

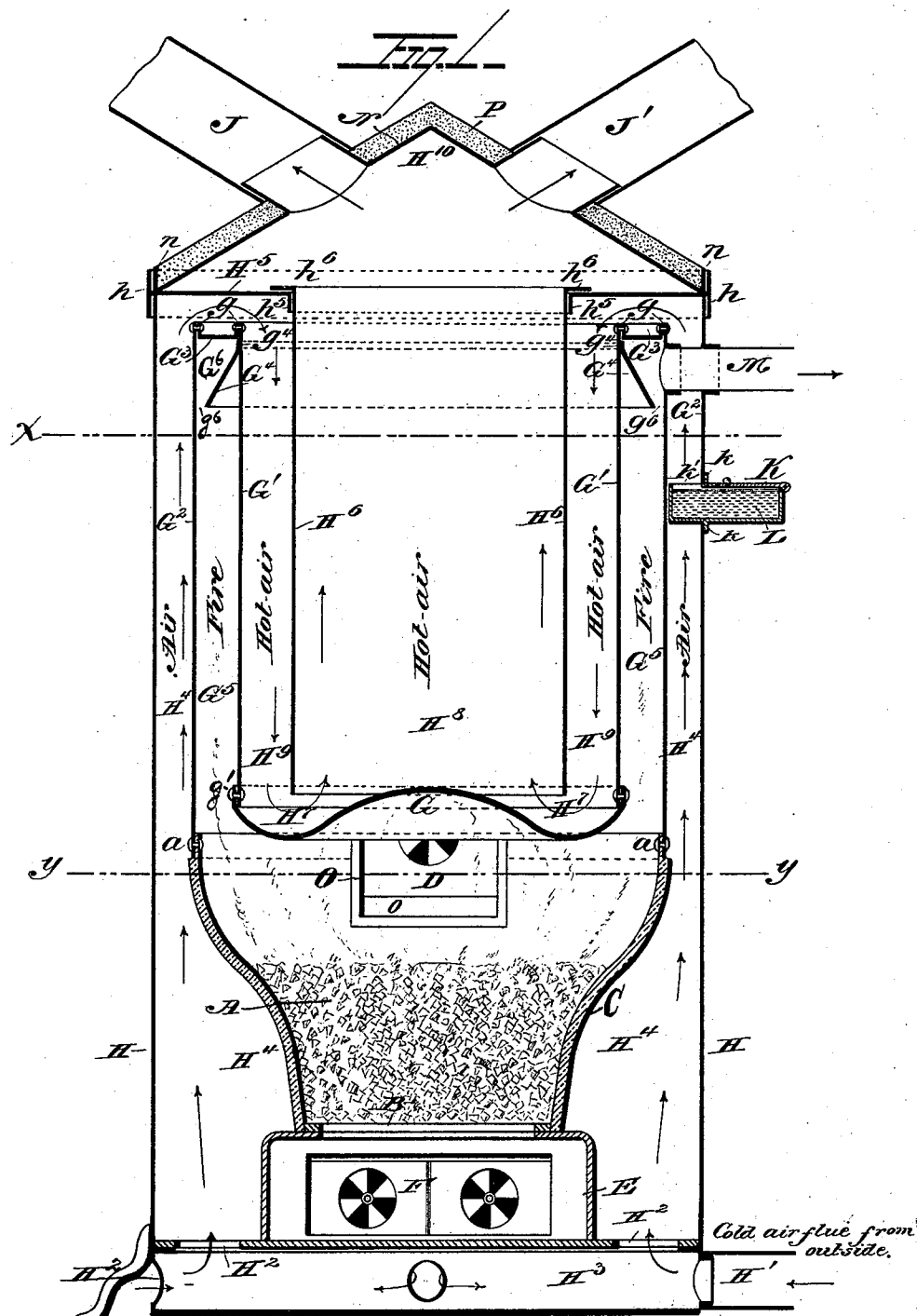
(No Model.)

3 Sheets—Sheet 1.

A. WILLIAMS.
HOT AIR FURNACE.

No. 400,886.

Patented Apr. 2, 1889.



WITNESSES:

No. 1022
Joshua Pusy

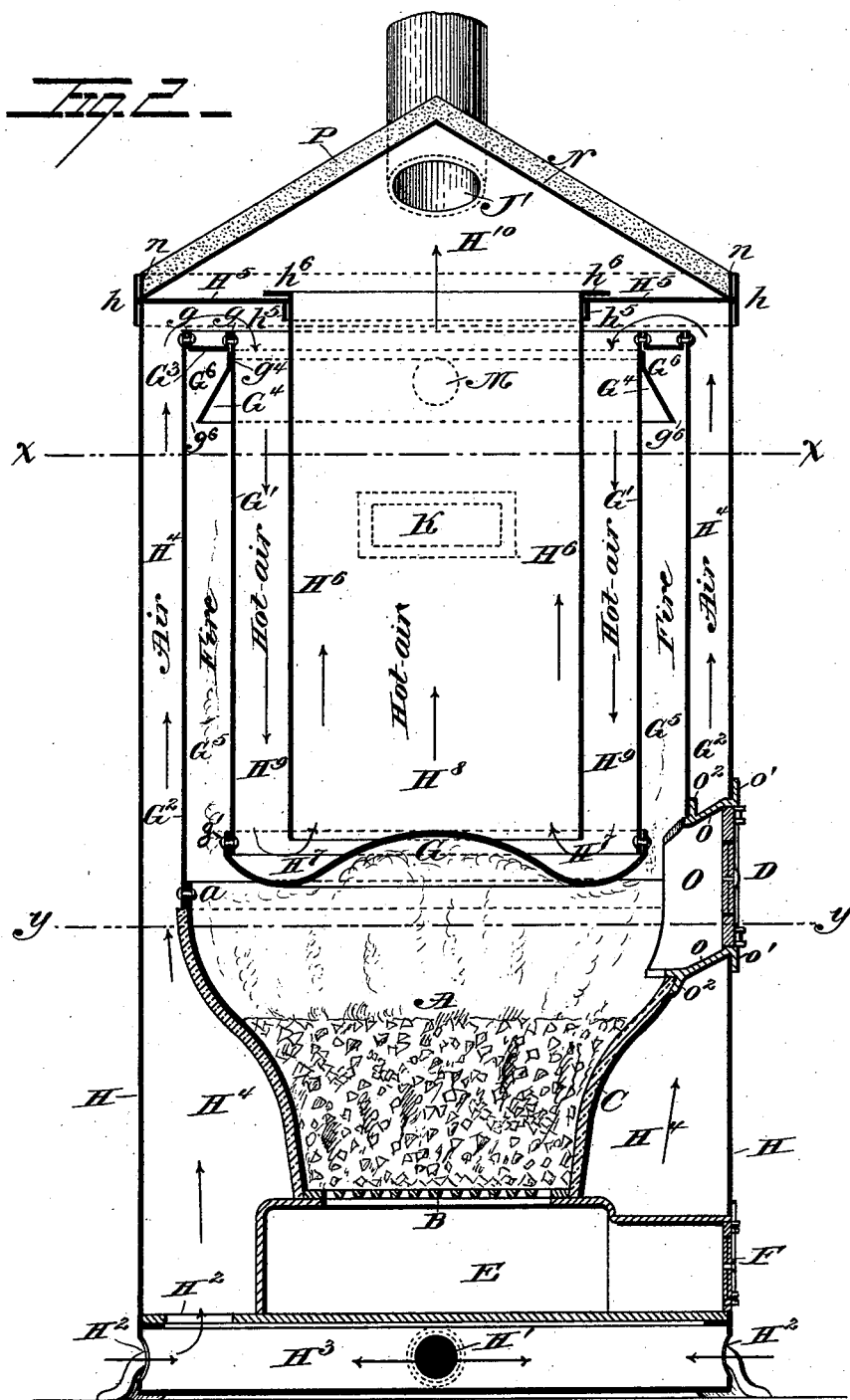
INVENTOR

Alfred Williams
by his attorney Isaac W. Hyman.

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WITNESSES:

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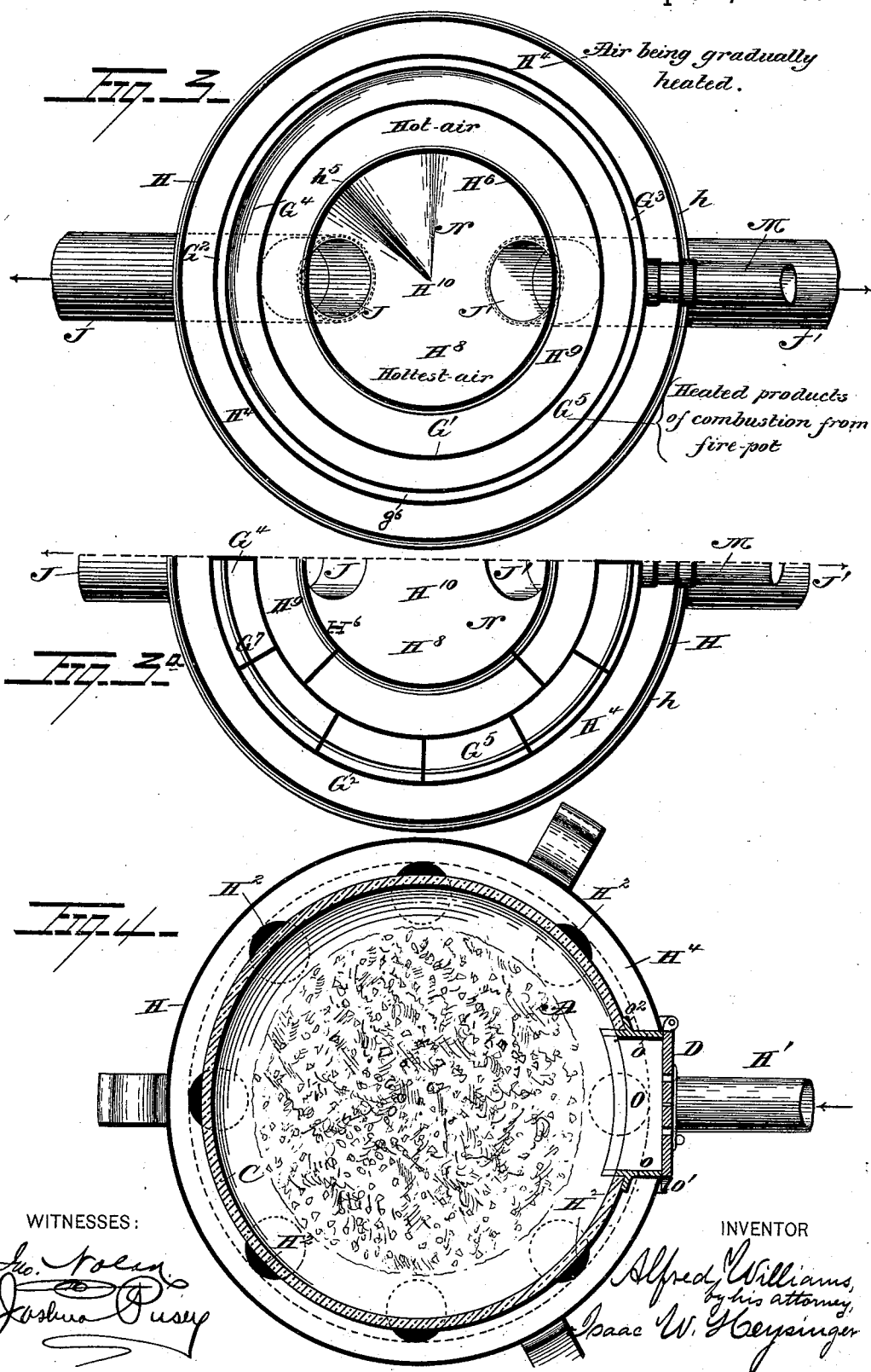
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3 Sheets—Sheet 3.

