April 13, 1937. L. A. MEKLER 2,076,854

FURNACE FOR HEATING FLUIDS

Original Filed April 17, 1931 3 Sheets-Sheet 1

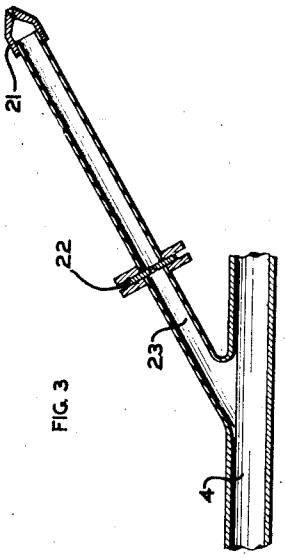


FIG. 3

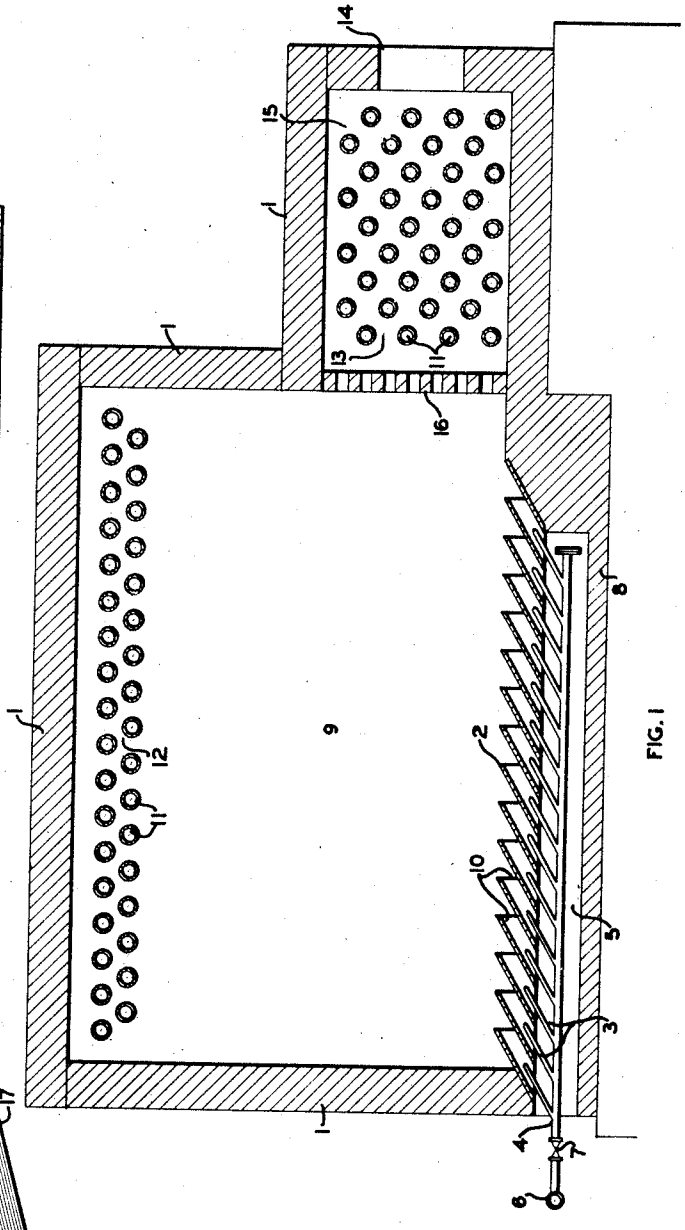


FIG. 1

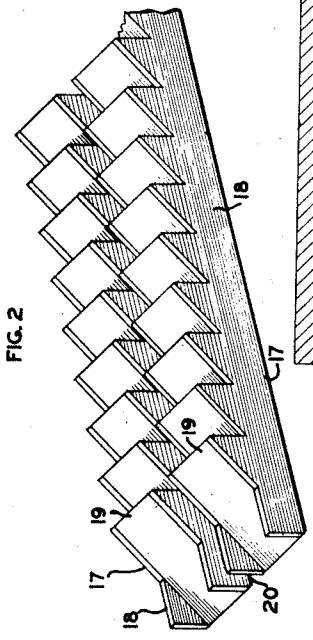


