M. J. & H. B. FARQUHAR.

HOT AIR FURNACE.

APPLICATION FILED MAR. 15, 1902. RENEWED APR. 20, 1909.

923,347. Patented June 1, 1909.

Fig. 1.

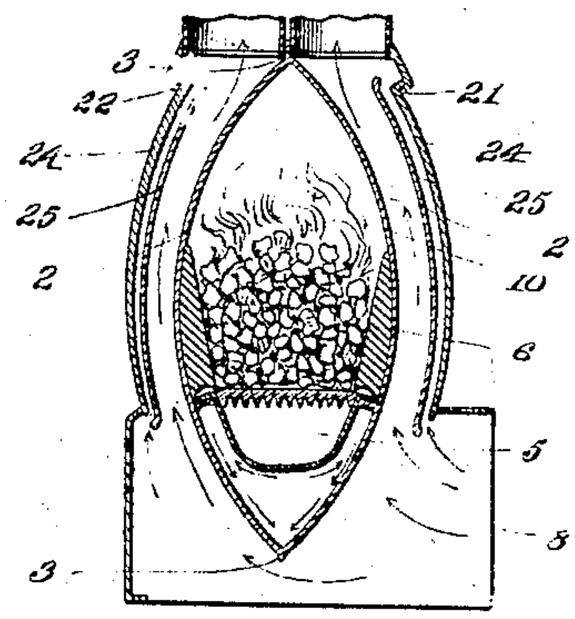


Fig. 4.

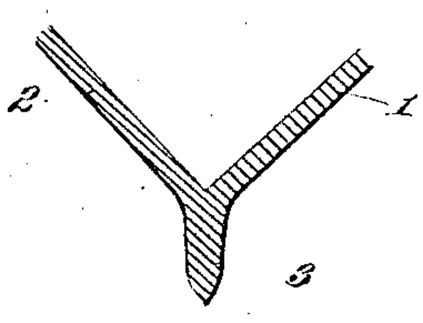


Fig. 2.

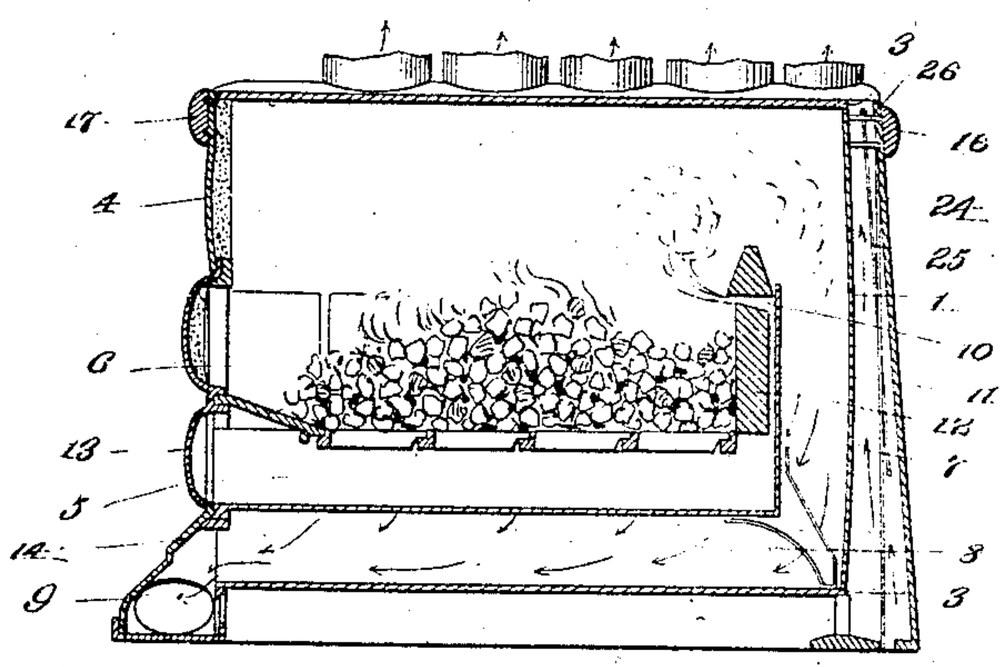
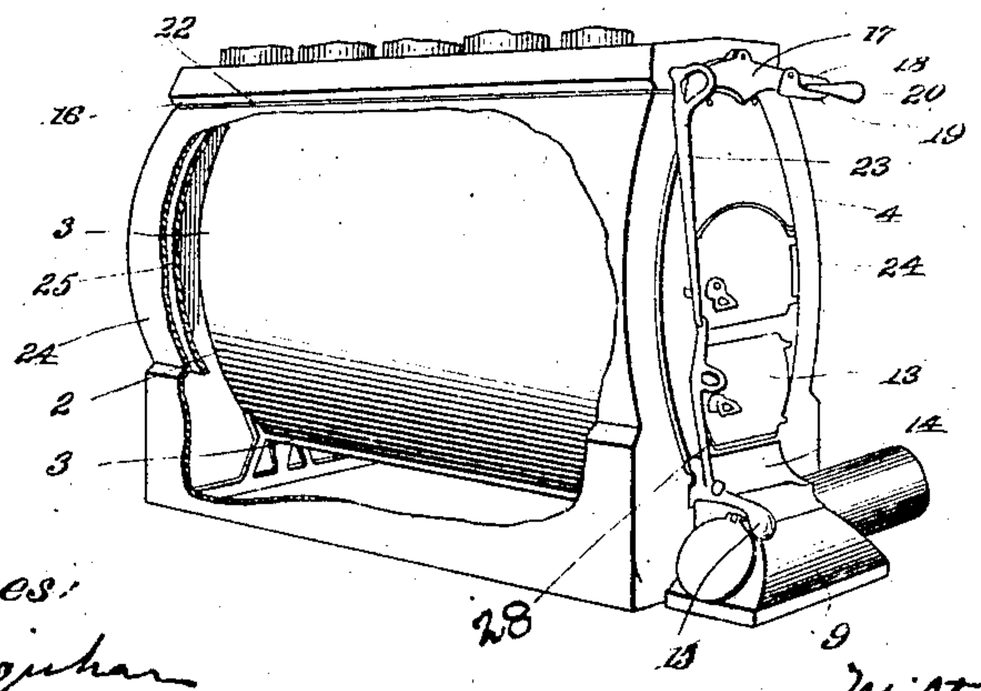


