

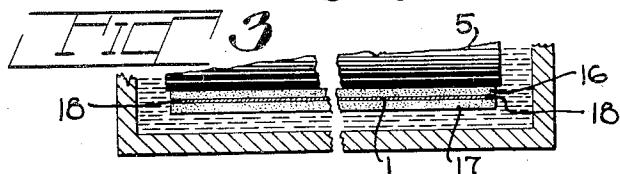
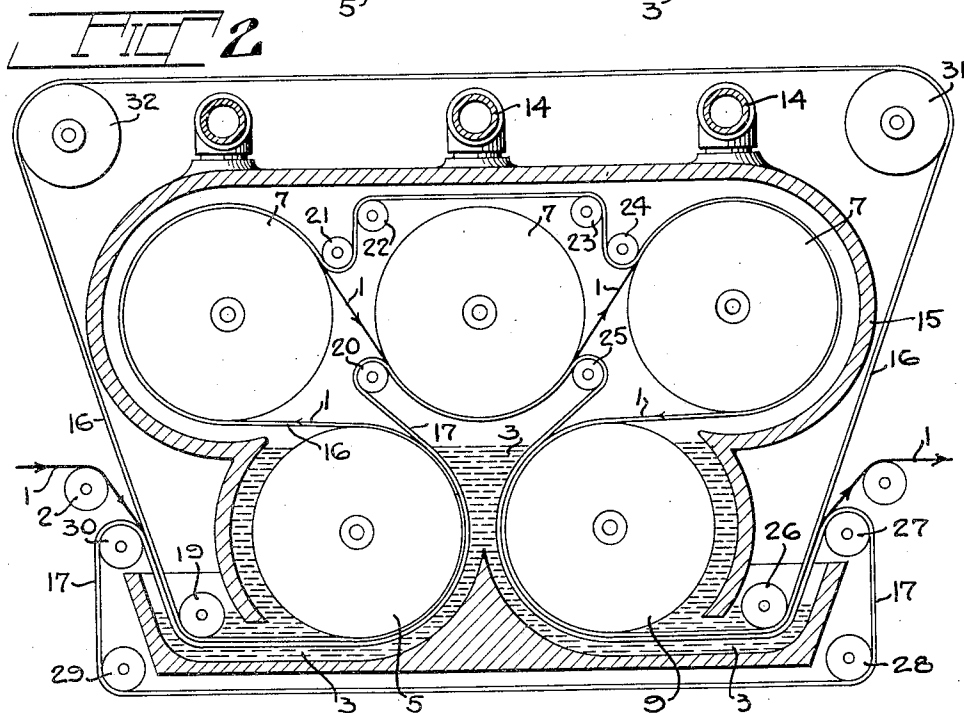
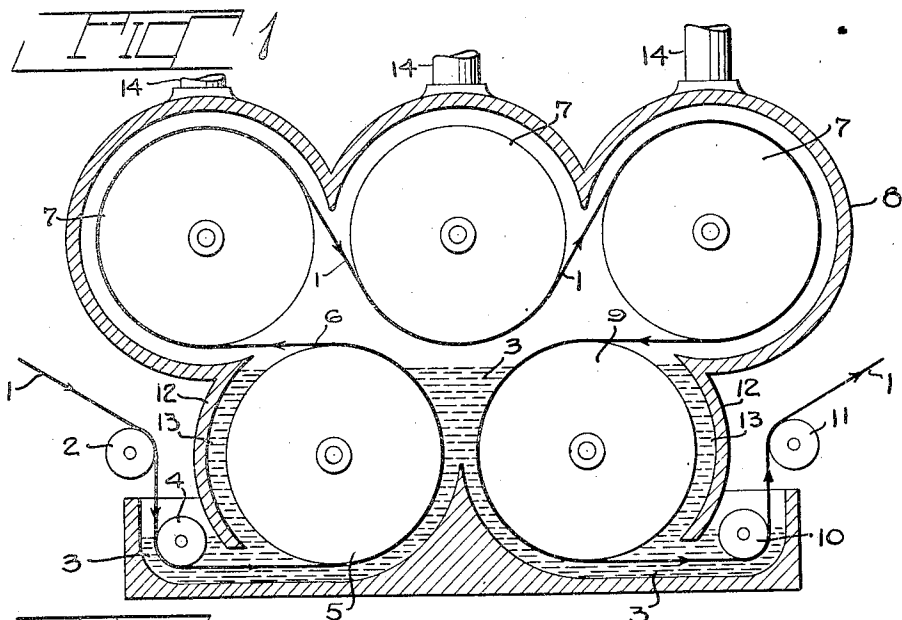
Aug. 10 , 1926.

