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(54) **Steam pressure reducing and conditioning system**

(57) A steam conditioning system including a steam conditioning valve 1 for depressurizing and desuperheating steam S by supplying moisture W in the conditioning valve. A discharge pipe 3 connected to the steam conditioning valve 1 has a horizontal section 3a, and the horizontal arrangement section 3a is provided with a moisture drain 4 or at a portion near the bottom. Condensed moisture W₁ is extracted from this moisture drain 4 and is recycled as moisture W to be supplied to the steam S in the conditioning valve 1. The steam conditioning valve 1 further has a reduced annular section 9 with a nozzle 5a disposed therein for injecting sub-cooled water mist W. A transport conduit 5 connects the drain 4 to nozzle 5a. Moisture W is drawn into steam flow S due to the Venturi effect caused by the pressure drop through the reduced annular section 9.

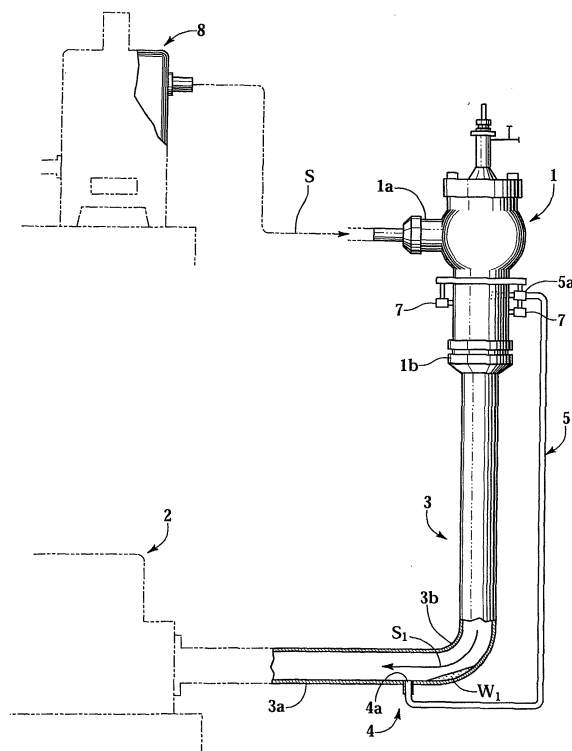


Fig.1

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention concerns a steam pressure reducing and conditioning system.

RELATED APPLICATION

[0002] The present invention includes common subject matter disclosed in U.S. Application Serial No. _____ [to be assigned], entitled Steam Pressure Reducing and Conditioning Valve by the same inventor Hiroyuki Higuchi filed concurrently on _____, under attorney docket number 52643-00351USPT, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0003] Referring to Prior Art Figure 3, it has been known to have a steam pressure reducing and conditioning system comprising a steam source 24 (such as boiler) for generating superheated steam S, a pressure reducing and conditioning valve 21 for depressurizing and desuperheating steam S generated by this steam source 24, and a discharge pipe 23 connected to an outlet of steam pressure reducing and conditioning valve 21, and connected to a steam work section 22, downstream of valve 21.

[0004] As illustrated in Prior Art Figure 3, steam pressure and conditioning valve 21 receives superheated and pressurized steam S inflowing in inlet 21a. Steam S is desuperheated and depressurized by passing steam S valve 21 and injecting subcooled water mist W (not shown) from one or more nozzles 25 in the lower portion of valve 21.

[0005] The desuperheated and depressurized steam S₁, discharged from the valve 21 and the subcooled water mist W injected in valve 21, flow into the discharge pipe 23 and are conveyed to the steam work section 22. A portion of discharge pipe 23 is arranged horizontally 23a. Some of the subcooled water mist W condenses and clings to the discharge pipe at 23a and flows along the bottom of the horizontal section. Steam S₁ flows past these areas of condensation creating temperature differentials in the interior surface of the pipe 23.

[0006] Consequently, the pipe 23 deforms (bends upward) and possibly breaks due to expansion and stress due to the temperature difference in horizontal section of pipe 23, and moreover, the condensed moisture W₁, flowing at the bottom of the pipe 23 is enrolled up by the high speed flow of steam S₁ (jumping phenomenon). The jumping phenomenon erroneous temperature measurements in temperature sensors in the pipe 23 for detecting the heat of the steam S₁.

[0007] It is an object of the present invention to provide a steam pressure reducing and conditioning sys-

tem that can solve the aforementioned problems.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The disclosed invention will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference. A more complete understanding of the present invention may be had by reference to the following Detailed Description when taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a partial side view with schematic elements illustrating the operation of the steam pressure reducing and conditioning system of the present invention;

Fig. 2 is a partial cross-section view illustrating a portion of the pressure reducing and conditioning valve used in the system of the present invention of Figure 1; and

Fig. 3 is a partial side view with schematic elements illustrating the operation of a prior art steam pressure reducing and conditioning system.

SUMMARY OF THE INVENTION

[0009] Reference is now made to the Drawings wherein like reference characters denote like or similar parts throughout the Figures.

[0010] The present invention concerns a steam pressure reducing and conditioning system comprising a steam reducing and conditioning valve 1 for desuperheating and depressurizing superheated steam S by injecting subcooled water mist W in the lower portion of valve 1. A discharge pipe 3 is connected at its proximal end to the exit of valve 1. A steam work section 2 is connected at the distal end of pipe 3. The discharge pipe 3 has a horizontal portion 3a, and said horizontal portion 3a is provided with a moisture drain 4 at the bottom portion or at a portion near the bottom of the horizontal portion 3a of pipe 3. Condensed subcooled water mist ("moisture") W₁ is extracted from discharge pipe 23 by drain 4 and is recycled and reinjected as moisture W to be supplied to the vapor S in said conditioning valve 1. Moisture drain 4 is connected by a moisture transport conduit 5 to the conditioning valve 1.

[0011] The steam conditioning valve 1 further includes a reduced annular section 9 with a nozzle 5a disposed therein for injecting subcooled water mist W into the reduced annular section 9 of conditioning valve 1. Moisture W is drawn into steam flow S due to the Venturi effect caused by the pressure drop through the reduced annular section.

METHOD OF OPERATION

[0012] A superheated steam S is desuperheated by supplying subcooled water mist ("moisture") W to steam conditioning valve 1. The desuperheated steam S₁ flowing out from the conditioning valve 1 and the moisture W used for cooling in discharge valve 1 flows into discharge pipe 3, and is introduced in the steam work section 2 connected to the downstream area of the discharge pipe 3.

[0013] In the present invention, when the moisture W discharged from the conditioning valve 1 flows through the horizontal section 3a of the discharge pipe 3, the condensed moisture W₁ is drained from a moisture drain 4 disposed at the bottom portion 3a of this pipe 3, and the moisture W₁ extracted from the moisture drain 4 is recycled as part of moisture W to be supplied to the steam S in the steam conditioning valve 1.

[0014] Consequently, moisture W₁ can be removed from the horizontal section 3a of the pipe 3, preventing the moisture W₁ from stagnating at the bottom of the pipe, solving the aforementioned problem of the prior art discussed in the background section, and further, the recycling of moisture W₁ used for cooling the vapor S again in the conditioning valve 1 saves energy.

DETAILED DESCRIPTION

[0015] The attached drawings show an embodiment of the present invention, which will be described below.

[0016] This embodiment of the present invention comprises, as shown in Figs. 1 and 2, a steam desuperheating and conditioning valve 1 wherein a superheated and pressurized steam S generated in a steam generation source 8 (for instance, boiler) flows into a first port 1a of conditioning valve 1. Steam S is desuperheated and depressurized by passing through a small hole section 6 (diffuser) having scattered small holes 6a, and the steam S₁ is discharged from a second port 1b of conditioning valve 1. Steam S₁ is desuperheated by injecting a subcooled water mist "moisture" W from one or more nozzles 7. A discharge pipe 3 is connected at its proximal end to the exit of conditioning valve 1, and at its distal end to a steam work section 2 (for instance, condenser for a nuclear reactor).

[0017] Also, in this embodiment, the discharge pipe 3 is provided with a horizontal section 3a extending from the conditioning valve 1 and disposed horizontally with an elbow section 3b (bent section). The discharge pipe 3 is so composed that the condensed moisture W₁ flowing in this horizontal section 3a is part of the moisture W to be supplied to the vapor S in the conditioning valve 1.

[0018] To be more specific, as shown in Fig. 1, said discharge pipe 3 is provided with a moisture drain 4 having a drain hole 4a at or near the bottom portion of the horizontal section 3a, said moisture drain 4 is provided with a moisture transport conduit 5 for conveying mois-

ture W₁ extracted from the moisture drain 4 to the vapor cooler 1.

[0019] This moisture transport conduit 5 is a tubular element having a predetermined diameter, and connected to a reduced annular area 9 constituting a predetermined area of the conditioning valve 1, where a steam S₁ flowing in the conduit will flow faster than the steam flowing in the larger diameter discharge pipe 3.

[0020] Referring to Figure 2, an annular reduced diameter section 9 is disposed in the lower portion of conditioning valve 1 at a position near the jet nozzle 7 of the conditioning valve 1. A nozzle 5a of the moisture conduit 5 exits into this reduced diameter section 9, and it is so configured that the moisture W₁ in the moisture conduit 5 is injected into depressurized steam S₁ path, in this reduced diameter section 9.

[0021] This reduced diameter section 9 obtains improved cooling effect by maintaining the steam S₁ flow rate immediately passing through the reduced diameter section 9 faster than the vapor S₁ passing through the discharge pipe 3, thereby reducing the pressure at the position of the reduced diameter section 9 below the pressure in the discharge pipe 3. This pressure drop in a reduced diameter section 9 is due to the increased velocity of a constant flow volume. Such an effect is well known in the art and is referred to as a Venturi effect. Consequently, this embodiment of the present invention allows return of the moisture W₁ from the discharge pipe 3 to the conditioning valve 1 by connecting the nozzle 5a of moisture transport conduit 5 to this reduced diameter section 9, and drawing the moisture W₁ from the nozzle 5a into the conditioning valve 1 using the differential pressure generated by the Venturi negative pressure phenomenon.

[0022] Considering the optimal conditions for the circulation method using this differential pressure, it is preferable to set this level difference to 10 meters or less, in the case where the moisture drain 4 is placed lower than the nozzle 5a (no limitation in the case where the moisture drain section 4 is placed higher than the nozzle 5a).

[0023] In this embodiment, the vapor S₁ differential pressure is used as mentioned before, as a means for recycling the moisture W₁ flowing from the conditioning valve 1 back to the conditioning valve 1. The system also permits connecting the moisture transport conduit 5 to a desired position of the conditioning valve 1 by disposing a forced delivery apparatus (for instance a pump or the like), in the middle section of the moisture transport conduit 5.

[0024] Composed as described above, this embodiment desuperheats the steam S in the conditioning valve 1, and the desuperheated and depressurized steam S₁ is discharged from the conditioning valve 1 together with moisture W into the discharge pipe 3. The steam S₁ flowing through discharge pipe 3 is introduced into the steam work section 2 connected to the distal end of the discharge pipe 3. The moisture W₁ flowing at

the bottom of the discharge pipe 3 is extracted by the moisture drain 4, transferred by the moisture transport conduit 5 and recycled as moisture W for cooling in the steam conditioning valve 1.

[0025] Therefore, this embodiment provides for an energy efficient removal of the moisture W_1 from the horizontal section 3a of the discharge pipe 3, thereby preventing the moisture W_1 from stagnating at the bottom of the discharge pipe 3, avoiding as much as possible the pipe 3 deformation (damage) and the detrimental effect to the temperature detection sensor and other problems of the prior art. Additionally, the present invention provides for recycling the moisture W_1 used for cooling the vapor S_1 in the conditioning valve 1 providing for energy efficient cooling.

Claims

1. A steam conditioning system having:

a steam conditioning valve for depressurizing and desuperheating superheated steam by supplying moisture thereto;
a discharge pipe connected to a discharge end of the steam conditioning valve, wherein the improvement comprises:

a horizontal section of the discharge piping being provided with a moisture drain in proximity to the bottom of the horizontal section of the discharge pipe;
a nozzle for injecting a water mist into a lower portion of the discharge valve; and a conduit for connecting said nozzle to said drain for transporting condensed water to said nozzle.

2. The steam conditioning system of claim 1 wherein the nozzle has an opening exiting into an annular reduction in the longitudinal cross-section of the lower portion of said valve, wherein moisture is drawn from the drain through the transport conduit and out the exit nozzle into the conditioning valve due to Venturi effect.

3. A steam pressure reducing and conditioning system operatively connected between a steam source and a steam work section, the system comprising:

a valve having an inlet and an outlet, the inlet receiving superheated steam from the steam source;
a discharge pipe having a proximal end, a distal end and a horizontal portion between the ends, the proximal end being connected to the valve outlet and the distal end being connected to the steam work section; and

a transport conduit connecting the horizontal portion of the discharge pipe to the valve.

4. The system of Claim 3, wherein the valve comprises a reduced annular section and a nozzle disposed in the reduced annular section relative to the discharge pipes, whereby steam flowing through the reduced annular section will flow faster than steam through the discharge pipe, and wherein the transport conduit is connected to the nozzle of the valve, whereby moisture is drawn through the transport conduit into the valve.

5. The system of Claim 3, comprising a forced delivery apparatus connected to the transport conduit for delivering moisture to the valve from the horizontal portion of the discharge pipe.

6. A steam pressure reducing and conditioning system operatively connected between a steam source and a steam work section, the system comprising:

a valve having an inlet and an outlet, the inlet receiving superheated steam from the steam source; and
a discharge pipe having a proximal end, a distal end and a horizontal portion between the ends, wherein the proximal end is connected to the valve outlet, the distal end is connected to the steam work section and the horizontal portion comprises a drain.

7. The system of Claim 6, wherein the horizontal portion comprises a bottom portion and the drain is positioned in the bottom portion.

8. The system of Claim 6, comprising recycling means connecting the drain and the valve for transporting moisture from the horizontal portion of the discharge pipe to the valve.

9. The system of Claim 6, comprising a transport conduit connecting the valve and the drain.

10. The system of Claim 9, wherein the discharge pipe has a predetermined area through which steam flows and the valve has a reduced area, relative to the predetermined area of the discharge pipe, through which steam flows faster than through the predetermined area of the discharge pipe.

11. The system of Claim 10, wherein the valve comprises one or more nozzles in the reduced area of the valve and the transport conduit is connected to the one or more nozzles, whereby moisture is drawn through the transport conduit from the drain to the one or more nozzles.

- 12.** A steam pressure reducing and conditioning system operatively connected between a steam source and a steam work section, the system comprising:

a valve having an inlet and an outlet, the inlet receiving superheated steam from the steam source;
 a discharge pipe having a proximal end connected to the valve outlet, a distal end connected to the steam work section and a portion having a predetermined diameter between the ends; and wherein the valve comprises:

an annular section having a diameter reduced relative to the predetermined diameter of the discharge pipe, and
 a nozzle in the annular section for injecting mist into the nozzle.

- 13.** The system of Claim 12, comprising:

a transport conduit connecting the portion of the discharge pipe with the nozzle.

- 14.** The system of Claim 13, wherein the portion of the discharge pipe is horizontal and comprises a drain to the transport conduit.

- 15.** A method of operating a steam pressure reducing and conditioning system, the method comprising:

receiving in an inlet of a valve superheated steam;
 cooling the superheated steam;
 receiving moisture in a discharge pipe connected to the valve;
 removing condensed moisture from the discharge pipe; and
 transporting the removed condensed moisture to the valve for cooling the superheated system.

- 16.** The method of Claim 15, comprising supplying the removed condensed moisture to the superheated steam passing through the valve.

- 17.** The method of Claim 16, wherein supplying the removed condensed moisture to the superheated steam passing through the valve comprises injecting the removed condensed moisture into the valve.

- 18.** The method of Claim 17, wherein supplying the removed condensed moisture to the superheated steam passing through the valve comprises misting the superheated steam with the removed condensed moisture.

- 19.** The method of Claim 15, wherein removing the con-

densed moisture from the discharge pipe comprises creating a pressure differential between an area in the valve and an area in the discharge pipe, whereby the condensed moisture is drawn into the valve.

- 20.** The method of Claim 15, wherein removing the condensed moisture comprises draining the condensed moisture from the discharge pipe into a transport conduit connected to the valve.

