Jan. 7, 1930. A. E. F. MOONE 1,742,365

WEB DRYING DEVICE

Filed Feb. 13, 1926

Fig. 1.

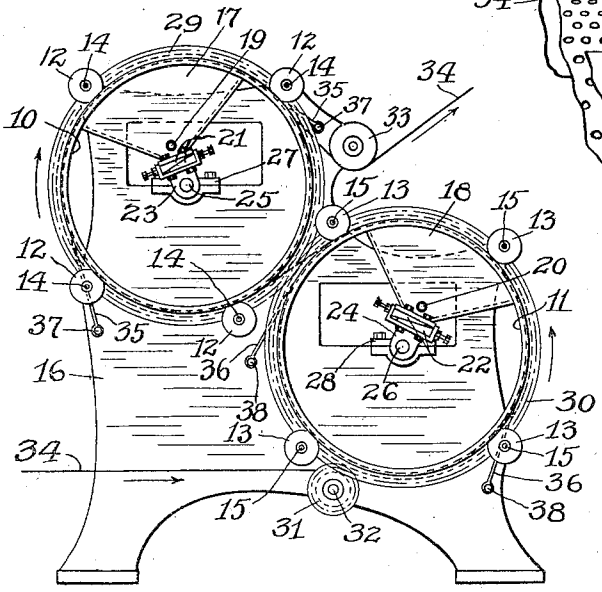


Fig. 2.

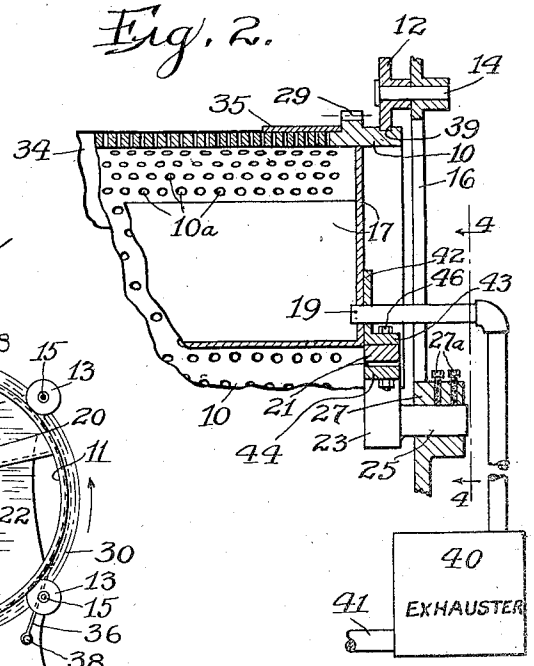


Fig. 3.

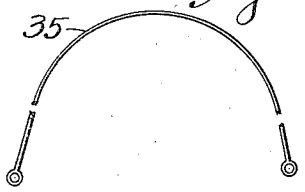


Fig. 4.

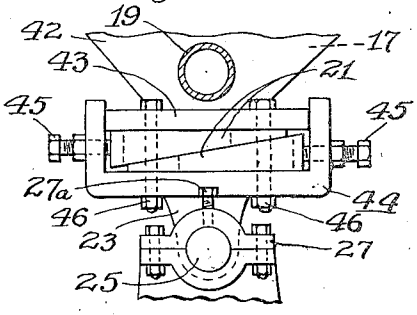


Fig. 5.

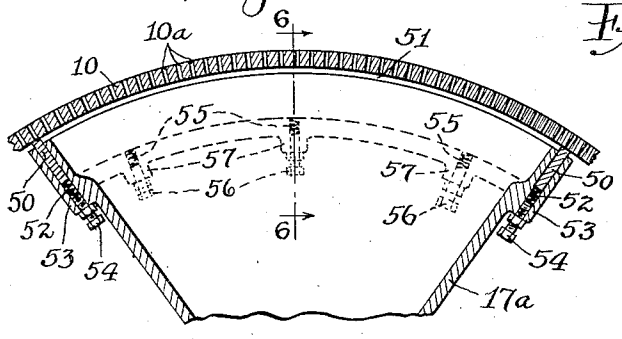
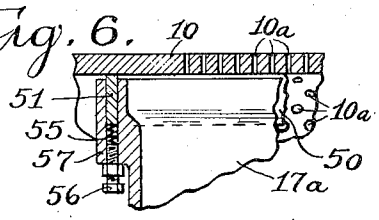


Fig. 6.



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UNITED STATES PATENT OFFICE

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WEB-DRYING DEVICE

Application filed February 13, 1926. Serial No. 88,103.

