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J. S. WILLIAMS.

FURNACE.

No. 286,887. Patented Oct. 16, 1883.

Fig. 1.

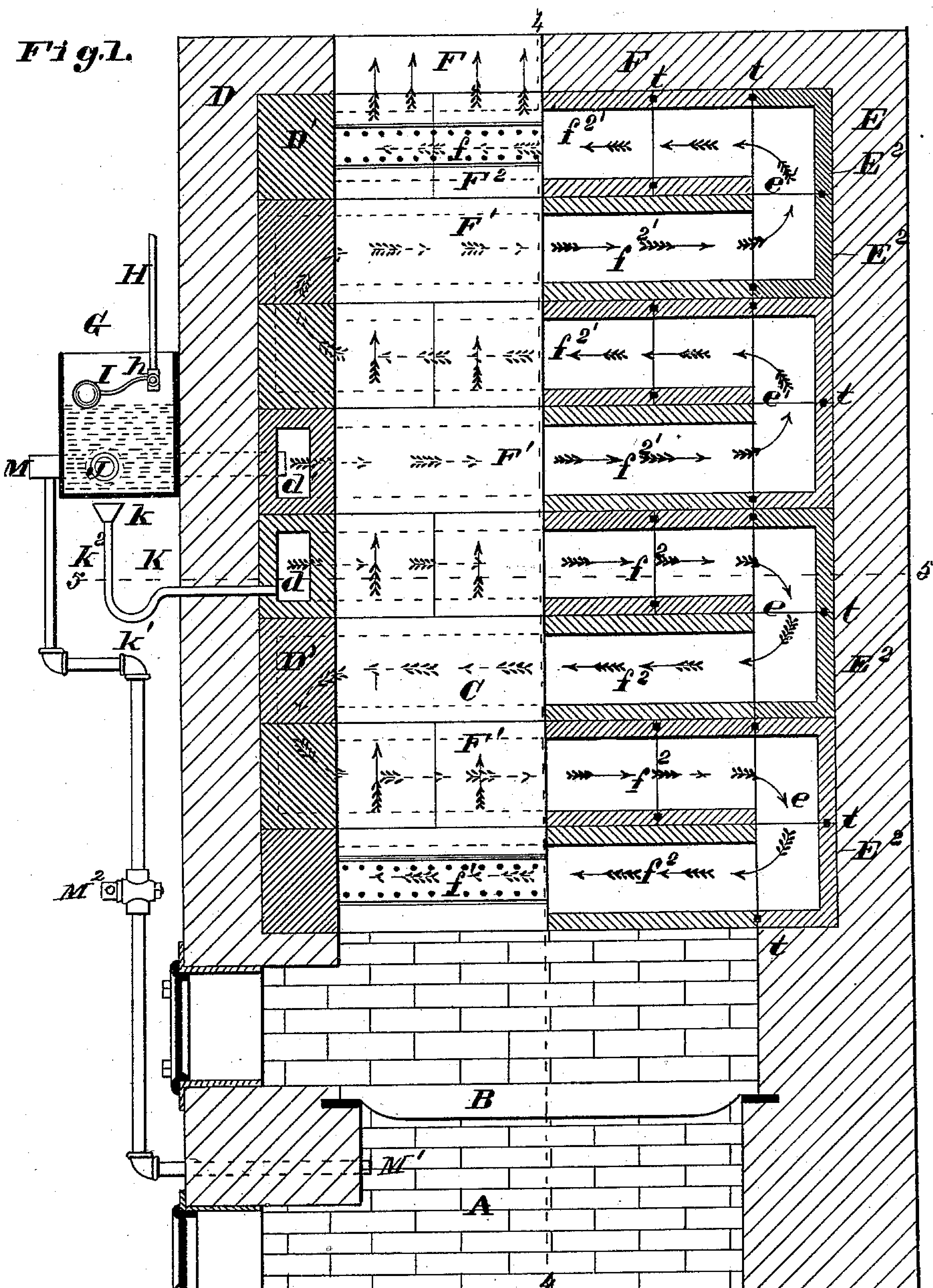

Fig. 2.

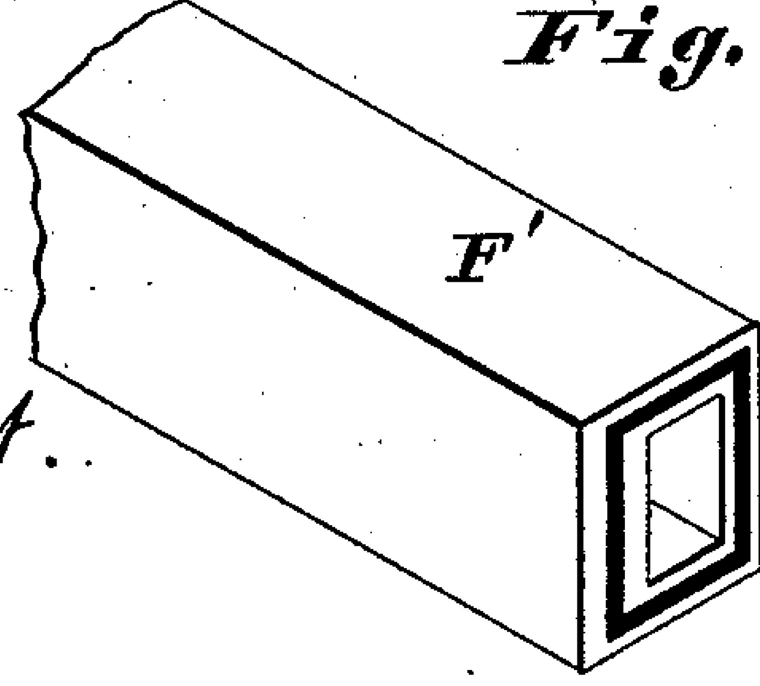

Fig. 3.

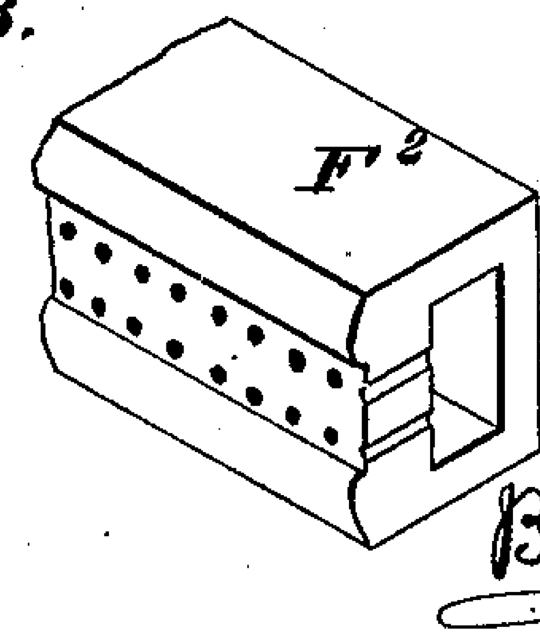

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Fig. 4.

