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PILOT BURNER FOR COMBUSTION HEATER

Filed April 26, 1952

2 Sheets-Sheet 1

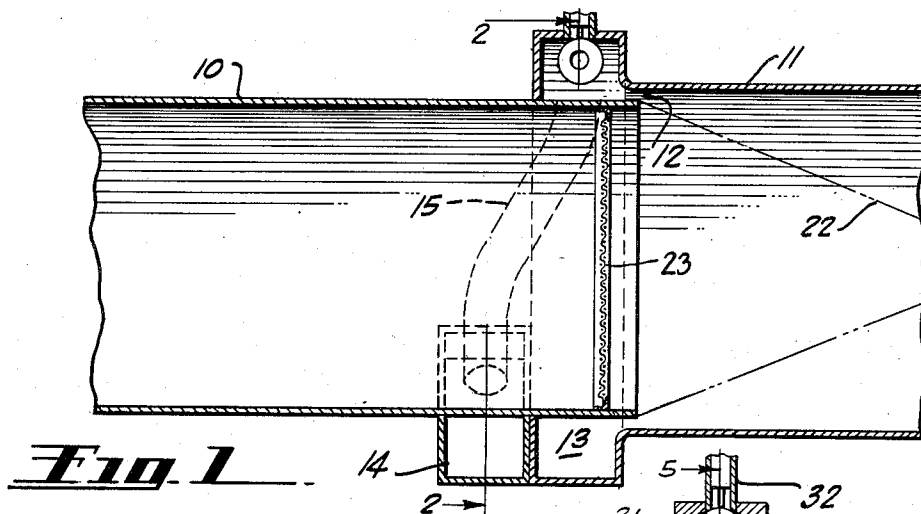


Fig. 1

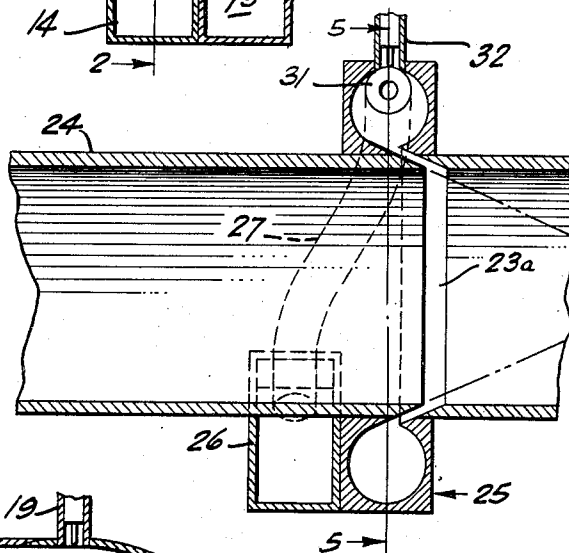


Fig. 4.

