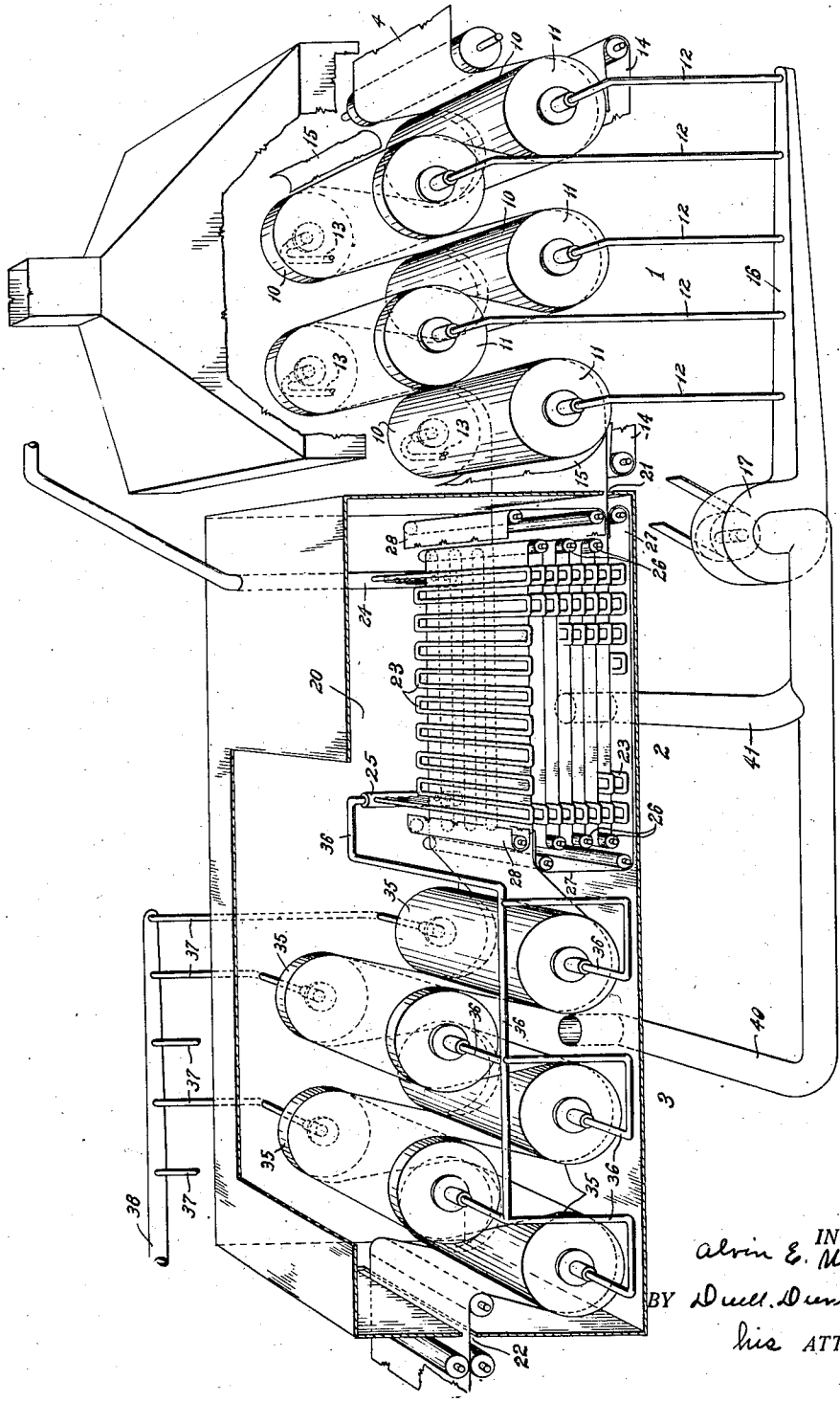
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A. E. MONTGOMERY

METHOD OF PAPER DRYING AND APPARATUS THEREFOR

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Alvin E. Montgomery INVENTOR.

BY Duell, Dunn & Anderson

his ATTORNEYS.

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ALVIN E. MONTGOMERY, OF OAK PARK, ILLINOIS.

METHOD OF PAPER DRYING AND APPARATUS THEREFOR.

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This invention relates to paper manufacture, and more particularly to a process and apparatus for drying the moisture from the web.

