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P. A. MUTCHLER

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FLUID FUEL COMBUSTION APPARATUS

Filed July 13, 1962

3 Sheets-Sheet 2

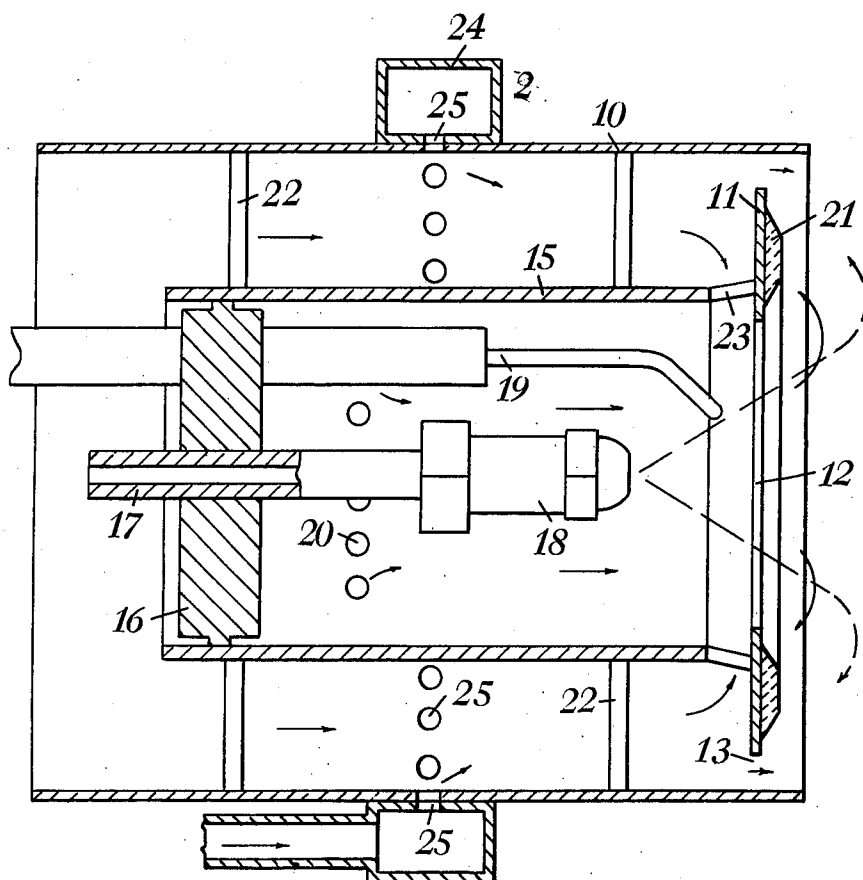


Fig.3

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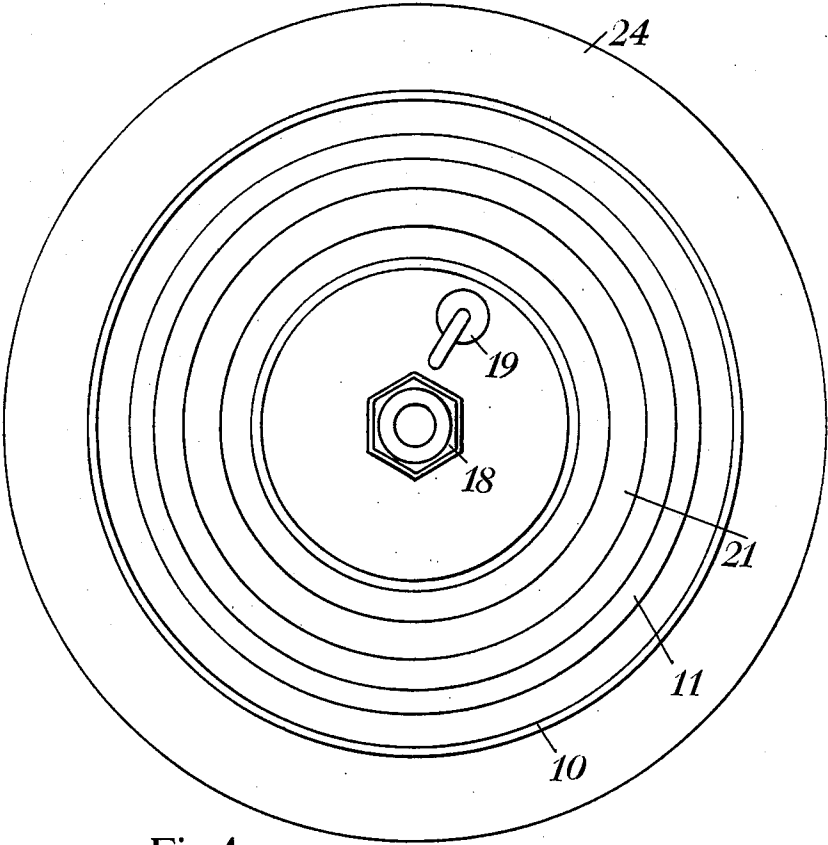