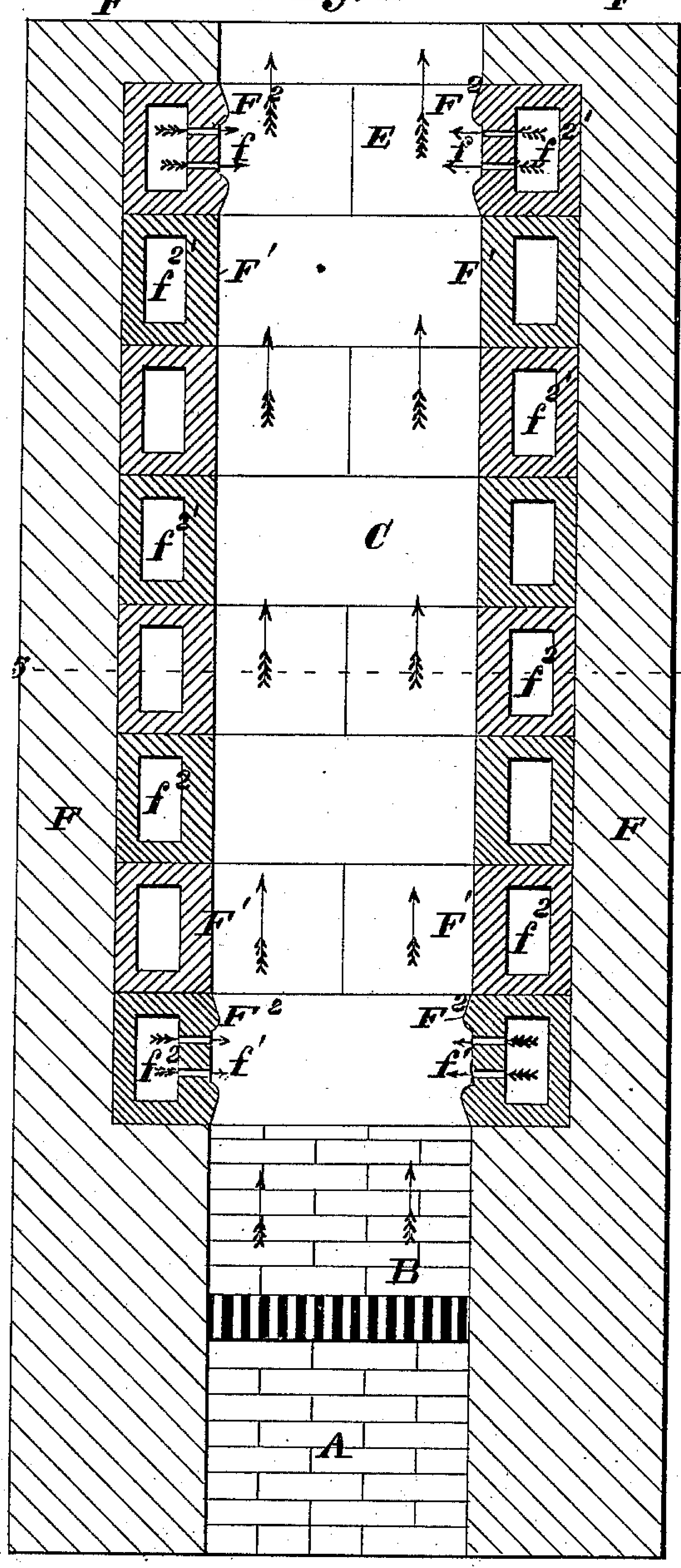


Fig. 5.

