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STEAM APPLICATION SYSTEM

Filed Aug. 2, 1968

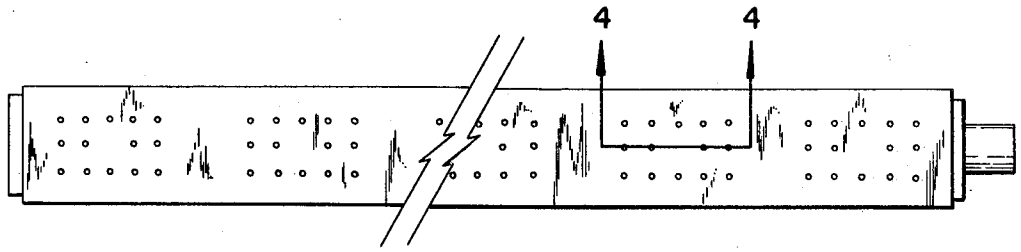


FIG. 3

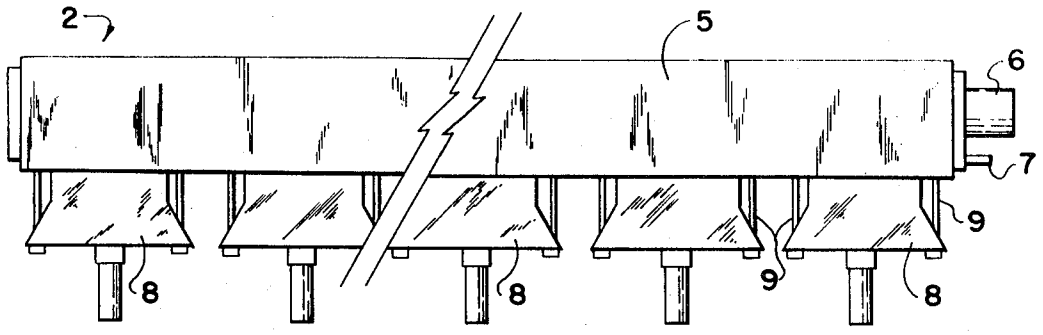


FIG. 2

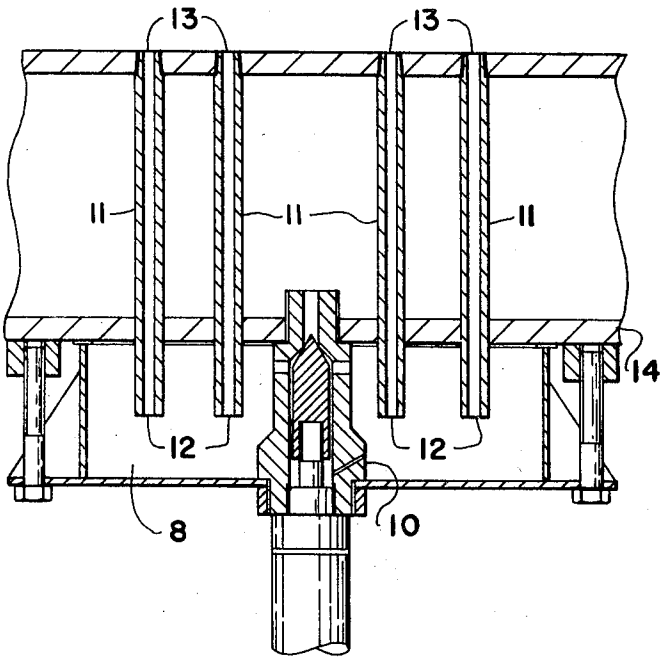


FIG. 4

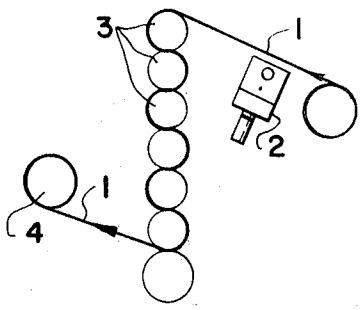


FIG. 1

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# STEAM APPLICATION SYSTEM

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## ABSTRACT OF THE DISCLOSURE

A steam application system for delivering dry steam to a moving paper web is formed with two chambers: a first, high pressure, high temperature chamber extending across the web and a series of relatively low temperature, low pressure chambers interconnected by valves to the first chamber. Several conduits are positioned in the first chamber with their inlet ends connected to the second chamber and their outlet ends delivering steam to the web of paper. When high temperature, high pressure steam is fed into the first chamber it passes through the valves into the second chambers and thence, through the conduits to the material being treated. Since the interior of the first chamber and hence, the conduits, is at an appreciably higher temperature than the steam in the second chambers, any water entrained in the steam as it exits the second chambers is vaporized to give a substantially dry steam at the outlets of the conduits.

