

PATENT SPECIFICATION

(11) 1 427 036

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- (21) Application No. 6608/73 (22) Filed 9 Feb. 1973
(31) Convention Application No. 237 328
(32) Filed 23 March 1972 in
(33) United States of America (US)
(44) Complete Specification published 3 March 1976
(51) INT CL² F16T 1/34; B01D 46/10//5/00
(52) Index at acceptance

F4U 37

B1B 2H

BIT 422 454 476 538 542 575 606 641 647 648 712

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(54) METHOD AND APPARATUS FOR REMOVING WATER VAPOR FROM HIGH PRESSURE STEAM LINES

(71) We, FLEXITALLIC GASKET COMPANY INC., a corporation of the State of Delaware, United States of America, of Post Office Box 680, Camden, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Part of the subject matter of this Specification formed the subject of U.S. Application Serial No. 50,501 filed 29th June 1970, now U.S. Patent No. 3,715,870.

This invention relates to an assembly for the removal of condensate from high pressure steam lines and the like.

The removal of condensate from high pressure steam lines or other pressurized lines found in ships, power plants and various industrial installations where a supply of steam or other gas under relatively high pressure is piped from one location to another is a troublesome problem which has received considerable attention in the past. Typically the devices in use today comprise valves operating in response to the movement of a bi-metal element or in some cases a float mounted for movement to operate a valve when liquid level in a float chamber reaches a predetermined point. Such arrangements are prone to failure chiefly because all piping systems contain many foreign particles. Rust and metal chips from threaded joints are only two examples of many particulates that are present to some degree. Systems involving mechanical links or levers are especially prone to cause trouble at high temperatures and pressures. Lubrication of movable elements in such systems is impossible. Any such system involving movable parts is subject to malfunction because the foreign particles

may cause fouling and sticking of the mechanism. Moreover the hostile environment in which such mechanisms must exist, involving pressures of up to 1500 psi or temperatures of 1000°F makes any such system extremely prone to failure.

Efforts to avoid the difficulties mentioned have led to rather large traps which are quite expensive, a typical trap in a high pressure steam line in a ship costing in excess of \$100. The total expense for a large ship is an appreciable item when it is considered that such a ship can have as many as 200 steam traps positioned in various steam lines.

Some well known condensate trap devices employ reservoirs having specifically designed conduit outlets open to the atmosphere. In the operation of these types of devices a predetermined quantity of condensate is allowed to collect in a reservoir within the trap. As the operating pressure in the lines of the steam equipment increases, a proportionate amount of the collected condensate is discharged from the trap. However, due to the varying pressure conditions within the steam system, largely based on the power demands in any given time period, the conduit outlets are not capable of discharging the condensate at a constant rate. Consequently the condensate, illustratively water in this instance, may be drawn back into the steam system from the trap, or is never removed from the system into the trap. This malfunction of the trap forces the retention of harmful moisture in the steam pipelines and results in the attendant disadvantages of a reduction in the efficiency of the steam powered equipment and damage to its working parts.

With the foregoing in view, it is an object of this invention to provide an improved and simplified device for removing

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condensate from steam lines or the like.

A further object of the invention is the provision of a condensate removing apparatus, which when used in place of conventional steam traps results in substantial reduction of maintenance and replacement costs.

According to the invention, there is provided an apparatus for use in a condensate line leading from a high pressure steam line or the like for removing condensate from the high pressure steam lines or the like, comprising a plate having a restrictive orifice therein, a screen on the upstream side of the orifice plate providing a multiplicity of flow passages having cross sections smaller than the orifice, a first gasket for providing a seal between the orifice plate and the downstream side of the condensate line and a second gasket for providing a seal between the orifice plate and the upstream side of the condensate line.

Also according to the invention, there is provided a method of removing condensate from a high pressure steam line or the like which comprises creating a pressure drop in a condensate line leading from the high pressure line by placing an orifice plate between gaskets in the condensate line, the orifice plate having a restrictive orifice therein, positioning a screen in the condensate line upstream from the orifice plate, said screen providing a multiplicity of flow passages having cross sections smaller than the orifice in the orifice plate.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is an elevational view showing an assembly according to the invention;

Figure 2 is a face view of a gasket and screen assembly taken along the line 2—2 of Figure 1;

Figure 3 is an enlarged half plan section taken along the line 3—3 of Figure 2;

Figure 4 is a face view of the orifice disk;

Figure 5 shows in axial section a second embodiment of the invention;

Figures 6A and 6B are detail illustrations of the orifice plate of Figure 5 and

Figure 7 is a detailed illustration of the embodiment of Figure 5.

