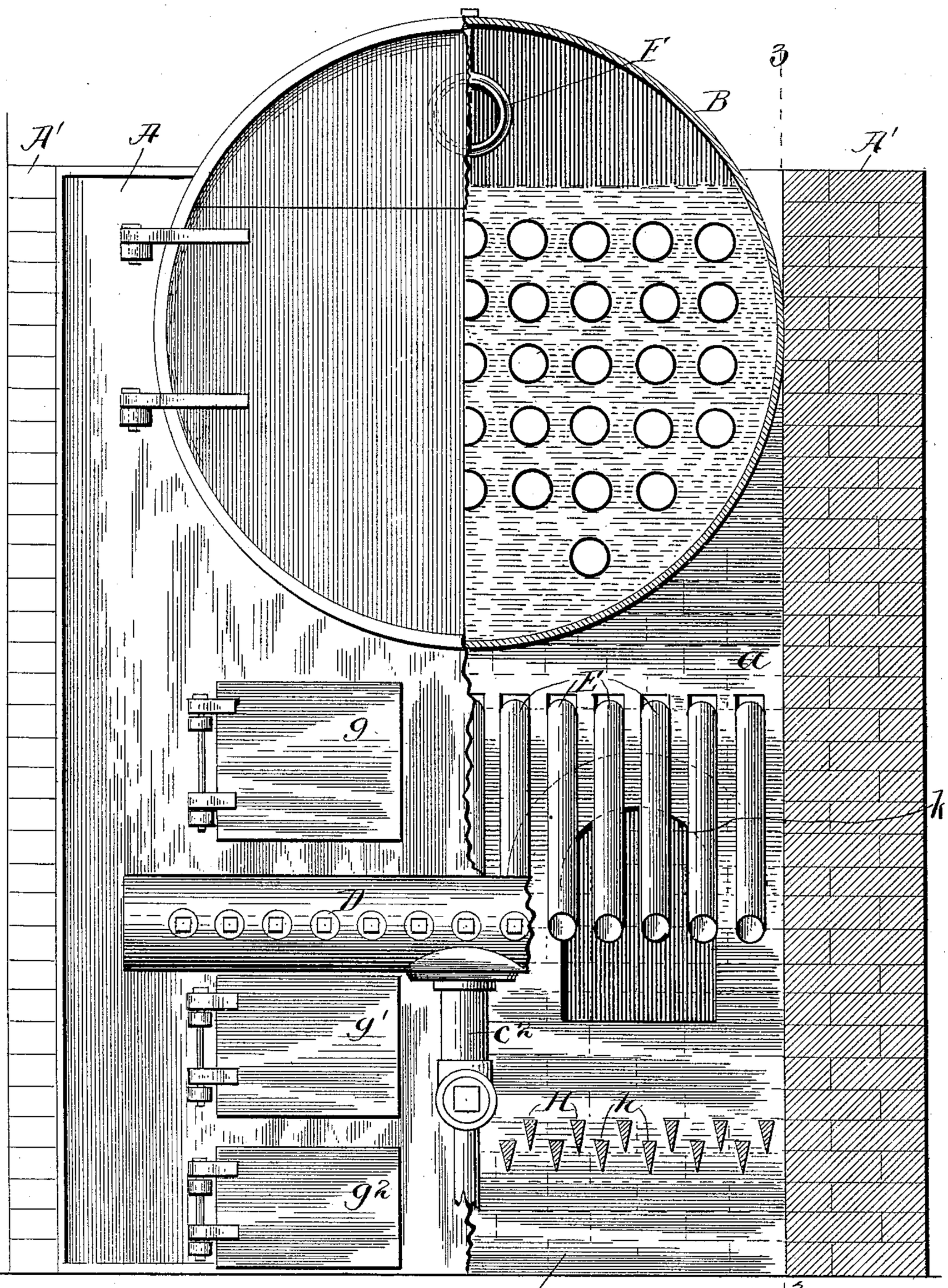
No. 633,271. Patented Sept. 19, 1899.

O. D. ORVIS.

DOWNDRAFT FURNACE.

(Application filed Oct. 31, 1898.)

(No Model.) 5 Sheets—Sheet 1.