FIG. 2

INVENTOR
LEV A. MEKLER
BY Frank L. Belknap
ATTORNEY

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FIG. 4

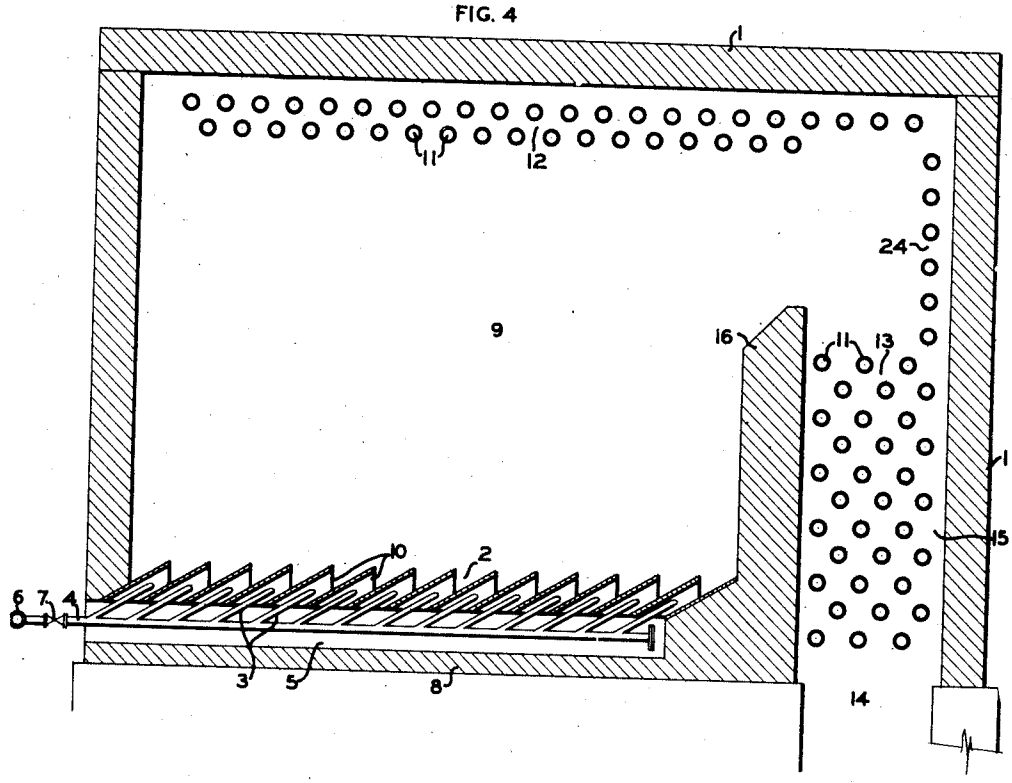


FIG. 7

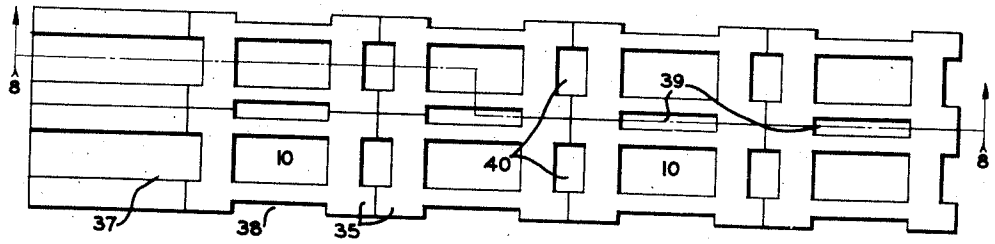
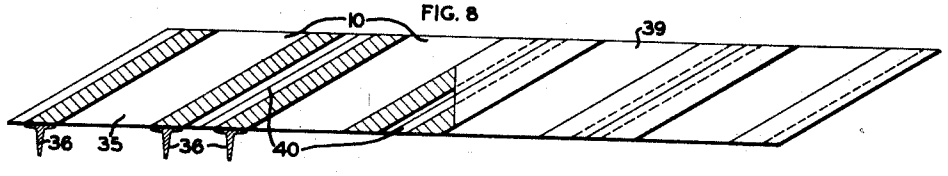