## BACKGROUND OF THE INVENTION

### Field of the invention

The treatment of steam in a steam application system to prevent moisture entrainment in the steam jets; particularly at start up.

### Description of the prior art

In many manufacturing operations it is desirable to apply dry steam to the material being treated. In the paper industry, for example, steam may be applied to a moving web of paper as it is being manufactured to increase the rate of water removal from the web, to modify calendering operations, etc. In processes of this type, it is desirable but difficult to insure that the steam be substantially dry and free from entrained moisture. This is particularly true where the nozzle is used on an intermittent basis; since, when the steam application unit is first turned on, any condensate which has collected in the system is likely to be entrained in the initial burst of steam from the nozzle. One approach to solving this problem is shown in Pat. No. 2,838,982, wherein the steam orifices **25** are separated by a series of condensate drains positioned beneath the level of the orifices.

## SUMMARY OF THE INVENTION

A high pressure chamber extends across the web of paper or other material being treated, and serves as a manifold for several low pressure chambers positioned across the web. A series of conduits extends from each low pressure chamber back through the high pressure chamber for directing steam from the low pressure chamber onto the web. As the steam passes through the conduits any moisture entrained therein is flashed off, since the conduits are at a higher temperature than the steam entering them. It will be noted that this construction is particularly suited for intermittent operation since, in the first few seconds of operation the conduits are at the same temperature as the high pressure steam. Of course, after running a few seconds, a temperature gradient will be established between the interior and the exterior of the conduits and the temperature on the interior of the



conduits will then be somewhat less than the initial temperature. However, it will be substantially greater than that of the steam passing from the low pressure chamber and sufficient to provide drying of the steam on a continuous basis. However, the additional capacity that is available at each low pressure chamber as it is brought into operation provides an added advantage since it is at this time that entrained moisture will most likely be encountered. It will also be noted that with the steam application system of the present invention the steam jets may be directed upwardly or downwardly or in any other direction without entraining moisture in the steam.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 of the drawings somewhat schematically shows the steam application system of the present invention as applied to a calendering operation;

FIG. 2 is an elevational view of the steam application system of the present invention;

FIG. 3 is a plan view of the apparatus of FIG. 2; and

FIG. 4 is a cross-sectional view taken on line **4**—**4** of FIG. 3.

## DESCRIPTION OF A PREFERRED EMBODIMENT

The present invention is particularly adaptable for use in treating a paper web with steam during the manufacture thereof. For example, steam might be applied at the wet end of a Fourdrinier machine to increase the water removal rate by suctions, foils, table rolls and the like or steam might be applied just prior to the presses or dryers to increase the water removal rate at these two sections of the papermaking machine. Additionally, dry steam might be applied to the web just prior to the calender to control the caliper of the web leaving the calender stack. Thus, steam applied to selected areas transversely of the web would raise the temperature of those sections of the web, which in turn would raise the temperature of the corresponding portions transversely of the rolls of the calender stack. The increase in temperature of the calender stack rolls would cause them to expand at that point and exert a greater pressing action on the web passing therearound; thereby decreasing the caliper of those portions of the web to which heat was applied. For a more detailed discussion of this general subject reference is made to Pat. No. 3,359,643. This type of operation is also shown somewhat schematically in FIG. 1 of the present drawings, wherein a paper web **1** is passed over a steam application system, referenced in its entirety by the numeral **2**, and thence, around a series of rolls **3** of the calender stack to a winder **4**.

As seen in FIG. 2 of the drawings, the steam application system **2** comprises a high temperature, high pressure chamber **5** having an inlet conduit **6** and a condensate drain **7**. Mounted on one wall of the chamber **5**, the bottom wall as seen in FIG. 2, are a series of low pressure, low temperature steam chambers **8**. Each chamber **8** may be attached to the chamber **5** by means of a pair of depending studs **9** and, as seen in FIG. 4, fluid communication between the chamber **5** and each chamber **8** is provided by means of the air cylinder actuated valve members **10**. A series of conduits **11** are mounted in the chamber **5** with their inlet ends **12** extending inwardly into and in communication with a low pressure chamber **8** and their outlet ends **13** in communication with ambience.

In operation, high pressure, high temperature steam is admitted to the chamber **5** by means of the inlet conduit **6**. From the chamber **5** the steam passes through the valves **10** into the chambers **8**. As the steam passes through the valves **10** the pressure of the steam is reduced; thereby

establishing a pressure differential between the chambers 5 and 8. From each of the chambers 8 the steam passes out through the series of conduits 11 to ambience, where it may be applied to, for example, a moving web of paper. Any condensate which may collect in the chamber 5 will be drained off through the condensate drain 7 and, it will be noted from FIG. 4, the inlet ends of the valves 10 may be positioned above the bottom wall 14 of the chamber 5 to prevent any of this condensate from draining into the lower chambers 8.

