Nov. 25, 1941. E. POIRIER 2,264,169

VACUUM PRODUCING APPARATUS FOR PAPER MAKING MACHINES

Filed April 6, 1938 2 Sheets-Sheet 1

Fig. 1

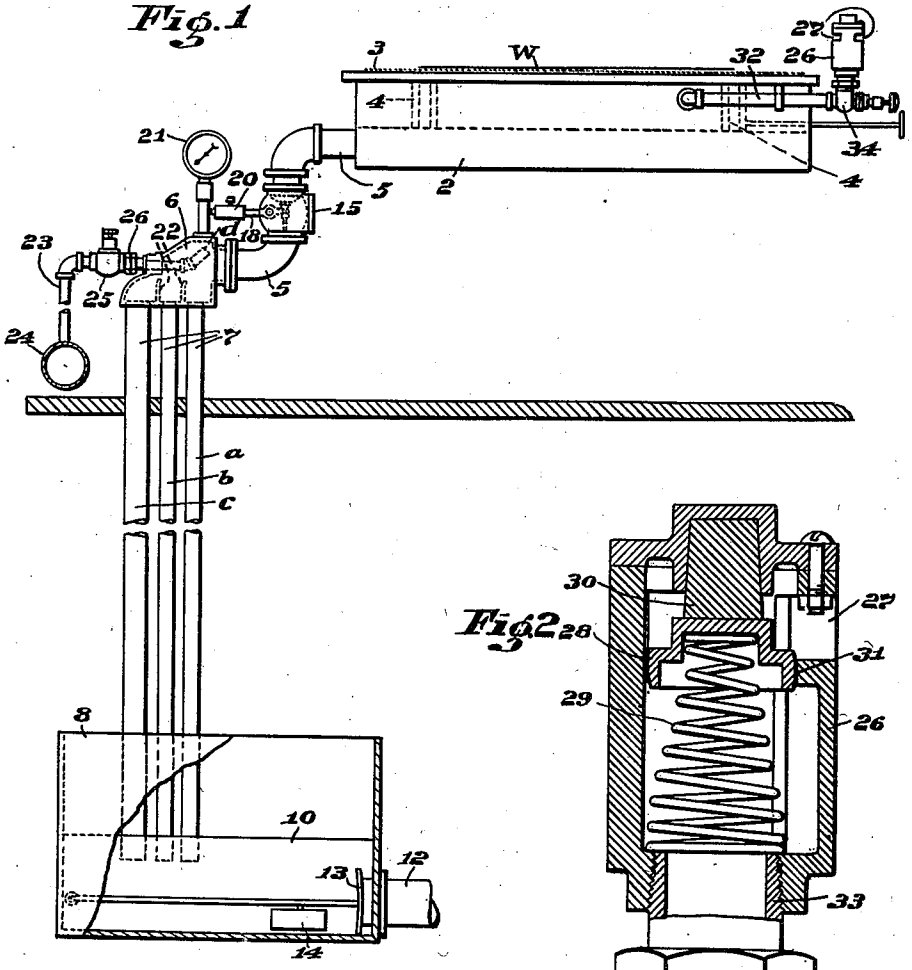


Fig. 2

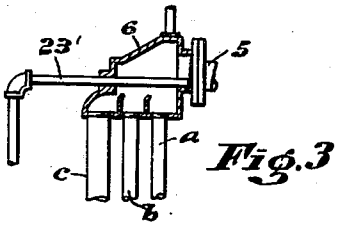


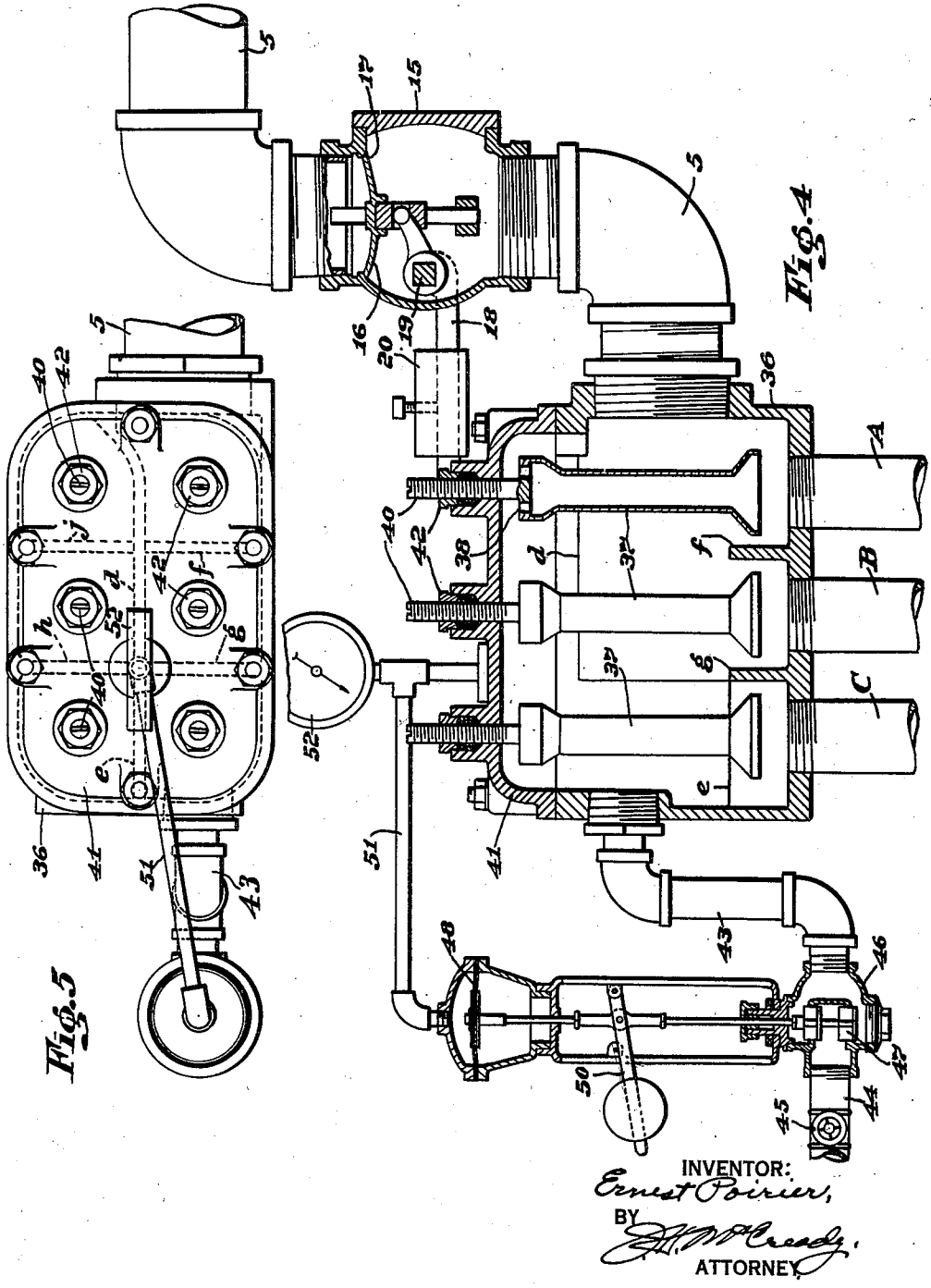
Fig. 3

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UNITED STATES PATENT OFFICE

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VACUUM PRODUCING APPARATUS FOR PAPER MAKING MACHINES

Ernest Poirier, Waterville, Maine

Application April 6, 1938, Serial No. 200,329

8 Claims. (Cl. 92—51)

This invention relates to paper making and more especially to the apparatus used in paper making machines to extract water from the sheet. While the invention will be herein disclosed as applied more especially to the problems involved in a Fourdrinier paper machine, it will be understood that it is also applicable to other types of paper machines and to other units used in the manufacture of paper.

