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(54) **Blue flame burner for liquid fuels.**

(57) The burner comprises an externally cooled combustion chamber (6), a pre-heating chamber (7) for the combustion air from an air-pressurizing blower, a neck (5) provided with a calibrated bushing through which the pre-heating chamber (7) is communicated to the combustion chamber (6). Both the pre-heating chamber (6) and combustion chamber (7) are formed within a tubular body (2) having a nosepiece (3) at one end which is adapted to delimit the combustion chamber (6), and a cap (4) at the other end which is effective to delimit the pre-heating chamber (7). The end cap (4) has a lug (18) extending inside the pre-heating chamber (7) in cantilever relationship therewith and being adapted to support, in cantilever-relationship within the bushing, an atomizing injector device 20.

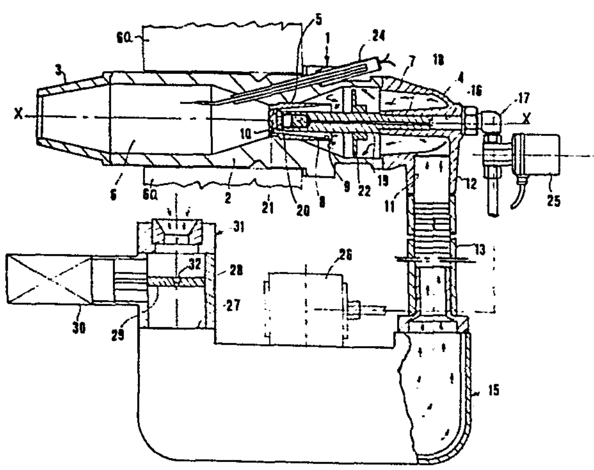

FIG.1

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This invention relates to a blue flame burner for liquid fuels.

Known in the art are blue flame burners for liquid fuels which, while being much more efficient than traditional white flame burners, require the provision of two discrete combustion air feed paths to the burner combustion chamber. The two paths are conventionally designated primary air path and secondary air path, respectively. The provision of such dual path involves, in addition to designing and construction problems, also the solution of complex problems connected with the volume and velocity metering of the air flown therethrough, as well as of mutual correlation and interdependence.

Thus the task of this invention is to provide a blue flame burner for liquid fuels which, additionally to substantially removing the cited problems and shortcomings affecting prior burners, can afford a definitely superior performance level.

Within this task it is an object of the invention to provide a burner as indicated, which affords, to all practical effects, a complete combustion, leaving no unburned portions of the fuel, by ensuring that the combustion can take place in a stoichiometric ratio of fuel to combustion air, or a ratio very close to the theoretical stoichiometric values. This means that the excess air flowing through the burner is nil or close to zero, for a higher thermal efficiency of the burner.

A further object of this invention is to provide a burner as indicated, which has a very simple construction, comprises a minimum of components, can be readily and conveniently assembled and disassembled, and can be manufactured at a highly competitive cost.

These and other objects, such as will be apparent hereinafter, are achieved by a blue flame burner for liquid fuels, characterized in that it comprises an externally cooled combustion chamber, a pre-heating chamber for combustion air from a source of pressurized air, a calibrated neck wherethrough said pre-heating chamber is communicated to said combustion chamber, an atomizing injector cantilever mounted inside said calibrated neck and being adapted to scatter atomized fuel toward said combustion chamber, and a pressurized fuel intake conduit arranged within said air pre-heating chamber in heat exchange relationship therewith and being connected to a source of pressurized fuel.

Further aspects and advantages will become apparent after considering the following detailed description of a preferred embodiment of this invention, given herein by way of example and not of limitation, in conjunction with the accompanying illustrative drawings, where:

Figure 1 is a schematic view, in elevation and longitudinal section, of a burner according to the invention;

Figure 2 is a schematic elevation view of the burner of Figure 1, as placed at the inlet end of a refractory material lined chamber; and

Figure 3 is a CO_2 vs. O_2 percent graph.

With reference to Figures 1 and 2, where similar parts have been designated with the same reference numerals, this burner 1 has an elongate hollow body 2, a calibrated nosepiece 3 removably attached to one end of the hollow body 2, and an end cap 4, removably attached to the other end of the hollow body. The latter is formed, at an intermediate region thereof, with an annular increased-thickness portion, whereat a restriction or neck 5 is defined internally. The annular thickened portion in the hollow body 4 acts as a partition member separating two internal cavities in the body 4, namely a front cavity 6 and rear cavity 7. The front cavity 6 is, thus, delimited on the front by the nosepiece 3 and constitutes the burner combustion chamber, which is cooled externally by a fluid circulated at 6a, while the rear cavity 7 is closed by the end cap 4 and constitutes a combustion air pre-heating chamber, as will be explained hereinafter. The chambers 6 and 7, and the neck 5, are all aligned together along the longitudinal axis x-x.