Witnesses
W. C. Curtis
Wm. Geiger

Fig 1

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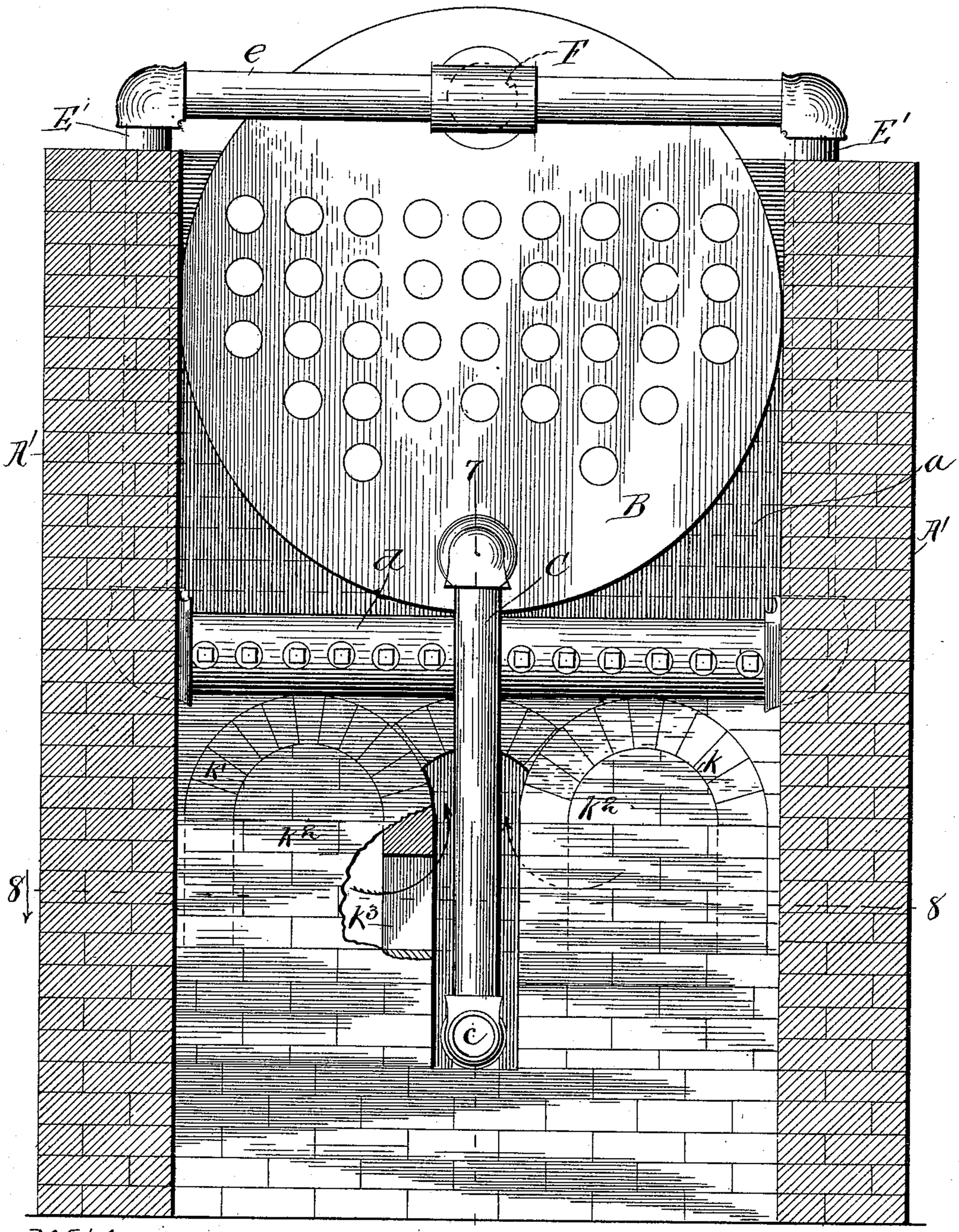

