No. 652,227. Patented June 19, 1900.

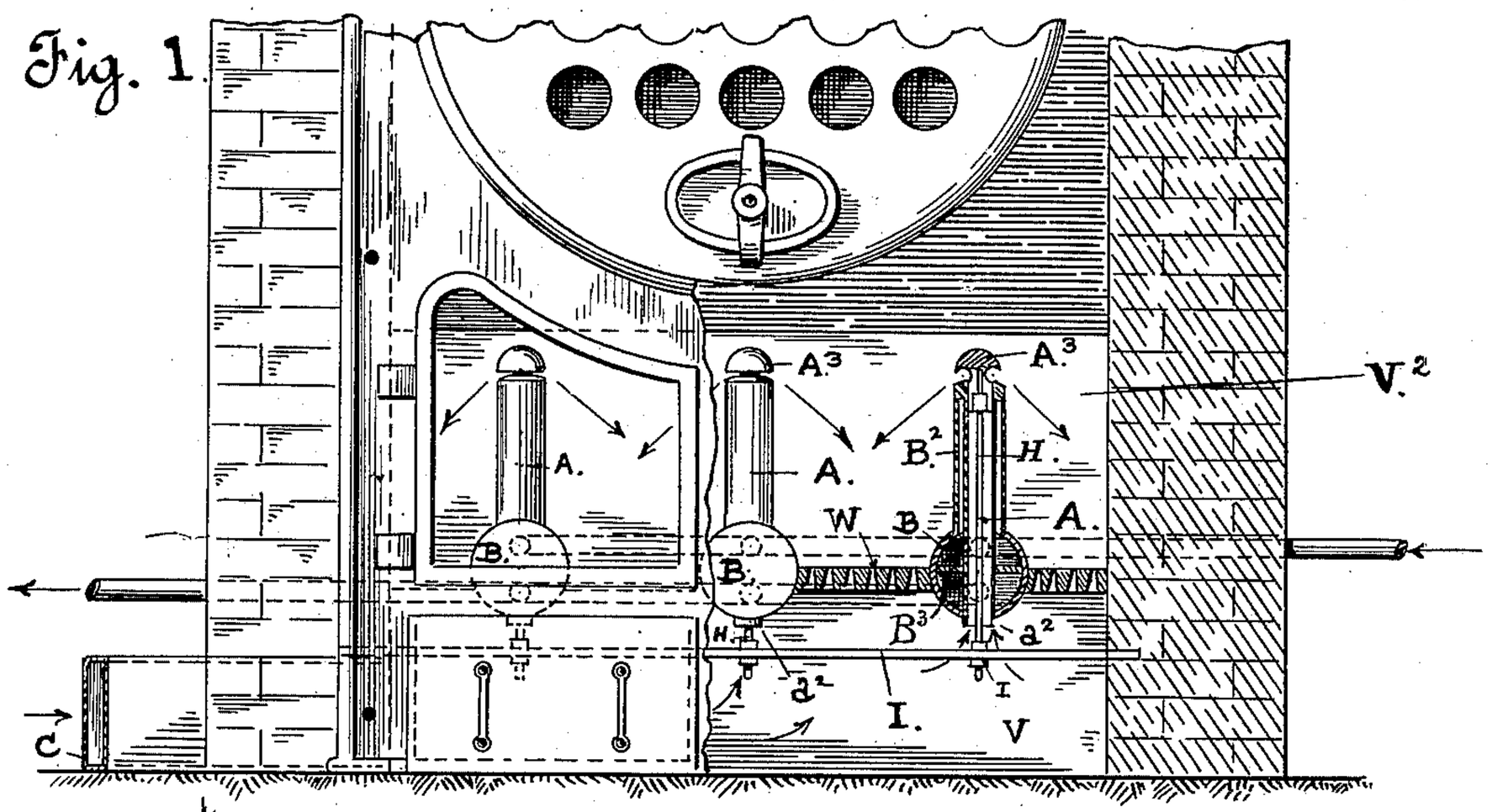
A. HEBERER.

SMOKELESS COAL BURNING FURNACE.

(Application filed Sept. 28, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



