Oct. 31, 1950 F. H. KLUG 2,527,937

HOT-AIR FURNACE

Filed Aug. 10, 1948 2 Sheets-Sheet 1

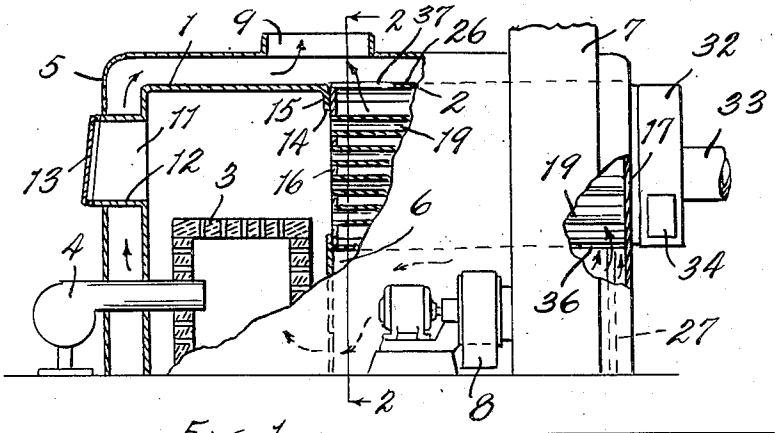


FIG. 1

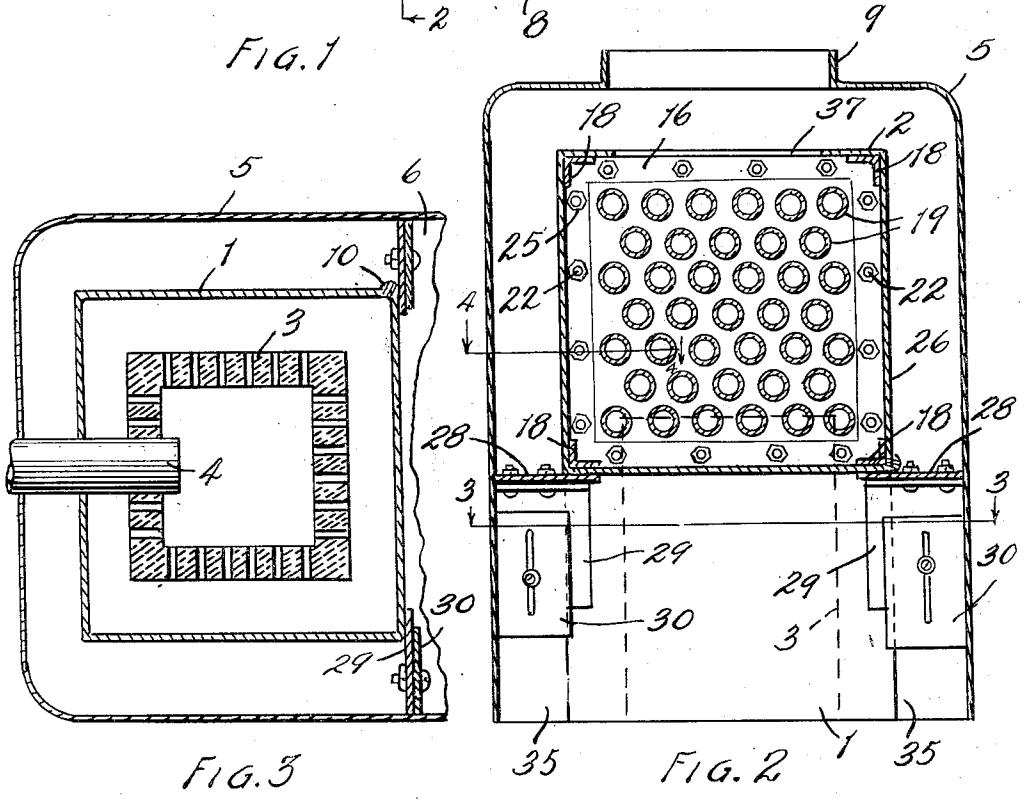


FIG. 3 FIG. 2

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HOT-AIR FURNACE

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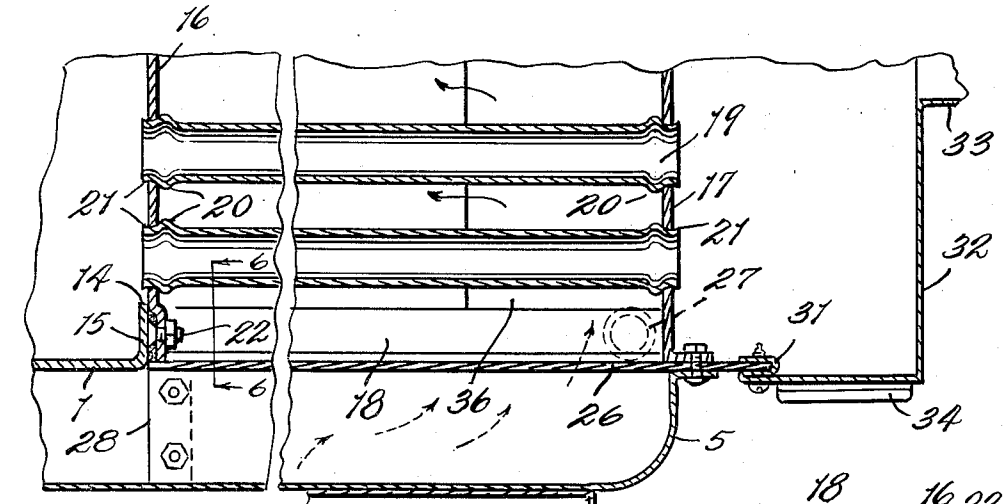


FIG. 4

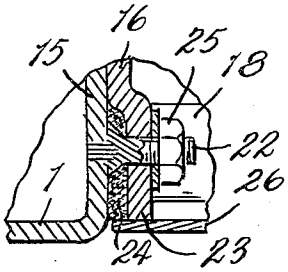


FIG. 5

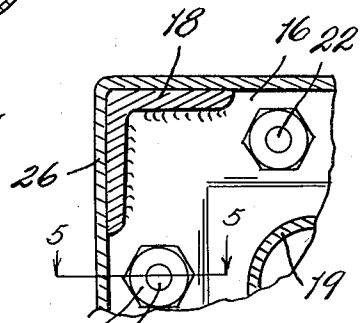


FIG. 6

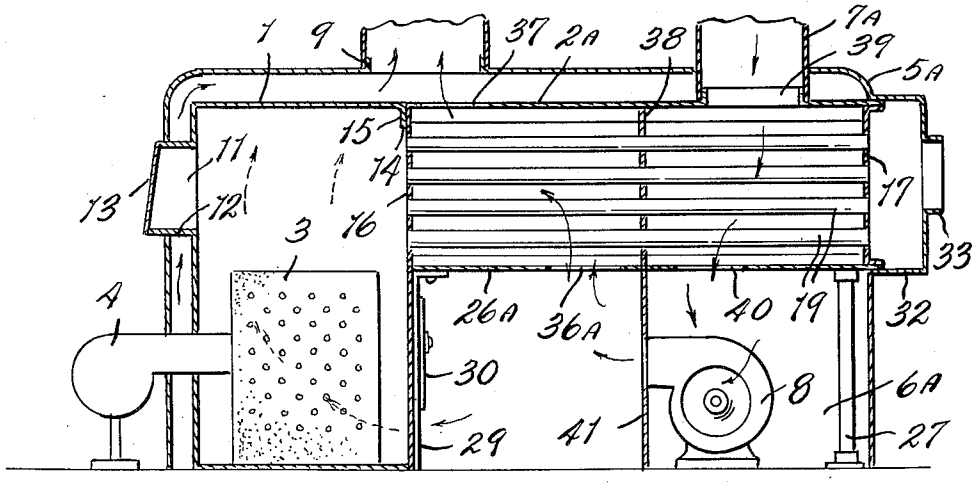


FIG. 7.

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2,527,937

## HOT-AIR FURNACE

Ferdinand H. Klug, Benton Harbor, Mich.

Application August 10, 1948, Serial No. 43,497

5 Claims. (Cl. 126—110)

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This invention relates to improvements in hot air furnace.

The principal objects of this invention are:

First, to provide a furnace for domestic use having increased efficiency and rapid heat transfer characteristics.

Second, to provide a furnace having a fire tube heat exchanger which is easily cleaned so that the furnace may be maintained at peak operating efficiency without tearing down the furnace or employing specialized workmen.

Third, to provide a furnace with a horizontal fire tube heat exchanger which is easily assembled as a unit on the remainder of the furnace and which employs the principle of counterflow of the hot gases and the air being heated.

Fourth, to provide a furnace with a refractory combustion chamber which functions to store heat for hold-over heating between operating periods of the burner and which at the same time does not materially obstruct the rapid passage of heat from the burner to the heat exchange surface.

