

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **86306344.2**

(51) Int. Cl. 4: **C10J 3/48 , C10J 3/52**

(22) Date of filing: **15.08.86**

(43) Date of publication of application:
24.02.88 Bulletin 88/08

(84) Designated Contracting States:
BE DE FR GB

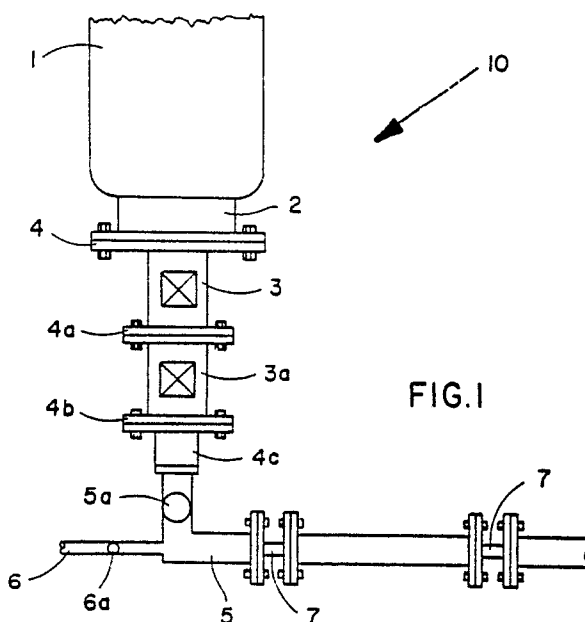
(71) Applicant: **THE DOW CHEMICAL COMPANY**
2030 Dow Center Abbott Road P.O. Box 1967
Midland, MI 48640(US)

(72) Inventor: **Mayes, M. Dale**
228 Rue de la Place
Baton Rouge Louisiana 70810(US)
Inventor: **White, William P.**
15740 Shetland
Greenwell Springs Louisiana 70739(US)
Inventor: **Ruiz, Frank A.**
5112 Chambord Street
Greenwell Springs Louisiana 70739(US)

(74) Representative: **Raynor, John et al**
W.H. Beck, Greener & Co 7 Stone Buildings
Lincoln's Inn
London WC2A 3SZ(GB)

(54) **Slag removal system for a solid fuels gasification reactor.**

(57) The present invention provides an apparatus and a process for removing a slag/water slurry from a pressurized solid fuels gasification reactor. The apparatus includes at least one pressurized crusher connected to the discharge end of the reactor, and a series of flow restriction elements in a conduit connected to the discharge end of the crusher. Water is beneficially mixed at a controlled rate of flow with the slurry discharged from the crusher, thereby cooling the slurry and controlling the flow rate of the slurry stream in the conduit.



SLAG REMOVAL SYSTEM FOR A SOLID FUELS GASIFICATION REACTOR

This invention concerns the gasification of solid carbonaceous materials such as coke, coal, or lignite. More particularly, this invention concerns discharging slag and/or heavy ash from a solid fuels gasification reactor.

As presently well-known in the art, solid fuels such as coke, coal or lignite can be ground to a fine particulate size and mixed with oil or water to form the feed stream for a gasification reactor which is designed to make a useful synthetic gas product. When this type of process is carried out, a large quantity of molten slag that requires disposal is formed in the reactor. Typically, the waste slag or heavy ash generated in a solid fuels gasification process consists of solidified inorganic matter and a small amount of unreacted carbon. Generally, this slag is discharged from the bottom of the reactor at an elevated temperature and pressure in the form of a water slurry. The slurry being discharged may be at a temperature as high as between 150 and 350°F (65 and 177°C) and at a pressure as high as between 100 and 500 pounds per square inch (690 to 3450 kPa). Prior art apparatus and methods generally include crushing the slag to reduce the size of the slag particles, using lockhoppers to reduce the pressure, and flashing the water from the slag in order to further lower the temperature and pressure of the slurry being discharged.

In general, the present invention provides an improved apparatus and process for the continuous, uninterrupted removal of a slag/water slurry from a pressurized solid fuels gasification reactor, the apparatus comprising: at least one pressurized crusher for reducing the particle size of the slag solids, said crusher being connected to the slag discharge end of the reactor, and a depressurizing system which includes a conduit through which the slag/water slurry continuously flows, said conduit being connected to the discharge end of the crusher, and at least one restriction element to restrict the continuous kinetic fluid flow of the slag/water slurry through the conduit, said restriction element being disposed within the conduit and having an opening, the diameter of which is less than that of the conduit, said element causing a reduction in the pressure of the slurry at the discharge end of the depressurizing system to a level substantially below the pressure of the reactor.

