Case & Soules,

Smoke Consumer,

No. 16,317. Patented Dec. 23, 1856.

Fig. 1.

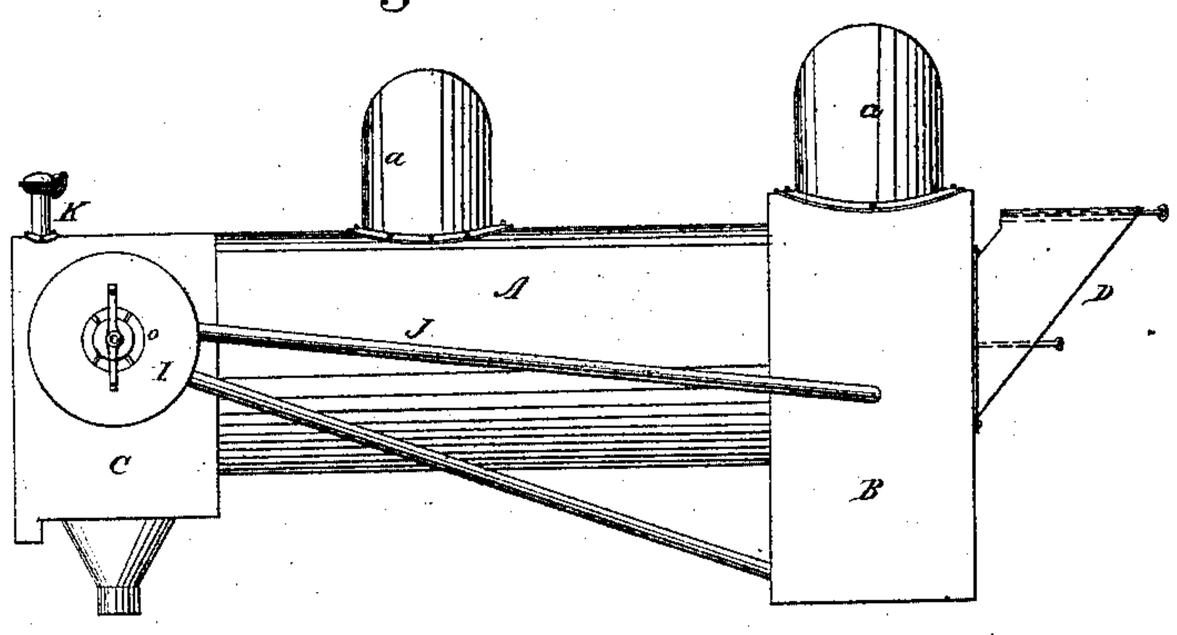


Fig. 2.

