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(54) Title: CATALYTIC CRACKING SPRAY NOZZLE WITH EXTENDED LIQUID INLET

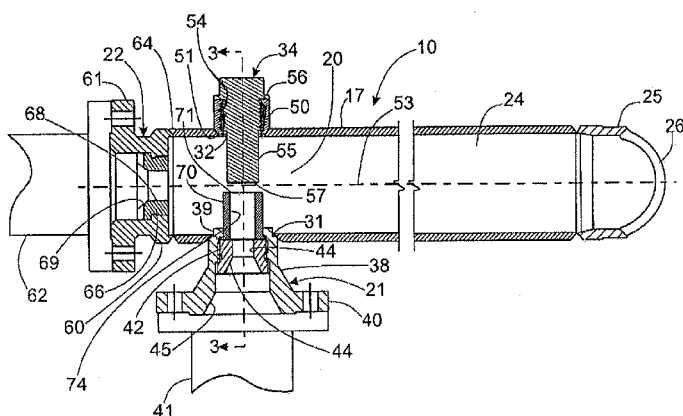


FIG. 2

(57) Abstract: A gas assisted liquid spray nozzle assembly having a nozzle body that defines a mixing zone, a liquid inlet communicating with the mixing zone from a side thereof, an impingement pin extending into said mixing zone in opposed relation to said liquid inlet, and a pressurized gas inlet communicating with the mixing chamber from an upstream end. The liquid inlet includes a liquid inlet extension and protective tube having a discharge orifice in close proximity to the impingement surface such that liquid discharging from the extension end protective tube directly impinges upon an impingement surface of the impingement pin for transverse direction into the mixing zone and more effective atomization by pressurized gas directed through the mixing zone from the gas inlet.

CATALYTIC CRACKING SPRAY NOZZLE ASSEMBLY WITH EXTENDED LIQUID
INLET

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of U.S. Provisional Patent Application No. 61/880,280, filed September 20, 2013, which is incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to spray nozzles, and more particularly, to spray nozzle assemblies particularly adapted for atomizing and spraying a liquid feed to a fluidized catalytic cracking riser reactor.

BACKGROUND OF THE INVENTION

[0003] A spray nozzle assembly of the foregoing type is shown and described in U.S. Patent No. 5,921,472, the disclosure of which is incorporated by reference. Such spray nozzle assemblies typically include a nozzle body which defines a mixing chamber into which a liquid hydrocarbon and pressurized gas, such as steam, are introduced and within which the liquid hydrocarbon is atomized. To enhance liquid atomization within the mixing chamber, an impingement pin extends into the chamber and defines a liquid impingement surface on the center line of the mixing chamber in diametrically opposed relation to the liquid inlet against which a pressurized liquid stream impinges and is transversely dispersed and across which pressurized steam from a gas inlet is directed for further interaction and shearing of the liquid into fine droplets. The atomized liquid within the mixing chamber is directed under the force of the pressurized steam through an elongated tubular barrel, commonly disposed within a wall of the catalytic reactor riser, for discharge from a spray tip at a downstream end thereof within the riser.

[0004] In such spray nozzle assemblies, the liquid hydrocarbon flow stream must pass through half the diameter of the mixing chamber before it impacts the impingement surface. Particularly in spray nozzle assemblies with relatively large diameter mixing chambers, such as those having a mixing chamber of four inches and more in diameter, there can be a tendency for the liquid hydrocarbon flow stream introduced into the mixing chamber to only partially impact the impingement surface of the impingement pin. The reason for this is that the liquid flow

stream must pass a significant distance through the mixing chamber where it is subjected to a heavy cross flow of steam before impacting the impingement surface. This tends to cause a shift in the liquid flow stream away from the center of the impingement surface, the magnitude of which is dependent upon the velocities of the pressurized steam and liquid flow streams for a particular setup. The shift prevents a portion of the liquid hydrocarbon flow stream from being shattered against the impingement pin resulting in a significant increase in droplet size for a portion of the spray volume that adversely effects the spray performance. In order to overcome such shift in the liquid flow stream introduced into the mixing chamber, heretofore it has been necessary to increase the liquid pressure to overcome the effect of the steam cross flow. This necessitates the need for larger and higher pressure process pumps that are more expensive to operate and more susceptible to breakdowns.

