United States Patent [19]

McVickar et al.

[11] **3,794,014**

[45] **Feb. 26, 1974**

[54] **HOT-AIR FURNACE**

[75] Inventors: **Dan B. McVickar; Adolf Wolf,** both of Holland, Mich.

[73] Assignee: **Lear Siegler, Inc.,** Holland, Mich.

[22] Filed: **Nov. 26, 1971**

[21] Appl. No.: **202,126**

[52] **U.S. Cl.** ..... **126/110 AA,** 126/110 R

[51] **Int. Cl.** **F24h 3/10**

[58] **Field of Search** ..... 165/130, 131, 128, 129; 126/110 R, 110 B, 110 AA, 116 R; 122/367 C

[56] **References Cited**

UNITED STATES PATENTS

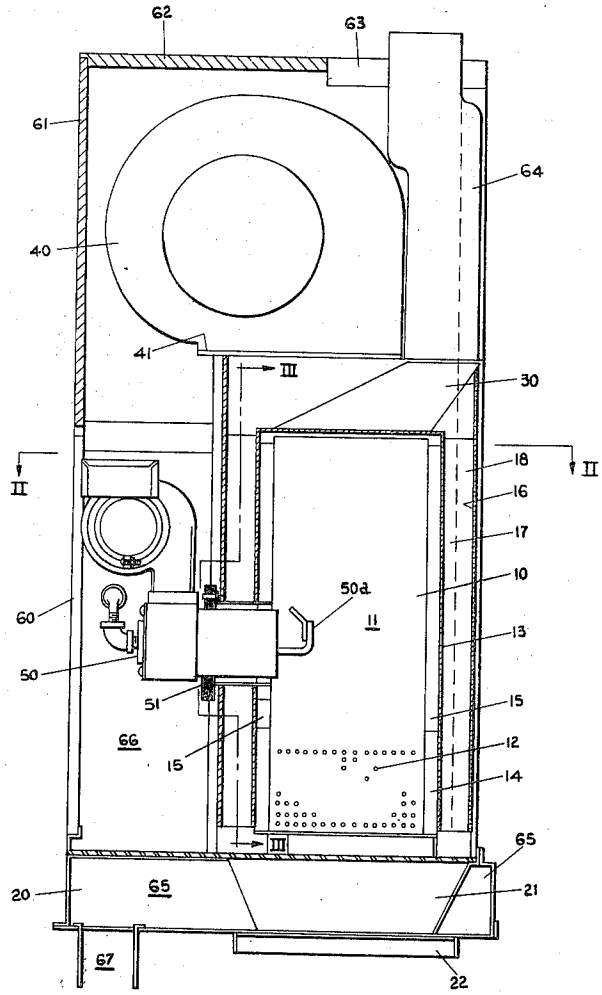
2,620,787	12/1952	Zink	126/110 B
2,386,746	10/1945	Hess	126/110 B
2,857,906	10/1958	Davidson et al.	126/110 B
2,625,150	1/1953	Little et al.	126/110 AA

Primary Examiner—William E. Wayner
Assistant Examiner—William E. Tapolcai, Jr.
Attorney, Agent, or Firm—Price, Heneveld, Huizenga & Cooper

[57] **ABSTRACT**

A hot-air furnace comprising a cylindrical combustion chamber with a plurality of apertures in the lower end of the combustion chamber wall through which flame jets are radially discharged into a flue chamber having a plurality of radiating vertical fins. An air chamber wall with a plurality of radiating vertical fins disposed therein surrounds the flue chamber. A novel blower means is in communication with one end of the air chamber.

