

Aug. 9, 1960

B. R. WALSH

2,948,478

NOZZLE

Filed Dec. 24, 1958

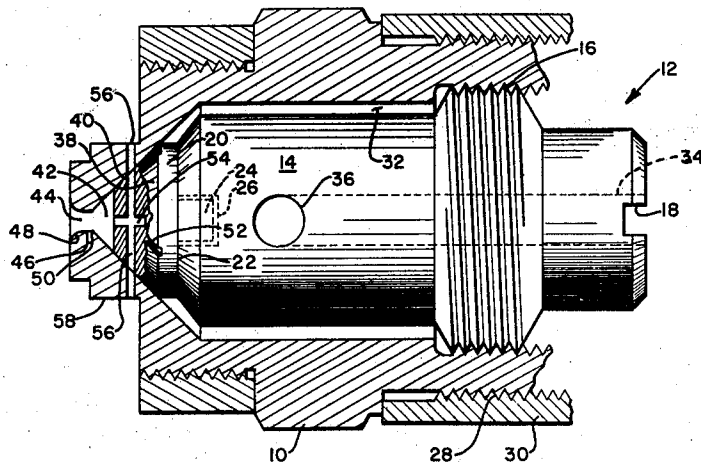


FIG. 1

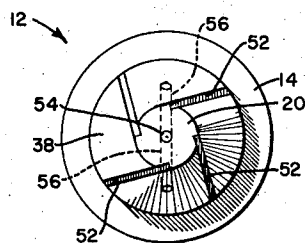


FIG. 2

INVENTOR.
BRUCE R. WALSH
BY *Bruce R. Walsh*
ATTORNEY

1

2,948,478

NOZZLE

Bruce R. Walsh, Pittsburgh, Pa., assignor to Gulf Research & Development Company, Pittsburgh, Pa., a corporation of Delaware

Filed Dec. 24, 1958, Ser. No. 782,916

5 Claims. (Cl. 239-405)

The present invention relates to new and useful improvements in high-pressure, gun-type burner nozzles, and more particularly pertains to a gun-type burner nozzle provided with passageways communicating between the exterior of the burner nozzle and the end of the swirl chamber remote from the discharge orifice. The present invention is related to that disclosed in my similarly assigned application entitled "Apparatus" filed concurrently with this application, and the nozzle disclosed in this application can include the discharge orifice construction involving a sharp-edged right angle at the intersection of the swirl chamber with the discharge orifice and/or the substantially cylindrical swirl chamber construction disclosed in such other application.

Conventional gun-type burner nozzles, as exemplified in U.S. Patent Nos. 2,321,428 (Schloz) and 2,044,696 (Huss) incorporate structure wherein an internal nozzle member, commonly referred to as a swirl stem, has a frusto-conical portion that seats flush against a complementary internal surface of the nozzle body or housing with a swirl chamber defined between such portion of the swirl stem and the nozzle body. Such conventional structure also comprises a discharge orifice in the nozzle body communicating with the swirl chamber and the axial extent of the frusto-conical portion of the swirl stem being provided with slots essentially tangential to the swirl chamber through which fuel enters the swirl chamber so as to swirl therein and thence pass out the discharge orifice as a generally conical spray.

Certain difficulties arise in the use of such conventional structure in that the rate of fuel flow varies substantially with changes in fuel viscosity resulting in substantial changes in air-fuel ratios with corresponding variation in combustion efficiency. Also, the discharge orifice dimensions are so small (particularly with nozzles of low fuel flow rate as are suited for domestic or household use, such nozzles having a flow rate in the neighborhood of one gallon per hour) that the performance of the nozzle is extremely sensitive to coking in the discharge orifice.

The purposes of the instant invention are to lessen the above-mentioned difficulties and to improve the combustion of the fuel as indicated by smoke number (as determined by standard filter test methods) versus the concentration of carbon dioxide in the combustion products.

Broadly, the present invention involves modifying the previously described conventional structure by the provision of a passageway in the swirl stem and the nozzle body, such passageway extending from the center of the swirl stem adjacent the swirl chamber to the exterior of the nozzle body and passing through the seated juncture of the swirl stem and the nozzle body intermediate the slots in the swirl stem.

In a more specific aspect, the present invention involves modifying the previously described conventional structure by the provision of an axial blind bore in the end of the swirl stem adjacent the swirl chamber, and the further provision of passageways extending from the

2

blind bore to the exterior of the nozzle body through the juncture of the frusto-conical portion of the swirl stem and the nozzle body intermediate the slots in the swirl stem.