SUMMARY AND OBJECTS OF THE INVENTION

[0005] It is an object of the present invention to provide a liquid hydrocarbon spray nozzle assembly that is adapted for more effective and complete liquid atomization, and hence, improved spray performance in catalytic cracking reactors.

[0006] Another object is to provide a spray nozzle assembly as characterized above that reliably directs a pressurized liquid hydrocarbon flow stream into centered relation to the diametrically opposed impingement surface for ensuring complete and effective liquid particle breakdown.

[0007] A further object is to provide a spray nozzle assembly of such type with a relatively large diameter mixing chamber, such as four inches in diameter and greater, wherein the liquid hydrocarbon flow stream injected into the mixing chamber is not shifted away from the center of the impingement surface.

[0008] Still another object is to provide a spray nozzle assembly of the above kind that reliably directs the inlet liquid flow stream in centered relation to the impingement surface without the need for higher pressure and more expensive process pumps.

[0009] Yet a further object is to provide a spray nozzle assembly of such type that is relatively simple in construction and lends itself to economical manufacture. A related object is to provide a spray nozzle assembly design of the foregoing type which lends itself to easy retrofitting of existing units in the field.

[0010] 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

[0011] Figure 1 is a schematic depiction of a spray nozzle assembly in accordance with the present invention mounted within the wall of a riser of a catalytic cracking reactor;

[0012] Fig. 2 is an enlarged longitudinal section of the spray nozzle assembly shown in Fig. 1; and

[0013] Fig. 3 is an enlarged transverse section taken in the plane of line 3-3 in Fig. 2

[0014] While the invention is susceptible of various modifications and alternative constructions, a certain illustrative embodiment thereof has 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 form disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions, and equivalents falling within the spirit and scope of the invention. In that regard, while the illustrated spray nozzle assembly is particularly effective for atomizing and spraying liquid hydrocarbons in catalytic cracking systems, it will be understood that the utility of the nozzle assembly is not limited to that usage.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] Referring now more particularly to the drawings there is shown an illustrative spray nozzle assembly 10 in accordance with the invention mounted in a conventional manner in an insulated wall 11 (shown in phantom) of a riser of a fluidized catalytic reactor. The spray nozzle assembly 10 is supported in a tubular sleeve 12 fixed within the wall 11 at an acute angle to the vertical for discharging atomized liquid hydrocarbon upwardly into the riser. The tubular sleeve 12 in this case has an outwardly extending flange 14 to which a support flange 15 fixed to the spray nozzle assembly 10 may be secured.

[0016] The illustrated spray nozzle assembly 10, as best depicted in Fig. 2, basically comprises a nozzle body in the form of an uninterrupted elongated tubular member 17 that defines a mixing zone 20 having a liquid hydrocarbon inlet 21 and a pressurized steam or other gas inlet 22 disposed on an outer side of the wall 11 of the riser and an elongated barrel extension zone 24 communicating with the mixing zone 20 disposed in and extending through

the nozzle support sleeve 12 and riser wall 11. A spray tip 25 having one or more discharge orifices 26 is supported at a downstream end of the tubular member 17 within the riser for discharging and directing the atomized liquid spray. The tubular member 17, which may be a single length of pipe, such as Schedule 80 steel pipe, in this instance has diametrically opposed drilled openings 31, 32 adjacent an upstream end for receiving the liquid inlet 21 and an opposed impingement pin 34, respectively.

