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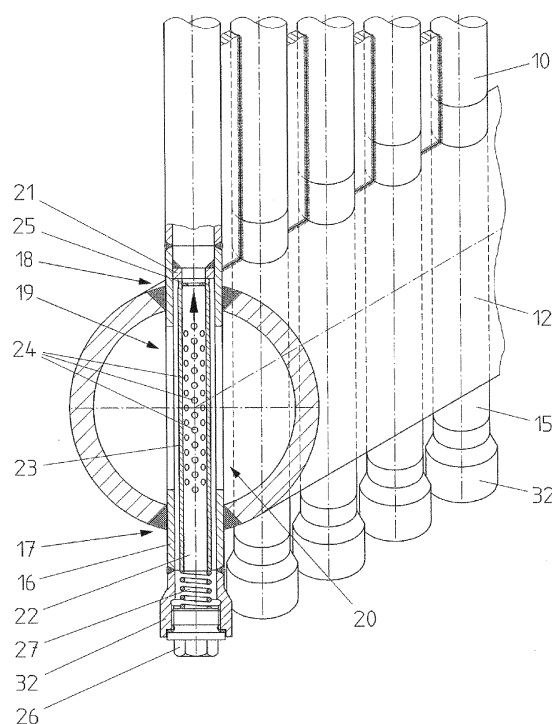
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(54) **Method of assembly of gasification reactor**

(57) Method of assembly of a carbonaceous feed-stock gasification reactor comprising a gasifier unit confined by a tubular burner wall, the burner wall comprising a tubular wall assembly comprising a plurality of tubular conduits through which a flow path extends between a distributor and a header, each flow path crossing a passage opening in a seat for a flow restrictor wherein for each conduit, the wall assembly comprises an opening bordered by a collar wherein the open end of the collar is closed by a cap and wherein the wall assembly is arranged within the pressure vessel without the flow restrictors and subsequently the distributor, the conduits and the header are flushed and/or boiled out and the caps removed from the collars, the flow restrictors positioned and the caps put back to close off the open ended collars.

FIG. 2



Description

[0001] The present invention relates to a tubular wall assembly comprising a plurality of tubular conduits in parallel arrangement interconnected to form a gastight structure, each tubular conduit being connected on one end to a common distributor and on another end to a common header, wherein through each conduit a flow path extends between the distributor and the header. The invention also relates to an insertable flow restrictor for such a wall assembly and to a gasification reactor comprising such a wall assembly for the partial combustion of a carbonaceous feed, to a method of assembling such a reactor and to a method of operating such a reactor.

[0002] Such wall assemblies are particularly used as a wall for a burner unit in a gasifier for the production of synthetic gas or syngas by partial combustion of a carbonaceous feed, such as pulverized coal. An example of such a wall assembly is disclosed in GB 1 501 284 and WO 2008/110592. During the gasification process, water flows from the distributor into the parallel tubes and leaves the tubes as a mixture of water and steam when it flows into the header. This way, heat evolved in the gasification process is partly recovered in the gasification zone itself. For a safe cooling an even distribution of the cooling water over the parallel tubes is required.

[0003] In some types of steam generating heat exchangers, such as disclosed in US 1,988,659 and JP 60-152803, the water distribution is improved by using strainer tubes having one end provided with an orifice. The end with the orifice is inserted into an opening in the distributor line facing the inlet opening of the corresponding tubular line. After inserting the strainer tube, it is kept in place by a matching pin with a screw head forming a threaded connection with a threaded portion of the opening in the distributor wall. This solution can only be used if the tubular lines are at sufficient distance from each other, since the screw heads are wider than the tubular lines and the openings in the distributor line would seriously weaken the wall of the distributor line. The diameter of the openings in the distributor wall should be large enough to receive the screw threaded part, which is wider than the diameter of the strainer tube. This larger diameter further weakens the distributor wall.

[0004] It is an object of the invention to provide a gastight tubular wall assembly wherein the cooling water can effectively and evenly be distributed from a distributor over the plurality of interconnected tubular lines over the full life time of the wall assembly.

