

Sept. 18, 1956

H. EICHHORN
FURNACE STRUCTURE

2,763,260

Filed Feb. 9, 1953

4 Sheets-Sheet 1

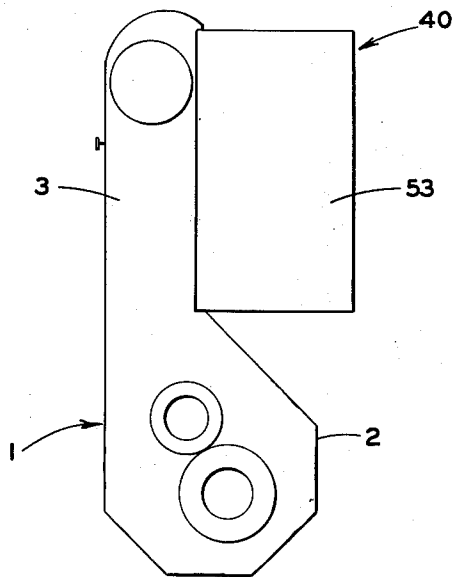


fig. 1

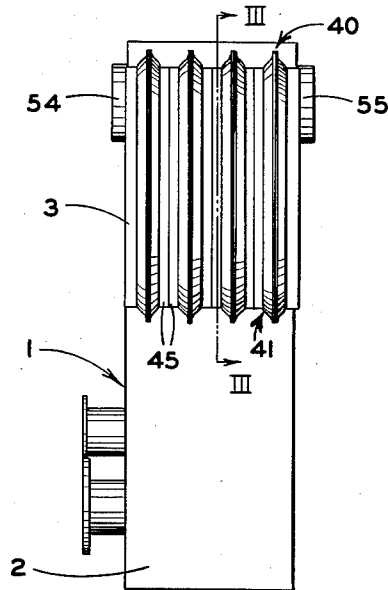


fig. 2

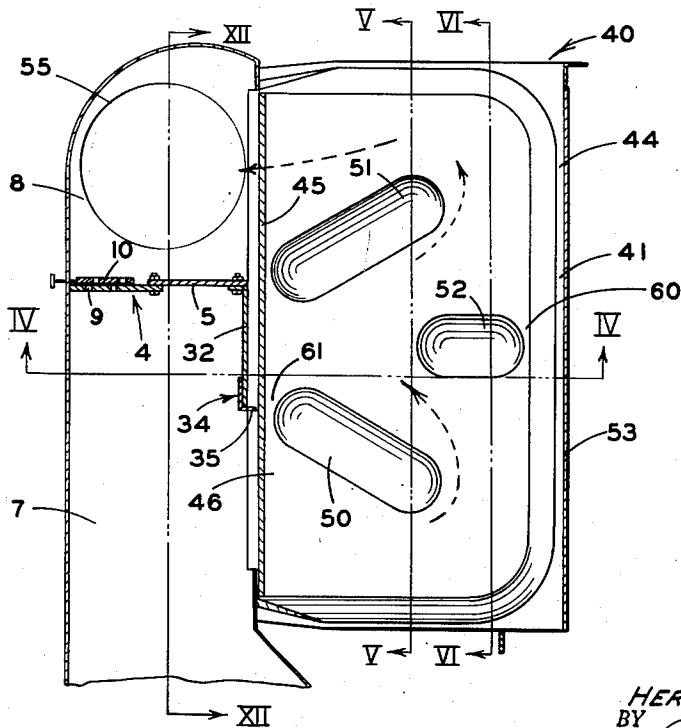


