

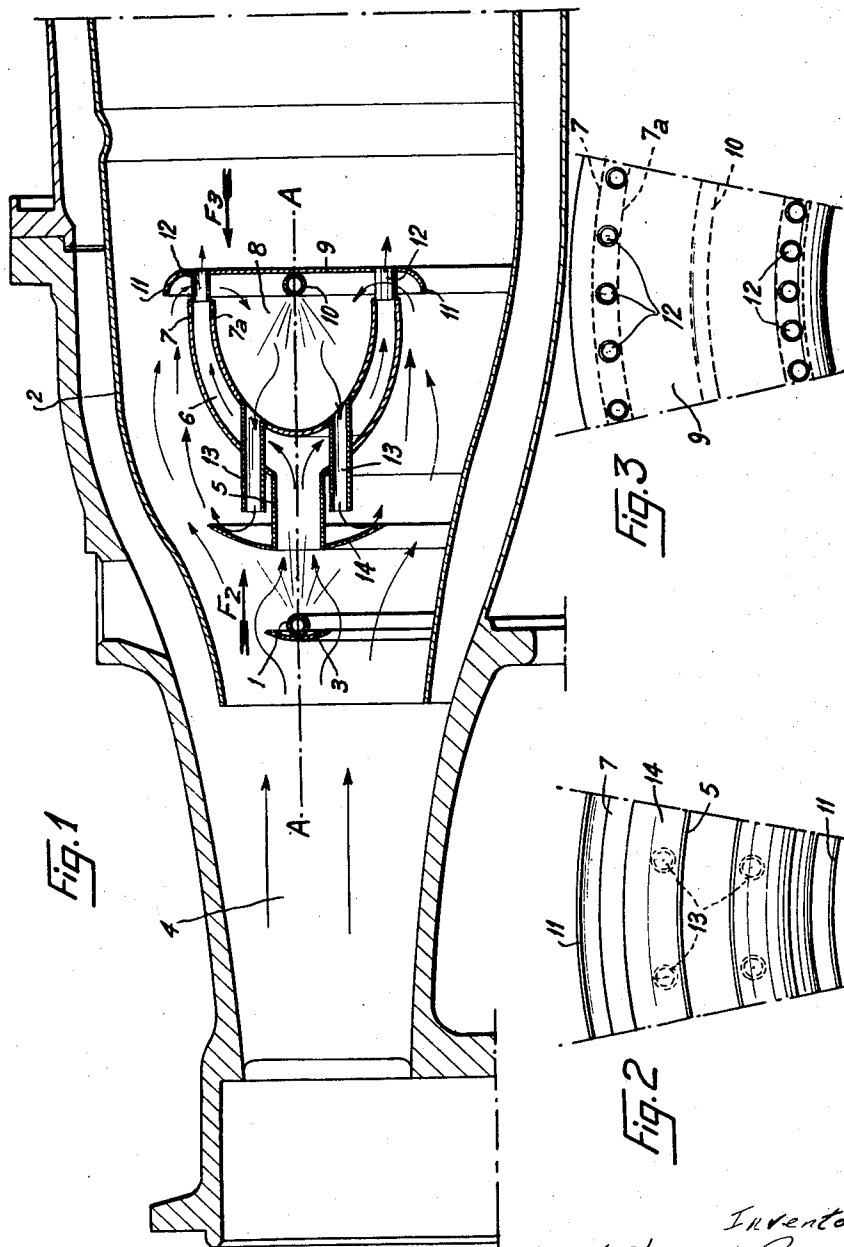
Aug. 16, 1960

F. G. M. FERRIE ET AL
VAPORISATION BURNER DEVICE

2,949,012

Filed Feb. 25, 1958

4 Sheets-Sheet 1



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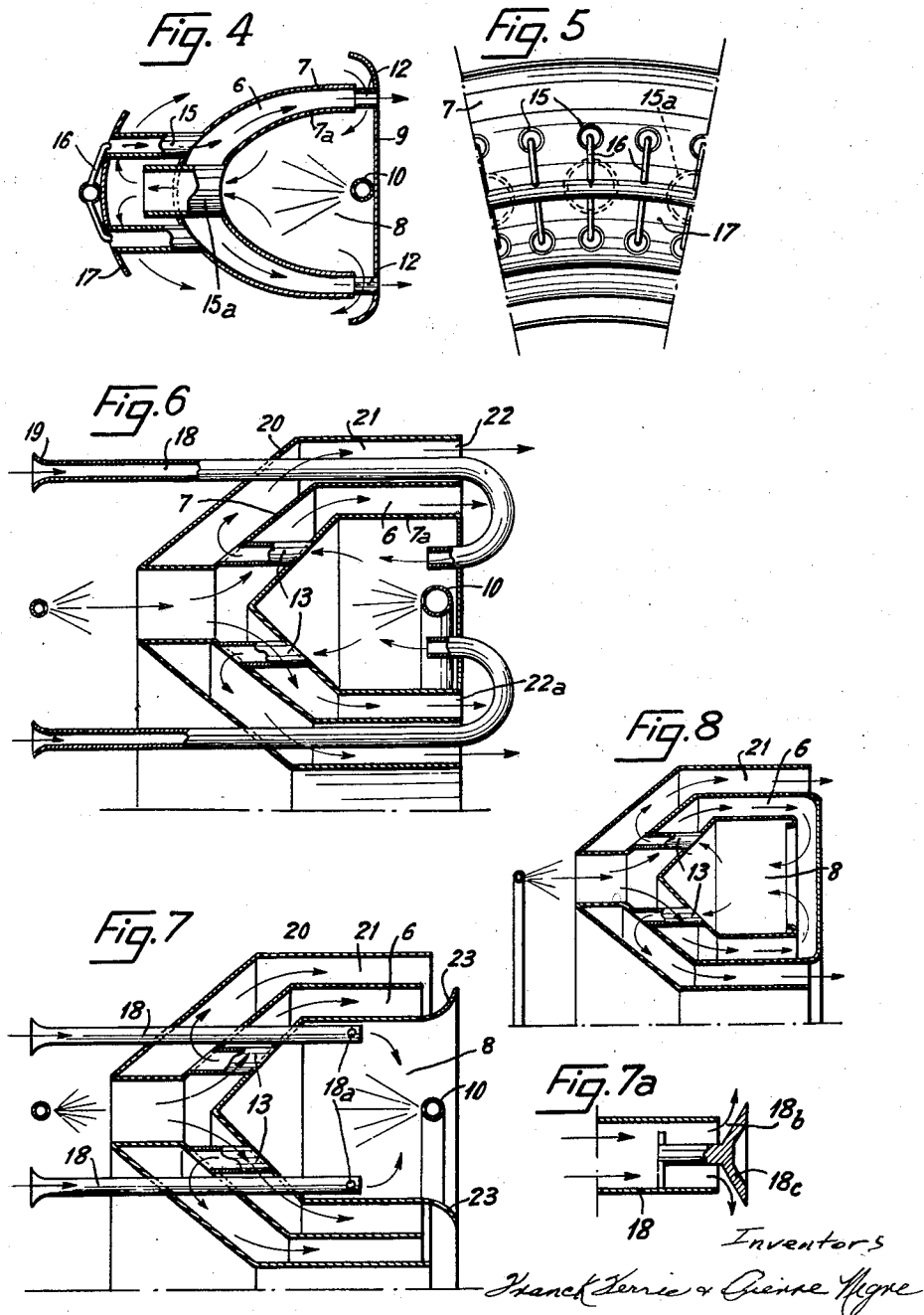