[0005] The object of the invention is achieved with a tubular wall assembly comprising a plurality of tubular conduits in parallel arrangement interconnected to form a gastight structure, each tubular conduit being connected on one end to a common distributor and on another end to a common header, wherein through each conduit a flow path extends between the distributor and the header,

wherein each flow path passes a passage opening in a seat for an insertable flow restrictor,

wherein for each conduit the wall assembly comprises an opening bordered by a collar with an open end in line with the seat,

wherein the open end of the collar is closed by a cap.

[0006] It has been found that such a collar can reinforce the distributor wall to compensate for the weakening by the openings. The diameter of the openings can be kept as small as the outer diameter of the insertable flow restrictor. As a result, although the collars are at short distance from each other, there is still material of the distributor mantle bridging both halves of the distributor line at either side of the collar. In this way, the tubular conduits of the gastight wall assembly can be arranged with a short pitch as required by the process conditions and in a cost efficient manner.

[0007] The parallel tubular conduits can for example be vertical or they can be helically wound. The conduits are interconnected to form a gastight wall, e.g., as a tube-stay-tube or fin-tube construction. The wall assembly can for example be cylindrical or it can have any other type of tubular geometry, e.g., being square or polygonal or elliptical in plan view.

[0008] The flow restrictors can for instance be provided with a strainer tube having one end provided with a nozzle with an outer surface matching the seat and with an opening or orifice, wherein the strainer tube is provided with a plurality of openings having in total a larger accumulated flow-through capacity than the orifice. The orifice can for example be formed by an inwardly flanging end surface of the nozzle. The strainer tube protects the orifice against plugging by foreign material.

[0009] To obtain a tight fit between the flow restrictor and the seat, the orifice can for example comprise a frusto-conical plug portion while the seat comprises a matching frusto-conical receptacle portion. Alternatively, the orifice can be connected to the seat by a threaded connection.

[0010] Optionally, a tensioned compression spring is arranged between the flow restrictor and the cap to push the flow restrictor against its seat.

[0011] The flow restrictor can be configured to maintain a desired pressure drop in the tubular wall assembly between the distributor and the header. In practice, a pressure drop between 0.15 and 0.75 MPa has been found to be particularly advantageous for the process of steam generation.

[0012] The openings in the wall assembly for insertion of the flow restrictors can for example be arranged in the distributor opposite the proximal end of the corresponding conduit. Alternatively, the openings can be arranged in the wall of the corresponding conduit. In such case, the collar may have a longitudinal axis at an acute angle with the longitudinal axis of the conduit in flow direction.

[0013] The gastight tubular wall assembly is particularly suitable for use as a burner wall in a reactor for gasification of a carbonaceous feedstock. Such a gasifi-

cation reactor comprises a pressure vessel, at least one gasifier unit confined by the tubular burner wall assembly within the pressure vessel, wherein at least one burner is arranged to heat up the interior of the gasifier unit.

[0014] Such a carbonaceous feedstock gasification reactor can for example be built by first arranging the tubular wall assembly within the pressure vessel without the flow restrictors. Subsequently the open ended collars are closed off. After that, the distributor, the conduits and the header are flushed and/or boiled out. Then the caps are removed from the open ended collars, the flow restrictors are positioned, and the caps are put back to close off the open ended collars. Optionally, the caps are welded to the open ended collars.

[0015] The carbonaceous feedstock gasification reactor can for example be operated by providing water via the distributor to the tubular conduits, where it is heated to form steam. The steam is then discharged from the tubular conduits via the header. With the flow restrictor as described above, it is possible to maintain a pressure drop in the water between the distributor and the header between 0.15 and 0.75 MPa by adjusting its flow-through capacity.

[0016] Exemplary embodiments of the invention will now be described by reference to the accompanying drawing, in which:

Figure 1: shows a gasification reactor with a burner wall assembly according to the present invention;
 Figure 2: shows in detail a flow restrictor and the connection between the distributor and the tubular conduits in the wall assembly of Figure 1;
 Figure 3: shows an alternative arrangement of the connection of Figure 2;
 Figure 4: shows a flow restrictor in an alternative embodiment of the wall assembly according to the present invention.