fig. 3

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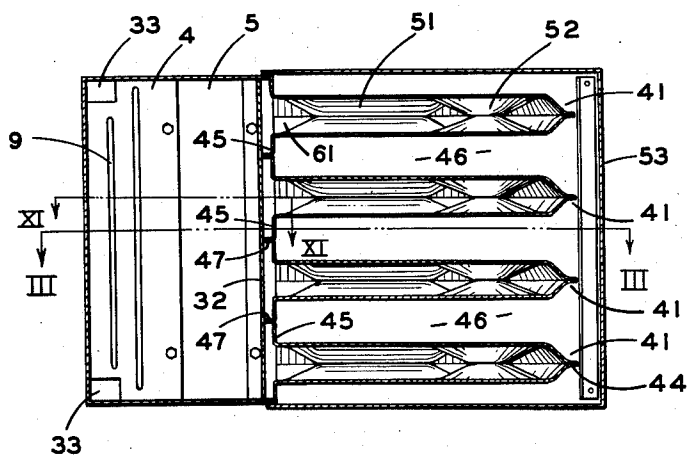
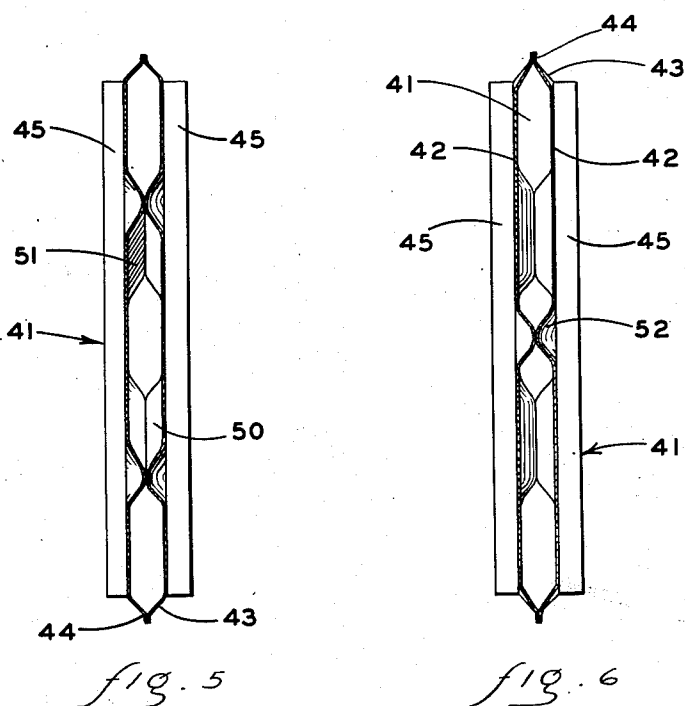
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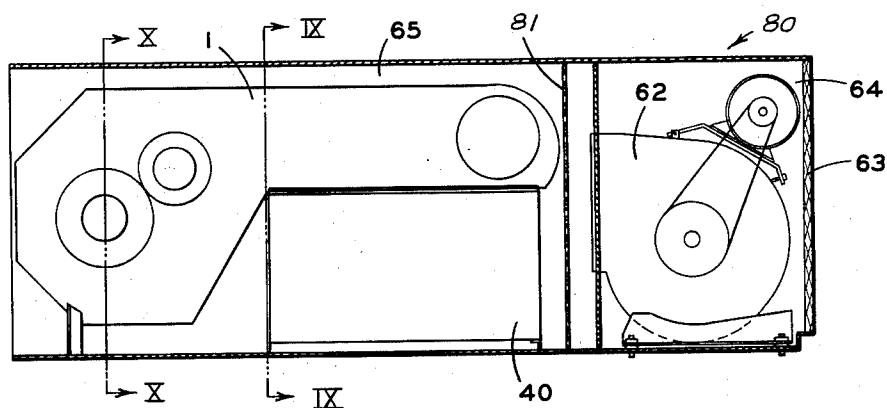


