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APPARATUS FOR PRODUCING AN INSULATED STREAM OF HOT FLUID

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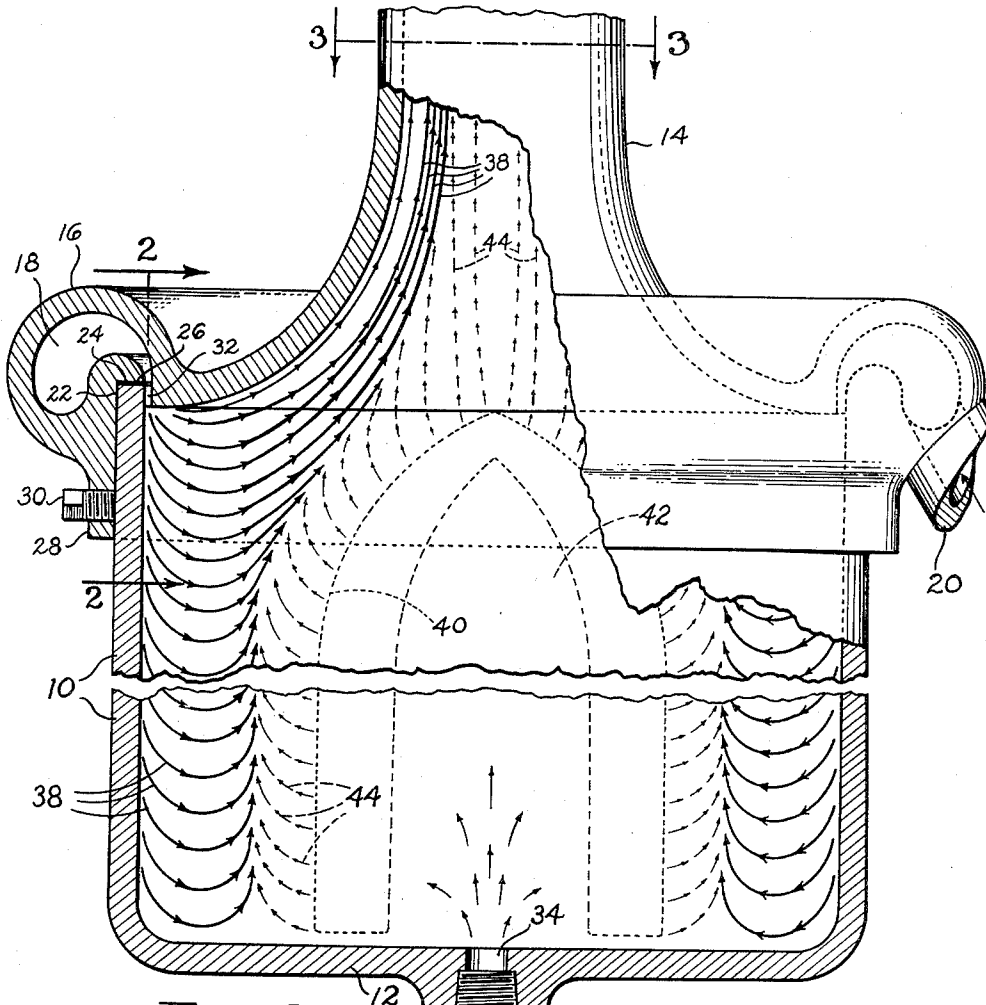


Fig. 1.

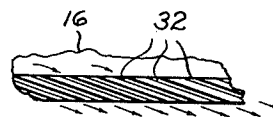


Fig. 2.

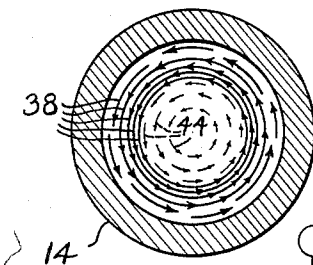


Fig. 3.

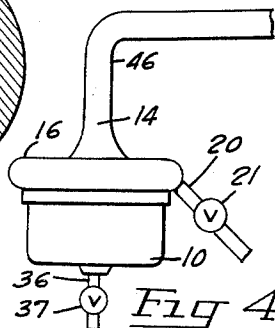


Fig. 4

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APPARATUS FOR PRODUCING AN INSULATED STREAM OF HOT FLUID

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1 Claim. (Cl. 263—19)

This invention pertains to the art of producing heat, and relates particularly to an apparatus by which to obtain from a given quantity of fuel substantially increased amounts of heat available for useful work.

This application is a continuation-in-part of my now abandoned earlier application, Serial No. 176,875, filed July 31, 1950, and entitled Process of Burning Fuel.

