

Aug. 17, 1965

H. H. HANLEY ETAL

3,200,870

DOUBLE VORTEX COMBUSTION CHAMBER APPARATUS

Filed Nov. 27, 1961

2 Sheets-Sheet 1

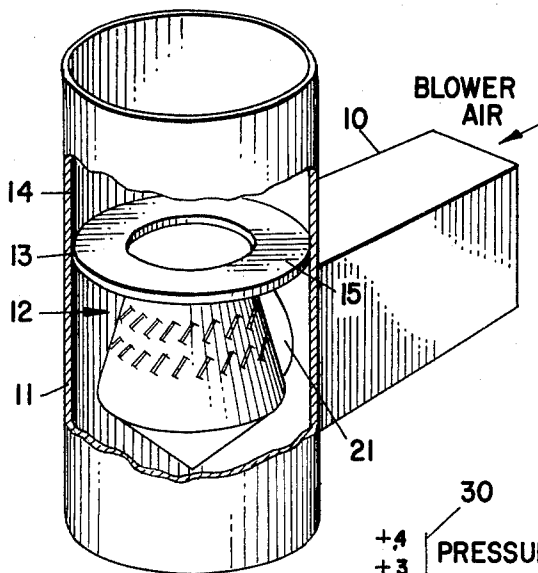


FIG. 1.

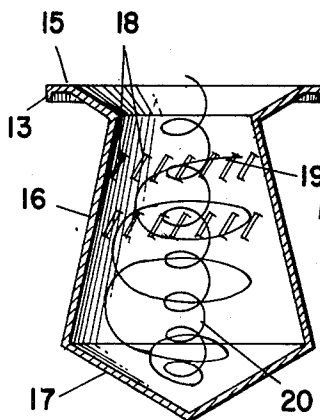


FIG. 2.

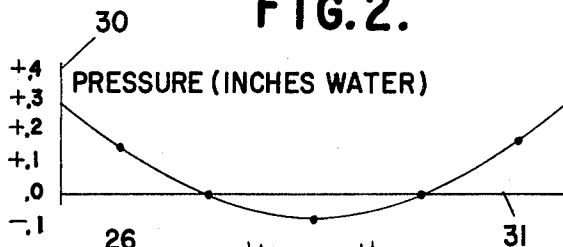
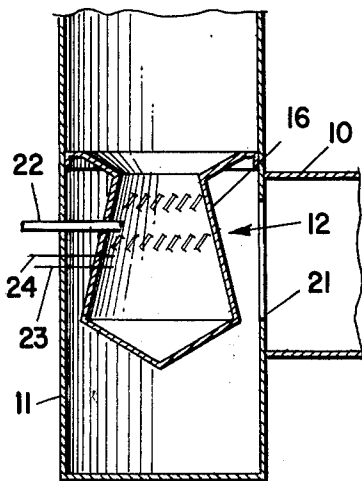


FIG. 3.

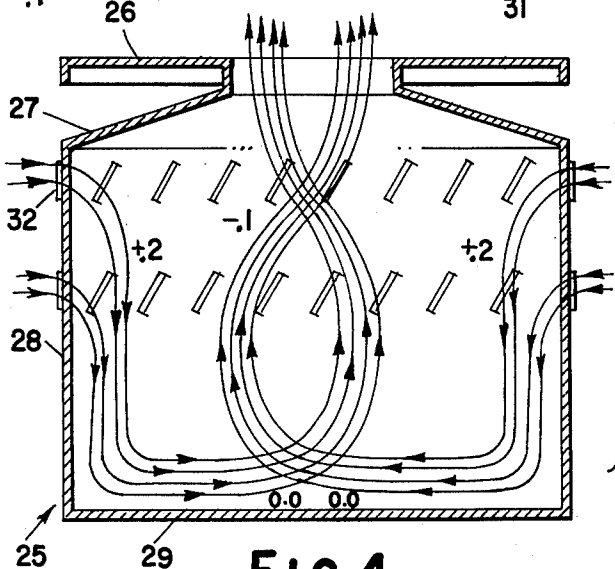


FIG. 4.