Witnesses
W. C. Coles
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Fig 2

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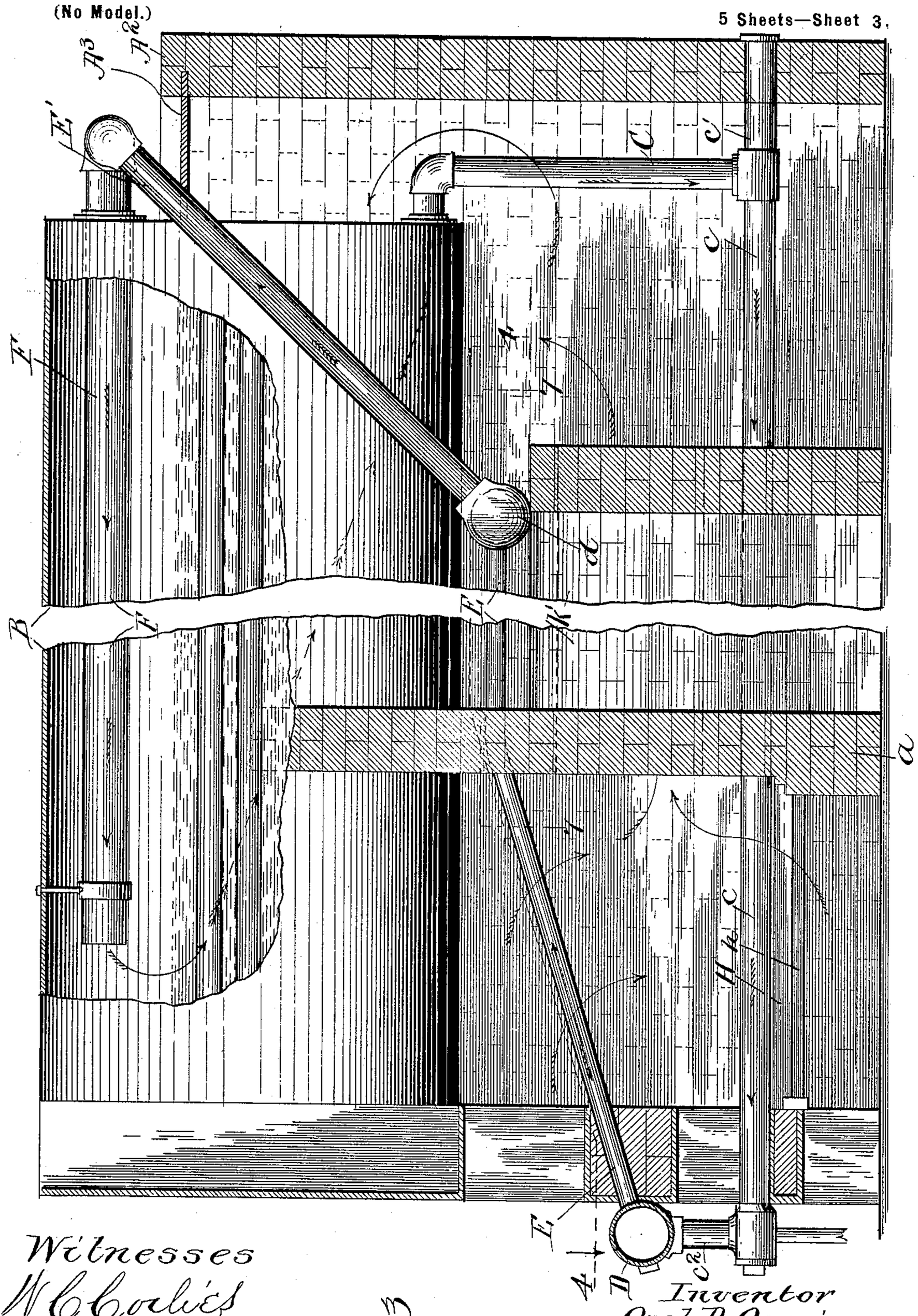

Witnesses
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Wm. Geiger

Fig 3

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(No Model.) 5 Sheets—Sheet 4.