[0017] Figure 1 shows a reactor for the production of synthetic gas by gasification of a carbonaceous feed. The reactor comprises a vessel 1 encasing a combustion chamber 6 in the upper half of the vessel 1. The vessel 1 is provided with a syngas outlet 7 at the bottom end of the combustion chamber 6 and two pairs of diametrical positioned burners 2. Through this outlet 7 the produced syngas and slag formed as a by-product is discharged from the combustion chamber 6. Each burner 2 is provided with supply conduits for an oxidiser gas 3 and a carbonaceous feed 4.

[0018] The combustion chamber 6 is surrounded by a substantially gas-tight wall assembly 8 made of interconnected parallel vertical tubular conduits 10, e.g., interconnected by fins. Such a wall assembly is also referred to as a membrane wall. The tubular conduits 10 run from a common distributor 12 to a common header 11. The distributor 12 is provided with a series of capped collars 15 opposite the tubular conduits 10. These collars form the entrance for an insertable flow restrictor, for instance

as shown in Figure 2 or Figure 3.

[0019] The distributor 12 is connected to a cooling water supply conduit 14. The header 11 is connected to a steam discharge conduit 13. The steam discharge conduit 13 and the water supply conduit 14 are fluidly connected to a steam drum 29. The steam drum 29 is connected to a supply conduit for fresh water and an outlet conduit for produced steam. A water pump 31 serves to enhance the flow of water from steam drum 29 to the distributor 12. Alternatively, the water flow can be driven by natural convection. In this case, the water pump 31 is replaced by a pipe.

[0020] The burners 2 are directed to fire into the combustion chamber 6 through a burner opening 5 in the wall assembly 8. Between the wall assembly 8 and the wall of vessel 1 is an annular space 9.

[0021] Figure 2 shows in detail the collars 15 on the distributor 12, with one of the collars 15 in cross section. The collar 15 is formed by a pipe section 16 having one end extending through an opening 17 at the lowest point of the cross section of the distributor 12. Opposite to this opening, the pipe 16 has a second end extending through an opening 18 at the highest point of the cross section of the distributor 12. At the openings 17, 18 the pipe 16 is welded to the wall of the distributor 12. Between the openings 17, 18, the pipe 16 is provided with two longitudinal slots 19, 20 at opposite sides. At its end near the opening 18, the pipe 16 is welded to the lower end of one of the tubular conduits 10.

[0022] Near the upper opening 18, the interior of the pipe 16 is provided with a ring shaped rim or shoulder 21 forming a seat for an insertable flow restrictor 22 and confining a passage opening for the flow path of the water flow. The insertable flow restrictor 22 comprises a strainer tube 23 with a plurality of openings 24, and an orifice 25 at its end abutting the seat 21. The total flow-through capacity of the plurality of openings 24 is substantially larger than the flow through capacity of the orifice 25.

[0023] Near the lower opening 17, the pipe 16 comprises a head 32 provided with an internal screw thread. A cap 26 with a correspondingly threaded portion is screwed into the pipe head 32. A compression spring 27 between the flow restrictor 22 and the cap 26 forces the flow restrictor 22 against the seat 21.

[0024] Water flows from the distributor 12 via the slots 19, 20 and the openings 24 into the strainer tube 23 and then via the orifice 25 through the seat 21 into the tubular conduit 10.

[0025] In an alternative embodiment, the pipe 16 may comprise two separate pieces: one being welded to the distributor 12 in opening 17 and one in opening 18. In a further alternative embodiment, the lower opening 17 is not in line with the upper opening 18. In that case, a bent or curved tubular transition piece should lead from the seat 21 to the opening 18 and the tubular conduit 10.

[0026] Figure 3 shows a further alternative embodiment of the present invention. The collar 15 is welded onto the edge of the opening 17 at the outer surface of

the distributor 12. Between the distributor 12 and the tubular conduit 10 is tubular transition piece 36 with a conical seat 28 in its interior. An insertable flow restrictor 22 extends from the collar 15 to the seat 28. The flow restrictor 22 comprises a strainer tube 23 with a plurality of openings 24, and a conical nozzle 30 abutting the seat 28. The nozzle 30 is provided with an orifice 33 confined by an inwardly extending flange at the top end of the nozzle 30. As in figure 2, the total flow-through capacity of the plurality of openings 24 is substantially larger than the flow through capacity of the orifice 33.