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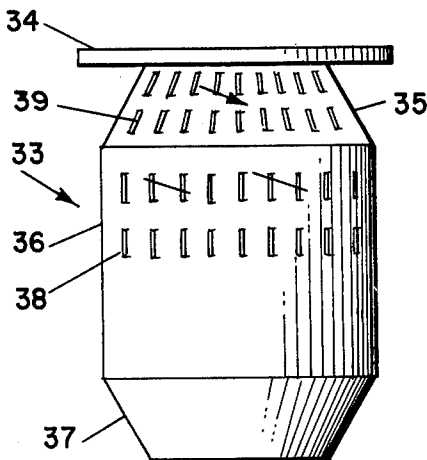


FIG. 5.

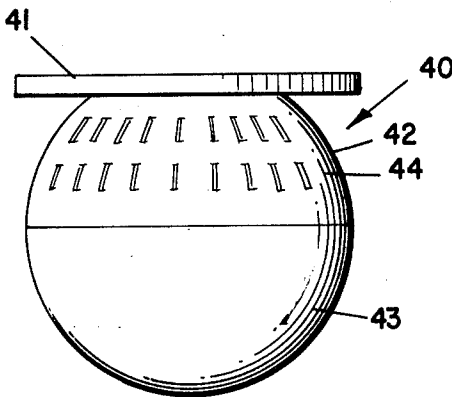


FIG. 6.

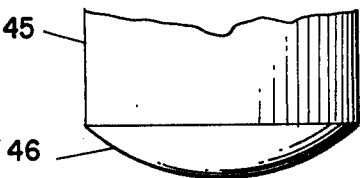


FIG. 7.

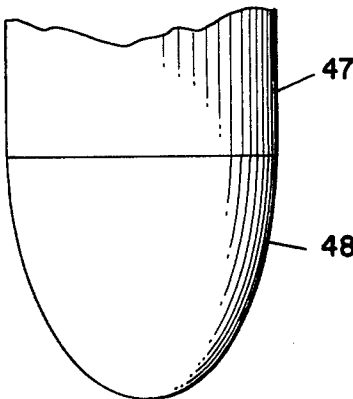


FIG. 8.

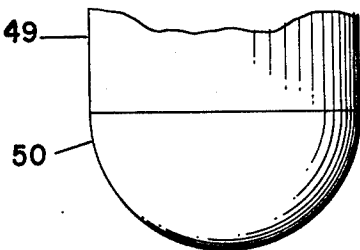


FIG. 9.

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DOUBLE VORTEX COMBUSTION CHAMBER APPARATUS

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6 Claims. (Cl. 158-4)

This is a continuation-in-part of application Serial No. 764,846, filed Oct. 2, 1958, and now abandoned.

This invention generally relates to a combustion apparatus and more particularly concerns an improved combustion chamber for heating and propulsion purposes. The combustion chamber or unit of the present invention may be employed as a part of a boiler or furnace installation in both home and industrial units, and it is equally adaptable to various space heating systems and other heat requirement applications. In addition, the combustion chamber of the present invention is adaptable with minor modifications to jet pods for helicopters, and for propulsion purposes in conjunction with rockets, missiles, and other airborne equipment.

The combustion chamber of the present invention is an improvement upon and embodies certain basic features of the combustion chamber set forth in H. H. Hanley's Patent No. 2,736,168, issued Feb. 28, 1956, and entitled Combustion Chamber and Method of Mixing and Burning Fuel. In Patent No. 2,736,168, a combustion chamber is disclosed and claimed in which air is admitted tangentially into the chamber to be directed in a radially outer vortex towards the closed end thereof. A fuel inlet and ignition means also communicate with the chamber. Although the combustion chamber as disclosed in Patent No. 2,736,168 is adaptable to installations in which ambient temperatures are relatively low and in which enclosed units are not required, it has been found that many applications require enclosed units which may be subject to unusually high temperature conditions.

It is therefore an object of the present invention to provide a combustion apparatus which embodies a self-cooling construction.

