

Aug. 28, 1951

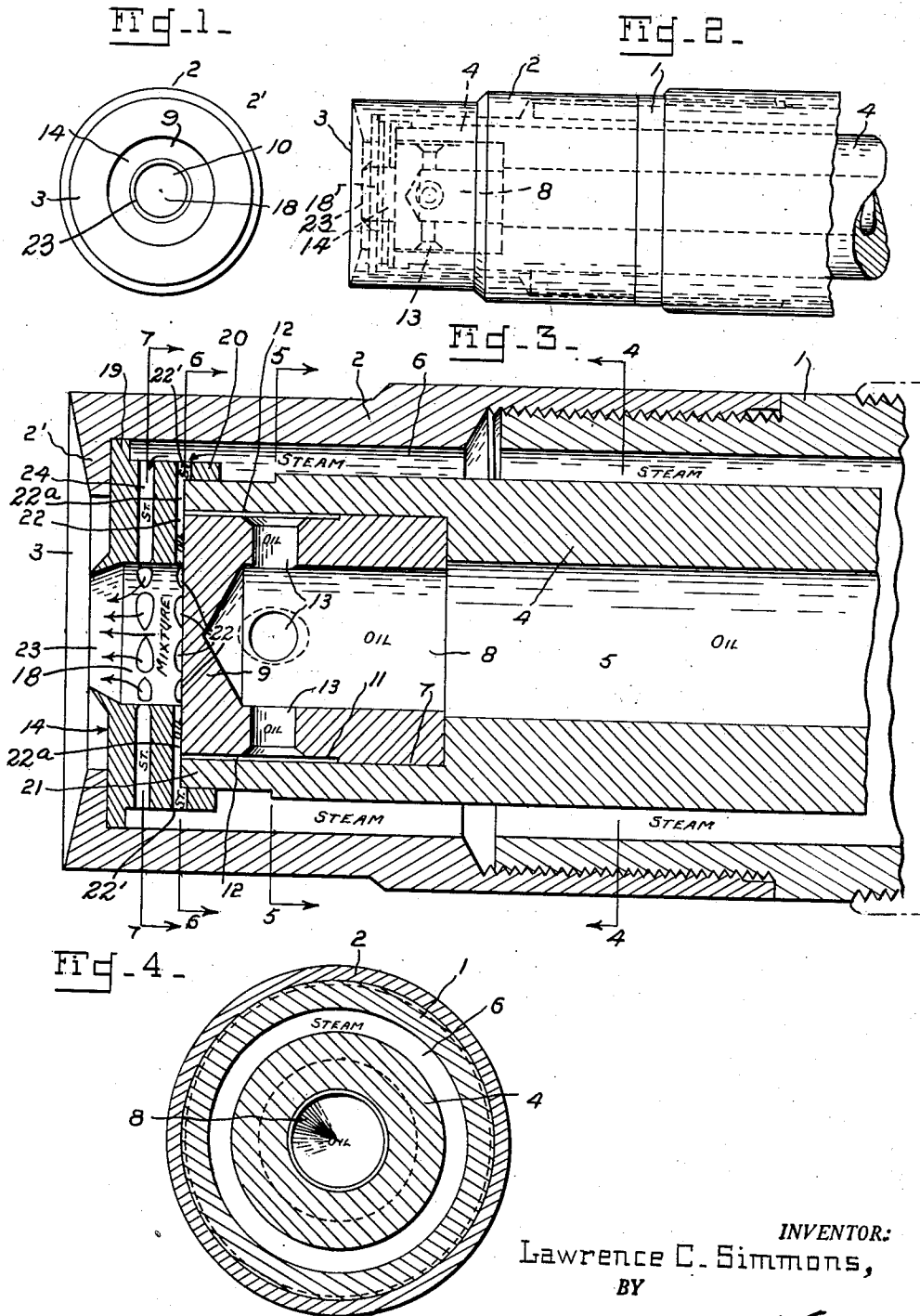
L. C. SIMMONS

2,566,040

FUEL BURNING METHOD AND BURNER

Filed Sept. 26, 1947

2 Sheets-Sheet 1



INVENTOR:
Lawrence C. Simmons,
BY

a. c. Sims,
ATTORNEY.

