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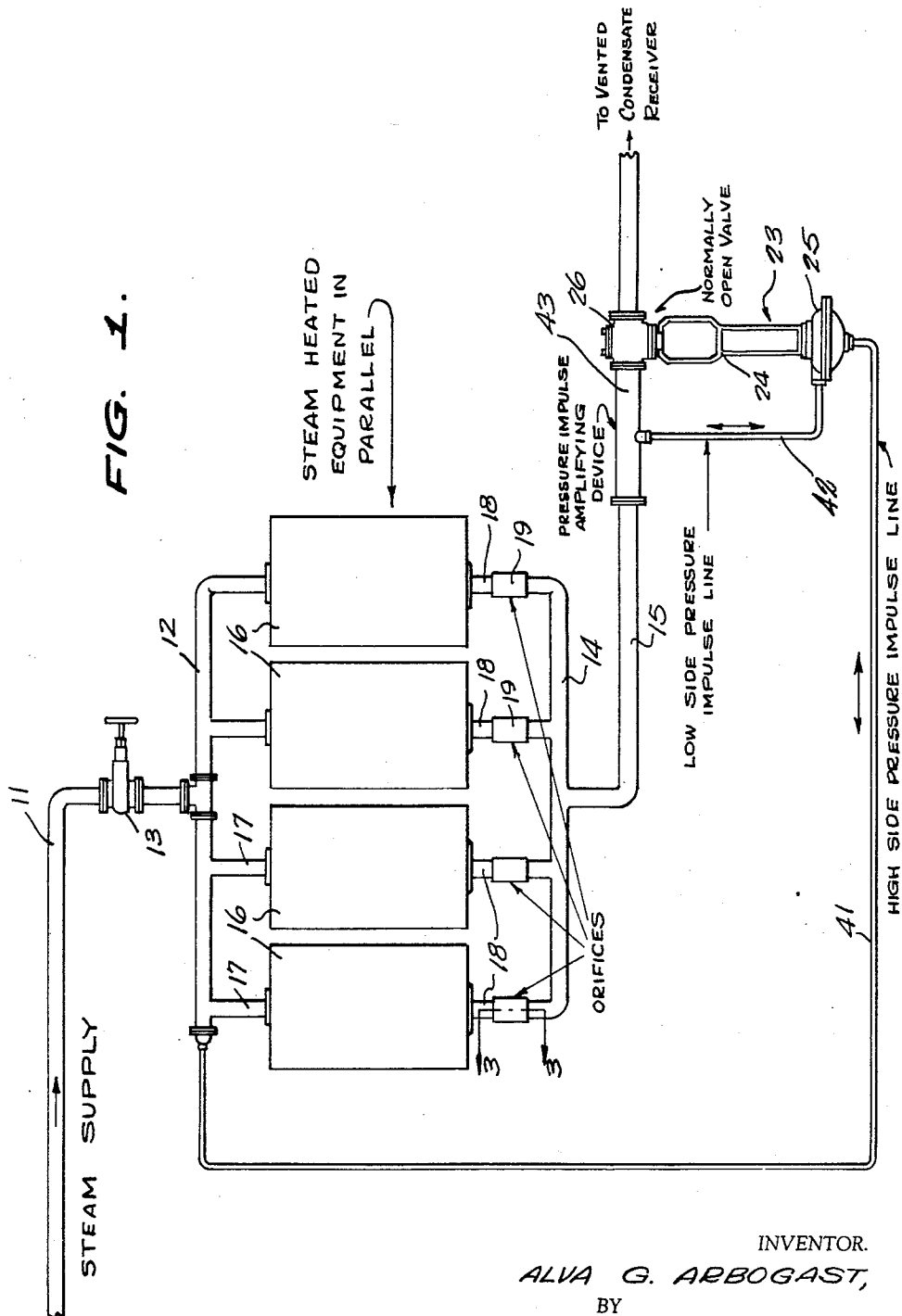
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2,942,785

TRAPLESS STEAM CONDENSATE SYSTEM

Filed Sept. 13, 1957

2 Sheets-Sheet 1



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FIG. 2.

