Oct. 14, 1952 T. M. BALL 2,613,997

FUEL ATOMIZING NOZZLE

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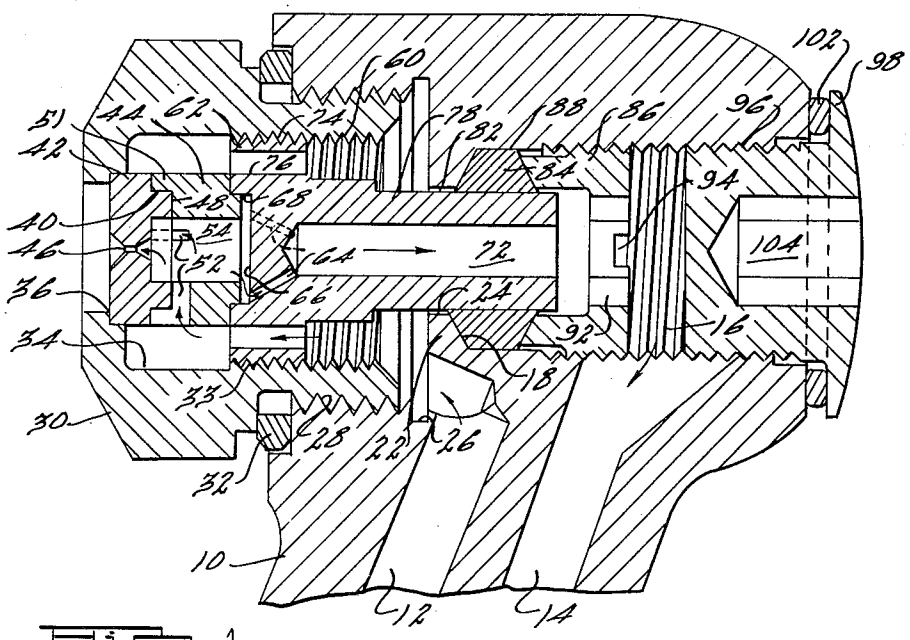


Fig. 1.

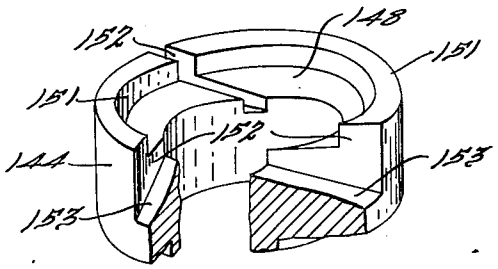


Fig. 2.

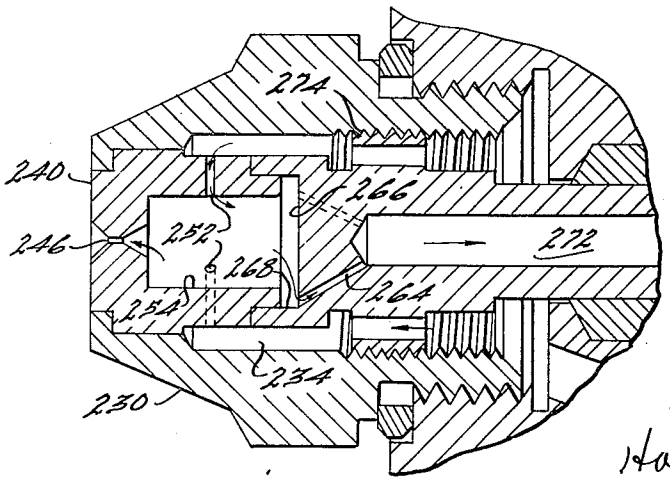


Fig. 3.

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FUEL ATOMIZING NOZZLE

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The present invention relates to atomizing nozzles such as used for supplying fuel to combustion chambers and more particularly to the so-called return flow or continuous bypass type nozzle.

A broad object of this invention is to produce an atomizing nozzle offering the cool operating behavior and other marked advantages inherent in return flow nozzles and yet being unhampered by the usual disadvantages attendant with the problem of confining the fuel, air-free, to its assigned passages.