FIG. 8



INVENTOR
LEV A. MEKLER
BY Frank L. Belknap
ATTORNEY

April 13, 1937. L. A. MEKLER 2,076,854

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FIG. 5

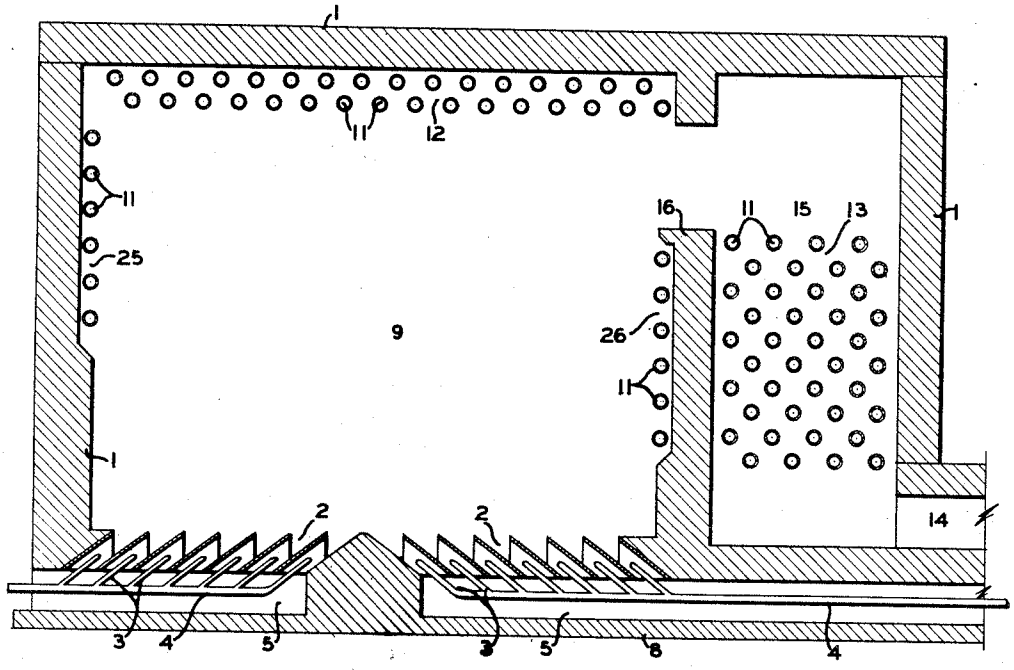
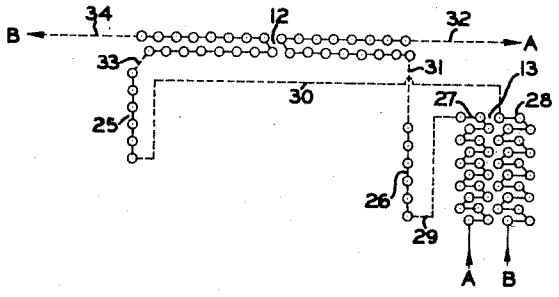


FIG. 6



INVENTOR

LEV A. MEKLER

BY Frank L. Belknap

ATTORNEY

UNITED STATES PATENT OFFICE

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FURNACE FOR HEATING FLUIDS

Lev A. Mekler, Chicago, Ill., assignor, by mesne assignments, to Universal Oil Products Company, Chicago, Ill., a corporation of Delaware

Application April 17, 1931, Serial No. 530,923
Renewed January 10, 1936

5 Claims. (Cl. 196—116)

This invention relates to the heating of fluids and particularly refers to an improved type of furnace for supplying heat to fluids such as, for example, hydrocarbon oils.

While the process and apparatus hereinafter described and illustrated is particularly adapted to heating hydrocarbon oils to relatively high temperatures, such as those employed in cracking, the principles of the invention may be utilized in ordinary distilling operations, in the generation of steam or, in fact, wherever furnaces employing gas, oil or pulverized fuel may be advantageously utilized.

The primary concepts of the present invention provide an improved furnace for heating fluids wherein all or a portion of the floor of said furnace may comprise a hearth through which combustible materials are supplied to the combustion zone of the furnace.

As a feature of the invention, the fuel supplied to the floor hearth of the furnace may be a combustible gas such as natural gas or refinery gases or oil or, if desired, pulverized fuel such as pulverized coal or coke may be employed or any combination of these fuels may be utilized.