My invention relates to an improved mechanism for drying webs of paper pulp and felt in the course of their manufacture, by which the web is effectively and rapidly dried, or nearly dried, by suction devices arranged to remove the moisture from the web as it passes through the machine by the action of a difference in atmospheric pressure on the two sides of the web, or more specifically by the action of atmospheric pressure on one side of the web and sub-atmospheric pressure on the other thereof.

As is well known in connection with the manufacture of paper and sheet felt, the web in either case, after it is collected and formed in any suitable manner by devices well known in the art, carries a great deal of moisture which must be removed in order that the web may pass through the remaining steps of manufacture to result in the finished product. The means most commonly used to accomplish this result, consists of revolving heated drums over which the web passes to dry it. This mode of drying is open to either one of two objections; first, slow motion must be imparted to the web if but few heating drums are employed, or second, a large number of drums must be used if a rapid motion is imparted to the web, on account of the temperatures necessarily being limited if the web is to be uninjured, and the relatively small amount of drying possible with each drum unless the motion of the web is so slow in passing over it as to be prohibitive from the standpoint of commercial manufacture. I am aware that it has been proposed heretofore to employ vacuum devices of one kind or another to in part remove the moisture from the web. As far as I am aware, however, these devices are open to the objection that the sub-atmospheric pressure employed has not been effectively applied to the web for the maximum possible time interval represented by the passage of the web through the vacuum devices. More specifically, the devices heretofore proposed, have employed a perforated drying drum or drums over which the web in wet condition is passed and a zone of sub-atmospheric pressure has been produced, of relatively limited extent as to its application to the web, and further, the devices employed have resulted in marked fluctuation of the sub-atmospheric effect on the web, due to the nature of the devices employed for reducing the atmospheric pressure throughout the vacuum zone, as a result of which, with a degree of sub-atmospheric pressure that will not injure the web, but small drying results, and where the sub-atmospheric pressure is high enough for drying the web, the pressure is not uniformly applied to the web and danger of tearing results. Thus in either case the action is not efficient.

In carrying out my invention I employ a perforated drum or drums and means for feeding the wet web over the surface of said drum or drums, and provide a sub-atmospheric pressure chamber directly in contact with the inner surface of the drum in each case, so that the desired condition of sub-atmospheric pressure is uniformly maintained in the chamber and uniformly applied to the web being dried throughout its entire passage through the vacuum zone. Furthermore, by my construction the wet web is caused to engage the perforated drum in each case, before its entry into the vacuum zone, it is introduced into the vacuum zone without dangerous air pressure being exerted upon it, and after passing completely through the vacuum zone, during which it is continuously subjected to the maximum sub-atmospheric pressure permitted by the nature of the web being dried without injuring it, the web passes from the vacuum zone still in contact with the perforated drum, so that it is readily removed therefrom in leaving the machine or passing to the next perforated drum, and without danger of tearing the web. An important feature of my present invention is arranging two perforated drums of the kind referred to so that the web first passes over one of said drums and through its vacuum zone and thereafter leaves the first perforated drum and passes around the surface of the second perforated drum and through its vacuum zone, in such a manner that one surface of the web engages the first drum and the other surface of the web engages the second drum. In this manner I remove the moisture from both

surfaces of the web by sub-atmospheric pressure and I find that this produces a highly efficient extraction of moisture from the web, for I have found that where it is attempted to remove the moisture from the web by sub-atmospheric pressure exerted on but one side of it, the other side of the web is left relatively wet, this being particularly true where the web is relatively dense, as is the case with webs formed from certain kinds of paper stock, although the same thing is true to a less degree with more porous webs, for example webs of felt stock. By my invention I also provide means for readily adjusting the position of the vacuum zone relatively to each perforated drum so that the vacuum zone may be given the most effective relation to the arc of contact of the web on the drum; I further provide devices for readily adjusting the vacuum chamber to compensate for wear and to insure effective relation between the vacuum chamber and the inner surface of the drum.

This is a continuing application of my application Serial No. 16,100 filed March 17, 1925, now Patent No. 1,577,839, granted Mar. 23, 1926, as to the subject matter shown in in Figs. 1 to 4 inclusive of the drawings, the subject matter shown in Figs. 5 and 6 comprising a modified construction thereof.