As is well understood by those skilled in this art, the stock delivered to the wire of a Fourdrinier machine contains an extremely high percentage of water and a correspondingly low proportion of fiber, fillers and other solid constituents. A large percentage of this water flows through the wire as it passes over the table rolls and more of it is extracted by the suction boxes. Control of the extraction of water from the sheet is highly important for the proper felting of the fibers together to form the sheet or web and to the delivery of the web to the dandy roll, couch roll, and subsequent devices and mechanisms which operate on it, with the proper degree of moisture or wetness necessary to enable these devices to perform the functions for which they are intended. For example, in the case of the dandy roll there is a fairly definite proportion of water in the sheet which is better for the operation of this roll than either a smaller or larger percentage. The operator customarily produces the desired result by properly spacing the "water line" from the dandy roll, and he tries to maintain those conditions necessary to hold this water line at a substantially fixed point. The term "water line" is well understood by anyone skilled in this art. In a general way it indicates the line extending across the sheet where the water has left it to such a degree that a very noticeable and relatively sharp difference in the surface appearance of the sheet is readily seen. If the sheet becomes "slower," that is, more dense or releases its water more slowly, the water line moves down the wire and the machine tender makes suitable changes, such as increasing the vacuum or decreasing the proportion of make-up water, to correct this difficulty. If the sheet becomes "freer," it loses its water more quickly, the water line moves up the wire and the operator makes other adjustments to correct this condition. A large part of the skill involved in properly tending a paper machine consists in making those adjustments necessary to properly control the position of the water line.

The present invention aims to reduce much of the care, skill and attention required in this operation, and particularly to devise an arrangement in which the degree of vacuum maintained in the boxes will adjust itself chiefly in accordance with changing conditions in the machine or in the web of paper being made in it.

It is practically the universal custom to produce the working vacuum required in a paper machine by means of power driven pumps, and the expense involved in maintaining a vacuum by this method is a very substantial item. While it has been proposed heretofore to produce this vacuum barometrically by running the water from the boxes through a so-called "drop leg," the lower end of the leg being placed in a well, tail race, or similarly located so that it will be sealed against the entrance of air, this system produces a vacuum varying so greatly that it has not been depended upon to any substantial degree in recent years, although it was probably the first method used of producing the vacuum required for this purpose. As heretofore employed, such a system has itself been responsible for much of the trouble in properly controlling the water line. Of course a drop leg is still used in pump systems to carry away the water extracted by the boxes, but it is depended upon only in rather rare instances to produce the working vacuum. It is one of the objects of the present invention to overcome the difficulties heretofore experienced in using systems of this character and adapting them to present day paper making methods and machines.

The same vacuum conditions exist and essentially the same problems are presented in other machines carrying a wet web of paper or pulp 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" or "water box" will be herein used in a generic sense to include vacuum rolls and similar devices to which the invention is applicable.

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

In the drawings,

Figure 1 is a side view, 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;

Fig. 3 is a vertical, sectional view through a

modified form of vacuum header or casing which may be used in place of that shown in Fig. 1;

Fig. 4 is a vertical, sectional view of another form of vacuum header which may be used in place of that shown in Fig. 1; and

Fig. 5 is a plan view of parts of the apparatus shown in Fig. 4.