As a further feature of the invention, the air required for combustion in the furnace may be substantially all supplied through said floor hearth. Auxiliary air may be supplied through the floor hearth preferably entering the combustion zone of the furnace through portions of the hearth through which fuel is not supplied but adjacent thereto, serving to cool the firing compartments of the hearth, said auxiliary air being itself preheated in its passage through ports adjacent said firing compartments. As a primary feature of the invention, the heat input to any section of the fluid conduit can be controlled to meet any predetermined requirements by regulating the quantity of fuel supplied to a given portion of the hearth. For example, by supplying more fuel to the forward portion of the hearth the temperature in the corresponding portion of the furnace is increased, thus increasing the heat input in a corresponding portion of the fluid conduit.

As another feature of the invention, fuel may be supplied through the floor hearth in such a manner that the hearth structure will assume a luminous quality thus enabling it to function as a radiating surface.

The principles and features of the present invention will be more apparent with reference to the accompanying diagrammatic drawings.

Figure 1 illustrates one form of combination radiant and convection heat furnace with a floor hearth such as provided by the present invention.

Figure 2 is a detailed view of a portion of the floor of this furnace.

Figure 3 illustrates a burner through which fuel may be supplied with this type of hearth.

Figure 4 illustrates another form of combination radiant and convection furnace employing a floor hearth similar to that illustrated in Figure 1.

Figure 5 illustrates still another form of combination radiant and convection furnace employing a modified form of floor hearth embodied by the present invention.

Figure 6 is a flow diagram illustrating one approved flow of fluid through the heating element of the furnace illustrated in Figure 5.

Figure 7 is a top plan view and Figure 8 a side elevation partially in cross-section showing one approved construction of the floor hearth provided by the invention.

Referring now to Figure 1, 1 designates the walls and roof of the furnace which may be constructed of suitable refractory material such as firebrick, and 2 indicates generally the floor hearth of the furnace. A branch header 4 may extend beneath the hearth 2 in space 5 provided between the hearth and the sub-floor 8 of the furnace. Any suitable fuel such as gas or oil may be introduced from header 6 into a plurality of branch headers 4 through valves 7, each of the branch headers 4 in turn supplying the fuel to a plurality of burners 3. In case pulverized solid fuel is used, individual burner units, instead of the multiple jet or header type of burner illustrated, are preferably employed. Each of the burners 3 discharge fuel into the combustion zone 9 of the furnace through separate sections or compartments 10 of the hearth 2. The burners 3 and firing compartments 10 may be inclined at any desired angle and, in the case illustrated, point toward the rear wall of the furnace.

The fluid to be heated may be supplied to tubes or other conduits 11 and in this case a double row of tubes along the roof of the furnace comprises a radiant heat bank 12 deriving the major portion of its heat by radiation from the flame and from the refractory walls and floor of the furnace. Series or parallel flow through the tubes may be employed and they may be connected outside the combustion zone by any suitable form of header or return bends not illustrated. A zone 15 may be provided separate from the combustion zone 9 of the furnace in which a convection bank 13 of tubes 11 may be positioned. A checker wall 16 may be provided

to separate combustion zone 9 from chamber 15, the principal purpose of which is to prevent flame impingement against the tubes of the convection bank. Tube bank 13 may derive a major portion of its heat by convection from the furnace gases, passing from combustion zone 9 through zone 15 to flue 14. The tubes in convection bank 13 may likewise be connected either in series or in parallel by any suitable form of header or return bends. Any desired flow may be employed through the radiant and convection banks of the furnace, depending upon the desired heating curve.

The heat input in any section of the fluid conduit and particularly in any portion of radiant bank 12 can be controlled by regulating the fuel supply to corresponding portions of the floor hearth 2. This control may be effected in various ways and for practical purposes burner tips and/or orifice plates, in the branch lines supplying fuel to the burners, may be utilized for this purpose. This means of control will be more fully described later, in connection with Fig. 3.