fig. 7

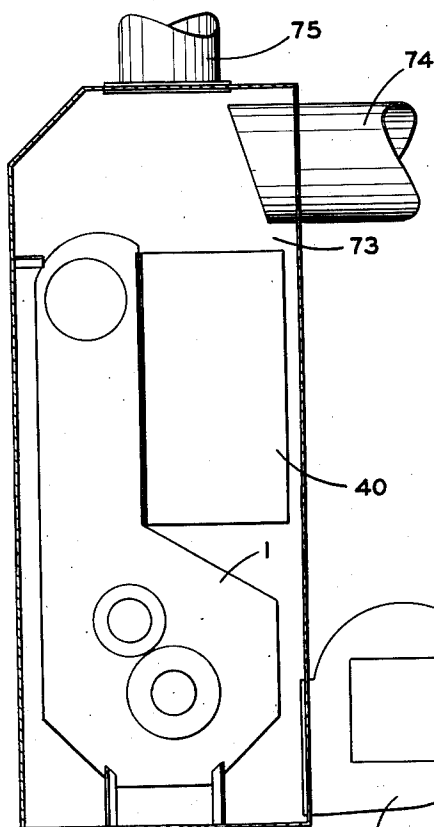


fig. 8

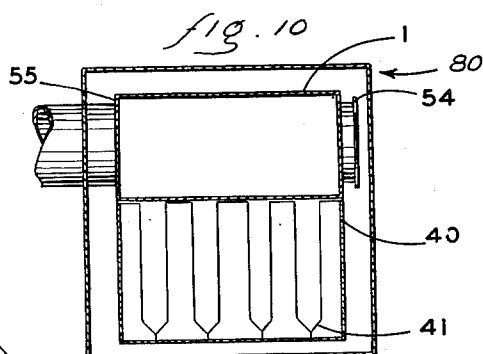
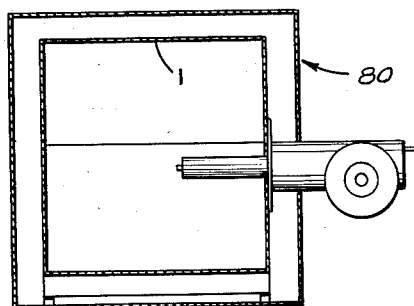


fig. 9

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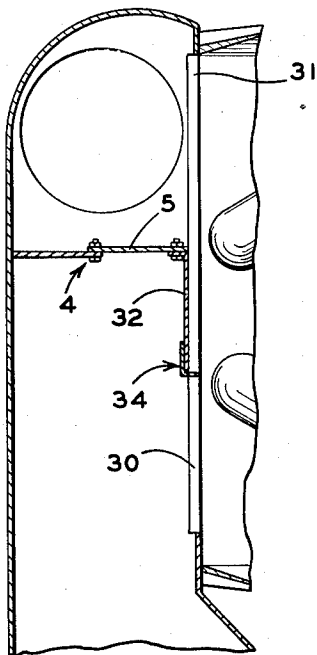


fig. 11

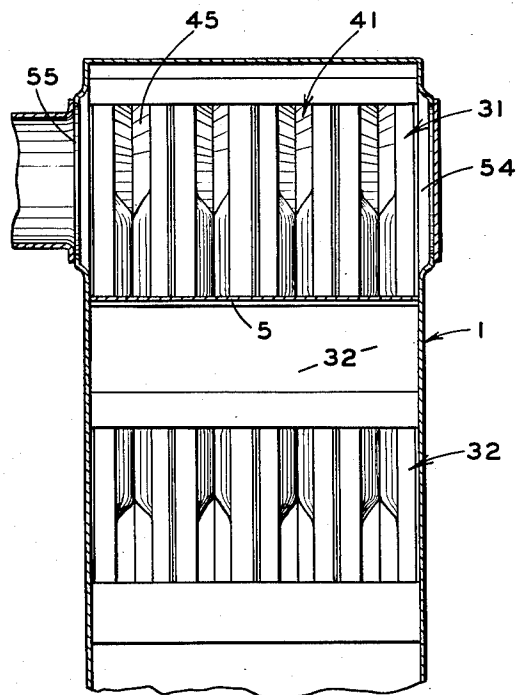


fig. 12

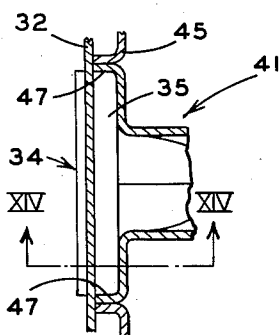


fig. 13

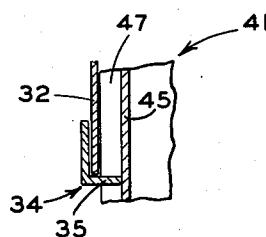
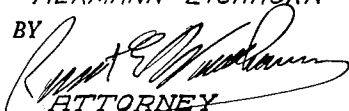


fig. 14

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2,763,260

FURNACE STRUCTURE

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Application February 9, 1953, Serial No. 335,866

4 Claims. (Cl. 126—99)

This application relates to furnaces and more particularly to that part of the furnace which both generates heat by combustion of a fuel and effects heat exchange between the hot combustion gases and a fluid to be heated.

Although a number of factors enter into the overall efficiency of a furnace, one of the most important of these factors is the efficiency of the heat exchanger by which the heat is transferred from the hot combustion gases to the medium which it is ultimately desired to heat. This invention is designed primarily for the purpose of providing efficient heat exchange between hot combustion gases and, in this embodiment, a gaseous fluid.