[0017] The illustrated liquid inlet 21 includes an inlet fitting 38 having a reduced diameter counter bore section 39 that fits within the opening 31, which in this case is formed with an inwardly tapered conical sidewall for facilitating securement of the fitting 38 to the tubular member 17 by an appropriate annular weldment. The liquid inlet fitting 38 has an upstream mounting flange 40 for securement of the fitting 38 to a supply line 41 which in turn is coupled to a suitable liquid hydrocarbon supply. The liquid inlet fitting 38 receives an internally mounted orifice member 42 which defines a liquid inlet flow passage 44 of predetermined diameter through which the feed liquid is directed into the mixing zone 20. The illustrated orifice member 42 and fitting 38, have respective conical entry sections 44, 45 for channeling the feed liquid into and through the orifice member 42.

[0018] The impingement pin 34 in this case is in the form of a threaded bolt mounted within an internally threaded bushing or threadolet 50 having an inwardly chamfered end 51 adjacent an inwardly chamfered side of the opening 32 for facilitating welding of the bushing 50 about the opening 32. The impingement pin 34 in this instance has an externally threaded outer section 54 for threaded engagement with the bushing 50, an inwardly extending cylindrical post section 55 disposed within the tubular member 17 and defining an impingement surface 57 in opposed relation to the liquid inlet 21, and a head having an outwardly extending flange 56 for fixing the post section 55 with the impingement surface 57 substantially on a central axis 53 of the mixing zone 20.

[0019] The steam inlet 22, like the liquid inlet 21, includes a fitting 60 having a mounting flange 61 for securement to a supply line 62 coupled to a steam or other pressurized gas supply and a downstream cylindrical section for securement to an upstream axial end of the tubular member 17. The ends of the steam inlet fitting 60 and the tubular member 17 again are chamfered for facilitating securement by a weldment 64. The steam inlet fitting 60 includes an orifice member 66 for defining a steam inlet passage 68 of predetermined diameter for the

pressurized steam with an upstream conical section 69 for channeling steam into and through the inlet passage 68.

[0020] In accordance with the invention, the spray nozzle assembly is adapted for enhanced liquid hydrocarbon atomization and spray performance even when the spray nozzle body has a relatively large diameter mixing zone, such as four inches or greater. To this end, in the illustrated embodiment, the liquid inlet 21 has an extended protective sheath or tube 70 that extends into the mixing zone 20 and defines a liquid extension passage 74 having a discharge orifice 71 at a terminal end in close proximity to the impingement surface 57 of the impingement pin 34 so as to minimize the distance a liquid flow stream directed into the mixing zone 20 is exposed to the pressurized cross flow of steam prior to engaging the impingement surface 57. In the illustrated embodiment, the sheath 70 is a separate tubular member fixedly mounted in abutting relation to a downstream end of the orifice member 42 with the terminal end and discharge orifice 71 disposed less than about $\frac{1}{4}$ of the radius of the mixing zone 20, such as about one inch, from the impingement surface. In this instance, the spatial separation preferably is less than $\frac{1}{2}$ the diameter of the extension passage discharge orifice 74. The protective sheath 70 in this case has an upstream outwardly extending annular flange 72 that is clamped between a shoulder 73 (Fig. 3) defined by an inner annular end of the fitting 38 and the downstream end of the orifice member 42. It will be understood that alternatively, the orifice member 42 and protective sheath 70 could be made as a single part. The protective sheath 70 in this case has a larger inside diameter passageway 74 than the orifice member 42 for allowing unimpeded flow of liquid hydrocarbon to the impingement pin 34.

[0021] In operation, it will be seen that the extended protective sheath 70 will shield the liquid flow stream from the steam cross flow until just before it impacts the impingement surface 57. This ensures that the liquid stream centrally impacts the impingement surface 57 before any appreciable shift away from the center of the impingement pin 34 by the pressurized steam cross flow. The sheath 70 thereby both optimizes the spray performance and allows operation at lower liquid pressures with comparable finely atomized droplet sizes as in previous higher pressure units. In addition, since the flow area of the mixing zone 20 at the region of the impingement pin 34 and protective sheath 70 is more constricted by virtue of the extended sheath 70, the velocity of the cross flow steam will be accelerated in the vicinity of the impingement surface 57 for further enhancing liquid atomization and direction into the downstream barrel and extension

zone 24 of the spray nozzle assembly 10. Since the extended protective sheath 70 is directly subjected to the steam cross flow, preferably it is coated or produced with a wear resistant material, such as stellite or ceramic. It will also be appreciated that the protective sheath 70, when used as a separate component from the liquid orifice member 42, is adapted for easy retrofitting into existing units in the field that may have problems with performance, particularly in spraying systems with relatively large diameter liquid mixing and atomization zones.