Another object is to provide a nozzle of which the swirl chamber has a portion of its confined fuel withdrawn therefrom for bypass purposes without any prospects of air being sucked into the bypass passages along with the fuel.

A further object is to provide a spray-type structure of simple construction and relative ease of manufacture.

Yet another object is to produce a nozzle built on return flow principles providing positive and adjustable seals for the holder whereby various stages are effectively isolated from one another and from the outside to insure against all possible leakage.

Still another object is to provide at the relatively cooler operating portions of a nozzle, that is, where the danger from excessive heat deterioration is precluded, a deformable seal susceptive of exact and controlled adjustment such that commonly experienced leakage may be avoided.

Yet a further object is to provide in a nozzle effective heat dams by the fuel passages themselves for protection of the less rugged metallic portions.

Still a further object is to produce an improved spray nozzle comprising a few parts and being simple in operation, easy to assembly and disassemble, and capable of being manufactured at low cost.

Additional objects and advantages are within the scope of this invention such as relates to the arrangement, operation and functioning of the related elements of the structure to various details in combination of parts, elements per se and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawings of a form of the invention which may be preferred in which:

Fig. 1 is a longitudinal section of a fuel nozzle embodying the invention;

Fig. 2 is a perspective view of a kerfed member for the spray tip in which the general angularity of the face passages has been rendered oblique; and

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Fig. 3 shows a form of the invention employing a modified spray tip.

In particular regard to Fig. 1 of the drawing, the nozzle shown comprises in essentials an inner casing surrounded by, and in radial spacing, to an outer casing or sleeve. This outer casing terminates in a tip which may be received by the holder 10. An inlet passage 12 and an outlet passage 14 may be formed in the holder to establish fuel supply and bypass return conduits. The outlet passage 14 communicates with a return chamber 16 forming an open end for the holder and being restricted at its inside end by the face 18 of an internal annular flange 22. Flange 22 may be disposed inwardly to define an aperture 24 which enters into a radially extended annular recess 26. In axial continuation of recess 26 there may be provided in the holder a threaded portion 28 for adjustable reception of the head 30. By means of this threading, the head may be adjustably positioned against washer 32 which is interposed to provide a liquid-tight seal between the two members 10 and 30. This washer may be constructed of some material suitable to withstand relatively high temperatures and may be desirably formed from annealed copper. The head 30 may be hollow and consist axialwise of a threaded portion 33 which flares into an annular chamber 34. The walls of the annular recess 34 merge inwardly to produce at their end an inner surface 36. The recess 34 thereby assumes more or less the form of a toroidal chamber. Supported within the head may be provided a tip proper 40 comprising two elements 42 and 44 arranged coaxially. The outer element 42 may be formed with an ejection orifice 46 and may be interfaced as at 48 with the complementary element 44. Member 44 on the other hand may be provided with a companion rim flange 51 within which may be received element 42 in axial alignment, and provided also with slots or kerfs 52 cut into its interface 48. The two cooperating pieces form in effect a member defining a central swirl chamber 54 into which the passages 52 feed tangentially. For forcibly abutting and supporting the swirl chamber member and constituting an essential part of the inner casing, there may be provided a sleeve 78 having a terminal member or head 62 formed with passages as at 64. The end of this passaged terminal may be faced off as at 66 to produce a floor for the swirl chamber and may be