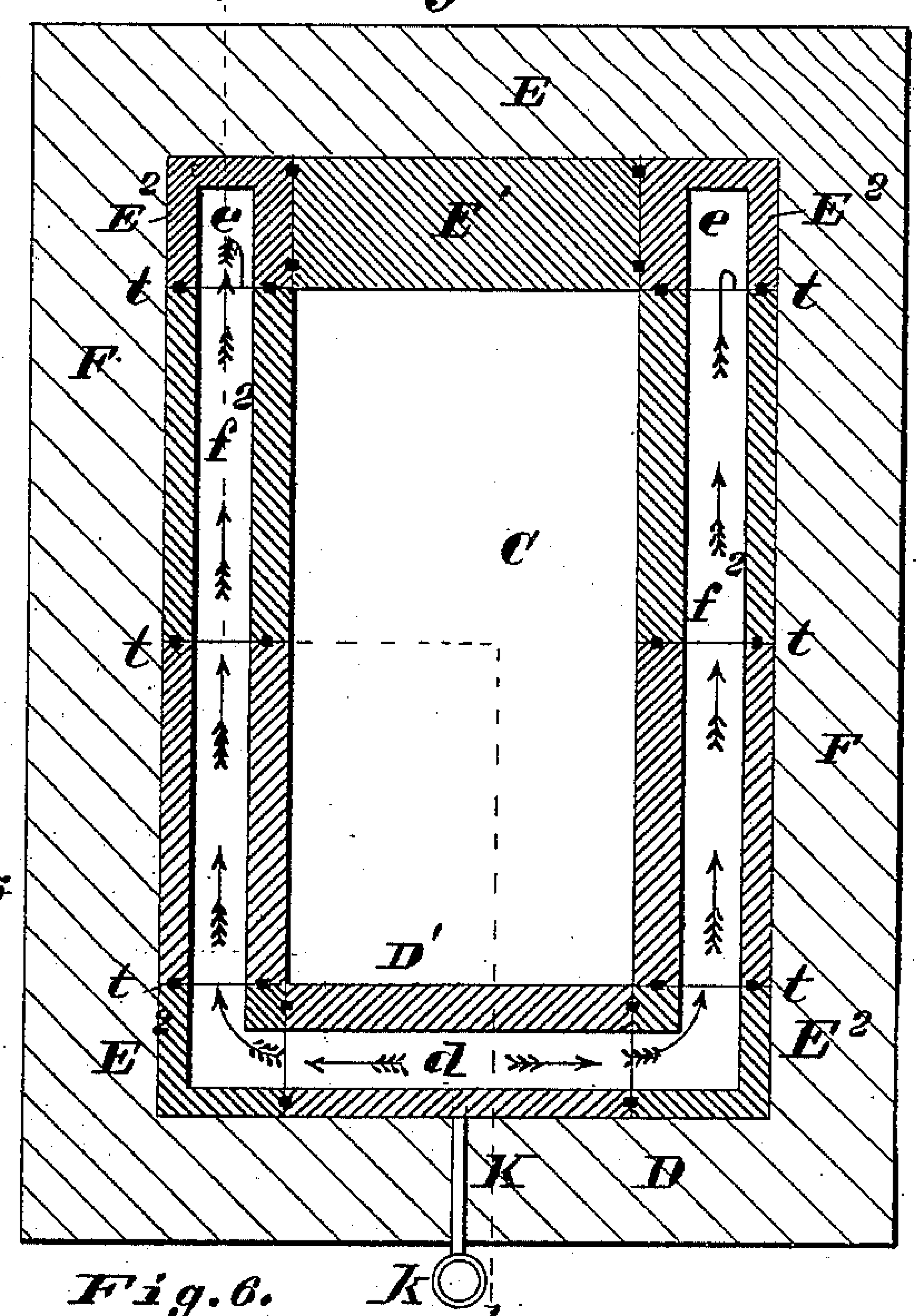


Fig. 6.

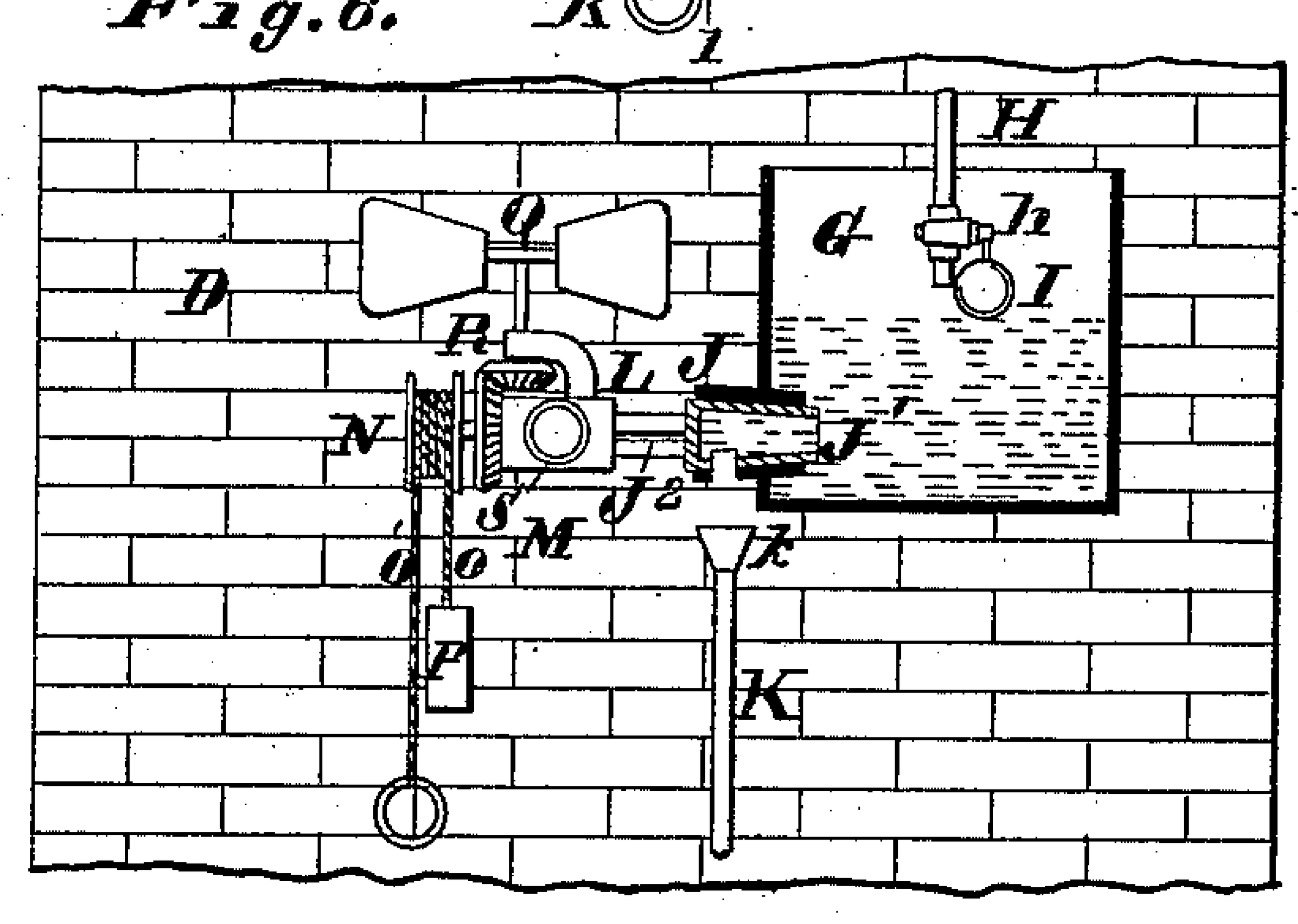


Fig. 7.

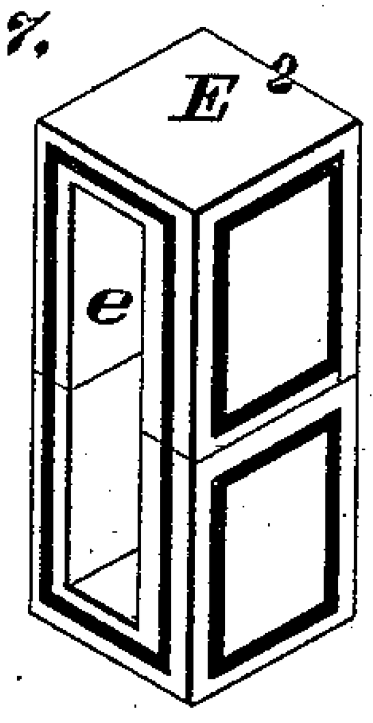


Fig. 8. Fig. 9. Fig. 10.

