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Dancy et al. [45] **Jan. 16, 1973**

[54] **VORTEX COMBUSTION CHAMBER**

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[73] Assignee: **Texaco Inc.,** New York, N.Y.

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[21] Appl. No.: **102,345**

[52] **U.S. Cl.** **431/173**
[51] **Int. Cl.** **F23c 5/18**
[58] **Field of Search**...........................431/173, 9, 187

[56] **References Cited**

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[57] **ABSTRACT**

This invention relates to a combustion chamber as applied in a preferred embodiment to a warm air heater wherein a vortex is provided by having the air intake means enter eccentrically with respect to the longitudinal axis thereof, the chamber having a main combustion zone and a post combustion zone separated by a plate orifice.

2 Claims, 5 Drawing Figures

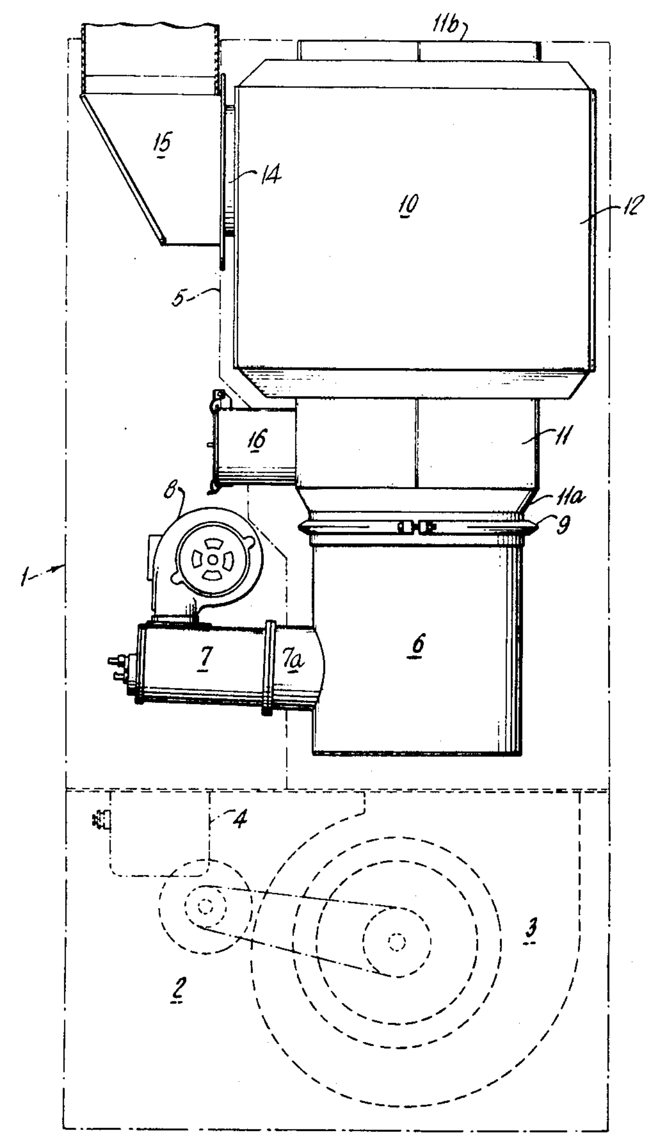


Fig. 1

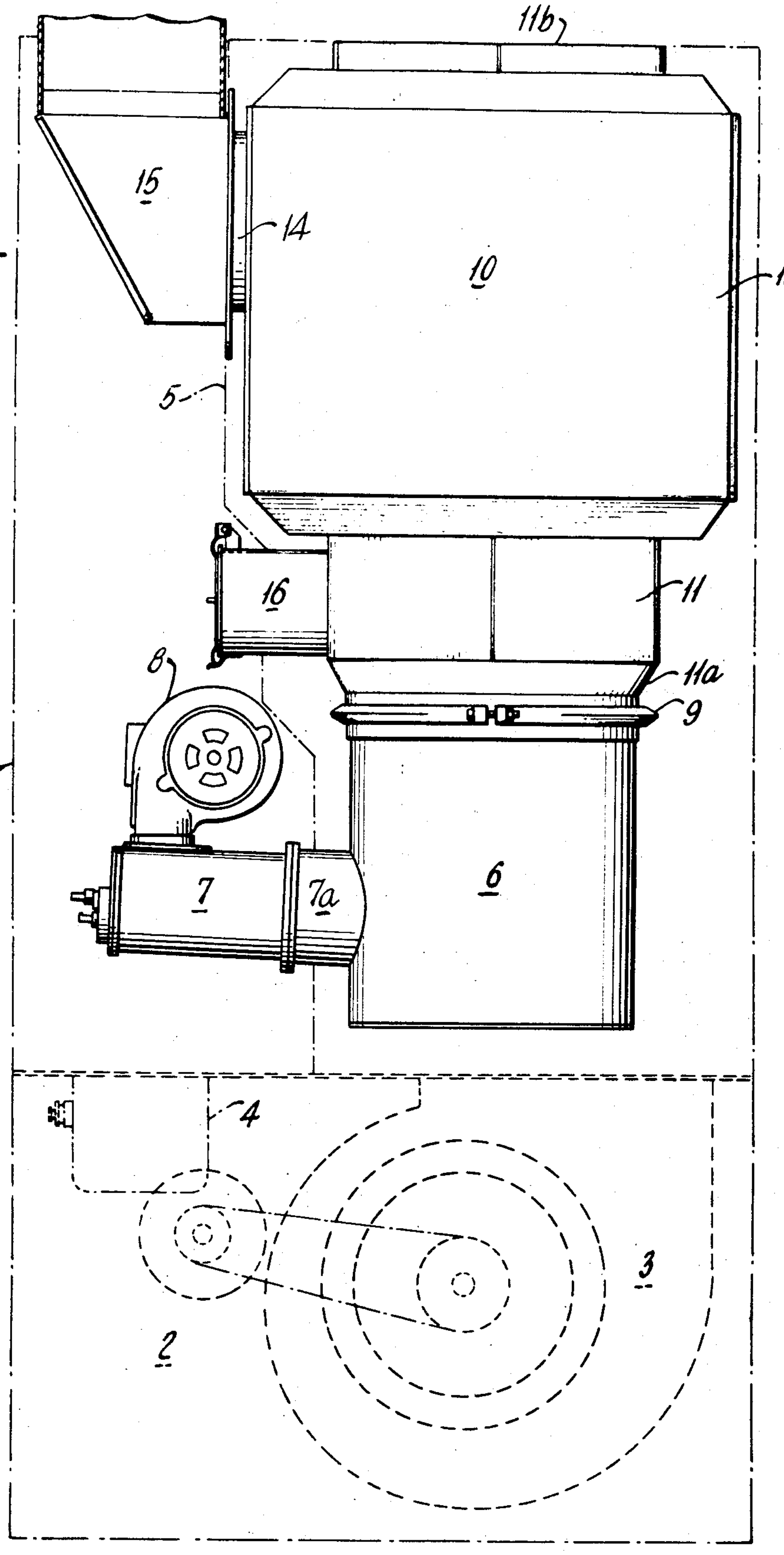


Fig.2.