[0027] The collar 15 comprises a head 34 provided with an internal screw thread. A cap 35 with a correspondingly threaded portion is screwed into the collar head 34. A compression spring 27 between the flow restrictor 22 and the cap 26 forces the flow restrictor 22 against the conical seat 28.

[0028] Figure 4 shows a further possible embodiment. In this embodiment, the distributor 12 is only provided with openings 18 at its upper side where it opens into the tubular conduits 10. The tubular conduit 10 comprises a Y-shaped transition piece 40 having a first tubular leg 41 in line with the other sections of tubular conduit 10, and a second tubular leg 42 forming a collar which makes an acute angle with the first tubular leg 41. The first leg 41 comprises a lateral opening 51. The collar 42 is connected to the first leg 41 via the lateral opening 51. At its top end the transition piece 40 is operatively connected to a further section of the tubular conduit 10. At this point the transition piece 40 comprises a ring shaped shoulder 43 extending in a plane perpendicular to the longitudinal direction of the second leg 42. The shoulder 43 forms a seat surrounding a passage opening for the flow path of the water.

[0029] An insertable flow restrictor 44 is inserted in the second tubular leg 42 to abut the seat 43. The flow restrictor 44 comprises a strainer tube 45 with a plurality of openings 46, and a conical nozzle 47. The nozzle 47 is provided with an orifice 48 abutting the seat 43. As in figure 2, the total flow-through capacity of the plurality of openings 24 is substantially larger than the flow-through capacity of the orifice 48.

[0030] At its outer end the second tubular leg 42 is capped by a screw cap 49 which is connected to the leg 42 with a threaded connection. A compression spring 50 between the cap 49 and the flow restrictor 44 presses the flow restrictor 44 against its seat 43.

[0031] In use, water flows from the distributor 12 via the opening 18 into the tubular conduit 10. When it passes the Y-shaped transition piece 40, the water swirls via the openings 46 into the strainer tube and the nozzle 47 through the orifice 48 into the subsequent section of the tubular conduit 10.

[0032] In this embodiment, the distributor 12 is not perforated and weakened by a series of openings for insertion of the flow restrictor, but the flow restrictors are inserted into the tubular conduits 10. Optionally, the various collars can be arranged in a staggered manner relative

to each other, which is particularly useful if the tubular conduits 10 are directly interconnected to each other.

[0033] In all embodiments, the orifices restrict the flow-through capacity. As a result, the distribution of water over the various tubular conduits is levelled out and optimized. The orifice of the flow restrictor causes a pressure drop in the tubular conduit. The orifice can be designed to optimize the pressure drop for the steam generation process, e.g., in such a way that the pressure drop between the distributor and the header is between 0.15 and 0.75 MPa. The strainer tubes function as a sieve protecting the orifices from plugging by foreign materials in the water flow. The flow restrictors can be easily taken away for maintenance, repair or replacement. Optionally, the flow restrictors can be placed permanently in the wall assembly 8. In that case, the caps can be welded to the respective collars.

Claims

1. Method of assembly of a carbonaceous feedstock gasification reactor comprising a pressure vessel (1), at least a gasifier unit (6) confined by a tubular burner wall (8) within the pressure vessel, wherein at least one burner (2) is arranged to heat up the interior of the gasifier unit (6) wherein the tubular burner wall comprises a tubular wall assembly (8) comprising a plurality of tubular conduits (10) in parallel arrangement interconnected to form a gastight structure, each tubular conduit (10) being connected on one end to a common distributor (12) and on another end to a common header (11), wherein through each conduit a flow path extends between the distributor and the header, wherein each flow path crosses a passage opening in a seat (21, 28, 43) for an insertable flow restrictor (22, 44), wherein for each conduit the wall assembly comprises an opening (17, 51) bordered by a collar (15, 42) with an open end in line with the seat, wherein the open end of the collar is closed by a cap (26, 35, 49), and wherein the tubular wall assembly (8) is arranged within the pressure vessel (1) without the flow restrictors (12, 44), and wherein subsequently the open ended collars (15, 42) are closed off, and wherein subsequently the distributor, the conduits and the header are flushed and/or boiled out, and wherein subsequently the caps are removed from the open ended collars, the flow restrictors are positioned, and the caps are put back to close off the open ended collars.
2. Method according to claim 1 wherein subsequently the caps (26, 35, 49) are welded to the open ended collars.