Fig. 2 is a slightly enlarged isometric view of a portion of the floor hearth 2. It will be understood that this figure illustrates only one of the many types of construction which may be employed. In this case the hearth consists of adjacent sections 17 running lengthwise along the floor of the furnace. Between the side walls 18 of each section are inclined plates 19 between which the firing ports 10 are formed. The burners 3 supply combustible material through firing ports 10 to the combustion zone 9 of the furnace as previously described. The adjoining side walls 18 of each section may coincide or, if desired, a space 20 may be provided between adjacent side walls through which auxiliary air may be admitted from space 5 into the combustion zone 9. The sections 17 of the hearth may be constructed of any suitable refractory material such as, for example, silicon carbide, molded or fused aluminum oxide, molded or fused silica or high temperature alloys. In the type of construction illustrated in Fig. 2 it will be noted that both sides of the top tiles 19 may be heated, thus imparting a higher average temperature to the floor hearth than that obtainable with a closed hearth. By firing both sides of the tiles 19, stresses due to difference in temperature in different portions of the tile are substantially avoided.

Figure 3 illustrates, in cross-section, a combination burner which may be employed. Fuel may be supplied from the branch header 4 into the burner tube 23 and the quantity of fuel supplied through each burner tube may be regulated either by the orifice plate 22 or by the tip 21. If desired, either or both the tip 21 and an orifice plate 22 may be employed, the choice between the orifice plate and the tip depending mainly upon the jet velocity desired. In general a relatively small orifice plate with a large tip or no tip at the end of the burner will give low velocities while a relatively small tip with or without an orifice plate will give relatively high velocities.

Figure 4 illustrates another type of furnace to which the principles of the invention may be applied. As in Figure 1 the furnace walls are indicated at 1, the hearth at 2, 3 being the burners, 4 the branch headers, 5 the burner compartment between the hearth 2 and the sub-floor 8 of the furnace, 6 is the main fuel header, 7 are valves controlling the supply of fuel to the branch headers 4, 9 is the combustion zone, 10 are the firing compartments of the hearth 2, 11 are the tubes or fluid conduits, 12 is the radiant tube bank, 13 the convection tube bank, 14 is the flue leading to a stack, not shown, and 15 is the convection zone.

This type of furnace differs mainly from that illustrated in Figure 1 in the flow of combustion gases through the furnace. With the furnace illustrated in Figure 1, the flow of combustion gases is substantially horizontal through the furnace to the flue 14 while in the type of furnace illustrated in Figure 4 the furnace gases rise through the lower portion of the combustion zone 9 in a substantially vertical direction, passing thence over the bridgewall 16 and downward through the convection zone 15 to flue 14.

In this furnace a row 24 of tubes connecting radiant bank 12 and convection bank 13 may receive partially radiant and partially convection heat. As in Fig. 1 any desired flow may be employed through the heating elements in Fig. 4, depending upon the desired heating curve and, also as in Fig. 1, the heat input to any section of the fluid conduit can be controlled by regulating the fuel supply to a corresponding section of the hearth.

Fig. 5 illustrates another type of furnace employing a slightly modified form of open floor hearth. The refractory walls and roof of the furnace are indicated at 1. 16 is a wall separating combustion zone 9 and convection zone 15 of the furnace. 14 is a flue leading to a stack (not shown). 8 is the sub-floor and 5 are spaces provided between the floor hearth 2 and sub-floor 8. 4 are branch headers leading to burners 3. The heating element comprising tubes 11, as here illustrated, is divided into a radiant roof section 12, a convection section 13 and additional radiant sections 25 and 26 located along the walls of the combustion zone 9. In this furnace the burners and firing compartments of the hearth comprise two main sections each inclined toward the central portion of the combustion zone. This type of construction is employed to prevent flame impingement against the tubes in sections 25 and 26.

As in Fig. 1 the flow of furnace gases may be substantially upward through the lower portion of combustion zone 9, thence over the bridgewall 16 and downward through the convection zone 15 to flue 14. With the type of hearth here illustrated, the flow of furnace gases may, however, be controlled or modified by regulation of the firing in the two sections of the floor hearth. For example, by firing harder in the rear section than in the forward section of the hearth the flow of gases may be forward and upward, in the lower portion of the combustion zone, thence substantially, toward the rear of the furnace in the upper portion of the combustion zone, adjacent the roof bank 12, and thence downward around convection bank 13. This in effect controls the heat input to the various portions of the radiant bank, which feature is particularly advantageous in furnaces where parallel flow of fluid through divided portions of the fluid conduit is employed.