Fig. 3.



Witnesses:

Francis Farquhar

Jesse Bull

Inventors

Milton J. Farquhar

Henry B. Farquhar

UNITED STATES PATENT OFFICE.

MILTON J. FARQUHAR AND HENRY B. FARQUHAR, OF WILMINGTON, OHIO, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO THE FARQUHAR FURNACE COMPANY, OF WILMINGTON, OHIO, A CORPORATION OF OHIO.

HOT-AIR FURNACE.

No. 923,347. Specification of Letters Patent. Patented June 1, 1909.

Application filed March 15, 1902, Serial No. 98,445. Renewed April 20, 1909. Serial No. 491,193.

To all whom it may concern:

Be it known that we, MILTON J. FARQUHAR and HENRY B. FARQUHAR, citizens of the United States, residing at Wilmington, in the county of Clinton and State of Ohio, have invented certain new and useful Improvements in Hot-Air Furnaces, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which the invention appertains to make and use the same.

Our invention relates to heating furnaces having a fire-box within an air-box or casing for the heating medium.

The principal objects of the invention are: (1) to generate a maximum amount of heat from the fuel and effectively transfer practically all available heat to the circulating air currents for distribution to the rooms; (2) to maintain an economical and lasting fire, and a limited fire, producing heat ample in volume but so moderate in intensity as to prevent clinker and avoid red hot metal or scorched air; (3) to effect equable distribution of heat to the walls of the fire-box, avoiding the usual high concentration of heat at the dome and eliminating ineffectual surfaces and dead-air blankets which are commonly the source of much waste, deterioration and scorching of air and wreckage of the furnace; (4) to obtain absolute and permanent security against the menace of poisoned air by leakage of gases through the walls of the fire-box, and incidentally against escape of smoke that damages the decorations and furnishings of a home; and also to prevent interference with the control and economy of the fire by leakage of air into the fire-box.

With the foregoing and other objects in view, the invention will hereinafter be first fully described by reference to the accompanying drawings, which form a part of this specification, and then more particularly pointed out in the appended claims.

In said drawings: Figure 1 is a vertical transverse section of a hot-air furnace embodying our invention. Fig. 2 is a vertical longitudinal section of the same. Fig. 3 is a front perspective view of the furnace, with a portion of the outer casing or air-box broken away and showing the interior fire-box. Fig. 4 is a detail cross-section of one of the longitudinal welds of the fire-box.