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UNITED STATES PATENT OFFICE.

ALFRED WILLIAMS, OF PHILADELPHIA, PENNSYLVANIA.

HOT-AIR FURNACE.

SPECIFICATION forming part of Letters Patent No. 400,886, dated April 2, 1889.

Application filed April 12, 1888. Serial No. 270,476. (No model.)

To all whom it may concern:

Be it known that I, ALFRED WILLIAMS, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have made a new and useful Improvement in Hot-Air Furnaces for Heating Dwelling-Houses and the Like, of which the following is a full, clear, and exact description, reference being had to the drawings which accompany and form a part of this specification, in which—

Figure 1 is a vertical section through the middle of a furnace embodying my invention, showing the smoke-flue carried off to the side and the door for supplying the furnace with coal in front, and in which the cold-air flue is shown underneath as brought in from outside. Fig. 2 is a vertical section of the same furnace, taken upon a line at right angles to that of Fig. 1, and in which no external cold-air flue or duct is employed. Fig. 3 is a transverse section of Fig. 1 or Fig. 2 upon the dotted line *xx*. Fig. 3^a is a similar view, only one-half being shown, in which the internal vertical passages are divided to form a series of vertical compartments or channels; and Fig. 4 is a transverse section through the dotted line *yy*, Figs. 1 and 2.

The lettering in all the figures is uniform.

My invention relates to the construction of hot-air furnaces, such as are used for supplying heated air to dwelling-houses, churches, halls, stores, factories, &c., in which greater simplicity and cheapness of construction and increased efficiency are secured, and in which the loss of heat from radiation from the furnace into the surrounding space is greatly diminished, and also in which the soot, dust, dirt, &c., which are liable to clog the passages of ordinary furnaces, are made to drop automatically into the fire-pot instead of by their deposit upon heated surfaces interfering with the heating of air in contact therewith and preventing free exit of the products of combustion, and in other improvements, which will be more particularly described hereinafter.

Referring now to the drawings, C is the fire-pot of a furnace lined with fire-brick and having the upper portion of the fire-pot made integral with the lower part, as shown, or separate, as in some furnaces in general use.

The grate B is of the ordinary form, as is

the ash-pit E and drawer F, with regulating apertures, as shown in Fig. 2.

From the periphery of the upper rim of the fire-pot C rises a vertical wall, G², forming a circular chamber, and which extends several feet above the fire-pot, as shown. This wall G², I prefer to make of sheet metal, attached to the rim of the fire-pot C by rivets (shown at *a*) or otherwise.

A cover, G³, extends inward at the top of the sheet-metal wall G², and from the inner margin of this cover G³ extends downward a wall, G', parallel with G², and forming with it an annular chamber, G⁵, closed above by the cover G³ and communicating below with the fire-space A of the fire-pot C. The cover G³ is attached to the vertical walls G' G² above by the rivets *g g* or a flanged seam; or the whole annular chamber may be cast in a single construction, if desired.

Attached to the lower margin of the inner vertical wall, G', is the crown-sheet of the furnace G, which is secured to G' by rivets *g'*, as shown, or otherwise. This crown-sheet G extends entirely over the fire-space A of the fire-pot C, so that the products of combustion and the radiated heat of the fire A impinge directly against its under side, and are thence deflected around the margins of the said crown-sheet G, and ascend through the annular space G⁵ between the vertical walls G' and G², escaping, as will be hereinafter described, at the upper part thereof.

The crown-sheet G, which is solid and imperforate across its entire exposed surface, I prefer to make convex upward in its middle and annularly convex downward at its margin, as shown, to increase the heating space and surface and retain the heated products of combustion, as well as facilitate the passage of the currents of air, as will be hereinafter described.

A door, D, and chute or passage O are provided in the side of the fire-pot C above the coal-space A to allow new supplies of fuel to be fed to the fire, and this passage O is inclined downward, as shown, so that the coal when shoveled into the furnace will not strike the lower outer surface of the annular chamber G⁵, but will clear its lower margin, as shown in Fig. 2.