Referring first to Figure 1, a pair of condensate pipe sections 1 and 2 are illustrated the pipe section 1 is connect to a high pressure steam line or other equipment to be drained of condensate. Each pipe section is provided with flanges ends 3 and 4, the flanges having circumferentially spaced holes 5 through which bolts 6 may be passed and tightened to provide a pressure tight coupling when the joint is

properly assembled with suitable gasketing.

In accordance with the invention the condensate removal assembly comprises a plate 8 having an orifice 9 of small diameter relative to the inside diameter of the pipe in order to provide a substantial pressure drop in the steam line. The orifice 9 may for example be in the range 0.020 to 0.030 inch in diameter. The orifice plate 8 further includes a tab 10 which projects outwardly beyond the outer periphery of the flanges 3 and 4. Tab 10 has suitable identifying indicia inscribed on one of its surfaces, for instance the diameter of orifice 9, so that this information can be determined by engineering personnel without disassembling the joint. Mounted on the low pressure side of the orifice plate is a gasket assembly 11 comprising a compressible gasket preferably of known type comprising spiral wound alternate layers of asbestos and strip metal, as is well-known in the art, the gasket being mounted in a centering ring 12. The open integral diameter of the gasket is slightly larger than the internal diameter of pipe section 2.

Mounted on the upstream or high pressure side of the orifice plate is a second gasket assembly 13 shown in face view in Figure 2. Typically gasket assembly 13 includes a centering ring 14 in which is mounted the gasket material itself which comprises spiral wound layers of asbestos and strip metal material. The gasket element 13 has mounted within it a screen or filter means 15 for the purposes to be described hereinafter. Filter means 15 preferably comprises a pair of screen elements 16 and 17. Screen element 16 is preferably a finely woven mesh screen having a multiplicity of openings sized to pass only those particles which are small enough to pass through aperture 9 in aperture plate 8. Although other types of screen elements may be employed in place of the woven mesh type element shown, as for example a perforated plate type screen element, it is critical that the openings in the screening element are smaller than the orifice and it is also important that there be sufficient openings so that when some of the openings become clogged there will be a multiplicity of alternate flow paths to the orifice.

Although the design of the combined gasket and screen may vary somewhat, a preferred assembly is that shown in U.S. Patent Specification No. 3,622,008. The assembly shown in Figures 2 and 3 is in most respects identical to that assembly. As is indicated in that patent the gasket is formed of a metal strip and a strip formed of packing material such as asbestos. In Figures 3 and 4 herein the metal strip is indicated at 18 and the asbestos material by

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the reference character 19. The metal strip is bent as indicated in Figure 3 with a groove running lengthwise thereof on one side and a corresponding bead or ridge on the other side. The strip of compressible material and the strip of asbestos material are wound together to form a gasket having in section alternate layers of asbestos and metal with a bead running about its outer periphery and a ridge exposed at its inner periphery as shown at 20 and 21 respectively in Figure 3. Preferably the bead or ridge 20 fits within a groove in the centering ring 14. The construction of the first gasket is substantially identical to that described.

The screen or filter means 15 is mounted in a rim 22 which is adapted to be snapped into the inner groove 21 in a portion of the metal strip on the inner periphery of the gasket 13. As indicated in the above-identified U.S. Patent Specification, when the gasket assembly is compressed as the pipe joint is tightened, the gasket expands radially inwardly sufficient to hold the screen tightly and firmly in place.

As indicated above and as shown in Figure 1 the screen assembly is mounted on the upstream or high pressure side of orifice plate 8 with the small openings in the screen element 16 providing flow passages having cross sections smaller than the orifice 9 and thus blocking the passage of particulates except those small enough to pass through the orifice plate. Screen element 17 is formed of relatively coarse wire with large openings as compared to those of element 16. It functions as a spacer means to hold screen element 16 in spaced relationship with respect to the orifice, thereby assuring that the maximum number of openings in screen 16 are available as flow passages for the mixture of gas and condensate in line 1.

In use, condensate collects on the upstream side of the orifice plate 8 until it is blown through the orifice. In addition to water passing through the orifice 9, a certain amount of steam will be condensed due to the expansion effect present because of the pressure drop on the downstream side of the orifice plate. All of the water is conveyed away through line 2 for subsequent reuse, for example to a feedwater supply system for a steam generator.

The presence of the screen assembly in combination with the orifice plate is essential to the operation of the embodiment shown in Figures 1 to 4. The multiplicity of small openings in the screen element 16 assures the availability of a flow path for the condensate even when numerous openings become clogged with large particles of foreign matter. An important feature is the provision of the

spacer screen element 17 which keeps the screen element 16 from being pressed against the face of the orifice plate. This arrangement further contributes to the availability of the maximum number of flow passages to the orifice plate.

Figure 5 illustrates another condensate discharge device embodying the invention for example for use with steam powered equipment designed for shipboard operation.

It is the usual practice when designing steam lines to include condensate traps to remove liquid, usually water, accumulating in the lines. Conventional steam traps open and close automatically depending on the presence of either water or steam at the trap location, and hence are subject to mechanical failure resulting in the likelihood of over-pressurization of the steam system in the manner as hereinbefore suggested.

The condensate removal assembly shown in Figure 6 comprises a plate 25 having an orifice 24 of a predetermined diameter centrally located in the plate.

In practice, the diameter of the orifice 24 is determined by the operating pressure within the particular steam system, to minimize the loss of steam while at the same time effecting optimum condensate discharge. For example, at lower pressure, the orifice 24 can be of a larger diameter, whereas at higher steam pressures, the diameter would be reduced accordingly. However, once the diameter of the orifice has been established for the particular working steam pressure in a system, no further changes in the orifice plate 25 need be made and the system will operate thereafter with a minimum of maintenance. Of course, if maintenance is required, or if the pressure of the steam system is changed to thereby require a different sized discharge orifice, the construction of the discharge device of the invention facilitates the removal and replacement of the plate 25 in a manner to be hereinafter described.

To provide easy removal of the plate 25 from a steam line or to permit substitution of a plate having a differently sized orifice, the plate 25 is located between flanges 26 and 28 of a steam line 30. Gaskets 32 and 34 are shown in Figure 5 to be disposed on opposite faces 36 and 38 of plate 25 and against shoulders 46, 48 of the flanges thereby providing an appropriate seal and preventing excessive loss of steam at the jointure illustrated.

While it is understood that any suitable gasket material may be used to accomplish the sealing effect, the spiral wound gasket assembly as shown in Figures 5 and 7 is preferred. The illustrated gasket assembly is commercially marketed by the Flexitallic

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Gasket Co. of Camden, New Jersey, and Philadelphia, Pennsylvania, under the trademark "Flexitallic".

5 It should also be understood that the plate 25 may be made from any material suitable for use in a high pressure steam environment. While relatively thick steel is contemplated as the preferred material for the plate 25, it should be recognized that
10 other metals, plastics material, or specially developed glass substances having a resistance to the cutting action of the condensate and steam may be employed without otherwise affecting the operation of the discharge device as herein proposed.

15 Figures 5 and 7 show a strainer screen 52 located within an annular groove 54 of the spiral wound gasket 32. The screen 52 is located on the pressure side of the plate 25 and comprises a mesh material, preferably
20 of stainless steel, of such size as to provide a multiplicity of flow passages having cross sections smaller than the orifice 24 to permit moisture and fine dirt to pass through the opening 24 in the plate 25 but to screen out the larger particles of dirt or scale which would clog up the opening 24 in the plate 25.

25 From the foregoing description it has been shown that this invention provides an improved, maintenance free condensate discharge device that is automatic in operation and which satisfies the previously stated objects and advantages as well as
30 others apparent from this description.

35 Of course it will be recognized that while the invention has been described with reference to a steam system, it is obvious that the condensate discharge device could be disposed for example in compressed air systems or in any system wherein the condensate in gas streams must be
40 automatically removed from the system.

WHAT WE CLAIM IS:—

45 1. Apparatus for use in a condensate line leading from a high pressure steam line or the like for removing condensate from the high pressure steam lines or the like, comprising a plate having a restrictive orifice therein, a screen on the upstream
50 side of the orifice plate providing a multiplicity of flow passages having cross sections smaller than the orifice, a first gasket for providing a seal between the orifice plate and the downstream side of the condensate line and a second gasket for
55 providing a seal between the orifice plate and the upstream side of the condensate line.

60 2. Apparatus according to Claim 1, wherein the first and second gaskets each comprise a spiral metal strip and a strip of

compressible packing material interposed in the spiral convolutions.

3. Apparatus according to Claim 1 or 2, wherein the screen is carried by the second gasket.

4. Apparatus according to Claim 3, wherein the second gasket has a grooved inner periphery, and the screen has a peripheral rim adapted to fit within said grooved inner periphery.

5. Apparatus according to any of the preceding Claims, wherein the screen is a wire mesh screen.

6. Apparatus according to any of the preceding Claims and further including means for holding the screen away from the orifice.

7. Apparatus according to Claim 6, wherein the means for holding the screen away from the orifice plate includes a member positioned intermediate the screen and the orifice plate having means extending over portions of the screen element for maintaining the screen in spaced relation from the orifice plate.

8. Apparatus according to Claim 7, wherein the member comprises a mesh screen having mesh openings which are relatively large as compared to the opening in the first-named screen.