provided at its extreme periphery with an annular recess **68** which serves to space the faced off member from the rear of the spray tip proper. There thus results an annular chamber located radially on the fringes of the actual swirl chamber. The take-off passages **64** located around the annular recess **68** converge toward the rear of the nozzle and merge into a central conduit **72** which serves as bypass for the head. An annular radial flange **74** has a threaded circumference by means of which the sleeve is positioned within the head described and by means of which fluid seals are maintained between the tip proper and the associated structure. Through the flange **74** there may be provided bores such as at **76** to provide for passage of fuel. The inner casing extends inwardly of the nozzle and may include a necked down portion **82** which serves as a toroidal shank. Shank **82** may be received in the aperture **24** of the holder and may extend on into the return chamber **16** thereof. This shank may thus serve to define an annular recess adapted to receive a deformable grommet or ring **84** forming a seal between the inner and outer casings. This packing is preferably of a soft metal such as silver for example, but on the other hand may be of a plastic or rubber-like consistency. The primary concern in choice of its composition is no doubt that the seal withstands the temperature in the normal operating range of the nozzle and the less elevated temperatures will permit use of less heat resistant materials. Bore **16** may be observed from the figure to be tapped to form an adjustable gland recess means. Provided for reception in this recess means may be a gland or clamping means **86** in which is formed a hollow bore **92**. By appropriate employment of the clamping means the seal **84** may be adjusted so as to provide a non-leaking packing as between the casings and to this end the member **86** may be formed with means for receiving an adjusting tool as by slot **94** for varying the pressure on the seal. The tapped bore **16** continues through to the end of the holder and is adapted to be blanked off by a plug as at **96**. This plug may have a lip **98** arranged to engage a washer such as shown at **102** to provide a seal as between the plug and the holder. This washer may be made of annealed copper or the like. The plug **96** may be formed with a recess as at **104** for embracing an Allen wrench or other adjusting means to control the compression on washer **102**.

As to operation of the structure just described, conduit **12** supplies high pressure fuel which is fed into the high pressure stage of the nozzle. Upon entering, the fuel will tend to fill up the annular chamber **26** and serve to provide a heat dam as between the direct line of heat transmitted through the tip of the nozzle as would ordinarily affect the non-metallic packing **84**. The transit of the fluid is such that it passes between the inner and outer casings through ports **76** provided in the flange **74** and into the toroidal chamber in part defined by recess **34**. Passages **52** in the swirl member represented in the figure as being coplanar tend to swirl in the fuel from the toroidal chamber into the swirl chamber **54** in a state of turbulent flow. From the swirl chamber **54** the fuel flow takes two paths, as hereinafter described, into which it is split up in varying proportions depending upon the particular nozzle output required. That is to say, the nozzle **10** is continuously bypassed and the amount of bypass bears an inverse proportional relationship to the amount of fuel

sprayed out of the nozzle. The resulting proportions of the foregoing relationship depend in turn on the respective back pressure and supply pressure being maintained on the nozzle, it being the general case, for example, that if the supply pressure is increased independently of change in the back pressure or that if the back pressure is decreased independently of change of the supply pressure, then the bypass rate of flow from the nozzle increases. It is found, however, that the nozzle tends to admit air through the ejection orifice **46** under the circumstance of certain conditions in the nozzle operating range which sometimes prevail, for instance, when the proportion of bypassed fuel is relatively great in comparison to the fuel actually being ejected by the nozzle, and particularly so when the ambient atmosphere around the nozzle (that is, the atmosphere of the flame chamber in which the nozzle is located) is under a pressure which approaches or exceeds certain local pressures existing internally of the nozzle. The latter said local pressures depend in part on the back pressure of the nozzle. It is, of course, undesirable that air enter or be sucked into the nozzle and introduced into the bypass of the system for the reason that the air must later be purged as another operation from the system and cannot be allowed to remain and recirculate therein.

In the swirl chamber **54**, a continuous portion of the fuel thus introduced is swirled outwardly through the ejection orifice **46** to produce a flame in the burning chamber. Owing to the centrifuge principles involved the fuel, being relatively denser than any vapors or gases which might exist in the swirl chamber due to cavitation or direct entry of the air through orifice **46**, will tend to hug the outside of the swirl chamber. The portions of the swirl chamber otherwise than occupied by the fuel will be localized more or less in the center portion. Accordingly the whirling fluid will be entirely rid of any entrained air or vapors by the time it reaches the outer fringes of peripheral takeoff **68**. The takeoff passages **64** then can transmit only the pure fuel into the bypass line, thereby precluding the above mentioned possibility of sucking air in such a bypass arrangement. The bypassed portion of the fluid will then be passed down through conduit **72** and into the low pressure stage area. From the return chamber **16** this fuel will be conducted on away from the nozzle by conduit **14**. With the grommet **84** adjustably positioned in the strategic position between the high pressure stage and the low pressure stage, fuel passing from one stage to the other needs must pass through the swirl chamber and through the passage **72** since between the two stages any possibility of leakage is effectually circumvented. As regards leakage to the outside, the washers **32** and **102** are so positioned as to be adjustably sealable and are thereby not subject to leakage.