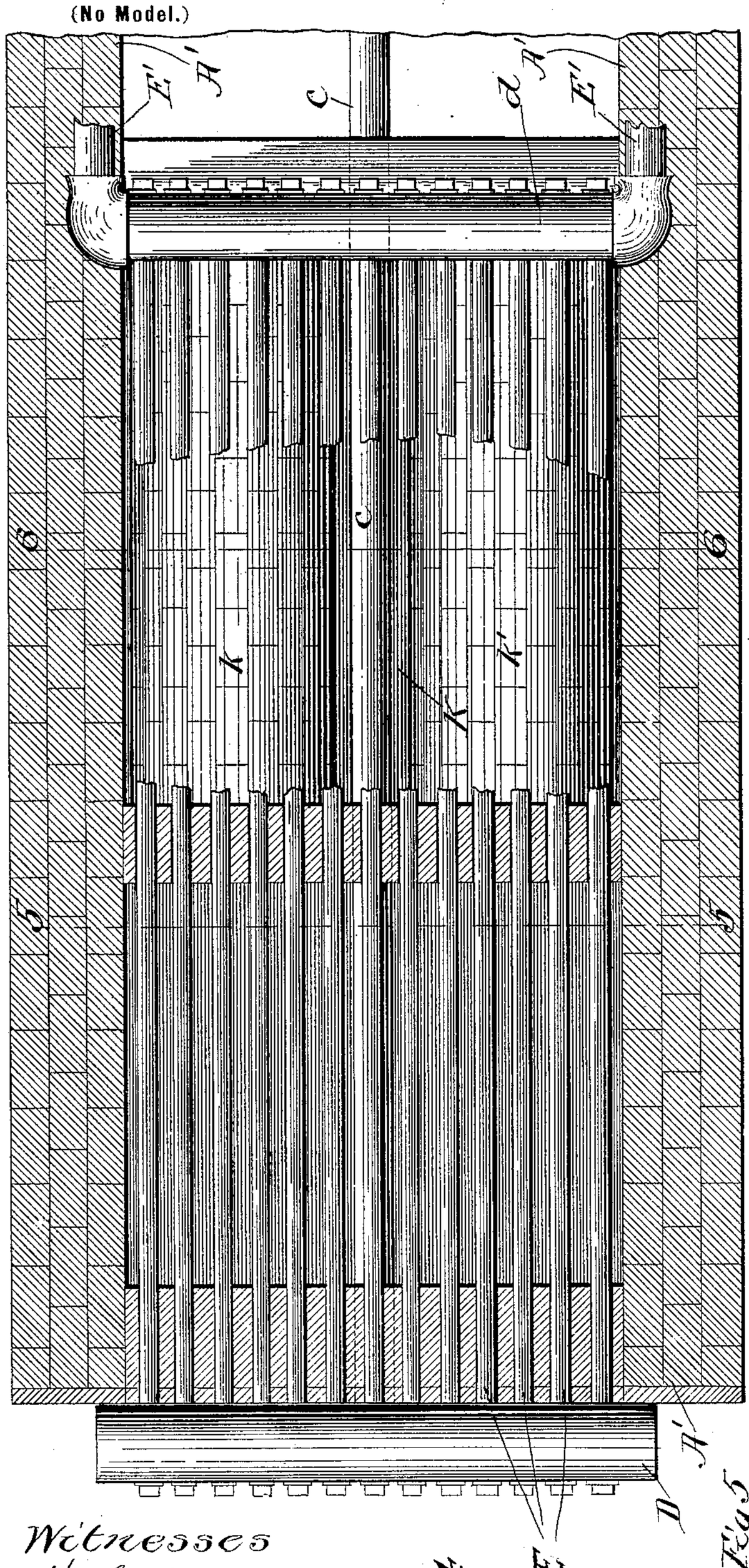

Fig 4

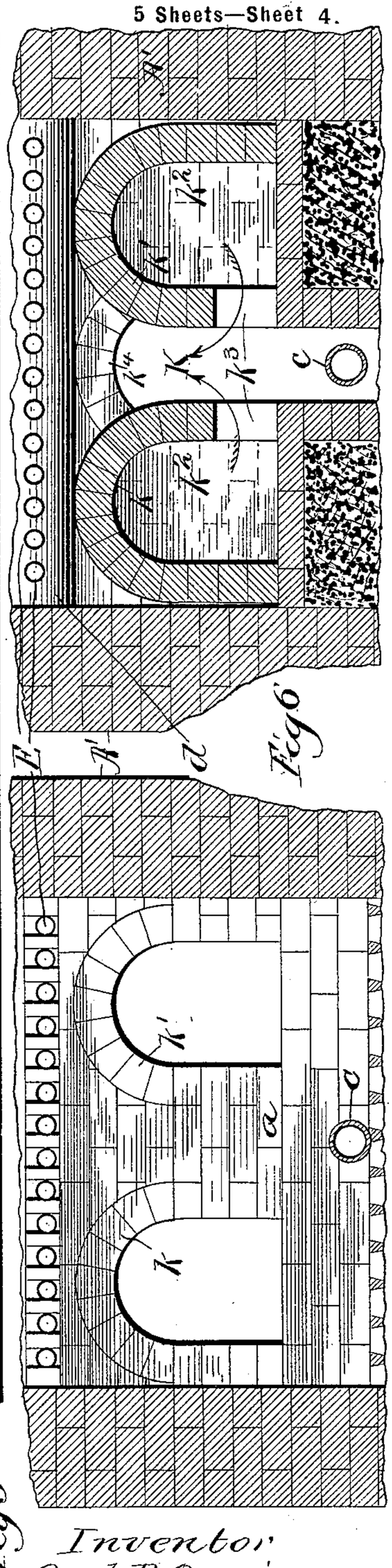

Fig 5

Fig 6

Witnesses
W. C. Coles
Wm. Geiger

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(No Model.) 5 Sheets—Sheet 5.