As in the furnaces illustrated in Figures 1 and 4 the flow of fluid through the heating elements of the furnace will depend upon the desired heating curve, however, this type of furnace structure is particularly adapted to heating two streams of fluid which may be passed through the furnace in substantially parallel flow as illustrated in Figure 6.

Referring to Figure 6, two streams A and B may be supplied to separate parallel sections 27 and 28 of the convection bank 13. Stream A may be transferred from section 27 through line 29 to section 26 of the heating element while stream B may be transferred from section 28 through line 30 to section 25 of the heating element. Stream A may thence pass through line 31 to the lower row of radiant roof tubes of section 12 of the heating element, passing through half the tubes in this row, thence transferring to the upper row of tubes in this section and out of the furnace through line 32. Stream B may pass through line 33 to the lower row of radiant roof tubes of section 12 of the heating element passing through the remaining tubes in this row, thence transferring to the upper row of radiant roof tubes and out of the furnace through line 34.

The flow illustrated in Figure 6 is particularly advantageous when it is desired to divide a stream of oil into two substantially equal portions, heating each portion under substantially the same conditions to substantially the same final temperature. This flow not only insures substantially the same final temperature for each of the two equal portions of the oil but also insures substantially the same heating conditions and oil temperature in each corresponding section of the heating element.

It will be understood that the furnace illustrated in Figure 5 is not limited to the type of flow illustrated in Figure 6 as modified flows may be employed to accomplish different results.

Figures 7 and 8 illustrate a form of open hearth floor embraced by the principles of the present invention which is somewhat different than the form illustrated in Figure 2. Figure 7 is a plan view of a portion of the hearth and Figure 8 is a sectional elevation taken along line 8—8 in Figure 7. This type of construction may replace that illustrated in Figure 2. The floor hearth is, in this case, composed of a plurality of tiles 35 which may be constructed of any suitable refractory material of high conductivity such as silicon carbide, moulded or fused aluminum oxide, moulded or fused silica or high temperature alloys or, if desired, low conductivity refractory materials may be used. The tiles may be supported upon suitable members such as steel angles or T-bars indicated at 36. 10 indicates the firing ports through which the burners supply combustible material to the combustion zone of the furnace and, as here illustrated, each tile contains one such firing port which may be inclined at any desired angle. Each tile is recessed on all four sides with grooves 37 and 38 which form passages 39 and 40 through which air may be admitted through the space below the tile into the combustion zone. These air passages not only serve the purpose of admitting air to the combustion chamber but serve, at the same time, as a means of cooling the tile.

It will be understood that the drawings illustrate only a few of the many possible applications of the principles embodied by the present invention and are given only for the purpose of illustrating some of the types of furnaces to which the principles of the invention are readily adapted and some of the forms which the open floor hearth structure may assume.

I claim as my invention:

1. A furnace for heating hydrocarbon fluids which comprises in combination, a heating chamber, a plurality of fluid passageways in said heating chamber, a convection heat zone, a plurality of fluid passageways in said convection heat zone, a floor for said heating chamber comprising a plurality of conduits obliquely disposed with respect to the floor and constructed of refractory material, means for introducing flames into said heating chamber through said conduits, heating said first mentioned fluid passageways substantially solely by the radiant heat emanating from the flame, and means for passing said hot gases of combustion through said convection zone and in contact with said fluid passageways therein.

2. A heating apparatus comprising a furnace chamber, heating tubes in said chamber, refractory plates inclined with respect to the horizontal and spaced one behind the other and forming a floor hearth for said chamber, and burners parallel to said plates disposed in the spaces between the plates.

3. In a furnace, the combination of a floor hearth comprising refractory plates inclined with respect to the horizontal and spaced one behind the other, and burners parallel to said plates disposed in the spaces between the plates.

4. A heating apparatus comprising a furnace chamber, heating tubes in said chamber, refractory plates inclined with respect to the horizontal and spaced one behind the other and forming a floor hearth for said chamber, means for supplying air to the spaces between said plates, and burners parallel to the plates disposed in said spaces.

5. In a furnace, the combination of a floor hearth comprising refractory plates inclined with respect to the horizontal and spaced one behind the other, burners parallel to said plates disposed in the spaces between the plates, and means for introducing air to the furnace through said floor hearth.

LEV A. MEKLER.