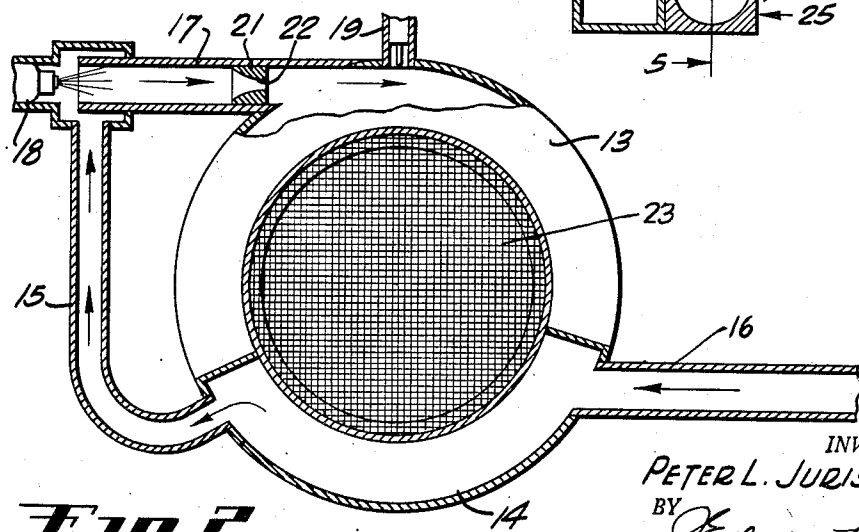


Fig. 2

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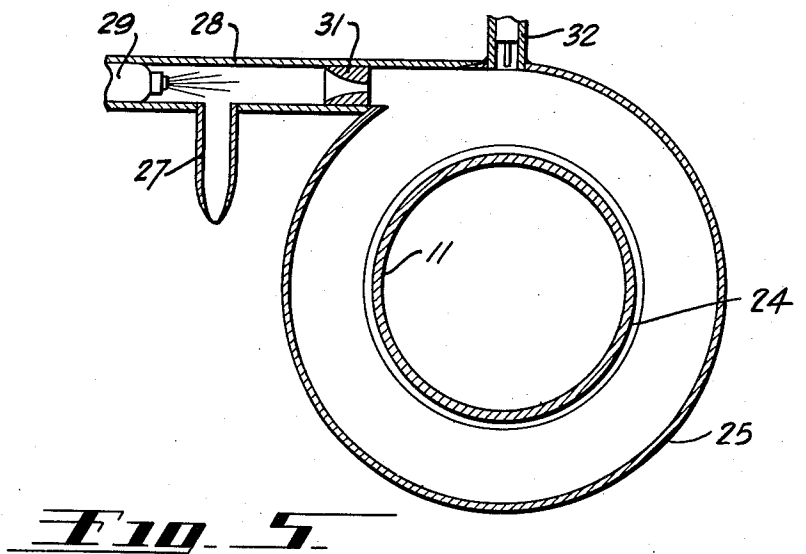
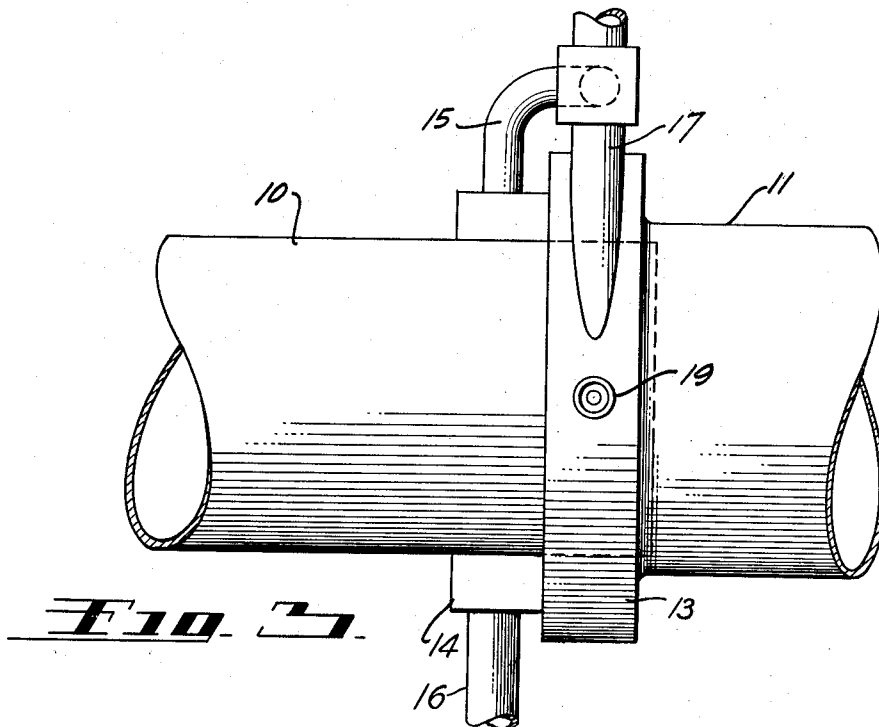
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PILOT BURNER FOR COMBUSTION HEATER

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10 Claims. (Cl. 158—4)

This invention relates to internal flow combustion devices, such as internal combustion heaters, primary and secondary burners for turbo, and ram, jet engines, and the like and particularly to the igniting means, or burners, thereof.

The invention provides a burner which effects starting of the internal combustion device somewhat nearer infallibility than that in current such devices; starts and operates the device with very infrequent detonations; and probably most important, nearly entirely eliminates "buzz-burning," irregular burning and back-firing, thus rendering the flame front and combustion of the device stable and continuous.