Referring first to Fig. 1, the apparatus there shown comprises a vacuum box 2 like those commonly employed in Fourdrinier machines, the paper making wire 3 running over the top of this box and the web W being supported on it. 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 is equipped with two sliding heads 4 arranged to be adjusted longitudinally of the box by any suitable construction to accommodate the width of the web being made. From the left-hand end of the box, a water discharge pipe connection 5 leads to a vacuum casing or header 6 from which a drop leg 7 extends downwardly into one compartment of a well or overflow box 8 equipped with the usual adjustable weir 10. The water discharged from the pipe flows from this compartment over the weir into another compartment from which the water is taken away by the pipe 12. In some cases the water flows directly from this overflow box into the river, while in other instances it is taken away by a pump. In the latter event, it is desirable to mount a float controlled shut-off device, such as that shown at 13, where it will close the end of the pipe in the event that the compartment from which it draws water becomes nearly empty. Normally the float 14 holds the shut-off plate 13 in an elevated position and leaves the intake end of the pipe 12 completely open.

Connected between the box 2 and header 6 is a valve 15, best shown in Fig. 4, comprising a valve plunger 16 mounted on suitable guides to move vertically toward and from a seat 17. Connected with it is a lever 18 mounted on a rock shaft 19 and carrying a weight 20 adjustable lengthwise of the lever.

The water extracted from the web by the box 2 and flowing through the drop leg creates a partial vacuum in the box which is utilized for normal operating purposes. The degree of vacuum so maintained depends primarily upon 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 W passing over the box, and to some degree, also, on the rate of release of the air entrained with the water as it flows through the drop leg and is discharged.

I have found that if the flow of air and water is yieldingly throttled or restricted between the box and the level of the water in the drop leg, the fluid pressure conditions maintained in the box will be improved very materially. Specifically, the intensity or amplitude of the variations will be reduced, and those variations which do occur can be made to assist in holding the water line at the desired point.

The reasons for this advantageous result are very obscure, but it has been determined in actual practice that this arrangement does maintain automatically very much better vacuum conditions in a system of this type than can be realized without it, particularly in some boxes. It will be evident that when the apparatus is in operation both the vacuum conditions in the neighborhood of the valve and the flow of water through it, cooperate to produce an opening movement of the valve. This action is yieldingly resisted, counterbalanced, or overcome by the weight 20, depending upon its adjustment. Thus the valve plunger 16 floats between the forces so acting upon it. Considering the box immediately after the dandy and assuming the web changes from a fairly free to a slower condition, with a corresponding increase in density or thickness, which practically always goes with a slower sheet, the fact that the top of the box then is sealed more effectively by the sheet, and thus reduces the volume of air leaking through it, tends to increase the degree of vacuum in the box. Also, an increase in the volume of water taken out by the box, which usually accompanies this condition, tends to raise the vacuum. These are helpful factors to a degree because a higher vacuum is needed to hold the water line in the desired position, but they must be controlled in order to produce this result. Such a control is afforded by the valve plunger 16 which is lowered by these changes in fluid pressure conditions but to a degree governed by the weight 20 so that it still throttles the flow through it and therefore controls the rise in vacuum.

On the other hand, if we assume that the sheet becomes freer, with the accompanying tendency for it to release its water more freely to the table rolls, which is characteristic of a free sheet, then the more rapid admission of air to the box will reduce the vacuum. At the same time the reduced volume of water extracted by this particular box also reduces the vacuum. The valve plunger 16 rises toward its seat 17 due to both of these factors and thus increases the resistance to flow of fluids through it. While, therefore, the vacuum in the box is lowered at this time and such an action is desirable in order to hold the water line in its normal and desired position, nevertheless such an action is controlled by the valve and the vacuum is not allowed to drop excessively or to be lost entirely, as it probably would be if the valve were not used.

Thus the valve exerts a stabilizing influence on the conditions affecting changes in vacuum in both the header and the box. Adjustment of the weight 20 to increase its leverage produces a reduction in vacuum in the box if other conditions remain unchanged, and vice versa. The degree of vacuum maintained in the header is indicated by the gage 21. This same arrangement is equally useful on the other boxes. Also, when a dandy is not employed, it is still desirable to hold the water line in substantially a fixed position. I have found that by properly adjusting the weight 20 the vacuum maintained may be made to change almost directly in proportion to changes in the characteristics of the web, and this is a highly desirable condition.