O. MINTON

1,595,477

METHOD AND APPARATUS FOR DRYING SHEET MATERIAL.

Original Filed May 25, 1920 2 Sheets-Sheet 1



INVENTOR
Cedric Minton
BY
Allan W. Johnson
ATTORNEY

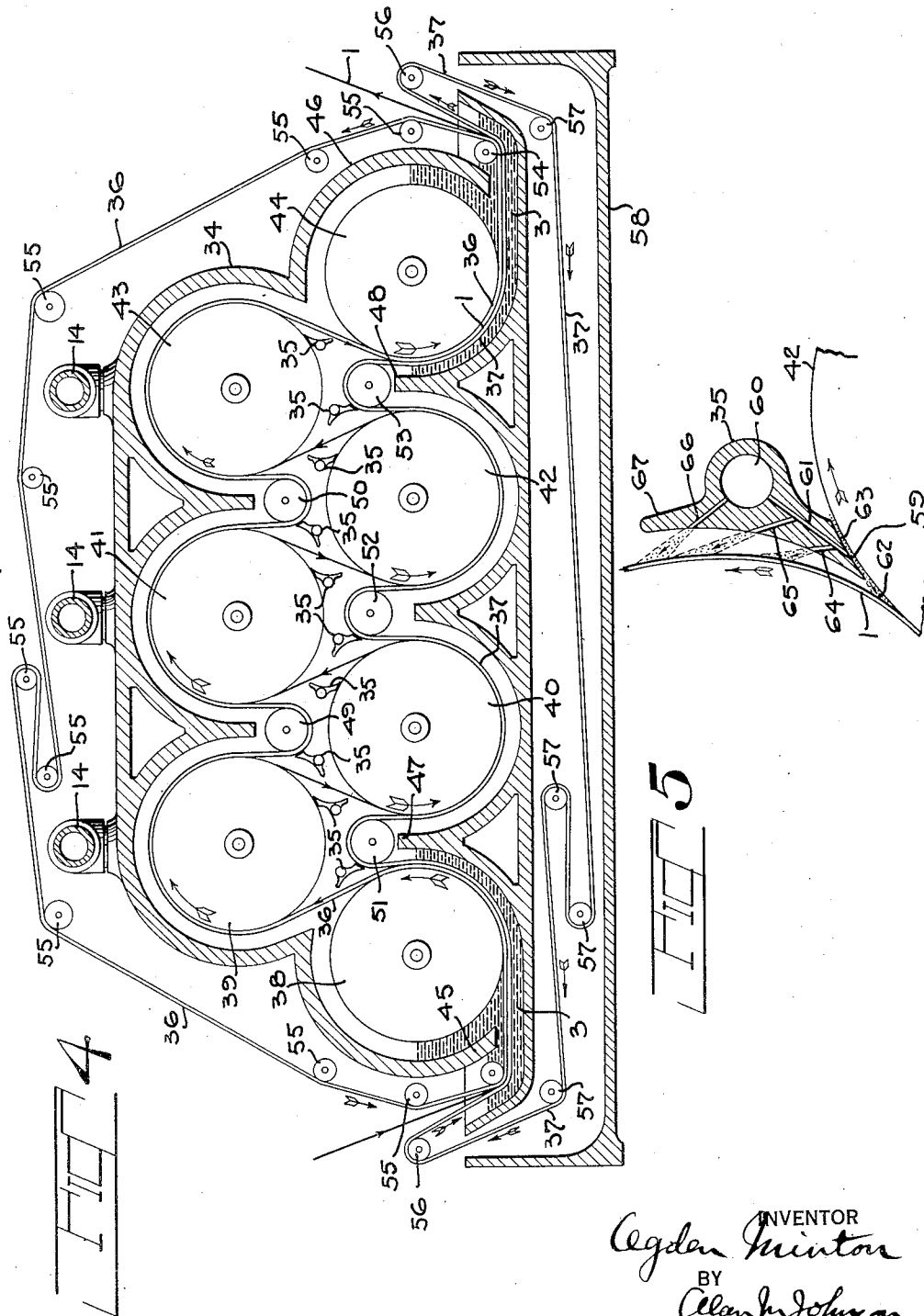
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METHOD AND APPARATUS FOR DRYING SHEET MATERIAL

Original Filed May 25, 1920 2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

OGDEN MINTON, OF GREENWICH, CONNECTICUT.