Roughly, the invention achieves these and other objects by providing an improved annular flame-type igniter exteriorly surrounding the main fuel-air path and communicating with the fuel-air mixture flowing in said path. The annular burner is constructed to obviate fuel-pockets therein and effect substantially perfect mixing of the fuel and air therein, these factors obviating detonation and rendering starting more certain.

Briefly, the burner also effectuates smooth stable burning by means including a novel configuration of the annular burner with the main fuel-air stream as well as by its internal construction and mode of communication with the main fuel-air mixture which configuration eliminates from the main fuel-air stream all protrusions. Previously, the duct conducting such stream bore spark-plugs, fuel or air injectors and the like, the inner ends of which projected into the stream and produced wake vortices and other forms of turbulence. The configuration of this invention eliminates such projections or protrusions and their stream-disturbances, as well as other causes of drag and rough burning. To aid in achieving this end, the invention also employs damping obstructions in the inlet of the pilot burner, these obstructions being of a type capable of quenching pulsating flow and local resonance in the burner and producing, if any, only isotropic turbulence in the inlet of the burner.

Several of the presently-preferred embodiments of these and other inventive concepts are illustrated in the accompanying drawings and described hereinafter in conjunction therewith. In these drawings:

Figure 1 is a diagrammatic longitudinal section of the main fuel-air passage of an internal combustion device with the present flame-type igniter or annular pilot burner annularly surrounding the end of the unignited mixture portion of this passage;

Figure 2 is a section taken on line 2—2 of Figure 1, sighting in the direction of the arrows;

Figure 3 is a top plan view of the configuration shown in Figure 1, taken to illustrate the fuel and air supplies to the pilot burner;

Figure 4 is a view similar to Figure 1 and showing another form of pilot-burner; and

Figure 5 is a cross-section on line 5—5 of Figure 4. The construction shown in Figures 1-3, inclusive, com-

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prises a duct section 10 for the inlet of the main mixture of fuel and air, the duct being coaxially nested at its downstream end in the upstream end of another duct 11 of the main passage of the internal combustion device, the relative diameters and arrangement being such that the overlapped portions of the ducts define an annular gap 12 open at the downstream end thereof and peripherally surrounding duct 10. Slightly upstream of this gap is disposed a toroidal chamber 13, here shown as of a rectangular cross-section, the downstream inner peripheral edge of the rectangle being open and lying adjacent gap 12. Peripherally integral with about half the lower periphery of the upstream face of the toroidal chamber 13 is a semi-toroidal chamber 14, also shown as rectangular in cross-section. An air inlet tube 15 for mixing air with the fuel separately supplied to the combustion-initiating chamber 13 is attached at its inner end to the one end of this chamber, the opposite end of the tube 15 communicating through chamber 14 with a source of low-pressure air, not shown but leading to chamber 14 through a pipe 16, Figure 3. Curvilinear tube 15 terminates at an inlet manifold 17 for supplying a fuel-air mixture to the pilot burner. In the outer end of manifold 17, there is coaxially mounted a fuel nozzle 18 for injecting a liquid fuel under pressure into the inlet manifold, there to mix with the air from tube 15 in a combustible ratio. This mixture passes into toroidal chamber 13 where its combustion is initiated by an igniter 19 which may take the form of an instantaneously operated spark plug, glow coil or the like. Igniter 19 is operated but once, as by a push-button circuit, not shown, ignition in the pilot burner thereafter being effectuated by the self-piloting means constituting an essential part of the invention.

A triple-function member 21 is coaxially mounted in the forward end of tube 17. It takes the form of a ring having a Venturi throat 22 as shown. It serves among other things, to hold to its face that portion of the flaming fuel-air mixture, initially ignited by the member 19, that extends towards the tube 17 from member 19. Member 21 also prevents ignition of the mixture in the inner reaches of tube 17. Member 21 is also so designed and arranged as to enable it to serve as a damper of flow in tube 17. The latter it does sufficiently to quench or minimize pulsating flow and resonance in tube 17. Its latter functions may be augmented by means of a wire-mesh screen, not shown, but disposed coaxially with its downstream face.

