

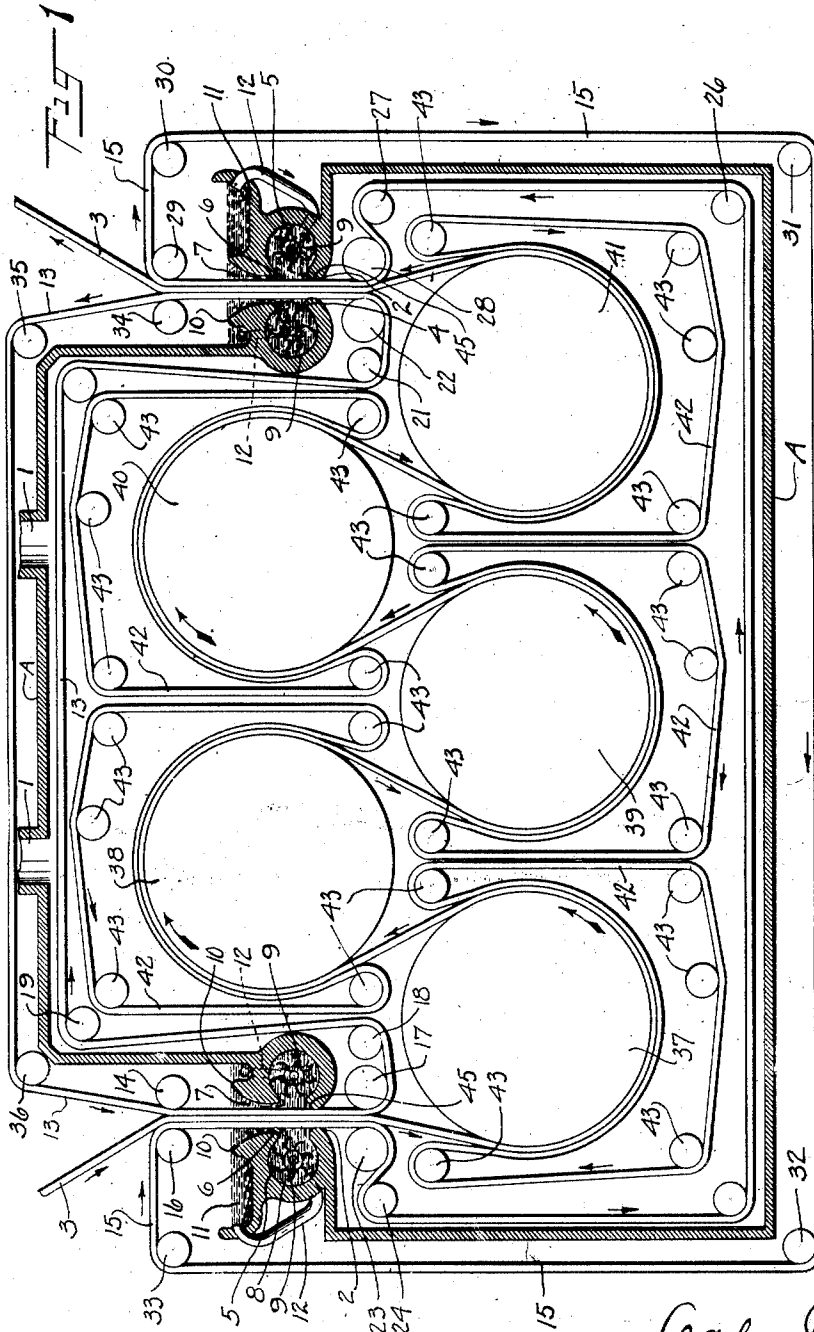
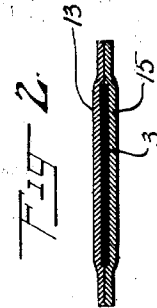
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VELOCITY FLUID VACUUM SEAL, METHOD, AND APPARATUS

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VELOCITY FLUID VACUUM SEAL, METHOD, AND APPARATUS.

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My present invention is covered broadly in my companion application Ser. No. 427,436 filed Nov. 30, 1920 and my companion application Ser. No. 530,990, filed January 21, 1922; this application being a species of the genus disclosed and claimed in said cases.