METHOD AND APPARATUS FOR DRYING SHEET MATERIAL.

Application filed May 25, 1920, Serial No. 384,212. Renewed February 17, 1926.

My invention relates to a method and apparatus for drying material, as for example sheet material, and more particularly to drying sheet material in the form of a web. My invention further relates more particularly to drying a wet web of paper coming from the wet end of a paper machine usually at high speed, though my invention is also adapted to dry this web at low speeds.

My invention further relates to feeding this material whether it be sheet material or a wet web of paper, or similar material, into a vacuum chamber through a liquid seal which has no affinity for, or deleterious effect, upon said web.

My invention further relates to feeding this web into said vacuum chamber in a manner which will prevent the web flapping or waving as it passes through the liquid seal. When the paper is dried by my improved method, which eliminates this flapping or waving of the web, the dry paper will not be crinkled. Where the wet web is permitted to wave or flap the resulting paper is more or less crinkled.

My invention further relates to reducing the amount of liquid necessary to form the liquid seal.

My invention further relates to passing the web over and in close contact with a guide cylinder partially immersed in the liquid seal.

My invention further relates to drying, the web of paper, or similar material, over a plurality of drying drums or cylinders mounted in the vacuum chamber, two of which are preferably partially immersed in the liquid seal and form the double function of driers and guides for the web. It is to be understood, however, in some cases, the guide cylinders need not be heated.

My invention further relates to passing the web into the vacuum chamber through a liquid seal and protecting all parts of the web, except the very edges, by endless felts.

My invention further relates to a vacuum apparatus in which the interior of the sealing chamber follows generally the curvature of the guide or drying cylinders, as the case

may be mounted in the liquid seal, the interior of said liquid chamber being located adjacent to the periphery of said guide cylinders or driers, so as to reduce the quantity of liquid necessary to fill the sealing chamber.

My invention further relates to manufacturing paper wherein the fibers are not weakened and the size in the paper is not injured or damaged due to drying at high temperatures.

My invention further relates to manufacturing colored paper and drying it without substantially impairing the coloring matter and mordants used in the paper. Among other advantages this insures that the paper will have bright colors which will be substantially uniform in different runs of paper, permitting matching of colored paper without any appreciable difference in tone or color.

My present invention is for an improvement on my prior Patent 1,147,809, patented July 27, 1915, and my co-pending application Ser. No. 350,233, filed Jan. 8, 1920.

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, different forms 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 section of one form of my improved vacuum apparatus in which the web of paper, or similar material, is fed over the guide cylinders without the aid of felts;

Fig. 2 is a vertical section through another form of my vacuum apparatus in

which endless felts are used to carry the web through the vacuum chamber;

Fig. 3 is a detail vertical section, on an enlarged scale, through a portion of the vacuum apparatus, the web and the two felts, showing that the felts protect the web of paper, or similar material, as it passes through the sealing liquid;

Fig. 4 is a vertical section through my preferred form of vacuum apparatus;

Fig. 5 is a detail vertical section, on an enlarged scale, showing one of my improved steam doctors.

In describing my invention I will describe it as applied to sheet material in the form of paper, though it is to be distinctly understood that it is equally applicable to and covers drying material and any 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.

In the ordinary drying of a web of wet paper such high heat is used as to injuriously affect the fibers of the paper; and in case the paper is colored it will materially affect the coloring matter and mordants used. In drying paper in the high temperatures used in ordinary practice it often affects the size, so that the resulting paper varies in quality, is not uniform, and is not a perfect product.