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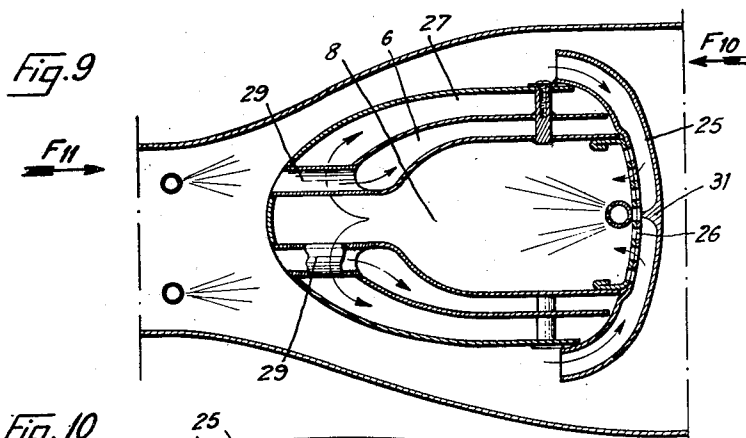
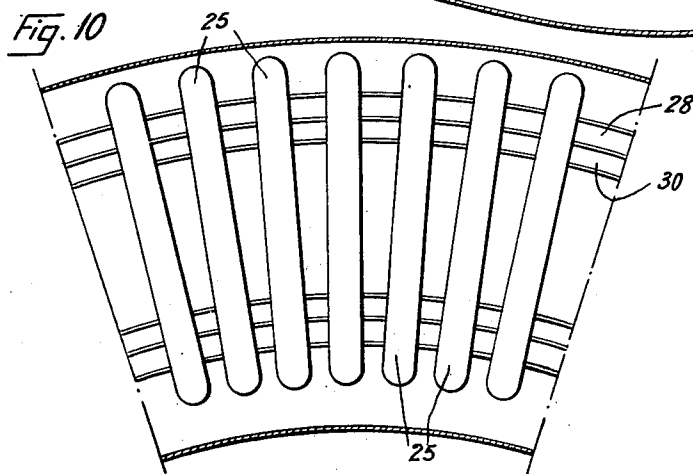
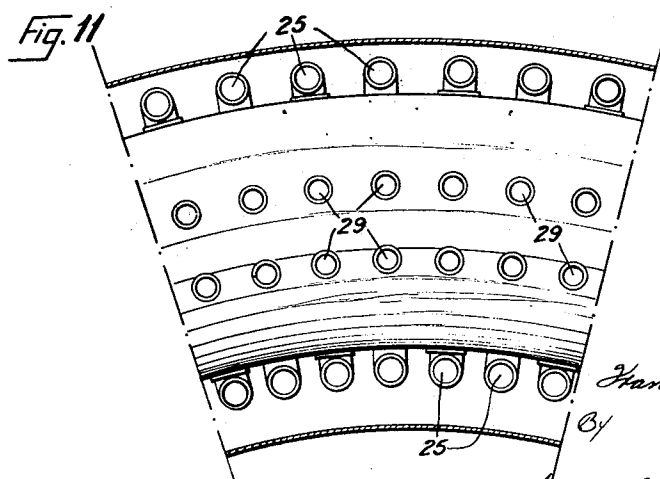
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4 Sheets-Sheet 4