FIG. 1

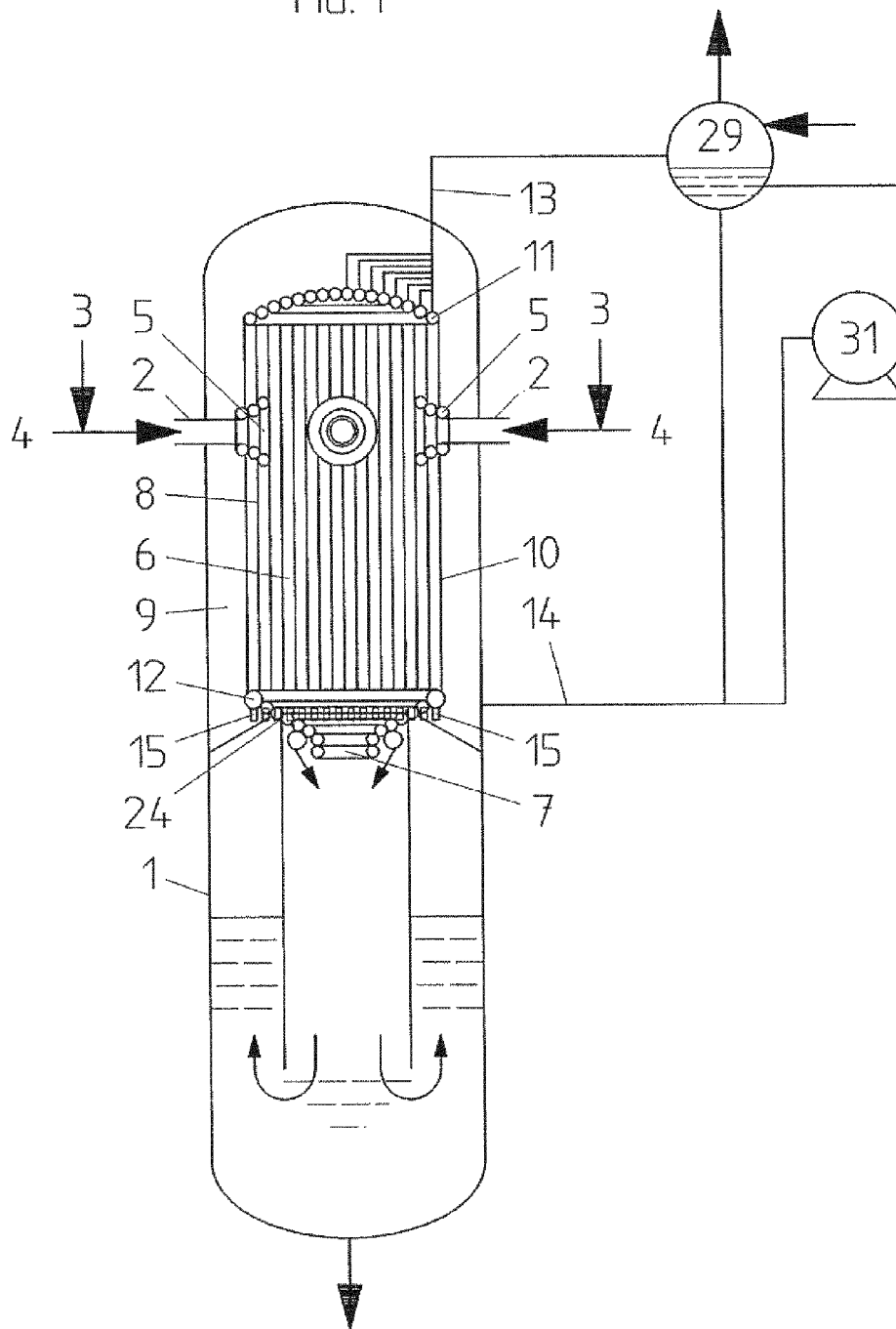