The problems of obtaining efficiency in heat exchanger designs includes as important factors the length of time the hot gases are kept in heat exchange relationship with the cold gaseous fluid to be heated and the total area available for heat exchange between the two mediums. The greater the area of heat exchange and the longer the two mediums are in heat exchange relationship, the greater will be the total amount of heat exchanged. The design of efficient heat exchangers is made complex by several factors inherent in this type of structure. One of these is the necessity for passing the combustion gases through the heat exchanger at a flow rate sufficient to assure removal of these gases from the combustion chamber at the rate at which they are produced. Unless this is done, the combustion efficiency of the furnace will be materially affected. This problem is generally known as the maintenance of adequate draft in the combustion chamber.

Another factor materially affecting the design of furnace heat exchangers is the necessity of making them readily accessible for periodic cleaning due to the accumulation of deposits of combustion products from the combustion gases on the heat exchanger walls. Unless these deposits are periodically removed, not only will the draft ultimately be seriously impaired but the deposits themselves will act as thermal insulators substantially reducing the heat exchange efficiency of the heat exchanger. Thus, although a maximum number of baffles, consistent with good draft, is still required, the furnace design must permit easy and rapid clean-out thereof. This means that the heat exchanger must permit the ready entrance of cleaning tools and provide accessibility of all parts of the heat exchanger to these tools.

A still further problem in furnace design involves providing a furnace having the desired heat exchange features while remaining of sufficient structural simplicity to be capable of economical manufacture. It is particularly desirable to minimize the number of seams required and to cause those which are used to be generally straight and easy to weld. It is also desirable, in the interest of attaining maximum structural simplicity, to eliminate special clean-out openings and to provide for the easy and rapid clean-out above mentioned by means of openings which are already present for other purposes or which are readily provided.

Another factor limiting the design of heat exchangers

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is the necessity for compactness. The heat exchanger must not be so big, heavy, and unwieldy that it takes up more space than can be economically allocated to it. In other words, the heat exchanger must be designed to effect the greatest thermal interchange in the smallest possible area.

My invention is designed to solve these problems in a new and novel manner, utilizing a simple, inexpensive, compact and efficient heat exchanger structure suitable for use with furnaces of many different types. My invention provides a lightweight and inexpensive heat generator and exchanger suitable for mass production and for ready adaptation to many different circumstances of use. For convenience in reference, the term "heating device" used hereinafter will refer to the combined heat generator and heat exchanger which is disclosed hereinafter and which may be used with a suitable external housing and air moving device to provide what is commonly known in the trade as a unit heater.

These and other objects and purposes of my invention will be immediately seen by those acquainted with the design and construction of furnace equipment upon reading the following specification and the accompanying drawings.

In the drawings:

Figure 1 is a side elevation view of a heating device made according to my invention.

Figure 2 is an end elevation view of said heating device.

Figure 3 is a sectional view taken along the plane III—III of either of Figures 2 and 4.

Figure 4 is a sectional view taken along the plane IV—IV of Figure 3.

Figure 5 is a fragmentary sectional view of my heating device taken along the plane V—V of Figure 3.

Figure 6 is a fragmentary sectional view of my heating device taken along the plane VI—VI of Figure 3.

Figure 7 is a somewhat schematic view in central longitudinal section of a unit heater utilizing my improved heating device.

Figure 8 is a somewhat schematic view in central longitudinal section of a floor based furnace utilizing my improved heating device.

Figure 9 is a section taken on the plane IX—IX of Figure 7.

Figure 10 is a section taken on the plane X—X of Figure 7.

Figure 11 is a section taken on the line XI—XI of Figure 4.

Figure 12 is a section taken on the line XII—XII of Figure 3.

Figure 13 is an enlarged portion of Figure 4 at the inner end of a radiator element.

Figure 14 is a section taken on the line XIV—XIV of Figure 13.

In executing the objects and purposes of my invention, I have provided a barrier in a flue for dividing same into a portion communicating with a combustion chamber and a portion communicating with a stack opening. Placed at one side of the flue, adjacent the barrier, is a heat exchanger through which the gases must pass in order to travel from one side of the barrier to the other side of the barrier and be exhausted. The heat exchanger is provided with baffles to cause the hot combustion gases to travel a tortuous path and thereby remain in heat exchange relationship with the cold fluid also passing through the heat exchanger for a maximum period of time.

