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(54) Title: INTERNAL MIXING AIR ATOMIZING SPRAY NOZZLE ASSEMBLY

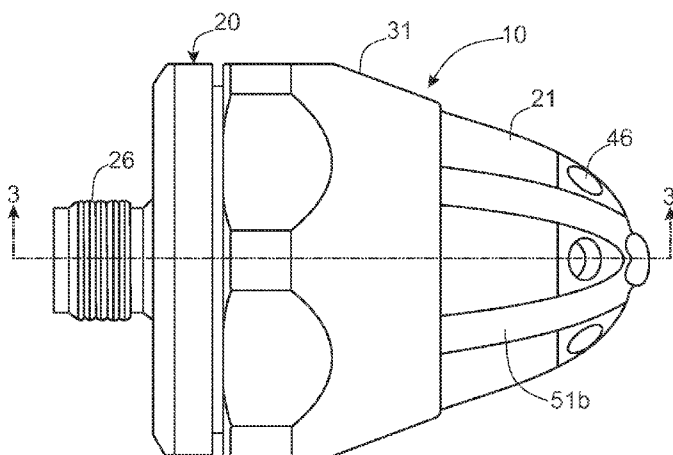


FIG. 1

(57) Abstract: An air atomizing spray nozzle assembly comprising a nozzle body with a downstream air cap into which pressurized liquid and atomizing air are directed and having a plurality of circumferentially spaced discharge orifices from which atomized liquid is directed. The air cap has a plurality of longitudinal external air passages extending along an outer surface for receiving a diverted portion of atomizing air directed to the air cap and directing purging air to locations between the circumferentially spaced discharge orifices of the air cap for minimizing build up of atomized liquid about the outer surface of the air cap.



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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

INTERNAL MIXING AIR ATOMIZING SPRAY NOZZLE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of U.S. Provisional Patent Application No. 61/836,710, filed June 19, 2013, which is incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to spray nozzle assemblies, and more particularly, to internal mix spray nozzle assemblies in which liquid is atomized by pressurized air prior to discharge from the nozzle.

BACKGROUND OF THE INVENTION

[0003] Internal mix spray nozzle assemblies are known which utilize pressurized air for breaking down liquid into relatively small particle sizes. Such nozzle assemblies have particular utility in gas scrubbing applications, such as where finely atomized lime slurry or the like is sprayed into a discharging stream of combustion gases for removing sulfur dioxide or other combustion byproducts.

[0004] Such spray nozzle assemblies commonly direct very finely atomized liquid spray discharges from a plurality of circumferentially spaced discharge orifices of the nozzle so as to generate a conical spray pattern. During operation, the high pressure discharging flow streams from the plurality of discharge orifices can cause a negative pressure within the conical spray pattern that draws ambient air and fine liquid particles inwardly back toward the nozzle with resulting strong eddy currents that can create a heavy buildup of particulate matter about the discharge orifices that choke off the spray and significantly degrade performance. This creates the need for frequent costly cleaning of the spray nozzles of such buildup. The negative pressures within the conical spray pattern further tend to draw inwardly the discharging flow streams from the plurality of discharge orifices so as to reduce the size and effective area of the spray coverage.

OBJECTS AND SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide an internal mix pressurized air atomizing spray nozzle assembly that is effective for directing liquids, such as lime slurries and the like, in gas scrubbing and other applications without the quick build up of residues about the discharge orifices that can impede spray performance and require frequent cleaning.

[0006] Another object is to provide spray nozzle assembly as characterized above that is effective as an incident to the spray operation for preventing spray particles due to eddy currents within the discharging spray pattern from accumulating on the nozzle about the discharge orifices.

[0007] A further object is to provide a spray nozzle assembly of the foregoing type which is effective for preventing negative pressures and eddy currents within a conical spray discharge from narrowing the angle of the conical spray pattern and the effective coverage of discharging spray.

[0008] Still another object is to provide such a spray nozzle assembly that is relatively simple in construction and economical to manufacture.