- 5 It has been found that such modification of conventional structure by the provision of the blind bore and the radial passageways results in air at atmospheric pressure being induced into the swirl chamber and substantially affects the performance of the nozzle. The introduction of air axially into the end of the swirl chamber remote from the discharge orifice being additive to the liquid fuel flow rate enables substantial enlargement of the diameter of the discharge orifice relative to the size thereof necessary in the absence of such modification; hence the deleterious clogging effects of foreign matter in the fuel or coking in the discharge orifice of a nozzle of a particular fuel flow rate can be substantially reduced. Such introduction of air directly into the center of the vortex of swirling fuel in the swirl chamber substantially stabilizes the fuel flow rate despite large variations in the viscosity of the fuel. It has also been found that the combustion efficiency of a conventional and commercial nozzle modified by the provision of the air-induction bore and passageways and enlargement of the discharge orifice is substantially improved as measured by the smoke number versus the carbon dioxide content of the combustion products.
- 10
- 15
- 20
- 25

The invention will be best understood upon reference to the accompanying drawings illustrative of a preferred embodiment thereof, wherein Figure 1 is a fragmentary view of a conventional nozzle, modified in accordance with the invention, showing the nozzle body in central section and showing the swirl stem in elevation except for a portion thereof adjacent the swirl chamber shown in central section; and wherein Figure 2 is an end view of the swirl stem with the passageways communicating with the blind bore being shown in dashed outline.

- Referring to the drawings, the numeral 10 designates a hollow nozzle body in which a two piece swirl stem designated generally at 12 is disposed. The swirl stem 12 includes an insert section 14 screwed into the nozzle body 10 as at 16, a kerf 18 being provided in the section 14 to accommodate a tool (not shown). The swirl stem 12 also includes a head section 20. The sections 14 and 20 have flat surfaces indicated at 22 that are in sliding engagement, such that the sections 14 and 20 can be rotated as well as shifted radially relative to each other. Relative radial movement of the sections 14 and 20 is limited by the provision of a cylindrical central stud 24 on the head section 20 that is received in a central cylindrical opening 26 in the insert section 14. The opening 26 is sufficiently larger than the stud 24 to permit a limited amount of radial movement of the head section 20 for a purpose presently to become apparent.
- 30
- 35
- 40
- 45
- 50
- 55

- The nozzle body 10 is externally threaded at 28 for threaded connection to a fuel oil supply conduit 30. The swirl stem 12 is spaced from the nozzle body 10 to define an annular space 32 to which liquid fuel is supplied under pressure from the conduit 30 through a central blind bore 34 in the section 14 of the swirl stem 12 and an intersecting transverse opening 36 through section 14 of the swirl stem 12.
- 60

- The head section 20 of the swirl stem 12 includes a frusto-conical end portion 38 that seats flush against a frusto-conical internal surface 40 of the nozzle body 10. A swirl chamber 42 is defined between the frusto-conical portion 38 of the swirl stem section 20 and the nozzle body 10, and a discharge orifice 44 is provided in the nozzle body 10 communicating with the swirl chamber 42. The swirl chamber 42 can be frusto-conical in configuration, as shown, or it can be of any desired
- 65
- 70

configuration, as for example the cylindrical form shown in my application filed concurrently herewith. The discharge orifice 44 along its axial extent includes an intermediate cylindrical section 46, with the discharge orifice 44 being outwardly flared, as at 48, from the cylindrical section 46 towards its exit end and flared, as at 50, to a substantially lesser extent from the cylindrical section 46 towards its inlet end at the swirl chamber 42.

The frusto-conical portion 38 of the swirl stem section 20 is provided with a plurality of circumferentially spaced swirl slots 52 extending along the axial length thereof that are essentially arranged tangentially with respect to the swirl chamber 42. The slots 52 can be essentially straight as shown or generally helical in configuration as those shown in previously mentioned U.S. Patent No. 2,321,428. The purpose of the slots 52 is to provide fluid communication between the space 32 and the swirl chamber 42 of restricted cross-sectional area and arrangement so that fuel will flow at high velocity into swirl chamber 42 and rotate or swirl about the central axis of the swirl chamber 42. Fuel entering the swirl chamber 42 swirls about in the swirl chamber 42 and thence passes, while still rotating, through the discharge orifice 44 to be emitted from the nozzle as a generally conical spray. The fuel swirling in the swirl chamber 42 constitutes a vortex such that a reduced pressure is produced in a central or axial zonal region of the swirl chamber 42 adjacent the center of the swirl stem section 20. Such reduced pressure is essentially sub-atmospheric and the means for admitting air to such region will now be described.

The frusto-conical end portion 38 of the swirl stem section 20 is provided with an axial blind bore 54, that is, a central opening in the end of the swirl stem section 20 that is otherwise closed except to the extent hereinafter mentioned.