Fig. 4

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FLUID FUEL COMBUSTION APPARATUS
Paul Albert Mutchler, Rock Island, Ill., assignor to
The Nu-Way Corporation, Rock Island, Ill.
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This invention relates to apparatus for burning fluid fuels. Such apparatus is commonly used for space heating and water heating and other purposes and it is desirable to provide a nonpulsating flame in order that more efficient combustion may be established and a more even transfer of heat provided to the surface or material which is being heated. A nonpulsating flame also provides the advantage of a reduction in the noise emitted by the apparatus when in use.

The primary object of the present invention is to provide fluid fuel burning apparatus in which, in use, a stable, nonpulsating flame is established in a simple and effective manner over a relatively wide range of firing rates.

Another object of the invention is to provide fluid fuel burning apparatus in which, in use, the flame is of generally symmetrical appearance and of shorter length than flames formed in hitherto known burners of similar capacity operating under similar conditions.

A further object is to provide fluid fuel burning apparatus which is capable of being operated at a relatively high thermal efficiency without the emission of an objectionable amount of smoke either under forced draught or natural draught conditions.

Yet a further object is to provide fluid fuel burning apparatus which is relatively quiet in operation.

Other objects of the invention will become apparent from the following description and accompanying drawing in which

FIGURE 1 is a longitudinal section of one example of fluid fuel burning apparatus constructed in accordance with the invention,

FIGURE 2 is an end view of the apparatus shown in FIGURE 1, and

FIGURES 3 and 4 are further views, similar to FIGURES 1 and 2 but showing an alternative embodiment in accordance with the invention.

In the example shown in FIGURES 1 and 2 there is provided a duct 10 which may be constructed as a cylindrical tube or tube of other cross-section of steel or other suitable material such as, for example, brickwork. The duct is adapted to be connected at one end to a source of combustion air which may be pressurized by a compressor if desired.

Adjacent to the opposite end of said duct 10 is a baffle member 11 of circular configuration, with said member having a centrally disposed aperture 12. The baffle member 11 is coaxially mounted in said duct 10 so as to provide a gap 13 of constant width between the outer periphery of the member and the adjacent surface of the duct.

There is also provided a sleeve 14 which is disposed within the duct 10 on the upstream side of the baffle member 11 so as to be coaxial therewith, the forward or leading end of said sleeve 14 being connected to the adjacent face (namely the upstream face) of the baffle member. The diameter of said sleeve 14 is somewhat less than that of the member 11 so that the outer periphery of the latter projects laterally beyond the sleeve as may be seen from FIGURE 1.

The apparatus is also provided with a hollow nozzle-mounting assembly 15 arranged coaxially of the sleeve and having a base portion 16 through which extends a fuel pipe 17 connected at one end to at least one nozzle

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18. An electrode 19 also extends through the base portion 16 for use in igniting fuel issuing from the nozzle 18. The fuel pipe 17 may be connected in use to a supply of gaseous or liquid fuel while the electrode 19 would of course be connected to a suitable source of electric potential. The nozzle mounting assembly 15 is also provided with a plurality of apertures 20 through which can pass air for cooling the nozzle 18.

The duct 10 is formed so that adjacent to said baffle member 11 on the downstream side thereof the duct is straight or of nondivergent configuration in a forward direction for at least a distance substantially equal to the width of said gap 13. In the example shown the duct 10 is of cylindrical configuration throughout its length. Furthermore, said member 11 is provided on its downstream face as shown in the drawings with a facing of heat-insulating material 21, with said material being of annular form and being chamfered on its inner and outer peripheries so as to be of forwardly tapered configuration in cross section. In an alternative arrangement, the heat insulating material may be provided on the upstream side of said member 11 but in either event it will assist in reducing the deposition of carbon on said member.

The aforesaid sleeve 14 and nozzle mounting assembly 15 may be conveniently mounted within the duct 10 by means of members 22.

In use air admitted to the upstream end of said duct 10 (i.e. the left hand end of said duct as seen in FIGURE 1) will be divided by the sleeve 14 into two streams, namely one stream passing between the exterior of said sleeve 14 and the interior of the duct 10 and another stream passing between the interior of the sleeve 14 and the exterior of the nozzle mounting assembly 15. The first mentioned stream flows without rotation or swirling until it meets the obstruction offered by the outer edge portion of the member 11 adjacent to the gap 13 and due to this obstruction the air pressure at this position will temporarily increase. Immediately after passing this obstruction expansion will take place and since the duct on the downstream side of said member 11 is straight or of nondivergent configuration the expansion will be directed inwardly as indicated by the arrows in FIGURE 1.