[0022] From the foregoing, it can be seen that a spray nozzle assembly is provided for more reliably directing a liquid hydrocarbon flow stream into centered relation to a diametrically opposed impingement surface of an impingement pin or post for ensuring complete and more effective liquid particle breakdown and atomization for improved spray performance. Yet, the spray nozzle assembly is relatively simple in construction, lends itself to economical manufacture, and can be operated without the need for higher pressure and more expensive processing pumps.

Patent Claims:

1. A gas assisted liquid spray nozzle assembly comprising:

a nozzle body which defines an annular mixing zone that communicates with an elongated barrel extension zone downstream of the mixing zone,

a liquid inlet supported by said nozzle body through which a pressurized liquid stream is directed into said mixing zone,

a gas inlet mounted in an upstream end of said nozzle body through which a pressurized gas stream is directed into said mixing chamber along a central axis of the mixing zone,

an impingement pin supported by said nozzle body and extending into said mixing zone,

said impingement pin having an impingement surface in alignment with said liquid inlet,

said liquid inlet including a liquid inlet extension and protective tube extending into said mixing zone which defines an extension passageway having a discharge orifice at a downstream end thereof,

said liquid inlet extension and protective tube discharge orifice being disposed a distance less than about $\frac{1}{4}$ the radius of said mixing zone from said impingement surface such that liquid discharging from said liquid extension and protection tube discharge orifice directly impinges upon said impingement surface and is transversely directed into said mixing zone for intermixing and atomization by pressurized gas directed through said mixing zone from said gas inlet which directs the atomized liquid through said barrel zone, and

a spray tip mounted at a downstream end of said barrel extension zone having a discharge orifice through which atomized liquid directed through said barrel zone is discharged in a predetermined spray pattern.

2. The gas assisted liquid spray nozzle assembly of claim 1 in which said liquid inlet extension and protective tube discharge orifice is disposed about 1 inch from said impingement surface.

3. The gas assisted liquid spray nozzle assembly of claim 1 in which said liquid inlet extension and protective tube is a cylindrical tube having an open downstream end that defines said extension passage discharge orifice.
4. The gas assisted liquid spray nozzle assembly of claim 1 in which said impingement surface is located substantially on the central axis of said mixing zone.
5. The gas assisted liquid spray nozzle assembly of claim 1 in which said liquid inlet includes an orifice member that defines a predetermined sized liquid inlet passage, and said liquid inlet extension and protective tube is a separate tubular member mounted downstream of said orifice member.
6. The gas assisted liquid spray nozzle assembly of claim 5 in which said extension passageway of said liquid inlet extension and protective tube is larger in diameter than said liquid inlet passage of said orifice member.
7. The gas assisted liquid spray nozzle assembly of claim 1 in which said nozzle body is in the form of a one piece hollow cylindrical tubular member that defines both said mixing chamber and said barrel zone.
8. The gas assisted liquid spray nozzle assembly of claim 7 in which said tubular member is a single cylindrical pipe section.
9. The gas assisted liquid spray nozzle assembly of claim 1 in which said annular mixing zone has a diameter of at least 4 inches.
10. The gas assisted liquid spray nozzle assembly of claim 1 in which said liquid inlet extension and protective tube is made of a wear resistant stellite material.
11. The gas assisted liquid spray nozzle assembly of claim 1 in which said liquid inlet extension and protective tube is made of a wear resistant ceramic material.
12. A gas assisted liquid spray nozzle assembly comprising:

a nozzle body which defines a mixing zone that communicates with an elongated barrel extension zone downstream of the mixing zone,