Another object of the present invention is to provide combustion apparatus which is efficient in its operation and which is characterized by very low heat radiation losses.

Another object of the present invention is to provide a combustion apparatus which may be constructed to have relatively small overall weight and dimensions and yet which is susceptible of effectively burning relatively large quantities of fuel.

Another object of the present invention is to provide a combustion apparatus which may operate in any position and which may be modulated to comply with varying heat requirements.

Still another object of the present invention is to provide a combustion apparatus which will operate with very low air pressures, and yet which is capable of almost instantaneously producing full load.

Still a further object of the present invention is to provide a combustion apparatus which may be relatively economically constructed and yet which requires very little maintenance because of its simple and rugged design.

These and other objects and advantages of the present

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invention are generally attained by providing in a combustion unit a sealed housing with a combustion chamber mounted therein. The combustion chamber is provided with an imperforate end portion and an open end portion, with the open end portion thereof communicating through the housing to the exterior thereof. The combustion chamber has its sidewalls spaced from the housing, and the sidewalls define therein a plurality of openings. Fuel input means communicate through the housing and the sidewalls of the chamber, and pressurized air input means communicate with the interior of the housing such that air is forced towards the openings.

The openings and sidewalls of the chamber are co-operatively formed so as to direct the air tangentially into the chamber and axially in a vortex towards the imperforate end thereof. Ignition means communicate through the housing and the chamber to the interior thereof whereby the vortex of air in conjunction with the closed end portion of the chamber will form an annular mass of relatively cool air surrounding an inner core of fuel air mixture and reactor products thereof after ignition.

A better understanding of the present invention will be had by reference to the drawings, which are partially schematic, and illustrate several embodiments, and in which:

FIGURE 1 is an isometric view of combustion apparatus according to the present invention;

FIGURE 2 is a sectional view of the combustion chamber embodied in the combustion apparatus of FIGURE 1;

FIGURE 3 is a sectional view of the combustion apparatus of FIGURE 1 schematically indicating the fuel input and ignition means;

FIGURE 4 is a sectional view of another form of combustion chamber for use with the combustion apparatus of FIGURE 1, and indicating flow paths as well as pressure gradients;

FIGURE 5 is another embodiment of a combustion chamber for use with the combustion apparatus of FIGURE 1;

FIGURE 6 is still a further embodiment of a combustion chamber configuration for use with the combustion apparatus of FIGURE 1;

FIGURE 7 illustrates a modification to the imperforate end portion of the combustion chamber of FIGURE 1;

FIGURE 8 illustrates another modification to the imperforate end wall of the combustion chamber of FIGURE 1; and

FIGURE 9 illustrates a still further modification to the imperforate end wall of the combustion chamber of FIGURE 1;

Referring now to the drawings, there is shown in FIGURE 1 a passage or air duct 10 which is designed to receive pressurized air, for example as designated by the nomenclature "blower air." The air duct 10 connects with a housing 11 which is closed off at its lower end and which may form a part of a heat exchanger to be used in conjunction with a furnace or the like. On the other hand, the upper end of the housing 11 may be co-terminous with the combustion chamber 12 such that the housing 11, duct 10, and chamber 12 form a separate integral unit, for example as shown in patent application Serial No. 764,846.

The combustion chamber 12 is formed with an upper rim portion 13, as more clearly shown in the view of FIGURE 2, which forms a band whereby the combustion

chamber may be welded or otherwise rigidly secured with-in the sidewalls 14 of the housing 11.

In the embodiment of FIGURES 1-3, the combustion chamber 12 includes the depending rim 13 (heretofore mentioned), an annular end portion 15, a frusto-conical portion 16, and an imperforate end wall portion 17, which may be of conical form.

Particular construction details do not form the essence of the present invention, and many variations may be made without departing from the spirit and scope of the invention. Thus, although the annular end portion includes a flared portion as well as a flat portion, the end portion 15 could be completely flat or normal to the axis of the chamber, if desired. Similarly, variations may be made in the shape of the chamber sidewalls 16 and the imperforate end wall 17, as will be clearer as the specification proceeds.

