United States Patent

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[54] **HEAT EXCHANGERS**
10 Claims, 4 Drawing Figs.

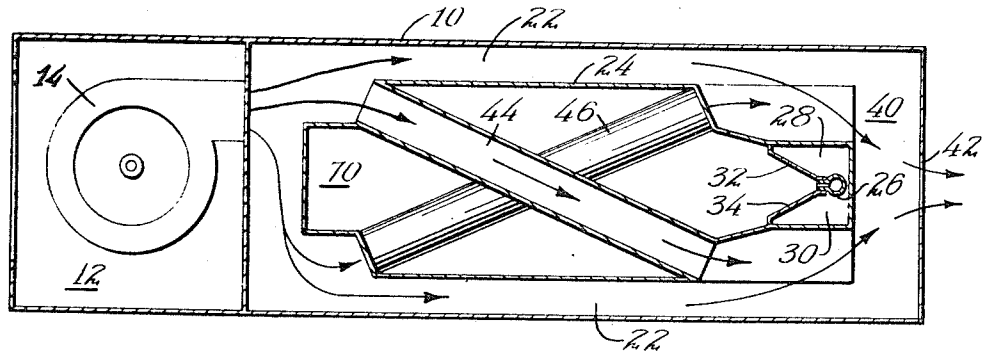
[52] **U.S. Cl.** ..... **126/110 R,**
126/104 A, 126/116 R
[51] **Int. Cl.** **F24h 3/08**
[50] **Field of Search** 126/110,
110 B, 116, 116 B, 104, 104 A, 90, 91

[56] **References Cited**
UNITED STATES PATENTS

1,389,408	8/1921	Wilputte	126/104 A
3,068,854	12/1962	Freeman	126/110

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ABSTRACT: A high-flame facing area heat exchanger in which the air passageways pass both around and through the combustion chamber in a repetitive crisscross pattern. Some of the passageways which pass through the chamber are isolated and connected to feed the burner with preheated combustion air.



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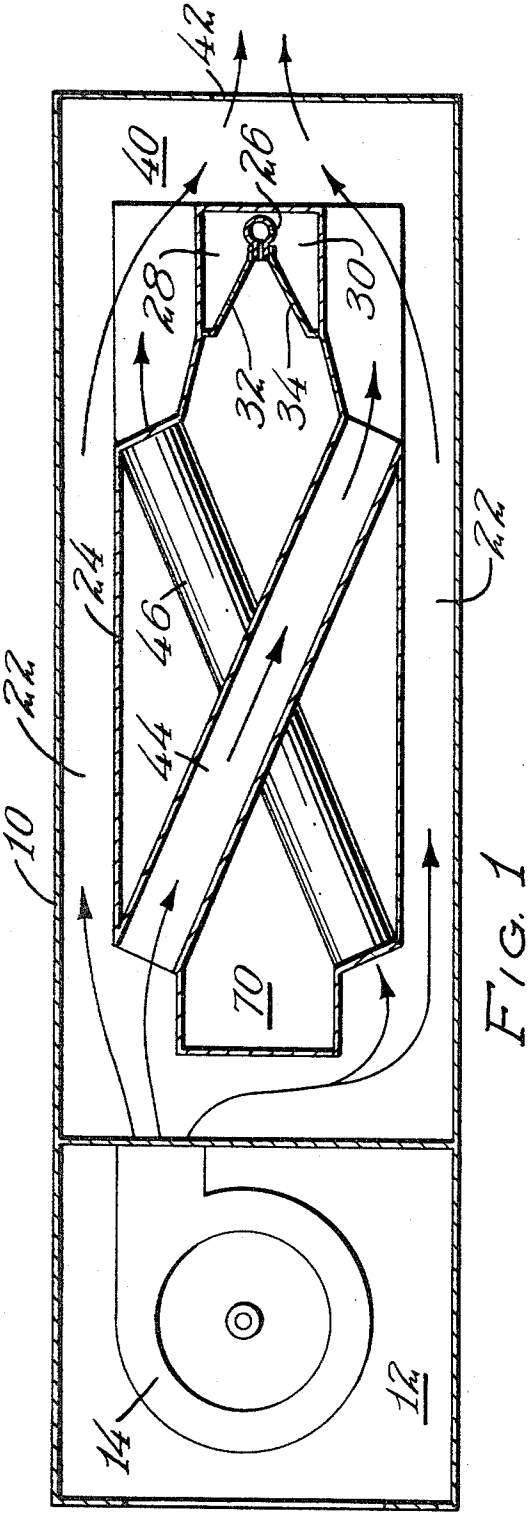


FIG. 1

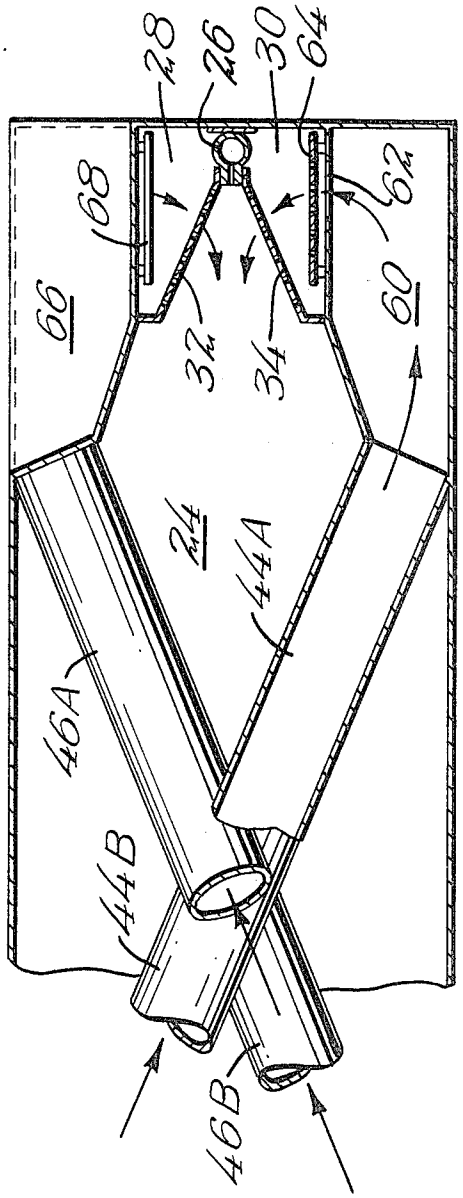


FIG. 2

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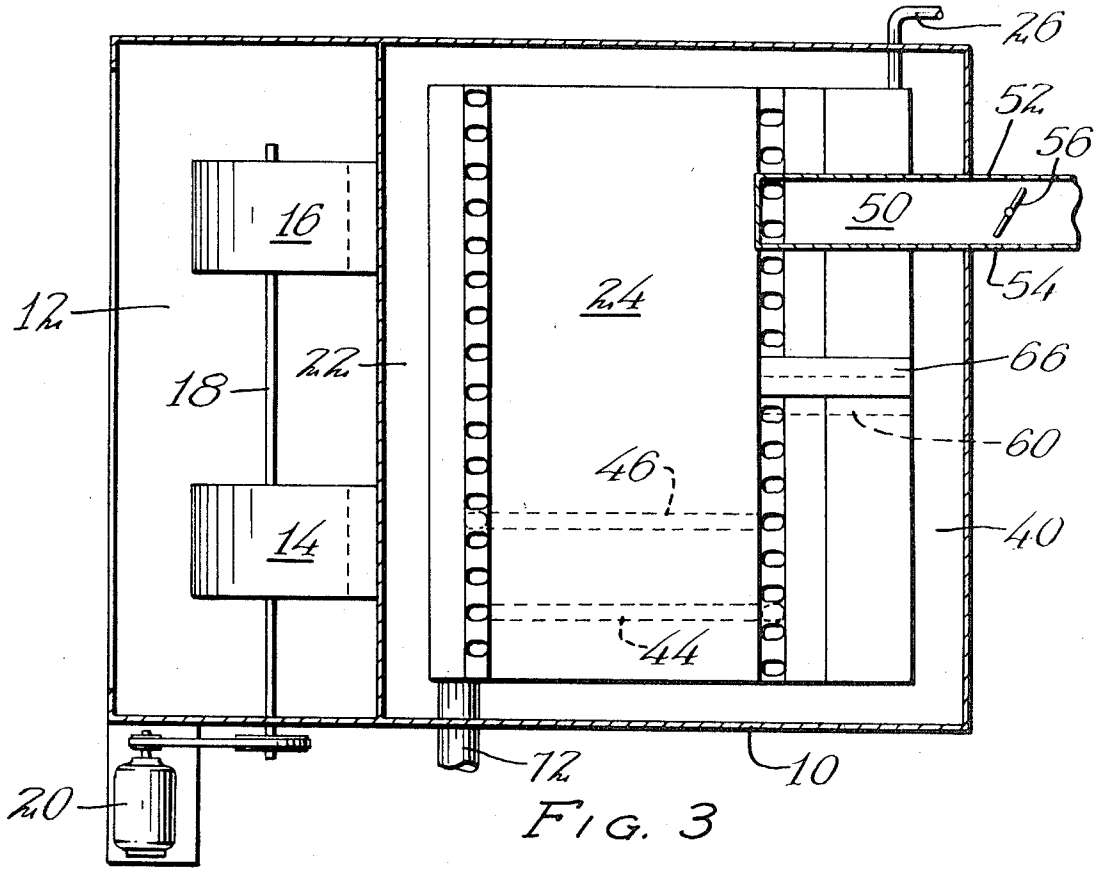