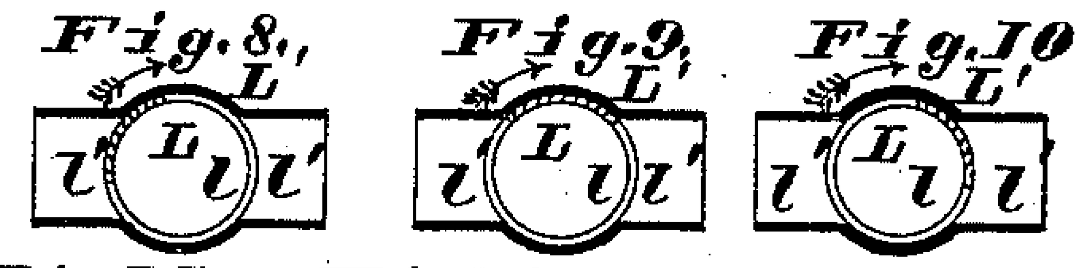
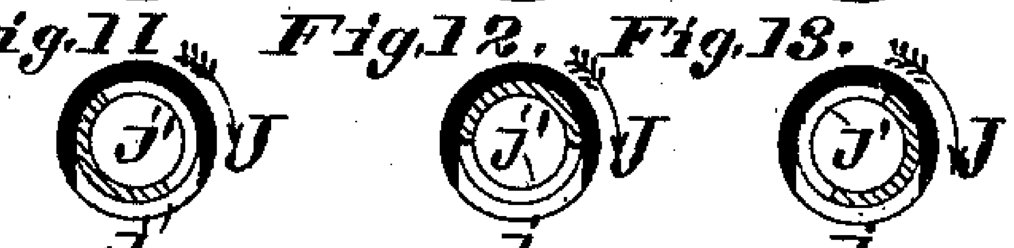


Fig. 11. Fig. 12. Fig. 13.



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FURNACE.

No. 286,887.

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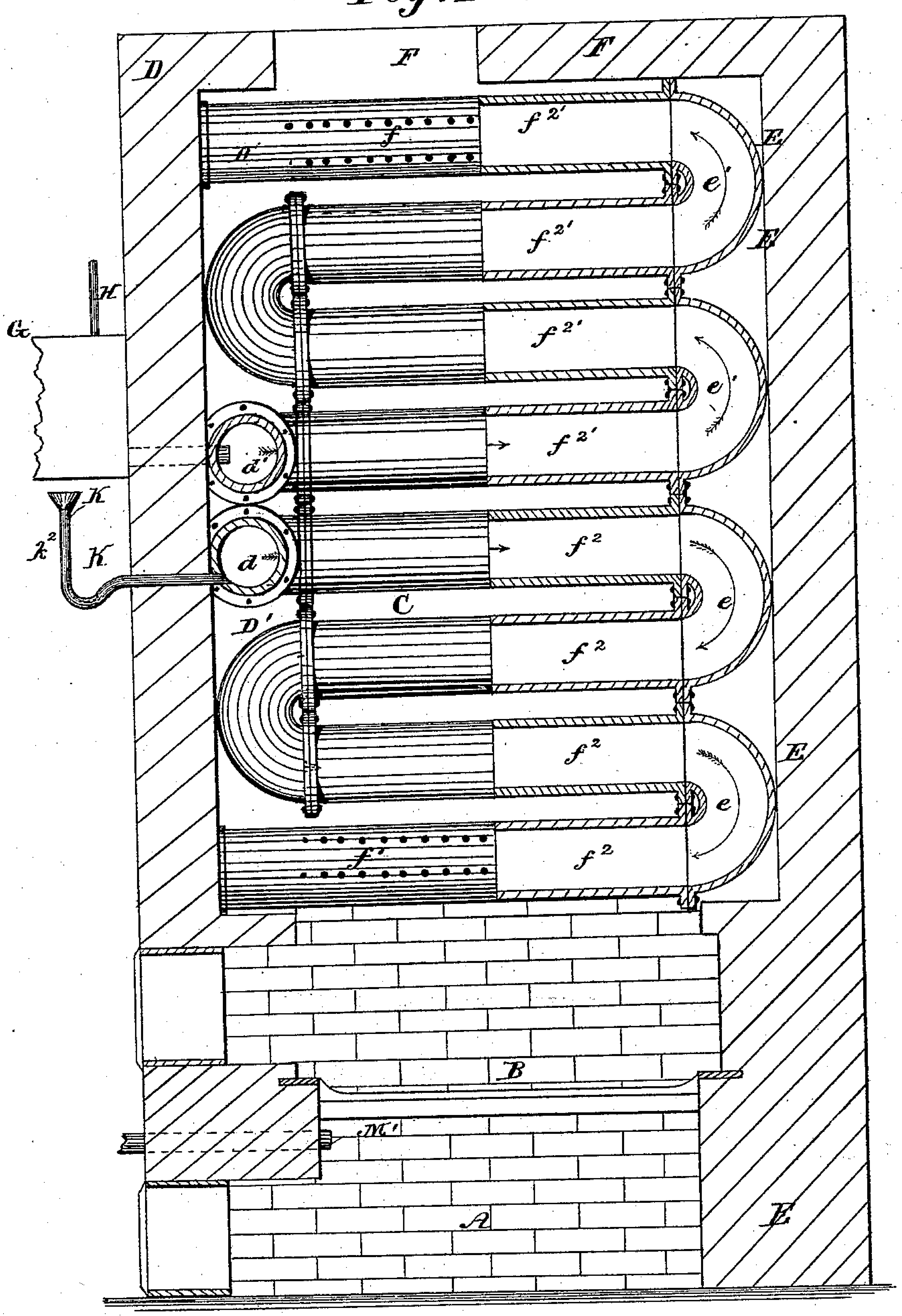
Fig: 14.



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FURNACE.