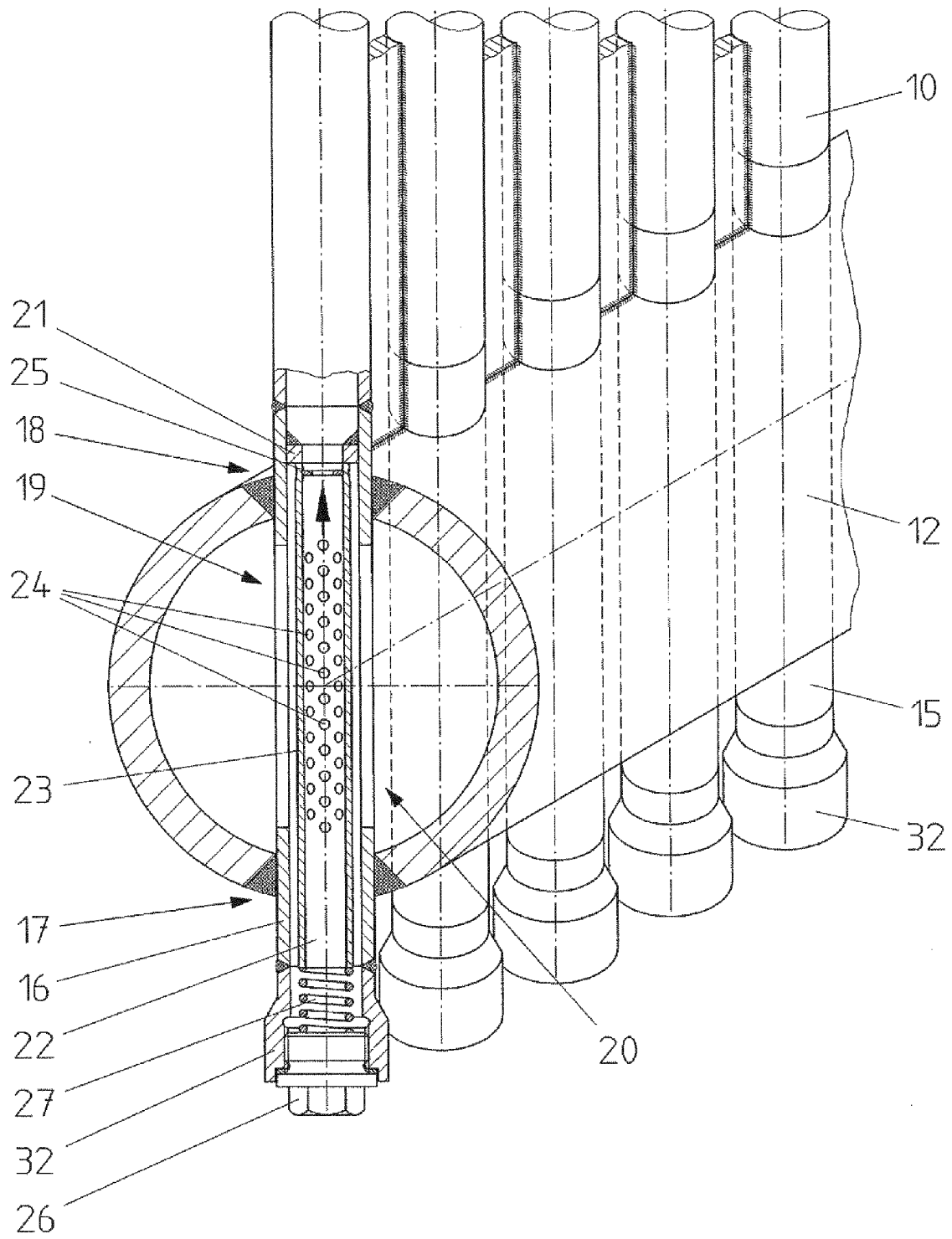
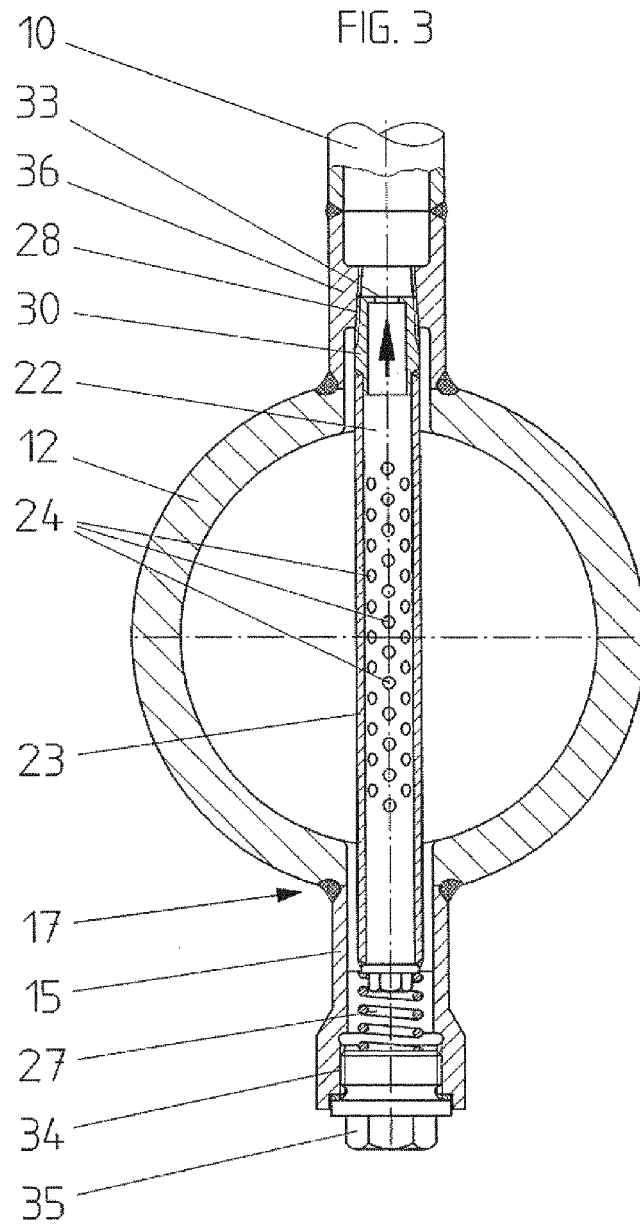