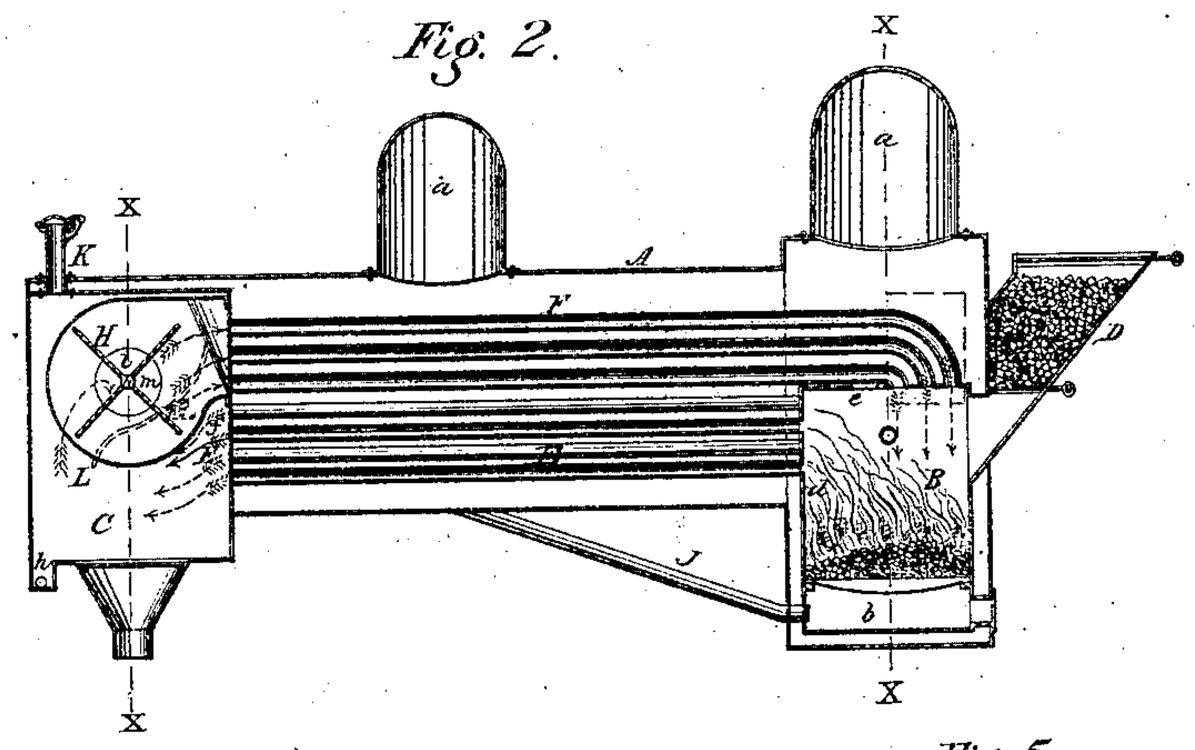


Fig. 3.

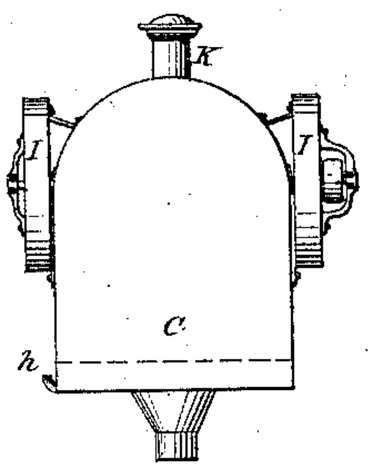


Fig. 4.

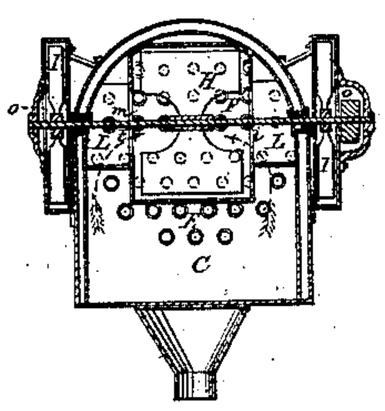
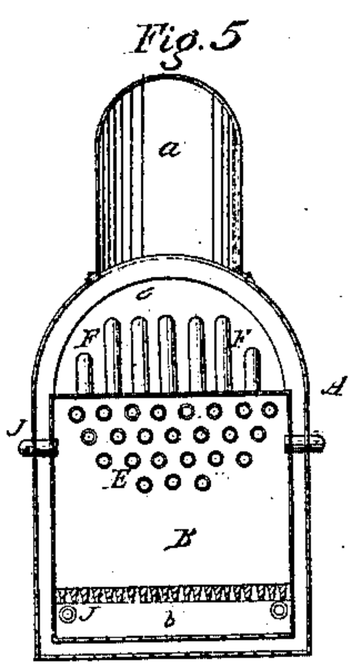


Fig. 5



UNITED STATES PATENT OFFICE.

JOHN CASE AND ISAAC SOULES, OF AMSTERDAM, NEW YORK.

IMPROVEMENT IN SMOKE-CONSUMING FURNACES.

Specification forming part of Letters Patent No. **16,317**, dated December 23, 1856.

To all whom it may concern:

Be it known that we, JOHN CASE and ISAAC SOULES, both of Amsterdam, in the county of Montgomery and State of New York, have invented certain new and useful Improvements in Furnaces Specially Adapted to the Generation of Steam for Motive Power, but Applicable to Furnaces for other Purposes, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which make part of this specification, and in which—

Figure 1 represents an elevation of the side of a tubular steam-boiler and furnace embracing our improvements. Fig. 2 represents a vertical longitudinal section of the same. Fig. 3 represents an elevation of the rear end of the boiler. Fig. 4 represents a transverse section at the line *x x* of Fig. 2, and Fig. 5 represents a transverse section at the line ※ ※ of Fig. 2.

The principal objects of our invention are to economize fuel in the generatian of steam for motive power by burning most of the combustible matter that usually escapes in the smoke, to diminish the quantity of the smoke and thereby lessen its capacity for carrying off heat when it escapes from the furnace, and to quench the sparks and prevent their escape. These objects we accomplish by burning the fuel in a close furnace with a regulated supply of fresh air kept constantly flowing through it and by means of a pump establishing through the furnace, above the fuel on the grate and through the flues of the boiler, a forced circulation of the gaseous products of combustion, in combination with a regular admixture of fresh air with and a reheating of these gases until they are thoroughly oxidated and have transferred most of the heat which they evolve during the process of oxidation to the water in the boiler, after which they are so reduced in bulk and increased in weight (the residuum being mainly carbonic acid) as to settle by their own gravity into a receptacle in the bottom of a part of the furnace termed the "smoke-box," whence they escape through a small orifice. The sparks also collect in this receptacle, where they are at once quenched by the carbonic acid in which they are immersed. By establishing this circulation and combustion of the gases above the solid fuel on the grate and maintaining a constant stream of pure air flowing beneath the grate into the fire the solid fuel is kept burning briskly instead of the smouldering, deadened, and slow combustion which has resulted from all attempts to burn the smoke by passing it through the solid fuel in a close furnace. By this means we combine the advantages of the open furnace in burning the fuel briskly on the grate with the advantages of the close furnace in consuming the smoke and avoid the disadvantages of both classes of furnaces as heretofore constructed.