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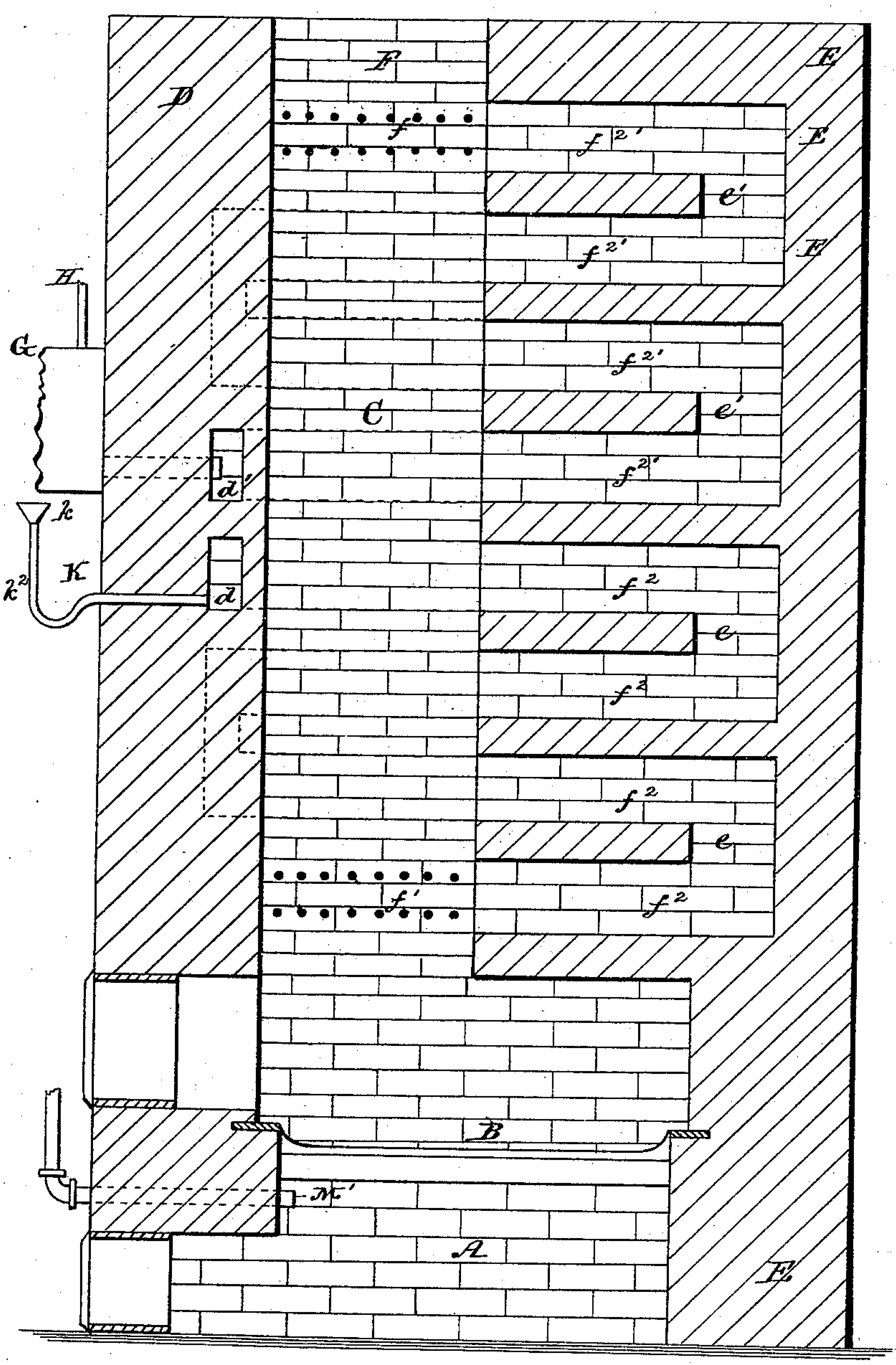
Fig: 15.



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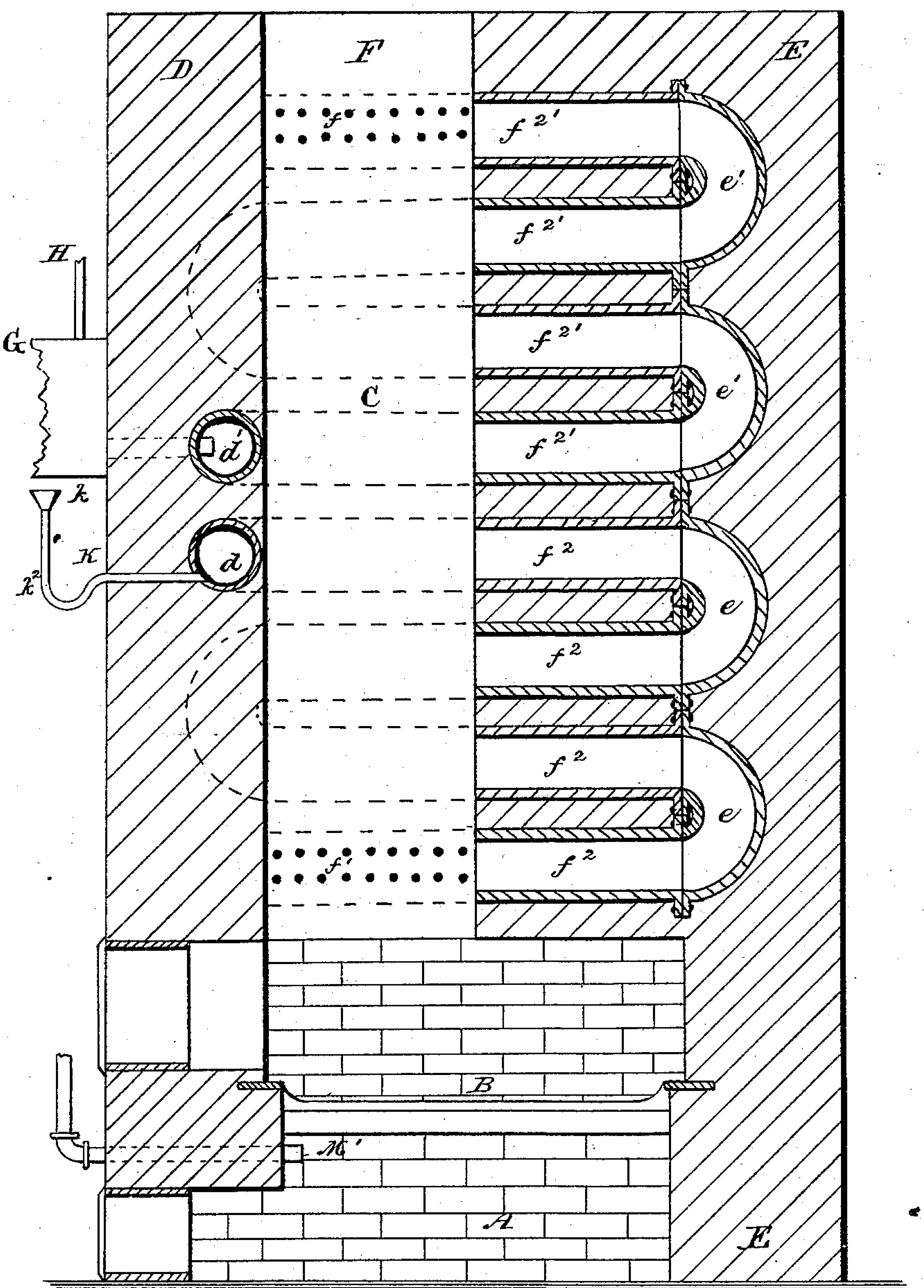
No. 286,887. Patented Oct. 16, 1883.