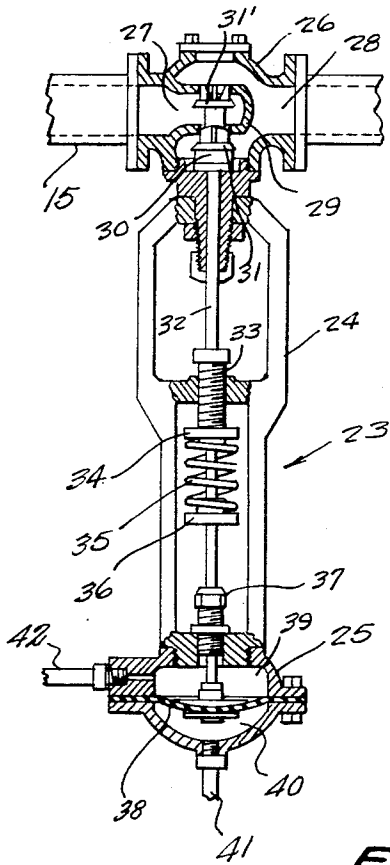


FIG. 3.

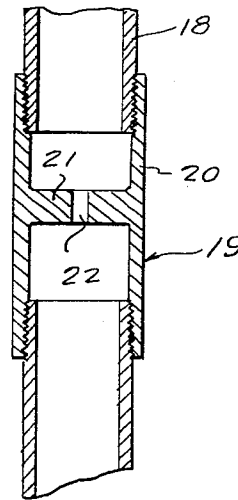
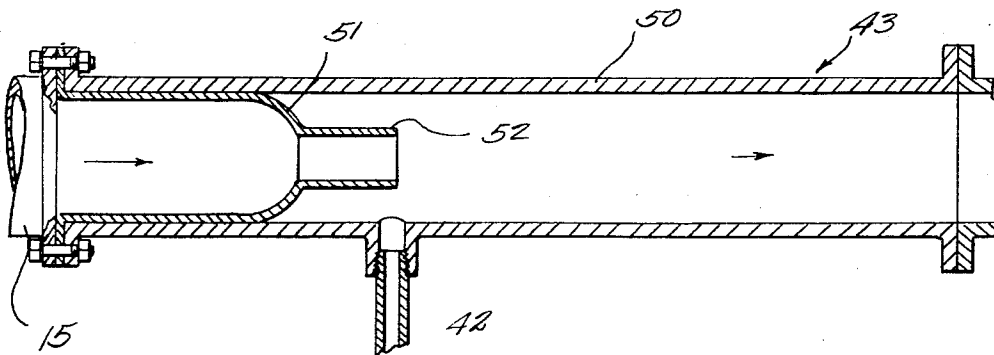


FIG. 4.



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TRAPLESS STEAM CONDENSATE SYSTEM

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3 Claims. (Cl. 237—9)

This invention relates to steam utilization systems, and more particularly to a method and means for removing steam condensate from steam-using equipment.

A main object of the invention is to provide a novel and improved system for removing steam condensate from steam-utilizing equipment of the type employing the latent heat of steam for the operation thereof, the system involving simple components, requiring no steam traps, and providing a higher rate of heat transfer to a steam-utilizing device than can be obtained in a system employing steam traps.

A further object of the invention is to provide an improved system for removing steam condensate from steam utilizing equipment, the system being arranged so that it provides positive control of condensate drainage, thereby permitting a controlled amount of steam to be withdrawn with the condensate and assuring complete drainage of the steam condensate.

A still further object of the invention is to provide an improved system for removing steam condensate from steam-utilizing equipment, the system involving relatively inexpensive components, being reliable in operation, and assuring maximum rate of heat transfer to the equipment, whereby the equipment may be efficiently employed for performing process work requiring heat transfer.

A still further object of the invention is to provide an improved method and means for removing steam condensate from steam-utilizing equipment of the type employing the latent heat of steam, the means being arranged so that it requires a minimum amount of maintenance, has high sensitivity to the presence of live steam in the condensate drain line, and is especially useful in process work, such as plastic moulding, air heating at high temperatures, contact heating of moving material over a heated platen or roll, or the like, or in other operations involving the use of extremely high steam pressures, the apparatus being characterized by the absence of steam traps and therefore being relieved of maintenance problems ordinarily connected with extremely high pressure steam traps.