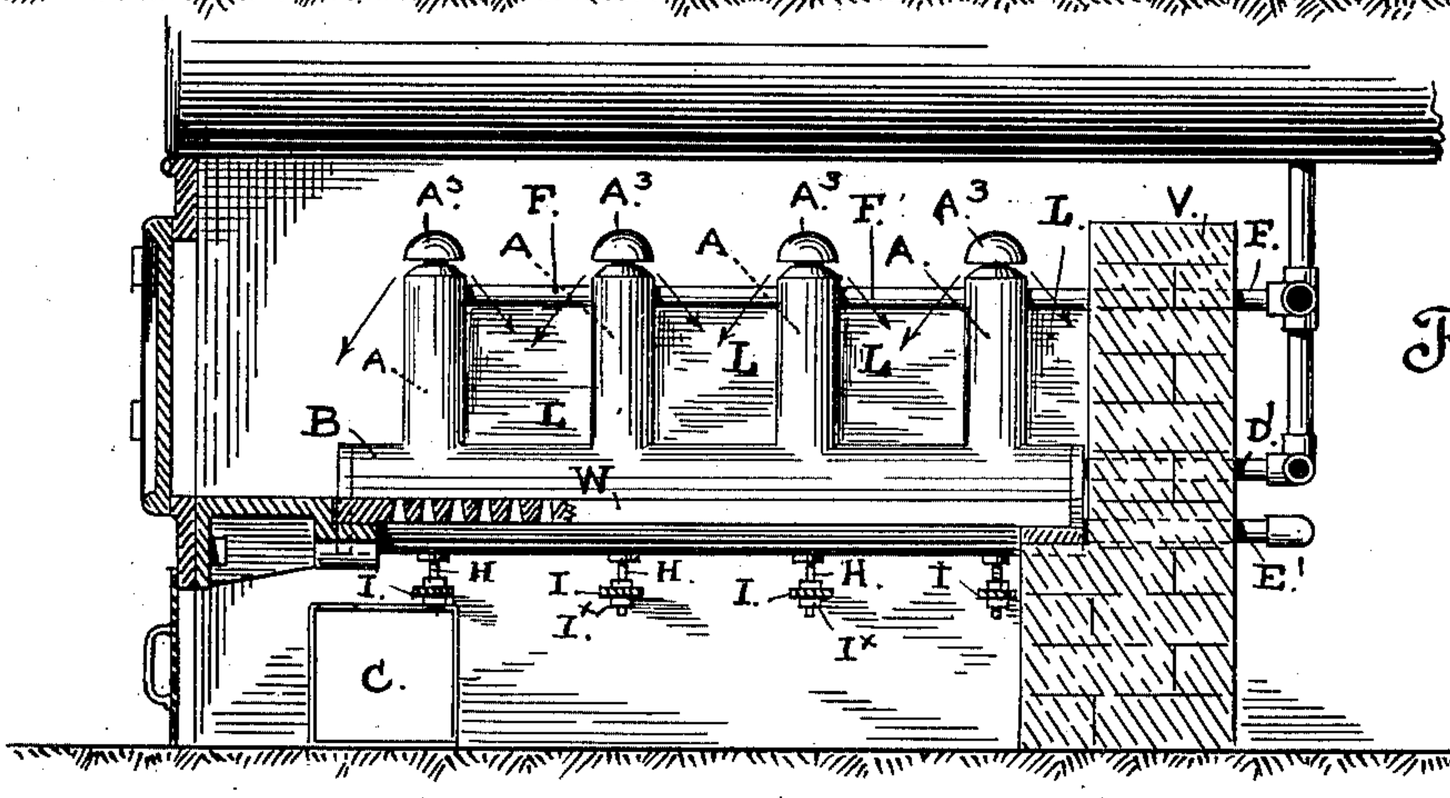


Fig. 2

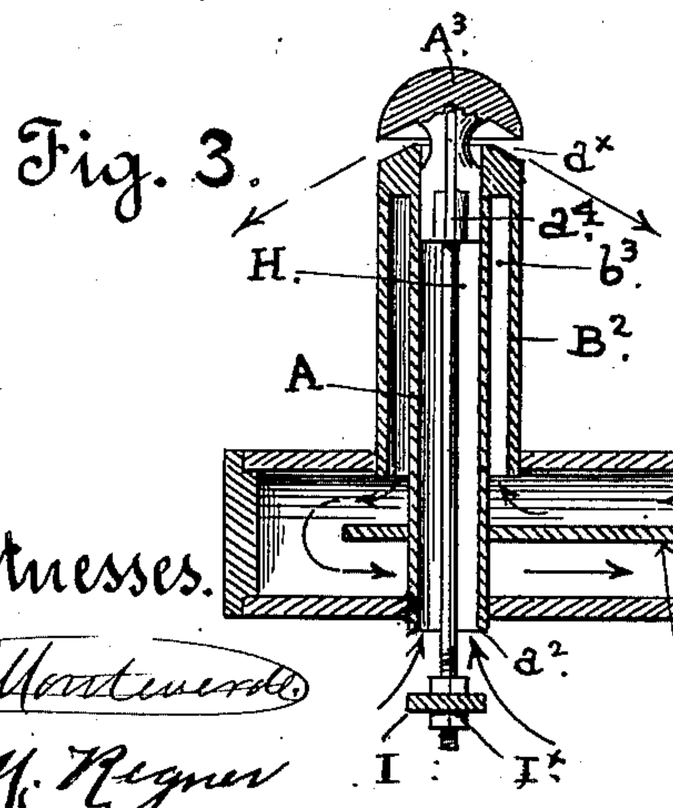


Fig. 3.