Fig. 12

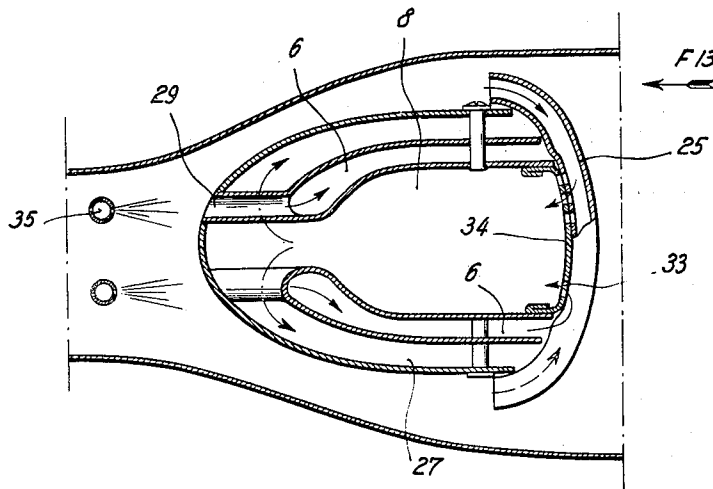
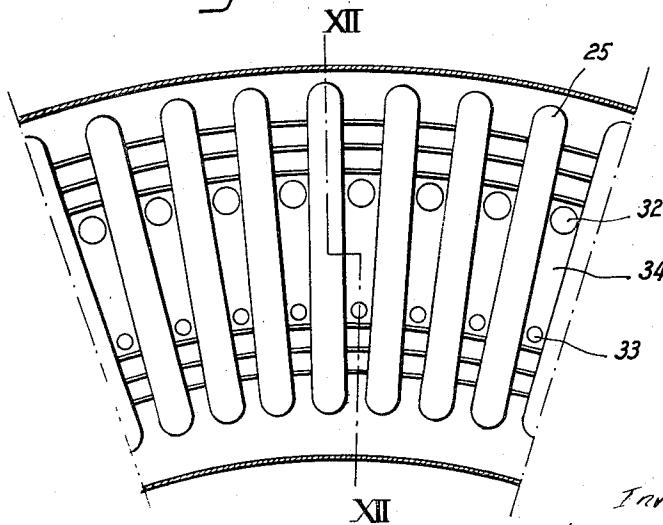