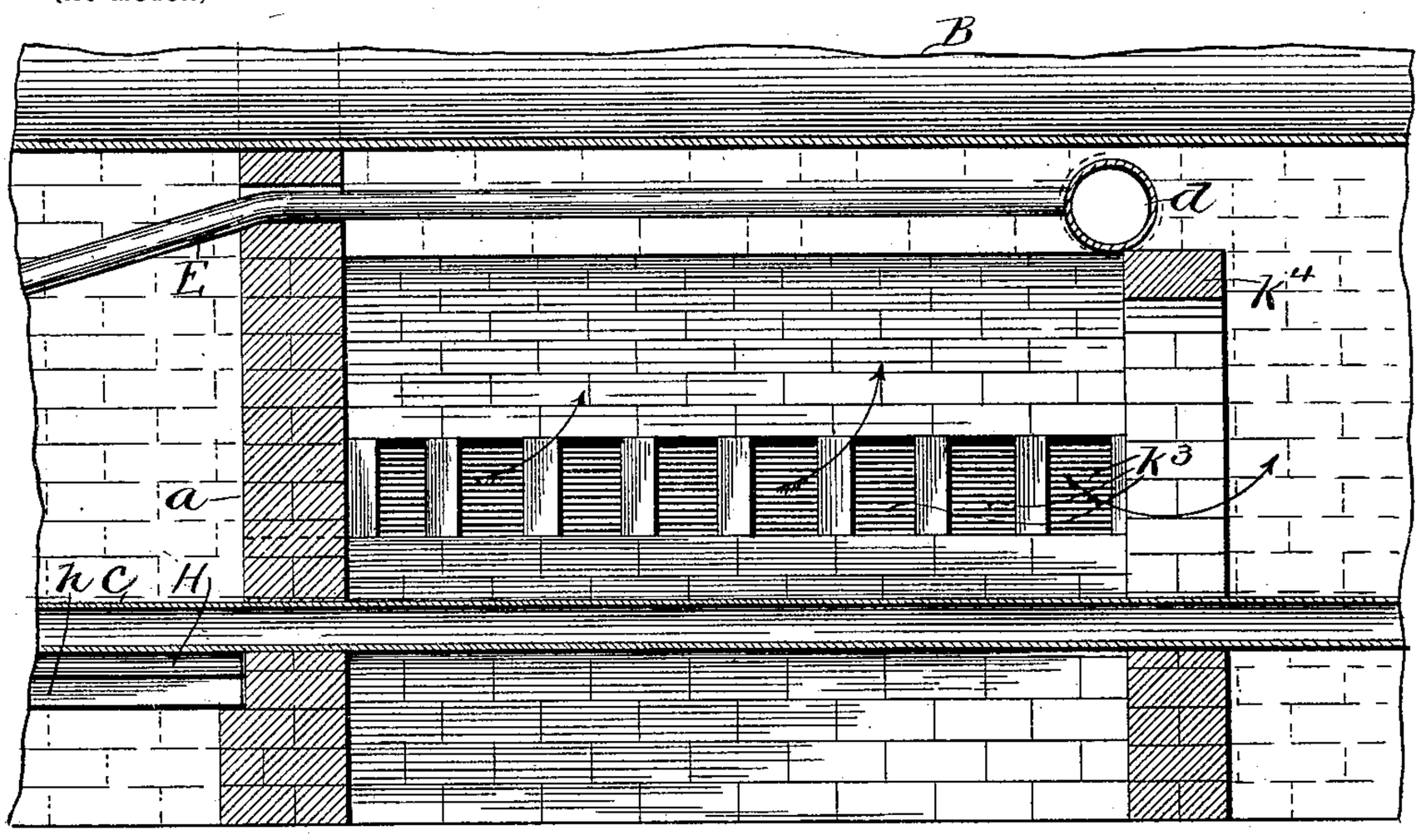

Fig 7

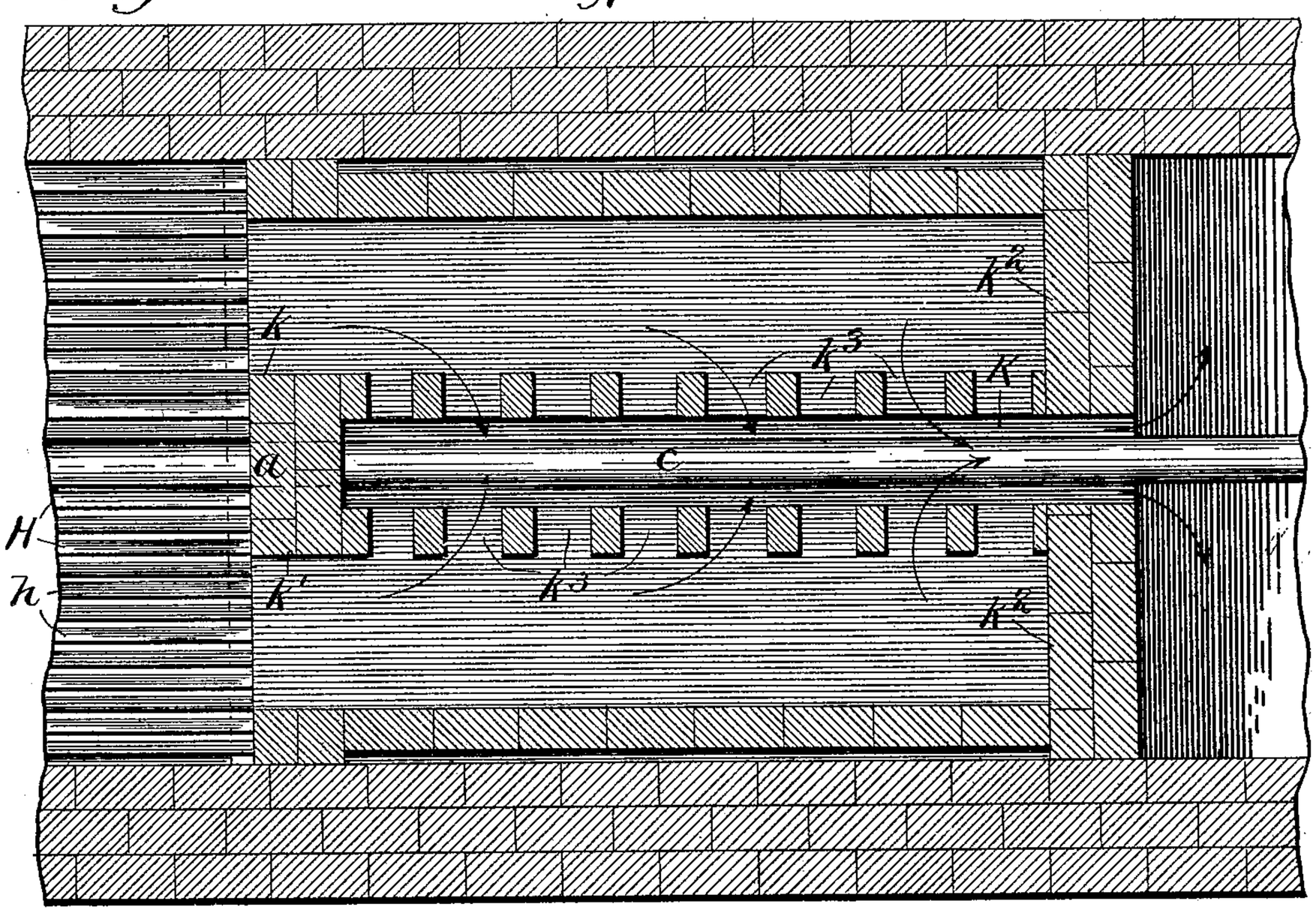

Fig 8

Witnesses
W. C. Collins
Wm. Geiger

Inventor
Orel D Orvis
By Louis T. Gleeson
Atty

UNITED STATES PATENT OFFICE.

OREL D. ORVIS, OF CHICAGO, ILLINOIS.

DOWNDRAFT-FURNACE.

SPECIFICATION forming part of Letters Patent No. 633,271, dated September 19, 1899.

Application filed October 31, 1898. Serial No. 695,039. (No model.)

To all whom it may concern:

Be it known that I, OREL D. ORVIS, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Downdraft-Furnaces, of which the following is a specification, and which are fully illustrated in the accompanying drawings, forming a part thereof.

This invention relates to that class of furnaces in which there are employed both the downdraft and the updraft, the upper set of grate-bars being water-tubes and being connected with the boiler by means of suitable tubes, whereby a circulating system is provided, and the lower set of grate-bars being adapted especially to receive the droppings of unconsumed fuel from the upper set of grates.

The objects of the invention are to provide for the independent expansion and contraction of the water-tube bars, to provide improved means for burning the fuel upon the lower set of grates, to provide for the burning of the smoke, and in accomplishing these various objects to provide increased efficiency in the generation of steam.