8 Claims, 8 Drawing Figures



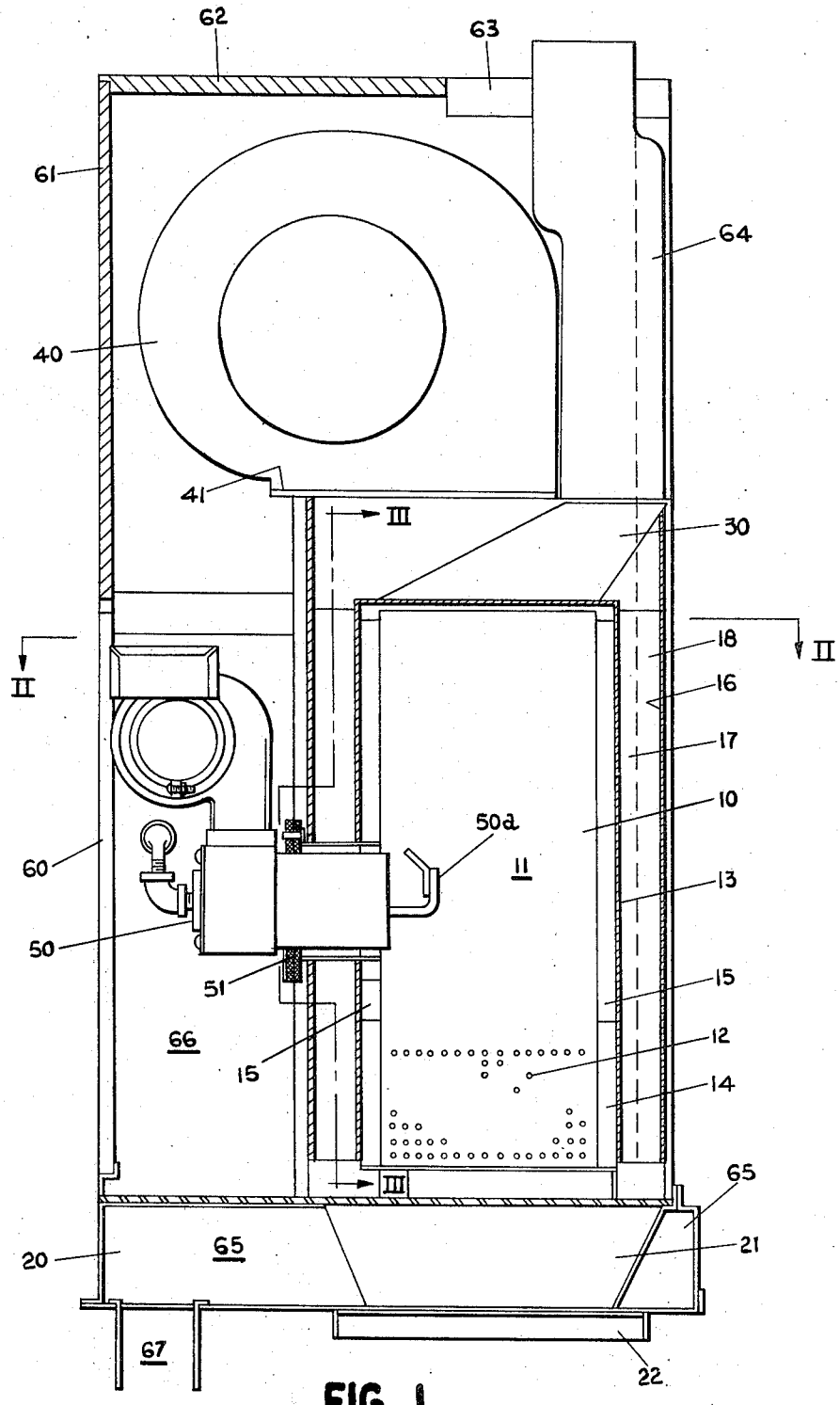

62
63
61
64
40
41
III
30
II
II
18
16
17
10
50a
11
60
13
50
51
15
66
15
12
14
65
III
20
65
21
67
22

FIG. 1

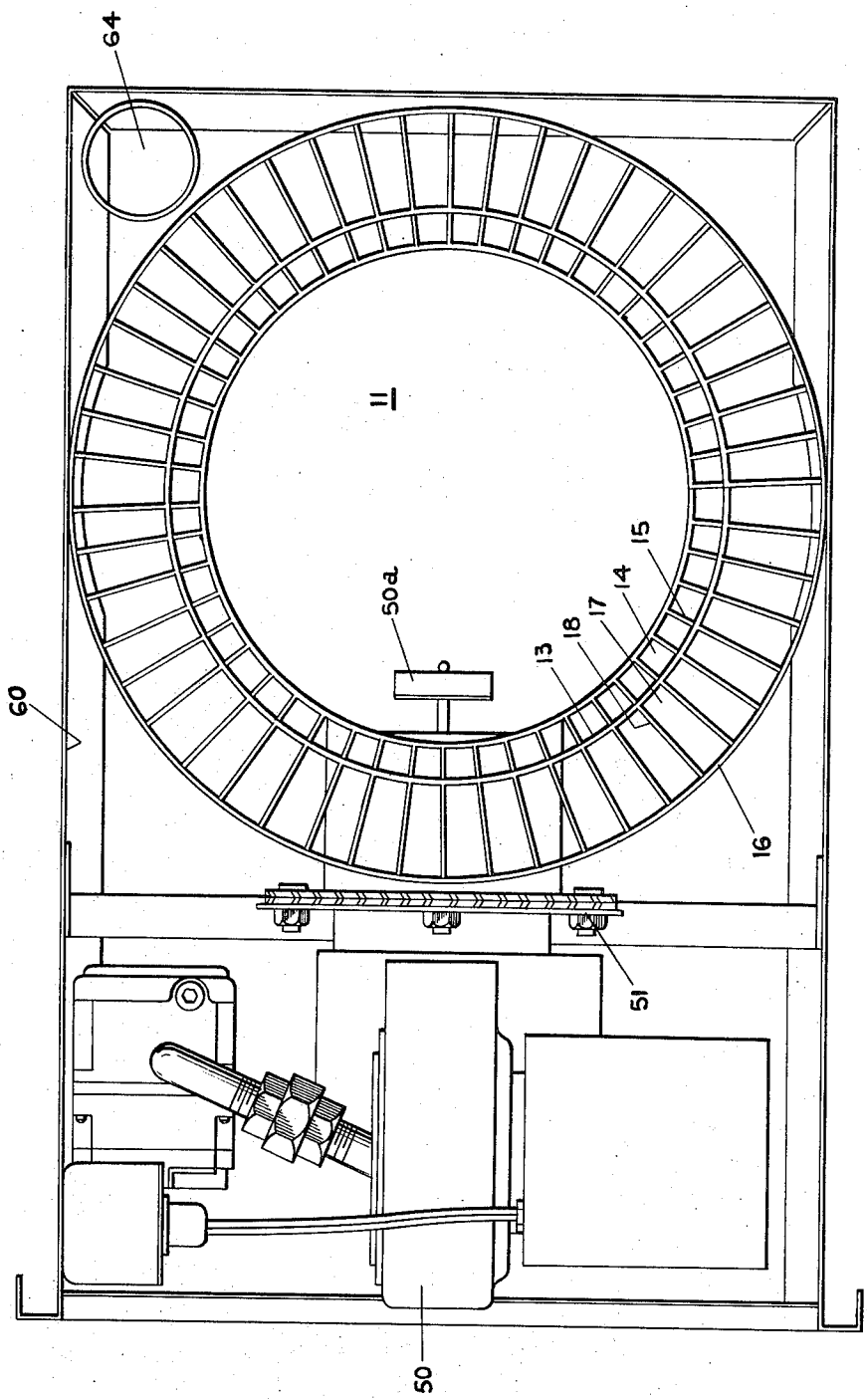