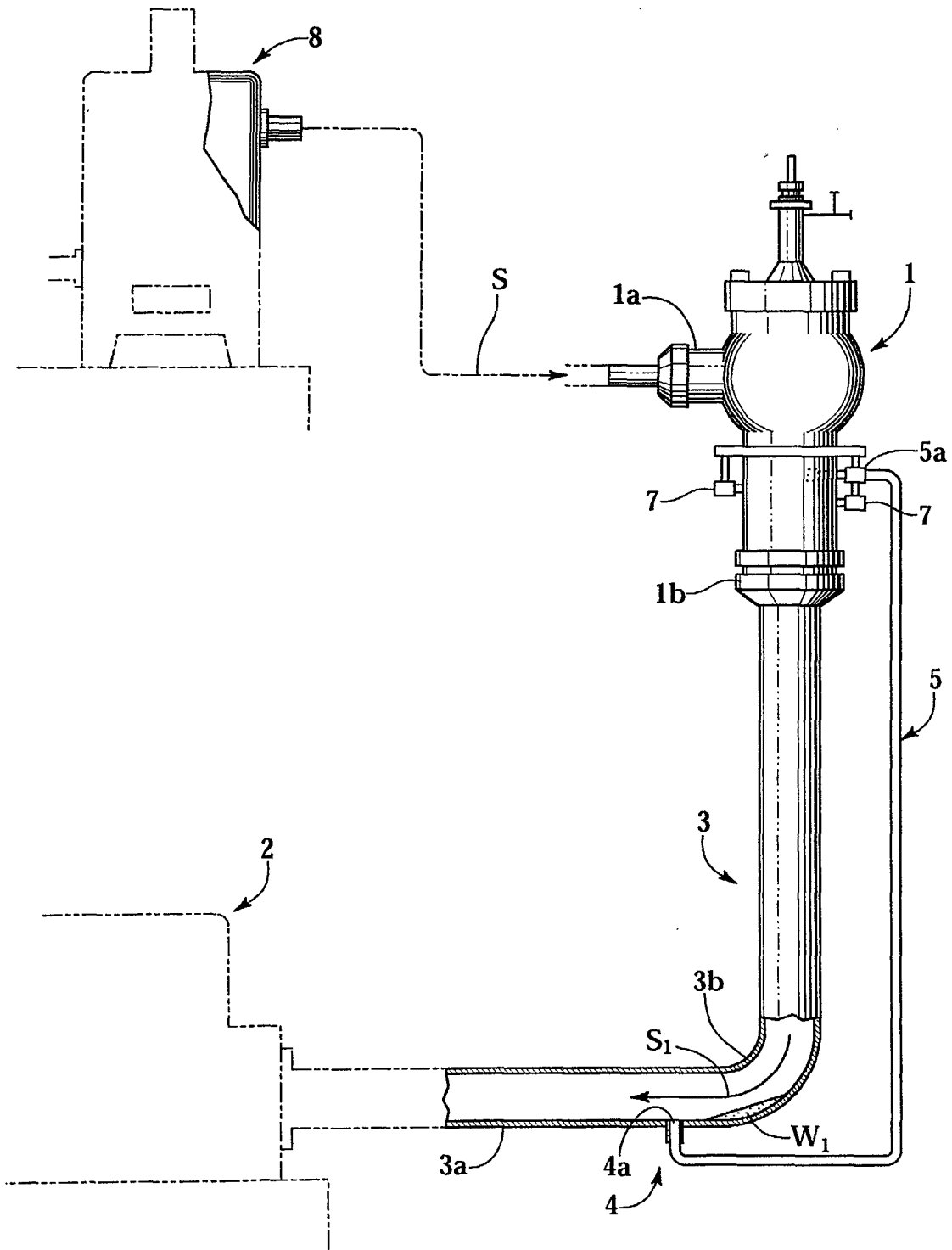


Fig.1

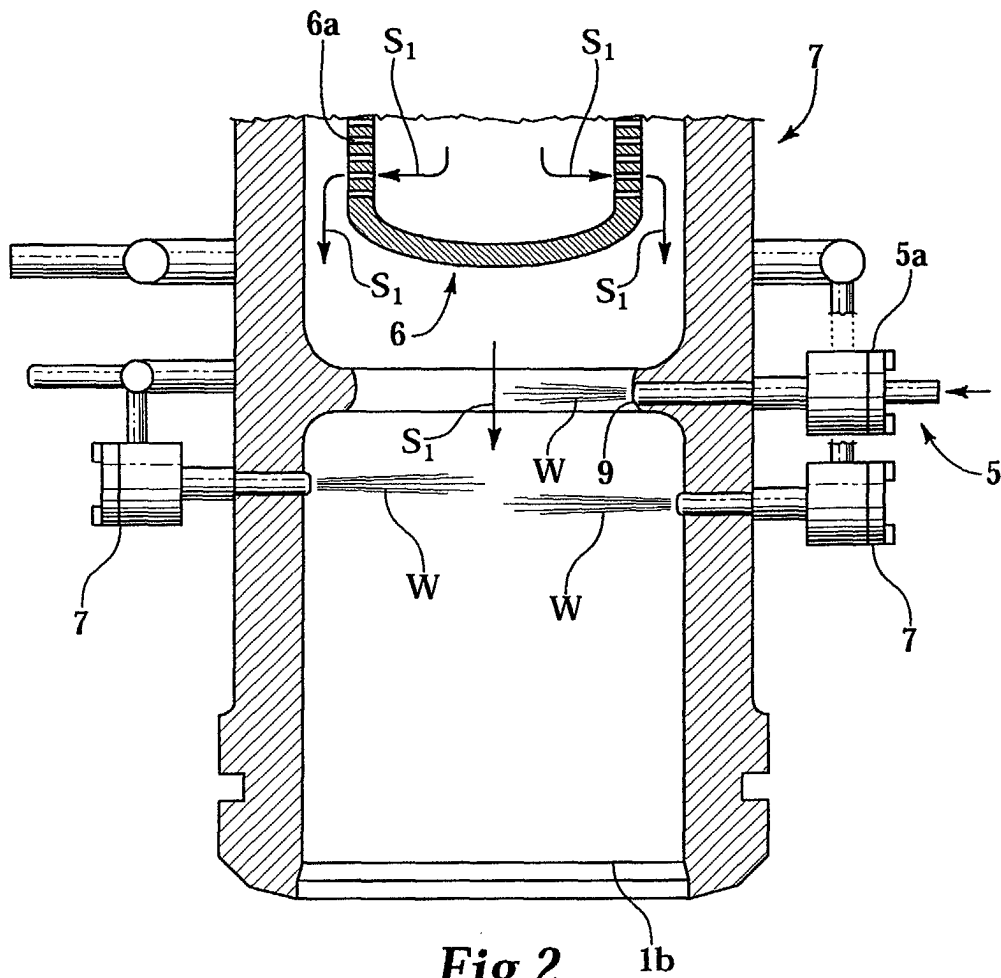


Fig.2

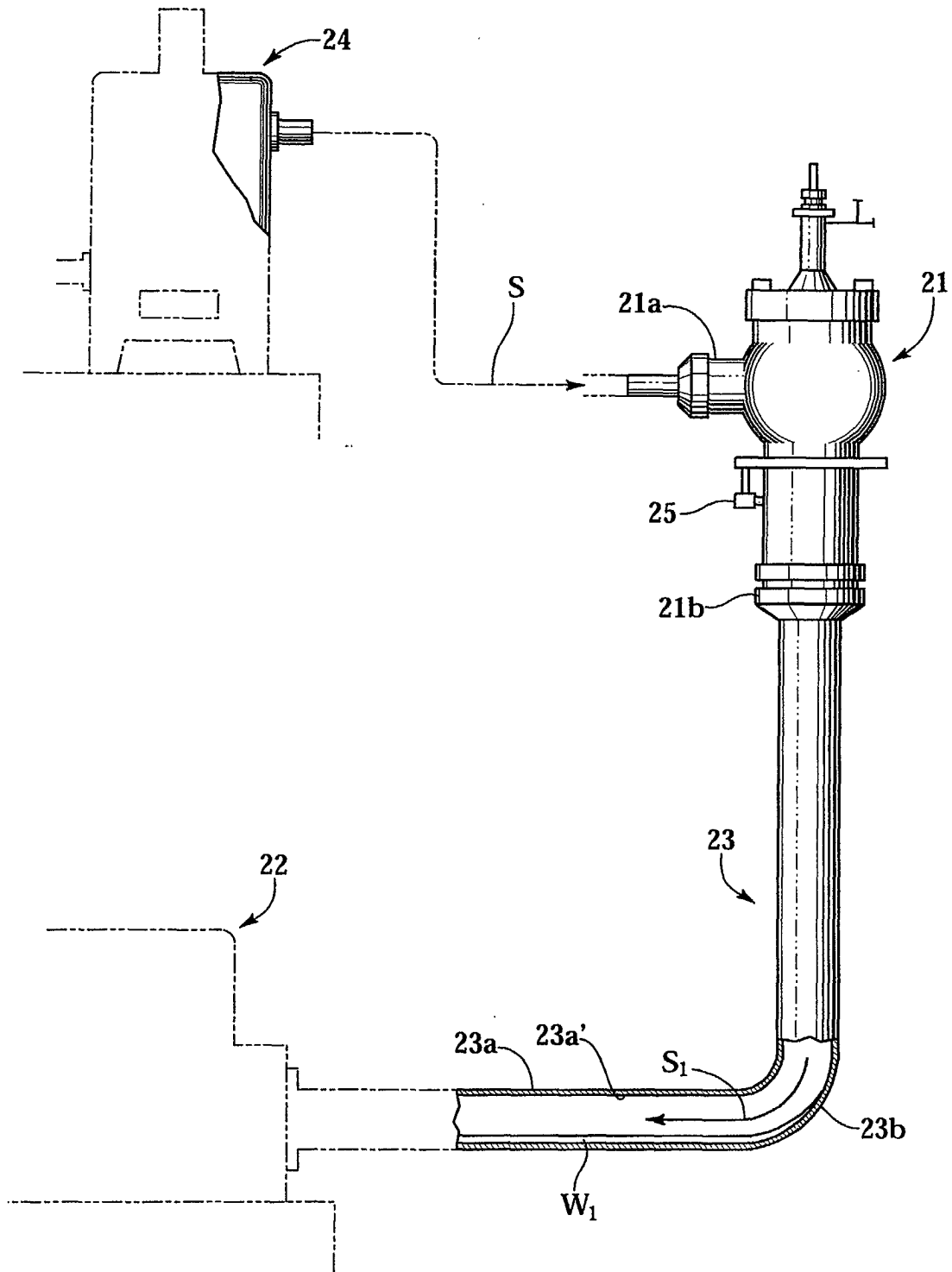


Fig.3
(PRIOR ART)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 00 7253

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.7)
X	US 3 034 771 A (HARRIS LE ROY S) 15 May 1962 (1962-05-15) * column 2, line 40 - column 5, line 56; figures 2,4,5,11,12,14,15 *	1-4,6-20	F22G5/12 F22B35/10
X	GB 772 058 A (ALFRED KENNETH PORTER) 10 April 1957 (1957-04-10) * the whole document *	1-3,6-9, 15-20	
X	US 3 496 724 A (WILSON CHARLES D) 24 February 1970 (1970-02-24) * column 5, line 3 - column 5, line 7 * * column 6, line 9 - column 6, line 16 * * column 17, line 49 - column 18, line 19; figure 1 *	6	
X	FR 2 082 083 A (APP PRECISION CONT) 10 December 1971 (1971-12-10) * the whole document *	12	
X	US 4 887 431 A (PEET WILLIAM J) 19 December 1989 (1989-12-19) * figure 2 *	12	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	FR 595 499 A (FRYER ALFRED HENRY) 3 October 1925 (1925-10-03) * the whole document *	1-20	F22G F22B
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 17 July 2002	Examiner Zerf, G
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

EPO FORM 1503 03.82 (P04C01)



European Patent
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Application Number
EP 02 00 7253

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



European Patent
Office

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 02 00 7253

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-11,15-20

Removal of condensed water from the horizontal part of the tube in order to avoid temperature differentials in the interior surface of the tube

2. Claims: 12-14

Injection of mist in an annular section having a reduced diameter, where the flow velocity is high in order to facilitate the mixing process

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

EP 02 00 7253

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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17-07-2002

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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