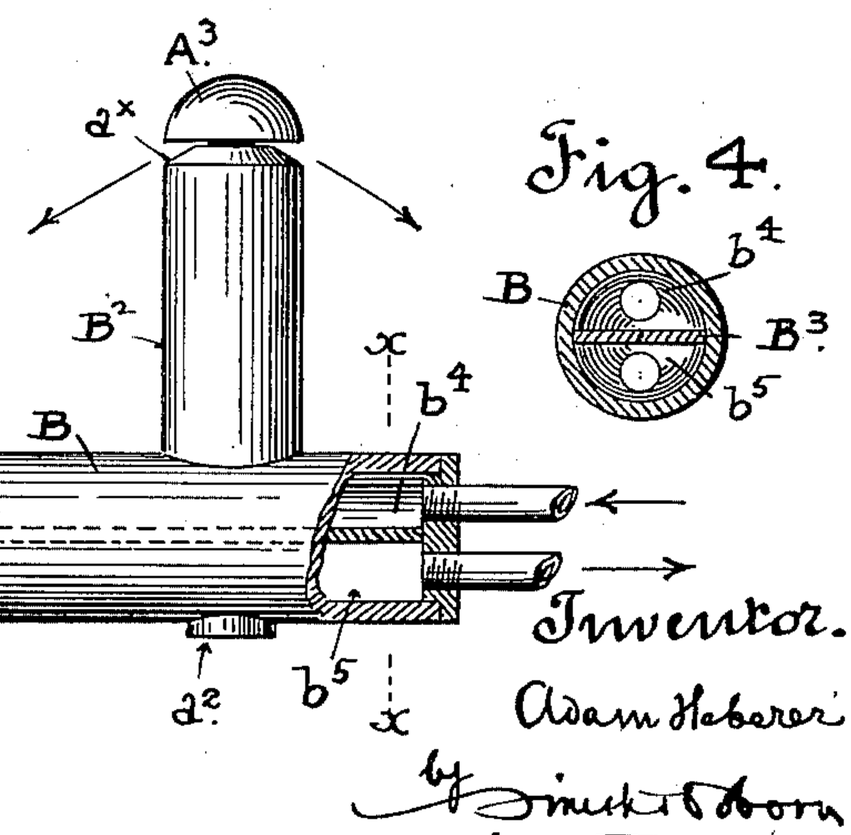


Fig. 4.

Witnesses.

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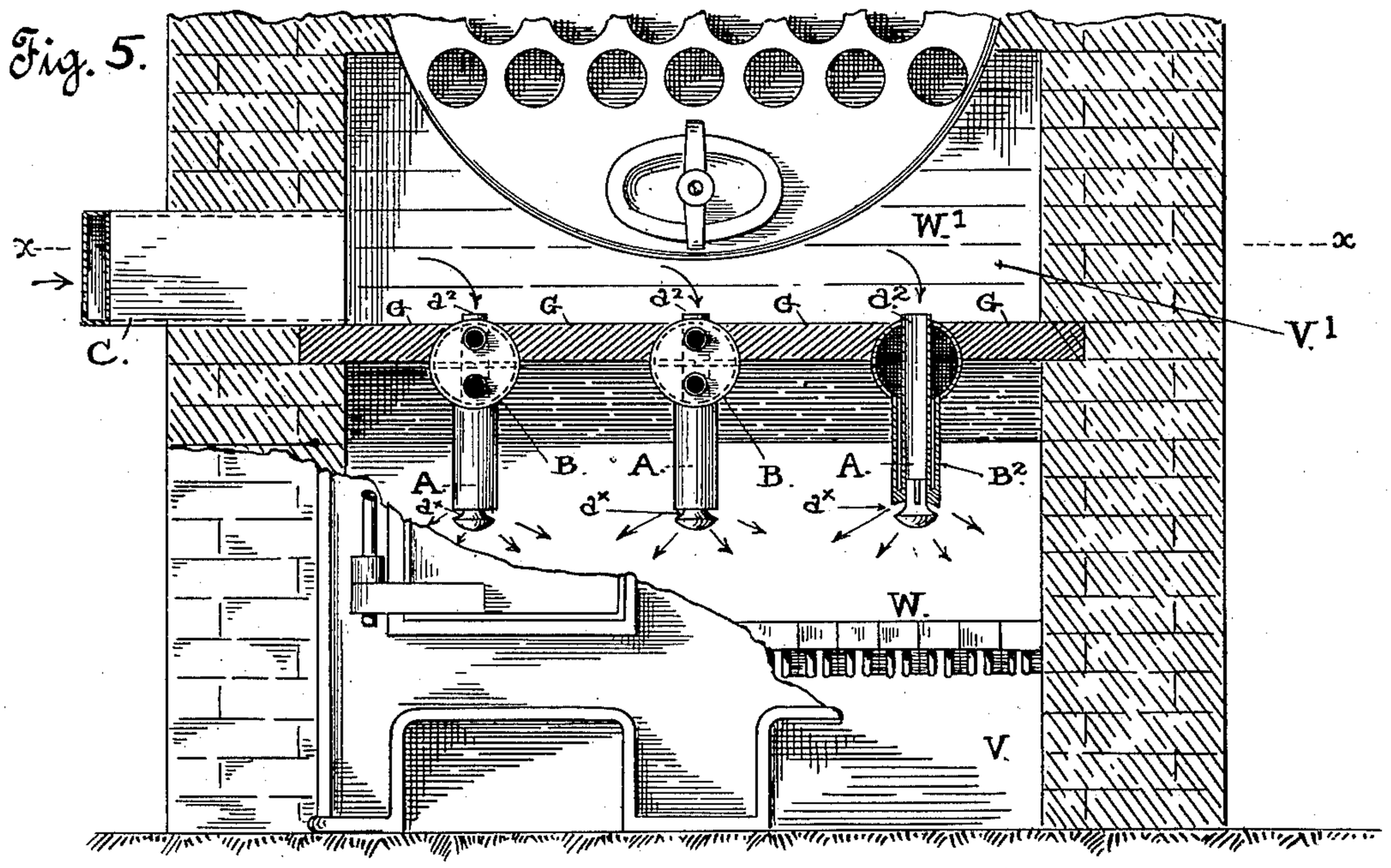
Fig. 5.