A plurality of circumferentially spaced passageways 56 are provided in the swirl stem section 20 and the nozzle body 10 that extend radially from the blind bore 54 to the exterior of the nozzle body 10, such passageways 56 passing through the juncture or flush seating area of the frusto-conical portion 38 with the surface 40 of the nozzle body 10 intermediate the slots 52. The arrangement is such that the juncture of the frusto-conical portion 38 with the nozzle body seals the passageways 56 as they extend from one into the other.

The bore or opening 54 can be made in any suitable manner as by drilling. The passageways 56 can be formed in any suitable manner, preferably by drilling with the swirl stem 12 and the nozzle body 10 assembled as shown. The drilling of the passageways 56 need not be completed with the swirl stem 12 and the nozzle body 10 in assembled relation, but can be completed after the drill has commenced to penetrate the swirl stem section 20, thereby assuring registry of the drilled openings upon reassembling the parts. Drilling of passageways 56 can be initiated most easily if the nozzle body 10 is given a cylindrical configuration 58 in the portion thereof where such drilling is to be commenced. Of course, diametrically opposed passageways 56 can be drilled in a single operation. The employment of a plurality of passageways 56 is preferred as the clogging of one of them would only partially impair their function, though a single passageway 56 of larger size could serve substantially as the functional equivalent of a plurality of such passageways 56.

The size of blind bore 54 is, at its entrance, substantially smaller in transverse dimensions than the swirl chamber 42 at the end of the latter adjacent the swirl stem section 20. This is for the reason that fuel swirling in the swirl chamber 42 will not be forced into the bore 54 by centrifugal force, and so that the bore 54 will communicate solely with the central region of the swirl chamber 42 of reduced pressure. Such construction assures air entering the center of the fuel vortex in the

swirl chamber 42. Aside from such limitation as to the maximum size of the bore 54 at its entrance at the axial extremity of the swirl stem section 20, the bore 54 and the passageways 56 can be made as large as desired to reduce the resistance of air flow therethrough commensurate with preserving the seal of the passageways 56 as they pass between the nozzle body 10 and the swirl stem section 20.

A nozzle according to the invention was made by modifying a standard, commercial, high-pressure, gun-type burner nozzle rated at one gallon per hour. Two passageways 56 were provided, each having a diameter of 0.013 inch, and a blind bore 54 was provided having a diameter of 0.018 inch. The discharge orifice 44 was enlarged so that the minimum diameter thereof was increased from 0.0105 inch to 0.037 inch. The delivery rate of such nozzle prior to such modification was 0.91, 0.98 and 1.21 gallons per hour for kerosene, No. 2 fuel oil, and mineral seal oil, respectively; and was 1.15, 1.11 and 1.16 gallons per hour for such fuels respectively after modification. Also, marked differences existed between the smoke number versus carbon dioxide content of combustion products prior to and after modification according to the invention. Comparative tests were made using the unmodified and the modified nozzle in which the conventional blast tube air supply (not shown) was varied to change the carbon dioxide content of the combustion products. Table I shows the results obtained with the unmodified nozzle, and Table II shows the results obtained with the same nozzle modified as specified above in accordance with the invention.

Table I

Percent carbon dioxide:	Smoke number (Bacharach)
8.2	0.55
8.5	1.4
9.4	2.3
10.0	3.2
10.6	4.8
12.0	6.65

Table II

Percent carbon dioxide:	Smoke number (Bacharach)
9.5	0.5
10.5	2.2
11.5	5.5

Comparison of the above tables shows the improved combustion characteristics obtained on modifying the conventional nozzle in accordance with the invention. Plots of the above data indicate that for a smoke number of 3 (about the maximum tolerable for domestic heating use), the unmodified nozzle yields only 9.85 percent carbon dioxide compared to 10.75 percent carbon dioxide for the modified nozzle.

An outstanding advantage of the invention, other than the stabilization of fuel flow rates, the reduction in the deleterious effects of orifice coking and the improved combustion characteristics obtained, is that the application of the principles thereof to existing nozzles can be readily and simply accomplished. Another major advantage resides in the fact that air is directly introduced into the swirl chamber 42 of the nozzle without the use of any special means for forcing air into the swirl chamber 42 being required. It will be understood, of course, that the nozzle of the invention is used in the conventional manner, that is, the same is concentrically disposed within an air blast tube (not shown), and is therefore exposed to an ambient air pressure slightly in excess of atmospheric air pressure (a few inches of water at most above atmospheric); however, such pressure differential tending to favor the desired induction of air into the swirl chamber 42 is incidental to customary nozzle use and is not considered to be the result of the provision of special means for forcing air into the swirl chamber 42. Though the nozzle of the invention does not require

5

the provision of special means for forcing air into the passageways 56 at a faster rate than would otherwise occur, the provision of special means for supplementing or increasing the rate of introduction of air into the passageways 56 is not precluded, and can be employed in conjunction therewith if desired.