[0009] Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a side elevational view of an illustrative internal mix pressurized air atomizing spray nozzle assembly in accordance with the invention;

[0011] Fig. 2 is a downstream end view of the spray nozzle assembly shown in Fig. 1;

[0012] Fig. 3 is a horizontal section of the illustrated spray nozzle assembly taken in the plane of line 3-3 in Fig. 1;

[0013] Fig. 4 is a vertical section of the illustrated spray nozzle assembly taken in the plane of line 4-4 in Fig. 2;

[0014] Fig. 5 is a side elevational view of the air cap of the illustrated spray nozzle assembly; and

[0015] Fig. 6 is a perspective of the air guide of the illustrated spray nozzle assembly.

[0016] While the invention is susceptible of various modifications and alternative constructions, certain illustrative embodiments thereof have been shown in the drawings and will be described below in detail. It should be understood, however, that there is no intention to limit the invention to the specific forms disclosed, but on the contrary, the invention is to cover all modifications, alternative constructions, and equivalents falling within the spirit and scope of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Referring now further to the drawings, and particularly Fig. 3, there is shown an illustrative internal-mix, air-atomizing spray nozzle assembly 10 in accordance with the invention connected to a conventional fluid supply manifold 11. The fluid supply manifold 11 in this case includes a central pressurized liquid supply passage 12 and a plurality of pressurized air supply passages 14 in surrounding relation to the liquid supply passage 12. The air passages 14 in this instance communicate with an annular manifold air passage 15 at a downstream end of the fluid supply manifold 11.

[0018] The illustrated spray nozzle assembly 10 basically comprise a nozzle body 20, a downstream air cap 21, and an air guide 22 interposed between the nozzle body 20 and air cap 21. The nozzle body 20 in this case is in the form of a multipart fluid supply subassembly comprising an outer annular body member 24 and an inner axial liquid supply tube 25 fixed therein which defines a liquid flow passage with a discharge orifice 27. The outer annular body member 24 has an externally threaded, upstream stem 26 secured within a threaded axial bore of the fluid supply manifold 11 with the liquid supply tube 25 in fluid communication with the liquid passage 12. An annular sealing gasket 28 is interposed between the annular body member 24 and the downstream end of the fluid supply manifold 11. The annular body member 24 further is formed with a plurality of circumferentially spaced axial air passageways 29 that communicate between the annular manifold air passage 15 and an air chamber 30 about the liquid supply tube 25.

[0019] The air cap 21, which in this case has an inwardly curved or tapered end, is secured to the nozzle body 20 by a threaded retaining cap 31 with the air guide 22 retained between an upstream end of the air cap 21 and a downstream end of the outer nozzle body member 24. The air cap 21 in turn retains the air guide 22 in seated relation within a downstream counter bore of

the outer annular body member 24. The air guide 22, as best depicted in Fig. 6, has a generally triangular configured upstream end 32 with the rounded corners 33 thereof in seated engagement within the annular body member 24 and flat sides 34 thereof defining air passages 35 communicating between the air chamber 30 and a downstream annular air passage 36 defined between a cylindrical downstream end 37 of the air guide 22 and the air cap 21. The annular air passageway 36 directs pressurized air into an expansion chamber 42 within the air cap 21 simultaneously as liquid is directed through and discharges from the downstream discharge orifice 27 of the liquid supply tube 25.

[0020] The liquid discharging from the liquid supply pipe 25 impacts a transverse impingement surface 44 of an upstanding impingement pin or pintel 45 of the air cap 21 which facilitates both mechanical and air atomized liquid particle breakdown of the liquid as it is dispersed laterally of the impingement surface 44. The lateral liquid dispersion is further broken down and atomized by the annular air flow stream about the impingement surface 44 prior to discharge from the air cap 21 through a plurality of circumferentially spaced discharge orifices 46 disposed in surrounding relation to the impingement pin 45 which effects further liquid particle breakdown and atomization.