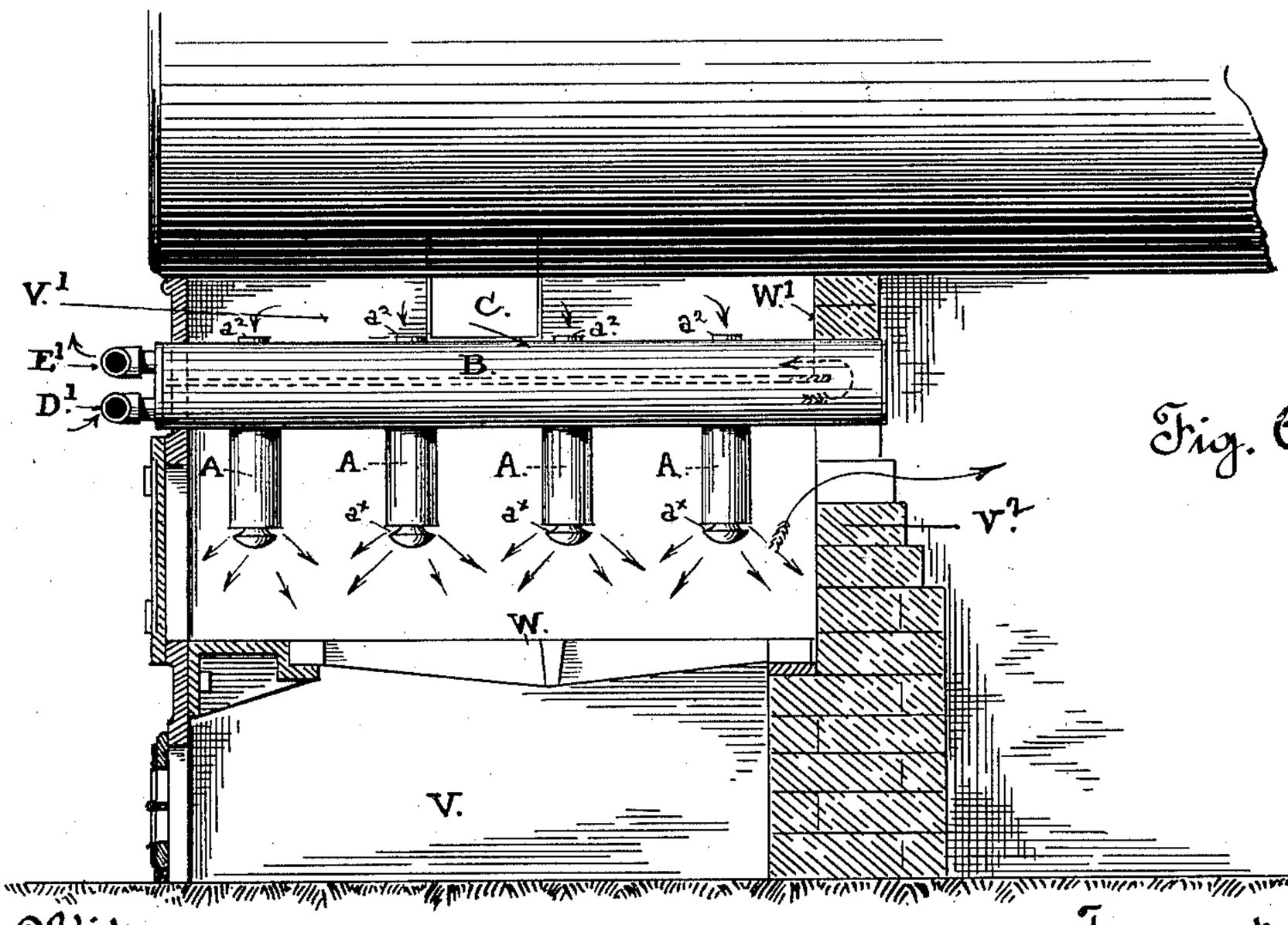


Fig. 6.

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No. 652,227. Patented June 19, 1900.

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SMOKELESS COAL BURNING FURNACE.

(Application filed Sept. 28, 1898.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 7.