In the following description the terms "upwardly" and "downwardly" are frequently used and are to be taken to mean "upwardly" in the direction appearing in Figure 1 and "downwardly" away therefrom. The terms "in-

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ward" and "outward" refer to directions toward and away from the geometric center of the heating device.

Referring specifically to the drawings, I have provided a combustion housing 1 having an enlarged lower portion 2, defining a combustion chamber, and an elongated flue portion 3 extending therefrom. Received into the lower portion 2 is a burner, as an oil burner, and a blower for supplying combustion air thereto, if desired.

Mounted within the elongated portion 3 is a barrier 4 (Figure 3) adjacent the upper end thereof, and extending all of the way across said elongated portion to divide said housing 1 into a portion 7 communicating with the combustion chamber and a portion 8 communicating with the stack. Part of said barrier 4 will preferably comprise a removable plate 5 for purposes appearing hereinafter. Apertures 9 may be provided in the barrier 4 and adjustably closed by the perforated plate 10 as hereinafter mentioned. Further, in many instances, it will be desirable to provide relatively small openings 33 (Figure 4) permanently in the barrier 4. These appear materially to improve the flow of combustion products to stack but without noticeably increasing the stack temperature.

A pair of openings 30 and 31 (Figure 11) are provided through the side of the elongated flue portion 3, the opening 30 being below the barrier 4 and the opening 31 being above the barrier. Preferably the wall 32 separating said openings is affixed to the plate 5 and is removable with it from its operating position. The openings 30 and 31 extend substantially the full width of the elongated portion 3 and provide communication between the elongated portion and the heat exchanger 40.

The heat exchanger 40 includes a plurality of radiator elements 41 each in open communication with both of the openings 30 and 31. Each of these radiator elements includes a hollow housing formed by a pair of generally dish-shaped, sheet metal components 42 (Figures 5 and 6), which are engaged by their peripheral rims 43 along three of their sides. The rim has a lip 44 parallel to the main portion of the component. The lips 44 of each pair of components are joined along the top, bottom and rear ends of said components 42 to form a radiator element enclosing a vertically elongated, laterally narrow, chamber, said chamber having an open front end. The joining of the components is preferably done by means of welding. Each of the sheet metal components 42 along the open end of the chamber 41 is equipped with an outwardly extending flange 45 (Figures 4 and 13) serving as a means for spacing the radiator elements 41 one from another and having terminal flanges 47 for attaching the radiator elements either to the furnace or to a support frame which, in turn, will be attached to the combustion housing. The radiator elements may be attached to said housing by any suitable means such as screws, bolts or welding. Which one is chosen will depend upon whether the heat exchanger is designed to be readily removable. The radiator elements may be attached individually or as a group. If they are made removable, the radiator elements may be made individually removable or removable as a group for repair or cleaning purposes. In operating position, the radiator elements 41 are mounted in side by side relationship with the terminal flanges 47 of one radiator element contacting the terminal flanges 47 of each adjacent radiator element to properly space the elements and to provide a barrier against the escape of combustion gases into the channels 46 between them.

A plurality of angle members 34 (Figures 3, 13, and 14) are preferably positioned at the lower end of the wall 32. The legs 35 of each of them extend to the flanges 45 of the several radiator elements and fill the space between each pair of flanges 47 connected therewith.

Each component 42 of each radiator element is provided with a pair of diverging baffles 50 and 51 (Figures 3 and 5). These baffles are formed by pressing a rib

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into the material to form a ridge extending in the same direction and to the same extent as the peripheral rim 43 surrounding the three sides of the section. When the components are assembled, the ribs of one component contact the ribs of the other (Figure 5) and are joined by welding to form a barrier extending across the chamber. The baffles 50 and 51 are adjacent the barrier 4 and, the ends of said baffles closest to said open front end are spaced from said front end, and said ends of said baffles are separated a short distance vertically and diverge at an angle of approximately 60° in a direction away from the combustion housing 1. The baffles are elongated away from the elongated part 3 and extend outwardly approximately one-half the width of the radiator elements. The baffles are so located that the end of baffle 50, adjacent the combustion housing, is approximately level with the top of the opening 30 and at its outward end it is substantially below this level. The baffle 51 at its end adjacent the combustion housing is just below the bottom of opening 31 and at its other end it is substantially above this level.