Fig. 13



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VAPORISATION BURNER DEVICE

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The present invention relates to combustion chambers in which a liquid fuel injected into moving air is to be burnt, such as in the case notably in gas turbine plants and aeronautical propulsive engines: turbo-jet engines, turbo-prop engines, ram jet engines etc.

It has the object of providing a burner device in which the heat developed by an auxiliary or pilot flame or by the main combustion flame or by both at the same time is utilised for vaporising the droplets of the liquid fuel injected into the air before this fuel is put to burning.

This device comprises a vaporisation duct, through which passes the pre-carburetted mixture, and which is formed between two hot walls, one of these walls forming a screen which protects the combustion against the rush of the air current, while the other, situated outside the first one with respect to this current, is impinged upon by the combustion gases directed towards the exterior of this wall by ducts leading from the zone of combustion and through which these gases flow in counter-current. One or more auxiliary injectors may be provided downstream of the inner wall of the vaporisation duct so as to form a pilot flame in such a manner that the combustion gases directed towards the outer surface of the external wall are then issued by this pilot flame, the combustion of the main fuel vaporised while passing through the heated duct taking place downstream of the device. However, one may also heat the inner wall of the duct by directing the whole or part of the principal mixture issued from the vaporisation duct towards this wall, and burning it in contact therewith.

In one or the other of these dispositions, the air required for the combustion (pilot or principal one) in contact with the inner wall of the vaporisation duct is supplied under the action of the total pressure of the air flowing through the air intake members opening towards the upstream side of the flow, the energy of pressure of the air let in by these members, augmented by the energy developed by the combustion, permitting the return in counterflow of the combustion gases for the heating of the outer wall of the duct.

It has been ascertained that such a device permits to obtain a very short flame for the principal combustion which allows, if required, to reduce the length of the combustion chamber and to increase its thermal loading, without any danger to the gas turbine in the case of a turbo-engine. The device permits likewise to push back the limits of extinction of a lean mixture or a rich mixture which may allow to simplify the regulation of the quantity of fuel to be injected.

The following description with reference to the accompanying drawing given by way of example but not of limitation, will make quite clear the invention and how the same is to be carried out the features disclosed by the drawing as well as by the text forming, well understood, part of the said invention.

Figure 1 is an elevation of a first embodiment of the invention, in section on a plane containing the axis of the combustion chamber.

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Figure 2 shows the device according to Figure 1 as viewed in the direction of the arrow f2, the device being applied (by way of example) to a combustion chamber of the annular type.

Figure 3 shows likewise the device according to Figure 1, but viewed in the direction of arrow f3.

Figures 4 and 5 show a modification of the embodiment in projections corresponding to the Figures 1 and 2.

Figures 6 to 9 are axial sections of four other modifications.

Figures 10 and 11 show the device according to Figure 9 viewed in the directions of the arrows f10 and f11, respectively, for the case of an annular chamber.

Figure 12 shows a modification of Figure 9, in section on the line XII—XII of Figure 13.

Figure 13 shows the device according to Figure 12 as viewed in the sense of the arrow f13.

In the embodiment illustrated in the Figures 1 to 3, a principal injection distributor 1 is disposed at the entrance of the flame tube of the combustion chamber which is assumed to be annular this distributor being protected by an annular deflector 3 from the direct effect of the air flow under pressure coming at 4 from the air compressor. This injection distributor issues into an annular slot 5 leading to a duct 6 formed between two concentric walls 7, 7a. The annular space 8 bounded by the inner wall 7a and an upstream baffle 9 contains an auxiliary injection distributor 10. Air is supplied to this annular chamber 8 under the action of the total pressure of the flow, the baffle 9 protruding as shown at 11 on both sides of the wall 7 for this purpose. The air which impinges on the protruding margins 11 penetrates into the chamber 8 in that it passes through the gaps between the tube lengths 12 which define the duct 6 and in turn issue behind the baffle 9. Tubes 13 put the interior of the chamber 8 in communication with the space situated behind the annular deflector 14 extending downstream of the principal distributor, on both sides of the annular gap 5.