The other stream of combustion air, namely that air passing between the sleeve 14 and the nozzle mounting assembly 15, will flow around the end of said assembly and through the aperture 12 in the member 11. At the same time fuel issuing from the nozzle 18 will pass through the aperture 12 and owing to the low pressure region on the downstream side of the member 11 (caused by the obstruction offered by said member), said fuel will be directed to said low pressure region and will be held there by the air flowing inwardly from the outer regions of the duct and the air flowing through the aperture 12. A relatively short annular flame will thus be established and it is found that the flame is extremely stable under a wide range of firing rates since it is held as above described by the stream of air. In other words the flame is securely anchored on the downstream side of said baffle member 11 and no pulsation occurs.

In the alternative embodiment illustrated in FIGURES 3 and 4, the duct 10, baffle member 11, and the aperture 12, are provided as in FIGURES 1 and 2 but in this embodiment the sleeve 14 is dispensed with and the baffle member 11 is secured to the forward end of the nozzle-mounting assembly 15 by means of spaced struts 23 projecting forwardly from the forward end of said assembly 15 so as to leave a space between said end and the upstream side of the member 11. At least one nozzle 18, an electrode 19 and apertures 20 for nozzle-cooling air are provided as before, and member 11 has a facing of heat-insulating material 21 while members

22 connect the nozzle-mounting assembly 15 to the duct 10.

Moreover, the apparatus is provided with a hollow ring 24 disposed on the exterior of the duct 10 and having a series of apertures 25. The ring 24 is adapted to be connected to a supply of gaseous fuel so that the apparatus can be used as a mixed burner when gas is admitted via the apertures 25 to be mixed with combustion air while liquid fuel is admitted through the nozzle or nozzles 18, burning of both the gas and the liquid fuel taking place on the downstream side of the baffle member 11 as previously described. Alternatively, the apparatus can be used to burn gaseous fuel only, or liquid fuel only.

The apparatus above described in either of the above embodiments produces a symmetrical flame coaxial with the duct 10 and of luminous form having a greater brilliance than is achieved by conventional burners operating at like inputs and CO₂ readings in the products of combustion. Furthermore this fixed and immovable flame front is not dependent upon any whirling or rotating air streams but relies on the low pressure region created on the downstream side of the member 11 allied to the anchoring effect produced by the air flow as mentioned above. This unique method of establishing a fixed and stable flame makes it impossible for any appreciable amount of combustion air to enter the firing region without being brought into intimate contact with the fuel being consumed. Some air flowing through the aperture 12 breaks through the fuel spray but is immediately returned to intimate contact with the fuel owing to the low pressure of the zone in which the flame is located thereby trapping the fuel between two converging air streams and resulting in a favourable situation for efficient combustion.

As an indication of the very superior results obtainable with apparatus according to the present invention it may be mentioned that the apparatus has been operated in a heat release range of 150,000-250,000 B.t.u. per cubic foot of combustion chamber or furnace volume per hour, firing against a furnace back pressure of approximately 0.1" water column with an air supply source pressure of approximately 0.8"-1.25" water column available in the duct 10. With additional pressure in the duct 10, however, there is no reason why the above-mentioned heat release rates should not be exceeded.

Furthermore, so far as liquid fuels are concerned, apparatus according to the present invention possesses a performance vastly superior to anything hitherto known in conventional apparatus of a similar kind. Thus, apparatus in accordance with the invention has been frequently operated with 13-14% CO₂ in the products of combustion and test results have been recorded in excess of 14% CO₂ with no trace of smoke on a Bacharach smoke tester pad when burning a No. 2 fuel oil having an A.P.I. gravity of approximately 36° and a gross heating value of 140,000 B.t.u. per U.S. gallon with an ultimate CO₂ of approximately 15.4%. One particular test was conducted in the 10 g.p.h. firing range where 14.7% CO₂ in the products of combustion was recorded with a No. 1 Bacharach smoke pad reading; at 15% CO₂ the smoke pad reading was a No. 2. All tests were conducted utilising Hays or Fisher orsats, and in the data recorded the excess oxygen in the products of combustion substantiated the CO₂ readings.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for burning fluid fuel to provide a stable, nonpulsating flame of relatively short length comprising a duct having inlet and outlet ends with said inlet end being adapted to be connected to a source of combustion air, a sleeve mounted within and spaced from said duct and having a thermal end located upstream of said outlet end for providing a flow path for combustion air between the sleeve and the duct, a baffle member carried