In prior constructions the drop leg has consisted of a single pipe which necessarily is made of ample dimensions to carry the maximum volume of water that can reasonably be expected ever to be discharged from the box. This fact is a source of variation in the degree of vacuum that will be maintained in the box and consequently is a factor in shifting the water line. It will be evident that if the sheet being made is of such a character that the volume of water delivered by the box is small, it will not be able to fill a large drop leg to the same height, other conditions being equal, as it would a small leg. Consequently, if the volume of air leaking through the sheet were to remain constant while the volume

of water decreased, the vacuum in the box would correspondingly decrease. Of course such a condition rarely, if ever, happens, but the limitations of a drop leg of this character nevertheless are responsible for much of the undesirable variation in vacuum that has attended prior attempts to rely solely on a drop leg to produce the working vacuum.

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 or conduits *a* and *b* each consist of two inch pipes, whereas the section or conduit *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 22, 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 5 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 or conduits 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 order to provide an 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 23 into the casing 6 from any convenient supplemental source of vacuum pressure as, for example, to the vacuum line 24 running to the couch roll. It is sometimes desirable to include a valve 25 in this line which may either by 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 24 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 24. Thus it creates a vacuum in the casing 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 23 is turned at an angle to the main portion of the pipe and is connected with the valve 25 through a coupling 26. 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. 2, the pipe 23', corresponding to the pipe 23 shown in Fig. 1, is led through the casing 6 and its inner end lies in the bottom of the intake pipe 5. Here it is contemplated that the pipe 23' 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 23' 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 to different levels. Thus the control of the flow of air, water, or mixtures of these fluids through the 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 taking care of an emergency rise in vacuum which might lock the wire or produce an excessive drag on it, I prefer to connect to this box a vacuum relief valve such, for example, as that shown at 26 in Figs. 1 and 2. This valve comprises a casing provided with air inlet ports 27 and also includes a valve plunger 28 and a spring 29 acting on said plunger and tending to hold it in contact with a yielding stop 30. When against said stop it cooperates with a circular seat 31 to prevent any substantial flow of air from the ports 27 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 28 is opposed by such fluid pressure as there may be inside the valve chamber, plus that of the spring 29. Normally this valve plunger simply floats between these two pressures and is moving almost constantly when in operation, although the range of such movement usually is relatively small. If, however, the vacuum rises beyond a normal operating value, the valve plunger 28 will descend sufficiently to admit air into the interior thereof and thence into the box 2 through pipe connections 32 therewith, thus relieving the vacuum. These pipe connections should be made very short so that the effect of change of vacuum in the box is felt as promptly as possible by the valve plunger 28. 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 heads 4, but preferably, also, at a point remote from the discharge end 5. The pressure at which this valve will respond can be adjusted either by screwing the casing 26 up or down on its supporting nipple

33, or by connecting it with the box through an ordinary valve 34 so that this valve can be adjusted by hand to throttle the flow of air through it more or less. This valve 26 is utilized chiefly to relieve excessive rises in vacuum and to prevent the locking of the wire which might occur under unusual conditions were such a valve not present.

A more efficient form of vacuum header and associated parts is illustrated in Figs. 4 and 5. Here the header or casing 36 corresponds, in general, to that shown at 6 in Fig. 1 and is connected in essentially the same manner through the pipes 5 and valve 15 with the vacuum box. This header or casing 36 is divided by a longitudinal partition *d*, and by baffles *e*, *f*, *g*, *h* and *j* into six compartments, as will be evident from an inspection of Fig. 5, arranged in a U-shaped series, the partition *d* compelling the water to flow successively over the partitions *f*, *g* and *e* before it can reach the compartments at the back of the partition where it can then flow successively over the baffles *h* and *j*. It should be understood, however, that each compartment must be filled before the water can flow into the next succeeding compartment. Drop leg sections extend downwardly from the respective compartments, those communicating with the first three compartments being shown at A, B and C, respectively, and the others being correspondingly located. Their lower ends may extend into an overflow box like that shown in Fig. 1, or they may be arranged in any other equivalent manner.