The annular chamber G⁵ is provided at its

upper part with a smoke-flue, M. (Shown in dotted outline in Fig. 2 and in section in Fig. 1.) Through this smoke-flue the products of combustion escape and are conveyed to the chimney or smoke-stack of the building in which the heating-furnace is located. This smoke-flue M may be provided with a damper, if desired.

It is obvious that the products of combustion rising through the annular chamber G⁵, having an exit only on one side and at its upper part, would be warped around, so that the opposite side of said annular chamber would be comparatively cool, and the products of combustion would rapidly escape in a twisted current converging to and passing through the said smoke-flue M, and that escaping in a highly-heated condition much of the available heat of the furnace would be wasted. To avoid this, beneath the level of the said smoke-flue M, I provide an annular shelf, G⁴, which is attached by rivets g⁴, or otherwise, to the inner vertical wall, G', of the annular chamber G⁵ and projects nearly across the said annular chamber, leaving a narrow crevice, g⁶, between the free margin of said shelf G⁴ and said outer wall, G², of said annular chamber G⁵. While the area of this space g⁶ is quite small for any limited segment of said vertical chamber, the aggregate for the whole circumference is equal to or greater than the area of the smoke-flue opening. In consequence the products of combustion deflected around the edges of the crown-sheet G and ascending through the vertical annular chamber G⁵ will be arrested in their upward current by the shelf G⁴ and retarded and distributed so as to flow equally through the crevice g⁶ into the space G⁶ above the same. This space G⁶ forms an annular passage around the top of the annular chamber G⁵, and the products of combustion, having passed into this passage through the crevice g⁶, are rapidly carried around to the smoke-flue and escape with a vigorous draft unimpeded by conflicting or intermingling currents. To prevent the lodgment of dirt, soot, ashes, &c., upon the upper surface of this shelf, and also to more effectually produce an eddy in and retard the upward flow of the products of combustion, I give this shelf a sharp downward slope from within outwardly, as shown in Figs. 1 and 2, and by this construction the flow is not only made more equal and slower, but the device is self-cleaning, so that any ashes or dirt will of itself roll down over the sloping surface and through the crevice g⁶ and fall back into the fire-space A of the fire-pot C. In case any soot should adhere a tap inside from the door D against the inner walls of the annular chamber G⁵ will jar it loose and cause it to drop. The walls of the annular chamber, including the shelf G⁴, I prefer to make of sheet iron or steel; but the crown-sheet should be made of cast metal or of heavy wrought or forged metal struck into shape while heated, as it is intended to resist heavy firing and to supply

the greatest increment of heat to the currents of air forced over its upper surface, as will be now described. All the joints should be made air-tight, either by riveting or by forcing the sheet-metal tubes over their seats upon the cast or wrought metal parts, as is done with boiler-tubes, or sometimes in drums for heating-furnaces. What is required is a tight joint which will not open under the expansion produced by the heat of the furnace or the cooling of the same, and such joint may be produced by any of the processes of manufacture in ordinary use.

It will be seen that we now have a furnace provided with a fire-pot, &c., and a chamber above the same and a crown-sheet, in which the crown-sheet is brought down directly over the fire-space A and relatively very near to it, so that the products of combustion act against it at their highest temperature, and in which the direct heat of radiation from the incandescent coal is also thrown directly upon it instead of into the rising products of combustion, as in ordinary furnaces having large cylindrical chambers above the fire-pot, and that in this furnace the upward currents of the products of combustion ascend through an annular chamber, heating the opposite walls thereof with a heat decreasing as the currents ascend and as their heat is dissipated into the space around the said annular chamber. What is now required is to bring currents of air to be heated into contact with these surfaces in such manner that the cooler currents shall receive heat from the cooler parts of this furnace, and that as the currents of air advance they will constantly pass over hotter and hotter parts of the heating-furnace, and finally be distributed for use. If these currents of air follow this course without admixture with fresh supplies, and if they pass steadily along in a constantly-flowing stream, growing hotter and hotter as they advance, the said currents of heated air will move forward with a high velocity, and the amount of heat received from the furnace will be greater in the same proportion, or, conversely, the fuel required to heat this air will be less. Interfering currents of air, composed of hot currents commingled with cooler ones, retard the flow, and by an amount of heat derived from an average between such currents permit the heat of the furnace to escape at a relatively high temperature.

In my furnace, as shown, the least heat of the furnace just before its exit comes in contact with the coolest currents of air, and the hottest currents of air just before their exit into the building come in contact with the hottest part of the furnace, and so for each intermediate flow of the currents of air growing hotter and products of combustion growing cooler, and also that each part of the furnace proper is jacketed or surrounded with a current of air ready to take up all the heat which such part of the furnace is capable of imparting, and that this current of air,

having received its heat, passes onward to a hotter part to receive more, and so on until its final exit into the building, so that scarcely any of the heat of the furnace is wasted in heating the cellar or basement, but the whole supply, practically, is delivered through the hot-air pipes into the rooms above.