Fig: 16.



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UNITED STATES PATENT OFFICE.

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FURNACE.

SPECIFICATION forming part of Letters Patent No. 286,867, dated October 16, 1883.

Application filed December 17, 1881. (No model.)

To all whom it may concern:

Be it known that I, JACOB S. WILLIAMS, of the city of St. Louis and State of Missouri, have invented a certain new and useful Improvement in Furnaces, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

My improved furnace is designed not only for the more perfect combustion of coal, but, in connection therewith, for the decomposition of water and the utilization of its constituents for the production of heat.

It is well known that there are three prerequisites to the perfect combustion of carbon, viz: first, a sufficiently high temperature—say 2,000° Fahrenheit—which temperature should be maintained during the entire time occupied in the combustion; second, a proper supply of oxygen, to be furnished when and where required; third, time in which the gases may mix mechanically, that the proper chemical action may take place.

A brief review of the defects ordinarily found in furnaces will more fully illustrate the points of a proper construction.

In boiler-furnaces the surface of the boiler is in such near proximity to the fire that the gases come in contact with said surfaces before thorough combustion takes place, and as the surfaces have water in contact they must be comparatively cold, and therefore in condition to and do absorb heat rapidly, so that the necessary temperature cannot long exist.

In reference to the second requirement it may be said of an ordinary furnace with natural draft that the draft through the furnace is in proportion to the heat in it, and that when the fire is renewed and the volatile matter being thrown off and more oxygen required at that very time the fresh coal is absorbing the heat, the temperature of the furnace being reduced, and in consequence the quantity of air decreased, whereas when the volatile matter has passed off and the amount of oxygen needed diminished the fire is hottest and will induce a greater flow of air, so that when the greatest quantity is required the supply is least, and when the least is required the supply is greatest.

In the third requirement—time—ordinary furnaces are also deficient, because at a point but little, if any, beyond the fire-place the temperature is so much reduced as to preclude proper combustion, as the rapidly-moving gases must reach and pass the vital point in a small portion of a second, during which time it is not possible that the air can be sufficiently heated, the oxygen separated from its nitrogen and combined with the carbon, because in contact with the cold surface of the boiler the required temperature cannot be maintained. I propose to produce and perfect combustion in the furnace, and afterward apply the heat generated to the boiler or other absorber of it.

My invention consists, first, of a furnace having its side walls extended and in close proximity, forming a long contracted combustion-chamber between the fire and the boiler or other receptacle of the heat, said walls being lined, in part or in whole, with blocks containing heating-flues, two series of which shall have jet-holes at different points, opening into the combustion-chamber.

My improvement consists, further, in an elongated combustion-chamber containing two series of blocks or pipes, the lower series being provided with jet-orifices at the bottom and the upper series with jet-orifices at the top.

My invention consists, further, in combining with the furnace devices for regulating the supply of air to the ash-pit and to one upper series of heating flues or pipes.

My invention consists, further, in combining with the lower series of heating flues or pipes a feed-water pipe.

My invention consists, further, in constructing the feed-water pipe with a downward bend, forming a trap to prevent the escape of steam, and also with an upward extension, to contain a sufficient amount of water to overcome the outward pressure of the steam.

My invention consists, further, in a peculiarly-constructed water-cock, which, by moving in the same direction, expands and contracts the opening so as to regulate the supply.

My invention consists, further, in so connecting the water-cock and the air-valve that they will be moved simultaneously, as required, and by the same mechanism.

My invention consists, further, in a combustion-chamber elongated in the direction of the current of the products of combustion, supplied by or through the means of a water-cock and air-valve with a definitely determined varying supply of oxygen in such manner as to produce within said chamber the perfect combustion of the carbon of the coal.

By the above construction I secure not only the conversion of the carbonic oxide—previously formed by the introduction of a definite amount of air under the grates, and in its passage through the fire—into carbonic acid, but also the conversion of the volatile carbon evolved above the incandescent coke when the fire is renewed, as also the combustion of the hydrogen set free in decomposing the steam by the introduction of superheated air through the upper jet-orifices, thus producing in the same furnace, at the same time, four distinct combustions—viz., first, in the production of carbonic oxide; second, its conversion into carbonic acid in two operations; third, the conversion of the volatile carbon into carbonic acid by one operation; and, fourth, the combustion of the hydrogen previously set free.

In the drawings, Figure 1 is a longitudinal section of the furnace at 1 1, Fig. 5. Fig. 2 is a perspective view of a part of one of the flue-blocks of which the sides of the furnace are mainly formed. Fig. 3 is a similar view of another of these blocks. Fig. 4 is a transverse section at 4 4, Fig. 1. Fig. 5 is a horizontal section at 5 5, Fig. 1. Fig. 6 is a front view of part of the furnace with the water-supply tank in sections. Fig. 7 is a perspective view of corner blocks. Figs. 8 to 13 are sectional views of the air and water valves. Fig. 14 is a longitudinal section of the furnace at 1 1, Fig. 5, showing the substitution of pipes for flue-blocks. Fig. 15 is a longitudinal section of the furnace at 1 1, Fig. 5, showing the flues within the furnace-walls. Fig. 16 is a longitudinal section of the furnace at 1 1, Fig. 5, showing pipes within the furnace-walls.

A is the ash-pit, B the grate, and C the fire or furnace chamber. The furnace has a front wall, D, back wall, E, and side walls, F. I show the walls of the furnace with an interior part of blocks made of fire-clay and a covering of brick-work. The front and back walls may be, for the most part, built up in any suitable manner. The side walls, as shown, contain flues through which air and steam are made to pass, and in which they become very highly heated, and from which they escape through numerous small orifices, *f f′*, into the chamber C; but as a modification, in place of the flues f^2 extending through flue-blocks in the body of the walls, pipes, as shown in Fig. 14, made of fire-tile or metal, may be placed at the inner side or face of the walls; or flues may be built in the walls, as shown in Fig. 15, or pipes in the walls, as shown in Fig. 16. The front and back blocks are marked D′ and E′, respectively. The side blocks are marked F′ in general. The jet-blocks are marked F^2 and the corner blocks E^2.

G is a water-tank, supplied with water by a pipe, H, that has a valve, *h*, operated by a float, I, in a well-known manner, to keep the water in the tank up to a certain level.