FIG. 2

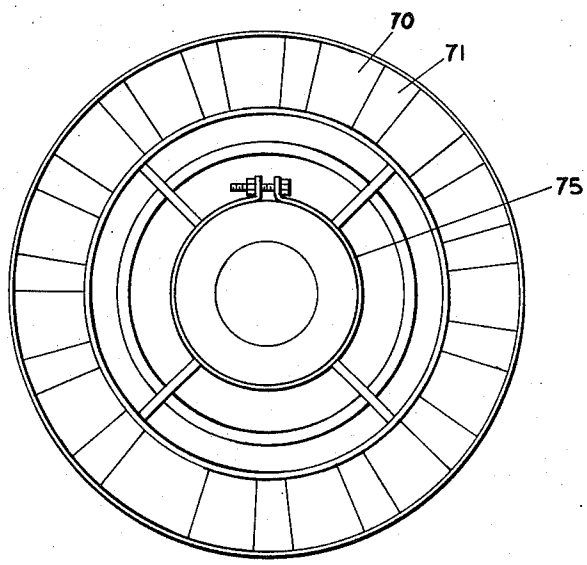


FIG. 8

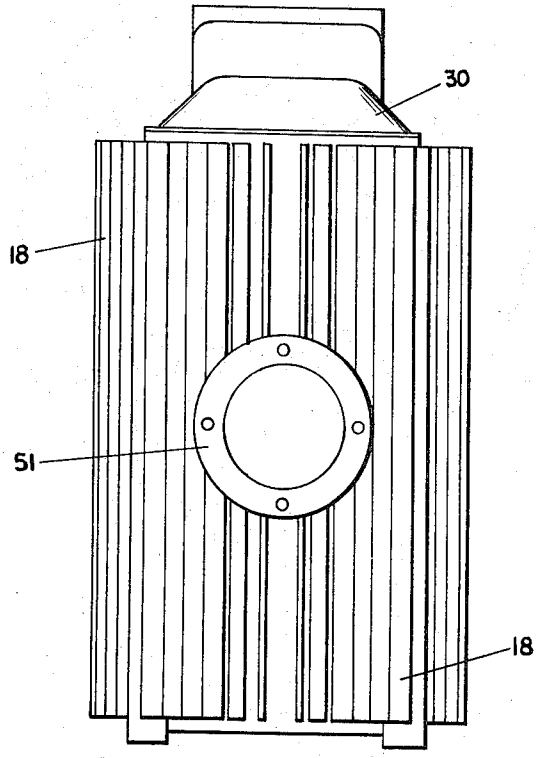


FIG. 3

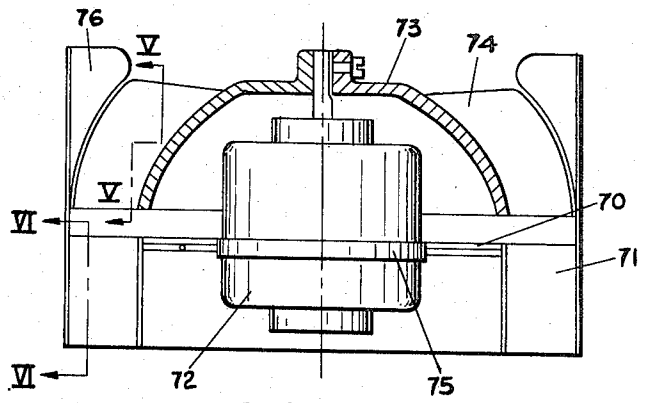


FIG. 4

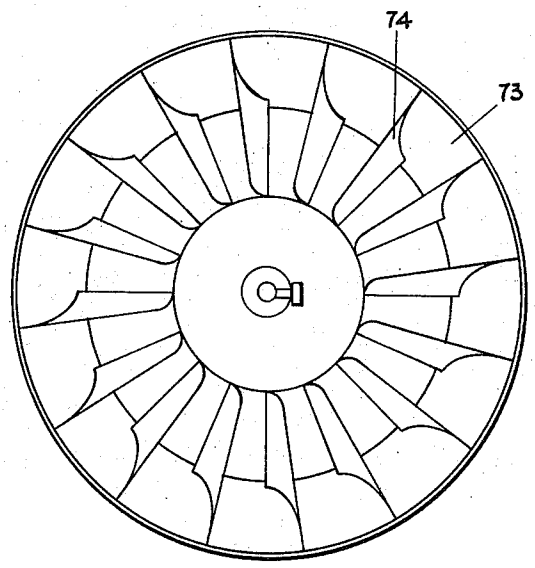


FIG. 7



FIG. 5

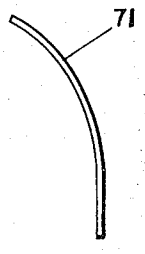


FIG. 6

HOT-AIR FURNACE

BACKGROUND OF THE INVENTION

This invention relates to furnaces, and, more particularly, to an improved hot-air furnace.

