Nov. 25, 1941. E. POIRIER 2,264,168

VACUUM PRODUCING APPARATUS FOR PAPER MAKING MACHINES

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Fig. 1

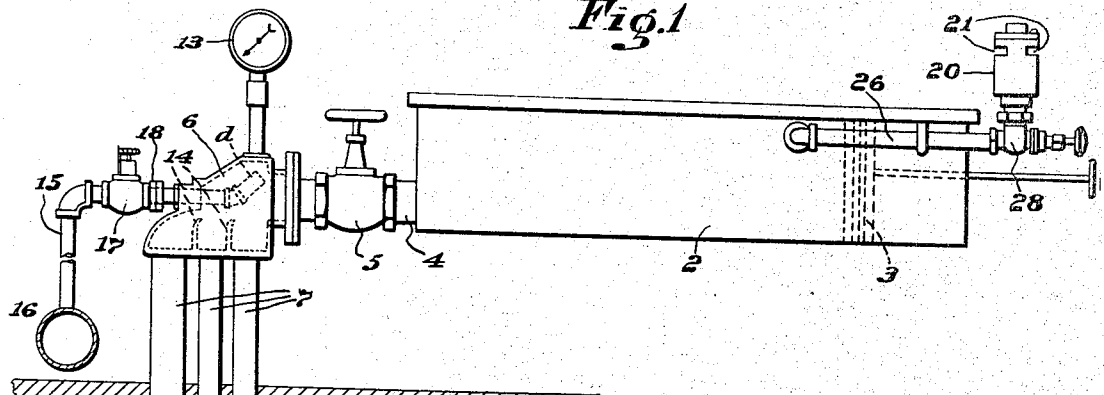


Fig. 2

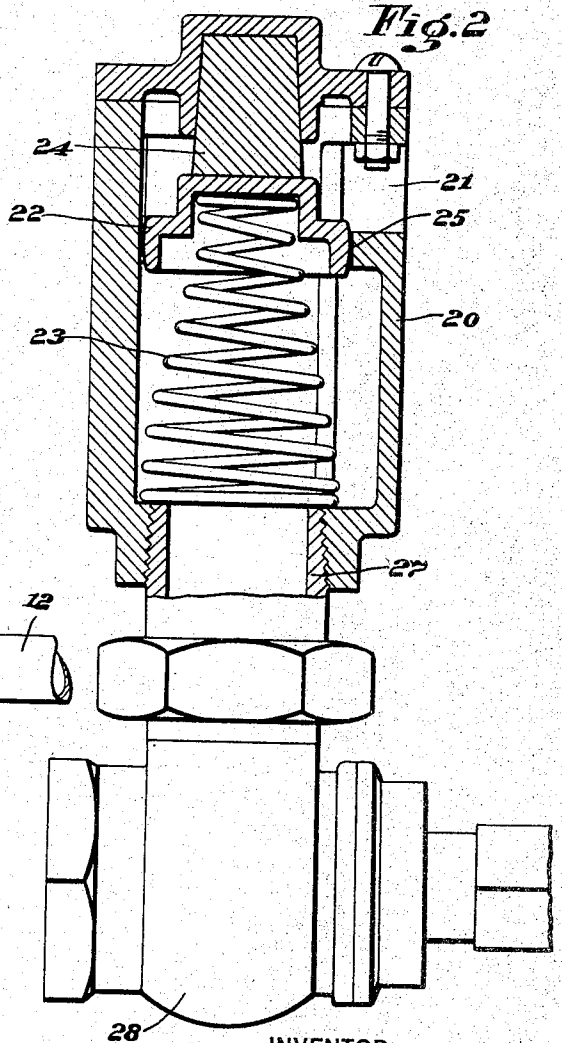
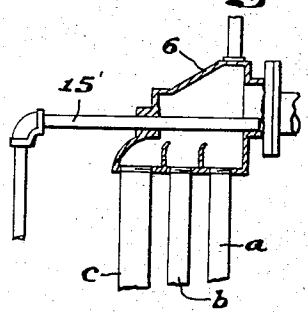


Fig. 3



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VACUUM PRODUCING APPARATUS FOR PAPER MAKING MACHINES

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12 Claims. (Cl. 92—51)