A further object is to secure an improved construction, generally and specifically, of furnaces of this type and to adapt such a furnace to plants already installed.

These objects are attained by the various parts and arrangement of parts hereinafter fully described and which are illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of the furnace and boiler, a portion being broken away to show the internal construction. Fig. 2 is a transverse vertical section inside of the rear wall of the furnace, looking forward. Fig. 3 is a longitudinal vertical section on the line 3 3 of Fig. 1. Fig. 4 is a detail plan on the broken line 4 4 of Fig. 3. Figs. 5 and 6 are detail sectional views on the lines 5 5 and 6 6, respectively, of Fig. 4. Fig. 7 is a detail section on the line 7 7 of Fig. 2, and Fig. 8 is a detail plan section on the line 8 8 of Fig. 2.

The face of the furnace is shown at A, its side walls at A′ A′, its rear wall at A^2, the boiler at B, and a plate for closing the space between the rear end of the boiler and the rear wall of the furnace at A^3. Any desired form of boiler may be employed. I show the ordinary tubular-flue boiler, and it may be assumed that the furnace shown in the drawings is adapted to a boiler already installed. A transverse partition *a* divides the furnace-space below the boiler, generally speaking, into a front and rear compartment, this partition extending entirely to the crown-sheet of the boiler and from side wall to side wall, flue-apertures being provided through it, as hereinafter described.