When the volume of water discharged by the box increases sufficiently to submerge the first baffle *f* to any substantial degree, there is often a tendency for the first section A to fill almost solidly with water and consequently to carry away relatively little air, the air discharging function being performed chiefly by the second section. If the volume of water increases further, the first two sections may discharge relatively little air, most of the air being handled by a succeeding section which is only partly filled with water. I have found that this tendency can be effectually overcome by limiting the working head of water at the top of each section. For this purpose tubes, such as those shown at 37, are positioned directly over each water discharging pipe where their lower ends are in the respective compartments and therefore are always in the stream discharged by the respective sections, while the upper ends of the tubes are open to the atmosphere above the maximum level of water in the casing. Each tube may be conveniently supported by casting a spider, such as that shown at 38, Fig. 4, into its upper end, and making this spider integral with, or securely fastened to, a screw threaded stem 40 which is threaded through the removable top 41 of the casing. Each stem is sealed by extending through a stuffing box, the gland of which is shown at 42.

Functionally the compartments at the upper ends of the leg sections form portions of, or continuations of, these sections, and the tubes 37 extending into them conduct air to a point where it is entrained by the water or is trapped in it in such a manner that it is carried through the pipe and discharged into the overflow box 8 or its equivalent. Here again, the exact action which occurs is somewhat obscure, notwithstanding the fact that the results obtained are clearly established. It is clear that the tubes perform a valuable function in creating and maintaining a vortex when the sections are submerged and therefore would tend to conduct water to the exclusion of air. Such a vortex is very valuable in making each leg discharge its proper proportion of air therefore under conditions such that this result would not be produced. It also has been clearly established that by belling out the lower ends of the tubes so that they are approximately the same diameter as the respective sections of the drop legs with which they cooperate, the level of water is maintained fairly constant at a point only slightly above the lower ends of these tubes. This also is a condition which contributes very materially to enabling the sections to continue their air discharging functions even when their upper ends are submerged. By mounting the tubes in some such manner as that shown, they may readily be adjusted to the position best adapted to produce the desired results.

The starting of the apparatus is facilitated in a manner similar to that shown in Fig. 1 by connecting the casing 36 either to an outside source of vacuum or to a supply of water which will serve to prime the drop leg. Such connections may be made by means of the pipe line 43—44, a hand valve 45 preferably being included in the latter pipe. In the particular arrangement shown an automatic valve 46 also is connected into this pipe line. It includes a balanced valve plunger 47 connected at its upper end to a diaphragm 48, and at an intermediate point to a weight actuated lever 50 which tends to hold the valve plunger 47 open. The chamber in the valve casing above the diaphragm 48 is in communication through the pipe 51 with the pressure conditions in the upper part of the header 36. Consequently, the vacuum maintained in this header normally will operate to hold the valve 47 closed. In starting, however, when there is no vacuum in the header, the valve 46 will be held open by the weight 50, thus either admitting priming water to the casing, or else connecting the casing with some other source of vacuum. After the drop leg has created a sufficient degree of vacuum for operating purposes, the diaphragm 48 will be operated to close the valve 47 and it will remain closed so long as the vacuum maintained in the header 36 is greater than a value predetermined by the setting of the weight on the lever 50. It will open, however, whenever the vacuum in the casing drops below said value. A vacuum gage 52 constantly indicates to the operator the pressure in the casing.