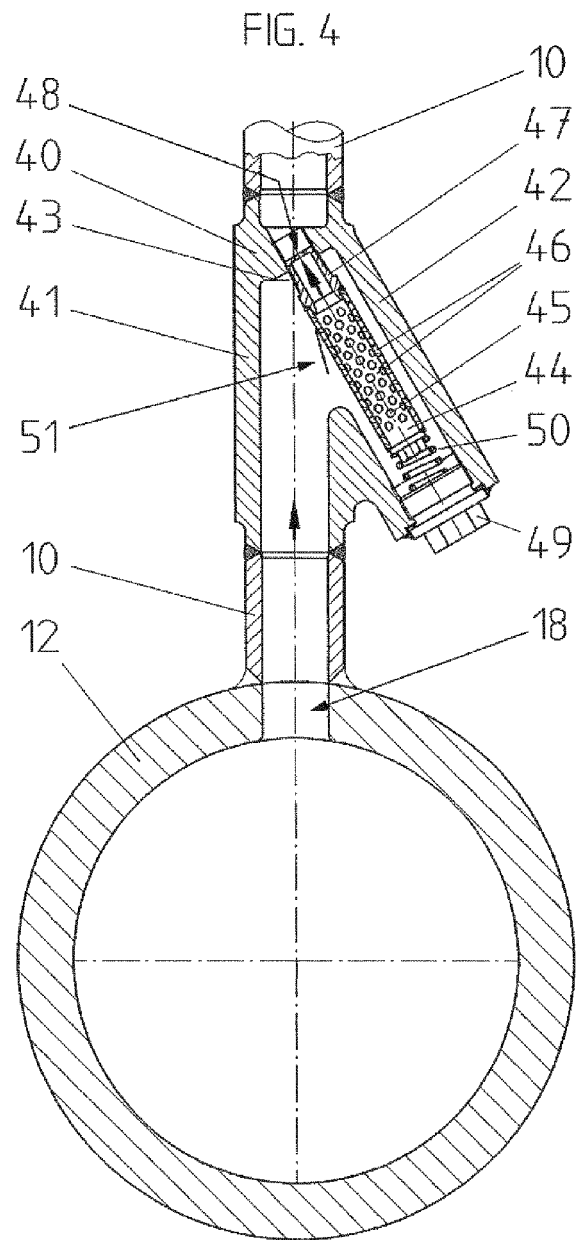