Fifth, to provide a furnace having a divided path of flow for the air being heated whereby part of the air is heated directly from the walls of the fire chamber and part of the air is heated from a fire tube heat exchanger.

Other objects and advantages relating to details of my furnace will be apparent from a consideration of the following description and attached drawings. The invention is further pointed out in the claims.

The drawings, of which there are two sheets illustrate two forms of my furnace.

Fig. 1 is a side elevational view, partially broken away in vertical longitudinal cross section, of a first form of my furnace.

Fig. 2 is a transverse vertical cross sectional view taken along the plane of the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary horizontal cross sectional view through the front end of the furnace and taken along the plane of the line 3—3 in Fig. 2.

Fig. 4 is a fragmentary horizontal cross sectional view through the rear end of the furnace and taken along the plane of the line 4—4 in Fig. 2.

Fig. 5 is an enlarged detailed fragmentary cross sectional view illustrating the connection between the fire chamber and heat exchanger of the furnace and taken along the line 5—5 of Fig. 6.

Fig. 6 is an enlarged detailed cross sectional

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view taken along the plane of the line 6—6 in Fig. 4.

Fig. 7 is a vertical longitudinal cross sectional view through a second form of my furnace.

My furnace consists generally of an upstanding rectangular fire chamber 1 having the horizontally extending rectangular heat exchanger 2 extending from the upper portion of the rear wall thereof. The fire chamber 1 encloses a combustion chamber 3 consisting of perforated fire brick or other refractory material. A burner such as the gun type oil burner 4 has its mouth arranged through the front wall of the fire chamber and combustion chamber to produce a flame within the combustion chamber. If desired, a gas burner can be substituted for the oil burner 4. The fire chamber 1 and heat exchanger 2 are enclosed in a suitable generally rectangular casing 5, the walls of which are spaced from all walls of the fire chamber and heat exchanger excepting the rear wall of the heat exchanger. The casing 5 and heat exchanger 2 define a plenum chamber 6 in the rear of the furnace and a cold air return duct 7 is connected through the blower 8 to discharge cold air into the plenum chamber. A hot air outlet and stack collar 9 is provided on the top of the casing just over the junction between the heat exchanger and the fire chamber.

More specifically, the fire chamber 1 comprises a sheet of relatively heavy gauge sheet steel folded into rectangular shape and welded as at 10 in Fig. 3. The front wall of the fire chamber is provided with an observation and clean-out opening 11 having the throat 12 secured thereabout and projecting forwardly through the front wall of the casing where it is closed by the door 13. The upper portion of the rear wall of the fire chamber defines a rectangular opening 14 which is provided with a narrow attaching flange 15 extending therearound. It should be noted that the casing 5 is spaced from the front and side walls of the fire chamber 1.

The heat exchanger 2 consists of a front plate 16 and rear plate 17 which are connected in spaced parallel relationship by four longitudinally extending angle irons 18. The plates 16 and 17 define a plurality of aligned apertures in which the ends of the fire tubes 19 are secured. As is most clearly shown in Fig. 4, the fire tubes are sealed to the plates 16 and 17 by upsetting the ends of the tubes to form the annular beads 20 which are sealed against the inside surfaces of the plates. The ends of the tubes outside of the plates are

then spun or swaged over the edges of the apertures as at 21.

The flange 15 around the opening 14 in the fire chamber is provided with a series of studs 22 which are welded to the fire chamber and project rearwardly through holes provided therefor in the front plate 16 of the heat exchanger. The periphery of the plate 16 is rearwardly offset as at 23 so that a sealing compound 24 can be positioned around the joint between the fire chamber and the heat exchanger. Nuts 25 clamp the heat exchanger to the fire chamber.

After the front plate 16 has been bolted to the fire chamber a rectangular sleeve 26 is slid over the angle irons 18 to enclose the fire tubes 19 and complete the heat exchanger. The rear end of the heat exchanger is supported from the floor by a pair of posts 27. It will be noted that the sleeve 26 extends rearwardly beyond the rear plate 17 of the heat exchanger and beyond the rear wall of the casing 5 (see Fig. 4).

In order to separate the plenum chamber 6 from the upper portion of the casing 5, the lower side edges of the sleeve 26 are provided with baffle plates 28 which extend laterally to the side walls of the casing 5. The forward ends of the baffle plates 28, adjacent to the rear wall of the fire chamber 1, are provided with depending vertical baffles 29 which support the vertically adjustable damper plates 30 for regulating the opening between the plenum 6 and the forward portion of the casing 5 around the fire chamber.