By reference to the accompanying drawings, which show the application of our invention to what is known as a "tubular" or "locomotive" boiler and furnace, the precise nature of our invention will more fully appear. This boiler consists of a cylindrical shell A, provided with the usual steam-domes *a a*, and is connected at one end with a fire-chamber B and at the other with a smoke-box C. The fire-chamber B is provided with an air-tight ash-pit *b* and a valvular feeding-hopper and tube D, by which the fuel can be supplied to the furnace from time to time as required without permitting the air to enter the furnace or gas to escape from it. The fire-chamber B is further provided with suitable tight doors to give access to its interior both above and below the grate-bars. Instead of having but one tube-sheet, and that placed at the back of the fire-box, as in the ordinary horizontal tubular boiler, this fire-box has one tube-sheet *d* at its back and another *e* at its top, the back sheet *d* for a series of straight tubes E, that conduct the gases and heat from the fire-chamber into the smoke-chamber C, and the top sheet *e* for a series of tubes F, that return the soot and lighter portion of the gases to the fire-chamber to be mixed with air and passed over the fire again to continue the burning of such parts of them as are combustible but had passed through the fire-chamber without being burned. These two series of tubes, at their ends terminating in the smoke-chamber, can only communicate through a rotary fan or pump H, the return-flues opening into the case of the fan H and the direct flues opening into the smoke-chamber C, so that the gases and soot in passing

from the direct to the return flues must pass through the fan-case, which they enter by the usual central openings *i*.

Within the smoke-chamber on each side of the fan-case a diaphragm L is placed, which extends backward from the tube-sheet above the lower flues about two-thirds of the way across the smoke-box. These diaphragms incline downward and backward, so as to deflect the sparks and gases as they enter toward the bottom of the chamber on their passage to the fan, and by compelling the gases to take a long circuit in the wide space of the smoke-box give sufficient time for the heavier portions of the gases, which are saturated with oxygen, to settle by reason of their gravity to the bottom of the smoke-box and thence run out through an opening *h*, provided for the purpose. By means of the diaphragms the ashes and cinders are in like manner precipitated to the bottom of the smoke-box. The fan H is constructed like a common fan-blower, and is placed in a suitable case, which occupies nearly the whole length and about half the depth and width of the smoke-box. The fan-case terminates where it meets the tube-sheet *f*, the whole of the front of the case being open, so as to communicate freely with the return-tubes F. The front portion of this case spreads out to include such of the return-flues as are not directly in front of the fan. The axle *m* of this fan extends through both sides of the smoke-box and is supported in bearings on the outside, where they are not liable to be affected by the ashes and heat, which would quickly destroy bearings placed on the inside of the smoke-box. On each of the projecting ends of the axle *m* of the gas-fan H an air-fan I of smaller dimensions is placed. The case of each of these air-fans communicates with a pipe or with pipes that communicate with the fire-chamber above and below the grate to supply the air necessary for the combustion of the fuel. The principal opening *o* for the admission of air into these fans is on the outside of each around its axis; but a smaller opening is made in each case on the side adjacent to the smoke-box to cause a draft of air to enter round the shaft to help to keep it cool. The apertures in the sides of the smoke-box, through which the shaft of the fans passes, may each be fitted with a tube, in which a series of diaphragms may be fitted to surround the shaft, like collars, leaving spaces between to permit the passage of gas, ashes, &c.

The top of the smoke-box is fitted with a short pipe K, with a lid on its upper extremity. This pipe is opened to create a draft while the fire is being kindled and until sufficient steam has been generated to work the fans. A door in the ash-pit is of course opened at the same time to admit air to the fuel. When sufficient steam is raised to work the fans, the doors in the pipe and ash-pit are both closed. The spent gases escape from the bottom of the smoke-chamber through a pipe turned upward at its outer end a little more than its own diameter, so that it allows the heavy gases to flow out freely without admitting atmospheric air. The fans are worked by a belt put in motion by the engine for which the boiler generates steam.