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L. C. SIMMONS

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Fig. 5-

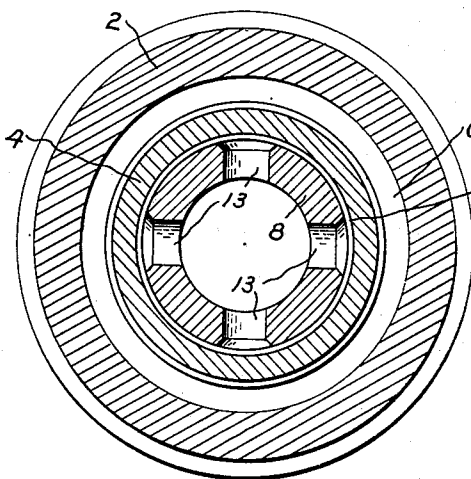


Fig. 6-

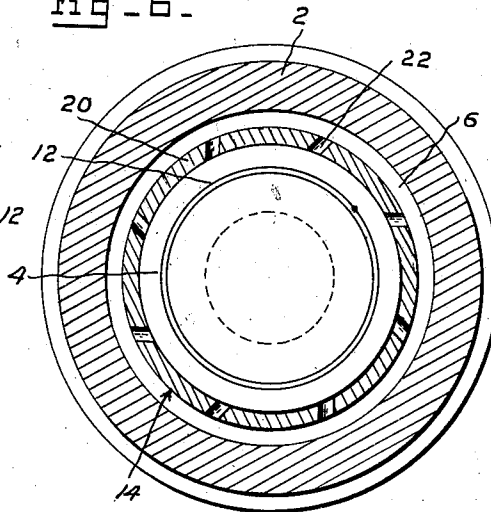


Fig. 7-

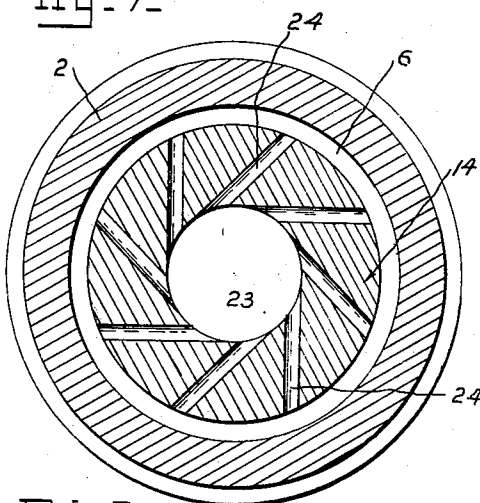


Fig. 8-

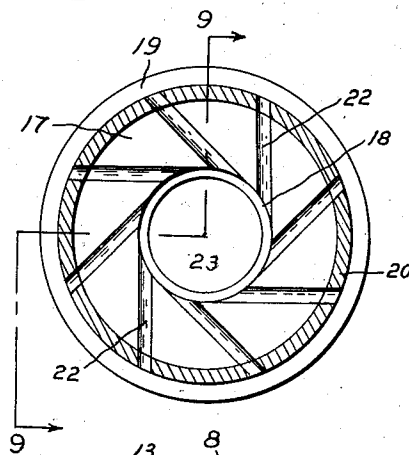


Fig. 9-

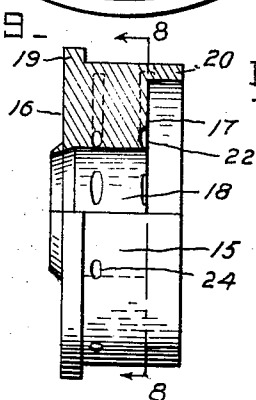
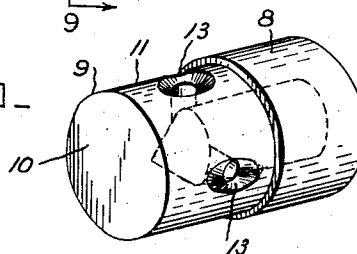