The currents of air to be heated are formed and directed by the following means: Over and above the annular combustion-chamber G^5 , forming the upward annular extension of the fire-pot C, is placed an annular air-casing, which forms an external vertical passage for the ascending cold air, a transverse passage inward over the top of the annular combustion-chamber, and an internal vertical passage for the descending partly-heated air in contact with the inner surface of the annular combustion-chamber G^5 , said internal vertical passage open at its lower margin, so as to leave a free space between said free lower margin and the upper surface of the crown-sheet of the furnace proper, the central space within the walls of said descending vertical passage forming a vertical tube, through which the thoroughly-heated air, after turning around the lower free margin of the descending vertical passage, ascends.

H, Fig. 1, shows the external casing of my heater, which may be of brick, if desired, but which I show as of metal in what is called a "portable" heater. This external casing surrounds the furnace proper, and the door D and passage O extend through the same transversely from the outer air to the fire-pot space A, Fig. 2.

At K, Fig. 1, is shown a water-evaporating tank, which is riveted to this casing at k , passes through the same, and faces flush against the annular combustion-chamber. A cover closes the projecting portion, which being removed water is admitted to the space L. The heat of the annular combustion-chamber evaporates a portion of this water, which vapor ascends through the opening k' and moistens the air. The inner end of K, I prefer to make with a wall of its own, facing against the annular combustion-chamber, as expansion and contraction are allowed for, and the heat of evaporation is not so great as if the water rested against the combustion-chamber itself. The smoke-flue M also passes through the external casing, H, as shown in Fig. 1. The walls of H are made air-tight, except at the bottom, where air-supply openings H^2 H^2 are shown, deriving their supply of air in Fig. 1 from an external feeder, H^1 , and in Fig. 2 from the basement or other place in which the heater may be located. These inlets may be controlled by check-valves, if desired. The ash-pan of the furnace proper, E, projects through the space H^4 and the casing H, just over these inlets H^2 H^2 , which may be few or many in number, as desired. The vertical casing or wall H, inclosing the furnace proper, leaves an air-space, H^4 , between the external walls of the

furnace proper and the internal wall of the casing H. At its lower part this air-space H^4 is enlarged by reason of the contraction of the fire-pot C beneath; but in its upper portion it is parallel with the external wall of the annular combustion-chamber G^5 , so that a volume of air passing up through the inlets H^2 H^2 will first travel slowly, absorbing the heat of the fire-pot C, and then, as the passage H^4 is narrowed above, will ascend more rapidly, taking additional heat from the closer contact which it makes with the annular combustion-chamber G^5 , along the external wall of which, G^2 , it ascends. The external casing, H, after extending a suitable distance above the annular combustion-chamber G^5 to give free passage across the top of the same, extends horizontally inward over the top of said annular chamber G^5 , having laterally-closed sides, so as to form a continuous passage out of contact with the distribution-chamber H^{10} above, as shown at H^5 , Figs. 1 and 2; or, if the casing H be of brick this horizontal extension is built into the brick wall, so as to extend across the top of the annular combustion-chamber and within the inner margin of the same, as shown. This inwardly-projecting part H^5 of the casing H extend inward beyond the inner line of the chamber G^5 , and is then continued downward by an inner casing, H^6 , forming an air-tight closed joint at h^6 , Figs. 1 and 2, ending below, so as to leave a free space, H^7 , between the free margin of H^6 and the top surface of G^5 , and producing a passage between the casing H^6 and the inner wall, G^7 , of the annular combustion-chamber. The space H^7 forms a communication between the downward hot-air passage H^9 and the central upward hot-air passage, H^8 , at the lower margins thereof. This inner casing, H^6 , forming a circle in section, (see Fig. 3,) when in place is a cylinder open below, so that a free passage is had within said cylinder for the ascending current of heated air. The walls H H^5 H^6 surround the furnace proper and the annular combustion-chamber G^5 and form an annular casing, which serves to hold the currents of air in contact and thoroughly heat them against the heated parts of the furnace proper, and also prevents admixture of more heated with less heated portions of the atmospheric current, and guides them forward toward the central and hottest part of the furnace. While I show this casing provided with angles at the lines of junction of the vertical with the horizontal parts, if preferred, I make them with rounded corners or give them any curvature desired.

Resting upon the outer casing, H, I show the conical cover N, which extends over the whole heater. If built of brick, this cover may also be of brick and may be flat or arched. Into the under side of this conical cover N opens the central passage, H^8 , and from the upper side lead the heat-pipes J J', which distribute the heat to various parts of the struct-

ure to be heated. When made of metal, as shown, I slip this conical cover, which is made in a single piece, riveted to form a cone, upon the outer casing, H, as is usual in drums of heaters, &c. These flanges are shown at *h h*, Figs. 1 and 2. I also provide, if necessary, a marginal flange or lip, *n*, around the circumference of the conical top or cover, and I fit over the whole cone a protecting cover or jacket of non-combustible felt or plastic composition, such as is used for covering steam-boilers, &c., and preventing escape of heat. This non-conducting covering P rests against the lip *n*, and is pierced for the pipes J and J', and may be extended along the same, if preferred.