My invention relates to the method of treating materials in a vacuum, and more particularly to the method of protecting the opening or openings into the vacuum chamber, through which opening or openings the material to be treated is introduced and withdrawn from the chamber.

My invention relates more particularly to a vacuum seal maintained by the application of velocity head, i. e. the difference in pressure between the atmosphere and vacuum being balanced by the velocity head of the sealing medium. Through this seal the material to be treated in the vacuum chamber is passed in any suitable manner.

My invention further relates more particularly to the method of drying sheet material, as a continuous web of paper either coming from the wet end of a paper machine, or from a sizing vat, or from a coloring apparatus, coating machine or printing machine or directly from a roll of wet paper.

My invention further relates to a vacuum apparatus including a vacuum chamber having passages extending from the said vacuum chamber and open to the atmosphere. These passages are protected by velocity fluid seals which prevent the admission of air into said vacuum chamber as the material to be treated is introduced and withdrawn through said seals.

My present invention relates to employing water, or other similar fluid having an affinity for the material being treated, as the fluid of the velocity seals, or any other suitable sealing liquid whether it has an affinity for the web or not.

My invention further relates to employing passages having restricted areas merging into progressively larger areas between the atmosphere and the interior of the vacuum chamber, forming in effect Venturi nozzles, through which the fluid of the velocity fluid seals flows and the web passes.

My invention more particularly relates to employing fountains of sealing liquid at the

entrance and exit passages to guard said passages against the admission of air into the vacuum chamber. The flow of the liquid in these fountains may just be sufficient to equal the pressure of the atmosphere, in which case the sealing liquid would have practically no flow. Preferably the flow of the sealing liquid in the fountains is a little greater than that necessary to balance atmospheric pressure, in which case there will be a bubbling of the liquid out of the restricted passage of the fountain, the liquid preferably being caught in catch basins.

My invention further relates to certain steps, and combinations of steps, also to certain elements and combinations of elements, whereby the method or processes herein described may be carried out, as well as to certain details of construction, all of which will be more fully hereinafter described in the specification and pointed out in the claims.

I have shown in the drawings, one form of apparatus which may be used to carry out my improved method, but it is to be distinctly understood that my invention is not to be confined to the particular form of apparatus, shown by way of illustration.

In the accompanying drawings the same reference numerals refer to similar parts in the several figures.

Fig. 1 is a vertical diagrammatic view of one form of my invention;

Fig. 2 is a transverse vertical section through the web and the upper and lower carrier belts.

The vacuum chamber A has a vacuum maintained therein in any suitable manner by connecting the pipes 1, 1 with any suitable exhausting apparatus. This vacuum chamber has two passages 2, 2 open to the atmosphere. Through these passages the material to be treated in the vacuum chamber A is introduced and withdrawn. Of course if the passages were left unguarded the vacuum in the vacuum chamber A would be broken.

My invention consists in guarding these passages 2, 2 from the atmosphere by fountains of sealing fluid, the fluid having an affinity for the web treated; or the sealing fluid may have no affinity for the web treat-

ed, such fluids for example, as mercury, amalgam or any similar substance.

I have shown the continuous web 3 of paper coming either from the wet end of a paper machine, or from a sizing vat, or from a coloring apparatus, printing machine, coating machine or directly from a roll of wet paper. This web 3 passes into the vacuum chamber A through the restricted passage 2 guarded by the entrance fountain 4. The sealing liquid 5 is caused to move in the fountain and pass through the restricted nozzle 6 into the progressively larger portion 7. Whatever velocity the liquid may have as it passes through the Venturi nozzle 6, its velocity will be reduced as it passes into the enlarged portion 7. The velocity of this sealing liquid must be such that it exerts a pressure which will equal the pressure of the outside atmosphere. I have shown my fountain 4 provided with two rotary pumps 9, 9, which propel the sealing fluid through the restricted passage 6 in the direction of the enlarged opening 7. For economy of operation, the speed of the rotary pumps 9, 9 should just be sufficient to cause the moving sealing liquid 5 to exert a pressure which will equal the atmospheric pressure, in which case, if maintained, there would be practically no movement or circulation of the sealing liquid. In practice, however, I preferably run the rotary pumps 9, 9 so that the moving liquid of the seal will have just sufficient velocity to slightly overcome the pressure of the atmosphere, causing the sealing liquid to bubble or flow over the lip 10, and into the catch basin 11. When the catch basin is full of sealing liquid the excess may be permitted to run to waste, or, it may be led by the pipe 12 back to the pumps 9, 9, so that it may be used over and over again. The rotary pumps revolve at such a speed and in such a direction that they throw the liquid of the seal towards the restricted passage 6 and away from the slot 45 so that no sealing liquid will pass through said slot into the vacuum chamber A.