Fig. 10-



INVENTOR:
Lawrence C. Simmons,
BY

C. C. Hines
ATTORNEY.

UNITED STATES PATENT OFFICE

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FUEL BURNING METHOD AND BURNER

Lawrence C. Simmons, Ossining, N. Y., assignor
to The New York Central Railroad Company,
New York, N. Y., a corporation of New York

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5 Claims. (Cl. 299—120)

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This invention relates to fuel burners of that type designed for burning hydrocarbon fuels and in which jets or streams of the fuel are introduced under pressure with jets or streams of a gaseous combustion promoting or atomizing agent, such as air or steam, acting as a whirling medium, into a whirl chamber in which the fuel and such agent are caused to whirl before ejection and ignition of the mass in order to secure a high degree of atomization of the fuel and intermixture of the fuel with the atomizing or combustion promoting agent. More particularly the invention relates to a burner of this type which is of wide-range capacity and adapted to use the fuel and atomizing or combustion promoting agent at low pressures and in such manner as to place the fuel in a highly atomized or divided state for consumption.

The invention also relates to a novel method of atomizing or finely dividing fuel by means of a gaseous whirling agent to form a highly combustible mixture.

Heretofore it has been the practice to employ burners of this type having a single set of tangential slots for introducing the fuel and whirling medium into the whirl chamber, the slots being of milled formation. Burners of this type are to a certain extent costly, owing to the amount of care and precise machine work required in milling the slots, and furthermore have not been of a desired high degree of efficiency in operation, due to the fact that slots of the exact dimensions necessary to secure a proper proportional admixture of the fuel and whirling medium and whirling velocity and degree of minuteness of atomization of the fuel could not be accurately produced by milling, resulting in incomplete combustion and waste of fuel and the deposit of products necessitating frequent cleaning of the burner.

It has also been a practice heretofore to inject streams of oil and gas into a whirl chamber so as to cause the mixed streams of oil and gas to whirl and move axially toward the outlet of the chamber, either by introducing the oil with the gas into the chamber through a single set of tangential passages, in which case the gas blows through the oil, with high ejection velocity, but with a loss of whirl velocity, thus causing the production of a long and unstable flame, or by introducing streams of gas into the chamber through one set of tangential passages, which streams set up a whirling motion of the mixture, and axially injecting streams of gas into the chamber at its inner end or through one or more

additional sets of tangential passages, acting on the mixed streams as they issue at the outlet end of the chamber, and inclined circumferentially in the opposite direction to the first tangential set of passages, in which case the whirl velocity is also reduced so that choking occurs and the action is a mixing action, causing the production of a conical stream containing non-atomized particles of the fuel at the burner outlet rather than a highly atomized hollow cone shaped spray. In each of these cases there is a loss of gas energy which is reduced or dissipated in turbulence so that a whirl velocity and centrifugal force within the whirl chamber of a sufficiently high degree to atomize the fuel in the whirl chamber and cause the production of a stable hollow cone shaped spray at the burner outlet cannot be obtained.

The main object of the present invention is to provide a burner which overcomes these objections to prior burners, and by means of which a precise supply of the fuel and whirling medium at the exact velocity for a highly efficient whirling action to atomize the fuel may be continuously produced and introduced into the whirl chamber.

A further object of the invention is to provide a burner embodying these and other working advantages, as well as greater convenience and economy of manufacture, by the use of bored slots or passages instead of milled slots.