An examination of Figs. 1 and 2 will now show the operation of my heater. The furnace being properly heated, the radiated heat will play against the crown-sheet G, and it will become intensely heated, the products of combustion assisting and then being turned around the free margin of the crown-sheet and ascending through the vertical annular combustion-chamber G⁵, the ascending current will be checked by the shelf G⁴ passing through the crevice *g*⁶, and equalized all around the annular crevice by its narrowness. The products of combustion enter the annular passage G⁶ and are rapidly drawn around the same to the smoke-flue M, through which they escape to the chimney, the soot and ashes falling back from the sloping shelf G⁴ into the fire-space A. At the same time the air entering the annular casing through the inlets H² H³, comes in contact with the external body of the fire-pot C, and as the space is considerable the cold air becomes gradually warmed, ascending slowly. As it reaches the narrower part of the passage H⁴ alongside the highly-heated wall G², it ascends rapidly, drawing heat from the wall G² as it ascends. Reaching the top of the annular combustion-chamber G⁵, the current of air turns inward, still in contact with the top plate, G³, of the annular combustion-chamber, G⁵, below and only separated by the plate H⁵ from the heated space H¹⁰ above, the currents being henceforth surrounded with opposite currents of highly-heated gases. Turning downward within the annular combustion-chamber G⁵, and between its highly heated inner wall, G⁴, and the inner casing, H⁶, which only separates it from the still hotter air-space H⁸, the descending current H⁹ is thrown directly downward upon the upper surface of the crown-sheet G, which is the hottest part of the furnace. Owing to the curvature of this crown-sheet G, the current follows it, as shown by the arrow, until it turns around the lower free margin of H⁶ and ascends through the inner casing, H⁸, to be distributed above. The currents thus not only grow hotter as they approach the central axis of the furnace, but are concentrated by constantly occupying more and more contracted cylinders, until finally the whole volume is thrown upward through the

central cylinder in its condition of highest temperature. While at first glance the downward current H⁹ might seem to retard the general delivery, yet this is only apparent, as the heights of the inlets of the cold air and of the exit of hot air control the air-pressure and forward movement of the inclosed currents, the gradually-increased heat of the current as it advances assisting greatly in giving force and vigor, as well as volume, to the output of heated air. In other words, the pull of the ascending very hot current H⁸, re-enforced by the push of the ascending warm current H⁴, supplemented by the weight of the cold atmosphere without, much more than merely neutralize the downward flow of the current in the passage H⁹, and the hot air is poured forth above with a volume and high temperature not otherwise easily secured. It will be observed that the currents are all direct and unmixed, and that no averages made by cold air mingled with hot are produced, but that each unit of heat is taken up and constantly planted one step forward as the current advances, holding its own and receiving new units of heat for every stage of progress, and that every degree of heat communicated from the hottest air, H⁸, to the less heated downward current H⁹ through the inner casing, H⁶, is immediately carried around the free lower edge of H⁶ and itself becomes the ascending current, receiving new heat from the crown-sheet G as it advances, and so on for the other passages of the currents through the heater, and also that the products of combustion rising through the vertical annular combustion-chamber G⁵ are cooled outside by the ascending current of nearly-cold air H⁴ and the descending current H⁹, cooler at its upper part, and the temperature of the narrow annular chamber G⁵, surrounded with currents of cooler air, rapidly sweeping over its surfaces, cools toward its upper part, and the products of combustion pass off at a comparatively low temperature, the hottest part of the furnace being reserved to act upon the current of air gradually growing hotter just before its final delivery and utilization, and that the same heat which acted upon the crown-sheet G in its highest temperature afterward passes up the annular chamber G⁵ to act upon the cooler currents of air as they advance from the outer to the inner and hotter parts of the heater.

Various modifications will suggest themselves to an intelligent mechanic without departing from the principles of my invention, as herein shown.

In Fig. 3^a I show the vertical annular combustion-chamber G⁵, divided by a series of vertical partitions, G⁷, to assist in preventing deflection of the ascending currents of the products of combustion, and I also show vertical partitions between the inner wall of the annular combustion-chamber G⁵ and the inner casing, H⁶, so as to divide the passage H⁹ into a series of vertical channels; but I pre-

fer to use the simpler construction shown in the other figures.

Sometimes I apply my invention to a stove which is used for heating a room in a dwelling, for instance, and the surplus heat is used to heat rooms above. In this case I dispense with my outer casing, H, leaving the fire-pot and the outer wall of the annular chamber G⁵ to heat the room which the stove occupies, and use only an inner casing, H⁶, as shown, with its passage H⁹ downward between H⁶ and G'. I carry this casing H⁶ upward above the level of the top of the furnace to supply a central column of heated air through the central passage, H⁸, and draw my air to be heated from the atmosphere of the room over the top of the annular chamber G⁵, the currents passing downward through the passage H⁹, radially inward through the space H⁷, over the crown-sheet G, and vertically upward through the central passage, H⁸. In such case, if desired, I rest the casing, by studs, upon the crown-sheet G or suspend it by brackets from the top of G⁵; or I distribute this extra heat, if desired, through the central passage, H⁸, extended above the level of the top of the annular chamber G⁵, into the room occupied by the stove itself, greatly adding to the heat produced thereby.

Having now described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a heating-furnace provided with fire-pot and contained fire-space and an annular combustion-chamber communicating with said fire-space and rising above the crown-sheet G, the smoke-flue M, leading from the upper part of said annular combustion-chamber at one side thereof, and the shelf G⁴, surrounding and contained within the said annular chamber beneath the exit of said smoke-flue, there being a crevice, g⁶, extending around the said annular chamber between the free edge of said shelf and the opposite wall and adapted to cause the products of combustion to ascend vertically into the space above said shelf and be thence drawn laterally into said smoke-flue M, substantially as described.