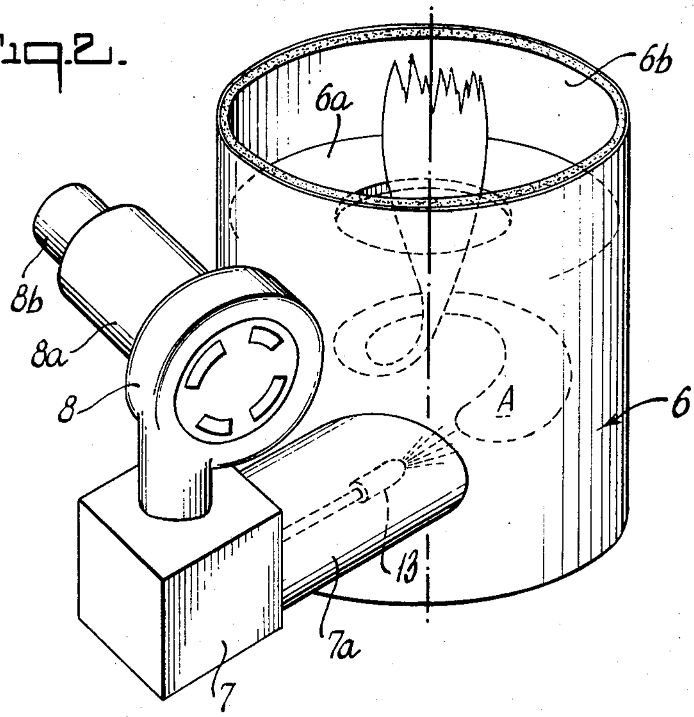


Fig.3a.

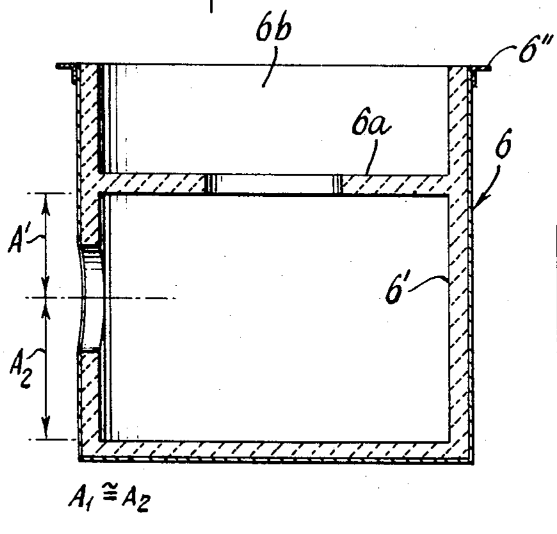


Fig.3b.