[0021] The atomized liquid discharges from the discharge orifices 46 in the form of a plurality of circumferentially spaced high pressurized streams of atomized particles. Since the discharge orifices 46 are angled outwardly relative to the longitudinal axis of the spray nozzle assembly, the discharging flow streams form a generally conical spray pattern.

[0022] As indicated previously, due to the high velocity of the plurality of discharging flow streams from the spray nozzle assembly, heretofore low pressure conditions could be created within the conical spray pattern which draws ambient air and fine liquid particles inwardly back toward the air cap that with the aid of resulting eddy currents can quickly accumulate on the end of the air cap, blocking the discharge orifices and choking off the discharging spray. The low pressure condition created within the conical pattern could further draw together the discharging flow streams from the plurality of discharge orifices reducing the effective coverage of the discharging spray.

[0023] In accordance with the present invention, the spray nozzle assembly has a pressurized air passage system communicating with the atomizing air inlet of the nozzle assembly that directs pressurized purging air externally of the air cap adjacent the discharge orifices for

preventing the buildup of particulate matter about the discharge orifices that can impede the efficient discharge of the atomized liquid spray. More particularly, the spray nozzle assembly is designed to actively purge the outer surfaces of the air cap adjacent the discharge orifices by utilizing a small percentage of the atomizing air from within the nozzle assembly which is directed under the retaining ring that holds the air cap in place and along external passageways that communicate between the circumferentially spaced discharge orifices of the air cap. To this end, in the illustrated embodiment, the air cap 21 is formed with a plurality of transverse, in this case radial, diverting air passages 50 (Fig. 3) that communicate with the annular air passage 36 that supplies atomizing air through the air cap 21 of the spray nozzle assembly. The transverse diverting air passages 50 communicate with exterior purging air passages 51 that extend axially along the outer periphery of the air cap 21.

[0024] In the illustrated embodiment, the air cap 21 has a fluted outer periphery that defines the plurality of the longitudinal purging air passages 51 in recessed relation to the outer surface of the air cap 21. As depicted in Fig. 4, due to the recessed nature of the longitudinal purging air passages 51 upstream closed sections 51a of the longitudinal purging passages 51 are defined between the outer periphery of the air cap 21 and an inner cylindrical portion of the retaining ring 30. Hence, purging air directed through the radial passages 50 communicates with the closed longitudinal passage sections 51a. The closed longitudinal passage sections 51a in turn communicate with open external longitudinal passage sections 51b that extend along an inwardly curved downstream end of the air cap 21 and between the discharge orifices 46 to a protruding end 52 of the pintel or impingement pin 45. It has been unexpectedly found that the purging air directed longitudinally along the closed purging air passage sections 51a will continue to follow the exterior passage sections 51b in a downstream direction between the discharging orifices 46 such that the purging air adjacent the terminal end of the air cap 21 effectively breaks up strong eddy currents at that location that normally cause the heavy build of particulate matter about the discharge orifices 46. Purging air also increases the pressure within the conical spray pattern so as to compensate for negative pressures that normally draw the discharging flow streams from the discharge orifices inwardly toward each other. Hence, the purging air further effectively prevents narrowing of the desired spray angle for more efficient and effective coverage.

[0025] From the foregoing, it can be seen that the internal mix air atomizing spray nozzle assembly of the present invention can be highly effective for discharging liquids, such as lime

slurries and the like, in gas scrubbing and other applications without undesirable buildup of residues about the discharge orifices of the air cap that can impede spray performance and require frequent cleaning. By utilizing a relatively small amount of the atomizing air, the external purging air effectively reduces negative pressure and resulting eddy currents within the discharging spray pattern that create such particle build up and which narrows the effective coverage of the spray nozzle assembly. Yet, the spray nozzle assembly is relatively simple in construction and lends itself to economical manufacture.