Although a wide variety of hot-air furnaces are commercially available today, there is a continuing need for new and improved hot-air furnaces. For example, with the recent increase in popularity of mobile homes and modular and apartment housing, there has been a great deal of interest in reducing the size of hot-air furnaces while maintaining high heat capacities. However, reducing the size of conventional hot-air furnaces while maintaining high heat capacities results in several problems. For example, one problem is durability, since as the size decreases, the high heat capacity tends to be more destructive to the structural components of the furnace. Another problem is versatility, since in mass producing large numbers of small furnaces, it becomes increasingly desirable to have such furnaces interchangeably useful with either gas or oil burners and interchangeable as to air-flow direction, i.e., in mobile homes there is generally a requirement for a downward air flow and in residential homes there is generally a requirement for an upward air flow where the furnaces are often located in basements. Finally, there is a problem with conventional small-size furnaces in that their capacity to accommodate air conditioner cold air passage is limited.

Thus, there is a need for an improved hot-air furnace of small size which has a high heat capacity and is versatile and durable.

SUMMARY OF THE INVENTION

According to the present invention, there is provided an improved hot-air furnace which can be manufactured in small sizes with high heat capacities, which is durable and which is versatile as to both the type of burner used and the air-flow direction required and which can accommodate optimum air conditioner cold air passage.

The improved hot-air furnace comprises a cylindrical combustion chamber having closed ends and a combustion chamber wall, and a plurality of apertures in the lower end of the combustion chamber wall. A flue chamber wall surrounds the combustion chamber wall and forms a flue chamber therebetween, the bottom of the flue chamber being closed. A flue pipe is mounted on top of the flue chamber and is in communication therewith, and a plurality of radiating vertical fins are disposed in the flue chamber. An air chamber wall surrounds the flue chamber wall and forms an air chamber therebetween, and a plurality of radiating vertical fins are disposed in the air chamber. A blower means, preferably an axial flow blower, is in communication with one end of the air chamber, and a burner means is adjacent the air chamber wall, with the burner nozzle being in communication with the combustion chamber through the air chamber wall, the flue chamber wall and the combustion chamber wall. Preferably, the combustion chamber wall, the flue chamber wall, and the air chamber wall are all annular, and the fins in the flue chamber extend from the top thereof to a position short of the bottom thereof, with the majority of the apertures in the combustion chamber wall being below the flue chamber fins.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation cross-sectional view of one embodiment of the hot-air furnace of the present invention;

FIG. 2 is a top cross-sectional view of the hot-air furnace of FIG. 1 taken along the line II—II of FIG. 1;

FIG. 3 is a side elevational view of the heat exchanger of the furnace of FIG. 1 taken along the line III—III of FIG. 1;

FIG. 4 is a side cross-sectional view of an axial-flow blower which is preferred for use in the furnace of the present invention;

FIG. 5 is a cross-sectional view of one of the rotor vanes of the axial flow blower of FIG. 4 taken along the line V—V of FIG. 4;

FIG. 6 is a cross-sectional view of one of the stator vanes of the axial-flow blower of FIG. 4 taken along the line VI—VI of FIG. 4;

FIG. 7 is a plan view of the rotor of the axial-flow blower of FIG. 4; and

FIG. 8 is a plan view of the stator of the axial-flow blower of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in greater detail, FIG. 1 represents a cross-sectional side elevational view of a hot-air furnace of the present invention positioned on base assembly 20 and containing heat exchanger 10. Heat exchanger 10 comprises combustion chamber 11, and flue chamber wall 13 which supports inwardly radiating fins 15 and outwardly radiating fins 18. Combustion chamber 11 has a plurality of apertures 12 in the lower end of the wall thereof. The number, size, spacing and pattern of apertures 12 will depend on the total heat transfer rate desired, since, as discussed more fully hereinafter, small jets of flame shoot out of apertures 12 into the flue chamber 14, one function of which is to add to the overall heat transfer of the heat exchanger. Since the pressure in the combustion chamber 11 resulting from the burner unit will affect the extent to which the jet flames shoot out of the apertures 12, this pressure should also be taken into account in determining the number, size, spacing and pattern of apertures 12. In general, however, it is preferred that apertures 12 are of small size, e.g., about one-eighth inch diameter, and are located substantially around the entire circumference of the lower end of the wall of combustion chamber 11 for uniform heat transfer.