Vertically midway between the baffles 50 and 51 and adjacent their outward divergent ends is a third baffle 52 of elongated design having its axis aligned horizontally. The end of baffle 52 lying closest to the open front end of said chamber is spaced rearwardly from the ends of baffles 50 and 51 closest to said front end, and the other end of said baffle 52 lies outwardly of the other ends of baffles 50 and 51. This baffle is so located that gases attempting to pass upwardly, after rounding the outward end of the baffle 50, must either curve inwardly or outwardly to pass around it. Thus, the inward end of this baffle intersects the vertical line connecting the outward ends of the baffles 50 and 51. The purpose of these baffles will appear more fully hereinafter.

Surrounding the radiator formed by the radiator elements as a group is a rectangular jacket 53 open at its top and bottom. The space enclosed by the jacket 53 and surrounding each of the radiator elements constitutes the channels 46 through which air or other fluid to be heated, is moved in heat exchange relationship with the surfaces of the radiator elements to receive heat from the combustion gases passing through the radiator elements.

The upper portion of the elongated portion 3, comprising the portion 8, has an opening 55 at one end and communicates with the opening 31 whereby gases discharged from the heat exchanger 40 are allowed to escape to an appropriate disposal stack. The opening 54 provided at the other end of the portion 8 constitutes a clean-out opening as further appearing below. It will be recognized, however, that either opening may be the stack opening and either opening may be the clean-out opening without altering the operation of the heating device.

The various parts of my invention may each be formed from sheet metal of various thicknesses by suitable metal working processes. Each of the various elements may be joined by suitable means such as screws, bolts, or welding, depending upon whether a permanent or a detachable joint is desired. My invention entirely eliminates the necessity for castings and as a consequence eliminates the high cost and weight characteristic of cast components.

Figure 7 illustrates the heating device of the invention used with a fan and external housing to provide a unit heater of the suspension type. A rectangular, external, housing 80 is divided into two sections by a perforated partition 81. A blower 62 of any conventional type occupies one section 64 and the heating device occupies the heating section 65. The heating device is preferably spaced on all sides from the walls of the housing 80 (Figures 9 and 10). Thus, air is drawn in from the rightward end (as appearing in Figure 7) of the unit heater by the blower 62 through the filter 63, if one is used, and thence through the said heating section 65.

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In going through the section 65, the air travels through the heat exchanger 40 and also contacts the sides of the combustion chamber 1, and is heated thereby. It then goes out the leftward end of the unit heater.

Figure 8 indicates the use of the heating device of the invention in a floor supported, vertically positioned furnace. Here the blower 70 directs air from the return duct 71 through a filter 72, into the combustion chamber 1, through the heat exchanger 40, thence into the bonnet 73 and finally out through the ducts 74 and 75. Alternatively, the blower may be omitted and the air permitted to flow by gravity.

Operation

The hot combustion gases are forced by the blower of the burner to flow from the combustion portion 2 of the housing 1 upwardly into the elongated portion 3 and thence through the opening 30 into the heat exchanger 40. When the furnace is first started and before the chimney, or stack is hot, it may be desirable to improve the draft by opening the openings 9 by proper movement of the plate 10, but the normal operation of the device will be with the openings 9 closed as shown.

After entering the heat exchanger 40, the gases are forced by the baffles 50, 51, and 52 to trace a tortuous path, first downwardly and outwardly, then upwardly and inwardly, then outwardly and upwardly and finally inwardly and downwardly in order to escape through the heat exchanger to the discharge flue. This tortuous path has the effect of keeping the gases in heat exchange relationship with all the walls of the radiator elements for a substantially longer period of time than would be true if the baffles 50, 51, and 52 were not present. Furthermore, the baffles cause these gases to spread out and not be concentrated in a narrow stream flowing through only a portion of the heat exchanger. This assures effective use of all portions of the heat exchanger's surfaces. To this end, it should be noted that the gases may pass around the outside end of the baffle 52 by means of the passageway 60 and the inside ends of the baffles 50 and 51 by means of the passageways 61. These secondary passageways are provided to prevent the creation of closed pockets. Since the gases are forced to flow through the heat exchanger 40 they will escape through all available openings. These secondary channels cause the gases to spread out through all parts of the heat exchanger.