The fountain 4 guarding the exit passage 2 of the vacuum chamber, is the same as that just described.

When the sealing liquid is water or any suitable liquid that has an affinity for the web 3 of paper or similar material. I provide means to protect the web from contact with the sealing liquid when it passes through the fountains guarding the entrance and exit of the vacuum chamber. I may, for example, as shown in Fig. 1, use an upper carrier belt 13 passing over the guide roll 14, where it meets the web 3 and the lower carrier belt 15, as it passes over its own guide roll 16. These upper and lower guide belts 13 and 15 are formed of some waterproof material and are wider than the web 3 and thoroughly protect it as shown for example in Fig. 2.

The web 3 is then fed continuously, with its surrounding and protecting waterproof carrier belts 13 and 15, through the entrance fountain 4 and into the vacuum chamber A. As soon as the carrier belts 13 and 15 are well within the vacuum chamber, I separate them by causing the upper carrier belt 13 to pass over the guide rolls 17, 18, 19, 20, 21 and 22. The lower carrier belt 15 is passed over the guide rolls 23, 24, 25, 26, 27 and 28, where it again meets the web of paper, now dry, and passes with it and the upper carrier belt 13 through the exit fountain 4. The lower carrier belt is caused to move continuously over the guide rolls 29, 30, 31, 32, and 33 back to the guide roll 16. The upper carrier belt 13 is likewise caused to move continuously over the guide rolls 34, 35, and 36 back to the guide roll 14.

It is found in practice that the shrinkage of the web 3 upon the different drying drums or cylinders 37, 38, 39, 40 and 41 is unequal. I, therefore, provide separate and individual felts 42, 42 for each one of the drying drums of cylinders 37, 38, 39, 40 and 41, the felts passing continuously over their respective guide rolls 43, 43.

My invention is particularly adapted to be used in connection with drying sheet material in the form of paper, though it is to be distinctly understood that it is equally applicable to and covers drying sheet material in the form of textile fabrics, as for example, drying such fabrics after they have been washed or bleached or dyed, or otherwise treated by a liquid of some description.

While I preferably use the same liquid in each of the fountains 4, 4, I may, of course, use one liquid in one fountain and a different sealing liquid in the other.

My method possesses many advantages not present in processes heretofore used for many years in the drying of paper.

The evaporation process, which is characteristic of the so-called loft drying of paper, has many fully recognized disadvantages, and yet it is used today and has been in use for many years. In this method the wet paper is taken from the paper machine, cut into sheets, hung on poles, carried to the drying room where it is subjected to hot air at about 130° F. for about 48 hours, and when dry, each sheet is separately calendered. Although possessing the advantage of drying at a comparatively low temperature, where by the moisture is slowly evaporated, loft drying is obviously very inefficient and costly, because it requires many separate manipulations, is extremely slow, uses extensive floor space and wastes heat.

The process which is employed in the ordinary paper machine in common use, is likewise subject to many disadvantages. In such machine, the wet paper as it comes from the paper machine, is passed over many

revolving cylinders, heated internally by steam to sufficiently high degree of heat, to raise the temperature of the water in the paper to 212° F., the atmospheric boiling point of water. It is customary to supply the drying cylinders with steam at approximately 5.3 pounds gauge pressure, at which the steam has a temperature of 228° F., giving a difference of temperature (228°—212°) of only 16° F. With this slight difference of temperature the transfer of heat is extremely slow, and hence it is necessary to employ many drying cylinders, in board machines often one hundred, and in news print machines, forty or more.