Preliminary to the discussion of Fig. 2 the fact should be pointed out that the tangential passages feeding the swirl chamber have for their prime object the function of spinning in the fuel and producing agitation vortices in the swirl chamber. It may be found, however, that the turbulence desirable may be more suitably produced if the flow passages are not strictly coplanar as represented in Figure 1 but rather cut, as in Figure 2, with the bottoms **153** of the kerfs **152** disposed along more of a conical region such

that the mean longitudinal axis of each passage is non-coplanar as respects the balance.

In respect to Fig. 3, the embodiment shown may have a head **230** in which is carried the tip **240** comprising a unitary member. In one end of the tip **240** may be an axial ejection orifice **246** communicating with swirl chamber **254**. Drilled through the walls of this swirl chamber may be provided small passages **252** adapted to swirl any fluid from the toroidal chamber **234**. These passages **252** are represented as being coplanar although it may be found advantageous to dispose these passages so as to lie oblique to the axis of the nozzle. The next succeeding member, which carries the tip, may have a faced off floor portion **266**, at the ends of which are recess means **268**. The takeoff recess may be served by passages **264** similar to passages **66** above described and merging into a central bypass conduit **272**. The assemblage and operation features of this embodiment are essentially the same as outlined in the foregoing discussion. The structure as disclosed may be found to be particularly suitable for high temperature operation such as is encountered in gas turbine installations. The non-leaking system of closed circulation affords the expedient of keeping the nozzle relatively cool and makes available the advantageous spray control afforded by the simple regulation of back pressure on the return line. Contemplated within its broader aspects, there may be ready application of the invention to oil burning furnaces and the like.

What is claimed is:

1. An atomizing nozzle comprising a hollow-headed outer casing having a centrally restricted body and an inner casing within the body of said outer casing received in said restriction, said outer casing having internal threads in the said hollow head thereof, said inner casing having a threaded flange received in said hollow head, and engaged by the internal threads of the same and held thereby in spaced relationship to the end of said hollow head, a spray tip held between and engaged by the inner casing and said end of the hollow head, said spray tip having an ejection orifice formed therein at a location remote to said inner casing, an axially aligned cylindrical chamber behind said orifice and being constructed and arranged as to admit air through the ejection orifice at one end thereof during a circumstance of operation in the operating range of the nozzle, said chamber being open-ended at the other end and said inner casing presenting a recessed transverse surface of a larger diameter than that of the cylindrical chamber and longitudinally spaced from said open-ended other end and forming a floor for the chamber extending circumferentially laterally of the open end of said chamber so as to form therewith a continuous cylindrical path of revolution; said spray tip further having whirl-producing passages formed therein so as tangentially to intersect said cylindrical chamber for whirling fuel thereinto and arranged in spaced relationship to the cylindrical path of revolution aforesaid to which at least a portion of the whirling fuel progresses, and means for selective takeoff and drainage from the said path of revolution, of fuel to the exclusion of air and comprising collecting passages in said floor at the periphery thereof and intersecting said path of revolution and extending convergingly and axially therefrom into said inner casing.