My invention is particularly adapted to dry the wet web of paper as it comes from the wet end of a paper machine, and will be so described in this application. In the manufacture of some classes of paper the web is fed, as for example in the manufacture of news, at the rate of 500 to 700 feet a minute. This web has to be dried as fast as it is fed from the paper machine. If it is not, or if any breaks occur, which are known in shop parlance as "broke," the web will pile up to the ceiling in a short time, foul the machine, require the stopping of the paper machine as well as the driers and rethreading of the web by hand through the driers. It is therefore absolutely necessary to satisfactorily dry this web as fast as it is made by the paper machine and reduce the "broke" to the minimum.

In the simplest form of my invention, shown in Fig. 1, the wet web 1 coming from the wet end of a paper machine at either high or low speed, as the case may be, passes over the guide roll 2, and into the liquid seal 3 under the guide roll 4, and thence in contact with the surface of the guide cylinder 5, while it is traveling in a vertical direction through the seal 3. It then leaves the guide cylinder 5 at the point 6, at a tangent to the guide cylinder 5 and in a horizontal plane, and almost immediately engages with the

drying steam heated drum or cylinder 7. It is completely dried by this and the other heated drying cylinders 7, 7 and passes out of the vacuum chamber 8 around the guide cylinder 9, through the seal 3, beneath the guide roll 10, and over the guide roll 11.

The sealing chamber 12 of the vacuum chamber 8 is so formed that it is very largely filled by the guide cylinders 5 and 9, so that only a comparatively little sealing medium 3 need be used. The liquid seal 3 may be of any suitable material which has no affinity for or deleterious effect on the web to be dried. Preferably I employ a seal of mercury but any amalgam, or other liquid having the characteristics above set forth may be used. The interior 13 of the sealing chamber is preferably formed in arcs of circles, the center of which are the axes of the cylinders 5 and 9 respectively. These drying cylinders 5 and 9 may act simply to guide the paper, or in addition thereto they may be heated in any manner, as by steam, when they perform the additional function of heating the paper and in effect become one of the drying cylinders 7, 7.

When a web of paper is fed through a sealing medium unsupported, it has a tendency to wave and flap. If this waving and flapping is sufficient for the web to engage with the fixed non-moving portion of the vacuum chamber, as for example a portion of the sealing chamber, the web is apt to cling to or be retarded by the fixed surface of the chamber, which will cause a break or "broke." This serves to foul the machine, requiring rethreading and delays which are very expensive in the manufacture of paper, as time is one of the most important factors.

Even if the waving or flapping of the web, while passing through the liquid seal and before it is taken up by one of the drying cylinders, is not sufficient to cause it to engage with the side of the sealing chamber which might break the web, it causes the fibers to rearrange themselves so that when the paper is dried it has an undesirable crinkle. This crinkle, as previously described, is more or less pronounced depending upon the amount of the waving or flapping of the web in its passage into the vacuum apparatus.

By my invention the web 1 is fed almost immediately on its entrance into the liquid seal 3 into contact with the rotating guide cylinder 5, which is traveling at the same rate of speed as the web. The web will cling to this guide cylinder during its vertical passage through the seal and until it emerges from the liquid seal 3, in the vacuum chamber 8, when almost immediately it passes onto the first of the driers 7,

so that there is no waving or flapping of the web and consequently the liability of broke from this cause is practically obviated. The undesirable crinkling of the paper is also prevented.

The required degree of vacuum within the vacuum chamber 8, preferably about 28 inches is maintained in any suitable manner, such as by connecting the pipes 14, 14 with any suitable vacuum apparatus.

Almost all paper mills are located on a stream of water or other abundant supply of water. With such a supply of cold water a barometric condenser or educator type of condenser may be used to maintain the vacuum without the use of an air pump. The cost of maintaining the vacuum is practically negligible and the cost of the apparatus itself is very low.

Preferably, though not necessarily, I feed the wet web 1 of paper, or similar material, through the liquid seal and through the vacuum chamber by means of endless felts.

I have shown in Fig. 2, a simple form of vacuum apparatus 15, having the drying drums or cylinders 7, 7 and the guide cylinders 5 and 9, which may also be steam heated, or not, as may be found convenient or expedient. If so heated, they become in effect steam drying drums, the same as the drums 7, 7.