J is a cock whose plug J′ is open to the tank at the inner end, so that the water flows readily into the hollow plug. The outer end of the plug is closed; but its side has a slot, *j′*, extending in a circumferential direction. The case has a similar orifice, *j*, at the lower side, through which the water flows more or less freely as the slot *j′* of the plug and the orifice *j* of the case are more or less perfectly in conjunction. The water drops from the cock J into the funnel *k* at the top of pipe K, and is carried by it into the transverse flue *d* in the front wall of the furnace. This flue connects by flues in the corner blocks, E^2, with the flues f^2 of the side blocks, and through diving-flues *e* and return side flues, f^2, and so descending until it reaches the flues f^2 in the jet-block F^2, from whence it issues in small jets through the small holes *f′* in the form of steam.

It will be understood that when the water enters at *d* it quickly becomes vaporized, and as it descends it becomes highly superheated, so that when it mingles with the carbonaceous gases rising from the fire the steam is readily decomposed, the oxygen uniting with the carbon, because of their superior affinity, by which the hydrogen is liberated, and, ascending, is reoxygenated by superheated air introduced through the jet-orifices at *f*.

The pipe K is made in the form of a trap, having a downward bend, *k′*, to contain water, and the vertical part k^2 is made sufficiently high to resist the pressure of steam from the flues *d* and f^2, the water rising in the pipe k^2 as the pressure of the steam increases.

The stem J^2 of the cock is attached to the air-valve L, so that the water-cock and air-valve always turn simultaneously, and the volume of air will always be proportional to the volume of water.

The air-pipe is shown at M. It is in conjunction with a fan or blower, (not shown,) of any suitable description, to force air through the pipe M and valve L into the flue of the furnace. The valve is of hollow cylindrical form, with an aperture, *l*, in the side, that may be brought in conjunction with the apertures *l′* of the case L′ of the valve, to allow a full or only a partial flow of air through the pipe M. The air from the pipe M enters a transverse flue, *d′*, in the front wall of the furnace, and passes through ascending flues *e′* to the side flues, f^2, as shown by the arrows, to the flue in the jet-block F^2, and passes through the small jet-holes *f* into the combustion-chamber C in a highly-heated state, to cause the combustion of any inflammable gases that may be present at that point.

As a means of turning the air-valve and water-cock, I place on their common stem or shaft J^2 a pulley, N, with a cord, O, passing around it and supporting a weight, P. It is necessary for the proper action of the valve and cock that they should have slow rotary motion, and to secure this any well-known or suitable escapement mechanism may be used. I have shown a fly, Q, connected with the shaft J^2 by cog-wheels R S.

I do not confine myself to any special mechanism for turning the valve and cock. Any clock-work mechanism may be used that will give the required movement in the required time—say between one-fourth and one-third of a revolution in half an hour, more or less, as circumstances may require.

I do not confine myself to the form of air-valve L or cock J shown and described, for any other form of valve and cock by which a like result could be produced would be essentially the same in principle; also, any mechanism causing the simultaneous movement would be a substantial equivalent of the stem J^2, connecting them for this purpose.

I will say here that the purpose of this device is to supply the superheated steam and air in greater quantity at the time when the fuel is giving out its volatile matter—viz., when fresh coal had been added to the fire. At such time the mechanism would be wound up and let to run its course, first gradually opening and then gradually closing to a certain degree the valve L and cock J. Three different positions of the valve and cock are shown in Figs. 8 to 13. Figs. 8 and 11 show their position when the mechanism is first wound up and the minimum quantity of air and water being supplied. Figs. 9 and 12 show their position when the mechanism is half run down and the maximum quantity being supplied, and Figs. 10 and 13 show their position when the mechanism has run down and the minimum supply reattained, at which they will rest until the fire is again renewed and the same operation again performed.

As a means of winding up the mechanism I show a hanging cord, O′.

The shaft J^2 may have a ratchet-connection with the retarding mechanism R S, so that in winding up the mechanism may remain at rest. This device is common in watches and clocks, and needs no description to enable a mechanic to apply it.

I have shown the flue and lining blocks hermetically connected together by joint-tongues *t*, of fire clay or cement occupying match-grooves in the ends of the blocks, so as to make the flues air-tight.

The operation of the siphon-shaped water-pipe is as follows: The pressure of the steam generated will keep the water in the long leg K^2 somewhat above the level in the short leg, and the counter-pressure of the water in the long leg will, by its greater or less pressure, overcome the outward pressure of the steam, thus forcing the water to enter the flues or pipes f^2 through the transverse flue d' as rapidly as it is furnished from the cock—that is, in sufficient quantities to supply the needed quantity of oxygen. The heating-channels of flues f^2 may be confined to the walls of the furnace, or may extend in part or in whole to the walls of the boiler, as may be found expedient. As perfect combustion of carbon can only be produced at a high temperature; as such high temperature can only be maintained during the absorption of the heat of the coke fire by the fresh coal by the radiation of heat previously generated and stored for the purpose; as effective radiation can not be attained if the walls are widely separated; as such radiation can maintain such high temperature in every part of a comparatively small area only; as the perfection of combustion depends to a great extent upon the attenuation of the jets containing the oxygen, as small jets of steam or air cannot, except by the use of considerable force, be made to penetrate a great distance into a highly-heated mass of rapidly-moving vapor, and as there are times in most manufacturing establishments where only a portion of the maximum power is required, for all these reasons I think it best to make each furnace quite narrow—say three (3) feet or less—and to multiply them in number as may be required. By this means, each being distinct in its operation, any number can be used, and such as are being used can be kept up to the temperature indispensably necessary to perfect combustion without waste.

For the purpose of simplifying the explanation of the operations of the furnace, we will suppose that the coal used consists of two-thirds ($\frac{2}{3}$) fixed carbon, (coke,) and one-third ($\frac{1}{3}$) volatile matter, and that all the volatile matter is carbon, omitting the hydrogen; that one hundred and fifty cubic feet of air contains the amount of oxygen to consume one pound of coal; that one hundred cubic feet shall be devoted to the combustion of the fixed carbon and fifty cubic feet to the combustion of the volatile matter; that one pound of coal only is to be used, and that there is a bright fire on the grate. The fire-door will be closed, the ash-pit closed, except an opening, M′, of definite size, controlled by a valve, M^2, to admit into the ash-pit, during the combustion of one pound of coal, a constant quantity of air, aggregating fifty cubic feet. The oxygen of this fifty feet of air will, in passing up through the incandescent coke, combine with all the carbon it will carry, the carbon being in excess, and will produce, by so combining, carbonic oxide. This carbonic oxide will be met above the fire by another constant quantity of air, aggregating fifty cubic feet, to convert it into carbonic acid, (two operations.) In the meantime the volatile matter is being evolved above the fire, and, unless oxygenated, will pass off unconsumed; but if the oxygen contained in the fifty cubic feet of air previously assigned to it be combined with it as evolved—a variable quantity—that will be converted into carbonic acid by one operation and the maximum amount of heat generated.