Combustion chamber 11 is closed at both ends. Flue chamber wall 13 surrounds the wall of combustion chamber 11 to form a flue chamber 14 therebetween. A plurality of radiating vertical fins 15 are disposed in flue chamber 14, and, preferably, extend from the top of the flue chamber to a position short of the bottom thereof so that a majority of apertures 12 are below fins 15, as will be discussed more fully hereinafter. Air chamber wall 16 surrounds flue chamber wall 13 to form an air chamber 17 therebetween. A plurality of radiating vertical fins 18 are disposed in air chamber 17, and, preferably extend the entire length of the combustion chamber.

A flue pipe 30 is mounted at the top of flue chamber 14 and is in communication therewith for egress of the flue gases. Above heat exchanger 10, a conventional

rotary blower 40 is mounted on blower deck 41 and is in communication with air chamber 17.

A burner unit 50 is mounted adjacent air chamber 17 in pouch 51 with the burner nozzle extending therethrough to be in commnication with combustion chamber 11. Burner 50 can be any conventional type of power burner, e.g., gas or oil, and the simple mounting of the burner unit to and through pouch 51 permits various burners to be used interchangeably without any changes in the construction or operation of the furnace.

The entire furnace is enclosed by casing 60 which has return air louvered panels 61 and 62 in the vicinity of blower means 40. At the top of casing 60 there is provided a combustion air collector trough 63 which is in communication with combustion air vestibule 66 via combustion air tube 64 and base airway 65. Combustion air collector trough 63 is used when combustion air is supplied through the roof of the dwelling. Combustion air can also be supplied through the floor of the dwelling via air chute 67 directly to base airway 65.

The furnace is supported on base unit 20. Base unit 20 also includes a transition duct 21 which is in communication with air chamber 17. Transition duct 21 is, in turn, in communication with feeder duct 22 for distribution of the hot air to the areas to be heated via conventional ducting.

In FIG. 2, which is a top cross-sectional view of the furnace of FIG. 1 taken along the line II—II of FIG. 1, the fin structure of flue chamber 14 and air chamber 17 is more clearly shown. In the preferred embodiment which is illustrated in FIG. 2, the wall of combustion chamber 11, flue chamber wall 13, and air chamber wall 16 are all annular, and flue chamber fins 15 and air chamber fins 18 are disposed around the entire circumference of flue chamber 14 and air chamber 17, respectively. FIG. 2 also more clearly shows the location of combustion air tube 64 and the mounting of burner unit 50 on and through pouch 51 so that the nozzle thereof and pilot 50a are in communication with combustion chamber 11.

In FIG. 3, which is a side elevational view of the heat exchanger of the furnace of FIG. 1 taken along the line III—III of FIG. 1, the location of flue pipe 30, pouch 51, and air chamber fins 18 are clearly shown.

Referring now to FIGS. 4–8, an axial flow blower which is preferred for use with the furnace of the present invention is illustrated. Referring first to FIG. 4, a side cross-sectional view of the axial flow blower is illustrated. The blower comprises an annular stator 70 having a plurality of generally vertical curved vanes 71 on the periphery thereof. Motor 72 is mounted axially in stator 70. Rotatably mounted on motor 72 is an annular rotor 73 having a plurality of generally vertical curved vanes 74 on the periphery thereof. Finally, shroud means 76, which is a continuous curved circular or doughnut-shaped member, is provided adjacent the rotor to maintain efficient and directional air flow created by the rotating rotor through the stator. FIG. 5, which is a cross-sectional view of one of the vanes 74 of rotor 73 taken along the line V-V of FIG. 4, more clearly shows the configuration of the curved vanes 74. Similarly, FIG. 6, which is a cross-sectional view of one of the vanes 71 of stator 70 is taken along the line VI—VI of FIG. 4, more clearly shows the configuration of the stator vanes 71.