Unlike in the other construction, however, the web 1 is fed through the vacuum chamber by means of the upper endless felt 16 and the lower endless felt 17. These felts are as wide as the web 1, and preferably a little wider, so that the web 1 is completely covered as it passes through the seal 3, except at its edges 18, 18. The web 1, protected by the felts 16 and 17, passes into the seal 3 under the guide roller 19, thence in contact with the guide cylinder or heated drier 5, as the case may be. The web 1 and the upper endless felt 16 pass around the first drying cylinder or drum 7. The lower endless felt 17 passes over the guide roll 20, and is in position to receive the web 1, after it has passed over the first drying drum or cylinder 7. The upper felt 16 after passing over the first drying drum or cylinder 7 is fed over the guide rolls 21, 22, 23, and 24, so that it will again contact with the web 1, when the web passes over the last drying drum 7. The lower felt 17, after passing over a portion of the periphery of the middle drying drum 7, passes over the guide roll 25 and thence contacts with the web 1 and passes around the guide cylinder 9 above the web, while the upper felt 16 is beneath the web.

The two felts with the enclosed web 1 then pass around the guide cylinder 9, through the seal 3, under the guide roll 26, and out of the seal, the web 1 being then perfectly dried and ready to be rolled or

reeled into a complete roll of finished paper, or cut into sheets as may be desired. The lower felt 17 after passing out of the liquid seal 3 passes over the guide rolls 27, 28, 29 and 30. The upper felt 16 passes above the vacuum chamber over the guide rolls 31 and 32.

In practice and particularly where the web is run at a high rate of speed, I use not only endless felts to guide the web through the vacuum chamber, but in addition thereto I preferably, though not necessarily, employ additional means to ensure the web passing through the vacuum chamber, even though it should break in the vacuum chamber. These additional means may be employed for threading the machine originally, and then be thrown out of operation, or they may be kept in operation to insure that if "broke" does occur, as it will at times without apparent reason, the broken ends of the web will nevertheless be fed through the machine in the same manner as if the web were continuous and not broken.

In my improved and preferred form shown in Fig. 4 I have shown a steam doctor 35 which will strip the web 1 from the drying cylinders or drums without the doctor actually touching either the cylinder or the web. I have shown also means for stripping the web from the endless felts.

In the common form of doctors now employed, the surface of the doctor normally rests upon the drying drum or cylinder and scrapes the paper from the roll or drum by contacting with it. This places considerable wear upon the doctors and requires frequent replacement of them. It also forms objectionable wrinkles or crinkles in the paper. So far as I am aware, there have been no successful doctors to strip the web from endless felts by contacting with the felt. Such a doctor, resting upon the felt, on meeting the joint connecting the ends of the felt, would cut or mar the felt and soon ruin it, besides the friction of the doctor resting upon the felt would soon wear the felt out. These felts are comparatively expensive and under the most favorable conditions their life is comparatively short.

By my invention I use means to strip the paper from the drying drum or cylinder and also from the endless felts, as the case may be, without actually contacting with either the drying drum or the felt. In my invention, where the doctors are located within the vacuum chamber, I use steam, to strip the web from the cylinders or driers, the web never touching the doctors, and the doctors while in operation never touching the cylinders or driers. Where the doctors are employed to strip the web from the felt they do not touch the felt, there being a thin film of steam between the end of the doctor and the felt. The steam serves to heat up the vacu-

um chamber 34 and is taken out by the pipe 14, 14 and is condensed by any suitable condenser.

By using steam in my doctors 35, Figs. 4 and 5, I serve not only to assist in drying the web, but in case the web should break in the machine, this steam will cause the end of the broken web to instantly dry and become firm so that it can be easily threaded through the machine.

The material to be dried, as for example, a wet web 1 of paper, or similar material, preferably coming direct from the wet end of a paper machine, passes into the vacuum chamber 34, between the upper felt 36 and the lower felt 37, into the liquid seal 3, around the guide cylinder 38, over the drying cylinders or drums 39, 40, 41, 42, 43 and out over the guide cylinder 44. The guide cylinders 38 and 44 may, or may not, be heated. If heated, they practically become one of the drying drums or cylinders, the same as the drying drums 39 to 43 inclusive. While in this preferred form of my invention, I have used five steam heated drying drums or cylinders, with two guide cylinders 38 and 44. It is of course to be understood that this number of drying drums or cylinders may be increased or reduced, as may be found convenient or expedient for the particular kind of material to be dried and for the particular speed at which it is fed to the vacuum chamber.