Claims:

1. An air atomizing spray nozzle assembly comprising:

a nozzle body having a liquid flow passageway for connection to a liquid supply;

an air cap connected at a downstream end of said nozzle body;

said nozzle body having at least one atomizing air passage for connection to a pressurized air supply and directing atomizing air into an internal chamber of said air cap;

said air cap defining an impingement surface in aligned relation to said liquid flow passage against which liquid discharging from said central liquid flow passage impinges and is dispersed laterally outwardly for interaction and atomization by atomizing air directed into said air cap internal chamber;

said air cap having a plurality of circumferentially spaced atomized liquid discharge orifices about said impingement surface from which atomized liquid is discharged;

said air cap having at least one diverting air passage communicating with said atomizing air passage for diverting a portion of the atomizing air directed to said air cap;

said air cap having a plurality of longitudinal external purging air passages extending along an outer surface for receiving diverted atomizing air from said at least one diverting air passage and directing purging air along said purging air passages to locations between the circumferentially spaced atomizing liquid discharge orifices of said air cap for minimizing the buildup of atomized liquid about outer surfaces of said air cap discharge orifices.
2. The air atomizing spray nozzle assembly of claim 1 in which said longitudinal purging air passages are outwardly opening defined by a plurality of longitudinal outwardly opening recesses in an outer side of said air cap.
3. The air atomizing spray nozzle assembly of claim 2 in which said at least one diverting air passage communicates transversely between the internal chamber of said air cap and a plurality of enclosed longitudinal passage sections which each in turn communicate with a respective one of said outwardly opening longitudinal purging air passages.

4. The air atomizing spray nozzle assembly of claim 3 in which said enclosed longitudinal passage sections are shorter in length than said outwardly opening longitudinal purging air passages.

5. The air atomizing spray nozzle assembly of claim 4 in which said air guide is secured to said nozzle body by an annular retaining cap, and said enclosed passage sections are defined between an outer side of said air cap and an underside of said retaining cap.

6. The air atomizing spray nozzle assembly of claim 5 in which said air cap and retaining cap define an annular passage within said retaining cap for communicating air from said at least one diverting air passage to said plurality of enclosed longitudinal passage sections.

7. The air atomizing spray nozzle assembly of claim 6 in which said annular passage is defined in part by an outer annular recess within said retaining cap.

8. The air atomizing spray nozzle assembly of claim 1 including an air guide disposed within said air cap in surrounding relation to said central liquid passage, said air cap internal chamber and said air guide defining an annular air passage communicating between said at least one atomizing air inlet passage and an expansion chamber downstream of said air guide, and said at least one diverting air passage communicating with said annular air passage.

9. The air atomizing spray nozzle assembly of claim 8 in which said impingement surface is defined by an impingement pin extending centrally disposed within said expansion chamber.

10. An air atomizing spray nozzle assembly comprising:

a nozzle body having a central liquid flow passageway for connection to a liquid supply;

an air cap connected at a downstream end of said nozzle body;

said nozzle body having at least one atomizing air passage for connection to a pressurized air supply and directing atomizing air into an internal chamber of said air cap;

said air cap defining an impingement surface in aligned relation to said central liquid flow passage against which liquid discharging from said central liquid flow passage impinges and is dispersed laterally outwardly for interaction and atomization by atomizing air directed into said air cap internal chamber;

said air cap having a plurality of circumferentially spaced atomized liquid discharge orifices about said impingement surface from which atomized liquid is discharged;

said air cap having at least one transverse air passage communicating outwardly from said air cap internal chamber;

said air cap having a plurality of longitudinally extending external purging air passages extending along an outer surface for receiving from said at least one transverse passage a portion of the atomizing air directed into said air cap internal chamber and directing purging air along said purging air passages to locations between the circumferentially spaced atomized liquid discharge orifices of said air cap for minimizing the buildup of atomized liquid about outer surfaces of said air cap discharge orifices.

11. The air atomizing spray nozzle assembly of claim 11 in which said external longitudinal purging air passages are outwardly opening defined by a plurality of longitudinal outwardly opening recesses in an outer side of said air cap.

12. The air atomizing spray nozzle assembly of claim 12 in which said air cap has an inwardly tapered downstream end.

13. The air atomizing spray nozzle assembly of claim 12 in which said purging air passages taper inwardly in a downstream direction.