In conventional heat producing systems, particularly those which utilize combustible materials as the source of heat, it has been the general practice heretofore to achieve a high degree of turbulence in the heat producing chamber in order to effect complete mixing of the fuel and assure complete combustion. Although the latter effect generally is achieved, the creation of such turbulent mixing necessarily results in the transfer of heat from the particles heated by combustion to all of the remaining particles of the air or other fluid introduced into the combustion chamber. Such transfer also results in substantial heating of the combustion chamber walls. Accordingly, it is evident that such dilution of heat throughout the entire mass of the combustion chamber results in a substantially lower output of heat from the chamber, i.e. the net heat ultimately available for useful work.

It is the principal object of the present invention to provide an apparatus by which the foregoing undesirable turbulence and consequent dilution of heat is eliminated and maximum available heat is obtained.

Still another important object of this invention is to provide an apparatus for producing a stream of hot fluid in such manner as to accommodate the transport of such heat without significant loss from the area of production to a point for conversion into useful work.

Another important object of this invention is the provision of an apparatus for producing a directed stream of hot fluid confined within an insulating envelop of cool fluid.

A further important object of the present invention is to provide heat producing apparatus in which the heat chamber requires no thermal insulation and yet is not subjected to the intense heat generated therein.

A still further important object of the present invention is to provide heat producing apparatus which is of simplified construction for economical manufacture, which is of minimum size for the production of a given quantity of heat, and which is capable of efficient operation with a minimum of maintenance and is operable with maximum facility.

The foregoing and other objects and advantages will appear from the following detailed description, taken in connection with the accompanying drawings, in which:

Figure 1 is a view in side elevation, partly in section, of heat producing apparatus embodying the features of the present invention;

Figure 2 is a fragmentary sectional view taken along the line 2—2 in Figure 1, showing a construction of the inlet port of the apparatus of the present invention;

Figure 3 is a sectional view taken along the line 3—3 in Figure 1 and showing by arrows the concentric flow of separated fluids at the output of the apparatus; and

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Figure 4 is a schematic representation of the apparatus of Figure 1 including the outlet delivery pipe and the inlet sources of fuel and air.

As stated hereinbefore, conventional heat producing systems of the fuel combustion type purposely are constructed and operated in such manner as to achieve maximum turbulence of the combustion supporting materials within the heat chamber in order to assure complete combustion. Because of such turbulence, the rapidly moving particles of gas which have been heated move about in random manner, colliding with slower moving particles which have not been heated. As a result of these collisions, a portion of the heat potential of the heated particles is transferred to the cooler particles, thereby diluting the heat throughout the system. Furthermore, the randomly moving particles within the heat chamber collide with the chamber walls which, in turn, receive a portion of the heat potential of the particles, further diluting the heat and reducing the heat output ultimately available for useful work.

Referring now to the drawings, the heat-producing apparatus of the present invention is shown to include a cylindrical heat chamber having side walls 10 and a bottom closure 12. The open end of the chamber is removably closed by a cap member which, in the embodiment illustrated, includes an outwardly constricted exhaust hood 14 and a peripheral manifold 16 forming an annular chamber 18 therein which communicates through feed pipe 20 and control valve 21 with a source (not shown) of air or other oxidizing gas. Adjacent the lower inner side of the manifold the latter is offset upwardly to form a groove 22 adapted to be received over the open end of the heat chamber. The base of the groove forms a shoulder 24 adapted to rest upon the upper end of the heat chamber. If desired, a ring-shaped seal 26 may be interposed between the shoulder and the adjacent edge of the heat chamber to form an airtight seal therebetween. Lugs 28 project downwardly from the manifold adjacent the outer surface of the heat chamber and are provided with internally threaded openings through which to receive the set screws 30 which are adapted to engage the outer surface of the heat chamber to secure the cap firmly thereto.

As shown in Figures 1 and 2 of the drawing, there is provided in the manifold 16 a multiplicity of circumferentially spaced inlet ports 32 which communicate at their inner ends with the annular chamber 18 and terminate at their outer ends adjacent the inner surface of wall 10 of the heat chamber. As best shown in Figure 2, these inlet ports are directed substantially tangential to the inner surface of the cylindrical heat chamber and are also directed slightly downward. By this construction, a gas or other fluid ejected from the annular chamber 18 through the ports 32 is projected into the heat chamber adjacent the cylindrical walls thereof with a helical rotation progressing toward the bottom 12 of the heat chamber. The purpose of this rotation is described in detail hereinafter.