2. In combination with the fire-pot C, fire-space A, crown-sheet G, and annular combustion-chamber G⁵, the smoke-flue M, opening from the upper part of said chamber G⁵ at one side thereof, and the downwardly-sloping shelf G⁴, attached at its upper margin to one of the walls of said annular combustion-chamber beneath said smoke-flue and extending around within the same, there being the crevice g⁶ around the free margin of said downwardly-sloped shelf, the whole constructed substantially as and for the purposes described.

3. An air-heating furnace consisting of fire-pot C and its attachments, fire-space A, transverse imperforate crown-sheet G, and annular combustion-chamber G⁵, surrounding and extending above the level of said crown-

sheet, with smoke-flue M leading from one side of said annular combustion-chamber at the upper part thereof, in combination with an annular air-casing surrounding said furnace, having air-inlets beneath said casing closed above, and extended inwardly over said annular combustion-chamber G⁵ and downwardly within the inner walls thereof, forming the annular inward passage H⁷ between the lower free margin of H⁶ and the upper surface of the crown-sheet G, and the central upward air-passage, H⁸, said casing adapted to convey a current of air to be heated upward and inward over the top of said combustion-chamber G⁵, thence downward within the same, and thence inward beneath the free margin of wall H⁶, and finally upward in a central column of highly-heated air, the products of combustion being carried off from the upper part of said combustion-chamber G⁵ at one side thereof, substantially as described.

4. In combination with the furnace A C, imperforate crown-sheet G, attached to the inner wall, G', of annular combustion-chamber G⁵, said combustion-chamber surrounding and rising above the level of said crown-sheet, open beneath into fire-space A, closed above by the wall G³, and having external wall, G², attached to fire-pot C, the smoke-flue M, leading from the upper part of said annular combustion-chamber G⁵ at one side thereof, and an air-guiding casing consisting of external vertical wall, H, surrounding said furnace and provided with air-inlets H² H² beneath, closed transverse top H⁵ attached to the upper part of wall H and extended inwardly over and within the annular combustion-chamber G⁵, inner vertical wall, H⁶, attached to and depending from the inner margin of H⁵ and terminating beneath in a free margin, leaving annular space H⁷ continuously extending around and over said crown-sheet G, and central vertical air-passage, H⁸, the whole constructed to operate substantially as and for the purposes herein shown and described.

5. In combination with the air-distributing chamber H¹⁰ above the level of a heating-furnace, and provided with one or more hot-air exits, J J', the upward central air-passage, H⁸, opening centrally into H¹⁰, annular downward air-passage H⁹, leading at its lower part, H⁷, into H⁸, transverse passage inward over annular combustion-chamber G⁵ and beneath plate H⁵ into the upper part of passage H⁹, annular upward air-passage H⁴, external to furnace A C G⁵, and leading from inlets H² H² beneath to passage into H⁹ above, said passages separated from each other by continuous annular walls and leading into each other through continuous annular passages from said inlets H² to said distribution-chamber H¹⁰, substantially as and for the purposes described.

6. In a furnace for heating buildings by hot air conveyed through passages thereof, the furnace proper having ash-pit, fire-pot, en-

trance for fuel, and the fire-space A, and over said fire-space, relatively near the same, the transverse crown-sheet G, formed entire and imperforate, and the annular combustion-chamber G⁵, connecting the outer margin of said crown-sheet with the wall of said fire-pot, and rising above the level of and surrounding said crown-sheet, and having smoke-flue M, leading from the upper part of said annular combustion-chamber G⁵, in combination with said furnace, an annular air-casing consisting of outer wall, H, external to said furnace, extending above the level of said annular casing and pierced by said smoke-flue M, having external air-inlet, H², beneath, and transverse top H⁵, continuing said casing H over and within the vertical inner line of said annular combustion-chamber, and downward inner wall, H⁶, continuing said casing H H⁵ downward within said annular combustion-chamber G⁵, having annular space H⁷ between said wall H⁶ and said combustion-chamber G⁵, and central passage, H⁸, over the center of said crown-sheet G, separated from said fire-space A thereby, and the inward passage H⁷, connecting the lower part of annular air-space H⁷ with lower part of central passage, H⁸, said passage H⁸ forming a central air-passage upward, together with one or more air-distributing pipes, J, above the level of the said furnace, substantially as described.

7. In combination with a stove or furnace having transverse crown-sheet over and relatively near the fire-space A, said crown-sheet formed entire without opening or perforation therein, and an annular combustion-chamber surrounding said crown-sheet above the level of the same and attached by its inner wall to the periphery thereof and by its outer wall to the upper part of the fire-pot C, closed above at G³ and having smoke-flue M leading from said annular combustion-chamber G⁵, the annular wall H⁶, extending downward within the inner walls of said annular combustion-chamber, having vertical downward passage H⁹ between said wall H⁶ and said chamber G⁵, and an air-inlet external to its upper part over said combustion-chamber, said wall H⁶ extending downward near to and above said crown-sheet G and leaving annular passage H⁷, together with the central upward air-passage, H⁸, receiving a current of air through the said passage H⁷ from said downward passage H⁹, the whole constructed to operate substantially as described.