It has been demonstrated in practice that this invention does maintain automatically those vacuum conditions suited to changes in the condition of the web and that it performs this operation far more effectually than could be done by a machine tender for the reason that it feels the conditions requiring adjustment more quickly than he could detect them, and, simultaneously with feeling them, makes the necessary adjustment itself. The fact that it performs these functions is best evidenced by the stability of the water line under conditions which it is known would shift the water line up or down the wire when the usual vacuum producing mechanisms are employed. In a large measure this unquestionably is due to the sectional water leg and the parts immediately associated with it, but the automatic valve 15 also is an important contributing factor to this result. The invention makes it entirely feasible to use a drop leg for creating the working vacuum and thus effects an important saving in power, in addition to maintaining vacuum conditions better suited to changes

in the character of the sheet than those heretofore produced with pumps.

The drawings show a single water box only but it will be understood that the other water boxes used in a given machine may be similarly equipped.

While I have herein shown and described typical embodiments of my invention, it will be evident that the invention may be embodied in other forms without departing from the spirit or scope thereof. Also, while I have given above the best explanation of the action of the apparatus which I am able to make at this time, I do not wish to be limited to this or to any other theory of operation.

This invention is a continuation, in part, of my copending application Serial No. 141,104, filed May 6, 1937. The claims of this application are confined to subject matter not disclosed in applicant's earlier case just mentioned.

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

1. That improvement in methods of controlling the operation of a vacuum box in a paper making machine, which consists in causing the water extracted by the box from the web of paper being made to create a working vacuum in said box of an intensity depending chiefly upon the character of said web and the volume of water so extracted, and constantly maintaining a yielding throttling action on the discharge of water from the box.

2. That improvement in methods of controlling the operation of a vacuum box in a paper making machine, which consists in causing the water extracted by the box from the web of paper being made to create a working vacuum in said box of an intensity depending chiefly upon the character of said web and the volume of water so extracted, and constantly restricting the flow of air and water from said box to a degree varying with the character of the web.

3. That improvement in methods of controlling the operation of a vacuum box in a paper making machine, which consists in causing the water extracted by the box from the web of paper being made to create a working vacuum in said box of an intensity depending chiefly upon the character of said web and the volume of water so extracted, and constantly maintaining a yielding restricting action on the flow of water from said box varying with the rate of discharge of water from the box.

4. In a paper making machine, the combination of a water box positioned in water extracting relationship to the web of paper being made, a drop leg connected with said box and serving to carry the water away from it, liquid sealing means at the lower end of said leg to cause the water flowing therethrough to create a working vacuum in said box, a valve in the connections between said leg and said box, and means tending to close said valve and yieldingly opposing the opening action exerted on the valve by the flow of said water therethrough.

5. In a paper making machine, the combination of a water box positioned in water extracting relationship to the web of paper being made, a drop leg connected with said box and serving to carry the water away from it, liquid sealing means at the lower end of said leg to cause the water flowing therethrough to create a working vacuum in said box, a valve in the connections between said box and said leg where it is subjected to the fluid pressure conditions in said connections tending to open said valve, and adjustable means acting on said valve to yieldingly counter-balance said fluid pressure.

6. In a paper making machine according to claim 4, a construction in which said drop leg consists of a plurality of conduits so arranged that the number of them utilized to carry the water away from said box will automatically vary in accordance with changes in the volume of water discharged by the box.

7. In a paper making machine, the combination with a vacuum box over which the web of paper being made 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, a drop leg leading downwardly from said casing, means for sealing the lower end of said drop leg, said leg being composed of a plurality of conduits communicating with said casing and so arranged that the number of them utilized at any time to carry the water away from said box will automatically vary in accordance with changes in the volume of water discharged by the box, one or more of said conduits being provided with a tube serving to conduct air from said chamber into the water flowing through its respective conduit.

8. In a paper making machine, the combination with a vacuum box over which the web of paper being made 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, a drop leg leading downwardly from said casing, means for sealing the lower end of said drop leg, said leg being composed of a plurality of conduits so arranged that the number of them utilized at any time to carry the water away from said box will automatically vary in accordance with changes in the volume of water discharged by the box, one or more of said conduits being equipped with a tube extending down into the upper end of the conduit substantially in axial alinement therewith and with its upper end opening into said chamber above the level of the water therein.

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