A still further object of the invention is to provide an improved system for removing steam condensate from steam-utilizing equipment, the system providing close control over the utilization of the steam and arranged so that it prevents excessive steam waste.

Further objects of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a schematic view of a steam-utilizing system constructed and arranged in accordance with the present invention.

Figure 2 is an enlarged vertical cross sectional view taken through the differential pressure control valve employed in the system of Figure 1.

Figure 3 is an enlarged cross sectional view taken through one of the restriction elements of the system on the line 3—3 of Figure 1.

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Figure 4 is an enlarged longitudinal vertical cross sectional view taken through the pressure impulse amplifying device employed in the system of Figure 1.

Referring to the drawings, Figure 1 illustrates a typical steam-utilizing system arranged in accordance with the present invention. Designated at 11 is a high pressure steam line leading from a source of high pressure steam, said steam line being connected to a steam header 12 through a manually controlled valve 13. Designated at 14 is an exhaust header which is connected to the condensate drainage line 15 leading to a suitable vented condensate receiver not shown.

Designated at 16 are a plurality of steam-utilizing devices, for example, heating devices employed in process work, said devices utilizing the latent heat of the high pressure steam admitted thereto. Thus, the heat transfer devices 16 are supplied with live steam from the header 12 through inlet conduits 17, as shown in Figure 1, the exhaust steam leaving the devices 16 through discharge conduits 18. The discharge conduits 18 are connected to the exhaust steam header 14 through respective restriction devices 19 which comprise sleeve members 20 provided with internal transverse walls 21 formed centrally with a restriction 22, as shown in Figure 3, defining an orifice, the orifice being calibrated or dimensioned to handle the maximum quantity of condensate that its associated steam-utilizing device 16 can produce in a given period of time under a predetermined pressure differential across the orifice.

The aforesaid pressure differential across the orifices 22 is controlled by a pressure differential responsive valve designated generally at 23, said valve being connected in the condensate drain line 15 and being controlled in accordance with the difference in pressures in the steam line 11 (and steam header 12) and the condensate drainage line 15.

As shown in Figure 2, the pressure differential-responsive valve 23 comprises a frame 24 to one end of which is secured a diaphragm housing 25 and to the other end of which is secured a plunger valve housing 26. Housing 26 comprises a first chamber 27 and a second chamber 28 separated from the first chamber by a wall 29 in which are provided valve apertures receiving a plunger member 30, said plunger member being provided with valve elements which are adapted to seat in the apertures in the wall 29 to close off said wall and seal space 28 from space 27 responsive to the axial movement of the plunger in an upward direction, as viewed in Figure 2. In the specific arrangement shown in Figure 2, the wall 29 comprises top and bottom sections, each formed with an aperture, and the plunger member 30 comprises top and bottom valve elements 31' and 31 engageable in corresponding apertures in the top and bottom portions of the wall 29 so as to provide a double sealing action. The valve is provided with a supporting rod 32 which extends slidably through a bearing sleeve 33 mounted in the frame 24 and provided at its bottom end with a flange 34. A coiled spring 35 surrounds the lower portion of the rod 32 below the flange 34, bearing between flange 34 and a collar 36 mounted on the rod, biasing the rod downwardly, as viewed in Figure 2, namely, toward a position wherein the valve is open.

The lower portion of the rod 32 extends slidably and sealingly through a suitable sealing bushing 37, into the diaphragm housing 25, and is secured to the central portion of a flexible diaphragm 38 mounted in housing 25 in the manner illustrated in Figure 2. Thus, the diaphragm 38 divides the diaphragm housing 25 into an upper chamber 39 and a lower chamber 40.

The lower chamber 40 of diaphragm housing 25 is connected by a conduit 41 to one end of the high pres-

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sure steam supply header 12, whereby the pressure of the live steam in the header 12 opposes the action of the coiled spring 35. The upper chamber 39 is connected to the condensate drainage line 15 by a conduit 42 through a pressure impulse amplifying device 43, so that the chamber 39 is exposed to the pressure in the line 15 through the aforesaid amplifying device 43.

Basically, the apparatus is arranged to operate in accordance with the difference in pressure between the steam supply line 11 and the condensate drain line 15, the pressure amplifying device 43 being employed merely to increase the sensitivity of the system. As above mentioned, the orifices 22 are dimensioned to handle the maximum quantity of condensate produced in a given period of time under a predetermined pressure differential thereacross by the devices 16. The pressure differential across the orifices is controlled by the pressure-responsive valve 23, since the valve 23 responds to the difference in pressure between that of the steam in the header 12 and the steam in the condensate line 15.

The general operation of the system is as follows: Steam enters the header 12 from the high pressure line 11 and passes through the steam-utilizing devices 16, where the latent heat of the steam is extracted to perform the required process work. As a result of the heat transfer, condensate will form, the condensate being discharged from the devices 16 through their discharge conduits 18 and passing through the calibrated orifices 22 of the restriction devices 19 into the exhaust header 14, and thence to the condensate drainage line 15 and through the top portion of the pressure-responsive valve device 23 to the vented condensate receiver employed with the system. Therefore, steam condensate and a controlled amount of steam flow from the devices 16 through the orifices 22 into the condensate header 14 and through the condensate drainage line 15. The steam condensate and a controlled amount of steam pass through the top portion 26 of the pressure-responsive valve 23 to the vented condensate receiver or other device employed in the system for the collection and storing of the steam condensate. The pressure-responsive valve device 23 is adjusted to allow complete drainage of the condensate plus a small amount of steam. Adjustment of the valve 23 is accomplished by adjusting the position of the spring bearing member 33, which is threadably engaged in the intermediate portion of frame 24, as clearly shown in Figure 2, so that its position may be readily changed, and so that the biasing force on the spring 35 may be readily adjusted.

Spring 35 normally biases the valve plunger rod 32 downwardly, as viewed in Figure 2, namely, toward a position wherein the valve is open. The pressure of the live steam in the header 12 acts in the bottom chamber 40 in opposition to the spring 35, thereby tending to urge the valve plunger 32 upwardly, namely, toward closing position of the valve. The pressure in the chamber 40 is opposed by the pressure in the chamber 39, namely, by the pressure in the condensate drainage line 15, whereby to provide a predetermined degree of opening of the valve 23 under normal conditions of operation of the system. If more than the desired amount of pressure is present in the condensate drainage line 15, the pressure in the upper diaphragm chamber 39 increases, thereby acting to move the valve rod 32 downwardly and increasing the degree of opening of the valve 23, allowing the pressure in the condensate drainage line 15 to be reduced, thereby increasing the pressure differential across the orifices 22 and thus increasing the throttling action of said orifices, whereby the proportion of condensate to vapor at the discharge side of the orifices is increased, and whereby the amount of vapor in the condensate discharge header 14 is consequently reduced to the desired permissible amount.

The pressure impulse amplifying device 43 comprises a main conduit section 50 connected in the condensate

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discharge line 15 and contains a nozzle member 51 having the reduced discharge spout portion 52 located substantially axially in the body 50 and discharging downstream, namely, toward the condensate receiver. The conduit 42 is connected to the body 43 at a point laterally adjacent to the discharge end of the nozzle spout element 52, as is clearly shown in Figure 4, and is thus exposed to the pressure in the area laterally adjacent to the discharge end of the nozzle spout 52. The direction of flow of the fluid is to the right, as viewed in Figure 4. When the fluid enters the nozzle member 51 its flow is accelerated by the passage thereof through the reduced spout portion 52, and the kinetic energy of the fluid discharged from the spout portion 52 causes a "vena contracta" in the zone surrounding the tip of the nozzle element 52, thus creating a zone of substantially reduced pressure around the nozzle tip. This reduced pressure is sensed by the upper chamber 39 of the diaphragm housing 25 through the conduit 42, causing a more rapid response of the valve 23 to changes of the fluid in the condensate drainage line 15 than would be otherwise obtained. For example, assume that the condensate is flowing from the steam-utilization devices 16 at the desired normal rate, whereby the desired pressure differential exists between chamber 40 and chamber 39 of the pressure differential-responsive valve 23. Should live steam appear in the condensate drainage line 15 for any reason, the steam will pass through the nozzle device 51 and create a sudden decrease in pressure in the zone surrounding the nozzle tip 52, which will be sensed by the upper diaphragm chamber 39 of valve 23. The decrease in pressure in chamber 39 thus acts to increase the pressure differential acting on the valve, moving the valve rod 32 upwardly toward closing position, and thus restricting the flow in the condensate line 15. The valve 23 is thus caused to overtravel in response to the impulse created by the "vena contracta," whereby the "vena contracta" no longer exists due to the increased restriction in the condensate drainage line 15, after which the valve 23 regains control at the desired control point under the influence of the true pressure differential across the system.