As soon as the fire has been kindled and has generated steam enough to work the engine and turn the air and gas fans the draft-doors are closed and the air for the support of the combustion is forced into the furnace through the pipes J. The comparatively cool return gases and soot descending from the tubes in the top of the fire-chamber, are heated by mixing with the hot gases which are rising from the fuel, so that they readily inflame on coming in contact with the jets of air injected above the fuel, and while inflamed pass through the tubes E into the smoke-box. On their passage through these tubes the gases impart to them a portion of their heat, which they in turn impart to the water in contact with them. Such portion of the gas as has been saturated with oxygen and thus cooled becomes so heavy that it readily falls, by reason of its gravity, to the bottom of the smoke-box and runs out at the waste-pipe, while the lighter, hotter, and but partially-oxidated gases are drawn by the fan into the case and forced through the return-tubes back into the fire-chamber, to be again heated and mixed with air to ignite them and complete their combustion, when they repass to the smoke-chamber, where such portions of them as are sufficiently cooled and saturated with oxygen settle to the bottom of the chamber and run off, while the remainder is returned by the fan and flues to the fire-chamber again to undergo the process of heating and mixing with air, which process is repeated until the whole of the combustible portion of the smoke is utilized. The motion of the fan while producing this circulation creates a partial vacuum in the smoke-box, which extends to the lower tubes and causes them to draw the gases from the fire-box, while at the same time a degree of pressure corresponding to the vacuum is produced in front of the fan, which pressure drives the gases drawn from the smoke-chamber by the fan through the return-tubes F to the fire-chamber, on their passage to which the gases impart a further portion of their heat to the tubes, which transfer it to the water surrounding them. During this operation of the gas-fan within the furnace the air-fans without are forcing air into the fire-chamber above the fuel to burn the gases and below the fuel to keep it burning brightly. By means of hand-valves in the air-pipes the quantity of air discharged into the furnace can be regulated at will, or the valves may be regulated by the governor of the engine, as may be deemed best. So, also, the orifice for the escape of the gases may be enlarged or diminished by means of a suitable valve or register. The pressure pro-

duced within the furnace by the influx of air accelerates the discharge of spent gases through the waste-pipe. The portion of these gases which is lowest, and consequently nearest the discharge-pipe, is pressed upon and gradually displaced by that portion immediately above. This pressure of one portion of the spent gases on the other forces it out much faster than it would be discharged by the action of gravity alone, which would not carry it off through an aperture sufficiently small to prevent the entrance of air or the escape of combustible gas. By this process the soot is effectually prevented from escaping and at the same time is utilized by burning it as fuel. The waste gases are much diminished in volume by the thorough oxidation which they undergo, and the heat carried out of the furnace by them is correspondingly diminished, and in this way an important saving is effected not only without expense, but by the burning of combustible matter, which effects another saving still more important by adding to the amount of heat-generating material utilized from a given quantity of fuel.

When the sparks fall to the bottom of the smoke-box, they are immersed in an atmosphere, chiefly of carbonic acid, which will not support combustion, and they are consequently quenched at once and may be withdrawn at suitable intervals through a door and again fed into the fire-box with fresh fuel, by which means they are also utilized.

For the purpose of still more effectually preventing the heat from being carried off by the waste gases we propose to heat the feed-water for the boiler by passing it through pipes placed in the lower part of the smoke-box.

It is obvious that our arrangement of the several parts which constitute our system of circulating and reheating gases until their oxidation is complete may be modified to adapt them to different boilers and the varied circumstances in which it is necessary to generate steam for motive power and other purposes; but we do not deem it necessary to enter into details of such modifications, as they will be sufficiently obvious to competent engineers.

Having thus described our improvements in the utilization of fuel, what we claim is—

1. The arrangement of the fire and the smoke chambers, the direct and the return flues, the gas and the air pumps, the pipes to supply air above and below the grate, and the waste-pipe for the spent gases, substantially as described.

2. The combination, with the smoke-chamber and direct and return flues, of the diaphragms to direct the gases downward and backward as they enter the smoke-chamber to facilitate the precipitation of the sparks and thoroughly-oxidated gases from those gases which are but partially burned and require for the completion of their combustion to be returned to the fire-chamber.

3. The arrangement at or near the bottom of the smoke-chamber of an open orifice for the free and constant escape of the waste gases, in combination with the smoke-chamber and direct and return flues, substantially as herein set forth.

4. In combination with the smoke-chamber, arranging the hot-gas and cold-air pumps, substantially as described.

In testimony whereof we have hereunto subscribed our names.

JOHN CASE.
ISAAC SOULES.

In presence of—
J. W. STURTEVANT,
THOS. S. FANCHER.