The member 21 directs gases into toroidal chamber 13 which gases immediately commence burning therein and completely encircle the chamber before advancing downstream through the open peripheral edge of the rectangular toroid 13. This configuration thus constitutes the burner a self-piloting igniter.

The flaming gases emerging from gap 12 and moving downstream and expanding radially inwardly in duct 11 encounter no obstacle or impediment of any sort and hence create no local vortices, drag or resonant burning.

Since they emerge at the periphery of the inner surface of duct 11, they first encounter only the very low velocity "boundary layer" of the main mixture moving relatively slowly along the inside surfaces of ducts 10 and 11. This fact, coupled with the total absence of obstructions to the flow of either stream, minimizes drag on the flaming gases and fuel-air mixture in the initial ignition region.

As the igniting-gases extend entirely around the main mixture and move continuously in a path that allows no unburned-fuel pockets to form in the burner or pass into the main combustion chamber, there is little likelihood of either detonation or back-firing occurring.

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It is to be noted that the inner surface of the inlet to the toroidal pilot-chamber is aligned with the inner surface of the pilot-chamber itself and that the axis of this inlet tube lies tangentially to the circular centerline of the pilot chamber, this configuration applying a swirling, circular motion to these gases which assists in completing the mixing and self-piloting circulation in the pilot-chamber.

The location of chamber 14 in adjacency both to chamber 13 and to duct 10 serves to pre-heat the pilot air before it mixes with the pilot fuel, thereby aiding ignition and adding to the heat-energy of the burner.

It will be observed that the main fuel-air mixture and the flaming ignition-gases mix near the periphery of the inner surface of the downstream conduit section where the flow velocity of the main fuel-air mixture is slower and less turbulent than towards the longitudinal center line of the fuel-air mixture. Hence, the incoming flaming gases are diluted very little by the main mixture and produce a long stable flame front 22 extending radially and longitudinally in the fuel-air mixture.

Stable burning in the combustion chamber 11 is furthered by means 23 for effecting viscous damping of the gases flowing in duct 10 sufficient to reduce the resonant amplitude of the pulsating flow in conduit 10, these means also serving to damp-out any gas-flow disturbances, due to fluctuations in the fuel or air supply sources. Thereby the flame front is constrained to continuous, non-fluctuating, stable burning. In the embodiment shown, these means 23 consist of a wire-mesh screen disposed transversely of duct 10 near the downstream end thereof and lying within the boundaries of the annular pilot burner. The screen is constructed of wires of a diameter and mesh size as small as is compatible with durability and with minimum reduction in gas-flow velocity.

The construction shown in Figures 4 and 5 employs the same principles as those incorporated in the afore-described embodiment but in a different configurational manner. It comprises an annular slot 23a penetrating a main mixture conduit 24 and angling downstream, the width of the slot being varied to suit other design factors. Around this slot extends a hollow annulus 25 carried by the outer periphery of conduit 24. Adjacent the upstream face of conduit 24 is a preheater in the form of a hemi-torus 26, air for the pilot burner being admitted to the one end (not shown) of the hemi-torus and being taken from the opposite end thereof by a pipe 27 leading to pipe 28, which terminates in the upstream side of the upper part of the annulus 25. Fuel for the burner is injected through the pipe 28 (Figure 5) containing a suitable fuel injector 29. Coaxially mounted in the inner end of pipe 28 is a Venturi and flame-holder 31, constructed and arranged as, and for the purposes, described hereinbefore with respect to member 21, Figure 2. A spark plug or igniter 32 is mounted as shown for igniting the pilot-burner's fuel-air mixture.

The operation and advantages of this form of the invention are substantially the same as those of the previously described embodiment.

Although a number of the presently-referred embodiments of the invention have been described and illustrated in detail hereinabove, it is to be understood that this has been done merely to clarify, and not to limit, the inventive concepts, which by law and in fact are susceptible of embodiment in any configurational form lying within the scope of the subjoined claims.

I claim:

1. An internal combustion device, comprising: coaxially endwise nested conduit sections, the periphery of the inner end of the inner section being radially spaced inwardly of the adjacent end of the outer section so as to define an annular gap between the adjacent ends of the conduit sections; substantially hollow means surrounding the nested pipe sections upstream of said gap and communicating on its inner, downstream portion with

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said gap; means for supplying said hollow member with a fuel and a combustion-supporting gas; and means for igniting the contents of said hollow means.