In a Fourdrinier paper machine the paper making wire, together with the wet web of paper being formed on it is run over a series of vacuum boxes. Subsequently, the web is delivered to the couch roll and is then taken off the wire. In most installations the vacuum is maintained in the boxes by means of a vacuum pump, but where circumstances permit, it is also occasionally a practice to equip each box with a drop leg which carries away the water discharged by the box, and this discharge of water is depended upon to create the working vacuum in the box. In a typical arrangement the lower ends of the drop legs are located in a well into which the water is delivered and which seals the ends of the legs, the surplus water either overflowing into a river, or being taken out of the well by a pump.

The drop leg arrangement has the advantage of being more economical both in initial cost and in operation than the vacuum pump installation. A serious objection to it, however, is the fact that the degree of vacuum produced in the boxes varies greatly with the amount of water discharged from them. For example, if the paper being manufactured at a given time is of a very porous nature, such as a news sheet, and the sheet begins to run denser, or a change is made to a denser type of paper, the change in characteristics of the sheet will effect a reduction in the flow of air through the sheet and will prevent as free an extraction of water from it at a given vacuum as in the former case. At the same time a higher degree of vacuum really is required by the denser sheet, but the smaller quantity of water extracted by and discharged from any individual box over which it is passing tends to create a lower degree of vacuum in that box. While the machine tender can make changes in the delivery of the stock and in its consistency, which will produce satisfactory conditions for operation on the denser sheet, it is evident that these changes and adjustments necessarily require a high degree of skill and very close attention on his part.

The present invention relates to apparatus of this general type, and it aims to improve equipment of this character with a view to maintaining automatically vacuum conditions in the boxes suitable for the characteristics of the sheet being produced and to reduce the care, skill and attention required on the part of the machine tender while still obtaining the advantages of the drop leg arrangement.

The same vacuum conditions exist, and essentially the same problems are presented, in other machines carrying a wet web of material from which the water is extracted by vacuum boxes, vacuum rolls, and the like. The present invention is applicable to situations of this type, and accordingly, the term "vacuum box" will be herein used in a generic sense to include vacuum rolls and similar devices with which the invention is useful.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawing, and the novel features will be particularly pointed out in the appended claims.

In the drawing,

Figure 1 is a side elevation, largely diagrammatic in character, illustrating an apparatus embodying the present invention;

Fig. 2 is a vertical, sectional view through the upper portion of one of the valves shown in Fig. 1; and

Fig. 3 is a sectional view, with parts in elevation, showing a modification.

Referring first to Fig. 1, the apparatus there shown comprises a vacuum box 2, like those commonly used in Fourdrinier machines, the paper making wire running over the top of the box. Usually several of these boxes are arranged side by side so that the wire runs over them successively. Also, as in the usual constructions, the box 2 is equipped with a sliding head 3 adjustable in accordance with the width of the sheet being made. From the left-hand end of the box a short pipe connection 4 is located to carry away the water extracted from the sheet, this connection being equipped with a hand operated valve 5 so that any selected number of the entire series of boxes can be cut into or out of operation, as desired. All of the foregoing is substantially like the usual constructions.

According to the present invention the discharge pipe 4 leading from the vacuum box is connected to the intake end of a vacuum casing 6 of a novel form and a drop leg, indicated in general at 7, leads downwardly from this casing. This leg consists of several independent sections or conduits, the number of which necessarily will vary somewhat with the requirements of different installations. In the particular arrangement shown three of these sections or conduits are employed indicated, respectively, at *a*, *b* and *c*. The lower end of the drop leg is located in one compartment of a well or overflow box 8 equipped with the usual adjustable weir 10, over which the water flows from the compartment in which the ends of the drop legs are located into another compartment from which the water is taken away by a pump (not shown) which is connected to the box 8 by the pipe 12. In some cases the water overflowing the weir 10 flows directly into the river. Preferably a vacuum gage 13 is connected into the casing 6 to indicate constantly to the operator the degree of vacuum maintained in it.