a liquid inlet supported by said nozzle body through which a pressurized liquid stream is directed into said mixing zone,

a gas inlet mounted in an upstream end of said nozzle body through which a pressurized gas stream is directed into said mixing chamber along a central axis of the mixing zone,

an impingement pin supported by said nozzle body and extending into said mixing zone,

said impingement pin having an impingement surface located substantially on the central axis of said mixing zone in alignment with said liquid inlet,

said liquid inlet including a liquid inlet extension and protective tube extending into said mixing zone which defines an extension passageway having a discharge orifice at a downstream end thereof,

said liquid inlet extension and protective tube discharge orifice being disposed a distance less than $\frac{1}{2}$ the diameter of said extension passage discharge orifice from said impingement surface such that liquid discharging from said liquid extension and protection tube discharge orifice directly impinges upon said impingement surface and is transversely directed into said mixing zone for intermixing and atomization by pressurized gas directed through said mixing zone from said gas inlet which directs the atomized liquid through said barrel zone, and

a spray tip mounted at a downstream end of said barrel extension zone having a discharge orifice through which atomized liquid directed through said barrel zone is discharged in a predetermined spray pattern.

13. The gas assisted liquid spray nozzle assembly of claim 12 in which said liquid inlet extension and protective tube discharge orifice is disposed about 1 inch from said impingement surface.

14. The gas assisted liquid spray nozzle assembly of claim 12 in which said liquid inlet extension and protective tube is a cylindrical tube having an open downstream end that defines said extension passage discharge orifice.

15. The gas assisted liquid spray nozzle assembly of claim 12 in which said liquid inlet includes an orifice member that defines a predetermined sized liquid inlet passage, and said liquid inlet extension and protective tube is a separate tubular member mounted downstream of said orifice member.

16. The gas assisted liquid spray nozzle assembly of claim 12 in which said annular mixing zone has a diameter of at least 4 inches.

17. A gas assisted liquid spray nozzle assembly comprising:

a nozzle body which defines an annular mixing zone that communicates with an elongated barrel extension zone downstream of the mixing zone,

a liquid inlet supported by said nozzle body through which a pressurized liquid stream is directed into said mixing zone,

a gas inlet mounted in an upstream end of said nozzle body through which a pressurized gas stream is directed into said mixing chamber along a central axis of the mixing zone,

an impingement pin supported by said nozzle body and extending into said mixing zone,

said impingement pin having an impingement surface in alignment with said liquid inlet,

said liquid inlet including a liquid inlet extension and protective tube extending into said mixing zone which defines an extension passageway having a discharge orifice at a downstream end thereof,

said annular mixing zone having a diameter of at least 4 inches and said liquid inlet extension and protective tube discharge orifice being disposed a distance of about 1 inch from said impingement surface such that liquid discharging from said liquid extension and protection tube discharge orifice directly impinges upon said impingement surface and is transversely

directed into said mixing zone for intermixing and atomization by pressurized gas directed through said mixing zone from said gas inlet which directs the atomized liquid through said barrel zone, and

a spray tip mounted at a downstream end of said barrel extension zone having a discharge orifice through which atomized liquid directed through said barrel zone is discharged in a predetermined spray pattern.

18. The gas assisted liquid spray nozzle assembly of claim 17 in which said liquid inlet extension and protective tube is a cylindrical tube having an open downstream end that defines said extension passage discharge orifice.

19. The gas assisted liquid spray nozzle assembly of claim 18 in which said impingement surface is located substantially on the central axis of said mixing zone.

20. The gas assisted liquid spray nozzle assembly of claim 19 in which said liquid inlet includes an orifice member that defines a predetermined sized liquid inlet passage, and said liquid inlet extension and protective tube is a separate tubular member mounted downstream of said orifice member.