14. The air atomizing spray nozzle assembly of claim 11 in which said at least one transverse passage of said air cap communicates with a plurality of enclosed longitudinal passage sections which each in turn communicate with a respective one of said outwardly opening longitudinal purging air passages, and said enclosed longitudinal passage sections being shorter in length than said outwardly opening longitudinal purging air passages.

15. The air atomizing spray nozzle assembly of claim 14 in which said air cap is secured to said nozzle body by an annular retaining cap, and said enclosed passage sections are defined between an outer side of said air cap and an underside of said retaining cap.

16. The air atomizing spray nozzle assembly of claim 10 including a plurality of said transverse passages.

17. The air atomizing spray nozzle assembly of claim 10 including an air guide disposed within said air cap in surrounding relation to said central liquid passage, said air cap internal chamber and said air guide defining an annular air passage communicating between said at least one atomizing air inlet passage and an expansion chamber downstream of said air guide, and said at least one transverse air passage communicating with said annular air passage.

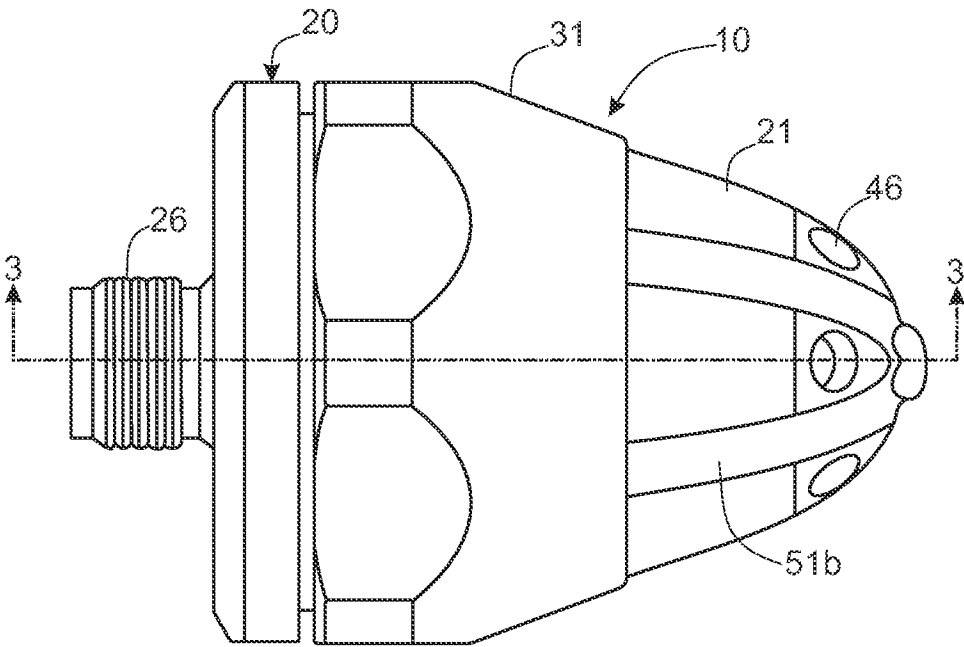


FIG. 1

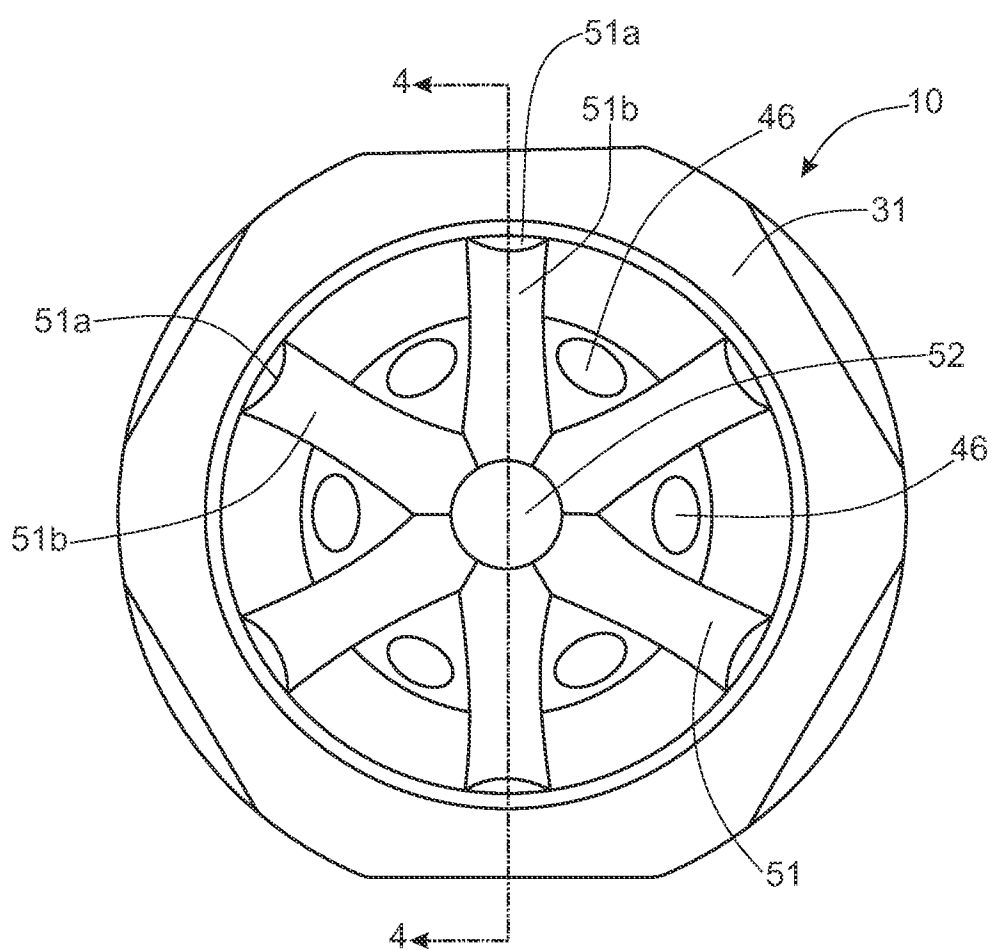


FIG. 2

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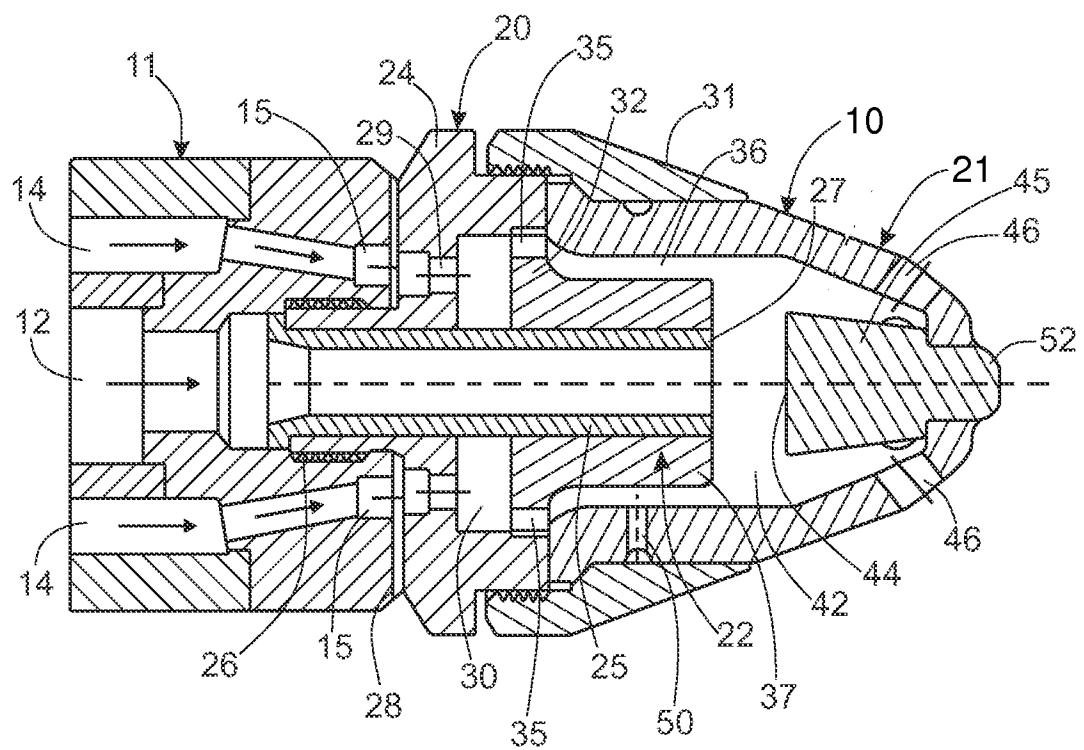