In the manufacture of paper, the web is first formed on a screen, the surplus moisture squeezed out or otherwise removed, and it is then dried and, if desired, calendared. The most common method of accomplishing the drying operation consists in passing the formed web over a plurality of heated rolls, with which it is maintained in intimate contact, often by means of a canvas belt or "felt."

The paper as it comes from the paper making machine may contain about one to two and a half pounds of water for each pound of dry paper, and one of the serious problems in drying the paper is the furnishing of the heat necessary to evaporate this moisture and the imparting of this heat to the paper without the employment of unduly high temperature. As a result, in the practical manufacture of paper, especially thin paper, produced at high speeds, it sometimes happens that as many as one hundred and fifty or eighty of these drying rolls are required, and as each of them is several feet in diameter and frequently eight to twenty-two feet long, the space occupied by the drying machinery alone is considerable. Furthermore, the driers must be constantly maintained at or above steam temperatures, and the consumption of heat is necessarily large.

In this customary method, as will be obvious, the heating is performed only while the paper is in contact with the rolls and hence it is not continuous, as a cooling effect necessarily occurs in passing the web from one roll to another.

Moreover, the drying is performed under atmospheric conditions, the actual evaporation taking place at slightly under the boiling point of water, and the vapor slightly cools as it leaves the web and comes into contact with the air. Under such conditions, the quantity of moisture evaporated is very largely affected by the saturated condition of the air immediately surrounding the paper due to the moisture which has been previously driven off from the webs. Furthermore, the heat absorbed by the vaporization is largely if not entirely lost and dissipated except as it may be partially utilized for ventilation and heating purposes under some modern systems.

It is an object of the present invention to overcome many of the difficulties and objections attendant upon such methods of drying, and not only to simplify and render the drying machinery more compact and less expensive, but to materially reduce the cost per ton of the drying operation, while at the same time to improve the character of the product.

More specifically, it is an object of this invention to effect the drying of the paper more quickly and with less complication of apparatus.

I have discovered that if paper be subjected to the direct action of superheated steam that the drying is very much hastened and the drying apparatus very much simplified. Also, if enough heat be supplied and so distributed as to maintain the atmosphere immediately surrounding the web at a temperature far above the boiling point of water at the pressure involved, in spite of the evaporation, the superheated steam atmosphere may, in fact, be produced from the moisture in the paper itself.

If such operation be carried on in an enclosure it maintains in the immediate vicinity of the paper an atmosphere which in effect is very dry, and which is higher in temperature than the paper and higher than the boiling point of the contained moisture, and thus serves to heat and dry the paper continuously and very rapidly. This is particularly true as compared with the present practice in which the moisture, evaporated from the rolls at a temperature higher than the surrounding atmosphere, cools immediately as it leaves the web, producing a layer of air in the immediate vicinity of the paper which is supersaturated with moisture.

It is a further object of the invention greatly to economize the cost of drying by reducing the amount of heat. In the drying of paper, the heat is largely consumed by furnishing the latent heat of the moisture to be eliminated. As heretofore conducted, once this heat was absorbed, it was not again utilized in the process. In accordance with this invention, however, provision is made whereby the heat absorbed in one stage of the drying operation is conserved in a form available for reuse at another stage. This may be accomplished by drying the paper at progressively different temperatures whereby the heat absorbed from the paper at one stage may be utilized at another stage to effect drying at a lower temperature. The drying by

an atmosphere of superheated steam lends itself readily to this result since the evaporation produces within the chamber large quantities of steam substantially at atmospheric pressure and materially above the boiling point. This permits of the transfer of this steam to another portion of the apparatus to be used as a heating medium therein.

The invention accordingly comprises the steps hereinafter described and the relation and order of one or more of them with respect to each of the others and the apparatus embodying the features of construction, combination of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

The drawing is a diagrammatic perspective of an apparatus embodying the invention and with which the process may be carried out. The web forming mechanism itself is not illustrated as it forms no specific part of this invention.

In feeding the paper to an atmosphere of superheated steam, I find it desirable to have it enter that atmosphere already considerably preheated, since if it enters cold, it must be heated by the steam and this causes the precipitation upon it of moisture which must be reevaporated before further drying can begin. In the preferred embodiment, therefore, the invention contemplates a preliminary heating as well as intensive drying. It is desirable also to add a third stage in which the paper is passed over heated rolls while still slightly damp in order to insure that it shall be finished flat and smooth. This division of the invention also facilitates the economy of heat since it enables the heat recovered from the intensive drier to be used to effect the preliminary heating or the final drying, or both. It is desirable to so proportion the parts of the apparatus that all of the available heat carried by the superheated steam will be utilized in other stages.