8. The combination of stove or furnace A C D E, solid imperforate crown-sheet G, annular combustion-chamber G⁵, surrounding said crown-sheet and extending above the level of the same, smoke-flue M, leading from said annular combustion-chamber, with the annular wall H⁶, extending downward within the inner wall, G', of said combustion-chamber and forming an annular downward passage, H⁹, open above externally and terminating beneath in a free margin, leaving annular space H⁷ between the upper surface of

said crown-sheet G and said free margin, said space H⁷ continuous around and within the periphery of said crown-sheet, and internal ascending passage, H⁸, connected therewith and extending above the upper surface of said furnace, substantially as described.

9. In combination with a heating-furnace having ash-pit, fire-pot, and a fire-space, A, and above and relatively near said fire-space, a transverse crown-sheet, G, attached by its periphery to the inner wall, G', of the annular combustion-chamber G⁵, the outer wall, G², supported by said fire-pot, said combustion-chamber closed above by transverse wall G³, and having smoke-flue M leading therefrom, and beneath said smoke-flue the annular shelf G⁴, extended around within said chamber G⁵, there being a crevice, g⁶, the air-casing surrounding said furnace and consisting of external annular wall, H, having inlets H², inturned top H⁵, forming transverse passage over and within the inner wall, G', of annular combustion-chamber G⁵, downwardly-turned inner wall, H⁶, forming downward passage H⁹, there being an inward passage, H⁷, between the lower margin of H⁶ and the upper surface of G, and ascending cylindrical passage H⁸ within the wall H⁶ and connected with passage H⁹ through space H⁷, chamber H¹⁰ above and connected with H⁸, cover N, and one or more hot-air-distributing pipes, J J', substantially as and for the purposes herein set forth.

10. In a portable metallic hot-air furnace for heating buildings, the furnace proper, having fire-space A, crown-sheet G, relatively near said fire-space and attached to inner wall of combustion-chamber, annular combustion-chamber G⁵, and air-casing consisting of outer wall, H, inturned top H⁵, connected therewith, and inner wall, H⁶, depending therefrom, having ascending cold-air passage H⁴ surrounding the outer wall of said furnace, having inlets H² beneath, transverse air-passage inward over the top of annular combustion-chamber G⁵, downward air-passage H⁹, inward passage H⁷, ascending central passage, H⁸, chamber H¹⁰ above the same, distributing-pipes J J', and metallic cover N, together with the supplemental non-conducting cover P, adapted to prevent escape of heat from said chamber H¹⁰ before distribution thereof, substantially as described.

11. In a hot-air furnace, in combination with a fire-space, A, and annular combustion-chamber G⁵, and an imperforate crown-sheet, G, within said annular chamber G⁵, closing the space within the inner walls, G', thereof and relatively near the fire-space A, the double annular casing H H⁶, there being transverse passages beneath H⁵ and H⁶, forming continuous annular passages H⁴ upward, transverse passage beneath H⁵ inward, H⁹ downward, H⁷ inward, and central cylindrical upward passage, H⁸, said passages continuous and adapted to convey currents of air in contact with more and more highly-heated parts of said furnace from fire-pot C to center of

crown-sheet G as said currents of air advance along the surfaces of said furnace, together with smoke-flue M, leading from the upper part of said annular combustion-chamber G⁵ and receiving the products of combustion at the lowest temperature from contact with the coolest currents of air in their ascent through passage H⁴, substantially as described.

12. In a hot-air furnace, an annular combustion-chamber, G⁵, supported by its outer wall, G², upon the margins of fire-pot C, having annular top G³, attached hermetically to outer wall, G², and to inner wall, G', imperforate crown-sheet G, attached hermetically to lower margin of said inner wall, G', and supported thereby, in combination with a double annular air-casing consisting of vertical outer wall, H, provided with air-inlets H² beneath, having annular top H⁵, hermetically attached to and supported by said wall H and hermetically attached to and supporting inner annular wall, H⁶, said wall H⁶ terminating in a free margin near to and above said crown-sheet G, leaving space H⁷ and internal upward passage, H⁸, the said furnace and said air-casing independent of each other and each self-supporting, substantially as described.

13. In a stove or furnace, the fire-pot C, annular combustion-chamber G⁵, solid imperforate crown-sheet G, attached to inner wall of the combustion-chamber, internal annular casing, H⁶, downward annular passage H⁹ be-

tween said casing H⁶ and the inner wall of said chamber G⁵, open above to receive the currents of air to be heated, there being a continuous annular passage, H⁷, connected externally with the lower part of downward air-passage H⁹ and internally with the lower part of upward central air-passage, H⁸, together with smoke-flue M, leading from said annular combustion-chamber G⁵, substantially as and for the purposes set forth.

14. In combination with the fire-pot C, fire-space A, annular combustion-chamber G⁵, smoke-flue M, leading therefrom, outer air-casing, H, inwardly-extended transverse top H⁵, having joint h, and downwardly-extended inner wall, H⁶, having joint h⁶, there being a space, H⁷, beneath wall H⁶, connecting the downward passage H⁹ and upward central passage, H⁸, the solid imperforate crown-sheet G, extended over and relatively near the fire-space A, hermetically attached to the lower margin of inner wall, G', of annular combustion-chamber G⁵, said crown-sheet having an upward convexity in the center thereof beneath said central passage, H⁸, and an annular concavity in its upper surface beneath the free margin of said annular wall H⁶, substantially as described.

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Witnesses:

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