When the machine is in operation water is

extracted from the travelling web of paper by the box 2, and this water is discharged through the pipe 4, vacuum casing 6 and drop leg 7, thus creating a vacuum in the box, which vacuum is utilized for normal operating purposes. The degree of vacuum so maintained is determined fundamentally by the head of water in the drop leg which, in turn, depends partly upon the volume of water discharged from the box, partly on the volume of air flowing through the sheet of paper passing over the box, and in some measure, also, on the rate of release of the air entrained with the water as it flows through the drop leg and is discharged. If the character of the sheet being made is such that the volume of water is small, it will not be able to fill a large drop leg to the same height as it would a small leg. Consequently, if the volume of air leaking through the sheet remains constant while the volume of water decreases, the vacuum in the box will also decrease, other conditions being equal. On the other hand, if the volume of water should increase, the degree of vacuum would rise, provided other conditions remain unchanged. Of course conditions such as those just described rarely, if ever, will happen in the actual operation of a paper machine because an increase in the volume of water delivered to any individual box practically always means that a more porous or "freer" sheet is passing over the box, whereas a reduction in water usually accompanies the formation of a less porous or "slower" sheet.

I have found that variations in the degree of vacuum produced by such changes in conditions as those just described can be greatly reduced by making the drop leg in sections somewhat as shown. In the particular instance illustrated it may be assumed, for example, that the sections *a* and *b* each consist of two inch pipes, whereas the section *c* consists of a four inch pipe. If now the volume of water is so reduced that the pipe *a* carries it all, then the degree of vacuum maintained in the casing 6 will be held at a higher value than it would if this pipe were, say, six inches in diameter for the reason that the head of water maintained in it would be considerably higher in the former case than in the latter. And, as above pointed out, this matter of hydraulic head is an extremely important factor in determining the degree of vacuum that will be maintained in the casing at any instant. Preferably baffles 14, Fig. 1, are provided in the bottom of the casing 6, dividing this part of the casing into three compartments from which the respective sections of the drop leg lead. These baffles assist in controlling the flow of water, directing a small flow almost exclusively into the section *a*, and when the first baffle is overflowed, preventing any substantial flow into the compartment farthest from the pipe connection 4 until the head of water in the casing has risen so that both baffles are submerged.

From the foregoing it will be evident that with this arrangement the number of sections of the drop leg which are utilized at any instant to carry away the water from the box 2 will change automatically with changes in the volume of water discharged from the box. In other words, when the volume is so small that a single section of the drop leg will take care of it, then practically all of the discharge will take place through that section. As soon, however, as the volume of water increases beyond the capacity of the first section, one or more of the other sections will be brought into operation automatically by such an increase. Upon a decrease in volume of water the drop leg sections actually in operation will decrease successively, only those remaining in operation at any time which are necessary to conduct the volume of water being used at that time.

In this connection it may also be pointed out that when, for example, the character of the sheet changes from a free to a slow sheet with a corresponding reduction in the volume of water extracted by the box, the fact that the top of the box then is sealed more effectively by the sheet, due to its higher density, and consequent reduction in the volume of air leaking through it, tends to increase the degree of vacuum produced by the flow of a given volume of water through the drop leg. This is a helpful factor at a time when a higher vacuum is needed. A reverse action occurs when a freer sheet is being run.

In order to provide a further increase in vacuum when it is needed, as for example, in starting up, or at any other time, I prefer to run another vacuum line 15 into the casing 6 from any convenient supplemental source of vacuum pressure as, for example, to the vacuum line 16 running to the couch roll. It is sometimes desirable to include a valve 17 in this line which may either be a gravity check valve or, more preferably, a valve of that general nature in which the movable valve element is backed up by a spring which can be adjusted, the valve in either event permitting a flow from the casing 6 toward the vacuum header 16 but preventing flow in the opposite direction. This valve may be set to open whenever the vacuum in the casing 6 is substantially lower than that in the vacuum line 16. Thus it creates a vacuum in the case 6 and box 2 during the starting period and increases the vacuum in these members whenever it falls below substantially a predetermined value for any reason.

Preferably the tip *d*, Fig. 1, of the vacuum pipe 15 is turned at an angle to the main portion of the pipe and is connected with the valve 17 through a coupling 18. Thus this tip can be adjusted so that its open end will practically always be above the level of the water in the casing 6.

In another arrangement shown in Fig. 3, the pipe 15', corresponding to the pipe 15 shown in Fig. 1, is lead through the casing 6 and its inner line lies in the bottom of the intake pipe 4. Here it is contemplated that the pipe 15' always will be open to the suction line. Normally, however, this pipe will be submerged in water. It is made relatively small say, for example, a one inch pipe, and consequently, the volume of water which can be carried off through it is relatively small. However, if the flow of water becomes excessively small with the consequent tendency to reduce the vacuum, the end of the pipe 15' then will be more or less open, thus permitting a relatively large flow of air through the pipe (since it will conduct a larger volume of air than water at a given vacuum) with a resultant increase in the degree of vacuum maintained in the casing 6. By making this pipe with an angularly disposed tip as shown at *d*, in Fig. 1, its intake end can be adjusted into different levels. Thus the control of the flow of air, water, or mixtures of these fluids through this pipe, which is afforded by the relation of said intake

end to the water level in the casing, can be changed to suit different conditions.

For the purpose of smoothing out further variations which otherwise would occur in the degree of vacuum maintained in the box 2, I prefer to connect to this box a vacuum relief valve such, for example, as that shown at 20 in Figs. 1 and 2. This valve comprises a casing provided with air inlet ports 21 and also includes a valve plunger 22 and a spring 23 acting on said plunger and tending to hold it in contact with a yielding stop 24. When against said stop it cooperates with a circular seat 25 to prevent any substantial flow of air from the ports 21 into the interior of the valve. The outer surface of the valve, however, is constantly subjected to atmospheric pressure, and the effect of this pressure on the plunger 22 is opposed by such fluid pressure as there may be inside the valve chamber, plus that of the spring 23. Normally this valve plunger simply floats between these two pressures and is moving almost constantly when the machine is in operation, although the range of such movement usually is relatively small. If, however, the vacuum rises beyond a predetermined value, the valve plunger 22 will descend sufficiently to admit air into the interior thereof and thence into the box 2 through pipe connections 26 therewith, thus relieving the vacuum. These pipe connections should be made very short so that the effect of any change of vacuum in the box is felt as promptly as possible by the valve plunger 22. Such connections, however, should open into the box 2 at such a point that it will communicate with the interior of the box regardless of the adjustment of the head 3, but preferably also at a point remote from the discharge end 4. The pressure at which this valve will respond can be adjusted either by screwing the casing 20 up or down on its supporting nipple 27, or by connecting it with the box through an ordinary valve 28 so that this valve can be adjusted by hand to throttle the flow of air through it more or less.

This valve, when connected with the box 2, approximately as shown, operates in conjunction with the sectional drop leg arrangement to produce an exceptionally uniform degree of vacuum in the box. This is highly desirable in the operation of a Fourdrinier paper machine, as is well understood by those skilled in this art, variations in the degree of vacuum having an important and undesirable effect on the formation of the sheet, whereas a constant vacuum is a great help in producing a uniform sheet. In addition to maintaining a higher hydrostatic head in a drop leg, constructed as above described, during those periods when the supply of water is small, than would be possible in a drop leg consisting of a single pipe of equivalent cross-sectional area, this divided leg arrangement is also of advantage in reducing the rate of separation of the entrained air from the water as compared with that which would occur in the larger leg. The higher head naturally creates a greater velocity of flow through the small section utilized than would occur through a large pipe or conduit. Consequently, the entrained air has less opportunity to escape from the water. This factor also is of advantage in producing a higher vacuum in the box during periods of low rates of water discharge than would be obtained with the customary arrangement.

When the water discharged into the overflow box 8 is carried away from it by means of a pump, it is desirable to mount a float controlled shut-off device, such as that shown at 30 in Fig. 1, where it will close the end of the pipe in the event that the compartment from which it draws water becomes substantially empty. Normally the float 31 holds the shut-off plate in an elevated position and leaves the intake end of the pipe 12 completely open, but if the pump takes the water so much faster than it is delivered to the supply compartment of the box 8 as to empty the outlet compartment, the plate 31 will substantially close the intake end of the pipe before this occurs and it thus aids in preventing the pump from becoming air bound. Usually such a condition shortly corrects itself.

While a single vacuum box has been shown in the drawing, it will be understood that a series of these boxes customarily is used, as above described, and that each is equipped with its own drop leg, although all the legs may, if desired, discharge into the same well or overflow box.

While I have herein shown and described a typical embodiment of my invention, it will be understood that this disclosure has been made rather by way of explanation than limitation, and that the invention may be embodied in other forms without departing from the spirit or scope thereof.

Having thus described my invention, what I desire to claim as new is:

1. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments and so arranged that the number of conduits utilized at any time to carry the water away from said box will automatically change with changes in the volume of water discharged by the box and means for sealing the lower end of said drop leg.

2. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, means dividing the casing into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments, the upper ends of said conduits being so arranged that successive conduits will automatically receive water from said box in accordance with variations in the volume of water discharged by the box and means for sealing the lower end of said drop leg.

3. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, means dividing said casing into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of independent conduits communicating with the compartments and so arranged that the number of said conduits utilized at any time to carry the water away from

said box will be automatically reduced by a substantial reduction in the volume of water discharged from the box and will be automatically increased by a substantial increase in the volume of water so discharged and means for sealing the lower end of said drop leg.

4. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with and closely adjacent to said box and into which the water extracted by the box is delivered, means dividing said casing into a plurality of compartments, a drop leg leading downwardly from said casing, said leg composed of a plurality of conduits, said conduits opening into said compartments in said casing at points so arranged that a small volume of water will be discharged by a single conduit and other conduits will be brought into operation automatically by a substantial increase in the head of water in said casing and means for sealing the lower end of said drop leg.

5. An apparatus according to preceding claim 1, in which the lower part of said casing is divided into compartments from which said respective conduits of the drop leg lead and said compartments are spaced at different distances from the point of delivery of the water to said box.

6. An apparatus according to preceding claim 1, in combination with a valve so connected into said box at a point remote from its water discharging end and arranged to open automatically to admit air to said box when the vacuum therein exceeds a substantially predetermined limit.

7. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with and closely adjacent to said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, and a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments and so arranged that the number of them utilized at any time to carry the water away from said box will automatically change with substantial changes in the volume of water discharged by the box, additional means for automatically increasing the degree of vacuum in said box when said drop leg apparatus fails to maintain the desired degree of vacuum therein and means for sealing the lower end of said drop leg.

8. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with and closely adjacent to said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, and a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments and so arranged that the number of them utilized at any time to carry the water away from said box will automatically change with substantial changes in the volume of water discharged by the box, a supplemental vacuum line leading into said casing, means in said line for automatically controlling the flow of fluid therethrough in accordance with fluid conditions in said casing and means for sealing the lower end of said drop leg.

9. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with and closely adjacent to said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, and a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments and so arranged that the number of them utilized at any time to carry the water away from said box will automatically change with substantial changes in the volume of water discharged by the box, a supplemental vacuum line leading into said casing, the end of said pipe being located with reference to the normal level of water in the casing to cause changes in said level to control the flow of fluid from said casing through said line and means for sealing the lower end of said drop leg.

10. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments, means cooperating with said conduits to control the flow of water to them to vary automatically the number of said conduits utilized in accordance with the volume of water discharged by the box and means for sealing the lower end of said drop leg.

11. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, baffles dividing said casing into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits, said baffles serving to distribute automatically the water to the conduits in a manner depending upon the number of them required to handle the volume of water discharged by the box and means for sealing the lower end of said drop leg.

12. In an apparatus for extracting water from a travelling web of paper or the like, the combination with a vacuum box over which the web runs in water extracting relationship thereto, of a vacuum casing communicating with said box and into which the water extracted by the box is delivered, said casing being divided into a plurality of compartments, a drop leg leading downwardly from said casing, said leg being composed of a plurality of conduits communicating with said compartments and so arranged that the number of them utilized at any time to carry the water away from said box will automatically change with substantial changes in the volume of water discharged by the box, a supplemental vacuum line opening into said casing and means for sealing the lower end of said drop leg.

ERNEST POIRIER.