In this form of my invention there are preferably two liquid seals 3, 3 and two sealing chambers 45 and 46. The partitions 47 and 48 preferably preventing the liquid of the two seals working into contact with the drying drums or cylinders 41 and 42, respectively.

The web 1 passes into the liquid seal 3 and immediately is brought into contact with the rotating guide cylinder 38, which performs the same function as the guide cylinders 5 of the simpler structures shown in Figs. 1 and 2. The web 1 with the upper felt 36, then passes around the drying drum 39, the upper felt passing around the guide roller 49, thence over the drying drum 41, guide roller 50, and the drying cylinder or drum 43. The lower felt 37, after passing around the guide cylinder 38, passes over the guide roller 51, around the drying drum 40, guide roller 52, drying drum 42, and guide roller 53, where it again meets the upper felt 36.

The two felts 36 and 37, with the interposed dried web 1, pass through the second seal 3, around the guide cylinder 44, and out over the guide roll 54. The two felts then separate the upper felt passing over the guide rolls 55, 55, back to the entrance of the apparatus. The lower felt passes over the guide roll 56 and in contact with the guide rolls 57, 57 mounted in the save-all 58.

To prevent the web adhering or sticking

to the different drying drums or cylinders, or to the felts, which would cause breaking of the web and the fouling of the apparatus, I locate one or more of my steam doctors 35, Fig. 5, to positively strip the web from the cylinders or drums and preferably also from the endless felts. I preferably locate these steam doctors 35 as shown in Fig. 4 of my drawing. The first steam doctor 35, it will be seen, will strip the web from the lower felt as that felt passes over the guide roll 51. The second steam doctor will strip the web from the surface of the drying drum or cylinder 39. The other steam doctors are shown in their proper positions to strip the web either from one of the endless felts or from the different drying cylinders or drums as the case may be.

With more particular reference to Fig. 5 the steam doctor is shown in connection with the drying drum or cylinder 42 which is normally rotating under the toe 59 of the doctor 35, in the direction of the arrow. Steam is supplied to the pipe 60, and passes through the port 61 to the end or toe 59 of the doctor. This steam will form a jet 62 which will project in front of the toe 59 and will lift the web 1 from the cylinder 42, Fig. 5. A little of the steam will form a cushion 63 between the end of the doctor and the surface of the cylinder 42. Preferably, though not necessarily, I use additional ports 64, 65, and 66, which will form additional jets of steam bearing upon the web 1, keeping it from contacting with the doctor, and directing it away from the heel 67 of the doctor and into its proper path through the vacuum apparatus.

This steam not only serves to direct the web through the apparatus, but it also assists in drying it. For example, in first threading the wet web through the vacuum apparatus, the steam in the first doctor will instantly dry the end of the web and cause it to become firm, so that the web will be provided with a dry end and have body and firmness. This firm dry end can be more easily threaded through the machine than can a limp wet end of the web.

When the steam of about 5.3 lbs. gage pressure is fed through the doctors 35 into a vacuum of 28 inches the steam will have the force of the steam pressure in the pipe 60, namely 5.3 lbs., plus the pressure due to the vacuum of 28 inches, or about 14 lbs. additional, making roughly a total pressure of approximately 19.3 lbs. It will therefore be seen that not only will the jet 62, issuing from the steam doctor, having a difference of 128° F. over the boiling point of the water in the web, but it will also have approximately 19.3 lbs. pressure.

It will therefore be clear, as previously noted, that I can by my steam doctor not

only strip the web 1 from the drying cylinder, but I also dry it, so as to make it easier to thread through the machine.

It will be seen that my steam doctor can be used to strip the web from one or both felts for it never touches the felt and consequently will not engage with the joint in the felt where the two ends are connected together. A doctor that rested upon the felt would not only wear the felt out by friction but the moment it engaged with the joint in the felt it would immediately tear and ruin it.

My steam doctors may extend clear across the different drying cylinders and felts, or may be mounted to extend part way so as to pass a ribbon through the machine in threading or rethreading. Preferably they would extend entirely across the machine the whole width of the web 1.