As shown in the drawings, the furnace has a tubular fire-box which consists preferably of a seamless and jointless metal shell, approximately oval in cross-section and with peaked top and bottom; the sides of the fire-box consisting of oppositely curved or bowed steel plates 2, meeting at an angle and welded together along the top and bottom ridges, and welded also to a rear head or end plate 1. The meeting edges 3 may be flanged outwardly and welded together substantially as shown in Fig. 4. Said fire-box is arranged horizontally in the enveloping air-box or air-casing 24, and projects through the front thereof and has an exposed front plate 4. All the doors, dampers, draft-openings, joints (including pipe-connection) and regulating or governing devices are placed on said exposed front of the fire-box. These include the fire-door, the ash-door 13, and a check-door or valve 14 of a smoke-box 9 which is constructed on the base of said front plate and is in communication with the smoke-pipe.

Within the air-casing, the fire-box is or may be a continuous integral metal shell, without seam, rivet or joint and without opening, valve, damper or pipe-connection, so that there is absolute security against leakage of poisonous gases to contaminate the air of the dwelling, as well as security against leakage of air into the fire-box to interfere with the control and economy of the fire.

The fire-box contains a longitudinal grate and fire-pit 6, having a back bridge-wall 12, and an ash-pan 5 under the grate, said ash-pan being substantially U-shaped in cross-section. These are arranged to leave a back diving flue 7 and a communicating bottom flue 8, the latter extending to the front smoke-box 9. There is thus provided in the rear and bottom of the fire-box an indirect draft-passage through which the products of combustion pass and have their final outlet at the base of the furnace front, that is into the smoke-box 9 which extends downward and has an outlet-opening to the chimney or smoke-pipe. This outlet-opening is desirably situated below the fire-box, or with its top approximately on a level with the bottom of the fire-box, so as to draw off only the coolest lower stratum of the products of combustion. A further advantage gained by locating the smoke-outlet at the

base of the front end of the bottom smoke-flue 8, outside the air-casing, is the avoidance of a pipe-joint in the bottom of the fire-box which would impair the latter and be liable to rupture and leakage.

Air to support combustion is of course admitted through the ash-door 13 and by way of the ash-pan 5. An air-blast, indicated at 10, is also admitted to the fire-space through a passage 11 in the rear bridge-wall 12. This air-blast meets and actively mixes with the combustible gases where they are gathered in a contracted triangular space in their passage over the bridge-wall, and where the heat is sufficient to ignite the mixture.

The described arrangement combines the advantages of an indirect draft and equable heat-distribution with a furnace having an imperforate fire-shell within the air-casing, that is without a single valve, damper or pipe-joint inside the air-casing, these parts being placed collectively on the exposed front plate as previously mentioned. Prior hot-air furnaces have had at least one or more pipes or flues leading from the fire-box through its enveloping air-casing, and hence liable to spring a leak at the joints and permit escape of poisonous gases into the air, as well as to interfere with the perfect control of the fire. Most of these pipes have been provided with dampers, which have to be operated through the air-casing, and these have been a further source of trouble. All of which objections are obviated by the present construction. In this respect, the efficiency of the fire-box is further increased by its form and by its welded joints, which offer great resistance to rupture and withstand readily the strains of expansion and contraction due to the variations in temperature to which the fire-box is subjected; thus safe-guarding against the menace of gas poison in the air, leakage through the fire-box being wholly impossible, not only on account of its integral formation and the absence of all joints or connections within the air-casing, but also by reason of the shape of the fire-box and its construction from integral bowed side-plates welded together along longitudinal meeting edges and to the rear head or end-plate. The oval shape of the fire-box not only tends to effect an even distribution of heat and consequent uniform expansion and contraction, but it also lends itself more readily than other forms to taking up such expansion and contraction, since the bowed sideplates expand practically uniformly both across and lengthwise, simply shifting or extending the welded joints; this result being facilitated by the meeting of the side plates at angles.