My invention will best be understood by reference to the accompanying drawings showing preferred embodiments thereof in which

Fig. 1 shows one form of my drying machine in end elevation with the end frame nearer the observer removed for the sake of clearance,

Fig. 2 shows in longitudinal, vertical, sectional view and to an enlarged scale, a part of one of the perforated drums shown in Fig. 1 and a corresponding part of the vacuum chamber and associated devices for removing the moisture,

Fig. 3 shows in end view one of the shields adapted for use in connection with the perforated drums,

Fig. 4 is a detail view to an enlarged scale of the supporting devices shown in Fig. 2, taken along the line 4—4 in said figure,

Fig. 5 is a transverse sectional view to an enlarged scale of part of one of the drying drums and its vacuum chamber, and shows packing devices that may be employed in connection with the vacuum chambers, and

Fig. 6 is a sectional view of the parts shown in Fig. 5, taken along the line 6—6.

Similar numerals refer to similar parts throughout the several views.

As shown in Fig. 1, my machine consists of two tubular drums 10 and 11 mounted for rotation on supporting and retaining rollers 12, 12 for the drum 10 and 13, 13 for the drum 11, said rollers engaging the outer surfaces of the drums so that they may turn freely on said rollers, said rollers in turn being supported on suitable stud shafts 14 and 15 from the end frames 16 of the machine, the end frame nearer the observer being removed to more clearly show the construction of the machine.

The drums 10 and 11 have located inside of them and extending longitudinally thereof, vacuum chambers 17 and 18 provided with cylindrical outer edge surfaces to closely fit with sliding engagement the inner surfaces of the drums 10 and 11, the latter being preferably provided with true and smooth cylindrical inner surfaces to permit the fit referred to. The chambers 17 and 18 are provided with outlet pipes 19 and 20 respectively, for withdrawing moisture and air from said chambers. As indicated in Fig. 2 for the drum 10, each of the drums is perforated throughout its entire length, excepting adjacent its end supporting and driving portion, said perforations being indicated in Fig. 2 at 10^a, to form the only inlet for air and moisture to the corresponding vacuum chamber. The perforations are preferably small diameter holes extending entirely through the drum radially and placed as close together as practical conditions of manufacture will permit. The end and side walls of each vacuum chamber are imperforate, as a result of which any condition of sub-atmospheric pressure which may be produced in either chamber, is communicated through the drum perforations in line with the chamber to the web that may be on the outer surface of the drum and thus the atmospheric pressure on the outer surface of the web is effective in forcing moisture from the web through the perforations into the vacuum chamber, the side walls of which are inclined to collect the moisture and direct it to the bottom part of the chamber so that it may be withdrawn from the outlet pipe connected with the chamber.

The chambers 17 and 18 are supported at their lowermost portions by wedges 21 and 22 from brackets 23 and 24 respectively, said brackets being in turn mounted on trunnion supports 25 and 26, engaged and rigidly supported by clamping caps 27 and 28 respectively, carried by the frame members 16, said caps being provided with set screws 27^a for this purpose.

The drums 10 and 11 carry near one end thereof external gear rings indicated diagrammatically in Fig. 1 at 29 and 30, which intermesh as indicated, the gearing 30 also meshing with a pinion 31 similarly indicated in Fig. 1, said pinion being rigidly secured to a shaft 32 carried in suitable bearings therefor on the end frames 16, to drive the machine.

The frame members 16 also support between them by suitable bearings, a guide roll-

er 33 for directing the web as it leaves the machine.

The web to be dried by the machine is indicated at 34 and as shown, on entering the machine engages the lower surface of the drum 11 around which it passes until it is adjacent the drum 10, being then led around the bottom and upwardly on the outer surface of the drum 10 until it is adjacent the roller 33 around which it passes to be delivered from the machine as indicated. The direction of rotation of the drums and the direction of motion of the web is indicated by the arrows.

The web may be any web of fibrous material made by collecting the fibers from solution in any manner known to the art, whether the resulting web is of paper pulp, felt fiber or otherwise, the web being in wet condition when it is delivered to the machine under consideration. As the web passes around the drum 11 the sub-atmospheric pressure in the chamber 18 is effective in causing the flow of moisture from the web under the action of atmospheric pressure on the outside of the web, through the perforations in the drum and into the chamber 18 from which the air and moisture are continuously removed from the outlet pipe 20 by suitable pumping means. This operation is effective in removing practically all of the moisture from that surface of the web in contact with the drum 11. The outer surface of the web however, still contains considerable moisture and this surface of the web, which is outermost in its passage around the drum 11, becomes the inner most surface of the web in its passage around the drum 10, where the now inner surface of the web is subjected to the same action above referred to by the sub-atmospheric pressure in the chamber 17. In this manner practically all of the moisture is removed from the web and the nearly dry web may be subsequently completely dried by heated drums in the usual manner, the advantage being that the number of heated drums required to thoroughly dry the web after the extraction of moisture from it just described, is small, even for high velocity of the web, whereas without the extraction of moisture in the manner described, a very large number of such heated drums is required to completely remove the moisture from the web, accompanied by a correspondingly large expense for fuel to generate the steam required to heat the many drying drums.