At the neck 5, there is arranged, in a removable manner, a bushing 8, which abuts externally and peripherally against the inner wall of the neck 5, and has an inner bore 9 convergent toward its calibrated end 10 facing the chamber 6.

The end cap 4, and accordingly the chamber 7, is communicated, through a hole 11 formed through a lug 12 whereto is secured one end of a preferably flexible hose line 13, to the delivery end of a blower or compressor 15 of the two-stage type which is arranged to deliver pressurized air into the chamber 7. Through the end cap 4, a hole 16 is also formed which extends coaxial with the axis x-x, and is connected to a a pressurized liquid fuel (e.g. Diesel oil) supply conduit 17. More specifically, the hole 16 is formed through an inside lug 18 which, from the rear wall of the end cap 4, extends in cantilever relationship along the axis x-x over the entire length of the end cap. At the free end of the lug 18, there is secured one end of a conduit or line 19, which enters the bushing 8 cantilever-fashion. The free end of the conduit 19 accommodates, mounted therein, an atomizing injector device 20, which barely clears with its spray nozzle 21 the calibrated end 10 of the bushing 8.

On that section of the line 19 which extends outside of the bushing 8, there is slidably mounted, and adjustably fastened, a disk or diaphragm 22 which functions as a restrictor element for the air coming from the passage 11 and directed to the combustion chamber.

Laterally to the restriction 5, at the thickened region of the hollow body 2, there are formed holes intended to accommodate flame ignition and control metal electrodes 24, which protrude into the combustion chamber 6.

The pressurized fuel supply line 17 is in turn connected, with the interposition of a control solenoid valve 25, to a suitable fuel pump 26.

At the intake mouth 27 of the blower 15, a conduit 28 is provided which can be shut off by means of a movable shutter 29 driven by a solenoid valve 30. Upstream of the shutter 29 is located a metering device 31 arranged to control the flow rate of the combustion air directed to the burner.

Preferably, the metering device 31 can be adjusted by means of a micrometric adjustment pin screw.

The burner described hereinabove operates in a very simple manner. After starting the blower 15 and actuating the pump 26, the shutter 29 will be in its air shut-off position; however, thanks to a central hole 32 provided therein, a sufficient amount of air can still be admitted to the combustion chamber 6 to cause ignition. Once the fuel has been so ignited, the solenoid valve 30 will be controlled, by an electronic control unit not shown in the drawings, to open, so that pressurized combustion air can be delivered into the chamber 7 at a pressure and volume consistent with the amount of fuel issueing from the atomizing injector 20, and in all cases in stoichiometric proportion for burning the particular fuel being used.

In operation, the hollow body 2 will be heated at the combustion chamber 3, and transfer part of its heat by conduction to both the air within the chamber 7 and fuel flowing through the lug 18. By convection, the air contained in the chamber 7 will in turn aasist in the transfer of heat from the inner walls of the chamber 7 to the conduit 19, thereby the oncoming fuel to the atomizing injector device 20 is adequately pre-heated.

The air contained in the chamber 7 initially undergoes expansion in flowing from the hole 11 to that portion of the chamber 7 which is located upstream of the diaphragm 22. The diaphragm 22 will instead force the air to flow peripherally past it and then sweep the inner wall of the tubular body 2, thereby its velocity is increased. Between the diaphragm 22 and bushing 8, the air is subjected to further expansion, and by virtue of the bushing 8 being configured to protrude in part, cantilever-fashion, toward the interior of the chamber 7 from the restriction or neck 5, it undergoes a mixing and thermal stabilization process prior to flowing through the bore 9 in the bushing 8. Through the bore 9, the air is uniformly distributed along and around the atomizing injector device 20, and upon reaching the calibrated end 10 of the bushing 8, it is directed concentrically toward the interior of the chamber 9, to encircle the jet(s) of atomized fuel issueing from the nozzle 21. It is important that the atomized fuel spray be focussed on the area of highest turbulence of the combustion air being fed into the combustion chamber.

With burners constructed as described hereinabove and operating as herein detailed, efficiency rates have been achieved on a regular basis which equal or exceed 99 percent, as against maximum rated efficiencies of 82-85 percent of comparable white flame burners of conventional design and construction.