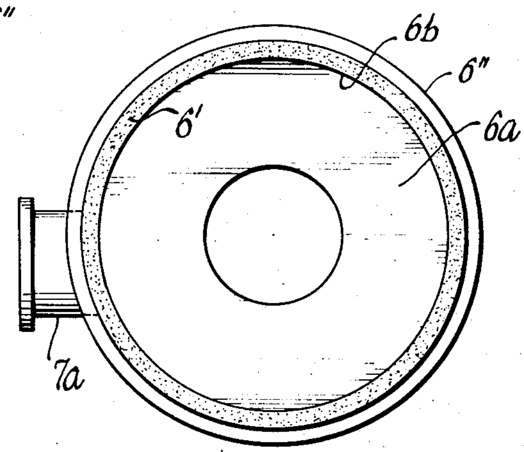
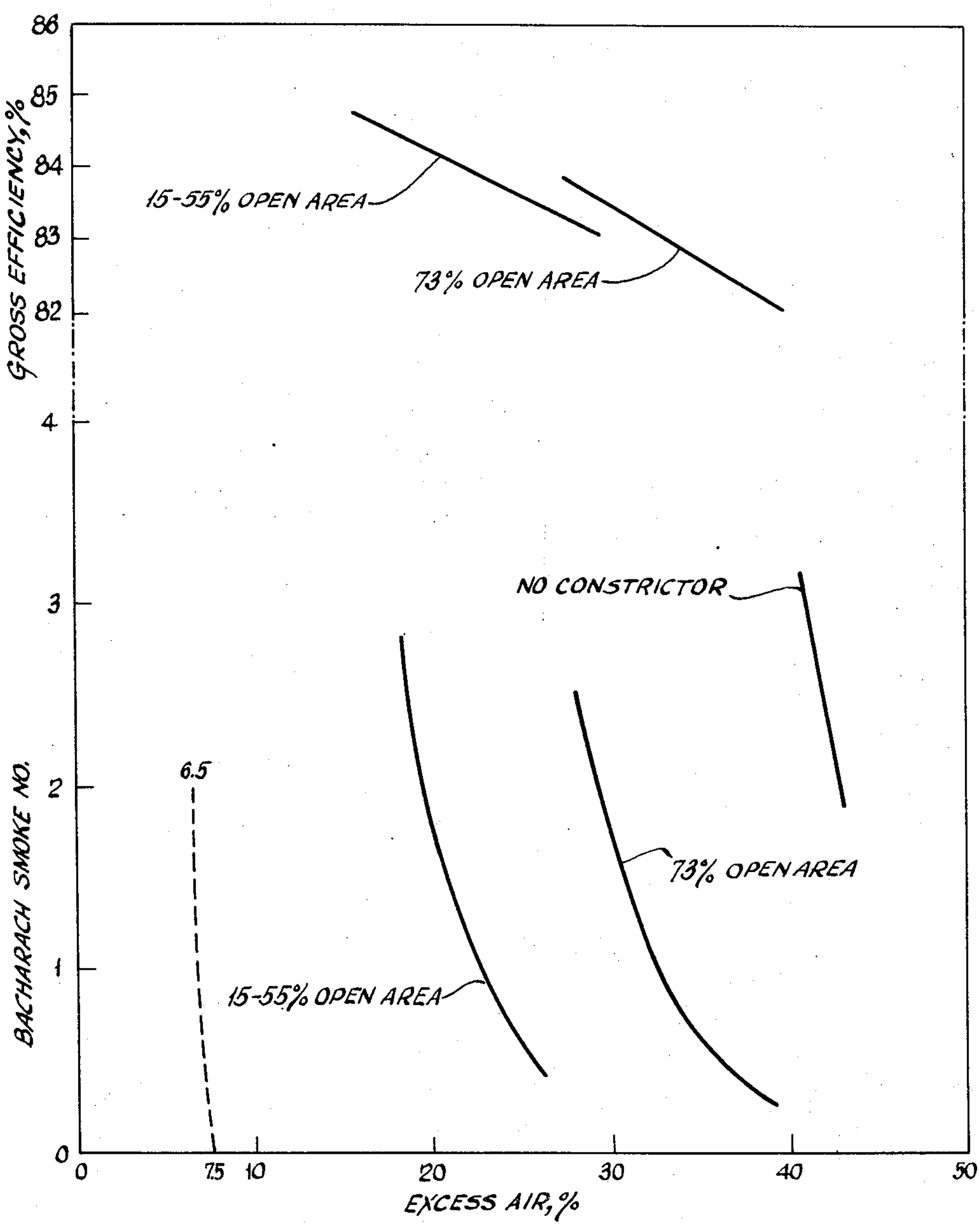


Fig.4.


86
85
84
83
82
GROSS EFFICIENCY, %
15-55% OPEN AREA
73% OPEN AREA
4
3
2
1
0
BACHARACH SMOKE NO.
NO CONSTRICTOR
6.5
73% OPEN AREA
15-55% OPEN AREA
0
7.5
10
20
30
40
50
EXCESS AIR, %

VORTEX COMBUSTION CHAMBER

BACKGROUND OF THE INVENTION

This invention relates generally to heaters, and particularly to a novel combustion chamber in a warm air furnace, with venting of the hot combustion products to a heat exchange structure and then to the exterior. The novel combustion chamber is applicable and equally effective when used with hot water or steam boilers for space heating purposes and other applications.

Warm-air furnaces as used in modern homes conventionally include a burner gun assembly firing into a combustion chamber which is joined to some form of heat-exchanging means for heating air and which serves as a flue for the discharge of the products of combustion. The heat exchanging means provides a circuitous flow of the hot products of combustion for heating the air. The air to be heated is provided to a distribution conduit which is spaced around the combustion chamber and heat exchanging means, and adjacent the latter, forms a plenum or distributing space for the ducts leading the heated air to the desired points of reception. Improvements in warm-air furnace construction generally are directed to an increase in the efficiency of combustion and/or heat transfer for better utilization of generated heat, thus lowering the temperature of the discharged products of combustion.