The rear end of the heat exchanger sleeve 26, which projects from the rear of the casing, is secured by the folded lapped joint 31 (see Fig. 4) to a rectangular smoke box 32. The smoke box is provided with a collar for attachment to the smoke pipe 33 and is further provided with a clean-out door 34 positioned at the bottom of one side thereof.

In operation of the furnace the burner 4 will be operated as required and will develop an intense flame in the combustion chamber 3. When initially started, a large portion of this flame will immediately pass through the perforations in the walls of the combustion chamber from where the gases will rise heating the walls of the fire chamber and passing rearwardly through the fire tubes 19 to the smoke box 32. Cold air drawn downwardly through the cold air duct 7 by the blower 8 will be forced into the plenum chamber 6 from where part of the air can pass forwardly through the openings 35 underneath the damper plates 30 to around the sides of the fire chamber 1. Here the air will be heated and forced upwardly through the stack collar 9. The rest of the air entering the plenum chamber will be forced through an opening 36 formed at the rear of the bottom wall of the sleeve 26. From the rear of the heat exchanger the air is forced upwardly and forwardly opposite to the direction of the flow of the hot gases through the fire tubes, and is discharged from the heat exchanger through the upper opening 37 adjacent to the stack collar 9. Thus part of the air will be heated by the relatively hot walls of the fire chamber while the remaining portion of the air will be heated by the relatively cooler fire tubes 19. The proportion of air passing over the two possible routes may be varied by adjusting the damper plates 30. Attention is invited to the fact that the inspection door 13 is positioned directly in front of the fire tubes 19 so that it is a simple matter for the householder to push a long handle brush directly through each of the fire tubes to force any soot which may have collected therein into the smoke box 32. The soot will fall to the bottom of the smoke box where it is easily removed through the clean-out door 34. It is thus easy to keep the furnace in clean efficient operating condition.



In the modified form of the furnace illustrated in Fig. 7, the fire chamber 1, combustion chamber 3, and burner 4 are the same as in the first form of the furnace. The heat exchanger 2A is different from the first form of heat exchanger in that it is provided with an intermediate partition plate 38 which divides the heat exchanger into two sections. The rear section of the heat exchanger is provided with an inlet collar 39 to which the cold air duct 7A is connected. In this case the duct 7A extends downwardly through the top wall of the casing 5A. The bottom wall of the sleeve 26A defines an opening 40, opening into the rear portion of the plenum chamber 6A. The plenum chamber is also divided into front and rear sections by the partition plate 41 and the blower 8 is positioned in the rear section of the plenum chamber to discharge through the partition plate 41 into the forward section of the plenum chamber. From the forward section of the plenum chamber, air can pass either forwardly around the fire chamber as in the first form of the furnace, or upwardly through an inlet opening 36A in the bottom of the heat exchanger and from there through the forward end of the heat exchanger to the outlet 37, which is the same as in the first form of the furnace. The second form of furnace is slightly more complicated than the first form in its structural details but has the advantage of mounting the blower 8 within the casing of the furnace so that no extra floor space is required for the blower or cold air return duct 7A.

I have thus described two highly practical forms of my furnace which are very efficient in operation and which materially reduce the temperature of the exhaust gases escaping up the chimney due to more complete transfer of heat from the gases to the air being heated. The elements of the furnace are easily fabricated and assembled and the furnace is very easy to keep clean.

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

1. A furnace comprising a generally rectangular casing having a hot air outlet in the top thereof, walls forming an upstanding rectangular sheet metal fire chamber positioned in the front of said casing and spaced from the walls thereof, the rear wall of said fire chamber defining an opening in the upper portion thereof, a heat exchanger comprising front and rear plates with a plurality of fire tubes supported therebetween and extending therethrough, the front plate of said heat exchanger being secured to the rear wall of said fire chamber and over said opening, the rear plate of said heat exchanger forming a portion of the rear wall of said casing, longitudinal bars connecting the corners of said plates, a rectangular sleeve positioned around said bars and enclosing said heat exchanger, baffle plates extending between the lower edges of said sleeve and the sides of said casing and cooperating with the bottom of said sleeve to form the top of a plenum chamber in the bottom of said casing, adjustable damper plates positioned between the sides of said casing and the rear wall of said fire chamber and extending upwardly to said baffle plates and arranged to control the flow of air

from said plenum chamber to the space surrounding said fire chamber, a smoke box secured to the rear end of said sleeve and having a cleanout door positioned in the lower portion of said box, means including a blower for delivering air to said plenum chamber, said sleeve defining an inlet opening from said plenum chamber in the rear portion of its lower wall and an outlet opening to within the top of said casing in the forward portion of its top wall, means forming a combustion chamber of perforated refractory material positioned in said fire chamber and spaced from the walls thereof, and a burner provided with a tube for projecting a flame into said combustion chamber.