This device functions as follows: the air captured by the protruding margins 11 of the baffle 9, passing into the chamber 8, sustains in this chamber the combustion of the fuel injected by the auxiliary distributor 10, which combustion may be ignited by any suitable means. Considering the wake formed behind the deflector 14, the energy of the combustion gases in the chamber 8 introduced into this chamber under the total pressure of the flow coming from the compressor is sufficient for these gases to escape behind the deflector 14 through the tubes 13, passing through these tubes in counterflow to the main flow. The combustion gases are then turned back in the upstream direction by the main flow and thus impinge upon the outer wall 7. The two walls 7—7a bounding the duct 6 are thus kept very hot, the one, 7a, by the pilot flame burning within the annular chamber 8, the other one, 7, by the gases impinging on it. The fuel introduced into this duct through the annular gap 5 is thus vaporised, and a good combustion is attained downstream of the baffle 9 at the outlet of the tubes 12. At the same time the evaporation of the fuel in the duct 6 prevents these walls from assuming too high a temperature which would be prejudicial to their life.

The end face area of the device remains comparatively small and does not induce any notable disturbances in the flow.

In the modifications according to Figures 4 and 5, the pre-carburated mixture arrives at the duct 6 through tubular ducts 15 ahead of each of which issues the pipe 16 of an injector. Tubular ducts 15a, issuing downstream of a deflector 17 through which pass ducts 15, permit the combustion gases to leave the annular space 8 enclosing the pilot injector 10. These combustion gases are turned

back by the air current against the outer wall 7 of the duct 6, which is thus heated. Moreover they are forced to pass through the interstices between the tubes 15, the wall of which is thus heated so as to assist in the vaporisation of the fuel.

Numerous modifications may be conceived.

Figure 6 shows a modification in which the air required for the combustion in the annular chamber 8 is supplied by one or more tubular air intakes 18 flaring out towards the air flow upstream of the injectors by means of flaring orifices 19.

Moreover, in this modification, the outer wall 7 of the duct 6 through which flows the pre-carburised mixture, is doubled by a parallel wall 20 in such a manner as to screen the combustion gases issuing from the chamber 8 through the tubes 13 against the air flow. These gases thus flow through an annular duct 21 before escaping rearwardly at 22 in the vicinity of the principal carburated mixture issuing at 22a and igniting itself in contact with the very hot gases.

In the duct 6 the carburised mixture is in contact with a surface of a hot wall, larger than in the previous embodiments, which fact improves the evaporation of the fuel.

In the modifications according to Figure 7, deflectors 23 provided at the end of the duct 6 lead the principal heated carburised mixture issuing from this duct into the flow of combustion gases deriving through the tubes 13 from the zone 8 where the pilot flame is kept burning. This facilitates the igniting of this carburised mixture. The dotted lines show that one may provide a baffle 20 similar to that according to Figure 6 for screening the combustion gases from the air flow. The air required for the combustion in the zone 8 is derived by tappings 18 opening upstream of the injector and issuing through radial holes 18a are circular slots 18b provided with an adjustable deflector 18c (Figure 7a).

The modification according to Figure 8 concerns a case where the principal combustion takes place in the annular chamber 8. The duct 6 leads the principal carburised mixture into this chamber, and the combustion gases flow through the tubes 13 into the duct 21 which corresponds to that of Figure 6. In this case it is therefore the heat of the principal combustion which heats the two walls of the duct 6 for evaporating the fuel.

In the modification according to Figures 9 to 11, the air required for the combustion in the annular chamber 8 is captured in the flow, at its total pressure, by tube lengths 25 opening upstream of the flow on both sides of the annular chamber 8. In their middle portions these tubes are provided with holes 26 through which the captured air issues into the chamber 8. The combustion gases leave the chamber 8 through an annular duct 27, and escape downstream between the tubes 25 through an annular gap 28. The annular duct 6 between the duct 27 and the chamber 8 receives the carburised mixture through tubes 29 opening upstream.