FIG. 7, which is a plan view of the rotor 73 of the axial flow blower of FIG. 4, also more clearly shows the configuration of the vanes 74 of rotor 73 and shows the arrangement thereof around the periphery of rotor 73. FIG. 8, which is a plan view of stator 71 more clearly shows the construction of stator 70 with the arrangement of stator vanes 71 around the periphery of stator 70 and the location of motor mount 75 in the center thereof.

It has been found that the axial flow blower of FIGS. 4–8 provides efficient and high-capacity directional air flow while being of small size, and thus is ideally suited for use with furnaces where small size and high heat capacities are desired such as in the furnace of the present invention.

OPERATION

Referring again to FIG. 1, the operation of the embodiment of the furnace of the present invention shown in FIG. 1 will now be described. As burner 50 is ignited by means of pilot 50a, the flames are directed into combustion chamber 11, the air for complete combustion being supplied to combustion chamber 11 through base airway 65 via either combustion air tube 64 or air chute 67. Apertures 12 in the lower portion of the wall of combustion chamber 11 serve several purposes. First, they permit the egress of flue gases out of combustion chamber 11 into flue chamber 14 to be carried out via flue pipe 30. Second, jets of flame shoot out of apertures 12 and cause a very effective jet heat transfer to flue chamber wall 13. These jets of flame also maintain apertures 12 free of any unburned carbon buildup to eliminate any interference with the egress of the flue gases, and burn any unburned carbon in the bottom of flue chamber 14. Because of the small jets of flame coming out of aperture 12 into the lower portion of flue chamber 14, it is preferred that flue chamber fins 15 do not extend into the region of apertures 12 to avoid burnout of fins 15 by direct contact with the jets of flame.

Thus, by the construction shown in FIG. 1, very efficient heat transfer from combustion chamber 11 to air chamber 17 results. First, the firing of the burner 50 into combustion chamber 11 causes the entire combustion chamber wall, which is preferably stainless steel, to glow and radiate heat to flue chamber wall 13. Second, the jets of flame out of apertures 12 transfer heat to the lower portion of flue chamber wall 13 by jet heat transfer. Third, the spent gases from the jets flow upward and uniformly transfer heat to flue chamber wall 13 by convection and conduction through the fines 15. Finally, the heat which reaches flue chamber wall 13 is transferred by conduction into fins 18 and therefrom via convection to air flowing between fins 18 in air chamber 17. The heated air is then transferred to the ducting via transition duct 21 by blower means 40 which transfers the air from air chamber 17 to the transition duct 21.

There are several advantages to the construction of the furnace of the present invention. The described construction permits a high and efficient rate of heat transfer. With a furnace of small size, e.g., on the order of between about 3 to 4 feet high, 1 to 2 feet wide, and 1½ to 2 feet deep, heat inputs of between about 60,000 to about 200,000 BTU's per hour are possible. In addition, the construction is very durable since the absence of large temperature gradients, i.e., the absence of re-

gions of abrupt and extreme heat changes, results in low stress levels giving long life to the metallic components of the furnace. Furthermore, the preferred annular construction of the combustion chamber, the flue chamber and the air chamber, produces optimum heat transfer and eliminates the undesirable "booming" noises of conventional rectangular constructions. Also, the construction is interchangeable between an upward air flow and a downward air flow furnace by merely switching the location of the blower and the ducting. Finally, the streamlined and unobstructed air chamber **17** allows the blower, the air chamber, and the ducting to be used for high capacity air conditioning cold air passage.