2. An internal combustion device, comprising: coaxially endwise nested conduit sections, the periphery of the inner end of the inner section being radially spaced inwardly of the adjacent end of the outer section so as to define an annular gap between the adjacent ends of the conduit sections; substantially hollow means surrounding the nested pipe sections upstream of said gap and communicating on its inner, downstream portion with said gap; means for supplying said hollow member with a fuel and a combustion-supporting gas; means for preheating said combustion supporting gas before supplying same to said annulus; and means for igniting the contents of said hollow means.

3. An internal combustion device, comprising: coaxially endwise nested inner and outer conduit sections, the periphery of the inner end of the inner section being radially spaced inwardly of the adjacent end of the outer section so as to define an annular gap between the adjacent ends of the conduit sections; a substantially hollow annulus peripherally surrounding the inner end portion of the inner conduit section upstream of said gap and having its inner downstream peripheral edge open; a hemi-annulus peripherally engaging said inner section upstream of said annulus and having a surface in heat-receiving relationship therewith; an air conduit communicating with a source of pressurized air at its outer end and with the inlet end of said hemi-annulus at its other end; an air conduit connected at the one end with said hemi-annulus and at the other end with said annulus; means for supplying a pressurized fuel to said annulus; and means for igniting in said annulus, said mixture of fuel and air.

4. As a new article of manufacture for internal combustion devices in which the main pass for the main body of fluid includes two coaxially endwise nested inner and outer conduit sections: the larger conduit section having the periphery of its one end enlarged radially and longitudinally in the form of a hollow annulus open on its inner peripheral face to establish communication of the annulus with the main body of fluid, the inner peripheral edge of the upstream wall of said hollow annulus tightly engaging the periphery of the downstream end-portion of the smaller conduit section and the inner peripheral edge of the downstream wall of said annulus lying longitudinally adjacent the downstream end of said smaller section and being radially outwardly spaced from said downstream end, thereby disposing said hollow annulus mainly outside both the conduit sections and upstream of the communication aforesaid so as to enable entrainment into said larger conduit section of a piloting body of fluid with the minimum turbulence and maximum homogeneity of said portion and of said main body, the periphery of said annulus bearing a conduit tangentially intersecting said periphery, said conduit including therein fuel and air supplying means and said annulus constituting a peripherally continuous piloting-ignition chamber and including fuel-and-air igniting means.

5. As a new article of manufacture for internal combustion devices in which the main pass for the main body of fluid includes two coaxially endwise nested inner and outer conduit sections: the larger conduit section having the periphery of its one end enlarged radially and longitudinally in the form of a hollow annulus open on its inner peripheral face to establish communication of the annulus with the main body of fluid, the inner peripheral edge of the upstream wall of said hollow annulus tightly engaging the periphery of the downstream end-portion of the smaller conduit section and the inner peripheral edge of the downstream wall of said annulus lying longitudinally adjacent the downstream end of said smaller section and being radially outwardly spaced from said downstream end, thereby disposing said hollow an-

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nulus mainly outside both the conduit sections and upstream of the communication aforesaid so as to enable entrainment into said larger conduit section of a piloting body of fluid with the minimum turbulence and maximum homogeneity of said portion and of said main body, the periphery of said annulus bearing a conduit tangentially intersecting said periphery, said conduit including therein fuel and air supplying means and said annulus constituting a peripherally continuous piloting-ignition chamber and including fuel-and-air igniting means; the lower portion of the upstream face of said chamber bearing, in heat receiving relationship therewith, a hemi-toroidal chamber adapted to receive combustion air at the one end thereof and to discharge same in a preheated condition at the opposite end thereof.