The apparatus, herein illustrated, therefore, includes an initial stage 1, comprising drying rolls and an intermediate stage 2 comprising the drier in which the intensive drying by superheated steam is carried on, and a final stage 3 comprising drying and finishing rolls. The paper coming from the machine as shown at 4 is conducted successively through these apparatus.

In the specific form of apparatus illustrated the initial drier comprises a plurality of rolls 10, each of which preferably has a thin circumferential wall and insulated ends 11. Means are provided for feeding steam into these rolls by an inlet pipe 12 while pipes 13 serve to permit the exit of exhaust steam and condensed water. Any convenient means may be provided associated with these rolls for causing the water to pass out of outlets 13.

The various rolls 10 are arranged on parallel axes, so that the paper may be threaded over them, preferably supported by the usual canvas strips or felts 14 and 15. These felts have herein been shown diagrammatically only, as their specific construction forms no part of this invention. The various inlets 12 may be connected to a header 16 receiving steam from a supply pump 17 from the chamber of the second stage, as will be hereinafter described. These rolls serve to raise the temperature of the freshly made paper and to evaporate therefrom an appreciable quantity of the contained moisture, and to dry it to the point where it can support its own weight. In practice the paper may leave these rolls at about 160 degrees F. During this first stage of drying, it may be desirable to maintain the paper under tension.

The second stage drier comprises a chamber 20 which is substantially steam tight save in so far as it is necessary to provide an inlet 21 and an outlet 22 for the paper web, and save for the steam outlet to be later described. This web inlet and outlet are preferably so designed as to admit the web with the minimum infiltration of air.

Within the chamber 20 is provided means for maintaining the atmosphere in the immediate vicinity of the paper at a temperature very materially above the boiling point. Since this results in a very large evaporation with a consequent cooling effect on the web, it is desirable that the heating means be distributed to affect the web as intimately as possible. As illustrated, the heating means comprises a plurality of layers of pipe 23, each layer being arranged in zigzag formation extending from an inlet header 24 to an exhaust header 25.

A plurality of rollers 26 are arranged at each end of the bank to permit the web to be threaded back and forth between the layers, the rollers being arranged to receive the paper coming from between two layers and to reverse it to be fed backward between the next two layers. If desired, the web may be supported at this stage also by felts or wires 27 and 28. The pipes 23 are designed to receive steam at a high temperature, as for example 200 lbs. pressure. This, allowing for inefficiencies of heat transfer, and in spite of the cooling effect of the evaporation, maintains the temperature within the chamber in the neighborhood of 260°. This corresponds to a superheat of substantially 48° if the pressure within the chamber be substantially atmospheric.

The drying effect of such an atmosphere is in excess of what can be obtained in any practical manner at temperatures approaching the boiling point. This steam either as it enters or leaves the header 25, may be reduced to a lower pressure, as for example 20 lbs. This causes a re-evaporation of an appreci-

able quantity of the condensed water for use in the third stage.

The rolls 35 of the final drier 3 are in general similar to the rolls 10 of the initial drier, save that it will not usually be necessary to support the web at this stage with felts. The rolls 35 may be supplied with steam through a pipe 36 leading from the header 25. The exhaust from these rolls may be carried off by pipes 37 to a header 38. In the form illustrated the drier 3 may be enclosed within the chamber 20.

The exhaust from the chamber 20, comprising the superheated steam given off from the webs, may be utilized to heat the initial drying rolls. To that end it may be led by conduits 40 and 41 from the casing to the fan 17 to be forced by it into the initial drying rolls. Obviously separate casings may be employed for the driers 2 and 3 if desired and also superheated steam from the intermediate drier 2 may be utilized to heat either the initial rolls or the final rolls or both, depending upon the quantity of steam available and the effect desired.

With the process above described the web is subjected to the highest temperature in the second stage drier 2, and it is preliminarily heated by the first stage drier 1. Furthermore, as the web leaves the drier 2 and it passes into drier 3, it is not necessarily maintained at the high temperature even though both are enclosed by one casing.

It will thus be observed that the initial stages of heating and the final stages are both at lower temperature than the intermediate.

It will also be seen that the water evaporated from the paper is at all times kept completely separated from the boiler steam used as the primary source of heat so that there can be no contamination of the boiler water by pulp or impurities. The water condenser in the drier 1, therefore, serves as a source of clean hot water for re-use in the paper making process, thus still further conserving its heat. The condensed boiler water from the final drying rolls and the condensate from the header 25 may be used as a source of boiler feed if desired.