While the preferred embodiments of the present invention have been described and illustrated, it will be obvious that various modifications can be made without departing from the scope of the invention. Accordingly, the scope of the invention is to be limited only by the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1. A hot-air furnace comprising:
- a combustion chamber having closed ends and a combustion chamber wall, and a plurality of apertures in the lower end of said wall;
- a flue chamber wall surrounding said combustion chamber wall and forming a flue chamber therebetween located immediately adjacent to said combustion chamber, the bottom of said flue chamber being closed, said combustion chamber wall forming the only wall between said combustion and flue chambers whereby the apertures in said combustion chamber wall permit jets of flame to shoot out of said combustion chamber into said flue chamber;
- a flue pipe on top of said flue chamber and in communication therewith;
- a plurality of radiating vertical fins disposed in said flue chamber;
- an air chamber wall surrounding and immediately adjacent said flue chamber wall and forming an air chamber therebetween;
- a plurality of radiating vertical fins disposed in said air chamber;
- a blower means in communication with one end of said air chamber; and
- a burner means adjacent said air chamber wall, the burner nozzle of said burner being in communication with said combustion chamber through said air chamber wall, said flue chamber wall and said combustion chamber wall.

2. A hot-air furnace according to claim **1** wherein said fins in said flue chamber extend from the top of said flue chamber to a position short of the bottom of aid flue chamber and a majority of said apertures in said combustion chamber wall are below said position.

3. A hot-air furnace according to claim **1** wherein said combustion chamber wall, said flue chamber wall, and said air chamber wall are all annular.

4. A hot-air furnace according to claim **1** wherein said blower means is mounted on one end of said air chamber.

5. A hot-air furnace according to claim **4** wherein said blower means is mounted on the top of said air chamber.

6. A hot-air furnace comprising:
- a combustion chamber having closed ends and a combustion chamber wall, and a plurality of apertures in the lower end of said wall;
- a flue chamber wall surrounding said combustion chamber wall and forming a flue chamber therebetween located immediately adjacent to said combustion chamber, the bottom of said flue chamber being closed;
- a flue pipe on top of said flue chamber and in communication therewith;
- a plurality of radiating vertical fins disposed in said flue chamber, said fins including fins which extend radially a substantial distance between said flue chamber wall and said air chamber wall and longitudinally from the top of said flue chamber to a position short of the bottom of said flue chamber, and a majority of said apertures in said combustion chamber wall being below said position;
- an air chamber wall surrounding and immediately adjacent said flue chamber wall and forming an air chamber therebetween;
- a plurality of radiating vertical fins disposed in said air chamber;
- a blower means in communication with one end of said air chamber; and
- a burner means adjacent said air chamber wall, the burner nozzle of said burner being in communication with said combustion chamber through said air chamber wall, said flue chamber wall and said combustion chamber wall.

7. A hot-air furnace according to claim **6** wherein said apertures are of small size and are located substantially around the entire circumference of the lower end of said combustion chamber wall whereby jets of flame are permitted to shoot out of said combustion chamber into said flue chamber via said apertures to uniformly supplement the heat transfer between said combustion chamber and said flue chamber.

8. A hot-air furnace comprising:
- a combustion chamber having closed ends and a combustion chamber wall, and a plurality of apertures in the lower end of said wall;
- a flue chamber wall surrounding said combustion chamber wall and forming a flue chamber therebetween, the bottom of said flue chamber being closed;
- a flue pipe on top of said flue chamber and in communication therewith;
- a plurality of radiating vertical fins disposed in said flue chamber;
- an air chamber wall surrounding said flue chamber wall and forming an air chamber therebetween;
- a plurality of radiating vertical fins disposed in said air chamber;
- a blower means in communication with one end of said air chamber; and
- a burner means adjacent said air chamber wall, the burner nozzle of said burner being in communication with said combustion chamber through said air chamber wall, said flue chamber wall and said combustion chamber wall; said apertures in said combustion chamber wall being of small size and located substantially around the entire circumference of the lower end of said combustion chamber wall whereby jets of flame are permitted to shoot out of said combustion chamber into said flue chamber via said apertures to uniformly supplement the heat transfer between said combustion chamber and said flue chamber.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,794,014 Dated February 26, 1974

Inventor(s) Dan B. McVickar and Adolf Wolf

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 57:

"aid" should be --- said ---

Signed and sealed this 3rd day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents