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(54) **Desuperheater**

(57) The present invention is related to a desuperheater in a steam generator, for producing spraywater in a steam pipe (1), comprising a control valve (2) connected to a water-conveying means (6) terminated by an injection nozzle (7) located at an injection point (3) within the steam pipe (1), characterized in that said water-conveying means (6) is made of at least one metal duct not fixed at its nozzle end and free from bulky metal parts.

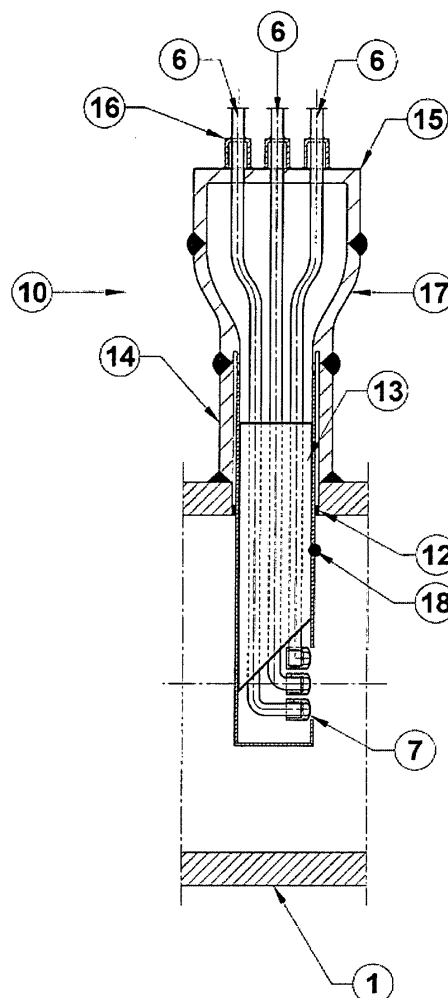


FIG. 3

Description

Field of the invention

[0001] The present invention is related to an improved design for a desuperheater nozzle head in the field of steam generators and particularly heat recovery steam generators (HRSG).

[0002] However the invention is applicable to any high temperature boiler application implying a final or intermediary desuperheater unit.

Technological background and prior art

[0003] In a combined cycle power plant, the flow of hot gases coming out of the gas turbine is cooled down by water or steam circulating in or passing through the steam recovery cycle. In a typical cycle having an unique pressure level, water enters the exchanger in the liquid phase at low temperature. It is then heated up in an economizer, then vaporized at constant temperature in an evaporator and at last superheated before to be directed to a steam turbine.

[0004] In some of prior art cycles, the temperature of the steam provided by the superheater is too high to safely enter the turbine.

[0005] A desuperheater, also called attemperator, is thus an equipment that allows the cooling-down of the steam in boiler applications, by means of the injection of a cooling medium, cold or lukewarm water in the present case. The cooling medium shall have a higher pressure to permit its injection, and in this particular case, the atomization of the water.

[0006] According to prior art, a desuperheater basically comprises a water pipe fed by a valve and terminated with a head equipped with a number of nozzles having a particular design. The design may be foreseen so that the control valve is integrated to the piping or dissociated, i.e. located away from it. In a typical dissociated design, a piston is actuated in a cylinder, resulting in the opening of a controlled number of water injection ports at the valve level. As represented in FIG.1, a typical desuperheater head 10 goes through the wall of the steam flow line and is connected to it by a cylindrical stub 14, said head comprising a bulky cylindrical metal tube (of typical outer diameter 75 mm), with a number of ducts machined in it, said ducts being ended with a series of machined longitudinally disposed nozzles 7 and intended to be placed in such a way as to perform the water injection in the direction of the steam (see for example NL 194 346 C).

[0007] The atomization of cold water transforms incoming pressurized water in a mist of saturated vapour so that a perfect mixing of the two fluids occurs, heat being transferred from water to vapour and inversely.

[0008] Desuperheater heads of prior art suffer from a number of drawbacks. In cycles where no desuperheating is needed, for some operative modes, there is no water flow in the head which may be maintained at a

temperature of more than 550°C. However, when the desuperheater is in use, the head circulates "cold" water at a temperature of 100-280°C. This huge temperature difference can lead to a thermal shock with cracks possibly occurring on the injection head, either longitudinally, or on the circumference or at the nozzle welds.

[0009] This risk of cracking is unacceptable. On the one side, there is a corollary risk that metal parts loose themselves from the head, further move in the steam pipes and deteriorate the turbine. On the other side, the installation cannot usually be demounted and repaired.

[0010] Another known drawback in the case of probe-style equipment is that the latter may be subject to flow-induced vibrations, according to its length and diameter.

[0011] Some improvements have been imagined to overcome these drawbacks (see for example JP 2005273952 A). In this case, as it will also be the case in the present patent application, the removing of metal bulk reduces heat storage. The above-mentioned bulky metal head has been replaced by a multiplicity of independent tubes of small diameter, each terminated by a nozzle. The foreseen design however relates to conventional boilers, and asks for a double fixing of the pipes at the nozzle locations as well as to a bulky distributor member, loops of flexibility provided in the pipes, as well as a cooling medium circulation in order to match the thermal stresses induced whilst injecting the cooling fluid.

Aims of the invention

[0012] The present invention aims to provide a solution to the drawbacks of prior art.

[0013] Moreover the invention aims at proposing a desuperheater head designed to prevent the problem of inevitable thermal expansion constraints.

[0014] Particularly the invention aims at proposing a desuperheater head designed so as to rapidly and uniformly dissipate the thermal shock inherent to the temperature difference between water and metal, when hot.

[0015] The invention pursues also the goal of preventing an accidental runaway of detached nozzle head parts to the steam pipe and further possible damage to the turbine.

Summary of the invention

[0016] The present invention relates to a desuperheater used in a steam generator, particularly in a heat recovery steam generator (HRSG), for producing spraywater in a steam pipe, comprising a control valve connected to a water-conveying means terminated by an injection nozzle located at an injection point within the steam pipe, characterized in that said water-conveying means is made of at least one metal duct not fixed at its nozzle end and free from bulky metal parts.

[0017] According to a preferred embodiment of the invention, said water-conveying means comprises one or more thin metal tubes which, at the nozzle side, are en-

closed in an injection head connected to the steam pipe external wall only by the intermediary of a pipe stub fixed on said external wall.

[0018] According to a still preferred embodiment of the invention, said injection head respectively comprises a top cap and a stub connector connected to the pipe stub at a remote place from the steam pipe.

[0019] Advantageously the desuperheater of the invention comprises a tube support made of a massive bulky part, configured to offer, during operation, sufficient backward reaction force opposite to the water ejection force.

[0020] Preferably, the injection head further comprises a skirt making an external envelope to the tubes up to their end in the steam pipe.

[0021] According to a preferred embodiment, the skirt is exclusively connected to the stub connector, without any connection to the metal tubes, especially at their nozzle end.

[0022] Preferably, the stub connector, the top cap and the skirt are made of thin metal sheet.

[0023] Still according to the invention, the stub connector and the top cap are configured to be pressure and temperature-resistant.

[0024] According to a still preferred embodiment, the diameter of the top cap is chosen large enough to accommodate thermal sleeves located externally on each tube at the place where the tube goes through the top cap.

[0025] Advantageously, the top cap, the stub connector, the pipe stub, the skirt and the massive bulky part are essentially revolution parts.

[0026] Still according to the invention, the massive bulky part is longitudinally machined so that to ensure passage and sliding of the tubes within it.

[0027] In a particularly preferred embodiment of the invention, the skirt is configured so that no detached parts of the injection head can accidentally fall within the steam pipe.

[0028] Advantageously, a guiding device is intercalated in between the skirt and the pipe and/or the stub.

[0029] Preferably, water injection is axial about the steam pipe, i.e. in the direction of the steam flow.

[0030] Still preferably, all connections are welds.

[0031] Advantageously, the injection nozzles can be of different shape, size and/or orientation.

Short description of the drawings

[0032] FIG. 1, as already mentioned above, represents an example of desuperheater bulky nozzle head according to

prior art.

[0033] FIG. 2A schematically represents a dissociated desuperheater installation according to prior art.

[0034] FIG. 2B schematically represents an embodiment for a valve body of a desuperheater according to

prior art.

[0035] FIG. 2C schematically represents an embodiment for a nozzle assembly in a desuperheater according to prior art.

[0036] FIG. 3 represents a preferred embodiment for a desuperheater nozzle head according to the present invention.

Description of an embodiment of prior art

[0037] In a typical prior art desuperheater installation example, as shown schematically on FIG. 2A, there is a dissociation between the control valve 2 determining the water flow to be injected and the piping and injection point 3 on the steam flow line 1, which is located away from said valve. Thus the control valve 2 remains at water temperature. The pipe(s) connect(s) the valve outlet(s) to an injection head welded or flanged to the piping.

[0038] For example, according to a known embodiment, the bottom part of the valve body 4 (stem 4A, plug 4B) is drilled in a number of locations 5. A corresponding number of tubes 6, to be determined by the manufacturer according to the characteristic curve of each specific desuperheater, are welded on the external side of the valve body 4, in front of the machined orifices 5 (see FIG. 2B).

[0039] The opening of the valve 2 allows the water to flow through the drilled holes 5 and therefore to feed the tubes 6.

[0040] Injection is performed through a nozzle assembly 7, located inside the steam pipe 1 and schematically shown on FIG. 2C, preferably comprising a swirler 8 to ensure the rotation of water droplets in cooperation with the orifice to permit atomization of water whilst getting out. The injection can either be radial (from the periphery towards the centre) or axial (in the direction of steam) about the steam pipe. Chosen geometry depends on the chosen flow factor kv, which may vary depending on the characteristic curve one ought to reach.

Description of a preferred embodiment of the invention

[0041] According to a preferred embodiment of the present invention, shown on FIG. 3, a series of thin tubes 6 (e.g. 12 mm outer diameter x 1,5 mm thick) are provided to flow water from the valve body 2 to each injection point 3. As such, a nozzle assembly 7 as described above is welded at each tube end.

[0042] Connection of the injection head 10 to the steam piping 1 is performed thanks to a pipe stub 14, which is not considered as being a part of the injection head.

[0043] Injection head 10 as such is made of :

- a top cap 15, whose diameter may be different of the diameter of stub 14, owing to the necessary welding access of thermal sleeves 16 ;
- a series of thermal sleeves 16 which are connectors between each tube 6 and top cap 15, providing some

flexibility to the assembly and ensuring namely that stress levels be lowered during rapid transient phases of injection. There are as many thermal sleeves 16 as there are tubes 6 ;

- a connector 17 between pipe stub 14 and top cap 15 ;
- a part 13, which is the only massive part foreseen within the head 10, which ensures tube support during desuperheater operation, i.e. when water flows through the pipes, thus offering a backward reaction force opposed to the water ejection direction. The massive part 13 is longitudinally machined so that to ensure passage and sliding of the tubes 6 within it. Moreover an additional hole (not shown) may be drilled throughout the massive part 13 in order to remove possible condensation from the cavity made above it by the injection head 10 ;
- a skirt 18, attached to connector 17, which is an envelope to massive part 13. The design of skirt 18 may be configured so that in case of weld crack occurrence between tubes 6 and associated nozzles 7, the latter are not released within the steam piping 1 (not shown) ;
- a guiding device 12 optionally added in the case it would be required to avoid flow-induced vibration. The guiding device will be located in between the skirt 18 and the pipe 1 and/or the stub 14.

[0044] The main advantages of the present invention are the following ones :

- water is flowed within a same, unique and independent tube 6 from the valve 2 to the injection point 3. Its boundaries are unique ;
- parts with symmetry of revolution are used to a maximum extent to minimize non-uniform stress distributions ;
- apart from massive part 13, which is not in direct contact with water, and therefore not directly subject to high thermally-induced stresses, all parts have thin walls and low inertia and thus allow fast temperature variations ;
- disymmetrical welds, if any, are all located outside the high steam temperature environment and are small ;
- skirt 18 is configured so that no foreign or unexpected part may fall within the piping 1. It permits therefore not to much worry in designing the equipment located downstream, such as control valves, or even the turbine.

Claims

1. Desuperheater in a steam generator, for producing spraywater in a steam pipe (1), comprising a control

valve (2) connected to a water-conveying means (6) terminated by an injection nozzle (7) located at an injection point (3) within the steam pipe (1), **characterized in that** said water-conveying means (6) is made of at least one metal duct not fixed at its nozzle end and free from bulky metal parts.

2. Desuperheater according to Claim 1, **characterized in that** said water-conveying means comprises one or more thin metal tubes (6) which, at the nozzle side, are enclosed in an injection head (10) connected to the steam pipe external wall only by the intermediary of a pipe stub (14) fixed on said external wall.
3. Desuperheater according to Claim 2, **characterized in that** said injection head (10) respectively comprises a top cap (15) and a stub connector (17) connected to the pipe stub (14) at a remote place from the steam pipe (1).
4. Desuperheater according to Claim 3, **characterized in that** it comprises a tube support (13) made of a massive bulky part, configured to offer, during operation, sufficient backward reaction force opposite to the water ejection force.
5. Desuperheater according to Claim 4, **characterized in that** the injection head (10) further comprises a skirt (18) making an external envelope to the tubes (6) up to their end in the steam pipe (1).
6. Desuperheater according to Claim 5, **characterized in that** the skirt (18) is exclusively connected to the stub connector (17), without any connection to the metal tubes (6) at their nozzle end.
7. Desuperheater according to anyone of Claims 3 to 6, **characterized in that** the stub connector (17), the top cap (15) and the skirt (18) are made of thin metal sheet.
8. Desuperheater according to Claim 7, **characterized in that** the stub connector (17) and the top cap (15) are configured to be pressure and temperature-resistant.
9. Desuperheater according to Claim 3, **characterized in that** the diameter of the top cap (15) is chosen large enough to accommodate thermal sleeves (16) located externally on each tube (6) at the place where the tube (6) goes through the top cap (15).
10. Desuperheater according to Claim 4, **characterized in that** the top cap (15), the stub connector (17), the pipe stub (14), the skirt (18) and the massive bulky part (13) are essentially revolution parts.
11. Desuperheater according to Claim 9, **characterized**

in that the massive bulky part (13) is longitudinally machined so that to ensure passage and sliding of the tubes (6) within it.

12. Desuperheater according to Claim 5, **characterized in that** the skirt (18) is configured so that no detached parts of the injection head (10) can accidentally fall within the steam pipe (1). 5
13. Desuperheater according to Claim 5, **characterized in that** a guiding device (12) is intercalated in between the skirt (18) and the pipe (1) and/or the stub (14). 10
14. Desuperheater according to anyone of the preceding Claims, **characterized in that** water injection is axial about the steam pipe (1), i.e. in the direction of the steam flow. 15
15. Desuperheater according to anyone of the preceding Claims, **characterized in that** all connections are welds. 20
16. Desuperheater according to anyone of the preceding Claims, **characterized in that** the injection nozzles (7) can be of different shape, size and/or orientation. 25
17. Desuperheater according to anyone of the preceding Claims, **characterized in that** the steam generator is a heat recovery steam generator (HRSG). 30

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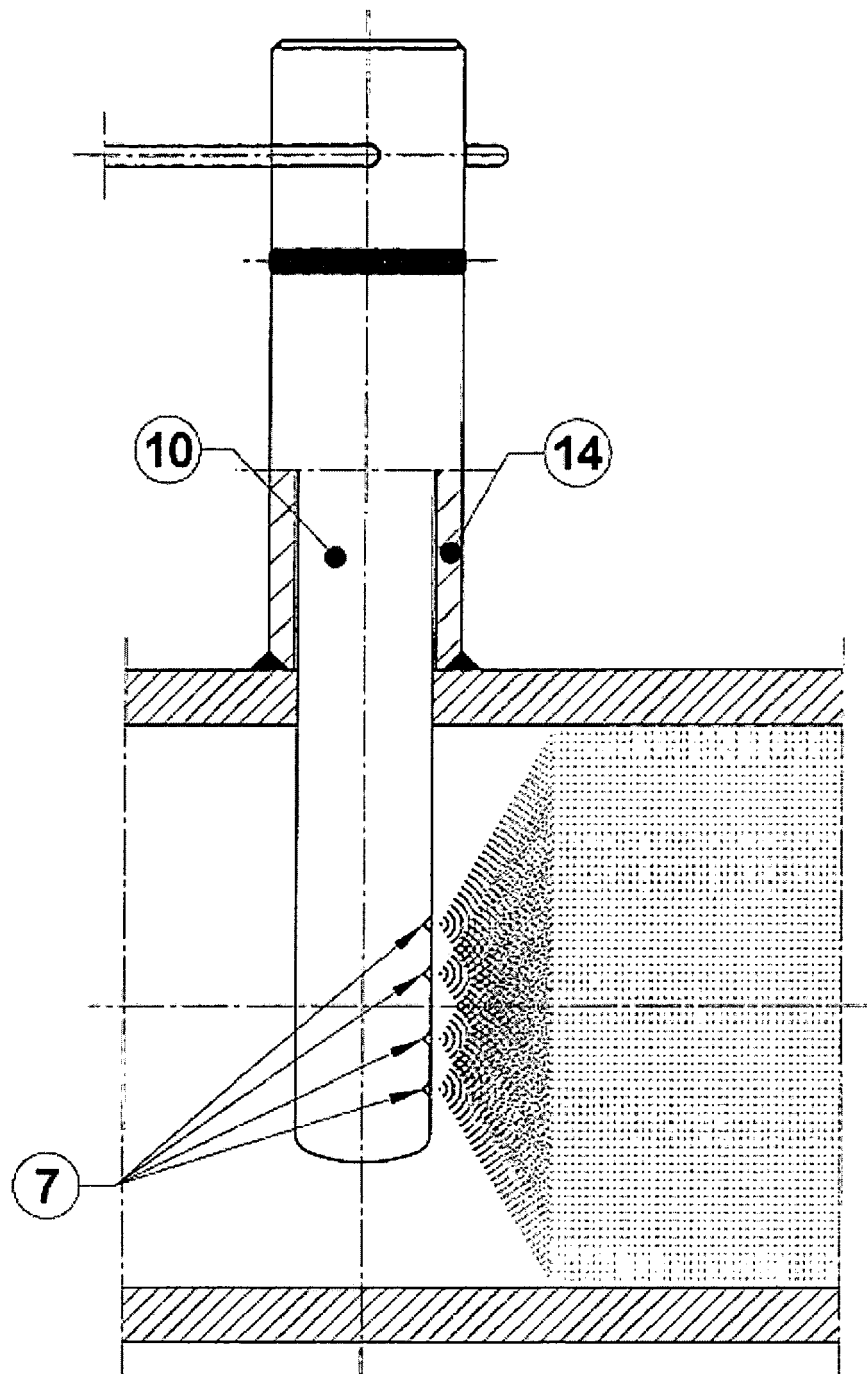


FIG. 1

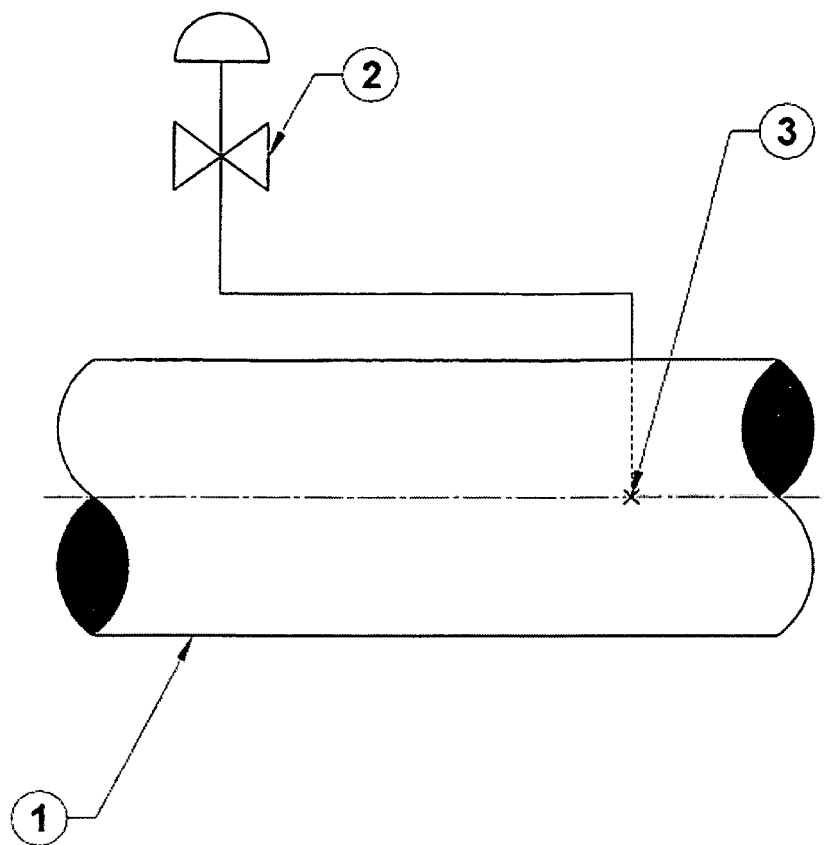


FIG. 2A

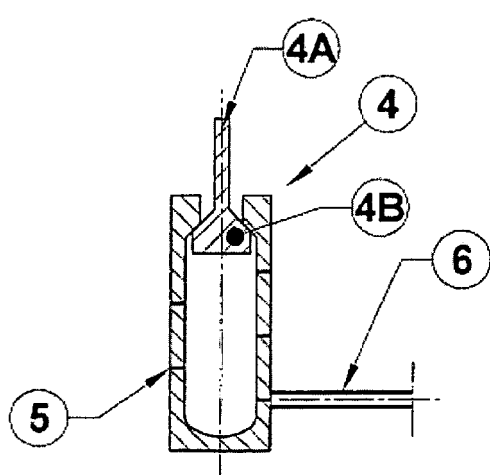


FIG. 2B

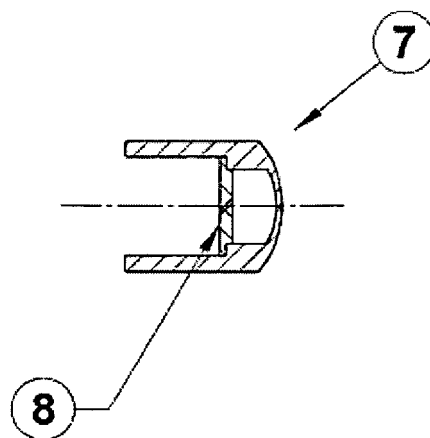


FIG. 2C

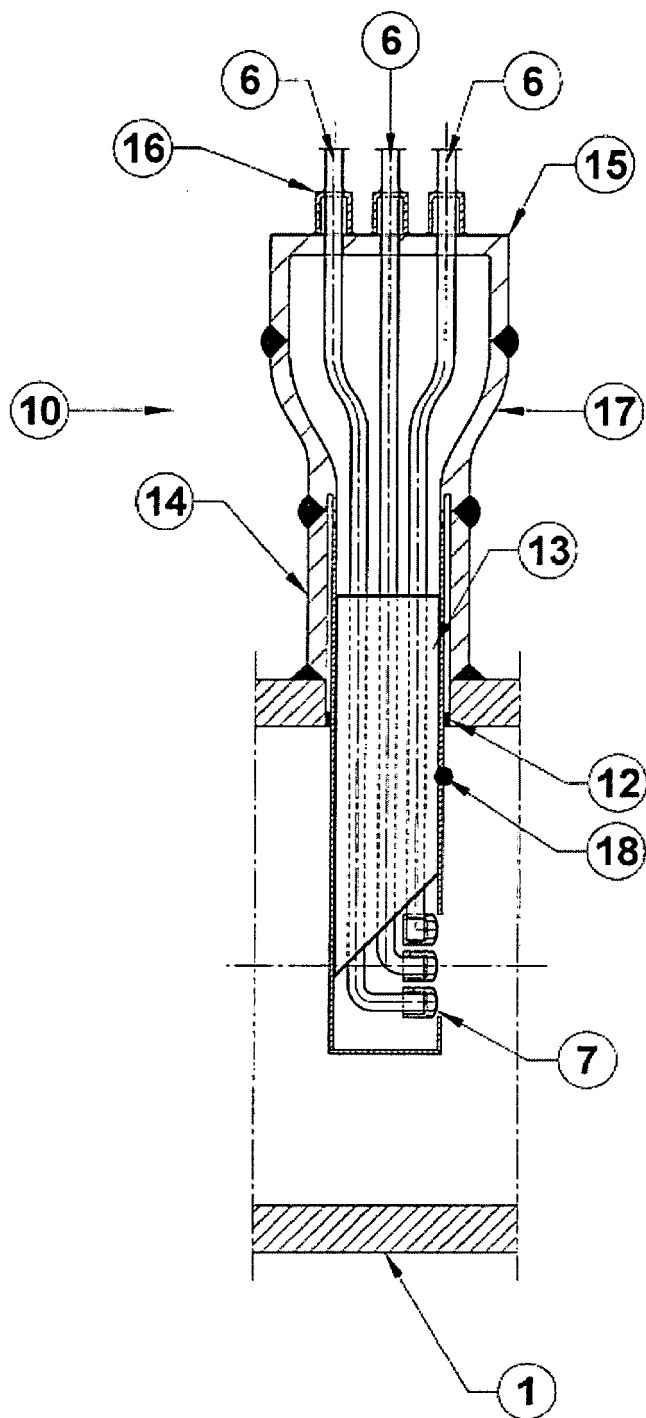


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 3979

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Place of search Munich		Date of completion of the search 22 January 2008	Examiner Lepers, Joachim
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 00 3979

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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