6. A piloting arrangement for combustion apparatus, comprising: surfaces defining a passage for the flow and combustion therein of a main combustible fluid, said passageway having a radially extending opening therein; a substantially hollow member for receiving and igniting a secondary combustible fluid, said member at least partially circumscribing said passageway, said member lying at least in proximity to said opening; said hollow member having means on its inner periphery flow-communicating the hollow member with said passageway through said opening; means for supplying a secondary combustible fluid to said hollow member; and means for igniting same so as to effect ignition of said main fluid; the hollow member having an annular shape and said secondary fluid supplying means being arranged tangentially to the outer periphery of said hollow member so as to direct said secondary fluid tangentially into said hollow member and said supplying means being thereby adapted to exert such a pressure on said secondary fluid as to confer homogeneity upon said secondary fluid in said hollow member and to constrain said secondary fluid to circulate in said hollow, annular member at least once before exiting, through said flow-communicating means, into said passageway thereby to effect discharge through said flow communicating means of a homogeneous, flaming gas devoid of occlusions of unignited combustible fluid, whereby to substantially obviate detonation and to ensure substantially infallible "starting" of said combustion apparatus.

7. As a discrete article of manufacture for internal combustion devices of the type in which the main pass includes two coaxial, endwise-nestable, inner and outer conduit sections for conducting a main body of combustible-fluid: a peripherally extending radial enlargement of the inner end of the larger conduit section, said enlargement constituting a hollow annulus open at the face thereof lying adjacent the smaller conduit section to enable the annulus to receive a piloting portion of combustible-fluid, the upstream wall of said annulus having the periphery of its inner edge gas-tightly engaging the periphery of the downstream end-portion of the smaller conduit section and the periphery of the inner edge of the downstream wall of said annulus lying longitudinally adjacent the downstream end-portion of the smaller conduit section, said periphery of said edge being radially outwardly spaced from said downstream end-portion, thereby disposing said annulus, radially, mainly outside both conduit-sections in the region of the longitudinal overlap of said sections so as to enable entrainment into said larger conduit from said annulus of a piloting-portion of combustible fluid in a substantially turbulentless manner and in a homogeneous condition, the periphery of said annulus bearing means for supplying a combustible fluid into said annulus and igniting it therein so as to effect continuous ignition of said main body.

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8. An internal combustion device, comprising: a confined conductor path for a main body of combustible fluid, the confines of said path having therein, at a predetermined portion of its length, an upstream-slanting peripherally substantially continuous slot, said slot extending entirely thru said confines; a hollow annulus circumscribingly disposed in contact with the periphery of the confines of said path, said annulus lying outside said slot and upstream of it and communicating with said slot to receive, upstream thereof, a piloting combustible fluid; and means mounted to said annulus for supplying said fluid thereto and igniting same therein thereby to effect piloted-ignition of said main body of fluid, said supplying means being arranged tangentially to said hollow annulus so as to direct said fluid tangentially into said annulus and effect homogenization of said combustible fluid in said annulus and to effect circulation of said fluid in said annulus at least once before it exits therefrom into said conductor path.

9. A pilot-burner for effecting burning of a mixture of a fuel and a combustion-supporting gas, comprising: a conductor that has an opening extending peripherally thereof at a predetermined locus on its length; and a substantially hollow annular member circumscribing said conductor at a locus lying longitudinally at least adjacent said opening, said annular member having a peripherally extending communication means adapted to flow-communicate through the first-said opening with the mixture in said conductor, said hollow annular member carrying fuel-and-air supplying means and fuel-and-air mixture igniting means; said supplying means being arranged tangentially to the outer periphery of said annular member so as to direct said fluid tangentially into said member and effect homogenizing of the mixture in said annular member and to effect circulation of said mixture in said annular member at least once before exit of said mixture therefrom into said conductor.

10. An internal combustion device comprising: a conduit defining a conductor path for a main body of combustible fluid, the wall of said conduit having a peripherally extending annular aperture therethrough, said aperture slanting in the down-stream direction through the said wall to constitute an inlet into said main body of combustible fluid for the discharge into the latter in the down-stream direction thereof of a piloting portion of a supplemental combustible fluid; a hollow annulus circumscribingly contacting said conduit adjacent said aperture and having an outlet communicating with the latter; and means mounted to said annulus for supplying a piloting portion of combustible fluid thereto and for igniting said portion in said annulus, said supplying means being arranged tangentially with respect to said annulus and directing said piloting portion swirlingly into said annulus, thereby to effect homogenizing of said piloting portion in said annulus and so as to constrain said portion to circulate at least once in said annulus before exit thereof therefrom into said main body of combustible fluid.

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