The pressure impulse amplifying device 43 thus provides close and instantaneous control of the system and prevents excessive steam waste which would otherwise result from sluggish control response.

As will be apparent from the above description, the calibrated orifices 22 are employed in place of steam traps and their flow capacity is controlled by the difference in pressure across the orifices as set up by the pressure differential-responsive control valve 23, in combination with the calibrated orifices. Positive control of condensate drainage is provided, by the adjustment of the valve 23, as above explained, which permits a controlled amount of steam to be withdrawn with the condensate, assuring complete drainage of the steam condensate. Thus, assurance is provided for obtaining the maximum rate of heat transfer in a device 16 of the type employing the latent heat of steam for performing process work requiring heat transfer from one material to another.

The pressure-responsive valve 23 is conventional per se, and in itself forms no part of the present invention.

While a specific embodiment of an improved trapless steam condensate system has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In a system of the character described, a high pressure steam line, a steam-utilizing device having an intake conduit and an exhaust conduit, means connecting the intake conduit to the steam line, a condensate drainage line, conduit means connecting said exhaust conduit to said drainage line, a restriction in said last-named conduit

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means, a nozzle element mounted in said drainage line and defining a restriction therein adapted to develop a reduction in pressure at its discharge side responsive to the passage of live steam through the nozzle element, a pressure-responsive valve mounted in said drainage line on the discharge side of said nozzle element, and means controlling said valve in accordance with the difference between the pressure in the steam line and the pressure in the drainage line adjacent the discharge end of said nozzle element.

2. In a system of the character described, a high pressure steam line, a steam-utilizing device having an intake conduit and an exhaust conduit, means connecting the intake conduit to the steam line, a condensate drainage line, conduit means connecting said exhaust conduit to said drainage line, a restriction in said last-named conduit means, a nozzle element mounted in said drainage line and defining a restriction therein adapted to develop a reduction in pressure at its discharge side in accordance with the amount of live steam passing through the nozzle element, a normally open pressure-responsive valve mounted in said drainage line on the discharge side of said nozzle element, and means controlling the degree of closing of said valve in accordance with the difference between the pressure in the steam line and the pressure in the drainage line laterally adjacent the discharge end of said nozzle element.

3. In a system of the character described, a high pressure steam line, a steam-utilizing device having an intake conduit and an exhaust conduit, means connecting the

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intake conduit to the steam line, a condensate drainage line, conduit means connecting said exhaust conduit to said drainage line, a restriction in said last-named conduit means, a nozzle element mounted in said drainage line and defining a restriction therein adapted to develop a reduction in pressure at its discharge side in accordance with the amount of live steam passing through the nozzle element, a normally open pressure-responsive valve mounted in said drainage line on the discharge side of said nozzle element and including a diaphragm chamber provided with a flexible diaphragm constructed and arranged to control the degree of closure of the valve in accordance with the difference in pressures on the opposite sides of said diaphragm, a first conduit connecting the portion of the diaphragm chamber on one side of said diaphragm to the high pressure steam line, and a second conduit connecting the portion of the diaphragm chamber on the opposite side of said diaphragm to said drainage line at a point laterally adjacent the discharge end of said nozzle element.

References Cited in the file of this patent

UNITED STATES PATENTS

25	1,047,622	Donnelly	Dec. 17, 1912
	1,679,215	Goldkamp	July 31, 1928
	1,697,343	Campbell	Jan. 1, 1929
	1,745,256	Groble	Jan. 28, 1930
	1,973,259	Kiefer	Sept. 11, 1934
30	2,349,938	Burnette	May 30, 1944