We will suppose that the air-valve L, as at Fig. 8, will admit the passage of the constant quantity of fifty feet to meet the carbonic oxide being produced by the fifty feet admitted below the grate, and that as it moves toward Fig. 9 it admits the same constant quantity, but in addition the constantly-increasing demands of the escaping volatile matter, until, upon arriving at the position shown at Fig. 9, it supplies the maximum requirement of the volatile matter in addition to the constant quantity, when, still moving slowly toward Fig. 10, still continuing the constant quantity, it gradually decreases the volume to conform to the decreasing evolution of the volatile matter, and at Fig. 10 only passes the constant volume to meet the like volume admitted beneath the grates, and so remains until the fire is renewed and the same operation is repeated. The oxygen in the air only is utilized, the nitrogen being negative, and any other equal amount of oxygen from any other source would accomplish the same end. One hundred cubic feet of air contains of oxygen 1.6770 pound, and 1.6770 pound of oxygen is contained in 1.8841 pound of water, which, in addition, contains .2071 pound of hydrogen; and if 1.8841 pound of water be introduced, in the form of superheated steam, into the furnace at *f′*, instead of the one hundred feet of air, the oxygen of the steam will be dissociated from its hydrogen, and (because of the superior affinity of oxygen for carbon at a high temperature) will combine with the carbon, the hydrogen being set free.

The object of introducing superheated steam is twofold.

First. The difficulty of combining oxygen and carbon gases increases in proportion to the volume of the accompanying non-combining gas. The volume of oxygen in air, as compared with its nitrogen, is as one to four, whereas in water, as compared with its hydrogen, it is as one to two.

Second. The hydrogen liberated by the decomposition of the steam will be reoxygenated by the introduction of one hundred cubic feet of air at *f*, and as hydrogen burns at any temperature, contact with the cold surface of a boiler will not militate against its proper combustion. The hydrogen will thus constitute a part of the fuel.

I have shown that the first prerequisite—heat—can be created by placing the radiating-surfaces of the side walls, F, in near enough proximity to keep up thorough combustion while fresh coal is absorbing heat from the coke fire. The time necessary—the third prerequisite—for the combination of the gases in a place hot enough to produce perfect combustion is found in the prolongation of the furnace, such prolongation giving area, and the greater the area the more time will be required to fill it by a given flow of gas.

Assuming a definite pressure of air in the supply-pipe M, (from the blower,) and knowing the amount that will pass through a definite opening at that pressure, and knowing the amount of air we want introduced at any particular point during any definite time, the valve L enables these requirements to be met.

When a definite amount of fuel is thrown into the fire, the volatile matter will immediately commence to escape. It will be evolved in a constantly-increasing volume until the maximum is attained, and then in a constantly-decreasing volume until coke only remains. Knowing the proportions of fixed carbon and the volatile matter contained in the coal, the time occupied in its escape, and the amount of air necessary for each, a definite opening will be made to conduct half of the amount required for the consumption of the fixed carbon under the grate to be met, as before described, by the other half above the fire, both being constant quantities; but the varying evolution of volatile matter above the grate will require a varying supply of oxygen to conform to it. This requirement is met by the valve L, or the valve and cock L and J, as before described, which will move simultaneously to conform in time to that occupied by the evolution of the volatile matter.

I am aware that the decomposition of superheated steam in the presence of carbon at a high temperature is not new; but I believe it to be new to decompose superheated steam in the presence of carbon and carbonic oxide, reducing both to carbonic acid, as is also the subsequent combustion of the liberated hydrogen at a more advanced position in the furnace by reoxygenating it through the agency of heated air in jets.

I am also aware that the supplying of oxygen to a furnace by means of a blower is old; but I believe it to be new to apportion the supply of oxygen below and above the grates in such a manner as to produce distinctly carbonic oxide, to be afterward converted into carbonic acid, but more especially the supply of oxygen to the varying requirements of the volatile matter escaping from the fuel newly added to the fire.

What I claim as new and of my invention is—

1. A furnace with the sides F in near proximity, as set forth, and supplied with two independent series of heating flues or pipes, f^2, in the body of the walls, or placed at the inner sides of the same, and having two separate series of jet-orifices, one for steam and the other for air, jet-holes extending from said flues or pipes to the fire-chamber.

2. The combination, in a furnace, of two independent series of jet-orifices, *f* and *f′*, the latter for steam, above but in close proximity to the fire, the other for air, at a greater distance from the fire, each regulated by means of valve or cock, so as to introduce water or air in definite quantities, as and for the purposes set forth.

3. The combination, with a furnace having heating flues or pipes *d* and f^2, of an apparatus for feeding water into such flues or pipes in the required quantity.

4. In combination with the tubes d and flues or pipes f^2, arranged within the walls F, and the walls F of a furnace, the inverted siphon K, having a downward bend, k', and an upward extension, k^2, for the purposes set forth.

5. The water-cock J, having circumferentially-elongated opening in the plug and case, when in combination with the tube d and flues or pipes f^2, arranged within the walls F of a furnace, for the purpose set forth.

6. The combination, with the tube d and heating flues or pipes f^2 in or within the sides of the furnace, of the partially-automatic valve L, constructed and operated substantially as and for the purpose set forth.

7. The combination of the two separate series of flues or pipes and their proper jets with the water-cock J and an air-valve, L, connected together to move simultaneously, for the purpose set forth.

8. The combination, with a furnace having heating flues or pipes, of a water-cock and air-valve connected, and mechanism, substantially as shown and described, to gradually open and then gradually close, substantially as and for the purpose set forth.

9. A furnace narrow in width and extended in the direction of the current of the products of combustion, having the sides provided with heating flues or pipes, and two series of jet-openings for air and steam, respectively, extending from the flues or pipes into the fire-chamber.

10. The combination, in a furnace, of heating flues or pipes f^2, jets f and f', inverted siphon K, cock J, tank G, compound air-pipe M, and valve L, connected with the cock J, and with mechanism to operate the valve and cock.

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