The final discharge pressure of the slurry may be essentially atmospheric or either higher or lower than atmospheric if the slurry is transferred to other apparatus. The present apparatus may also include additional crushers and flow restriction elements in a series configuration to further reduce the particle

size of the slag and pressure drop from the reactor. The flow restriction elements provide a restriction to the fluid flow of the slurry in the passageway transporting the slurry from the reactor, thereby causing a pressure drop across the element under continuous kinetic fluid flow conditions.

The present process for discharging a slag/water slurry from a coal gasification reactor includes: first comminuting or crushing the slag solids in the slurry discharged from the reactor to reduce the particle size thereof, said slurry being discharged from the reactor at a pressure substantially equal to the reactor pressure; and passing the slurry through a depressurizing system which includes a conduit through which the slurry flows continuously and at least one restriction element to restrict the continuous kinetic fluid flow of the slurry and thereby reduce the pressure of the slurry at the discharge end of the depressurizing system to a level substantially below that of the pressure of the reactor said restriction element being disposed within the conduit and having an opening the diameter of which is less than that of the conduit. The process may also include additional steps of comminuting or crushing the solids in the slurry, and restricting the fluid flow of the slurry, to further reduce the size of the slag and lower the exit pressure of the slurry from the depressurizing system. The present method further provides for injecting and mixing water with the slurry at a controlled rate of flow after the slag solids have been comminuted, thereby cooling the slurry and providing for variable flow and pressure control of the slurry through the depressurizing system of the reactor.

The present system provides for the continuous flow removal of slag from a pressurized gasification reactor with a reduced risk of plugging as compared to intermittent removal provided by the known lockhopper systems. These and other aspects of the present invention will be apparent to those skilled in the art from the more detailed description which follows.

The advantages of the present invention are even more apparent when taken in conjunction with the accompanying drawings in which like characters of reference designate corresponding material and parts throughout the several views thereof, in which:

Figure 1 is a schematic representation illustrating a slag removal system in a solid fuels gasification process constructed according to the principles of the present invention;

Figure 2 is a cross-sectional view of a specific restriction element of the depressurizing system made according to the present invention;

Figure 3 is a cross-sectional view of another restriction element of the depressurizing system made according to the present invention; and

Figure 4 is a cross-sectional view of still another restriction element of the depressurizing system made according to the present invention.

The following description illustrates the manner in which the principles of the present invention are applied, but such description is not to be construed as limiting the scope of the invention.

More specifically, a slag removal apparatus 10 is illustrated by Figure 1 for comminuting, cooling, and depressurizing the slag/water slurry from the bottom of a coal-gasification reactor 1. The waste discharge from reactor 1 comprises a solid residue which can be characterized as either a solidified inorganic residue or heavy ash. The slag discharge is combined with water in reactor 1 to form a slurry. The reactor 1 is operated under conditions of temperature, pressure, and concentrations generally well-known and practiced in the art for converting coke, lignite, or coal into gaseous fuel. The temperature at the discharge end of the reactor 1 is between 150 and 350°F (65 and 177°C) and the pressure is between 100 and 500 pounds per square inch (690 and 3450 kPa). Preferably, the reactor 1 is operated continuously; and the comminution, cooling, and depressurization of the reactor slag/water slurry are carried out as a continuous process.

The slag/water slurry is discharged from the reactor 1 through a first conduit 2 to a primary crusher 3. The crusher 3 is provided with a housing capable of withstanding the full pressure at the discharge end of the reactor 1. The conduit 2 and crusher 3 are connected together by flanges 4.

The partially comminuted slag from the primary crusher 3 is discharged to a secondary crusher 3a, where the slag is further comminuted. The crusher 3a is also provided with a housing which, like the housing for the primary crusher 3, is capable of withstanding the full operating pressure at the discharge end of the reactor 1. Crushers 3 and 3a are connected together by flanges 4a.