A still further object of the invention is to provide a burner having a plurality of rows or sets of bored passages relatively dimensioned and arranged to secure accuracy in the supply of the fuel and whirling medium in proper proportions and at the velocity necessary to ensure a most efficient whirling action and atomization of the fuel for perfect combustion, while at the same time effecting a saving in steam or air consumption.

A still further object of the invention is to provide a whirl type of burner which may be readily designed to whirl and burn heavy liquid hydrocarbon fuels as well as to spin a solid hydrocarbon fuel, such as powdered coal, so that such fuels or coal may be efficiently and economically used with a burner of this type.

A still further object of the invention is to provide a burner structure embodying means for intermixing the fuel with a whirling medium in successive stages at spaced points axially of the whirl chamber, thereby producing a more intimate mixture and a higher degree of velocity for the whirling action in the whirl chamber.

A still further object of the invention is to

provide a low pressure method and burner whereby a whirl velocity substantially equal to that of a mechanical pressure atomizer may be obtained, and whereby the pressure of the gaseous whirling agent is fully utilized to whirl the mixture of fuel and the gaseous agent within the whirl chamber at a sufficiently high velocity and centrifugal force in the whirl chamber to atomize the fuel therein and produce a stable hollow cone shaped spray of finely divided fuel particles at the burner outlet.

Still another object of the invention is to provide a novel method of conditioning the fuel to produce a combustible mixture without leaving any material amount of residue requiring frequent cleaning of the burner.

With these and other objects in view, which will appear in the course of the subjoined description, the invention consists of the novel steps of the method and novel features of construction, combination and arrangement of parts, hereinafter fully set forth and claimed, and as shown in the accompanying drawings, in which:

Figure 1 is an end elevation looking toward the ejection outlet of the burner tip or atomizer of a fuel burner embodying my invention.

Figure 2 is a view in side elevation of the burner assembly.

Figure 3 is an irregular vertical longitudinal section on an enlarged scale through the burner assembly, the section being taken on an irregular line through the forward end of the burner casing and the burner tip to more clearly show the arrangement of the fuel and gas feed channels.

Figures 4, 5, 6 and 7 are transverse sections taken, respectively, on the lines 4-4, 5-5, 6-6 and 7-7 of Figure 3.

Figure 8 is a cross-section through the burner tip or atomizer taken on the line 8-8 of Figure 9.

Figure 9 is a part sectional and part side elevational view of the burner tip or atomizer, the section being taken on line 9-9 of Figure 8.

Figure 10 is a perspective view of the feed plug.

Referring now more particularly to the drawings, 1 designates the burner casing or tube, and 2 the burner tube cap having an inwardly extending flange 2' defining air outlet opening 3 at its forward end.

Mounted within the burner tube or casing and spaced from the side walls thereof is a fuel conducting pipe or tube 4, through the bore or passage 5 of which the fuel to be atomized, such as oil, for example, is conducted toward the burner tip at the discharge end of the burner. The space between the tubes 1 and 4 provides an annular passage 6 for the flow of the gaseous combustion-promoting, atomizing or whirling medium, such as air or steam, to the burner tip.

The bore or passage 5 of the conductor 4 is counterbored or recessed at its forward end, as at 7, to receive a hollow oil feed plug 8. This plug has an open rear end communicating with the passage 5 and is closed at its front end 9, the latter having a plane front face 10 lying flush with the forward end of the tube 4. The forward portion of this plug is externally reduced in diameter, as shown at 11, to form with the opposed portion of the wall of the recess 7 a shallow, annular oil delivery passage 12 opening outwardly about the face 10 of the plug. Formed in the plug is an annular set or series of equally spaced radial feed parts 13 which communicate at their inner ends with the interior of the plug

and at their outer ends with said oil delivery passage 12. Oil under pressure may thus flow from passage 5 into the plug and outward through the ports 13 to the passage 12 for supply in a regulated amount to the burner tip or atomizer 14.