2. A furnace comprising a casing having a hot air outlet in the top thereof, walls forming an upstanding sheet metal fire chamber positioned in the front of said casing and spaced from the walls thereof, the rear wall of said fire chamber defining an opening in the upper portion thereof, a heat exchanger comprising front and rear plates with a plurality of fire tubes supported therebetween and extending therethrough, the front plate of said heat exchanger being secured to the rear wall of said fire chamber and over said opening, the rear plate of said heat exchanger forming a portion of the rear wall of said casing, longitudinal bars connecting the corners of said plates, a sleeve positioned around said bars and enclosing said heat exchanger, baffle plates extending between the sides of said sleeve and the sides of said casing and cooperating with the bottom of said sleeve to form the top of a plenum chamber in the bottom of said casing, damper plates positioned between the sides of said casing and the rear wall of said fire chamber and extending upwardly to said baffle plates and arranged to control the flow of air from said plenum chamber to the space surrounding said fire chamber, a smoke box secured to the rear end of said sleeve and having a cleanout door positioned in the lower portion of said box, means for delivering air to said plenum chamber, said sleeve defining an inlet opening from said plenum chamber in its lower wall and an outlet opening to within the top of said casing in the forward portion of its top wall, means forming a combustion chamber of perforated refractory material positioned in said fire chamber and spaced from the walls thereof, and a burner arranged to provide a flame in said combustion chamber.

3. A furnace comprising a generally rectangular casing having a hot air outlet in the upper portion thereof, walls forming an upstanding sheet metal fire chamber positioned in the front of said casing and spaced from the walls thereof, the rear wall of said fire chamber defining an opening in the upper portion thereof, a heat exchanger comprising front and rear plates with a plurality of fire tubes extending therebetween the front plate of said heat exchanger being secured to the rear wall of said fire chamber and over said opening, the rear plate of said heat exchanger forming a portion of the rear wall of said casing, longitudinal bars connecting the corners of said plates, a rectangular sleeve positioned around said bars and enclosing said heat exchanger, baffle plates extending between the sides of said sleeve and the sides of said casing and cooperating with the bottom of said sleeve to form the top of a plenum chamber in the bottom of said casing, damper plates positioned between the sides of said casing and the rear wall of said fire chamber below said baffle plates and arranged to control the flow of air from said plenum chamber to the space surrounding said fire chamber, a smoke box secured to the rear end of said heat exchanger and having a cleanout door positioned in the lower portion of said box, means for delivering air to said plenum chamber, said sleeve defining an inlet opening from said plenum chamber in its lower wall and an outlet opening to within the top of said casing in its top wall forwardly of said inlet opening, and a burner for developing a flame in said fire chamber.

4. A furnace comprising a casing having a hot air outlet in the upper portion thereof, walls forming an upstanding sheet metal fire chamber positioned in the front of said casing and spaced from the walls thereof, the rear wall of said fire chamber defining an opening in the upper portion thereof, a heat exchanger comprising front and rear plates with a plurality of horizontal fire tubes extending therebetween and opening therethrough, the front plate of said heat exchanger being secured to the rear wall of said fire chamber and over said opening, a rectangular sleeve enclosing said heat exchanger, baffle plates extending between the sides of said sleeve and the sides of said casing and cooperating with the bottom of said sleeve to form the top of a plenum chamber in the bottom of said casing, means for delivering air to said plenum chamber, said sleeve defining an inlet opening from said plenum chamber in its lower wall and an outlet opening to within the top of said casing in its top wall forwardly of said inlet opening, and a burner for developing a flame in said fire chamber.

5. A furnace comprising a casing having a hot air outlet in the top thereof, walls forming an upstanding sheet metal fire chamber positioned in the front of said casing and spaced from the walls thereof, a heat exchanger in said casing comprising a plurality of fire tubes secured at their front to the rear wall of said fire chamber and communicating with said fire chamber, a sleeve positioned around and enclosing said heat exchanger, baffle plates extending between the sides of said sleeve and the sides of said casing and cooperating with the bottom of said sleeve to form the top of a plenum chamber in the bottom of said casing, means for delivering air to said plenum chamber, said sleeve defining an inlet opening from said plenum chamber in the rear portion of its lower wall and an outlet opening to within the top of said casing in the forward portion of its top wall, and a burner for developing a flame in said fire chamber.

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