The comminuted slag is then discharged as a slurry from the secondary crusher 3a to a second conduit 5. The conduit 5 is connected to the crusher 3a by flanges 4b and 4c. Flow through the conduit 5 may be controlled by a first valve 5a. Downstream of the valve 5a, water is introduced into conduit 5 from conduit 6 through valve 6a. The slag/water slurry then passes through a series of restriction elements 7 in the conduit 5. Valves 5a and 6a regulate and control the flow rate of the water and of the slag/water slurry. As the stream

continuously flows through conduit 5, there is a drop in pressure caused by the resistance to flow imposed by each restriction element 7. The slurry stream may then be discharged from the last restriction element 7 at substantially atmospheric pressure.

The addition of water through conduit 6 and the provision of the restriction elements 7 in conduit 5 beneficially eliminate the necessity for flashing the water from the slurry to reduce the temperature and pressure of the slurry stream after it exits from the depressurizing system. Moreover, the use of the valve 6a to control the flow rate of the water added to the slag stream overcomes the need for providing a downstream valve in conduit 5 to control the slurry flow rate. Since the rate of mechanical wear in such a valve would be much higher due to the abrasive characteristics of the slurry as compared to the wear caused only by water, this method of injecting water into the slurry to provide flow control is highly beneficial, economical, and advantageous. The introduction of water into conduit 5 also provides both a positive safety and most beneficial means of preventing plugging of conduit 5 with the slag.

A preferred restriction element 20 of a modified design which has been successfully used in conduit 5 is shown in Figure 2. As shown in Figure 2, element 20 is similar to the reduced diameter pipe element 7 shown in Figure 1, in that element 20 includes a wear-resistant plate 8 through which a reduced diameter orifice 8a is provided for restricting the flow of the slag/water slurry. The plate is held in position by flanges 4d in conduit 5. The plate 8 may also be formed as a laminated structure in which the up-stream layer is a highly abrasion-resistant material such as silicon carbide, tungsten carbide, alumina, or wear-resistant metal or ceramic material. Although not shown, an abrasion-resistant liner for conduit 5 may also be provided if the conduit is not directly formed of an abrasion-resistant material.

Two additional restriction elements 30 and 40 which have been successfully used in conduit 5 are shown in Figures 3 and 4. Figure 3 illustrates a restriction element 30 which includes a frustraconical support 9 which is held in place by flanges 4e in conduit 5, and which in turn holds a wear-resistant cone-shaped liner 9a with an orifice 9b in place to receive the slag/water slurry. Conduit 5 on both sides of element 30 also has a wear-resistant liner insert 11. Figure 4 illustrates still another useful restriction element 40 which includes a restriction plug 12 with an orifice 12a held in place by a wear-resistant liner insert 13 in conduit 5. The restriction element 40 is further held in place by an

obstruction, not shown, in a down-stream flange of conduit 5. Plug 12 is beneficially molded in one piece from a hard abrasion-resistant ceramic material such as alumina.

The restricted opening or orifices of all the above restriction elements may be formed with any desired cross-sectional shape. For example, an orifice having a round, oval, square, triangular or rectangular shape may be used successfully in conduit 5. The most beneficial shape is a round cross-section with the orifice having a relative diameter of ten to thirty percent of the diameter of the conduit in which it is disposed. The size of orifices of different shapes should be selected to provide about the same relative orifice to conduit size ratio. The materials of construction for the slag removal apparatus 10 may be selected from known materials that will stand up under the temperatures and pressures previously noted, with the preferred material being carbon steel. Also in areas where severe mechanical wear is expected from the slag/water slurry, the high wear-resistant materials noted above should be used.

The primary and secondary crushers 3 and 3a are beneficially rotary crushers which include rotor plates and breaker plates, not shown. Such crushers are well-known in the art. Preferably, the slag is comminuted in the primary crusher 3 to a maximum dimension of about two and one-half inches (63.5 mm), and in the secondary crusher 3a to a dimension of between one-eighth of an inch and one inch (3.2 and 25 mm).

The present combination of slag crushers, restriction elements and means for introducing water at or down-stream from the crushers provides a continuous, reliable, controllable apparatus for removal of slag from a solid fuels gasification reactor which has a far less tendency to be plugged by slag than other known slag removal systems.

While certain representative embodiments and details have been shown for the purpose of illustrating the present invention, it will be apparent to those skilled in the art that various changes and modifications can be made therein without departing from spirit and scope of the invention.