Moreover, besides the very high thermal efficiency afforded by a burner according to this invention, several other advantages can be secured, among which:

- complete combustion of the fuel with total absence of unburned residue;
- high temperature of the resulting flame emerging from the combustion chamber 6;
- issue of polluting gases in negligible amounts; and
- very low maintenance costs, largely on account of the absence of unburned products.

Tests have been carried out on a burner as described above, having its nosepiece 3 located at the inlet end of a chamber 33 lined with tiles 34 of a refractory material, as shown in Figure 2. The refractory material lining, upon becoming red-hot, will issue light in the white-red bands with a high emissivity. Thus, inside the chamber 33 temperatures in excess of 1,500°C are to be achieved within few minutes (3 to 5 minutes) from burner ignition.

With a burner 1 and chamber 33 as shown in Figure 2, but associated with a small-size boiler (having outside dimensions of 45 x 88 x 58 cm) surrounded by a water jacket, actual tests have provided the following values:

Furnace output 11,000 Kcal/hour

Useful thermal efficiency	95%
Flue gas temperature	176°C
Excess air	1.3
Smoke emission rate (Bach. app.)	0.0
CO_2 emission	14.5%
CO emission	.01%

As may be appreciated from the graph of Figure 3 (Ostwald triangle), for a content of carbon dioxide of 14.5 percent, there only occurs a both theoretical and practical excess of air of 1.3. Moreover, the virtual absence of carbon monoxide from the combustion products along with the high percentage of carbon dioxide is a sure indication, to all practical effects, of all the fuel being burned completely.

Actual tests have also shown that the sizing of this burner to meet varying power requirements in different applications will depend on the varying and mutual correlation of but a few structural elements. These are the inlet port size of the metering device 31 (T), the port size (U) of the calibrated end 10 of the nozzle 8, the maximum inside diameter (C) of the combustion chamber, the length (L) of the combustion chamber, and the diameter (B) of the nosepiece 3.

The following exemplary correlations of the above-specified values T,U,C,L and B have shown to be advantageous in practicing the invention:

Kcal/hour	T (mm)	U (mm)	C (mm)	L (mm)	B (mm)
10,000	34	17	65	192	22
20,000	10	20	65	162	32
50,000	16	19	65	212	42

100,000	34	18	85	263	55

The above-tabulated results relate to a fuel delivery pressure of 18 kg/cm^2.

The invention as described is susceptible to many modifications and variations without departing from the scope and spirit of the instant inventive concept.

The materials and dimensions used may vary to suit individual applicational requirements.

CLAIMS

1. A blue flame burner for liquid fuels, characterized in that it comprises an externally cooled combustion chamber (6), a pre-heating chamber (7) for combustion air from a source of pressurized air, a calibrated neck (5) wherethrough said pre-heating chamber (7) is communicated to said combustion chamber (6), an atomizing injector (20) cantilever mounted inside said calibrated neck (5) and being adapted to scatter atomized fuel toward said combustion chamber (6), and a pressurized fuel intake conduit (16) arranged within said air pre-heating chamber (7) in heat exchange relationship therewith and being connected to a source of pressurized fuel.

2. A burner according to Claim 1, characterized in that said neck (5) accommodates a calibrated passage bushing (8) adjacent said combustion chamber (6).

3. A burner according to either Claim 1 or 2, characterized in that said combustion and pre-heating chambers (6,7) are formed within an internally restricted hollow body (2) closed at one end by a calibrated nosepiece (3) adapted to confine said combustion chamber (6), and at the other end by an end cap (4) adapted to confine said pre-heating chamber (7).

4. A burner according to Claim 3, characterized in that said end cap (4) has a bored lug (18) connected to said pressurized fuel supply source and adapted to feed and cantilever carry said atomizing injector 20.

5. A burner according to Claim 4, characterized in that said combustion chamber (6), calibrated restric-

tion or neck (5), pre-heating chamber (7), and end cap bored lug (18) are all aligned together along a common axis.

6. A burner according to any of the preceding claims, characterized in that it further comprises a velocity regulator for the airflow entering said pre-heating chamber (7).

7. A burner according to Claim 6, characterized in that said regulator comprises a disk-like diaphragm (22) the position whereof is adjustable.

8. A burner according to any of the preceding claims, characterized in that said pressurized air source includes a two-stage blower (15) comprising a metering-shutter device (29,31) located at the intake end thereof (27).

9. A burner according to Claim 8, characterized in that said shutter device (29) is controlled by means of a solenoid valve (30), while said metering device (31) includes a micrometric adjustment pin screw.