FIG. 3

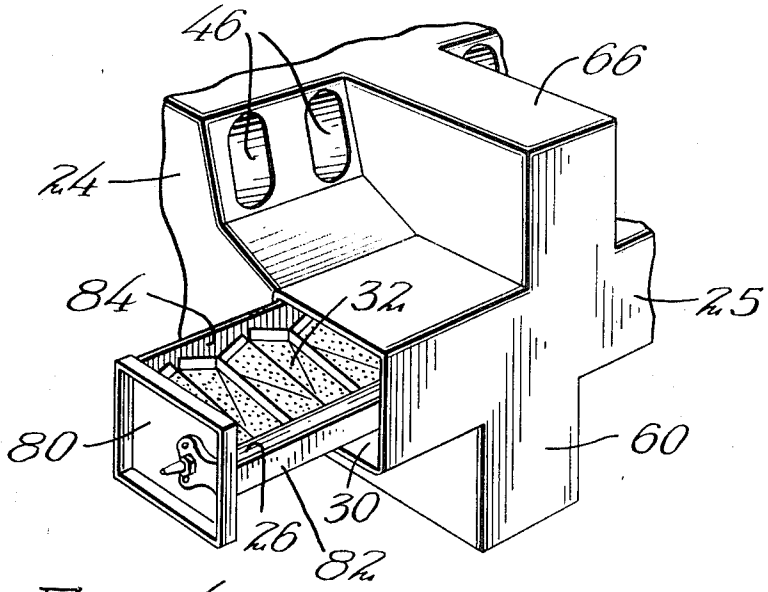


FIG. 4

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HEAT EXCHANGERS

BACKGROUND OF THE INVENTION

In the prior art, heat exchangers typically burn gas and air in a combustion chamber and direct the hot exhaust gases through an extended metal tube which can be folded upon itself, coiled, or arranged in a variety of configurations. The air which is to be heated is circulated amongst this tube configuration to pick up heat by conduction. Such an arrangement generates a large amount of heat near the combustion area and a low amount of heat far down the tube from the combustion area. As a result, the systems have been found to be inefficient, Furthermore, tubes near the combustion area receive relatively excessive amounts of heat and often burn out. The size of the prior art units are cumbersome and the known arrangements do not lend themselves to multiple zone heating applications. My invention avoids the above mentioned problems by means of a unique, compact heat exchanger configuration.

SUMMARY OF THE INVENTION

Briefly, the present invention contemplates an elongated combustion chamber which has a narrow portion along one of the long sides. Over substantially the entire length of this narrow portion air and gas apertures supply and generate a flame which heats the chamber. The air to be heated is circulated not only around the combustion chamber but also through a large number of crisscrossing tubes which pass through the combustion chamber.

Maximum efficiency in a heat exchanger is accomplished by subjecting all of the metal heat transfer surfaces to both hot exhaust gases and direct thermal radiation from the flame. My invention, in contrast to the prior art, provides a design wherein a very large percentage of the available heat exchanging surface faces the flame and thereby enjoys this ideal situation. In addition, the various heat exchange surfaces across the width and length of the present heat exchange unit receive the same degree of heating so that the design has no unduly hot or cold spots as in the prior art. Thus, the present invention is particularly well suited to zone heating applications as will be described presently. It is apparent from the foregoing that it is an object of my invention to provide an improved heat exchanger design. It is a further object to provide a heat exchanger of high efficiency wherein localized hot and cold spots are minimized and the flame facing heat transfer surface area is maximized. Further objects and advantages will become apparent from the following description and drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic sectional end view of the major components and passageways of the preferred embodiment showing generally the direction of air flow through the apparatus by means of arrows.

FIG. 2 is an enlarged schematic sectional cutaway drawing showing in greater detail the burner elements of FIG. 1.

FIG. 3 is a schematic sectional side view of the apparatus of FIG. 1 showing some additional elements including a typical zone heating modification.