Also due to convection and conduction losses, as well as those incident to leaks in the piping system and other inefficiencies, the heat actually required for atmospheric drying of a ton of wet paper, is very much in excess of the theoretical requirement. The thermal efficiency of atmospheric drying by steam heated cylinders is therefore very low. Furthermore, the vapor produced from boiling the water out of the paper, is driven off into the operating room, and although fans and exhausters are employed, at large expense for power and maintenance, the room atmosphere is so constantly saturated with moisture as to rust and ultimately destroy all iron and steel materials, and produces an exceedingly disagreeable and unhealthy atmosphere in which to work. It is well known that the minimum temperature 212°, the atmospheric boiling point of water, is positively injurious to, and results in oxidizing, the fibres of the paper, the strength of which is vastly improved when the paper is dried at lower temperatures, as in loft drying. This atmospheric drying process requires large initial cost for cylinders, felts, and other necessary equipment, and extensive floor space, and results in the consumption of large amounts of power, and great cost for operation, maintenance and repairs.

In my improved vacuum drying method I contemplate maintaining within the chamber a vacuum of about 28" of mercury, in which water boils at 100° F., and supplying the drying cylinders with steam at 5.3 pounds gauge pressure, producing a temperature of 228° F. The temperature difference between the temperature of the steam in the cylinders and that of the paper, is therefore, 128° F. in my vacuum method, or 8 times greater (16° F. $\times$ 8 = 128° F.) than the temperature difference in atmospheric drying. In my improved method the paper dries approximately 8 times faster than in atmospheric drying, and I require only about one-eighth the number of drying cylinders to dry paper at the same rate of speed. I am able to dry paper with 5 cylinders in the same time required of 40 cylinders

drying at atmospheric pressure, resulting in great economies in cost of the machine, floor space and of necessary piping, felts, auxiliary equipment, and particularly in power and maintenance charges.

The thermal efficiency of my vacuum method is very much greater than that of the atmospheric cylinder drying heretofore in universal use for drying paper. Theoretically, it requires about 4287 pounds of steam to dry one ton of paper at atmospheric pressure, but to compensate for convection and conduction losses, and those due to leaks in the piping system, and other inefficiencies, it has been shown in practice that about 10,600 pounds are required.

In my method, using a vacuum of about 28", the convection, conduction and piping losses are exceedingly small and the total steam required to dry a ton of paper by my method is approximately 5200 pounds.

It is an established fact that paper dried at low temperatures is much stronger than when it is dried at the high temperatures used in paper machine atmospheric drying. Paper dried in a vacuum of 28", or at a temperature of about 100° F. as in my method, is very much stronger than paper dried at atmospheric pressure, when the steam in the driers is at 228° F. When paper is dried by my method, therefore, a cheaper furnish or stock can be used and still produce a paper equal in strength to atmospheric dried paper, in which a higher grade furnish or stock is used. In making newsprint paper, I am able to dispense with a considerable portion of the more expensive sulphite pulp, as this can be replaced with the cheaper ground wood pulp. By my method I also reduce the number of breaks in the web as it passes over the cylinders.

Furthermore, in my method there is a great saving of heat (or steam) because the process is carried on in a vacuum chamber which acts on the principle of a thermos bottle, and the steam and vapors driven out of the wet paper are caught in the closed vacuum chamber, and conducted away to the condenser. The operating room is free from steam, humidity and heat, and fans, and exhausters are dispensed with. In the use of my method the apparatus is at all times operating under definite humidity, the control of the drying can be closely standardized, and the moisture content in the paper carefully regulated.

Some of the modern open air dryers are equipped with a blower system by which air, either heated or not, is blown through the dryer section, which will lower the temperature at which the water is evaporated from the paper much below 212° F. and may, in some cases, reduce the temperature of evaporation as low as 180° F. or lower.

Having pointed out the many advantages of my method and apparatus over those heretofore used, it will be apparent that the use of my invention results in great economy in the initial cost of apparatus and in large savings in cost of operation, maintenance and repairs.

Having thus described this invention in connection with an illustrative embodiment thereof, to the details of which I do not desire to be limited, what is claimed as new and what is desired to secure by Letters Patent is set forth in the appended claims.