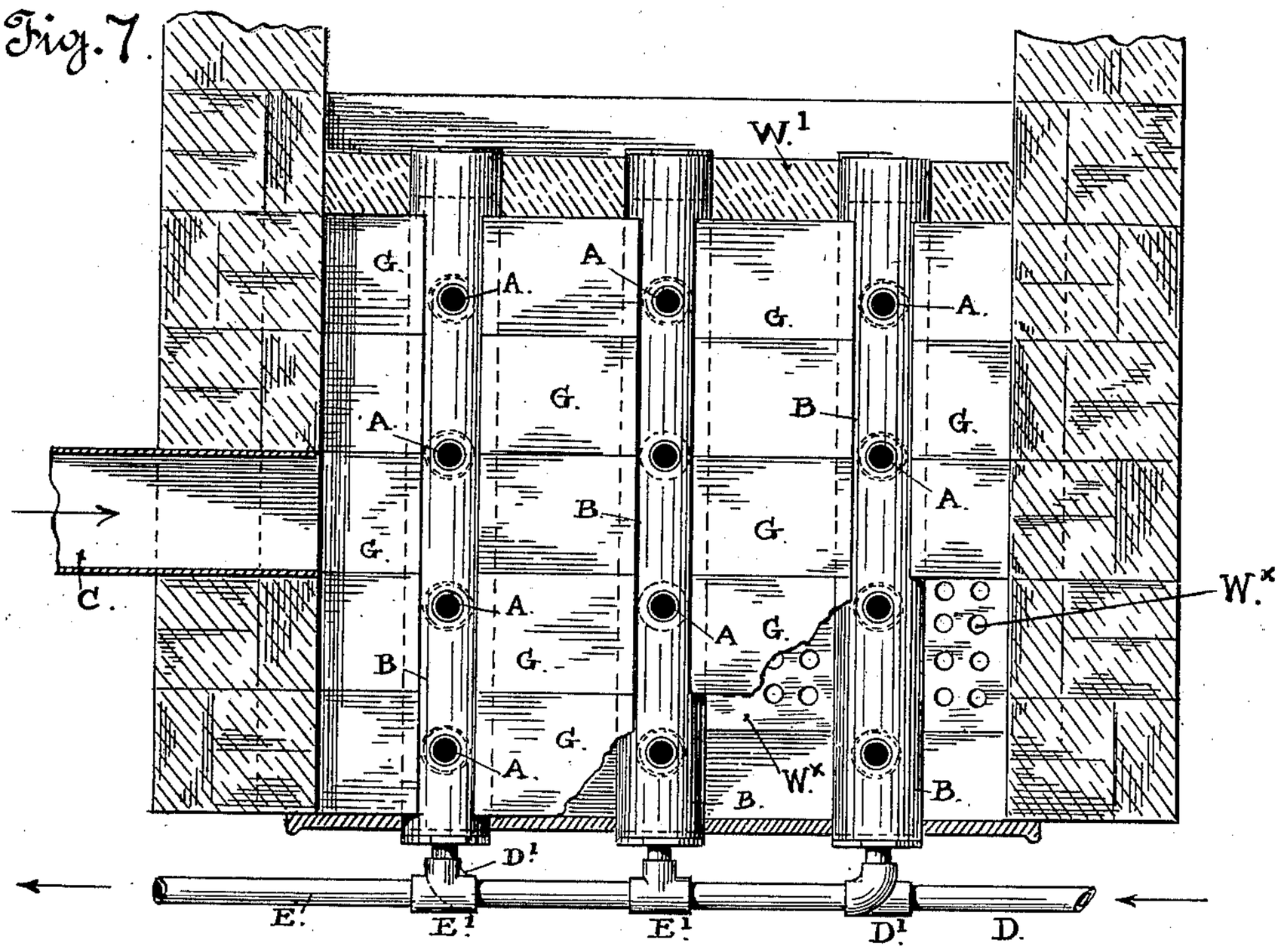
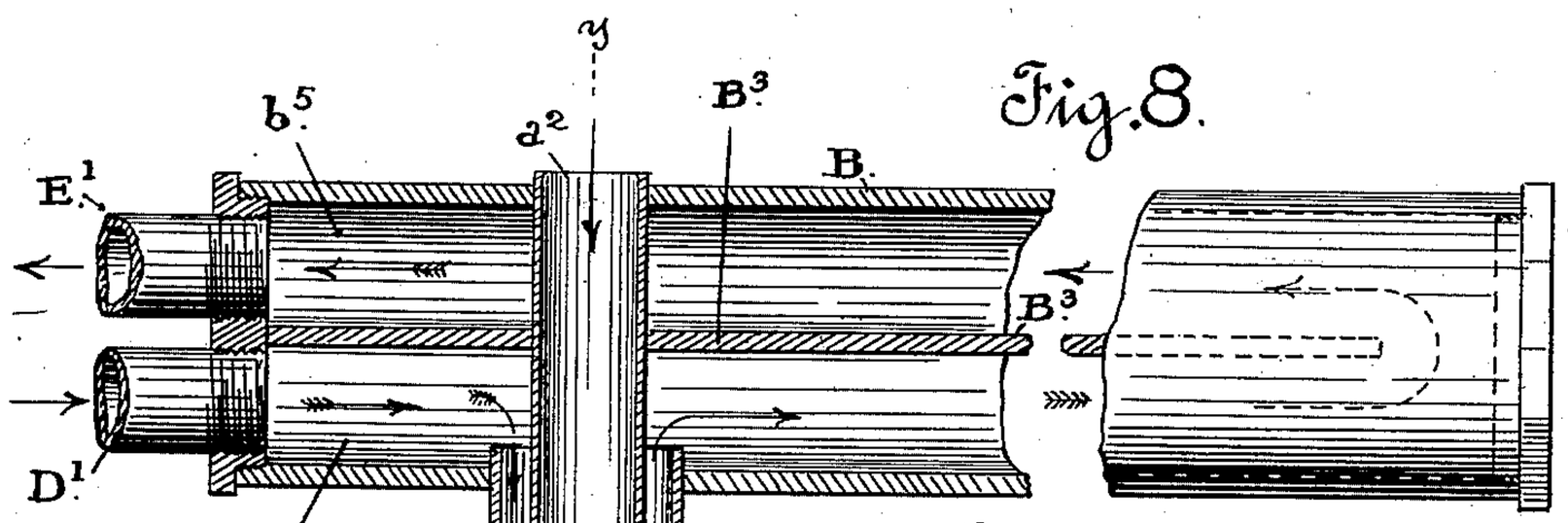
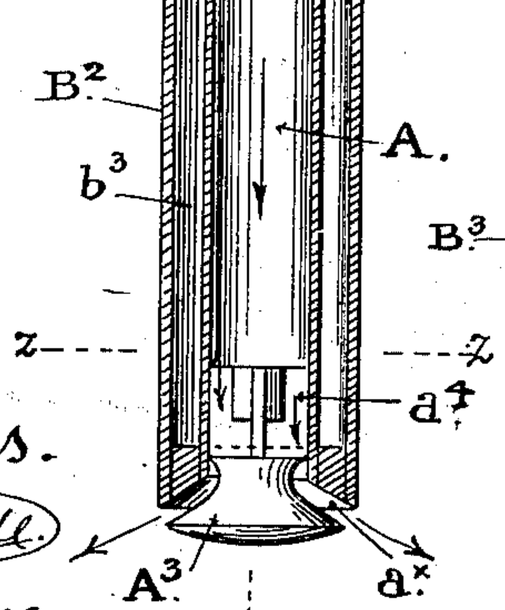