FIG. 4 is a perspective detailed view of the burner assembly showing the slide out capability utilized in the preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a furnace housing **10** is shown having a separate compartment **12** in which an air blower **14** is positioned. A brief reference to FIG. 3 will demonstrate that the preferred embodiment utilizes, in fact, a pair of blowers **14** and **16** driven by a common shaft **18** from a motor **20** operating through a belt and pulley connection. Referring simultaneously to the end view of FIG. 1 and the side view of FIG. 3 it may be seen that air from blowers **14** and **16** is directed into a

plenum chamber **22**. Disposed within plenum chamber **22** is a combustion chamber **24** within which gas and air are burned. It should be understood that the present invention has applicability for different types of fuel and is not limited to the particular type of heat generating mechanism shown herein. In the preferred embodiment gas enters by means of a fuel feed tube **26** and is directed therefrom through a series of small nozzles into combustion chamber **24** along substantially the entire length of the combustion chamber **24**. The direction along which fuel feed tube **26** is positioned is defined as the elongate direction for convenience although it should be understood that some versions of my invention could indeed be shorter in the elongate direction than in the direction orthogonal to the elongate direction. Air is introduced into a pair of plenum chambers **28** and **30** which are in communication with the combustion chamber by means of a series of perforated plate members **32** and **34**.

Air from blowers **14** and **16** enters plenum chamber **22** and passes around combustion chamber **24**, as indicated by the arrows, into an exhaust plenum chamber **40** and thence outward through a vent **42** to be utilized as desired. In addition, air from the blowers passes through a large number of crisscrossing interwoven heat exchange tubes **44** and **45** which are positioned to pass through combustion chamber **24** diagonally. In the preferred embodiment sixteen diagonal tubes **44** and 16diagonal tubes **46** are shown although any number may be utilized depending on the particular size heat exchanger contemplated. A further understanding of the crisscrossing arrangement of the heat exchanging tubes **44** and **46** may be had by reference to FIG. **3** wherein two of these tubes are shown by means of dashed lines **44** and **46**. To keep the drawing simple the remaining tubes are not shown with dashed lines in FIG. **3**.

As mentioned earlier, maximum efficiency in a heat exchanger is accomplished when the heat exchanging surfaces contact not only the hot combustion gases but also view or face the combustion area so that heat may be received by direct thermal radiation. Since, in my invention, the combustion takes place in the area between perforated plates **32** and **34** it may be readily seen in FIG. **1** and FIG. **2** that a maximum amount of the interior surface of tubes **44** and **46** faces the combustion area. Also, the whole combustion chamber receives approximately equal heating so that there are no localized hot or cold spots. Furthermore, the combustion area extends from top to bottom in FIG. **3** so that all of the tubes **44** and **46** and all of the combustion chamber receives an equal amount of conductive and radiant heating. Consequently, the heat exchanger of the present invention is particularly suitable for zone heating application as indicated in FIG. **3**.

In FIG. **3** a separate compartment **50**, not shown in FIGS. **1** and **2**, has been shown in the exhaust plenum chamber **40** defined by walls **52** and **54**. With this type of separate compartment, heat from just a few selected tubes may be directed to a particular zone. The amount of flow is controlled by a suitable damper or butterfly valve **56**. Any number or size of compartments such as enclosure **50** may be positioned to accept heat from various different sets of tubes in FIG. **3** without difficulty since the entire exchanger is heated equally along its length. Therefore, zone heating applications become relatively easy with the present invention.

In order to provide air to the combustion feed plenum chambers **28** and **30** some of the diagonal heat exchange tubes **44** and **46** are closed off from the normal air flow path and connected so that the air from those tubes is directed into plenum chambers **28** and **30**. This operation may be more readily understood with reference to FIG. **2**.

In FIG. **2**, two of the diagonal tubes have been connected so as to direct preheated air into the combustion chamber. The section of FIG. **2** passes through the center of diagonal tube **44A**. The air from tube **44A** passes into a chamber **60** which is closed off from the normal exhaust plenum chamber **40** shown in FIG. **1**. The air continues from chamber **60** through a vent hole **62** and against a perforated deflector plate **64**. Deflector

plate **64** serves to prevent a localized blast of air against perforated plate **34** and helps distribute the incoming air throughout plenum chamber **30**. Small perforations in perforated plate **64** ensure that the air will not be totally blocked from the particular area of perforated plate **34** opposite plate **64**. The preheated air in plenum chamber **30** passes through perforated plate **34** into the combustion area inside combustion chamber **24**. In FIG. **2** the very next cross diagonal tube **46A** is utilized to bring preheated air to the other side of the combustion chamber. Since tube **46A** is lower, in FIG. **2**, than tube **44A**, it is not shown in section but enters a compartment **66** in the same manner. The preheated air from tube **46A** passes through compartment **66**, through a suitable opening, and against a deflector plate **68** in plenum chamber **28**. The air passes through perforated member **32** as described with respect to the other side of the heat exchange unit. After combustion takes place the hot exhaust gas passes over the diagonal heat exchange tubes and travels down to the opposite end of combustion chamber **24** to an area generally designated by the numeral **70** in FIG. **1**. From there the exhaust gases travel out an exhaust pipe **72** which is shown more clearly in FIG. **3**.