1/3

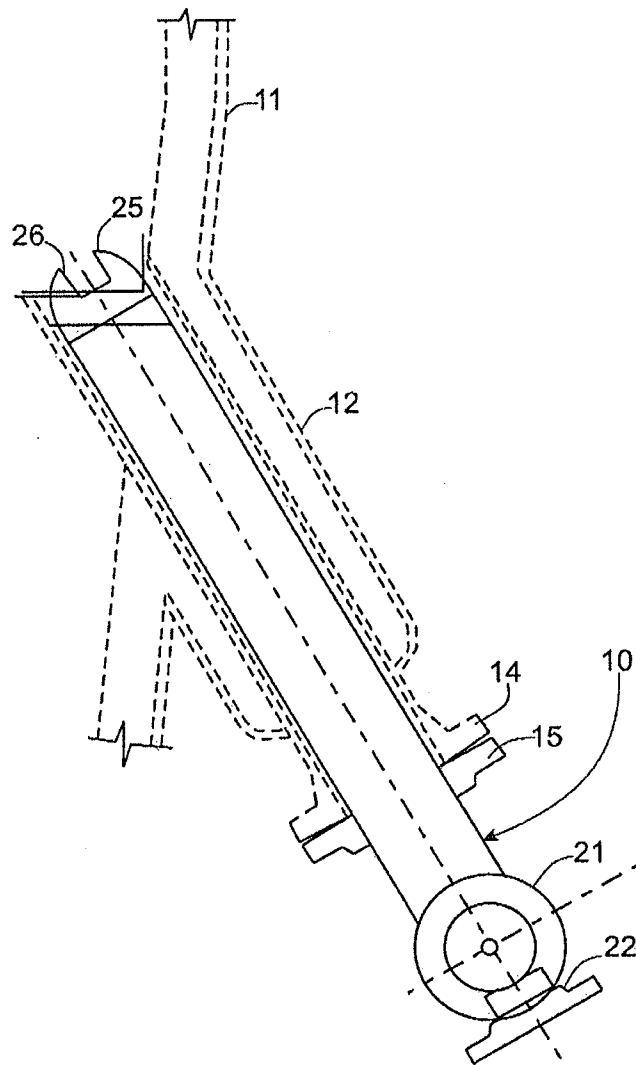


FIG. 1

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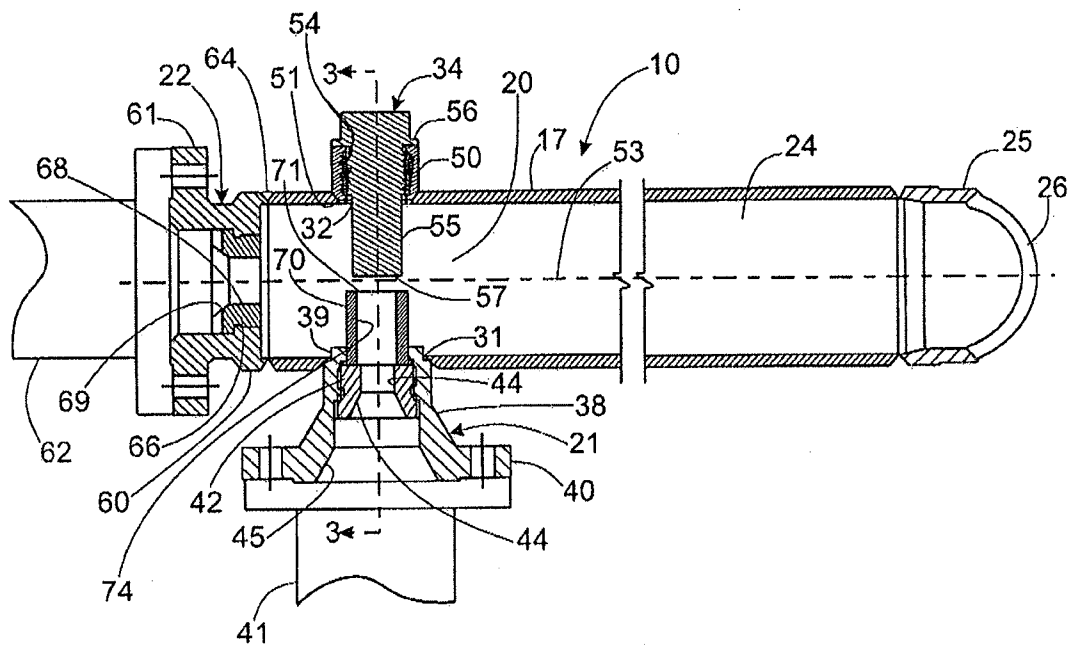