Claims

1. An apparatus for the continuous, removal of a slag/water slurry from a pressurized solid fuels gasification reactor, the apparatus comprising: at least one pressurized crusher for reducing the particle size of the slag solids, the crusher being connected to the slag discharge end of the reactor, and a depressurizing system which includes a conduit through which the slag/water slurry continuously flows, conduit being connected to the di-

schARGE end of the crusher, and at least one restriction element to restrict the continuous kinetic fluid flow of the slag/water slurry through the conduit, said restriction element being disposed in the conduit and having an opening, the diameter of which is less than that of the conduit, said element causing a reduction in the pressure of the slurry at the discharge end of the depressurizing system to a level substantially below the pressure of the reactor.

2. The apparatus of Claim 1 wherein two pressurized crushers are present, comprising

a primary crusher for reducing the particle size of the slag solids, connected to the slag discharge end of the reactor,

a secondary crusher for further reducing the particle size of the slag solids, said secondary crusher being connected to the discharge and of the primary crusher,

a depressurizing system which includes a conduit through which the slag/water slurry continuously flows, said conduit being connected to the discharge end of the secondary crusher, and

a restriction element as defined in Claim 1.

3. The apparatus of Claim 1 or 2, including means for injecting and mixing water with the slurry after the particle size of slag solids has been reduced by the crusher.

4. The apparatus of Claim 3, wherein the means for injecting water into the slurry stream include a valve for controlling the flow rate of the water, thereby cooling the slag/water slurry and providing for variable flow and pressure control thereof through the depressurizing system.

5. The apparatus of any one of the preceding claims, wherein the restriction element has a reduced diameter orifice which restricts the flow of the slurry.

6. The apparatus of any one of Claims 1 to 4, wherein the restriction element includes a restriction plug with a orifice, said plug being held in place by a liner insert in the conduit.

7. The apparatus of Claim 5 or 6, wherein the orifice has a diameter of from 10 to 30 percent of the diameter of the conduit in which the restriction element is disposed.

8. A process for the continuous, removal of a slag/water slurry from a pressurized solid fuels gasification reactor, which process comprises the steps of:

(a) comminuting the slag solids in the slurry discharged from the reactor to reduce the particle size thereof, said slurry being discharged from the reactor at a pressure substantially equal to the reactor pressure; and

(b) passing the slurry through a depressurizing system which includes a conduit through which the slurry flows continuously and at least one re-

striction element to restrict the continuous kinetic fluid flow of the slurry and thereby reduce the pressure of the slurry at the discharge end of the depressurizing system to a level substantially below the pressure of the reactor, said restriction element being disposed within the conduit and having an opening the diameter of which is less than that of the conduit.

5

9. The process of Claim 8, further comprising injecting and mixing water with the slurry after the particle size of the slag solids has been reduced by comminution in order to cool the slurry and provide for variable flow and pressure control thereof through the depressurizing system.