Fig. 8.





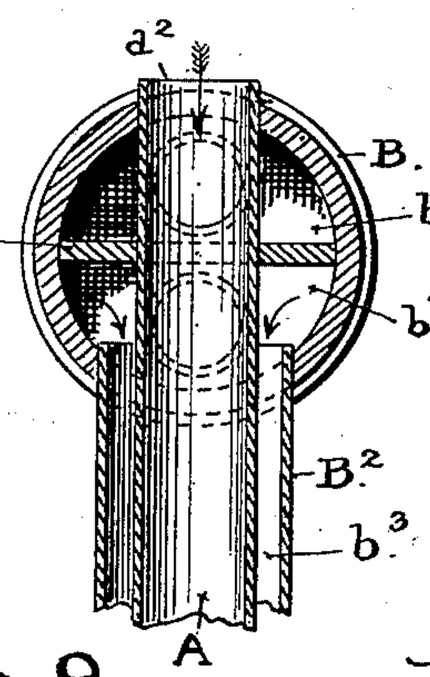
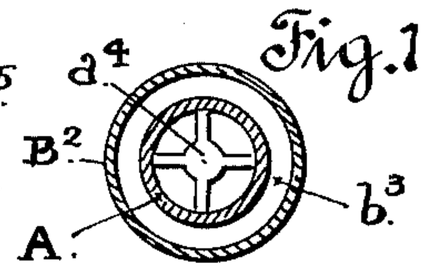


Fig. 9.

Fig. 10.



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UNITED STATES PATENT OFFICE.

ADAM HEBERER, OF ALAMEDA, CALIFORNIA.

SMOKELESS COAL-BURNING FURNACE.

SPECIFICATION forming part of Letters Patent No. 652,227, dated June 19, 1900.

Application filed September 28, 1898. Serial No. 692,108. (No model.)

To all whom it may concern:

Be it known that I, ADAM HEBERER, a citizen of the United States, residing in Alameda, county of Alameda, State of California, have invented certain new and useful Improvements in Smokeless Coal-Burning Furnaces, of which the following is a specification.

This invention relates to improvements made in furnaces for burning coal without the production of smoke and the same has for its object to produce a furnace for burning bituminous and lignite coals without the production of smoke, and under such conditions of economy and efficiency that coals of the softer kinds or varieties can be used to advantage for steam-generating purposes and for other purposes in the art and manufactures in place of anthracite coal and in situations or localities also where soft coals by reason of their great smoke-producing qualities cannot be used.

To such end and object mainly my invention consists in a novel means or apparatus for forcing and distributing streams of air into a furnace at varying angles to one another downward and from different directions in close relation to the mass or body of fuel, so as to cover the entire surface of the fuel, and in a furnace of novel construction especially adapted for burning bituminous and lignite coals, all as hereinafter more fully described and claimed, reference being had to the accompanying drawings, forming part of this specification.