What I claim is:—

1. The method of sealing a vacuum chamber having openings for the admission and withdrawal of material into and from said vacuum chamber consisting in propelling a sealing liquid through the openings against the pressure of the atmosphere and with sufficient force to exceed the pressure of the atmosphere to prevent air working into the vacuum chamber.

2. The method of drying a web of paper or other sheet material consisting in passing it into and out of a vacuum chamber through entrance and exit passages opening upwardly, and through a sealing liquid propelled in a substantially vertical direction and with sufficient velocity to exceed the pressure of the atmosphere and drying the web of paper in the vacuum chamber.

3. The method of drying a web of paper or other sheet material consisting in passing it into and out of a vacuum chamber through entrance and exit passages opening upwardly, and through water mounted in said passages and propelled in a substantially vertical direction and with sufficient velocity to exceed the pressure of the atmosphere and protecting the web from contact with the water and drying the web of paper in the vacuum chamber.

4. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of sheet material, fountains protecting the entrance and exit passages, said fountains being provided with passages for the web of sheet material, a sealing liquid in the fountains, and means to cause the liquid to move with sufficient velocity to obtain a pressure slightly exceeding that of the atmosphere to prevent air working into the vacuum chamber.

5. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of sheet material, fountains protecting the entrance and exit passages, said fountains being provided with passages for the web of sheet material, a sealing liquid in the fountains, and means to cause the liquid to move with sufficient velocity to obtain a pressure slightly exceeding that of the atmosphere to

prevent air working into the vacuum chamber, and means to prevent the liquid of the seal contacting with the web.

6. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of sheet material, fountains protecting the entrance and exit passages, said fountains being provided with passages for the web of sheet material, a sealing liquid in the fountains, and means to cause the liquid to move with sufficient velocity to obtain a pressure slightly exceeding that of the atmosphere to prevent air working into the vacuum chamber, and upper and lower carrier belts to prevent the liquid of the seal contacting with the web.

7. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of paper, fountains including rotary pumps located in and guarding the entrance and exit passages, and a sealing fluid in said fountains.

8. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of paper, fountains including rotary pumps located in and guarding the entrance and exit passages, and water in said fountains.

9. In a vacuum apparatus provided with entrance and exit passages opening upwardly for the continuous passage of a web of paper, fountains including rotary pumps located in and guarding the entrance and exit passages, a sealing fluid in said fountains, and a catch basin and means to lead the overflow liquid back to the rotary pumps.

10. The combination in a vacuum apparatus of one or more fountains guarding passages opening upwardly into the vacuum chamber, each fountain provided with a passage for the material to be treated and having pumping means located in the passages adapted to propel a sealing liquid in the direction of the atmosphere and at sufficient velocity to obtain a pressure exceeding the pressure of the atmosphere, and said sealing fluid.

11. The combination in a vacuum apparatus of one or more fountains guarding passages opening upwardly into the vacuum chamber, each fountain provided with a passage for the material to be treated and having pumping means located in the passages and adapted to propel a sealing liquid in the direction of the atmosphere and at sufficient velocity to obtain a pressure exceeding the pressure of the atmosphere, and said sealing fluid having an affinity for the material treated.

12. The combination in a vacuum apparatus of one or more fountains guarding passages opening upwardly into the vacuum chamber, each fountain provided with a pas-

sage for the material to be treated and having pumping means located in the passages and adapted to propel a sealing liquid in the direction of the atmosphere and at sufficient velocity to obtain a pressure exceeding the pressure of the atmosphere, and water as the sealing liquid.

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13. The combination in a vacuum apparatus of one or more fountains guarding passages opening upwardly into the vacuum chamber, each fountain provided with a passage for the material to be treated and having pumping means located in the passages

adapted to propel a sealing liquid in the direction of the atmosphere and at sufficient velocity to obtain a pressure exceeding the pressure of the atmosphere, and water as the sealing liquid.

14. The method of sealing a vacuum chamber provided with entrance and exit passages opening upwardly, consisting in closing said passages with a sealing liquid which by gravity supplemented by atmospheric pressure and the vacuum of the chamber tends to force the liquid into the vacuum chamber, and balancing these combined forces so that the sealing liquid continues to seal the entrance and exit passages.

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