10

15

20

25

30

35

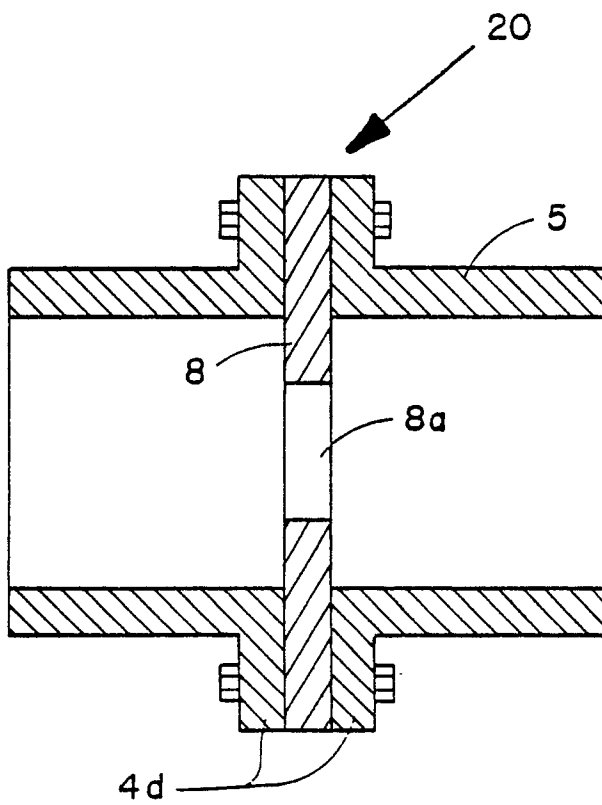
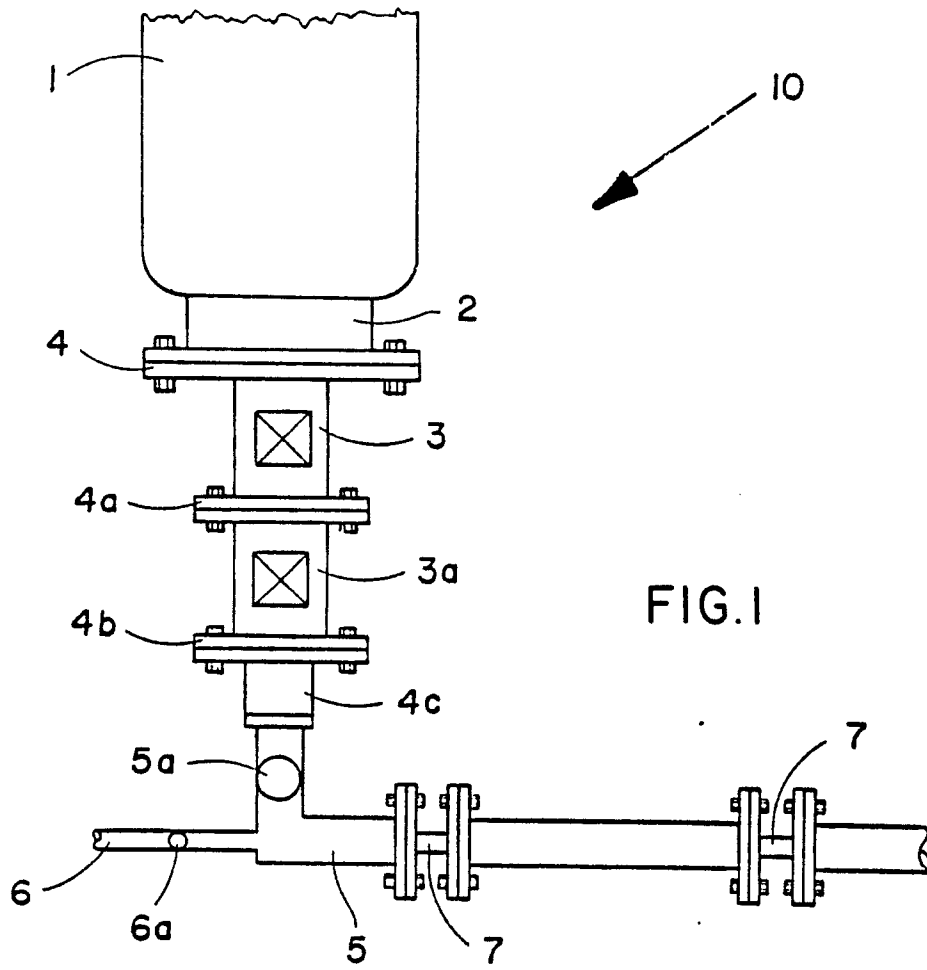
40