2. An atomizing nozzle comprising a hollow-headed outer causing having a centrally restricted body and an inner casing within the body of said outer casing received in said restriction, said outer casing having internal threads in the said hollow head thereof, said inner casing having a threaded flange received in said hollow head, and engaged by the internal threads of the same and held thereby in spaced relationship to the end of said hollow head, two axially aligned elements forming a spray tip held between and engaged by the inner casing and said end of the hollow head, said spray tip having an ejection orifice formed therein at a location remote to said inner casing, an axially aligned cylindrical chamber behind said orifice and being constructed and arranged as to admit air through the ejection orifice at one end thereof during a circumstance of operation in the operating range of the nozzle, said chamber being open-ended at the other end and said inner casing presenting a recessed transverse surface of a larger diameter than that of the cylindrical chamber and longitudinally spaced from said open-ended other end and forming a floor for the chamber extending circumferentially laterally of the open end of said chamber so as to form therewith a continuous cylindrical path of revolution; said spray tip further having whirl-producing passages formed therein between said two said elements thereof so as tangentially to intersect said cylindrical chamber for whirling fuel thereinto and arranged in spaced relationship to the cylindrical path of revolution aforesaid to which at least a portion of the whirling fuel progresses, the longitudinal axes of said passages being coplanar, and means for selective takeoff and drainage from the said path of revolution, of fuel to the exclusion of air and comprising collecting passages in said floor at the periphery thereof and intersecting said path of revolution and extending convergingly and axially therefrom into said inner casing.

3. An atomizing nozzle comprising a hollow-headed outer casing having a centrally restricted body and an inner casing within the body of said outer casing received in said restriction, said outer casing having internal threads in the said hollow head thereof, said inner casing having a threaded flange received in said hollow head and engaged by the internal threads of the same and held thereby in spaced relationship to the end of said hollow head, a spray tip of one-piece construction held between and engaged by the inner casing and said end of the hollow head, said spray tip having an ejection orifice formed therein at a location remote to said inner casing, an axially aligned cylindrical chamber behind said orifice and being constructed and arranged as to admit air through the ejection orifice at one end thereof during a circumstance of operation in the operating range of the nozzle, said chamber being open-ended at the other end and said inner casing presenting a recessed transverse surface of a larger diameter than that of the cylindrical chamber and longitudinally spaced from said open-ended other end of said chamber forming a floor therefor extending circumferentially laterally of the open end of said chamber so as to form therewith a continuous cylindrical path of revolution; said spray tip further having whirl-producing passages formed therein so as tangentially to intersect said cylindrical chamber for whirling fuel thereinto and arranged in spaced relationship to the cylindrical path of revolution aforesaid to which at least a portion

of the whirling fuel progresses, the longitudinal axes of said passages being coplanar, and means for selective takeoff and drainage from the said path of revolution, of fuel to the exclusion of air and comprising collecting passages in said floor at the periphery thereof and intersecting said path of revolution and extending convergingly and axially therefrom into said inner casing.

4. An atomizing nozzle comprising a hollow-headed outer casing having a centrally restricted body and an inner casing within the body of said outer casing received in said restriction, said outer casing having internal threads in the said hollow head thereof, said inner casing having a threaded flange received in said hollow head and engaged by the internal threads of the same and held thereby in spaced relationship to the end of said hollow head, two axially aligned elements forming a spray tip held between and engaged by the inner casing and said end of the hollow head, said spray tip having an ejection orifice formed therein at a location remote to said inner casing, an axially aligned cylindrical chamber behind said orifice and being constructed and arranged as to admit air through the ejection orifice at one end thereof during a circumstance of operation in the operating range of the nozzle, said chamber being open-ended at the other end and said inner casing presenting a recessed transverse surface of a larger diameter than that of the cylindrical chamber and longitudinally spaced from said

open-ended other end of said chamber forming a floor therefor extending circumferentially laterally of the open end of said chamber so as to form therewith a continuous cylindrical path of revolution; said spray tip further having whirl-producing passages formed therein between two said elements thereof so as tangentially to intersect said cylindrical chamber for whirling fuel thereinto and arranged in spaced relationship to the cylindrical path of revolution aforesaid to which at least a portion of the whirling fuel progresses, the longitudinal axes of said passages being non-coplanar according to a generally conical configuration, and means for selective takeoff and drainage from the said path of revolution, of fuel to the exclusion of air and comprising collecting passages in said floor at the periphery thereof and intersecting said path of revolution and extending convergingly and axially therefrom into said inner casing.

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