9. An assembly for removing condensate from high pressure steam lines or the like, substantially as hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings.

10. An assembly for removing condensate from high pressure steam lines or the like, substantially as hereinbefore described with reference to Figures 5 to 7 of the accompanying drawings.

11. A method of removing condensate from a high pressure steam line or the like which comprises creating a pressure drop in a condensate line leading from the high pressure line by placing an orifice plate between gaskets in the condensate line, the orifice plate having a restrictive orifice therein, positioning a screen in the condensate line upstream from the orifice plate, said screen providing a multiplicity of flow passages having cross sections smaller than the orifice in the orifice plate.

12. A method according to Claim 11, further include the step of supporting said screen in spaced relation relative to the orifice plate.

13. The method of Claim 11 or 12, further including placing spiral wound gaskets composed of strip metal and a non-metallic compressible packing material on each side of the orifice plate in contact with the adjacent ends of the condensate line to form high pressure, temperature resistant

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Gasket Co. of Camden, New Jersey, and Philadelphia, Pennsylvania, under the trademark "Flexitallic".

5 It should also be understood that the plate 25 may be made from any material suitable for use in a high pressure steam environment. While relatively thick steel is contemplated as the preferred material for the plate 25, it should be recognized that
10 other metals, plastics material, or specially developed glass substances having a resistance to the cutting action of the condensate and steam may be employed without otherwise affecting the operation of the discharge device as herein proposed.
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Figures 5 and 7 show a strainer screen 52 located within an annular groove 54 of the spiral wound gasket 32. The screen 52 is located on the pressure side of the plate 25 and comprises a mesh material, preferably
20 of stainless steel, of such size as to provide a multiplicity of flow passages having cross sections smaller than the orifice 24 to permit moisture and fine dirt to pass through the opening 24 in the plate 25 but to screen out the larger particles of dirt or scale which would clog up the opening 24 in the plate 25.
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From the foregoing description it has been shown that this invention provides an improved, maintenance free condensate discharge device that is automatic in operation and which satisfies the previously stated objects and advantages as well as
30 others apparent from this description.
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Of course it will be recognized that while the invention has been described with reference to a steam system, it is obvious that the condensate discharge device could be disposed for example in compressed air systems or in any system wherein the condensate in gas streams must be automatically removed from the system.
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WHAT WE CLAIM IS:—

45 1. Apparatus for use in a condensate line leading from a high pressure steam line or the like for removing condensate from the high pressure steam lines or the like, comprising a plate having a restrictive orifice therein, a screen on the upstream
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60 2. Apparatus according to Claim 1, wherein the first and second gaskets each comprise a spiral metal strip and a strip of

compressible packing material interposed in the spiral convolutions.

3. Apparatus according to Claim 1 or 2, wherein the screen is carried by the second gasket. 65

4. Apparatus according to Claim 3, wherein the second gasket has a grooved inner periphery, and the screen has a peripheral rim adapted to fit within said grooved inner periphery. 70

5. Apparatus according to any of the preceding Claims, wherein the screen is a wire mesh screen. 75

6. Apparatus according to any of the preceding Claims and further including means for holding the screen away from the orifice. 80

7. Apparatus according to Claim 6, wherein the means for holding the screen away from the orifice plate includes a member positioned intermediate the screen and the orifice plate having means extending over portions of the screen element for maintaining the screen in spaced relation from the orifice plate. 85

8. Apparatus according to Claim 7, wherein the member comprises a mesh screen having mesh openings which are relatively large as compared to the opening in the first-named screen. 90

9. An assembly for removing condensate from high pressure steam lines or the like, substantially as hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings. 95

10. An assembly for removing condensate from high pressure steam lines or the like, substantially as hereinbefore described with reference to Figures 5 to 7 of the accompanying drawings. 100

11. A method of removing condensate from a high pressure steam line or the like which comprises creating a pressure drop in a condensate line leading from the high pressure line by placing an orifice plate between gaskets in the condensate line, the orifice plate having a restrictive orifice therein, positioning a screen in the condensate line upstream from the orifice plate, said screen providing a multiplicity of flow passages having cross sections smaller than the orifice in the orifice plate. 105

12. A method according to Claim 11, further include the step of supporting said screen in spaced relation relative to the orifice plate. 110

13. The method of Claim 11 or 12, further including placing spiral wound gaskets composed of strip metal and a non-metallic compressible packing material on each side of the orifice plate in contact with the adjacent ends of the condensate line to form high pressure, temperature resistant 125



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seals between the ends of the line and the orifice plate.

14. A pressure gas or vapour installation characterised by a condensate discharge line incorporating apparatus according to any of Claims 1 to 10.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1976.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.