiler constructed with the following combination of coacting elements: a combustion-chamber in the course of the flues between furnace and smoke-arch, one large flue opening into said chamber from the furnace to convey igniting-flames into said chamber, a fresh-air inlet or inlets opening

into said chamber, and a regulating device for opening or closing said inlet to desired extents, substantially as herein shown and described.

3. The combination, in a tubular boiler, with a combustion-chamber, *a*, in the course of the flues, of the air-inlets *d*, opening from the outside of the boiler, extending through the body of the same and discharging into the combustion-chamber, with the movable perforated plate *h*, arranged to cover and uncover the mouths of said tubes, substantially as and for the purpose set forth.

4. In a steam-boiler, such as set forth, the combination, with the combustion-chamber *a*, of the air-inlet tubes *d*, adjustable perforated cover *h*, and the engaging pinion *g*, with its rotary operating-shaft *f*, arranged and operating substantially as and for the purpose set forth.

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