After having been heated in this duct, the mixture escapes downstream through an annular gap 30. This gap 30 is directly adjacent the gap 28 in such a manner that the pre-carburised mixture ignites itself in contact with the flame issuing from the latter. It will be noted that owing to the shape of the tubes 25 taking the air from the flow at their two ends, two air currents in opposite directions flow through these tubes in their middle which fact permits to attain a transformation of the kinetic energy of the streamlines of air into pressure energy on entry into the chamber 8.

A baffle 31 placed in the middle of each tube may be provided if desired, in order to guide the air in a better way.

In the modification of the Figures 12 and 13 openings 32 and 33 are provided in the wall 34 at intervals included between the lengths of tubing 25. In this manner, part of the fuel captured by the tubes 29 and issuing from

the duct 6 into the turbulent zone penetrates into the annular chamber 8 through the holes 32 and 33.

This disposition permits the igniting and continuous functioning of the burner by the aid of the upstream injector distributors 35 only.

All the burners described, designed for annular combustion chambers, are of simple construction, their walls can be formed simply by bending metal sheets. Their vaporisation device permits to attain a more perfect combustion of the carburised mixture, and it has been found that the danger of coking has become negligible.

The screen formed by the vaporisation device gives a good stabilisation of the flame, and keeps the latter short.

Tests have shown that the combustion is perfect even with very lean or very rich mixtures.

In the burners comprising a pilot flame, the latter is protected from the rush of the flow in such a manner that igniting and re-igniting of the combustion chamber can be attained easily whatever may be the conditions of flight.

Naturally, although an annular combustion chamber has been assumed in the devices described herein above, the latter are perfectly applicable to tubular combustion chambers in turret arrangement. For example a device of the kind of Figure 1 may be conceived, which is attained by revolving the same about the axis A—A, so that it may be placed in a tubular chamber. The same applies to the other devices described.

What is claimed is:

1. A combustion device for a combustion chamber comprising an inner wall forming a capacity closed upstream and protecting a combustion zone, an outer wall coaxially mounted with said inner wall to provide an annular passage, an open inlet in the outer wall at the upstream side thereof, means to introduce fuel into said annular passage through said open inlet, a plurality of ducts passing through said annular passage, each duct having at one end an inlet open to receive the combustion gases from said combustion zone and at the other end an outlet in the region exterior to the outer wall, and means to reverse said combustion gases into contact with said outer wall, so that the mixture of fuel and air passes through said annular passage between said inner and outer walls both heated and is therefrom vaporized.

2. A device according to claim 1 comprising further auxiliary injectors to introduce fuel downstream of said combustion zone and form a pilot flame, in such a way that the combustion gases directed towards the exterior of the outer wall are those issued by said pilot flame, while said vaporized mixture is directed by said annular passage downstream of said injectors.

3. A device according to claim 1 comprising further a deflector placed downstream of said auxiliary injectors to introduce into said combustion zone the air required therefor, and a plurality of conduits passing through said deflector, each conduit having at one end an inlet open inside said annular passage to receive the vaporized mixture and at the other end an outlet in the region downstream of said deflector.

4. A device according to claim 1 comprising a plurality of tubes to introduce into said combustion zone the air required therefor, each tube having an upstream intake arranged to utilize the total pressure of the air.

5. A device according to claim 1 comprising a plurality of radial lengths of tube having curved ends provided with air intakes directed upstream, the radial portion of each tube being provided with orifices issuing in said combustion zone.

6. A device according to claim 1 wherein the said means to reverse said combustion gases comprise a turning baffle extending upstream of the outlets of said ducts to screen from the air flow and reverse the combustion gases into contact with said outer wall.

7. A device according to claim 1 wherein the said means to reverse said combustion gases comprise a wall

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exterior to said outer wall, secured and coaxially mounted therewith to provide a duct coaxial with said annular passage and reversing said combustion gases and maintaining said gases into contact with said outer wall.

8. A device according to claim 7 wherein said annular passage has a downstream open outlet, wherein said duct coaxial with said passage has a downstream open orifice adjacent to said downstream open outlet, and comprising deflecting means so that the combustion gases escaping from said duct ignite the vaporized mixture 10 escaping from said annular passage.

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9. A device according to claim 1 comprising a downstream deflecting wall to direct said vaporized mixture escaping from said annular passage into said combustion zone.

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