by said terminal end of the sleeve arranged transversely with respect to said sleeve, said baffle member having a central aperture therein and a peripheral edge projecting into the air flow path between the sleeve and the duct with such peripheral edge providing a continuous gap of constant width between the baffle member and the opposed surface of the duct, at least one fuel nozzle mounted within said sleeve for directing fluid fuel through said central aperture to the downstream side of said baffle member, means for directing air upstream of said baffle member for passage through said central aperture, and the outlet end of said duct being straight and extending beyond said baffle member a distance substantially equal to the width of said gap whereby the air pressure between the sleeve and duct will temporarily increase due to the projecting peripheral edge and after passing such edge will expand and be directed inwardly with the air flow and fuel passing through the central aperture and due to the low pressure area on the downstream side of the baffle member, the fuel will be directed to the low pressure area and maintained in such area by the inwardly flowing air and the air passing through the central aperture.

2. The apparatus as claimed in claim 1, in which said duct and sleeve are of cylindrical configuration.

3. The apparatus as claimed in claim 2, in which a facing of heat-insulating material is provided on the downstream side of said baffle member, said facing being of annular form and being chamfered on its inner and outer peripheries for providing a forwardly tapering cross-section.

4. Apparatus for burning fluid fuel comprising a duct having inlet and outlet ends with said inlet end being adapted to be connected to a source of combustion air, a sleeve within and spaced from said duct and having a terminal end located upstream of said outlet end thereby providing a flow path for combustion air between the sleeve and the duct, a baffle member carried by said terminal end of the sleeve arranged transversely with respect to said sleeve, said baffle member having a central aperture therein and a peripheral edge projecting into the air flow path between the sleeve and the duct with such peripheral edge providing a continuous gap of constant width between the baffle member and the opposed surface of the duct, a hollow nozzle assembly located within and spaced inwardly of said sleeve, said assembly having a forward end spaced from the upstream side of the baffle member, the space between said assembly and the opposed surface of said sleeve providing a second air flow path, at least one nozzle mounted within said assembly for directing fluid fuel through said central aperture to the downstream side of said baffle member, and the outlet end of said duct being straight and extending beyond said baffle member a distance substantially equal to the width of said gap whereby the air pressure between the sleeve and duct will increase due to the projecting peripheral edge and after passing such edge be directed inwardly with the air in said second path entering the space between the forward end of the assembly and the upstream side of the baffle and passing through the central aperture together with the fluid fuel and due to the low pressure area on the downstream side of the baffle member the fuel will be directed to the low pressure area and maintained in such area by the inwardly flowing air and the air passing through the central aperture.

5. The apparatus as claimed in claim 4 wherein said nozzle-mounting assembly is provided with apertures for the admission of nozzle-cooling air.

6. Apparatus for burning fluid fuel to provide a stable, nonpulsating flame of relatively short length comprising a duct having inlet and outlet ends with said inlet end being adapted to be connected to a source of combustion air, a hollow nozzle-mounting assembly disposed within and spaced from said duct and having a terminal end located upstream of said outlet end for providing a flow

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path for combustion air between the assembly and the duct, a baffle member means within the duct arranged transversely with respect to said mounting assembly, means for supporting said baffle member means in spaced relation to the terminal end of said assembly, said baffle member means having a central aperture therein and a peripheral edge projecting into the air flow path between the mounting assembly and the duct with such peripheral edge providing a continuous gap of constant width between the baffle member means and the opposed surface of the duct, at least one fuel nozzle supported within said assembly for directing fluid fuel through said central aperture to the downstream side of said baffle member means, and the outlet end of said duct being straight and extending beyond said baffle member means a distance substantially equal to the width of said gap whereby the air pressure between the mounting assembly and the duct will temporarily increase due to the projecting peripheral edge and after passing such edge will expand and be directed inwardly with the air impinging on the upstream side of the projecting edge being directed into the space between the terminal end and the baffle member means and through said central aperture together with the fuel and due to the low pressure area on the downstream side of the baffle member means, the fuel will be directed to the low pressure area and maintained in such area by the inwardly flowing air and the air passing through the central aperture.

7. The apparatus as claimed in claim 6 wherein said

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duct is provided with a plurality of apertures located upstream of the terminal end of said mounting assembly adapted to be connected to a source of gaseous fuel.

8. The apparatus as claimed in claim 6 wherein said duct is provided with a plurality of apertures located upstream of the terminal end of said mounting assembly, and a hollow component adapted to be connected to a source of gaseous fuel embracing said duct and having a plurality of openings registering with said apertures in the duct.

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FREDERICK L. MATTESON, JR., *Primary Examiner*.

PERCY L. PATRICK, MEYER PERLIN, JAMES W. WESTHAVER, *Examiners*.