Figure 1 of the said drawings represents in front elevation a furnace under a stationary steam-boiler constructed in accordance with my invention, showing the front broken away on one side of the center and the wall or brickwork setting in section. Fig. 2 is a longitudinal sectional view. Fig. 3 is a sectional view, partly in elevation, on an enlarged scale, showing details of the construction of the air-distributing tubes and the water-jacket protection. Fig. 4 is a cross-section at $x\,x$, Fig. 3. Figs. 5 to 10, inclusive, illustrate a construction of furnace in which the air-tubes are set in an inverted position, extending from above the fuel-supporting surface perpendicularly downward, with their outlet ends in close relation to the surface of the fuel. Fig. 5 is a front elevation of the furnace, showing the front broken away and one of the air-distributing tubes in section. Fig. 6 is a longitudinal sectional view. Fig. 7 is a cross-section at $x\,x$, Fig. 5, showing the floor or bottom of the air-chamber in the upper part of the furnace from which the air-tubes extend downward toward the fuel. Fig. 8 is a side view, on an enlarged scale, of one of these air-distributing tubes and its water-jacket protection. Fig. 9 is a longitudinal section at $y\,y$, Fig. 8; and Fig. 10 is a cross-section at $z\,z$, Fig. 8.

Air-tubes A A, having in one end outlet-apertures $a^{\times}$ and the opposite end a^2 open, are fixed in upright position in the furnace in spaced rows at uniform intervals of distance apart over the grate-surface from front to rear and from side to side of the furnace. The ends a^3, extending below the grate or fuel-supporting surface W, are open to the ash-pit, and their upper outlet ends above the grate-surface are set to stand at suitable distance above the surface of the body of fuel to keep the air-outlets always uncovered. These outlets are suitably formed also to turn the air-currents downward at varying angles to one another toward the body of fuel and to deflect them at such degrees of inclination that the currents from one tube are made to meet those from the adjacent tubes over the surface of the fuel, so as to cover the whole surface. The outlet end of each tube is fitted with a cap A^3, having a stem a^4, formed with wings or ribs, fitting tightly into the tube, and the space under the cap, between it and the end of the tube, forms the air-outlet. The under side of the cap is suitably flared to deflect the air outward and downward, and the rim of the tube is sloped or beveled to give a free outlet. In one way of applying these air-tubes they are fixed in upright position, extending upward through the grate-surface from the ash-pit V, which is closed to form a chamber from which all the tubes are supplied with air. The chamber is connected with a suitable air-blower or pressure-fan situated in any convenient place outside the furnace by means of an air-supply pipe C, laid through the furnace-wall into the chamber and carried to the blower outside. Figs. 1 to 5 of the drawings represent this manner of setting the air-tubes in upright position.

In another way the air-tubes are arranged in an inverted position, extending downward into the fire-space from an air chamber or space formed in the top part of the furnace. The chamber V′ is separated from the upper part of the furnace-space by a floor or horizontal partition extending from side to side and from front to rear of the furnace, at which part the end of the chamber is closed by a plate or partition W′, carried up to the boiler. From this chamber the air-tubes are carried through the floor perpendicularly downward into the fire-space below, with their lower outlet ends setting in close relation to the top of the mass of fuel. The outlet-apertures in these ends are suitably formed to direct the air-currents downward at varying angles, so that they will meet and close together above the surface of the fuel in the same manner as the currents are directed and distributed downward by the standing tubes in the first-described arrangement. The inverted tubes thus carried through the bottom of the air-chamber distribute the air in streams over the whole body of fuel below and against the top surface. An air-pipe laid through the wall of the furnace is connected with an air-blower outside to maintain a continuous supply of air in the chamber V′ at a constant pressure above that of the atmosphere. Figs. 5 to 10, inclusive, illustrate the arrangement of the air-distributing tubes in the inverted position. In both constructions or arrangements provision is made for protecting the tubes from the great heat to which they are exposed in the furnace. For this purpose all the tubes composing one row or set are fixed in a common header-tube B, closed at both ends and having a water-circulating passage running from end to end. The inlet ends a^2 of all the air-tubes are carried through one side of the tube B to the outside, and the main portion or body of each air-tube outside the header-tube is surrounded by a tubular jacket B^2, Figs. 8 and 9, so as to inclose an annular space b^3, that is open at one end to the water-space in the header-tube and is closed at the opposite end where the inner air-tube and the surrounding tube are united. A partition B^3 divides the header-tube longitudinally into the return circulating-passages b^4 b^5, one of which is connected with a water-supply pipe D by a coupling D′, fixed in the end of the header-tube outside the furnace, while the corresponding end of the passage on the opposite side of the partition is connected by a coupling E′ with an outlet-pipe E. The two water-pipes D E are carried across the end of the furnace, and the ends of all the header-tubes in the set or system are coupled to them in such manner that the water circulates from the two pipes directly through each header-tube and out again. The water jacket or space surrounding each air-tube in the row or set thus being directly connected with the passage on the inlet side of the partition, the water circulates through all the water-jacket tubes and around the end of the partition to the outlet side of the header-tubes.