The circulating system comprises a water-leg C, connected with the boiler B through its rearward end and communicating with a horizontal pipe *c*, which leads to the front of the furnace and is connected by means of a short vertical pipe-section c^2 with a header D, which, as shown, is in front of the face of the furnace. The water-tube grate-bars E are connected with the header D, pass through the furnace-front, being inclined upwardly, and through the partition *a*, being bent at this point, and continued on horizontally and connected with a header *d*, from the ends of which rise pipes E′ E′, communicating with a header *e*, located across and near the top of the rearward end of the boiler B, and from which there extends a horizontal pipe F, which is preferably continued, after entering the boiler, nearly to the front thereof, so that while the water leaves the boiler at its rearward end it is returned to its forward end, thereby permitting the circulation not only through the pipe system, but also through the boiler itself, while still admitting of the location of both connections with the boiler at its rearward end, avoiding the necessity of making connections with its curved walls. Plugs may be provided, as shown, at any of the angles of the pipe system and in the headers opposite the ends of the pipes connected thereto, and for the purpose of gaining access to the rearward end of the pipe *c* it may be extended backwardly through the rear wall A^2, as shown at *c*′.

The water-tubes E are preferably connected with the headers D *d* by the well-known means of expanding, and I prefer to make them of light metal, so that the heat is readily transmitted therethrough, to the advantage not only of the steam-generating qualities of the furnace, but of the tubes themselves, in that they are much less liable to burn out

than when thick tubing is used. By bending the tubes E, as shown, I avoid the necessity of resorting to the expedient practiced by some of providing a telescopic connection with one of the headers in order to provide for expansion and contraction. The heat is not uniformly applied to these tubular grate-bars. Usually a stronger fire is maintained near the central portion of the grated surface than at its margins, and, furthermore, some of the fuel may burn more sharply than other portions. As a result of these conditions some of the grate-bars have a greater range of expansion and contraction than others, and it therefore becomes necessary to provide for the variations in the lengths of these pipes independently of each other. The bent form of pipe shown accomplishes this object, as the expansion of the tube slightly increases the flexure, while its contraction tends to straighten it, and hence each should adjust itself independently of all the others and without undue strain upon the headers. This vertical movement of the water-tubes, due to their flexure, is provided for by setting the masonry of the walls *a* somewhat open, as shown, the bricks, however, staying the tubes laterally.

A further advantage in employing the bent form of tubular grate-bar is found in the fact that the grated surface may be given a more decided pitch or inclination from the horizontal than when straight tubes are used which enter a header at the rearward end of the fire-box, and as a result the direction of draft through the grate is less objectionable than when it is directed downward, and, furthermore, the vapors distilled are not obliged to hug the lower face of the grate as they pass backwardly, thereby choking the draft at the rearward part of the fire-box.

A still further advantage in the use of the bent water-tubes as distinguished from the straight tubes entering a header at the rearward end of the fire-box arises from the fact that the flue-openings in the wall *a* may be brought well up to the grate, so that it is not necessary for the vapors to be carried down any considerable distance to gain an entrance to these flues.

The lower grate consists of two sets of solid bars H *h*, arranged the one slightly above the other and set staggered—that is to say, the bars of the one set alternating with the bars of the other set. I am aware that the staggered arrangement of grate-bars has been employed in the upper grates of a downdraft-furnace, but when so employed give rise to a serious disadvantage in that the fuel has a tendency to choke up the air-passages, and hence must be freely dislodged by the use of a slice-bar. By the staggered arrangement of the lower set of grate-bars, on the contrary, a decided advantage is gained. Usually little or no air is passed upwardly through the lower grate. The fuel usually reaches this grate in a partially-consumed state and quite finely subdivided. It is desirable that it accumulate on the lower grate and become coked and be slowly consumed. This process is promoted by providing a series of pockets within which it may accumulate, and I obtain such pockets by the staggered arrangement of the bars, most of the fuel finding its way between the bars H and resting directly upon the bars *h*. Again, it is important that the surface of the lower grate be well covered with fuel in order that whatever draft there may be through it shall be uniformly distributed. Unless direct feeding upon the lower grate is resorted to the quantity of fuel reaching the same is comparatively small, and the arrangement of grate-bars shown results in concentrating it by arranging it in rows between the bars H. A still further advantage arising from the staggered arrangement of the bars of the lower grate is found in the fact that by this arrangement the passages between the bars may be made quite small, so as to prevent the dropping therethrough of the fuel until it has been thoroughly consumed, but are twice as numerous as when a single set of bars is used, and hence ample provision is made for draft through the grate when it is desired to complete the combustion of the fuel by opening the ash-pit door. Such openings may be provided in the face of the furnace as may be desired for feeding and draft. I show a door *g*, giving access to the chamber above the upper grate, a door *g'*, giving access to the chamber between the two grates, and a door g^2, giving access to the ash-pit. As the grates extend continuously from side wall to side wall of the furnace, there will usually be employed two doors for each of these chambers.