As an important feature of the present invention, a plurality of slots or openings 18 are provided about the periphery of the sidewalls 16 to enable air to be received therethrough and to move downwardly in a spiraling vortex adjacent the inner periphery of the sidewalls 16.

In every instance, the slots 18 are provided so that the incoming blower will enter the chamber sidewalls 16 tangentially. Preferably, these slots are also canted such that the air will also be directed at a slight angle downwardly towards the imperforate end wall 17. With the configuration of FIGURES 1-3, it will be appreciated that since the sidewalls 16 are of a larger diameter below the openings 18 (in a direction towards the imperforate end 17) than they are above the openings 18, the air entering the slots 18 will move in the direction of the larger diameter whereby its pressure will be reduced. In other words, the air entering through the openings 18 will tend to move in a direction in which it can expand rather than in a direction in which it will be compressed.

The air passing through the slots, of course, because of centrifugal action will tend to "hug" the inner periphery of the sidewalls 16 and move in a spiraling movement as indicated at 19 in FIGURE 2 towards the imperforate end wall 17. Thereafter, it will reverse in axial direction and move in an inner core and vortex (as indicated at 20) towards the open end of the combustion chamber.

As clearly seen in the view of FIGURE 3, the duct 10 has an opening 21 which communicates with the housing 11 to allow the blower air to enter and encircle the sidewalls 16 of the combustion chamber 12.

Of course, a fuel line 22 must communicate through the housing 11 and the sidewalls 16 of the combustion chamber 12 to inject fuel to mix with the downwardly spiraling vortex of air 19. The fuel nozzle, preferably, is also directed tangentially downwardly to create the least resistance to movement of the air 19 in this direction. Leads 23 and 24 have been shown in FIGURE 3 to indicate lines leading to a conventional spark electrode or the like supplied for initiating the reaction. Of course, once ignition takes place, the reaction is self-perpetuating. It will be appreciated that other types of ignition or heating means could be employed towards the same end.

It will be noted from the views of FIGURES 1-3 that the sidewalls 16 and the imperforate end wall 17 of the combustion chamber 12 are spaced from the sidewalls 14 of the housing 11. With this type of construction, pressurized air entering through the opening 21 of the housing 11 will not only freely circulate about the periphery of the sidewalls 16 but also will circulate underneath the imperforate end portion 17.

As a result of this construction, the sidewalls 16 and the end wall 17 actually serve as a heat exchanger, in which the combustion products enclosed serve to pre-heat and warm the incoming air directed into the openings 18. Similarly, the incoming air serves to cool the sidewalls 16 and the end wall 17.

In the view of FIGURE 4, there is shown another embodiment of a combustion chamber for use with the combustion apparatus of FIGURE 1. In this embodiment, there is provided a combustion chamber 25 embodying an annular end wall 26 at its open end, truncated sidewalls connecting thereto and cylindrical sidewalls 18 in the main body of the combustion chamber. The chamber is provided with an imperforate bottom end wall 29.

With the type of construction illustrated in FIGURE 4, it is of course essential that the air be directed downwardly since the sidewalls of the chamber are not tapered outwardly in a direction towards the bottom end 29.

In connection with the view of FIGURE 4, there is shown a pressure chart having a vertical abscissa 30 and a horizontal abscissa 31 indicating that the highest pressure is in the radially outer portions of the combustion chamber with the pressure decreasing and actually reaching a negative value in an upper central portion of the chamber.

Thus, the air will enter through slotted openings 32 which are necessarily canted downwardly towards the imperforate end 29, spiral around the inner sidewalls 28 of the combustion chamber and thereafter spiral upwardly in an axially reversed flow path as indicated.

As the air enters, in one instance it has a water column pressure of +.2 inch which decreases to zero as the air reverses in flow adjacent the center portion of the imperforate end wall 29. Thereafter, as the air moves upwardly in an inner spiraling movement, it has a negative pressure of -.1 before finally being exhausted through the annular open end 26.