The combustion of the fuel and gas is effected in an extraordinary and thorough manner. The slow combustion principle is used. High temperature in the fuel-bed is avoided. The long narrow shape and relative size and proportions of the fire-box help to make this possible, in connection with the indirect draft passage in the back and bottom of the fire-box leading to a front smoke outlet at a still lower level. The result is that the gas is evolved but slowly from the fuel and the fuel substance is retained, preventing waste. The gas evolved does not pass off unburned, but is mixed with the active air-blast 10 which issues from the rear bridge-wall, where the mixture is ignited as aforesaid. As the hot products of combustion do not pass off directly, but move slowly down behind the fuel-bed and forward under the same, they are thus retarded and maintained in the fire-box as long as possible, giving ample time for parting with their heat. Saving in heat is effected by the position of the smoke-flue 8 in the coolest part of the air-casing, and by the shape of said flue. It will be seen, also, that practically the entire surface of the fire-box is exposed to the hot gases or products of combustion; that is the fire acts on the walls of the fire-box above, behind and under the fuel-bed, while the middle of the fire-box is heated by the fuel-bed itself. Hence the circulating air-currents which enter beneath the fire-box and sweep upward on opposite sides and behind the same take up the heat from practically the entire surface of the fire-box.

The steep narrow arch or peaked shape of the fire-box above the fuel-bed eliminates all surface approximating the horizontal; the oppositely curved side-walls or metal heating plates 2 of the fire-box being more nearly vertical. Hence the flames, instead of acting directly against an approximately horizontal surface, lick against the steep or nearly vertical curved sides and gradually part with their heat as they rise, so that at the top ridge of the fire-box the intensity of the fire is not sufficient to injure the metal or to scorch the air. Concentration of heat at the dome is thus avoided, and the available heat is equably distributed to the walls of the fire-box, whose outer surfaces are thoroughly and rapidly swept by unretarded air-currents, extracting the heat rapidly and effectually, since outside the fire-box the upward course of the air is unobstructed and there is no space within the air-casing where the air can linger and become too highly heated for health and injuriously blanket the metal, as in ordinary furnaces where commonly a layer of dead air lingering above the dome becomes superheated and allows melting or burning of the metal. The air-currents, entering below and passing off above the fire-box, will naturally sweep closely against the steep side heating plates, and this effect is promoted by making the upper portion of the air-casing 24 conform in shape approximately to that of the fire-box, as shown in

Figs. 1 and 3, providing equalized contracted air-spaces with smooth inclosing surfaces, causing the air-currents to ascend the more rapidly, so that an abundant supply of fresh heated air may be constantly supplied to the rooms of the dwelling. Likewise the shape of the bottom flue-space or passage 8 is adapted for spreading the hotter products of combustion against the side-plates 2. The contour of the ash-pan 5, in conjunction with the lower side walls of the fire-box, gives to this passage a substantially V-shaped form, something like the letter "A" inverted. Gravitation causes the coolest products of combustion to settle and the hottest products of combustion to rise and fill the narrow upward extensions of this flue-space, thus crowding the hotter gases against the heating plates 2 which are constantly being swept by a current of the coolest air, extracting and saving the last residue of heat. A slow movement is maintained within this heat extractor, giving the smoke ample time to part with its heat; while against the outer surface of the metal a swift movement of the cold-air absorbs the heat thoroughly. As aforesaid, the outlet to the smoke-pipe is situated so low down that it draws off only the lowest stratum, which contains only the coolest products of combustion left within the fire-box.

Within the air-casing are shown radiating plates 25, also conforming to the shape of the fire-box and having both surfaces swept by the ascending air-currents which absorb from such plates the heat radiated from the fire-box. The conformation of shape makes the two surfaces parallel, so that the heat is radiated from one surface at right angles and absorbed at right angles by the opposite surface. By helping to extract the heat by radiation, these plates 25 increase the heat-saving power.

In connection with the furnace, we have illustrated an improved automatic heat-governor or regulating apparatus, to which, however, no claim *per se* is made herein, since this mechanism forms the subject-matter of a divisional application for automatic furnace regulator, filed by us January 30, 1905, Serial No. 243399. Hence a brief reference will be sufficient. This heat-governor operates upon the ash-door 13 to control the air admitted to the fuel and upon the check-door 14 in the smoke-flue to check the draft when necessary. 23 denotes a suspended lever which rocks on a fulcrum edge on the front cross-bar 17. This lever 23 has a link connection with the suspended lever 28, which has suitable connections with the ash-door and check-valve. The lever 28 is provided with a weight 15 which is utilized to move the lever in a direction to open the ash-door as the temperature of the furnace is lowered. Said lever is moved in the opposite direction, to close the ash-door or restrict the opening thereof and open the check-valve, by the force of expansion of the fire-box when heated against an inclosing frame-work not heated, and which operates on the lever 23. Said frame-work as shown consists of a rear cross-piece 16, having pins or projections 26 that bear against the rear wall of the fire-box to receive its thrust therefrom when expanded by the heat; and longitudinal connecting rods 21 and 22 connected to opposite ends of said rear cross-piece 16. One of the rods 22 is connected to the lever 23 a little below its fulcrum; while the other rod 21 is connected to an adjusting lever 20 attached to said front cross-piece 17 and engaging a locking rack 19, the front cross-piece 17 having a graduated arc 18. When the heat of the fire-box causes it to expand against the rear cross-piece 16, the rod 22 draws the lever 23 inward with sufficient force to overcome the weight 15. A specific explanation of this mechanism is made in the specification of our aforesaid divisional application Serial No. 243399.