FIG. 3

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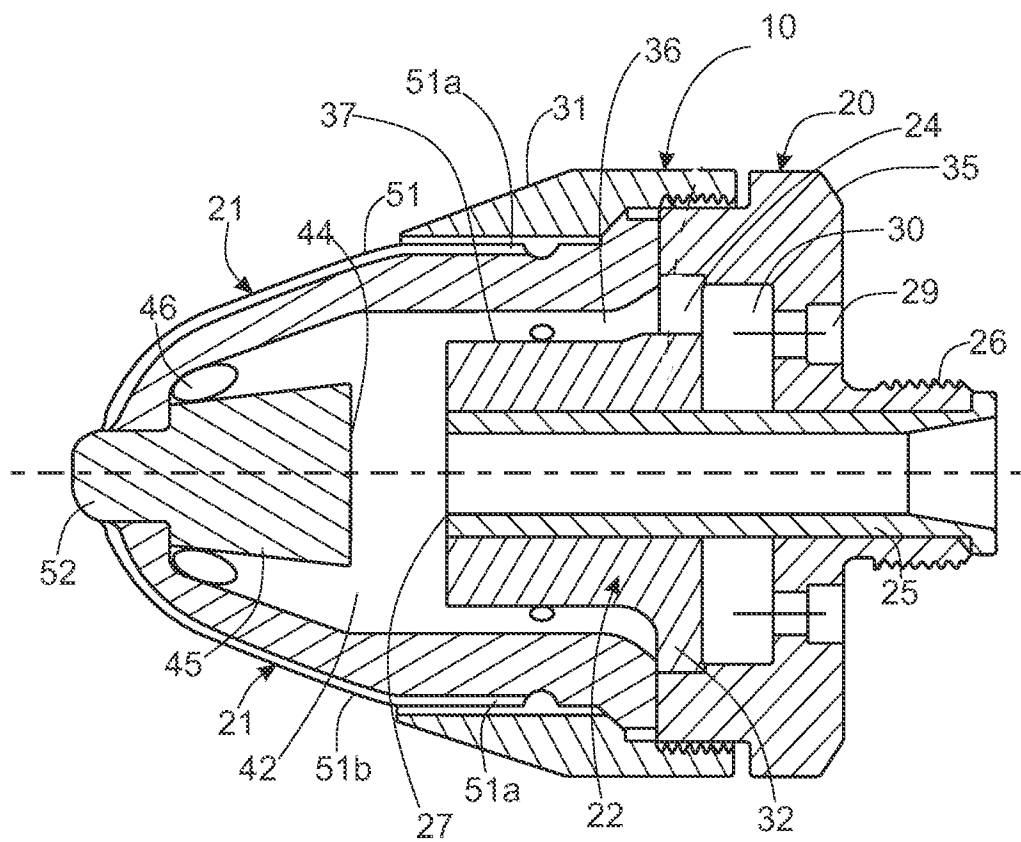