The steam for the doctors may be turned on only when the machine is originally threaded, or when it is desired to rethread it after a break or "broke", or I may leave the steam turned on slightly all the time, so that in case the web does break from any unforeseen reason on the drying drums or cylinders, as it will do at times, my steam doctors will automatically feed the web through the machine without delay or the machine becoming foul.

It will be noted that the escape of steam from my steam doctors does not heat up the temperature of the drying rooms, but on the contrary passes off through the pipe 14, 14 and is condensed by a barometric or other condenser with practically no expense as previously pointed out.

The method wherein the steam doctors are employed, as well as the steam doctors, are not covered in this application, but are covered in my companion application Ser. No. 384,213, filed May 25, 1920.

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, whereby 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 steam 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. × 8 = 128° F.) than the temperature difference in atmosphere 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 fewer drying cylinders. For example, with 5 cylinders, I can dry the paper 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 driers are

equipped with a blower system by which air, either heated or not, is blown through the drier 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 illustrative embodiments 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 drying material in a vacuum chamber, consisting in passing said material into and out of said vacuum chamber through liquid seals and keeping the material to be dried taut while passing through said seals so that it cannot wrinkle or crinkle, and drying said material in the vacuum chamber.

2. The method of drying material in a vacuum chamber, consisting in passing said material into and out of said vacuum chamber through liquid seals and preventing the material to be dried from flapping or waving while passing through said seals so that it cannot wrinkle or crinkle, and drying said material in the vacuum chamber.

3. The method of drying material in a vacuum chamber, consisting in passing said material into and out of said vacuum chamber through liquid seals and keeping the material to be dried flat while passing through said seals so that it cannot wrinkle or crinkle, and drying said material in the vacuum chamber.

4. The method of drying a wet web of paper consisting in passing said web into and out of a vacuum chamber through liquid seals and preventing the web of paper from flapping or waving while passing through said seals so that it cannot wrinkle or crinkle, and drying said web of paper in the vacuum chamber.

5. The method of drying a wet web of paper consisting in passing said web into and out of a vacuum chamber through liquid seals and keeping the web of paper taut while passing through said seals so that it cannot wrinkle or crinkle, and drying said web of paper in the vacuum chamber.

6. The method of drying a wet web of paper consisting in passing said web into and out of a vacuum chamber through liquid seals and keeping the web of paper flat

while passing through said seals so that it cannot wrinkle or crinkle, and drying said web of paper in the vacuum chamber.

7. The method of feeding sheet material into a vacuum chamber having a liquid seal, consisting in feeding the sheet material downward and then in a substantially horizontal plane through the liquid seal to a rotating guiding member partially immersed in the liquid seal, and then guiding the sheet material vertically through and out of the liquid seal by the rotating guiding member to prevent flapping and waving of the sheet material.

8. The method of feeding a wet web of paper into a vacuum chamber having a liquid seal, consisting in feeding the web of paper downward and then in a substantially horizontal plane through the liquid seal to a rotating guiding member partially immersed in the liquid seal, and then guiding the web of paper vertically through and out of the liquid seal by the rotating guiding member to prevent flapping and waving of the web.

9. The method of feeding material into a vacuum chamber having a liquid seal consisting in feeding the material between two endless felts through the liquid seal, and keeping the felts and material taut to prevent flapping and waving of the material.

10. The method of feeding a wet web of paper or similar material into a vacuum chamber having a liquid seal, said method consisting in feeding the wet web between two endless felts through the liquid seal, and keeping the felts and wet web taut to prevent flapping and waving of the web and the crinkling of the resulting paper.

11. The method of feeding a wet web of paper or similar material into a vacuum drying chamber having a liquid seal, said method consisting in feeding the wet web between two endless felts into the liquid seal and thence in a horizontal plane to a rotating guiding member partially immersed in the liquid seal, moving the web vertically through the seal while one of the felts is in contact with the rotating guiding member to prevent flapping and waving of the web and crinkling of the paper, the web leaving the guiding member in the vacuum chamber in a horizontal plane.

12. The method of feeding a wet web of paper into a vacuum drying chamber having a liquid seal, said method consisting in feeding the wet web between two endless felts into the liquid seal and thence in a horizontal plane to a rotating guiding and drying member partially immersed in the liquid seal, moving the web vertically through the seal while one of the felts is in contact with the rotating guiding and drying member to prevent flapping and waving of the web and

crinkling of the paper, the web leaving the guiding and drying member in the vacuum chamber in a horizontal plane.