In the embodiment illustrated, heat is produced by the combustion of a fuel such as gas. Accordingly, there is provided at the center of the bottom 12 a fuel inlet opening 34 which communicates with a source (not shown) of gas supplied through pipe 36 and regulated by control valve 37. Manual or automatic ignition means (not shown) of any conventional type may be employed to initiate the combustion of the fuel, which thereafter is sustained by the oxygen content of the air introduced through the ports 32.

In the operation of the apparatus illustrated, the gaseous fluid enters the heat chamber through the fuel inlet opening 34, where it is ignited in the usual manner. Air is supplied under pressure to the annular chamber 18 in

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manifold 16 through feed pipe 20, and is ejected into the heat chamber through the tangential ports 32, producing a rotating layer of air adjacent the inner walls of the chamber. This rotating layer of air moves downwardly along the wall of the chamber toward the bottom of the latter. As the volume of air admitted to the chamber increases, it moves in toward the center line of the chamber, as indicated by the arrows 38. The oxygen content of the air mixes with the gaseous fuel, resulting in combustion and the development of a flame 40.

When the feed of fuel and air are in proper adjustment, the flame pattern produced is substantially as illustrated in Figure 1, wherein the flame is shown to originate a spaced distance above the bottom 12 of the chamber and to extend upwardly therefrom toward the exhaust hood 14. The flame is generally cylindrical in shape having substantially constant diameter for a major portion of its length, and converging outwardly to a pointed tip which terminates adjacent the upper end of the chamber. The flame front is maintained a spaced distance from the inner surface of the wall 10 to provide an annular space for the rotating air layer. The cylindrical flame envelopes a gas filled central core 42.

The rotating layer of air surrounding the flame causes the latter to rotate in the same direction. Thus, the products of combustion are ejected horizontally outward from the flame front, as indicated by the light arrows 44, toward the inner front of the rotating air layer. These products of combustion are substantially hotter than the air front, and hence the gaseous layer of combustion products is considerably less dense than the surrounding layer of air. Moreover, the hot particles possess substantially greater kinetic energy than the cooler surrounding air particles and therefore possess correspondingly greater straight line velocity. Thus, these high speed heated particles collide tangentially with the slow moving air particles at the inner front, thereby causing said high speed particles to be deflected back toward the flame front. Accordingly, the core layer of hot combustion products and other hot inert particles, such as the nitrogen content of the air that has been brought into contact with the flame front, is maintained substantially separate from the denser outer layer of cool air which envelopes it. A portion of the surrounding rotating layer of air progresses inwardly into contact with the flame front and becomes a part of the inner core of hot fluid. This portion of the air layer is continually replaced by air from the ports 32. In addition, excess air is introduced into the heat chamber through said ports and, since this excess air is prevented from moving into the air layer surrounding the flame front, it is directed inwardly and upwardly in spiral rotation along the inner surface of the exhaust hood 14, as indicated by the arrows 38 in Figure 1. This rotating layer of cool air forms an insulating envelop for the hot gaseous core entering the exhaust hood as it passes from the flame front.

By constricting the discharge opening of the heat chamber, the rotation of the concentric streams of gaseous particles is caused to increase, in well known manner. This increase in rotational speed functions to maintain the gaseous streams separate for a substantial distance after leaving the heat chamber, thereby insuring efficient transport of the concentrated heat layer through delivery pipe 46 to a heat exchanger or other apparatus where the heated layer is converted to useful energy. Since the heated inner core of fluid is maintained separate from the surrounding insulating envelop the former may be readily separated from the latter to provide a concentrated source of heat at the heat exchange.

An illustration of the apparatus and its operation is as follows: A heat chamber was constructed having a diameter of about five inches and a length of about twelve inches, and a constricted outlet opening of about two inches in diameter. Manufactured gas was supplied to the chamber through the fuel inlet opening at a rate of

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one cubic foot per minute, and atmospheric air was injected into the chamber through the ports 32 at a rate of about 25 cubic feet per minute. Complete combustion was achieved, as indicated by analysis of the exhaust gases by standard Orsat apparatus. Under these conditions, the temperature of the outer surface of the heat chamber midway between the ends thereof was 76° F. and the temperature of the flame at the same level, but 1/4 inches in from the inner surface of the chamber wall, was 1957° F. Temperature readings at the two inch diameter exhaust end of the apparatus indicated the outer surface of the exhaust outlet to be 97° F.; the temperature of the insulating gas layer one half inch in from the inner surface of the exhaust outlet was 124° F.; and the temperature of the inner layer of hot combustion products, three fourths inch in from the inner surface of the exhaust outlet, was 2145° F.