The burner tip or atomizer 14 is disposed between the forward end of the conductor 4 and the inwardly extending flange 2' at the front of the cap 2. This tip is of generally circular form and has a body portion 15 of less diameter than the internal diameter of the cap 2 but of greater diameter than the portion 11 of the plug 8, a front face 16, a rear face 17, and a central passage 18 forming an elongated whirl chamber. The front face 16 of the tip is arranged to bear against the flange 2' of the cap 2 and adjacent thereto the tip is provided with a circumferential flange 19 which bears against the inner periphery of the cap and spaces the body portion 15 of the tip from said surface of the cap. The rear face 17 of the tip is arranged to bear against the front end of the conductor 4 and the front face 10 of the plug 8, and extending rearwardly from this face 17 of the tip is a flange 20 which overlaps the reduced front portion 21 of the conductor 4 and centers the tip with relation thereto and to the plug 8.

The burner tip is provided in its rear portion with a set of fuel and air or steam conducting channels or passages 22 and at a suitable point between said channels 22 and an ejection outlet 23 at the front of the whirl chamber 18 with a set of air or steam conducting channels or passages 24, the channels of each set extending from its periphery toward and entering the whirl chamber substantially tangentially thereto. The channels of each set are formed by boring or drilling them in contradistinction to milling them, by which they may be more economically produced and also more accurately dimensioned for fuel and steam supplies in proper ratios and arranged to secure a more efficient whirling action and atomization of the oil. At least two sets of channels are provided for these purposes, one for mixed jets of oil and air or steam and the other for jets of air or steam alone, to make up for reduction in the sizes of the channels necessitated by drilling and which in the use of a single set might cause undesirable restriction to steam flow. Any number of sets or rows of bored channels, suitably dimensioned and placed at spaced points axially of the tip, may be used to increase the whirl velocity and adapt the burner to atomize heavy hydrocarbon oils or to spin powdered coal at the velocity necessary to use it as fuel. In the present instance two such sets or rows of channels are disclosed to secure feed and velocity ratios sufficient for the fine atomization of hydrocarbon oil of a certain viscosity, but by the use of one or more additional rows velocities sufficient for atomization of heavier hydrocarbon oils or to spin powdered coal may be obtained.

In the construction illustrated the channels 22 are arranged at the inner end of the tip and consist of circular 22' bores formed in the flange 20 and aligned grooves 22a formed in the face 17 extending from the flange to the inner end of the chamber 18, while the channels 24 are in the form of continuous circular bores extending from the outer periphery of the tip to and intersecting the chamber 18 at a point between the grooves 22a and the ejection outlet 23. As shown in this particular instance the channels 24 intersect the chamber 18 at a point somewhat in advance of

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its transverse center and between its transverse center and the outlet 23, but this arrangement may be varied as circumstances may require. The grooved portions of the channels 22 are closed at the rear by the surface 10 of the plug 8 and communicate with the oil feed passage 12 at a point between their outer ends and the chamber 18, while both sets of channels 22 and 24 communicate at their outer ends with the steam passage 6. While steam has been more particularly described above as the atomizing, combustion-promoting and whirling medium used, it is to be understood that under certain conditions or for certain installations air, air and steam combined, or any suitable gaseous whirling medium may be employed. The outlet 23 tapers to a degree not sufficient to reduce the outlet end of the chamber to a diameter materially impeding the outward flow of the fuel mass, but only to a degree to slightly check the flow of and concentrate the fuel mass at its point of discharge and to produce a guide surface converging toward an exit edge over which the fuel may flow to form a hollow diverging conical spray.