FIG. 2

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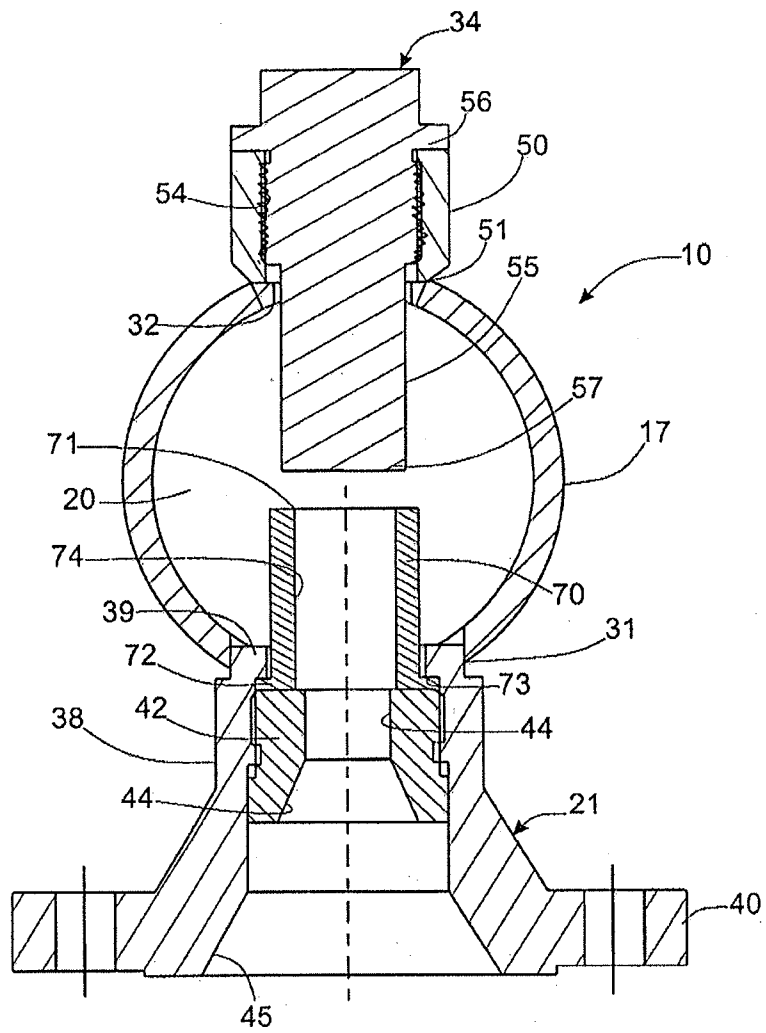


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/056340

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B05B 1/02 (2014.01)

CPC - B05B 7/0487 (2014.11)

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 1/02, 1/04, 1/26, 7/04 (2014.01)

CPC - B05B 1/042, 7/0416, 7/0483; B01F 3/04049 (2014.11) (keyword delimited)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 208/157; 239/8, 432, 434

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents, Google

Search terms used: spray, nozzle, mix, mixing, atomize, atomizing, stellite, mixing zone, liquid, gas, hydrocarbon, chamber, catalytic cracking, inlet, outlet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,921,472 A (HARUCH) 13 July 1999 (13.07.1999) entire document	1-20
Y	US 5,306,418 A (DOU et al) 26 April 1994 (26.04.1994) entire document	1-20
Y	US 2012/0318399 A1 (YAO et al) 20 December 2012 (20.12.2012) entire document	10
Y	US 4,875,996 A (HSIEH et al) 24 October 1989 (24.10.1989) entire document	11

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 November 2014

Date of mailing of the international search report

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