In order to determine the efficiency of transport of the heated gas core enveloped by the insulating gas layer, a Pyrex glass tube, two inches in diameter and three feet long, was bent in the shape of a U, and one end placed over the exhaust outlet of the heat chamber. Temperature measurements taken at the opposite end of the glass tube were substantially the same as the temperatures at the exhaust outlet indicated above.

By standard test procedure, the exhaust from the heat chamber was transferred to a heat exchanger, and it was determined that 98.3 percent of the total heat value of the fuel was actually transferred as available heat to the exchanger.

Although the means by which heat is developed is illustrated in the drawing as a system utilizing the combustion of a fuel in the presence of air, it is to be pointed out here that various other well known sources of heat may be utilized for the purposes of the present invention. For example, the source of heat may be an electrical resistance connected to a suitable source of electric potential. In such event, it is preferred that the resistance element be constructed in the shape of the flame pattern illustrated in the drawing, in order to provide the flow pattern of the heated gaseous layer and the surrounding insulating layer discussed hereinbefore. The operation of apparatus utilizing a resistance heater is analogous to the operation described hereinbefore, with the exception that the heated core layer is not composed of combustion products, but rather rapidly moving particles of air or other fluid injected into the heat chamber through the ports 32.

To illustrate the operation of apparatus utilizing an electrical resistance heater, the heat chamber exemplified hereinbefore was fitted with a 1000 watt resistance element mounted on a base contoured to the configuration of the flame front illustrated in the drawing. Air was admitted through the ports 32 at the rate of volume previously exemplified, this amount being substantially more than is capable of being heated by the resistance element. In this installation the temperature of the outer surface of the heat chamber midway between the ends thereof was 72° F., the outer surface of the constricted exhaust hood was 83° F., and the gas core enveloped by the insulating gas layer was 1387° F.

The apparatus of the present invention may also utilize liquid forms of fuel, such as burner oil, or solid forms of fuel, such as coal. In the latter instance, coal is ground to convenient size and fed to the heat chamber through the opening 34 by such means as a screw conveyor. The pile of coal deposited upon the central area of the bottom 12 of the heat chamber is ignited in the usual manner to provide a flame pattern similar to that illustrated in the drawing.

Other sources of heat, e.g. an atomic pile, may be utilized in the present invention to provide the results described hereinbefore, i.e. the development of a heated fluid core and a surrounding insulating layer of air or other fluid, with the temperature of the heated core being

at least 20 times the temperature of the insulating layer.

In addition, fluids other than air may be injected through the ports 32 to provide the laminar flow of heated and insulating layers described hereinbefore. Such fluids capable of use include gases such as nitrogen, carbon dioxide, oxygen, and others; liquids such as water and other non-combustible liquids; and liquid metals such as mercury and others.

The heat chamber and cap may be constructed of various materials such as metal, synthetic plastics, glass and others. Use of synthetic plastic and glass is accommodated because of the fact that the walls of the heat chamber and exhaust cap are maintained at relatively low temperatures by virtue of the insulating layer surrounding the heated core.

The heat producing capacity of the apparatus may be varied, as desired, by variations in the dimensions of the apparatus, the quantity of air or other fluid admitted thereto, and/or the quantity of combustible fuel admitted to the chamber or the heat producing capacity of a resistant element or atomic pile utilized as a source of heat. In each instance the characteristic operation of the apparatus is maintained, i.e. the temperature of the heated core exhaust is at least 20 times the temperature of the insulating layer surrounding it.

It will be apparent to those skilled in the art that the foregoing and other modifications and changes in structural details may be made without departing from the spirit and scope of the present invention. Accordingly, it is to be understood that the foregoing description is primarily illustrative of the invention, and is not to be considered as limiting the scope thereof.

Having now described my invention and the manner in which the same may be used, what I claim as new and desire to secure by Letters Patent is:

Apparatus for producing an insulated directed stream of hot gases, comprising a cylindrical chamber having a closed end, the opposite end of the chamber being tapered

smoothly and symmetrically outward to form a constricted central outlet, annular air inlet means adjacent the outlet end of the chamber directing air toward the closed end along the inner surface of the chamber wall and tangentially thereto, a source of air under pressure connected to the air inlet means, a central combustible gaseous fuel inlet means in the closed end of the chamber cooperating with the air in the chamber to provide a flame concentrically within the chamber a spaced distance from the chamber wall and extending toward the outlet, a source of combustible gaseous fuel under pressure connected to the central fuel inlet means, means for adjusting the volume and velocity of combustible fuel and air to produce at the constricted central outlet a central rotating core of hot gases separated from the outlet wall by a rotating insulating layer of air, and an elongated pipe connected to said central outlet to receive said core of hot gases and said insulating layer of air and to deliver said core and layer under laminar flow conditions to a point of use.

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