By the above process it will be clear that the drying is accomplished much more intensively with a very large saving in apparatus and consequent overhead expense in the plant. This may also obviously be utilized to increase the speed of paper manufacture and thus the plant capacity.

A practical illustration of the operation of such a plant may be as follows:—

We may assume that the sheet comes from the paper making machine with somewhat more than two pounds of water per pound of dry paper, of which two pounds are to be evaporated. This means, in a fifty ton plant, the evaporation of 139 pounds of water per minute. The plant may be designed to evaporate 46.3 pounds in the first drier, 86.2 pounds in the second drier and 6½ pounds in the third drier. The steam may be supplied to the coils of the second stage at 200 pounds per square inch, which may maintain the temperature of the steam generated within the chamber 20 as it is exhausted from the chamber at about 232 degrees Fahrenheit, although a somewhat higher temperature will be produced at the webs. These correspond to steam consumption within the plant of substantially 1.74 pounds of steam per pound of paper dried, which is about one half the steam used in the customary paper drying machines which, at present commercial rates, is a very material saving in steam consumption alone.

Furthermore, by reason of the fact that the apparatus is more compact and the heat more nearly concentrated on useful work, it would be clear that there would be less parasitic radiation of heat into the room. This process, in addition to enabling the capacity of the mill to be increased with an improved product, also reduces the steam capacity per pound of paper produced to substantially one-half that required by existing processes, and at the same time frees the mill from a large part of the space now occupied by the present cumbersome drying machinery.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In an apparatus for drying paper, in combination a plurality of drying drums, a drying chamber having surfaces therein heated by high temperature steam, a plurality of finishing drying drums and means for passing steam from said surfaces to said finishing drying drums whereby the latter are heated by the steam which is cooled by said surfaces, and means for subjecting the paper to the influence of said surfaces to generate steam therefrom and means for conducting said generated steam to said initial drying drums.

2. A process of drying paper consisting in

supplying steam to heating means, forming superheated steam, using said superheated steam for preliminary heating purposes and withdrawing the steam from said means for use in other heating means.

3. A process of drying paper consisting in subjecting the paper to steam heated coils in one step of the process, forming superheated steam for another step in the process and using the steam from the coils in a third step of the process.

4. A process of drying paper which comprises passing it over steam heated coils heated to a temperature sufficiently above the boiling point to produce an atmosphere of superheated steam, using the superheated steam in another step of the process and using the steam from the coils to complete the process.

5. An apparatus for drying paper comprising first means adapted to be heated by steam under pressure, means for subjecting a web of paper to said first means whereby the moisture from the web will be converted into superheated steam, means for using said superheated steam to preliminarily heat another portion of the web in its passage to the first means, and finishing means for utilizing the steam from said first means at a different pressure.

6. In a system for drying paper, preheating means for evaporating moisture from a web of paper by utilizing superheated steam formed in a main heating chamber, heating apparatus in said chamber utilizing steam under pressure to cause the evaporation of moisture from the web and the transformation of said moisture to superheated steam for the preheating means, and finishing means employing steam from the heating apparatus at a lower pressure to cause the re-evaporation of condensed water from said steam and to further heat the web to substantially dry condition.

7. In a combination of apparatus for drying paper, a chamber, heat radiation means in the chamber, means for moving a web of paper in association with said radiation means to convert moisture in said web into superheated steam, other heating means in said chamber adapted to be heated by steam from said radiation means, the web being adapted to contact therewith to become substantially dry.

8. In a combination of apparatus for drying paper, a chamber substantially steam tight, a plurality of heating means in said chamber, means for moving a web of paper through said chamber in intimate association with said heating means, heating drums in said chamber utilizing steam from said first means at a lower pressure, heating drums without the chamber adapted to utilize superheated steam formed in the chamber.

9. In a combination of apparatus for drying paper, a chamber substantially steam tight except for an inlet and an outlet for a web adapted to pass therethrough, means heated by steam at a certain temperature adapted to dry the web passing through the chamber and form superheated steam from the moisture evaporated from the web, other heating means in the chamber heated by steam from said first means at a lower temperature, the web adapted to contact therewith to be further dried, the superheated steam in said chamber being adapted to serve preheating means without the chamber for initially heating the web prior to its entering the chamber.

In testimony whereof I affix my signature.

ALVIN E. MONTGOMERY.