It will be appreciated that the fuel may be injected at different points in the outer downwardly spiraling air stream. Preferably, the fuel is injected at a point below the slotted openings 32 (or 18 in the embodiment of FIGURE 1) such that the air will have achieved a certain velocity and whereby the fuel will be thoroughly intermixed with the air as it travels downwardly. Also, in this way, the upper portion of the combustion chamber is kept relatively cool, which may be desirable in certain instances. In other cases, it might be desirable for the purpose of pre-heating the incoming air to have the fuel inlet at a higher point in the combustion chamber such that a substantial part of the sidewalls of the combustion chamber are heated. It is essential, however, that the fuel be intermixed with the air as it is moving in a downwardly direction in order that effective mixing be obtained and in order that the proper spiraling exhaust action be achieved.

FIGURES 5 and 6 illustrate other constructions for the combustion chamber which may be used in conjunction with the combustion apparatus of FIGURE 1 or in the self-contained unit, for example as set forth in the heretofore identified patent application of which the present invention is a continuation-in-part.

In FIGURE 5, there is shown a combustion chamber 33 including an annular end wall 34 (surrounding the open end of the combustion chamber). The end wall 34 is connected through a truncated sidewall portion 35 to a cylindrical sidewall section 36, and terminates in a lower truncated sidewall portion 37. The sidewall portion 37 is closed at its bottom end. In this construction, a plurality of openings 38 are provided in the cylindrical sidewall portion 36; a further plurality of openings 39 are provided in the upper truncated sidewall portion 35. It is preferable that the openings 38 and 39 all be canted in a direction such as to bias the incoming air in a downward direction, as viewed in FIGURE 5. However, since the truncated portion 35 will, because of its inherent construction, bias the air downwardly, it is not necessary to have the openings 38 and 39 canted, although such construction is preferred.

FIGURE 6 illustrates another possible embodiment, wherein a combustion chamber 40 is shown provided with an annular end wall 41 at its open end. The chamber

40 may include an upper portion 42 and a lower portion 43; the upper portion 42 is provided with slotted openings 44. This construction, however, has not been completely tested and may not be desirable since the lower portion 43 is of decreasing area. In this construction, it is essential that the openings or slots 44 be above the center line of the spherical chamber such that the air will have an opportunity to expand in a downward direction after entering the openings 44 before being forced inwardly by the lower portion 43 and thereafter being reversed in direction.

The embodiments of FIGURES 7-9 merely illustrate various other modified bottom or closed end constructions for the combustion chamber. For clarity of illustration, the combustion chamber in each instance is assumed to have cylindrical sidewalls such as the combustion chamber of FIGURE 4. These views are thus merely meant to disclose various bottom configurations other than the conical, flat, frusto-conical, and spherical configuration shown in FIGURES 2, 4, 5, and 6, respectively.

In FIGURE 7, there is shown a fragmentary portion of a combustion chamber 45 which terminates in a convex imperforate bottom portion 46; similarly, in FIGURE 8, there is shown a fragmentary portion 47 of a combustion chamber terminating in a semi-elliptical imperforate bottom end portion 48; and, similarly, in FIGURE 9, there is shown a partial portion of a combustion chamber 49 terminating in a hemispherical imperforate end wall 50.

From the foregoing, it will be appreciated that many variations and modifications may be made in the combustion chamber shape so long as the bottom end wall is maintained imperforate and so long as the configuration of the combustion chamber in cooperation with the slotted openings therein is such as to cause the outer vortex of air to move in a downward direction towards the imperforate bottom end wall. These two purposes seem to be best achieved by the construction of FIGURES 1-3, modified possibly to include the convex end wall 46 of FIGURE 7. It is also essential to the present invention that the fuel be introduced at a point spaced from the imperforate or closed end wall; however, the particular point where it is introduced through the sidewall of the combustion chamber, as heretofore stated, may be varied.

With the foregoing in mind, applicants' invention is not to be thought of as limited to the particular embodiments and modifications shown but in accordance with the scope of the following claims.