FIG. **4** shows in a much shortened version how the design of the burner mechanism permits easy removal. Perforated members **32** and **34** and the gas supply pipe **26** are supported by an end plate **80** and a pair of lengthwise support members **82** and **84**. Consequently, the whole assembly may be slid easily in and out of a generally rectangular recessed portion **25** at the side of combustion chamber **24**. When the burner assembly is inserted in recessed portion **25** it serves to define and segregate the two combustion plenum chambers **28** and **30**.

It will be readily apparent that numerous variations may be made to the present invention without departing the spirit and scope of the concept herein involved. For example, an additional blower may be connected to supply air exclusively to the diagonal tubes which are connected to feed plenum chambers **28** and **30**. The passageways can be modified in shape or a bypassageway employed to mix cool air with the heated air. Thus, I do not intend to be limited to straight diagonal tubes, or to a combustion chamber formed exactly in the shape of chamber **24**, nor to the particular heat generating means utilized, or any of the passageway configurations shown except as defined by the appended claims.

I claim:

1. A fuel burning heat exchanger comprising in combination:

a combustion chamber having an elongate direction and a multitude of apertures along a first side which is generally parallel to said elongate direction, said multitude of apertures adapted to admit air to said combustion chamber over substantially the entire elongate length of the combustion chamber and further having a plurality of apertures contiguous to the air admission apertures, said plurality of apertures connected to a source of fuel and adapted to admit fuel to said combustion chamber over substantially the entire length of the combustion chamber;

first plenum chamber means connected to said multitude of apertures so as to supply air thereto;

a plurality of air passageways disposed around and through said combustion chamber shaped to present a maximum area toward the combustion area inside said combustion chamber;

means connecting at least one of said air passageways disposed through the combustion chamber to said first plenum chamber means so as to supply preheated air thereto; and

blower means connected to said plurality of air passageways operable to move air therethrough.

2. The apparatus of claim **1** in which said plurality of air passageways disposed around said combustion chamber are defined by an outer housing surrounding said combustion chamber, said plurality of passageways around the combustion chamber comprising the spaces between the combustion chamber and said outer housing; and in which the plurality of air passageways disposed through said combustion chamber comprise heat conductive tunnels passing through generally orthogonal to said elongate direction.

3. The apparatus of claim **2** in which said tunnels comprise a first groups of generally similar tubes interwoven with a second group of generally similar tubes.

4. The apparatus of claim **3** in which said first group of tubes pass through the combustion chamber generally in a first diagonal direction and said second group of tubes pass through the combustion chamber generally in a second diagonal direction which forms an angle with respect to said first diagonal direction so that the exit ends of the tubes pass on either side of said first side of said combustion chamber with said multitude of apertures therebetween.

5. The apparatus of claim **4** in which said multitude of apertures comprise first and second apertures members positioned on each side of said plurality of fuel admission apertures and said first plenum chamber means comprises a first chamber in communication with said first apertured member and a second chamber in communication with said second apertured member.

6. The apparatus of claim **5** in which at least one of said first group of generally similar tubes is connected at its exit end to said first chamber and at least one of said second group of generally similar tubes is connected at its exit end to said second chamber.

7. The apparatus of claim **6** including a second plenum chamber means located and connected between said blower means and the entrance ends of said first and second groups of tubes and the entrance ends of the passageways which pass around the combustion chamber.

8. The apparatus of claim **7** in which said second plenum chamber means is defined by said outer housing and comprises the space between said outer housing and the second side of said combustion chamber which second side is opposite from said first side and disposed generally between the entrance ends of said first and second groups of tubes.

9. The apparatus of claim **8** including deflection plates disposed in said first and second chambers positioned to spread and diffuse air introduced from said tubes and in which plurality of fuel admitting apertures comprise a series of nozzles in a fuel feed tube disposed between said apertured plates and generally along said elongate direction.

10. The apparatus of claim **9** in which said apertured plates and said nozzled fuel feed tube comprise a separate assembly adapted to be removably positioned in a recess in said first side of said combustion chamber so as to form therein said first and second chambers.