13. The method of feeding a wet web of paper into a vacuum chamber having a seal of mercury or similar material, consisting in feeding the wet web between two endless felts through the seal of mercury or similar material, and keeping the felts and wet web taut to prevent flapping and waving of the web and the crinkling of the resulting paper.

14. The method of feeding a wet web of paper into a vacuum drying chamber having a seal of mercury or similar material, consisting in feeding the wet web between two endless felts into the seal of mercury or similar material and thence in a horizontal plane to a rotating guiding member partially immersed in the seal of mercury or similar material, moving the web vertically through the seal while one of the felts is in contact with the rotating guiding member to prevent flapping and waving of the web and crinkling of the paper, the web leaving the guiding member in the vacuum chamber in a horizontal plane.

15. The method of feeding a wet web of paper or similar material into a vacuum drying chamber having a seal of mercury or similar material, consisting in feeding the wet web between two endless felts into the seal of mercury or similar material, in a curved path and keeping the web of paper and the felts taut thereby preventing flapping, waving and crinkling of the resulting paper.

16. The method of feeding a wet web of paper or similar material into a vacuum drying chamber having a liquid seal consisting in feeding the web into the seal between two endless felts, the felts protecting the web and keeping it from contact with the liquid seal except at the edges of the web.

17. The method of feeding a wet web of paper or similar material into a vacuum drying chamber having a liquid seal consisting in feeding the web into the seal between two endless felts, the felts being wider than the web and protecting and keeping it from contact with the liquid seal except at the edges of the web.

18. The method of feeding a wet web of paper or similar material into a vacuum drying chamber having a seal of mercury or similar material consisting in feeding the web into the seal between two endless felts, the felts protecting the web and keeping it from contact with the mercury or similar material except at the edges of the web.

19. The combination in a vacuum drier having an opening of a sealing chamber for the opening, a liquid seal mounted in the sealing chamber, driers mounted in the

- vacuum chamber, and movable means mounted in the sealing chamber adapted to prevent the material to be dried from flapping or waving while passing through the liquid seal into the vacuum chamber.
20. In a vacuum drier, the combination of a vacuum chamber, a sealing chamber adjacent to the vacuum chamber, a liquid seal in the sealing chamber, and a guide cylinder mounted in the sealing chamber and nearly filling said chamber so as to reduce the quantity of the liquid to form the seal.
21. In a vacuum drier the combination of a vacuum chamber, means in the vacuum chamber to dry a web of material, a sealing chamber adjacent to the vacuum chamber, and a combined guide and heated drying cylinder mounted in the sealing chamber.
22. In a vacuum drier the combination of a vacuum chamber, a plurality of drying cylinders mounted in said vacuum chamber, one of said drying cylinders being mounted in a liquid seal for said chamber, and a liquid seal.
23. In a vacuum drier the combination of a vacuum chamber, a sealing chamber mounted adjacent to the vacuum chamber, a plurality of drying cylinders mounted in said vacuum chamber, one of said drying cylinders being mounted in a seal of mercury or similar material, and a seal of mercury or similar material mounted in the sealing chamber.
24. In a vacuum drier the combination of a vacuum chamber, a sealing chamber adjacent to the vacuum chamber, a plurality of drying cylinders mounted in said vacuum chamber, two of said drying cylinders being mounted in a liquid seal for said chamber, and a liquid seal.
25. The combination in a vacuum drier of a vacuum chamber, a sealing chamber adjacent to the vacuum chamber, a liquid seal mounted in the sealing chamber, and two endless felts passing through said liquid seal and being as wide or wider than a web of material to be dried.
26. The combination in a vacuum drier, of a vacuum chamber provided at its lower end with two sealing chambers to contain a liquid seal for the vacuum chamber, steam heated drying drums or cylinders mounted in the vacuum chamber, and two drying drums or cylinders mounted in the sealing chambers respectively and each nearly filling its chamber so as to reduce the quantity of liquid necessary to form a seal and also act as a guide for the web to be dried preventing flapping or waving of the web on its path through the seal.

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