What is claimed is:

1. A combustion unit comprising: a sealed housing; a combustion chamber mounted in said housing, said combustion chamber being defined in part by circular sidewalls and an imperforate end wall at one end, said combustion chamber being open at the opposite end, said sealed housing having an exhaust outlet opening registering with the open end of said combustion chamber, said sidewalls and said imperforate end wall being spaced from said housing and said sidewalls defining a plurality of peripherally spaced opening means tangentially directed towards said one end; fuel input means communicating through said housing and said sidewalls to the interior of said combustion chamber at a point spaced from said imperforate end wall; pressurized air input means communicating with the interior of said housing, whereby air may be forced towards said opening means, said opening means and said sidewalls being cooperatively formed so as to direct said air tangentially into said chamber and axially in a radially outer vortex towards said imperforate end wall, and said air also serving to cool said end wall and sidewalls; and ignition means communicating through said housing and said sidewalls to the interior of said combustion chamber; said side walls and opening means co-functioning whereby a radially outer vortex of air may be directed towards said imperforate end wall and thereafter reversed in axial direction to move in a radially

inner vortex through said combustion chamber towards said opposite open end.

2. A combustion unit, according to claim 1, in which said sidewalls increase in circumference in a direction towards said imperforate end wall, whereby said air will tend to move towards said imperforate end wall because of increased volume of the combustion chamber in that direction.

3. A combustion unit, comprising: a sealed elongated housing; a combustion chamber mounted in said housing, said combustion chamber being partially defined by circular sidewalls and an imperforate end wall at one end, said combustion chamber being open at the opposite end, said housing having an exhaust outlet opening registering with the open end of said combustion chamber, said sidewalls and said imperforate end wall being spaced from said housing, and said sidewalls defining a plurality of spaced peripheral opening means tangentially directed towards said one end; said sidewalls further defining a truncated conical portion having the larger end thereof disposed towards said imperforate end wall of said combustion chamber and the smaller end thereof disposed toward said opposite end; fuel input means communicating through said housing and said combustion chamber at a point spaced from said imperforate end wall; pressurized air input means communicating with the interior of said housing, whereby air may be forced towards said peripheral opening means, said opening means being formed so as to direct air tangentially into said chamber and said truncated conical portion serving to guide air entering therein axially in a radially outer vortex towards said imperforate end wall, and said air also serving to cool said end wall and sidewalls; and, ignition means communicating through said housing and said sidewalls to the interior of said combustion chamber; said side walls and opening means co-functioning whereby a radially outer vortex of air may be directed towards said imperforate end wall and thereafter reversed in axial direction to move in a radially inner vortex towards said opposite open end.

4. A combustion unit comprising: a sealed housing; a combustion chamber mounted in said housing, said combustion chamber being partially defined by circular sidewalls and an imperforate end wall at one end, said combustion chamber being open at the opposite end, said sealed housing having an exhaust outlet opening registering with the open end of said combustion chamber, said sidewalls and said imperforate end wall being spaced from said housing and said sidewalls defining a plurality of peripherally spaced opening means tangentially directed towards said one end; fuel input means communicating through said housing and said sidewalls to the interior of said combustion chamber at a point spaced from said imperforate end wall; pressurized air input means communicating with the interior of said housing, whereby air may be forced towards said opening means, said opening means being formed in said sidewalls so as to direct said air tangentially into said chamber and axially towards said imperforate end wall, and said air also serving to cool said end wall and sidewalls; and, ignition means communicating through said housing and said sidewalls to the interior of said combustion chamber; said side walls and opening means co-functioning whereby a radially outer vortex of air may be directed towards said imperforate end wall and thereafter reversed in axial direction to move in a radially inner vortex through said opposite end of said combustion chamber.

5. A combustion unit, according to claim 4, in which said opposite end defines a venturi section in said combustion chamber.

6. A combustion unit, according to claim 4, in which the cross-sectional area subtended by said sidewalls proximate said opposite end on one side of said opening means is smaller than the cross-sectional area subtended by said sidewalls towards said imperforate end wall on the other

side of said opening means, whereby said air will tend to move towards said imperforate end wall upon being introduced through said opening means.

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10 JAMES W. WESTHAVER, *Primary Examiner*.

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