We claim as our invention and desire to secure by Letters Patent:

1. A furnace comprising a casing, and a horizontally-disposed tubular fire-box inclosed therein, said fire-box having its front exposed or projecting through the casing and provided with all doors and draft openings, the walls of the fire-box within the casing being closed or imperforate, and a longitudinally-disposed grate, subjacent ash-pan and rear bridge-wall arranged in the fire-box to provide an indirect draft passage for the products of combustion in the rear and bottom of the fire-box, said passage having its outlet at the lower front of the fire-box.

2. A furnace comprising a casing, and a fire-box inclosed therein having an exposed front, said fire-box being wholly closed except at its said front wall and containing a fire-pot with bottom grate and ash-pan thereunder arranged to provide an indirect smoke-passage in the bottom of the fire-box, its said front wall having a fire-door and ash-door thereunder and a smoke-box under said ash-door for connection with a smoke-stack or pipe, said smoke-passage leading to and communicating with said smoke-box, and a check-valve in said smoke-box.

3. In a furnace, a horizontally-disposed tubular fire-box of oval form in cross-section and relatively long and narrow, a longitudinally-disposed fire-pot therein arranged substantially at the longitudinal middle of the fire-box and occupying the full width across thereof, said fire-pot including a bottom grate and rear bridge-wall arranged to provide a down-draft flue in the back of the fire-box, and an elevated U-shaped ash-pan under the grate, providing in the bottom of the fire-box a passage for the products of

combustion under and straddling the sides of the ash-pan, said bottom passage being in communication with said back flue and having a front outlet.

4. A furnace having a horizontally-disposed tubular fire-box provided with a front ash-door, grate, ash-pan and rear bridge-wall, there being an indirect draft-passage leading from the fire-space above the grate down behind the bridge-wall and forward under the ash-pan, and said bridge-wall having a passage therein for admitting an air-blast from the ash-pan above the fuel.

5. A furnace having a horizontally-disposed tubular fire-box, a longitudinally-arranged grate therein providing a fire-space above the grate, and a U-shaped ash-pan depending below the grate and by its contour in conjunction with the interior walls of the fire-box forming a continuous smoke-passage in the bottom of the fire-box and straddling the ash-pan, said passage having a front outlet and communicating only at the back of the fire-box with the fire-space above the grate.

6. A furnace comprising a casing and a horizontally-disposed tubular fire-box therein of approximately upright oval or elliptical form in cross-section, and a longitudinally-arranged grate and subjacent ash-pan in said fire-box partitioning the same transversely, the contour of said ash-pan in conjunction with the sides of the fire-box providing an approximately inverted A-shaped indirect draft-passage in the bottom of the fire-box, said draft-passage being in communication at the rear of the fire-box with the space above the grate and having a front outlet.

7. A furnace comprising an air-box, and an inclosed horizontally-disposed tubular fire-box occupying nearly the full space of the air-box, said fire-box being approximately elliptical in cross-section and having oppositely bowed side-plates meeting at an angle or peak at the top and bottom, and a grate and raised ash-pan thereunder arranged within the fire-box so as to provide a passage for the products of combustion under and at the opposite sides of the ash-pan, whereby the side-walls of the fire-box are exposed to heat above and below the grate; and the air-box having its side-walls approximately conforming to the shape of the fire-box, means whereby the air is admitted into the air-box under the fire-box, and the air-box having air-exit openings above the fire-box, there being narrow spaces for circulation of air between opposite sides of the fire-box and the air-box, said spaces being nearly vertical and only slightly curved inwardly toward the top and bottom of the fire-box, causing the air-currents to sweep closely over and take up the heat from the whole exterior surface of the sides of the fire-box.

MILTON J. FARQUHAR.
HENRY B. FARQUHAR.

Witnesses:
FRANCIS FARQUHAR,
CAROLYN MCPHAIL.