FIG. 2









EUROPEAN SEARCH REPORT

Application Number
EP 13 16 2294

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	WO 2008/110592 A1 (SHELL INT RESEARCH [NL]; JANCKER STEFFEN [DE]; VON KOSSAK-GLOWCZEWSKI) 18 September 2008 (2008-09-18) * figure 1 *	1,2	INV. C10J3/76 F22B29/02 F24H1/40 C10J3/46 F22B21/20 F22B1/18 C10J3/84
A	WO 2008/125556 A1 (SHELL INT RESEARCH [NL]; PLOEG JOHANNES EVERDINUS GERRIT [NL]; SCHEERM) 23 October 2008 (2008-10-23) * figure 1 *	1,2	
A	GB 1 501 284 A (SHELL INT RESEARCH) 15 February 1978 (1978-02-15) * figure 1 *	1,2	
A	US 4 745 943 A (MORTENSEN ERIK M [US]) 24 May 1988 (1988-05-24) * figure 3 *	1,2	
A,D	US 1 988 659 A (LA MONT WALTER DOUGLAS) 22 January 1935 (1935-01-22) * figures 3,4 *	1,2	TECHNICAL FIELDS SEARCHED (IPC) C10J F22B F24H
A	US 2 907 306 A (GEORG STABENOW) 6 October 1959 (1959-10-06) * figures 2,5 *	1,2	
A,D	JP S60 152803 A (SUMITOMO METAL IND) 12 August 1985 (1985-08-12) * figure 2 *	1,2	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 May 2013	Examiner Lachmann, Richard
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			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 16 2294

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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29-05-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008110592 A1	18-09-2008	AU 2008225747 A1	18-09-2008
		CA 2680445 A1	18-09-2008
		CN 101675146 A	17-03-2010
		EP 2126003 A1	02-12-2009
		JP 2010521545 A	24-06-2010
		KR 20090121379 A	25-11-2009
		RU 2009138052 A	20-04-2011
		US 2008222955 A1	18-09-2008
		WO 2008110592 A1	18-09-2008
		ZA 200905995 A	26-05-2010
WO 2008125556 A1	23-10-2008	AU 2008237959 A1	23-10-2008
		CN 101547998 A	30-09-2009
		EP 2134818 A1	23-12-2009
		US 2008262111 A1	23-10-2008
		WO 2008125556 A1	23-10-2008
GB 1501284 A	15-02-1978	AU 8164275 A	02-12-1976
		BE 829733 A1	01-12-1975
		BR 7503392 A	27-04-1976
		CA 1078613 A1	03-06-1980
		CS 181294 B2	31-03-1978
		DD 119266 A5	12-04-1976
		DE 2425962 A1	11-12-1975
		DK 237875 A	01-12-1975
		FR 2273232 A1	26-12-1975
		GB 1501284 A	15-02-1978
		IE 42149 B1	18-06-1980
		IN 143291 A1	29-10-1977
		IT 1037718 B	20-11-1979
		JP S515302 A	17-01-1976
		JP S5817519 B2	07-04-1983
		LU 72613 A1	08-10-1975
		NL 7505661 A	02-12-1975
		SU 839442 A3	15-06-1981
		ZA 7502996 A	28-04-1976
US 4745943 A	24-05-1988	CA 1288022 C	27-08-1991
		US 4745943 A	24-05-1988
US 1988659 A	22-01-1935	NONE	
US 2907306 A	06-10-1959	NONE	
JP S60152803 A	12-08-1985	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 1501284 A [0002]
- WO 2008110592 A [0002]
- US 1988659 A [0003]
- JP 60152803 A [0003]