FIG. 4

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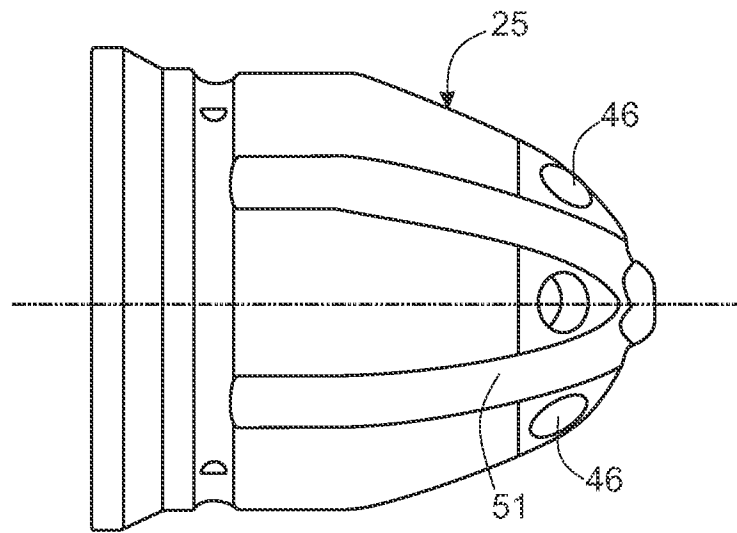


FIG. 5

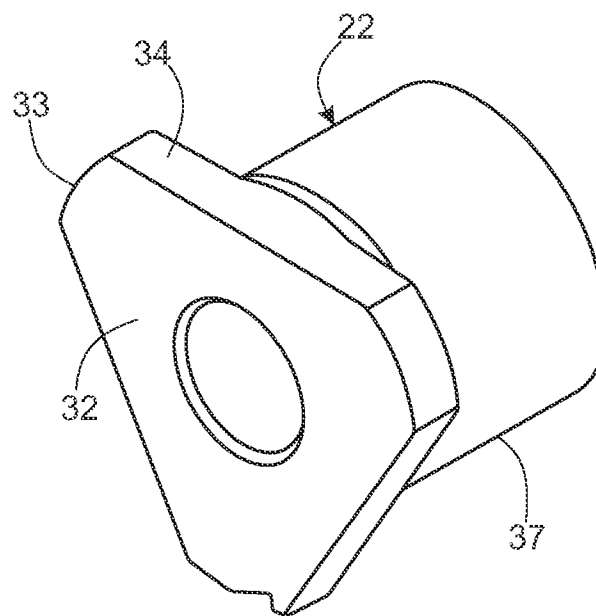


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/43244

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B05B 7/04, B05B 1/00 (2014.01)

CPC - B08B 3/026

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8): B05B 7/04, B05B 1/00 (2014.01)

CPC: B08B 3/026

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 239/419, 239/126Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google (Web, Patents, Images), Atom, atomizing, nozzle, tip, fluid, air, pressure, high, purge, purging, clean, prevent, stop, reduce, reducing, minimizing, minimize, plurality, multiple, low, pressure, discharge, orifice, impingement, plate, surface, disperse, opening, outwardly, recesses, outer, longer, shorter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 101122289 B1 (Jung Yeoun Hee) 21 March 2012 (21.03.2012) entire document, especially fig. 6, para [0023]-[0030].	1-17
Y	US 2,656,218 A (Campbell) 20 October 1953 (20.10.1953) entire document, especially figs.1-3, col 3, ln 20-25.	1-17
Y	US 7,028,867 B2 (Acum et al.) 18 April 2006 (18.04.2006) entire document, especially figs. 2A-2B; Abstract, col 13 ln 55-63, col 14, ln 5-10.	4-7, 14-15
A	US 2010/0116900 A1 (Wurz) 13 May 2010 (13.05.2010) entire document.	1-17
A	US 6,012,647 A (Ruta et al.) 11 January 2000 (11.01.2000) entire document.	1-17

☐ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

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Date of mailing of the international search report

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