10. A blue flame burner for liquid fuels, substantially as herein described and illustrated.

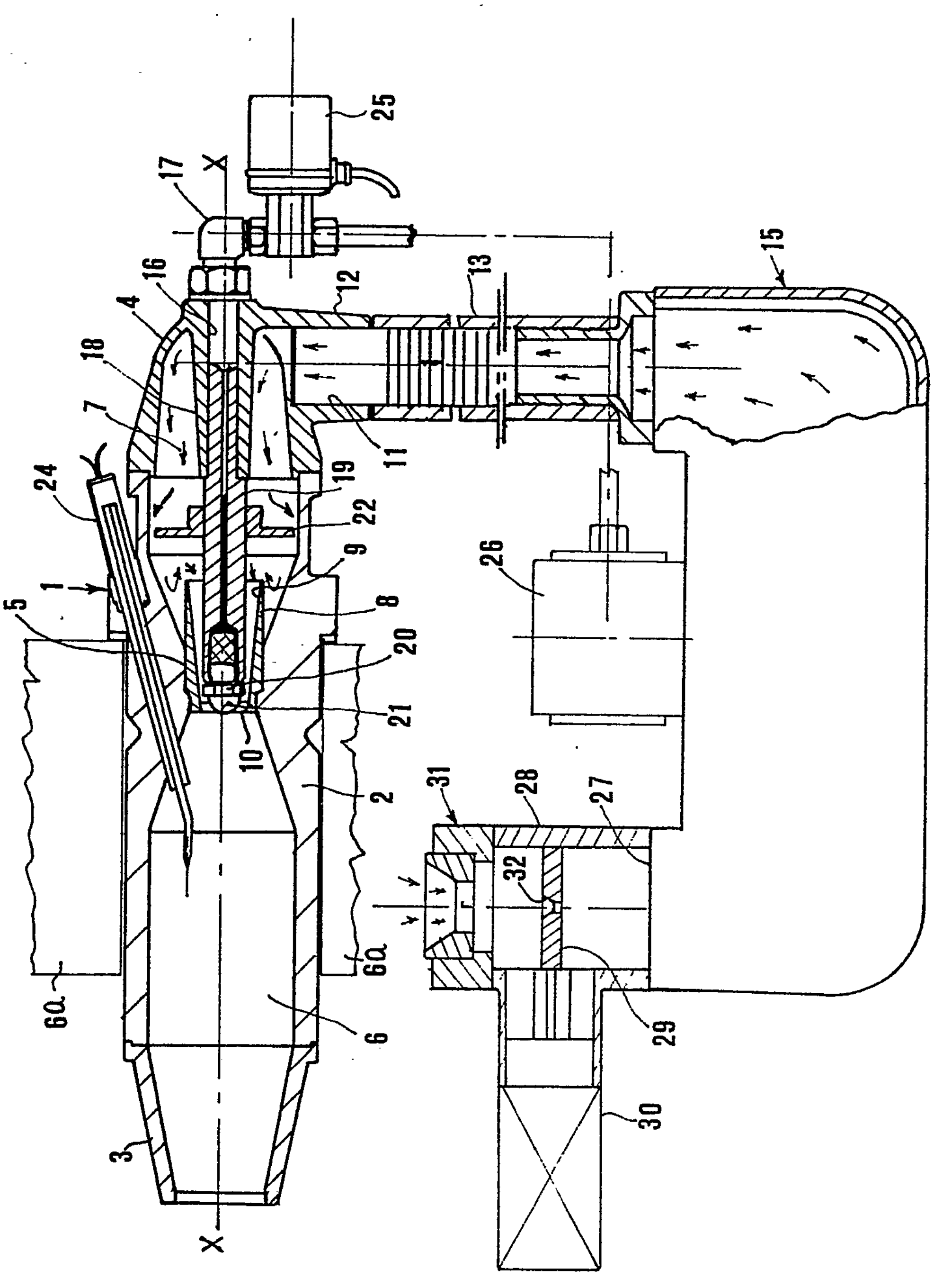
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FIG.1