By reason of my construction, the heat exchange portion of the furnace may be placed in such a position with respect to the combustion chamber that the maintenance and cleaning of the heat exchange unit is greatly facilitated. This is accomplished by, first, removing the wall 32 and the removable plate 5 through the clean-out opening 54 and, second, reaching in through said clean-out opening with a suitable brush by which the entire interior of the heat exchanger becomes fully accessible.

Further, the location of the heat exchanger outside of the combustion housing permits the fluid to be heated to flow directly through the heat exchanger, an operation which is often not possible when the heat exchanger is located within the combustion housing. In the construction shown, convection currents may be, if desired, relied upon to cause the fluid to pass upwardly through the jacket 53 as well as forced air movement.

Placement of the heat exchanger 40 outside the combustion housing effects another important improvement. It makes possible the application of radiators of various sizes and shapes to the same basic combustion housing unit without the necessity of any changes in the combustion unit itself. Thus, a basic combustion unit may be used and, within reasonable limits, the size of the burner varied and accordingly the size of the heat exchanger may be varied without necessitating a change in the combustion housing design. This greatly reduces the cost of the over-all furnace.

While I have described my invention as utilized for the

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heating of a gaseous medium, it will be recognized that, with slight modifications in its construction, particularly in the strength of the jacket and perhaps in the gauge and type of material used to form the radiator elements, my heat exchanger may be used for heating a liquid. Whether the heat exchanger is designed for heating a gaseous or a liquid fluid, the same principles will be employed. Therefore, such a heat exchanger is well within the concept of my invention.

These and other modifications of my invention may each be made without departing from the principle of my invention. Each of these modifications is to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. In a radiator element for a heat exchanger, the combination comprising: a hollow housing defining an internal chamber, said housing including a pair of spaced walls facing each other, each of said walls having a rim on its top, bottom and rear ends, said rims on said top, bottom and rear ends of said walls being joined to seal the housing, said housing being open only at its front end; means extending across said front end of said housing to provide a pair of openings through said front end into said internal chamber; means on said spaced walls defining a pair of spaced, elongated baffles in said chamber, said baffles converging toward said front end, the ends of said pair of baffles closest to said front end being spaced from said front end and from each other; means on said spaced walls defining a third elongated baffle, the longitudinal axis of said third baffle lying substantially at a right angle to said front end, the end of said third baffle closest to said front end lying between said pair of baffles and being spaced rearwardly from the ends of said pair of baffles closest to said front end, the other end of said third baffle lying outwardly of the ends of said pair of baffles which are remote from said front end.

2. The combination of claim 1 wherein said housing defines a substantially rectangular internal chamber, the ends of said pair of baffles remote from said front end and the other end of said third baffle being spaced from said rims.

3. A furnace comprising in combination: a combustion chamber, a flue extending from, and communicating with, said combustion chamber; means defining a stack opening communicating with said flue adjacent the end thereof remote from said combustion chamber; a heat exchanger communicating with said flue and located outside of said flue, said heat exchanger including a plurality of radiator elements attached to said flue, each of said radiator elements including a hollow housing defining an internal chamber, said housing including a pair of spaced walls facing each other, each of said walls having a rim at its top, bottom and rear ends, said rims on said top, bottom and rear ends of said walls being joined to seal the housing, said housing being open only at its front end, said open front end providing a communicating opening between said flue and said internal chamber; baffles in said internal chamber defining passageways for the combustion gases, said passageways communicating with said open front end whereby said internal chamber may be easily cleaned; an angle member having one of its legs extending across said front end of said housing to divide said communicating opening into a pair of openings into the internal chamber of each radiator element; a barrier extending across said flue between said stack opening and said combustion chamber, said barrier including a fixed plate secured to said flue and a removable plate detachably secured to said fixed plate extending across the entirety of said flue forwardly of said front end, said removable plate having a leg supported upon said angle member; a clean-out opening in said flue through which said removable plate and said leg may be removed and through which a cleaning tool may be inserted through

either of the openings into the passageways in each of the internal chambers.

4. The combination of claim 3 wherein said fixed plate of said barrier has apertures therethrough and including a perforated plate mounted on said fixed plate for selectively closing the apertures in said first plate.

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