In carrying out my invention the drums 10 and 11 are made of a sufficient length to accommodate the widest web to be dried by the machine. To accommodate webs of less width I employ cover strips 35 and 36 encircling the drums around the portions thereof in angular alignment with the vacuum chambers, these cover strips being preferably placed at the ends of the drums and having their ends secured by suitable retaining devices, for example pins 37 and 38, to the frame members 16 in such a manner that the cover strips, which are preferably of thin sheet metal, will prevent practically all air flow through the perforations under them into the vacuum chambers and yet at the same time permit the drums to rotate freely under them. The cover strips are taken of a width to cover that part of the outer surfaces of the drums that is not covered by the web being dried. The cover strips are of similar construction, one of them for example a cover strip 35 being shown in end elevation in Fig. 3.

The vacuum chambers 17 and 18 are of substantially the same construction as each other and they are similarly supported on the frame members of the machine so that detail reference to the manner of supporting but one of them will suffice. As indicated in Fig. 2, the drum 10 is provided on its outer surface near its end with a groove 39 to receive the rollers 12 located at that end of the drum. The relation of the gear ring 29 to the rollers 12 and to a cover strip 35 that may be employed as desired, is indicated in Fig. 2. As shown in this figure, the pipe 19 is extended outside of the machine to connect with any desired form of pumping mechanism, indicated diagrammatically at 40 from which a discharge pipe 41 extends. It is immaterial what form of pumping mechanism is employed, the only requisite being that it shall have sufficient capacity to produce the desired condition of sub-atmospheric pressure in the chamber 17 and remove from the chamber 17 all of the moisture that may collect in it adjacent the end of the pipe 19.

As indicated in Fig. 2, the end wall of the chamber 17 has secured thereto in any suitable manner, a reinforcing plate 42 through which the pipe 19 extends, said plate carrying at its lower edge an outwardly projecting flange 43. As indicated in Figs. 2 and 4, the trunnion 25 is securely held in place by a cap 27 through which set screws may extend if desired as indicated at 27^a to further restrain the trunnion from rotary movement in its support. The inner end of the trunnion 25 has rigidly secured thereto a bracket 23 carrying on its upper end a U-shaped flange member 44 forming a supporting surface for the wedges 21 disposed between the flange member 44 and the flange 43 secured to the vacuum chamber. The flange member 44 carries adjusting screws 45 in line with the wedges 21 to move them to desired position so that the outer edge surfaces of the chamber 17 will make sliding engagement with the inner surface of the drum 10. Clamping bolts 46 extend through the flange 43, the wedges 21 and the flange member 44, to clamp the parts together in any desired adjustment.

It will be understood that the construction

of supporting devices described for the chamber 17 in connection with Figs. 2 and 4, is duplicated at the other end of chamber 17. As a result of the construction described, it will be observed that the chamber 17 may be given any desired angular adjustment by releasing the caps 27 and set screws carried thereby, without modifying the fit of the chamber against the inner surface of the drum, since the trunnions 25 are co-axial with the drum. In this manner the chamber 17 may be given such an angular relation to the web being dried as to most effectively remove the moisture therefrom. In any event it is desirable that the leading edge surface of the vacuum chamber shall be in advance of the leading engagement of the web with the outer surface of the drum, so that the web will not be pulled violently into engagement with the drum by the suction effects produced through the perforations; it is also desirable that the trailing edge of the vacuum chamber shall be sufficiently back of the line of departure of the web from the surface of the drum, to insure that the web is in engagement with the outer surface of the drum for at least a small angle after passing from the zone of sub-atmospheric pressure, so that there will be no tendency to tear the web by attempting to remove it from the surface of the drum while it is subject to the action of the sub-atmospheric pressure.

It will also be understood from the description just made in connection with Figs. 2 and 4 that each end of the vacuum chamber may be adjusted radially of the drum independently of the other end, and without changing the angular position of the chamber, either to secure the sliding engagement described between the vacuum chamber and the inner surface of the drum, or to move the vacuum chamber slightly to compensate for wear that may occur after continued use of the machine.