As many of the header-tubes as the width of the furnace may require to be used are set in rows across the furnace-space, and the spaces between one tube and the next is closed by tiles or plates G G G. In the first-described arrangement the air-tubes are set through the fuel-supporting surface, and in the other arrangement the air-tubes are inserted through the floor or bottom of the chamber V′. A better circulation of the water in the upper part of the standing tubes will be obtained by connecting the water-jacket tubes together at or near the top by horizontally-placed tubes F, extending lengthwise from one tube to the next through all the tubes of the row.

In the application illustrated in Figs. 5 to 10, where the tubes are inverted, it will be seen that the water will always reach the bottom of the water-jacket space, and the connecting-tubes F can be omitted in that construction.

Where the same may be desirable, provision is made for regulating the size or area of the air-outlets by making the cap adjustable in the ends of the air-tubes, so that they can be raised or lowered. This is done by carrying a rod H from the end of the stem downward through the middle of the air-tube and fastening it to a stationary cross-bar I by nuts $I^{\times}$. This means of adjustment will be understood from Figs. 1, 2, and 3 of the drawings.

The arrangement of the standing tubes in rows running longitudinally from front to rear of the furnace admit of the fuel-supporting surface being divided into separate fuel-troughs by setting fireproof slabs or tiles L in an upright position between the tubes A, as represented in Fig. 2 of the drawings, the edges of the tile being fitted to the tubes A, so as to hold it against lateral displacement.

In a furnace of ordinary dimensions having about twenty (20) square feet of fuel-surface good results will be obtained with air-tubes two inches in diameter set from eighteen (18) to twenty-four (24) inches apart, with their distributing-outlets situated about twelve (12) inches above the fuel-supporting surface, the air supplied to the tubes being maintained at one-half to one ounce pressure above that of the atmosphere. The amount or degree of pressure to employ will be found to be governed by the conditions prevailing in the fire, such as the volatile character of the fuel being used and the crowding of the fires from time to time, according to the work required of the furnace. The conditions existing in the furnace while the operations of combustion are going on, to be ascertained by inspection through the door, are the best guide in regulating or varying the volume of air to secure effective results. A bright clear condition of flame and the absence of smoky

vapors will be observed when the volume or proportion of air being distributed is sufficient. On the other hand, a dull smoky appearance or the presence of smoky vapors in the flame will indicate the need of a greater proportion of air, and in such case the pressure must be increased until the imperfect conversion of the gaseous or volatile compounds is seen to be remedied.

The fuel-supporting surface of the furnace may be formed of grate-bars W, as shown in Figs. 1 and 2, or in place of bars perforated plates $W^{\times}$, fitted between the headers and suitably supported at the ends, can be used.

Air in sufficient quantity to maintain active combustion and an incandescent condition of the carbonaceous or solid portion of the fuel is permitted to pass through the grate-surface from the ash pit or chamber below, but the volume or proportion of air so supplied should be the least amount or quantity that will produce the desired result.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination, with a coal-burning furnace; of a fuel-supporting surface, horizontally-set water-tubes extending longitudinally from front to rear of the furnace and divided interiorly into chambers for return circulation of water from end to end thereof, standing air-tubes fixed in the water-tube at intervals apart, the lower ends of said air-tubes extending through the water-tube and opening into the air-space below the fuel-supporting surface, and the upper end opening into the space above the fuel, a tubular water-casing inclosing each air-tube having its upper end closed and its lower end opening into the water-space of the horizontal water-tube, a cap covering the open end of the air-tube and inlet and outlet pipes connecting the compartments of the water-tube with a supply of water under pressure.

2. In an apparatus for feeding air to furnaces, the combination of a horizontally-set water-tube divided longitudinally into return circulating water-spaces extending from end to end of the tube, pipes connecting said compartments with a supply of water, air-tubes fixed in said water-tubes at right angles and having their lower ends open to the outside through the wall of the tube and their upper ends standing above the tube, a tubular water-casing fixed in the upper shell of the water-tube around that portion of the air-tube which stands above the water-circulating tube, the upper end of said casing being united to the inclosed air-tube, a cap covering the open end of the air-tube and means for supporting said cap at a distance above the end of the upright tube, as described.

3. In an apparatus for feeding air to furnaces, the combination of the water-tube B divided longitudinally by a partition for producing a return circulation of water, the spaced air-tubes A extending perpendicularly through the water-tube and open at both ends to the air, the tubular casing B^2 surrounding the air-tubes and open at the lower end to the water-circulating space, and the cap A^3 covering the top of the air-tube, and means for supporting said cap over the open end of the tube.

4. The combination of the water-tube B, diaphragm B^3 dividing the same interiorly into water-circulating spaces, standing air-tubes A opening through the walls of the water-tubes, tubular casings B^2 surrounding the air-tubes and united thereto at the top to inclose the water-circulating spaces b^3, the water-circulating pipes D′ E′ F, the tiles L closing the space between one standing tube B^2 and the next, and the caps A covering the open end of the air-tubes.

In testimony that I claim the foregoing I have hereunto set my hand and seal.

ADAM HEBERER. [L. S.]

Witnesses:
JOHN S. HOWARD,
JAMES L. KING.