By maintaining a sufficient pressure differential between the chambers 5 and 8, the temperature in the upper chamber 5 maintains the conduits 11 at a higher temperature than the steam in the lower chambers 8. Therefore, when the steam exits the chambers 8 through the conduits 11, its temperature is quickly increased, vaporizing any moisture entrained with the steam. While the pressure differential necessary to obtain this result will vary somewhat with the materials used and hence, the thermal transfer characteristics of the system, in most cases it will be found necessary to have at least a 10 p.s.i. differential between the upper and lower chambers. While there does not appear to be a similar criticality in the pressure differential between the inlet and outlet ends of the conduits 11, as a practical matter this differential in most cases should be maintained at less than 1 p.s.i. In an actual installation, using mainly stainless steel components, a temperature and pressure in the chamber 5 of approximately 350° F. and 150 p.s.i.g. and a temperature and pressure in the chambers 8 of approximately 212° F. and less than 1 p.s.i.g., with the outlet ends of the conduits 11 at atmospheric conditions, were found to give satisfactory results.

In most instances when applying steam to a moving web of material, the amount of steam applied at the various positions across the web will vary. Therefore, the amount of steam admitted to each of the chambers 8 from the chamber 5 may be controlled by means of a valve, as at 10, in response to varying conditions in the papermaking process. When a particular chamber 8 is continuously receiving steam from the chamber 5 a temperature gradiant will be established through the wall of the conduit 11. However, by selecting a high enough pressure differential between the chambers 5 and 8 the temperature of the internal surfaces of the conduit 11 will be sufficient to vaporize any moisture existing in the steam as it exits the chamber 8.

A particular problem which exists, however, when a steam application system is used for intermittent operation is that moisture tends to collect in the system when it is inactive. In this regard, it should be noted that with the steam application system of the present invention, when a particular chamber 8 is activated there is initially an additional capacity for drying the steam exiting the chamber 8; since the conduits 11, while the chamber 8 is inactive, are allowed to reach the full saturated temperature of the high pressure steam in the chamber 5. Thus, additional capacity is provided exactly when it is needed most.

While the present invention has been described in conjunction with a calendering operation it should be noted that it is applicable to any process where it is desired to apply steam. Additionally, it should be further noted that although the steam application system has been shown and described with the high pressure, high temperature chamber mounted above the low pressure chambers 8 and the jets from the outlets 13 existing upwardly, the steam application system may be oriented in any desired position; the only modification necessary being the relocation of the condensate drain 7.

It will be obvious that other modifications will occur to those skilled in the art within the scope of the appended claims.



What I claim is:

1. A method of distributing substantially dry steam comprising:
(a) directing steam to a first chamber,
(b) directing said steam from said first chamber to a second chamber,
(c) maintaining an appreciable pressure differential between said first and second chambers, and
(d) redirecting said steam from said second chamber through said first chamber to ambience.

2. The method of claim 1 wherein:
(a) said pressure differential between said first and second chambers is maintained by reducing the pressure of the steam in said first chamber as it is directed to said second chamber.

3. The method of claim 2 wherein:
(a) said pressure differential between said first and second chambers is maintained at at least 10 p.s.i.

4. The method of claim 3 further comprising:
(a) maintaining a pressure differential between said second chamber and ambience of less than one p.s.i.

5. The method of claim 4 further including:
(a) redirecting said steam from said second chamber through said first chamber to substantially atmospheric conditions.

6. The method of claim 5 further comprising:
(a) removing condensate from said first chamber.

7. Apparatus for distributing substantially dry steam comprising:
(a) a first, high pressure chamber,
(b) a second, low pressure chamber,
(c) means establishing fluid communication between said first and second chambers, and
(d) means for redirecting steam from said second chamber through said first chamber to ambience.

8. The apparatus of claim 7 wherein:
(a) said redirecting means comprises conduit means mounted in said first chamber and establishing fluid communication between said second chamber and ambience.

9. The apparatus of claim 8 wherein:
(a) said means for establishing fluid communication between said first and second chambers comprises valve means interconnecting said two chambers.

10. The apparatus of claim 9 further comprising:
(a) a series of openings defined in a wall of said first chamber,
(b) a series of openings defined in a wall of said second chamber,
(c) said conduit means having inlet and outlet ends,
(d) the inlet ends of said conduit means being positioned in said openings in said second chamber,
(e) the outlet ends of said conduits being positioned in said openings in said first chamber,
(f) means for supplying steam to said first chamber, and
(g) means for removing condensate from said first chamber.


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