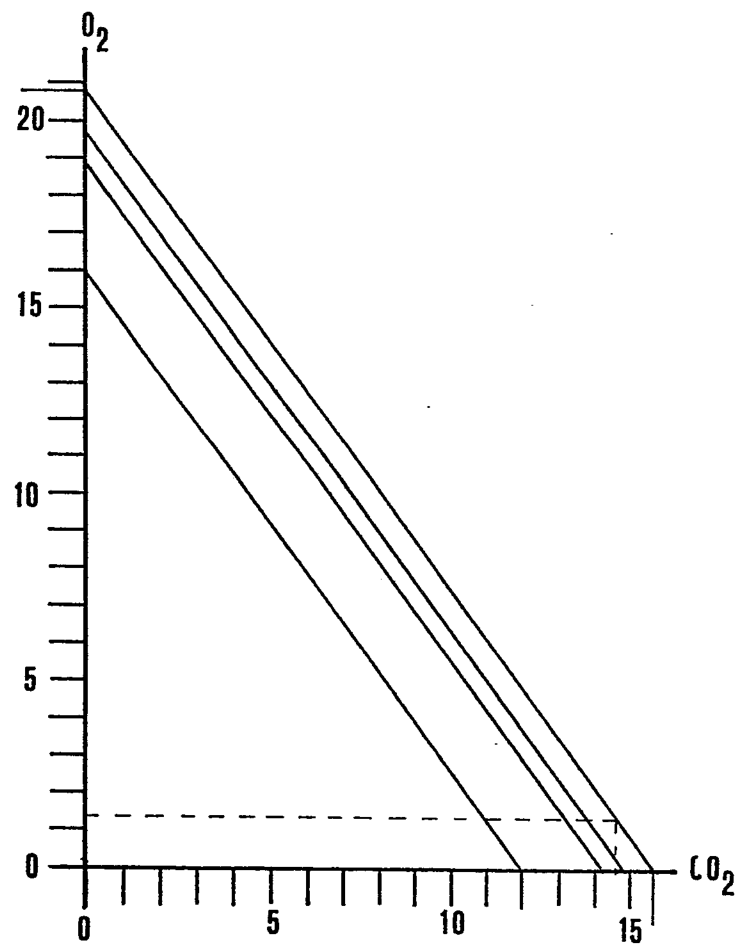
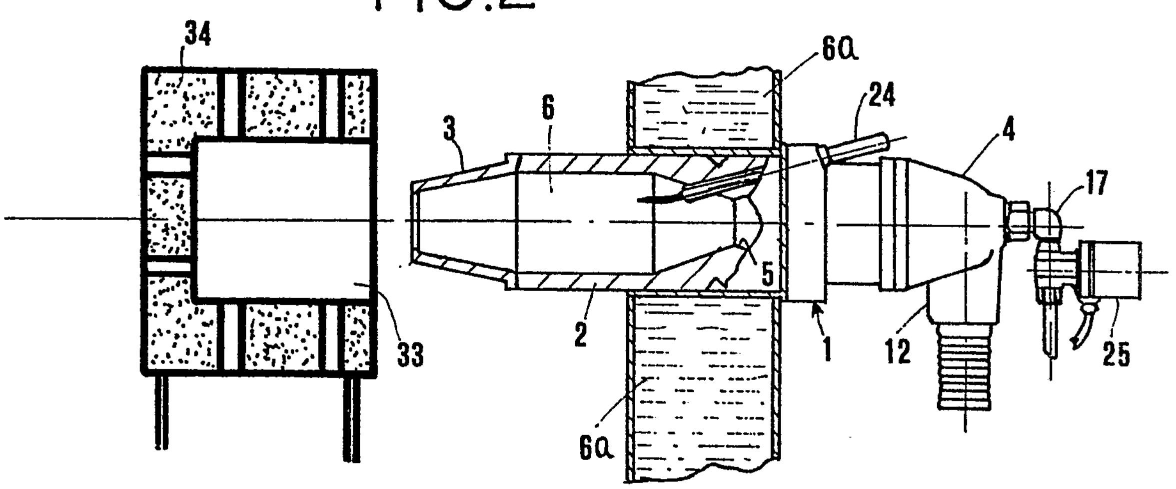


FIG.3

FIG.2



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EUROPEAN SEARCH REPORT

Application number

EP 82102973.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	EP - A2 - 0 023 001 (ZAMPIERI) * Page 4, lines 6,7; page 4, line 25 - page 5, line 5; page 10, lines 4-23; page 20, claim 1; fig. 2-4,7 *	1,5,6, 8,10	F 23 D 11/00
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A	GB - A - 716 841 (ETCHELLS)		
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A	GB - A - 1 378 306 (KOEHRING) * Fig. 9 *		
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A	AT - B - 157 474 (DICA S.A.) * Page 1, lines 16-18; fig. 1 *	1,7	

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

F 23 D 3/00
F 23 D 11/00
F 23 C 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	13-08-1982	TSCHÖLLITSCH

CATEGORY OF CITED DOCUMENTS

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