In making the perforations in the drum, it is desirable that said perforations shall be of sufficiently small diameter so that a required degree of sub-atmospheric pressure may be produced in the vacuum chamber to effectively remove the moisture from the web, without however, appreciably disturbing the material of the web by the suction action upon it. Where the web is composed of material having long fibers, the perforations may be relatively large, particularly if the web is of substantial thickness; on the other hand, where the web is thin and consists of relatively short fibers, for example where the web is of paper stock, it is desirable that the perforations 10^a be of very small diameter. For any diameter of the perforations 10^a, required for the drying of webs of any particular kind, it is desirable that as many perforations shall be made through the drum as permitted by mechanical considerations, to the end that as much as possible of the surface of the web passing over the vacuum chamber, shall be subject to the suction action.

In Figs. 5 and 6, I illustrate a form of packing device that may be used to advantage with the vacuum chambers. In this construction, the vacuum chamber 17^a is provided with packing strips 50, 50 in suitable grooves provided therefor in the outer edges of the inclined sides of the chamber, and is also provided with similar arcuate packing strips in the outer edges of its ends, as shown for one of said ends at 51. Each of the packing strips 50 is a sliding fit in its supporting groove and is held outwardly against the inner surface of the drum 10, by springs 52 mounted in bores therefor in bosses 53 projecting from the side wall of the chamber, each of said bosses carrying also an adjusting screw 54 engaging one end of a spring 52, to place desired stress on said spring, by which the strip 50 is caused to bear with desired pressure against the inner surface of the drum 10. Each end strip 51 is similarly supported by springs 55 and screws 56 supported in bosses 57, as indicated for one end of the chamber 17^a in Fig. 5, it being understood that the end of said chamber which is not shown in Fig. 5, is provided with a similar strip 51, similarly supported. It will be understood that as many springs and adjusting screws may be used with each of said packing strips, as necessary to exert desired pressure on said strip. These screws also provide a ready means for compensating for wear on said strips, and by adjusting these screws from time to time, any desired bearing pressure may be maintained on said strips, even for a considerable amount of wear of said strips. In some case this construction may be employed as the sole means of radial adjustment of the outer edges of the chamber 17^a, and the wedges 21 may be omitted; in other cases, it may be advisable to employ the adjusting wedges 21 in addition to the packing strip adjustment. The packing strips may be made of any suitable material, for example, metal, wood, or packing composition of any nature that is adapted to the purpose described. The ends of the strips 50 and 51 closely fit each other to prevent undue leakage into the chamber at these points.

The vacuum chamber construction shown in Figs. 5 and 6, may be employed with either or both of the drums shown in Fig. 1, and the machine in other respects may be constructed and operated as above described.

While I have shown my invention in the particular embodiment above described, it will be understood that I do not limit myself to this exact construction as I may employ equivalents known to the art at the time of the filing of this application and my prior application referred to, without departing from the scope of the appended claims.

What I claim is:

1. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum.

2. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, holding devices for said trunnions permitting angular adjustment of said chamber, and wedges for adjusting said chamber radially of the drum.

3. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum, said chamber having packing devices around the edges of its open side comprising strips of packing material carried by said edges and springs between said strips and said chamber holding said strips against the inner surface of said drum.

4. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum, said chamber having packing devices around the edges of its open side comprising strips of packing material carried by said edges and springs between said strips and said chamber holding said strips against the inner surface of said drum, and tensioning screws engaging said springs to adjust the pressure thereof.

5. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum, said chamber having grooves in its edges around said open side, and packing strips in said grooves to engage the inner surface of said drum.

6. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum, said chamber having grooves in its edges around said open side, packing strips in said grooves to engage the inner surface of said drum, and springs between said strips and said chamber to hold said strips against said drum with desired pressure.

7. In a web drying machine, the combination of a rotary tubular drum having perforations through its cylindrical wall, a vacuum chamber having an open side against the inner surface of the drum, a delivery pipe extending from said chamber, trunnions separate from said delivery pipe supporting said chamber against rotation, and wedges for adjusting said chamber radially of the drum, said chamber having grooves in its edges around said open side, packing strips in said grooves to engage the inner surface of said drum, springs between said strips and said chamber to hold said strips against said drum with desired pressure, and adjusting screws engaging said springs for changing the pressure thereof.

In witness whereof, I hereunto subscribe my name this 8th day of February, A. D. 1926.

ALBERT E. F. MOONE.