SUMMARY OF THE INVENTION

The invention comprises a cylindrical combustion chamber having air intake means mounted to provide air eccentrically with respect to the longitudinal axis of the combustion chamber. The fuel injector is mounted concentric with the air intake means. There is a plate orifice constrictor adjacent the discharge end of the combustor which discharges products of combustion into heat exchange means.

The invention in general furnishes a more effective combustion chamber structure to provide an aerodynamic vortex system which is set up to afford a high degree of turbulence thus aiding the fuel-air mixing and combustion processes. A large percentage of the hot products of combustion are recirculated internally, which maintains a high temperature zone at the fuel-air mixture, thus aiding the combustion reactions.

Accordingly, it is an overall object of this invention to provide for more effective combustion in a warm-air furnace.

Another object is to provide for a combustion chamber construction with a vortical flow of fuel-air mixture and products of combustion therein.

These and other objects, advantages and features of the invention will become more apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 discloses a warm-off furnace cabinet assembly;

FIG. 2 illustrates the vortical flow of combustion gases in the combustion chamber;

FIG. 3*a* is an elevation cross section of the improved combustion chamber;

FIG. 3*b* is a plan view of the improved combustion chamber; and

FIG. 4 is a graph disclosing the advantages achieved by use of a plate orifice constrictor in a combustion chamber.

The objects of the invention are achieved by the use of a plate orifice constrictor having an optimum exit opening generally about one half of the chamber plan area in combination with air intake means which enter the chamber eccentrically with respect to the longitudinal axis thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1 of the drawings, a warm-air furnace cabinet assembly is disclosed at **1**, comprising the air intake section **2** with the air blower assembly **3**, and a control assembly at **4** positioned therein. The air distributing conduit **5** leads from the air intake section **2** and surrounds the combustion chamber **6** and the radiating means or heat exchange construction **10**, the latter being a two-stage heat exchanger which is joined to the combustion chamber by V-band clamp means **9**.

A burner gun assembly **7** fires into the combustion chamber **6** and eccentrically with respect to the longitudinal axis thereof and supports the fuel pump assembly and combustion air blower **8** thereon.

The heat exchanger **10** comprises the first stage **11** having the transition portion **11*a*** where the bottom cylindrical structure, which is connected to the circular combustion chamber **6**, is changed to a rectangular structure having a closed top **11*b***. and the second stage of the exchanger is shown at **12**.

The outlet from the second stage is disclosed at **14** leading to flue **15**. This connection and flanges on the opposite panel joined to the cabinet wall (not shown) support the heat exchanger in the cabinet. An inspection door and air bleed is shown at **16**.

FIG. 2 is a diagrammatic view of the vortex flow of the hot combustion gases in the combustion chamber and their exit through the plate orifice restrictor. The gun assembly is shown at **7**, the air blower at **8**, motor at **8*a*** and fuel pump at **8*b***. Blast tube **7a** enters the combustion chamber **6**, eccentrically with respect to the longitudinal axis thereof, shown as an interrupted line, and houses the fuel line ending at nozzle **13**. Not shown are the ignition means for igniting the fuel-air mixture or air handling parts such as an end cone or choke and burner head air swirler. The vortex flow of the hot combustion gases is shown schematically at A, passing through the exit of the constrictor plate **6*a*** and into the upper extension or post combustion chamber, indicated as **6*b***.