In the operation of the burner, the liquid fuel to be atomized is supplied continuously to the passage 5, from which it flows into the plug 8 and through the ports 13 in the latter to the annular passage 12, from which it is delivered into the channels 22 at an intermediate point in the length of each of said channels. At the same time low-pressure steam or air flows from the passage 6 into both sets of channels 22 and 24. The streams or jets of steam or air entering the channels 22 pick up and are intermixed with the fuel entering such channels and these streams are commingled and flow in a commingled condition into the whirl chamber 18 at a high initial velocity and are caused to whirl therein by which a high degree of atomization of the fuel is effected. This whirling mass moves axially in the tip toward the ejection outlet 23 and meets the streams or jets of steam or air entering the tip through the channels 24. As these stream or jets, entering through the channels 24 in the same direction circumferentially of the chamber as the streams injected by the channels 22, strike the whirling mass after it has already obtained a high velocity due to injection through the channels 22, the mass is whirled continuously in the same direction but at a still higher velocity whereby the atomization of the fuel is increased and effected in the whirl chamber to a much higher degree than is possible to obtain with burners of the ordinary type using milled slots or prior methods causing loss of gas pressure or choking or turbulence of the mixture in the whirl chamber. This is due to the fact that the efficiency of a jet is a function of the speed of a mass it is required to move. By the provision of air or steam injection channels 24, which inject the added streams of gas into the whirl chamber in the same direction circumferentially as the channels 22, the whirling speed is not only greatly increased, with a resulting higher centrifugal force producing a higher degree of atomization, but the whirling agent, air or steam, is more intimately admixed with the minute oil globules, so that a fuel mixture of maximum combustibility is produced. This mixture feeds in the form of a slightly converging conical mass to the conical outlet 23 and then discharges in the form of a diverging stable, hollow conical stream through the burner outlet, where it is suitably ignited.

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The result of atomizing the fuel in the manner described is to provide a method of atomization which effects a saving in steam or air consumption and reduces liability of irregularities of action of the burner and furnishes a highly combustible fuel which will leave less residue, so that frequent cleaning of the burner is unnecessary. By increasing the number of rows of air or steam jets employed, the whirl velocity of the mass in the whirl chamber may be increased to degrees allowing atomization and burning of heavy liquid hydrocarbon fuels as well as the spinning and mixing of powdered coal with a whirling and combustion-promoting agent, so that low grade liquid hydrocarbon oils and powdered coal may be used as fuel with this type of burner.

While for purpose of disclosing one form of embodiment of my invention I have shown the channels of the sets 22 and 24 as similarly disposed about the burner tip and having the discharge ends of their similarly arranged channels opening into the whirl chamber in line with each other axially, of the chamber, it is to be understood that the channels and their delivery ends may be staggered or otherwise arranged with relation to each other so long as their functional characteristics hereinbefore described are preserved. In some cases also it may be found desirable to feed portions of the fuel with the gaseous whirling medium into the whirl chamber through both sets of passages 22 and 24, and hence I do not limit myself in this particularly except when specifically set forth in the claims.

From the foregoing description, taken in connection with the drawings, the construction, mode of operation and advantages of my invention will be readily understood without a further and extended description. While the structural features shown are preferred, it is to be understood that changes in the form, arrangement and details of construction may be made within the scope of the appended claims, without departing from the spirit or sacrificing any of the advantages of the invention.

Having thus described my invention, I claim:

1. A fuel burner including in combination a fuel conductor, a member enclosing said conductor and spaced therefrom to provide a gaseous agent supply conductor, a fuel feed plug fitted in the forward end of the fuel conductor and peripherally spaced therefrom to form a fuel feed passage, said plug having radial ports communicating with said passage, and a burner tip arranged between the fuel conduit and enclosing member in advance of the plug, said tip having a whirl chamber provided with an ejection outlet at its forward end, a set of tangential passages at its rear end communicating with the gaseous agent conduit, fuel passage and whirl chamber, and a set of tangential passages arranged between the first-named passages and the ejection outlet of the whirl chamber and communicating at their outer ends with the gaseous agent conduit and at their inner ends with the whirl chamber.