Two flue-openings are provided in the wall *a*, leading from the chamber between the upper and lower grates, and arches *k k'* are built immediately back of the wall *a*, one inclosing each of its flue-apertures, these arches being continued backwardly a considerable distance and having their rearward ends closed, as shown at k^2 k^2. The arches *k k'* are spaced a small distance apart, and near the bottoms of their adjacent walls they are provided with apertures k^3, alternate bricks being omitted. The interspace K between the two arches *k k'* forms a combustion-chamber or retort. There may be sprung across the rearward end of this chamber or retort an arch k^4, which serves, together with the arches *k k'*, to support the header *d*. The precise location of this header is immaterial—that is to say, the tubes E may have any preferred length. The advantage of locating the header a little forward of the rearward ends of the arches *k k'* k^4 is found in the fact that the plugs closing the apertures opposite the ends of the tubes E are thereby protected from the intense heat of the flame by the masonry.

The operation of the furnace is as follows: Fires are started and maintained on both grates. When the fire is well established,

firing upon the lower grate may be discontinued, the fuel therefor being supplied from the upper grate to better advantage, it being undesirable to develop smoke from below in large quantities. The direction of the currents is downwardly and backwardly and upwardly and backwardly, respectively, moving in lines which intersect as they enter the mixing-chambers inclosed by the arches *k k'*. As the vapors enter these chambers longitudinally and leave them through their lateral apertures, they are caused to swirl or roll and become thoroughly intermixed. The walls of these chambers soon become highly heated, and combustion is continued and increased as the vapors enter and pass through them. As the two currents of burning gases emerge from the apertures k^3 into the retort-flue K they clash, and the most intense heat is developed at this point. The thorough intermixture of the gases and the high temperature attained result in complete combustion. It will be seen that this maximum of temperature is developed directly below the rearward ends of the water-tubes E. The highly-heated vapors for the most part ascend among these tubes to the crown-sheet of the boiler, following it back to its rear end. Such of the vapors as pass out of the retort-flue K beneath the arch k^4 also rise to the crown-sheet.

By the construction described all the advantages of a combined downdraft and updraft furnace are secured and the vapors are thoroughly intermingled and burned before they come into contact with the comparatively cool surface of the boiler and are directed thereagainst when they have attained their greatest temperature.

The combination of the mixing-chambers with the central-retort combustion-flue are not dependent for their successful operation upon the arrangement or kind of grates employed, though the relation of all the parts as shown and described I regard as the most advantageous, the commodious chamber between the upper and lower grates and the inclination of the upper grate contributing to the freedom of draft and the highest efficiency of the mixing-chambers.

The arrangement of the pipe system has positive advantages. Both egress and ingress tubes communicating with the boiler through its end the connections are more easily and cheaply made than when through the side walls. The water is drawn from the boiler a little above its lowest point, so that the sediment is not drawn into the pipe system. All of the tubes and headers are readily accessible for cleaning without disconnecting any of them, and, as already explained, the contraction and expansion of any one or more of the tubular grate-bars does not disturb the remainder of the system or any part of it.

I claim as my invention—

1. In a furnace, the combination with a fire-box, a wall, *a*, closing the rearward end of the fire-box and having two flue-apertures, a downdraft-grate composed of water-tubes forming parts of a circulating system, such tubes passing through the wall *a* above its apertures and being prolonged backwardly, and an updraft-grate below such apertures, of arches inclosing such apertures and extending backwardly and being closed at their rearward ends, said arches being spaced apart and having flue-apertures at the bases of their adjacent walls.

2. In a furnace, the combination with a fire-box, a wall, *a*, closing the rearward end of the fire-box and having two flue-apertures, a downdraft-grate composed of water-tubes forming parts of a circulating system, such tubes being inclined upwardly from their front ends and passing through the wall *a* above its apertures and being prolonged backwardly in a horizontal plane, and an updraft-grate below such apertures, of arches inclosing such apertures and extending backwardly and being closed at their rearward ends, said arches being spaced apart and having flue-apertures at the bases of their adjacent walls.

3. In a furnace, the combination with a fire-box, a wall, *a*, closing the rearward end of the fire-box and having two flue-apertures, a downdraft-grate composed of water-tubes forming parts of a circulating system, such tubes passing through the wall *a* above its apertures and being prolonged backwardly and entering a header, *d*, and an updraft-grate below such apertures, of arches inclosing such apertures and extending backwardly and being closed at their rearward ends, said arches being spaced apart and having flue-apertures at the bases of their adjacent walls, the header, *d*, being supported upon the arches.

4. In a downdraft-furnace, the combination with a fire-box and a wall, *a*, closing the rearward end thereof and having a flue-opening, of a series of water-tube grate-bars extending from the front of the fire-box through the wall *a* above the flue, such tubes being inclined upwardly in the fire-box and bent downwardly back thereof, and water-headers for receiving both ends of the tubes.

5. In a downdraft-furnace, the combination with a fire-box and a wall, *a*, closing the rearward end thereof and having a flue-opening, of a series of water-tube grate-bars extending from the front of the fire-box through the wall *a* above the flue, such tubes being inclined upwardly in the fire-box and bent downwardly back thereof, the wall, *a*, being apertured to allow the tubes to bow upwardly as they expand.

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