The two piece construction of the swirl stem 12 yields two important advantages, namely, the radial freedom permitted the head section 20 affords greater assurance of the proper alignment of and seating of the swirl stem section 20 in the nozzle body 10, and the rotational freedom of the head section 20 facilitates reassembly of parts of the nozzle so that the portions of the passageways 56 in the section 20 and the nozzle body 10 are in registry. It will be noted that the nozzle can be assembled with a wire or other alignment instrument inserted in one of the passageways 56 during the time that the swirl stem section 14 is screwed in tight.

The illustrated preferred embodiment of the invention is susceptible to numerous variations without departing from the spirit thereof. Exemplary of such changes would be the seating and sealing area of the swirl stem section 20 with the nozzle body 10 being only an approximation of a frusto-conical surface, or the placing of the swirl slots 52 in the nozzle body 10 rather than in the swirl stem 12.

From the foregoing, the principles of the invention as well as the application thereof will be clear to those skilled in the art and further description is believed unnecessary. Narrowness of inventive scope is not to be inferred from the detail of the description, attention being directed to the appended claims for ascertainment of the actual scope of the invention.

I claim:

1. In a gun-type burner nozzle, apparatus comprising a hollow nozzle body having a central axis, the interior of the nozzle body having a substantially frusto-conical surface adjacent one end thereof that is coaxial with the central axis, a swirl stem coaxially positioned in the nozzle body having a substantially frusto-conical portion adjacent one end thereof that is complementary to and seated flush against the frusto-conical surface of the nozzle body, said one end of the swirl stem being spaced from the nozzle body to define a swirl chamber therebetween, said one end of the nozzle body being provided with a discharge orifice coaxial with the swirl chamber, means defining a plurality of circumferentially spaced slots at the seated juncture of the swirl stem and the nozzle body extending along the axial length of such juncture and arranged essentially tangential to the swirl chamber, a passageway extending through the swirl stem and the nozzle body from the center of said one end of the swirl stem to the exterior of the nozzle body, said passageway passing through the seated juncture of the swirl stem and the nozzle body intermediate the slots.

2. The combination of claim 1, wherein the swirl stem is comprised of a head section and an insert section, said sections having flat surfaces in sliding engagement on a plane normal to the central axis.

6

3. The combination of claim 1, wherein the swirl stem is comprised of a head section and an insert section, said sections having flat surfaces in sliding engagement on a plane normal to the central axis, one of said sections having a central opening, and the other of said sections having a stud loosely received in said central opening.

4. In a gun-type burner nozzle, apparatus comprising a hollow nozzle body having a central axis, the interior of the nozzle body having a substantially frusto-conical surface adjacent one end thereof that is coaxial with the central axis, a swirl stem coaxially positioned in the nozzle body having a substantially frusto-conical portion adjacent one end thereof that is complementary to and seated flush against the frusto-conical surface of the nozzle body, said one end of the swirl stem being spaced from the nozzle body to define a swirl chamber therebetween, said swirl chamber being substantially frusto-conical in configuration, said one end of the nozzle body being provided with a discharge orifice coaxial with the swirl chamber, the frusto-conical portion of the swirl stem being provided with a plurality of circumferentially spaced slots extending along the axial length thereof and arranged tangential to the swirl chamber, a passageway extending through the swirl stem and the nozzle body from the center of said one end of the swirl stem to the exterior of the nozzle body, said passageway passing through the seated juncture of the swirl stem and the nozzle body intermediate the slots in the swirl stem.

5. In a gun-type burner nozzle, apparatus comprising a hollow nozzle body having a central axis, the interior of the nozzle body having a substantially frusto-conical surface adjacent one end thereof that is coaxial with the central axis, a swirl stem coaxially positioned in the nozzle body having a substantially frusto-conical portion adjacent one end thereof that is complementary to and seated flush against the frusto-conical surface of the nozzle body, said one end of the swirl stem being spaced from the nozzle body to define a swirl chamber therebetween, said one end of the nozzle body being provided with a discharge orifice coaxial with the central axis and communicating with the swirl chamber, the frusto-conical portion of the swirl stem being provided with a plurality of circumferentially spaced slots extending along the axial length thereof and arranged tangential to the swirl chamber, said swirl stem having a blind axial bore in said one end thereof, and a plurality of circumferentially spaced passageways extending radially from the blind bore to the exterior of the nozzle body through the juncture of the frusto-conical portion of the swirl stem with the nozzle body intermediate the slots.

References Cited in the file of this patent

UNITED STATES PATENTS

1,639,685	Coffey et al. _____	Aug. 23, 1927
2,019,815	Holtham _____	Nov. 5, 1935
2,107,601	Davis _____	Feb. 6, 1938
2,321,428	Schloz _____	June 8, 1943