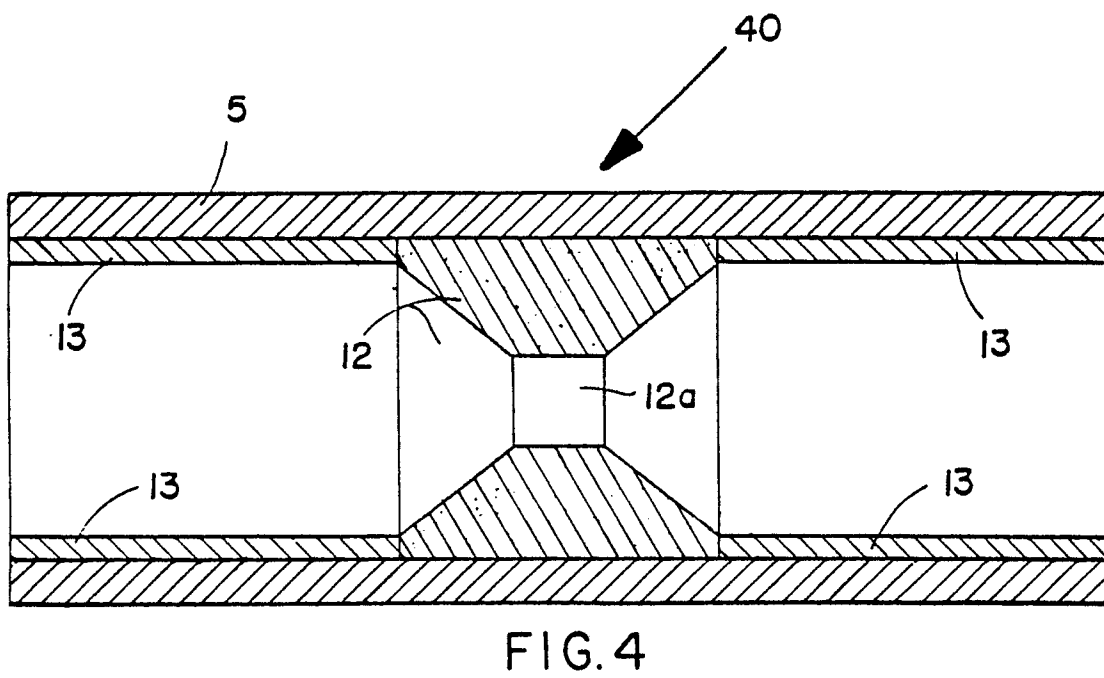
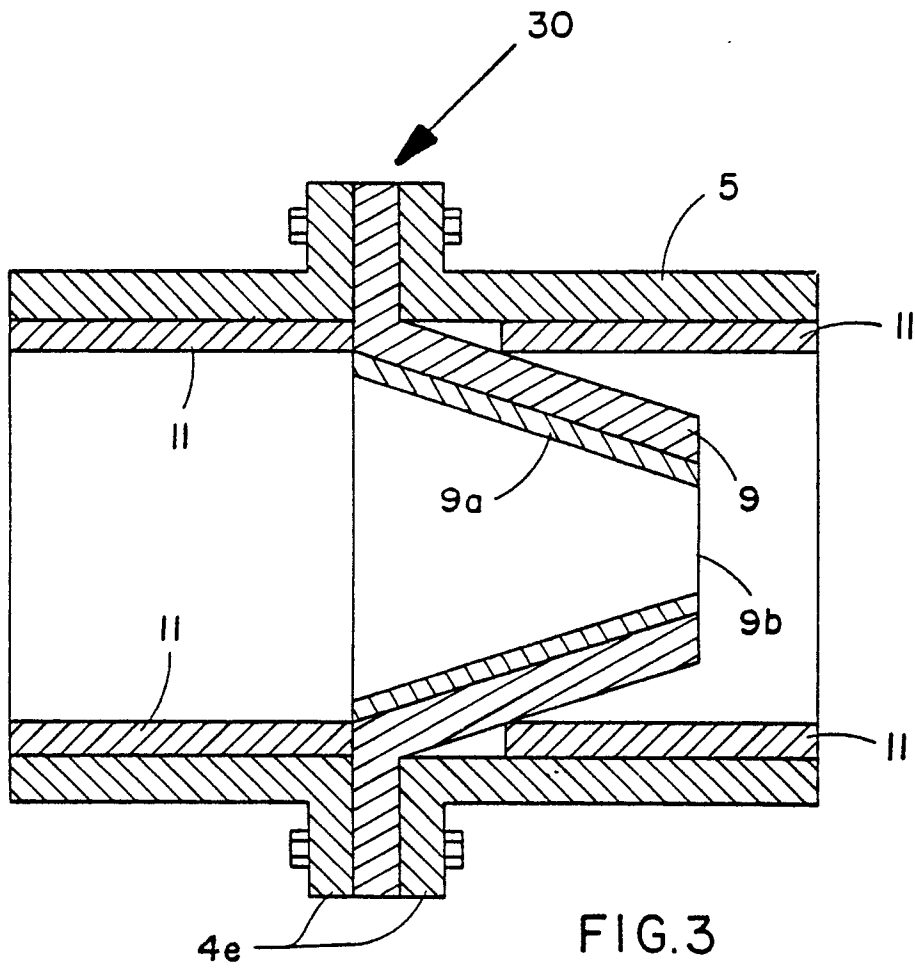
45

50

55

5







EP 86 30 6344

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
A	US-A-4 472 171 (BRODERICK) * Columns 5,6, claims *	1,8	C 10 J 3/48 C 10 J 3/52
A	GB-A- 801 103 (KOHLENSCHIEDUNGS GmbH) * Page 3, line 119 - page 4, line 22 *	3,4	
A	FR-A-2 264 859 (THE LUMMUS CO.) * Pages 8,9 *	1,8	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			C 10 J B 01 J F 23 J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 02-03-1987	Examiner WENDLING J.P.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	