2. A fuel burner including in combination a fuel conductor, a member enclosing said conductor and spaced therefrom to provide a gaseous agent supply conductor, a fuel feed plug fitted in the forward end of the fuel conductor and peripherally spaced therefrom to form a fuel feed passage, said plug having radial ports communicating with said passage, and a burner tip arranged between the fuel conduit and enclosing member in advance of the plug, said tip having:

a whirl chamber provided with an ejection outlet at its forward end and closed at its rear end by the plug, a set of tangential passages at its inner end communicating with the gaseous agent fuel conduit, fuel passage and whirl chamber, and a set of tangential passages arranged between the first-named passages and the ejection outlet of the whirl chamber and communicating at their outer ends with the gaseous agent conduit and at their inner ends with the whirl chamber.

3. An atomizing burner including in combination a fuel supply conduit, a gaseous agent supply conduit, and a burner body having a longitudinally extending whirl chamber having front and rear ends and provided with an atomized fuel discharge orifice at its front end, a set of tangential passages communicating at their inlet ends with the fuel supply conduit and opening at their discharge ends into the rear end of the whirl chamber, said rear end of the whirl chamber being closed against the admission of fluid except through said tangential passages, and a second set of tangential passages communicating at their inlet ends with the gaseous agent supply conduit and opening at their discharge ends into the whirl chamber tangentially in the same direction as the first-named passages, said discharge ends of the second-named set of passages being arranged to open directly into the whirl chamber at a point located axially of the chamber forwardly of the first named passages and rearwardly of the discharge orifice at the forward end of the chamber, said orifice being of a diameter at its inner end portion corresponding substantially to that of the chamber and converging therefrom to a slightly less diameter at its outer end portion and terminating at its outer end portion in an end edge over which the atomized fuel may discharge in the form of a hollow diverging conical stream.

4. An atomizing fuel burner including in combination a fuel supply conduit, a gaseous agent supply conduit, and a burner body having a longitudinally extending whirl chamber provided with an atomized fuel discharge orifice at its forward end, a set of tangential passages formed in the burner body and communicating at their inlet ends with said conduits externally of the whirl chamber and opening at their discharge ends into the rear of the whirl chamber for supplying to the chamber streams of fuel mixed with the gaseous agent prior to their discharge into the chamber, and a second set of tangential passages formed in the burner body and communicating at their inlet ends with the gaseous agent supply conduit and opening at their discharge ends into the whirl chamber tangentially in the same direction as the first named passages, said discharge ends of the second set of passages being arranged to open directly into the whirl chamber at a point located axially of the cham-

ber forward of and in spaced relation to the first named set of passages and in rear of the inlet end of the discharge orifice at the forward end of the chamber, said orifice being of frustoconical form and converging from a diameter substantially equal at its inner end to that of the chamber to a diameter at its outer end slightly less than that of the chamber, the latter named end portion being formed by a flange on the burner body which terminates in an end edge over which the atomized fuel may flow in the form of a hollow cone.

5. The low pressure method of obtaining a high whirling velocity to fuel and a gaseous agent in a cylindrical whirl chamber having an outlet end for discharge of the atomized fuel, to produce a fuel mixture comprising interspersed particles of the gaseous agent and finely atomized particles of the fuel globules, which consists in mixing streams of fuel with gaseous streams outside the chamber, introducing the previously mixed fuel and gaseous streams tangentially into the chamber at a point remote from its outlet so as to cause said streams to spirally whirl at a predetermined speed and centrifugal force circumferentially of the chamber toward the outlet, introducing other gaseous streams tangentially into the chamber closer to the outlet than the point of introduction of the first named streams but axially of the chamber at a point also remote from the outlet, causing said streams to mingle with the first named streams and spirally whirl unidirectionally therewith toward the outlet at a velocity and centrifugal force progressively increasing toward the chamber outlet so as to minutely disrupt the fuel and intimately mix the gaseous agent therewith, causing the mixture to slightly converge and to be slightly checked in its flow as it enters the outlet, and then releasing it and permitting it to freely discharge as it leaves the outlet in the form of a hollow diverging conical stream.

LAWRENCE C. SIMMONS.

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