FIGS. **3*a*** and **3*b*** are an elevation cross sectional and plan view respectively of the vortex combustion chamber, the former being shown without the air intake means **7*a***, for purposes of clarity. This vertical position is shown as a preferred embodiment, but other positions for use are not excluded, e.g., horizontal or downwardly firing. The combustion chamber **6** is insulated internally, as indicated at **6'**, and usually has a typical internal diameter of 10 or 11 inches and a height of 12 inches for a firing rate range of 0.5 to 1.0 gallons per hour, the main combustion chamber having a height of 7½ to 8 inches, the post combustion being less than 3½ inches in height and the exit area having an optimum opening of about 50 percent of the plan area of the combustion chamber. As the firing rate is reduced, it is desirable to reduce the constrictor exit. The air intake means has a center line which is about 1¼ inches eccentric to the longitudinal axis of the chamber (see FIG. 3*b*) and is about one half the height of the main combustion chamber (see FIG. 3*a*), so that the partially burned fuel droplets in the fuel-air mixture will not impinge either on the top or bottom of the chamber. A mounting flange of the combustion chamber is shown at **6'**. Commercial oil burner nozzles come with spray angles of 30° to 90°. For the combustion system described herein, use of spray angles in the range of 45° to 60° are preferred to further aid in avoiding impingement of partially burned fuel droplets on the chamber walls.

FIG. 4 illustrates the effect of constrictor size on steady state performance. The best performance solid line curves shown on FIG. 4 have been averaged to cover the range of from about 15 percent to about 55 percent open areas and this produces excellent performance with excess air in the range of from about 20 percent to about 30 percent. The other curves on the graph are self-explanatory. These data were obtained from the operation of two furnaces rated at 120,000 Btu/hr. with a firing rate of one gallon per hour at 50 psig fuel pressure and also at 80,000 Btu/hr. with a firing rate of ⅔ gallon per hour also at 50 psig fuel pressure. The larger furnace had an efficiency of 84.5 percent with smoke-free combustion at 25 percent excess air and 85.5 percent with No. 2 smoke level (Bacharach) at 18 percent excess air and the small furnace had an efficiency of 85.5 percent with smoke-free combustion at 32.5 percent excess air and 87 percent efficiency with No. 2 smoke level at 20 percent excess air.

The combustion chamber as disclosed herein has been tested within the firing rate range 0.35 to 1.25 gallons per hour. The effective open area of the constrictor becomes smaller at lower firing rates. Open area ratios as low as bout 5 percent are desirable for the lower firing rates described above. The best experimental performance obtained for a 1.0 gallon per hour unit was zero Bacharach smoke number at 7.5 percent excess air at 100 psig fuel pressure and using a different gun burner than that used in the solid line curves in FIG. 4. The broken line curve in this figure illustrates this best experimental performance.

The use of the disclosed system offers the following advantages over present conventional systems: (*a*) small volume, high intensity combustion chamber, (*b*) low excess air with zero Bacharach smoke number, (*c*) reduced fuel and air transfer power requirements, (*d*) leading to potential cost savings in equipment and fuel consumption.

Other modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. In a heater structure combination providing a heated fluid, a combustion chamber and a heat exchange construction joined thereto and having a discharge outlet therefrom, and means for providing combustion supporting gas and fuel to said combustion chamber, said combustion chamber having a constrictor adjacent its discharge end defined by a plate orifice, said combustion chamber having a main combustion zone and a post combustion zone separated from each other by said plate orifice, the size of the orifice opening being related to the firing rate of the fuel provided said combustion chamber, the orifice opening size being in the range of from about 5 percent for a low firing rate to about 55 percent of the combustion chamber plan area for a high firing rate, said combustion supporting gas being air and said means for providing said gas comprising air intake means having a longitudinal axis with an eccentricity of about 1½ inch with respect to the longitudinal axis of said main combustion zone to provide a vortex flow therein, the means for providing fuel being concentric with said air intake means, said main combustion zone having about twice the volume of said post combustion zone, said longitudinal axis of said air intake means entering about midway of the height of said main combustion zone.

2. In the combination as defined in claim **1**, the main and post combustion zones and said plate orifice having interior walls with insulating properties.

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