This invention relates to methods and equipment for removing condensate from dryer rolls, which are internally steam heated, the invention among other possibilities being particularly adapted for use in connection with the dryer rolls of high speed paper making machines.

In paper making machines, the paper after being formed is customarily conducted over a series of dryer rolls, each of which is generally heated by circuiting steam through the interiors thereof, with the result that considerable proportions of the steam become condensed within the rolls. If the machine is one which operates at a relatively low or moderate speed, such condensate will remain as a so-called "puddle" at the bottom of the roll cavity and in that position a constant pressure differential between the steam inlet and outlet connections to the roll will serve efficiently to remove such condensate without substantial difficulties and according to well-known methods. However, if the machine speed is increased, as is the case with many modern paper machines, to an extent such that centrifugal force will cause the condensate to "rim" or to be distributed around on the interior surface of the roll, then serious difficulties tend to occur with known equipment for controlling condensate conditions in such rolls. These difficulties will be even greater if the paper machine is one which has from time to time to be operated at different speeds for forming different kinds of paper requiring more or less drying heat and at different rates of drying. As a consequence, in the usual present-day high speed paper making machines, accumulations of condensate in the rolls become so great that from time to time it is necessary to stop the machine and to blow out the condensate. Otherwise, as the "rim" of water in the roll increases in thickness, the efficiency of the roll as a drying unit will rapidly decrease. Furthermore, as the mass of water in each roll increases, the power necessary to drive the machine is greatly increased due to increased friction at the roll bearings. Also, as the masses of water in the rolls increase, turbulent conditions may arise whereby the inertia of the roll plus its content of water will not be symmetrically distributed around the axis of the roll, thereby causing variations or surges in the driving power required and consequent roll speed variations, to the point where the paper web may be broken. The loss of machine time and the paper losses resulting from paper breakage on a paper machine, are of course very expensive, as is also the shutting down of such machines in order to remove the condensate.

In order that the steam in such dryer rolls may be efficiently used, it is preferable to introduce steam at a temperature and pressure such that the greater portion thereof will become condensed in the rolls and thus give up its latent heat. To achieve this condition, it becomes important to control as closely as possible the pressure differential between the inlet and outlet connections for the rolls, and so that such differential will effectively control the rate of flow through the rolls for a given set of conditions without waste of steam and while avoiding excessive accumulations of condensate. Heretofore it has also been well-known practice for efficient utilization of the dryer roll steam to divide the large number of rolls into groups with provision for a different steam pressure for each group and with facilities for withdrawing condensate separately from each group. But any attempt properly to control such an extensive system manually involves inaccuracies and uncertainties, particularly if the paper machine speed is changed from time to time. This has tended to result in the practice of making the pressure differential high enough to insure proper condensate removal under all of the varying conditions under which the machine is operated, but with the consequence of quite inefficient use of the steam.

With the present invention, the above-mentioned difficulties have been eliminated by providing a method and equipment which will preferably automatically control the pressure differential at varying machine speeds and at all of the dryer rolls, and if desired with a different pressure level for succeeding groups of rolls as is required for most efficient use of the steam. If the machine is running fast enough so that the condensate in the rolls will "rim," I have found that the most important factor in determining the most efficient pressure differential to be used is the peripheral velocity of the roll and the consequent effect of centrifugal force tending to hold the condensate against the interior surface of the roll and preventing its easy removal. Such centrifugal force will vary according to the well-known formula

\[ F = \frac{MV^2}{R} \]

where \( F \) is the centrifugal force upon a mass of the water; \( M \) is the mass of water; \( V \) is a velocity equivalent to the effective linear velocity of the mass of water; and \( R \) is the effective radius of the mass of the water. Thus assuming that \( M \) and \( R \) are maintained substantially constant, the force effective in preventing withdrawal of the condensate varies as the square of the velocity of the water and hence it will be apparent that at increased machine speeds, the pressure differential necessary to force out the condensate must also increase in accordance with the square of the velocity, that is, to say, substantially in accordance with the square of the velocity of the paper running through the machine over the exterior surfaces of the rolls. Tests of the present invention have proven that such other factors as might be expected to effect the ideal pressure differential, are substantially insignificant as compared with the machine speed, when the machine speed is high or relatively high. Hence in accordance with the present invention, provision is made for varying the pressure differential at the dryer rolls, preferably automatically, in accordance with the square of the linear velocity of the paper. This may be accomplished by a variety of different types of known valve controlling devices, that is, devices which, in response to changes of the machine speed, will adjust the pressure differential control valves in accordance with a square law, for example well-known forms of tachometer-generators may be used with electro-pneumatic converters or with proper amplification to actuate electrically driven valves according to the square law. However, I have found that a very convenient way of accomplishing this result, with inexpensive apparatus, is by adjusting the differential pressure control valves responsive to variations in the liquid head in the headbox of a Fourdriner type of paper making machine. According to the formula

\[ H = \frac{V^2}{2g} \]

the pressure head \( H \) of the liquid in the headbox is equal to the square of the spouting velocity at the slice of the headbox, divided by 2g. In the usual paper making ma-
chines, such spouting velocity is substantially equal to the speed of the paper through the machine, and since the factor 2g is a constant, the pressure head in the headbox gives a measure which varies proportionately with the square of the velocity of the paper through the machine. Hence, such measure may be used to control the desired dryer roll pressure differential so as also to vary such differential according to the square of the dryer roll surface speed.

Various further and more specific objects, features and advantages of the invention will appear from the description given below, taken in connection with the accompanying drawings illustrating by way of example certain preferred forms of the invention.

In the drawings:

Figure 1 is a schematic diagram of a Fourdriner type of paper making machine and showing the position of a master differential pressure controller at the headbox, in accordance with the presently preferred form of the invention, such controller being used to control the dryer roll pressure differentials;

Figure 2 is a schematic diagram showing the various groups of dryer rolls of a typical high speed large paper making machine and with the various connections, valves and controlling devices schematically shown in accordance with a preferred example of the invention;

Figure 3 is a schematic diagram of certain of the differential pressure controlling equipment used for the system of Figure 2;

Figure 3a shows a valve like one of the valves in Figure 3 but modified as required when the control equipment of Figure 3 is used in certain parts of the system;

Figure 4 is a vertical sectional view through a typical one of the dryer rolls showing the steam inlet and condensate withdrawal connections; and

Figure 5 is a schematic diagram of an alternative arrangement for controlling the pressure differential valves.

Referring now to Fig. 1 in further detail, there is here shown schematically a typical paper making machine having a headbox as indicated, from which the pulp stock flows through a slice onto the Fourdriner wire, the paper as formed then passing through any desired number of press sections and thence through a dryer section comprising an extensive series of dryer rolls such as schematically indicated in Fig. 2. At the headbox a master differential pressure controller 10 (one form of which will be hereinafter described in further detail) is indicated as having a pressure connection 11 to the liquid at the bottom of the headbox. This controller, which in one well-known commercially available form, for example, may comprise a Foxboro differential pressure cell, is so constructed and arranged that responsive to any variations in the pressure head of the liquid in the headbox, it will transmit corresponding variations as through a pressure connection 12 to differential pressure control apparatus hereinafter explained in connection with Fig. 2. That is, the pressure transmitted through the connection 12 will vary in accordance with the square of the velocity of the stock emanating from the slice. Thus the pressure transmitted varies substantially in accordance with the square of the velocity of the paper being made on the machine and in accordance with the square of the velocity circumferentially of the surfaces of the dryer rolls over which the paper passes. Accordingly, if the pressure variations in the connection 12 are so used as to vary directly in accordance therewith the pressure differentials of the steam entering and leaving the dryer rolls, then such differentials will necessarily be varied according to \( V^2 \) as above explained.

Referring now to Fig. 2, there is here shown schematically the dryer section of a typical large high speed paper machine equipped in accordance with the invention and in which the dryer rolls are divided into groups 13, 14, 15, 16, 17 and 18. Live steam for these rolls is admitted through a steam main 19 connected to a branch line as at 20 for roll group 14, branch line 21 for roll group 16 and branch line 22 for roll group 17. The other roll groups 13, 15 and 18, as hereinafter explained, receive steam indirectly respectively from groups 14, 16 and 17.

The control connections for roll groups 13 and 14 will now be described and it will be apparent that like control connections are provided for roll groups 15 and 16 as well as for groups 17 and 18.

From branch line 26, connections 27 conduct the live steam in through a suitable axial conduit of well-known form, as indicated in the sectional view of Fig. 4, and concentrically with the steam inlet connection of the roll, there is a conduit outlet connection 28. The inlet openings to such condensate connections are located as at 25 (Fig. 4) close to the inner wall of the dryer roll, for example about one-half inch from the wall surface, the apparatus preferably being so constructed and arranged that the condensate will be kept down to a layer, as at 26, which will be only a fraction of an inch in thickness.

From the outlet connections 25, the condensate is collected in a flash tank or receiver as at 27, where its temperature is lowered so that steam is flashed off at the lower pressure leaving a body of condensate 28. The steam is conducted through a connection 29 to a header 30 connected to the steam inlet connection of the roll group 13. The header 30 is also connected through a pressure-operated differential control valve 31 to the branch main 20. The condensate is withdrawn from roll group 13 through connections 33 and thence to another receiver 34, the lower part of which will contain a body of condensate, whereas noncondensable gases and some flashed steam will be drawn through connection 35 from the upper part of this receiver. Between the flash tank 27 and the receiver 34 a connection with a control valve 36 is provided. This valve may, as schematically indicated, be controlled by a float in flash tank 28 so as not to allow the condensate level in such tank to fall low enough to permit steam to pass directly into receiver 34.

Condensate is pumped from receiver 34 as by a pump 37 through a control valve 38 and thence through a line 39 back to the powerhouse or a central condensate collecting point. Valve 38 is also float-controlled, as schematically indicated by the height of the liquid in receiver 34 and whereby the liquid will never be wholly withdrawn, which would permit steam to pass out through the pump to the condensate line 39.

The pump from receiver 34, which passes out through connection 35, then passes through a differential pressure control valve 40 to a discharge line 41 which in the particular example here being described, is subjected to vacuum. The connection 41 may pass into a heat exchanger or condenser 42 which cools the remaining steam below the flashing temperature before it goes into another receiver 43. Condensate is removed from receiver 44 as by a pump 44 which discharges through a control valve 45 to a condensate discharge line which may be connected to the discharge line 39 above referred to. The valve 45 is, as schematically shown, controlled by a float in receiver 43 so that a body of liquid will be maintained in this tank as a seal. The upper part of tank 43 has a connection 47 running to a vacuum pump 48. The purpose of this vacuum pump is to maintain a sufficiently low pressure on the condensate side of the system, as compared with the live steam inlet, so that an adequate vacuum may be obtained across the dryer rolls without an excessively high live steam inlet pressure. Also, non-condensable gases pass out through the vacuum pump 48.

In Fig. 2, the master differential pressure controller, as indicated at 10, is connected by pneumatic tubing (indicated by dash lines) to pneumatic receiver-operated controllers for each group of the dryer rolls. That is, for the dryer roll group 14, the receiver controller is indicated at 50 and for the roller group 13, the controller is indicated at 51. The master controller 10 in conjunction with the
controller 59, for example, will now be described in connection with Fig. 3, which schematically illustrates the essential parts of this equipment. The pressure at the bottom of the headbox is brought through pipe 11 to chamber 50 having a vane 55 located in the path of an air jet from an orifice 56. The orifice 56 is arranged to release variable amounts of air from pipe 12 which is connected to a suitable source of air at constant pressure, the amount of air released depending upon the proximity of the air jet to the orifice. Thus the vane 54 which may be fulcrumed as at 57 is normally held by a spring 58 in a position spaced close to the orifice but when the headbox pressure against the diaphragm 53 is increased, the vane 55 will move closer to the orifice, thereby checking the escape of air there-through and conversely when the headbox pressure is reduced, the vane 55 will move to a position more remote from the orifice, allowing more air to escape. Thus the air as supplied through pipe 12 will vary in pressure in accordance with the variations in pressure at the headbox.

The device 50 above referred to may be connected to the upper part of the apparatus shown in the upper part of Fig. 3. That is, a pipe 60 is arranged to bring the steam branch line 20 into communication with a diaphragm chamber 61.

A pipe 62 is arranged to bring the steam pipe 30 (Fig. 2) into communication with a diaphragm chamber 63. That is, diaphragm chambers 61 and 63, respectively, are connected to the high and low pressure side of control valve 31. A pivotally mounted lever 64 is arranged to be tilted in either direction by the diaphragms 61, 63 and to an extent depending on the relative pressures in the steam pipes 20 and 30. The lever 64 has a vane 65 opposed to an air jet from an orifice 66, the orifice being attached to diaphragm variable amounts of air from an air line 67, which extends from a suitable source of constant air pressure to a Bourdon tube or the like 68. Thus depending upon the relative pressures at opposite sides of the control valve 31, this Bourdon tube will be expanded or contracted. The movable end of the Bourdon tube may be connected as by link means 69 to a lever 70. One end of this lever is arranged to be movable by a bellows 71 which communicates with the above-mentioned pipe 12. The other end of lever 70 carries a vane 72 arranged in opposed relation to an orifice 73 which discharges air from a pipe 74, which pipe runs from a source of constant air pressure to the pressure diaphragm-operated valve 31. It will be noted that the pressure-operated valve 31 is arranged to be moved toward closed position whenever the pressure in pipe 74 increases, as when orifice 73 becomes blocked.

The operation of the arrangement of Fig. 3 is as follows. When the master controller 10, for example due to increased headbox pressure, causes the pressure in pipe 12 to increase, then the bellows 71 will expand, thereby moving the vane 72 closer to orifice 73 with the result that the pressure in pipe 74 increases and the valve 31 is moved toward closed position. This, of course, occurs when the paper machine speed increases, at which time the pressure drop between the steam inlet and outlet connections for the group of rolls 14 should be increased in proportion to the square of the machine speed. Thus when valve 11 tends to close, less steam will flow from branch line 20 to steam pipe 30 and consequently the pressure in the latter pipe will decrease. Since pipe 30 communicates with the condensate outlets of rolls 14, there will result a greater pressure drop between the inlets and outlets of rolls 14, the increase in pressure drop being to the degree required by reason of the increase in the condensate which has to be overcome to withdraw such condensate. It should be mentioned that the pressure in branch line 20 may be regulated at a constant value as by a pressure-regulating valve 80, or such valve may be controlled by any of the various well-known mechanisms for varying dryer steam pressure in accordance with the desired degree of dryness of the paper. Similarly, valves 80' and 80'' for the branch lines 21 and 22 may comprise either constant pressure-regulated valves or valves whose apparatus may be varied to vary the steam pressure according to the desired dryness of the paper.

Referring further now to the upper portion of Fig. 3, let us assume that the pressure in line 60 (as controlled by valve 80) should rise. Then the vane 65 would move to release more air from orifice 66 in line 67 thereby lowering the pressure in the Bourdon tube 68 and acting to move vane 72 so as to release more air through orifice 73 from line 74 and thus tending to open the valve 31 further. This in turn will tend to increase the pressure in line 30 and thus react in diaphragm chamber 63 to bring vane 65 back to normal position with respect to orifice 66. Thus the equipment at the upper part of Fig. 3 permits the maintaining of the desired pressure differential as determined by controller 10 regardless of the temperature level at which the live steam is admitted through valve 80 to the branch line 20.

The construction and operation of the receiver controller means indicated at 51 (Fig. 2) may be the same as above described in connection with Fig. 3 with one exception. That is, the pressure diaphragm-operated valve 40 to which this controller is connected (instead of a valve like that at 31) is, as shown in Fig. 5a, arranged to be opened more widely when the pressure applied thereto is increased and conversely to move toward closed position when the pressure applied thereto is decreased. This difference arises from the fact that while the valve 31 is at the inlet steam connection to rolls 14, the valve 40 is in the condensate outlet side of the roll group 13 in which the pressure is to be controlled by the latter valve. In other words, valve 31 is arranged to bleed off steam into the outlet side of rolls 14, whereas valve 40 is arranged to tend to shut off steam passing from the outlet side of rolls 13.

As will be apparent from Fig. 2, all of the control connections for roll groups 15 and 16 respectively may be in substance duplicates of those for roll groups 13 and 14 and same are identified by the same reference characters but accompanied by prime marks. Similarly, the control connections for roll groups 18 and 17 respectively are like those for groups 13 and 14 and are identified by the same reference characters accompanied by double prime marks.

In a typical case, the live steam pressure as controlled by valve 80 may be 20 pounds and the pressure differential across roll group 14 may amount to 5 pounds, with a consequence that the pressure on the inlet side of roll group 13 will be 15 pounds; and if the pressure differential across roll group 13 is also to be 5 pounds, then the pressure in the outlet pipes 33 in advance of the control valve 40 will be 10 pounds, whereas following the valve 40 there may, for example, be 10 inches of vacuum. If for example, properly to dry a given web of paper, the live steam pressure in branch line 20 has to be raised to say 30 pounds then the steam pressure differentials across the roll groups may still be maintained at 5 pounds, although the inlet and outlet pressures for roll group 13 would then be 25 pounds and 20 pounds respectively.

Similar pressures and pressure differentials may be used for roll groups 15 and 16, inclusive, although in some cases it will be desirable to introduce the live steam at a higher temperature level in the roll groups 15 and 16, and at a still higher temperature level in the final groups 17 and 18, under the control of valves 89 and 89', but in each case with the same preferred differential.

It will be understood that with paper machines having different numbers of dryer rolls, same may be grouped in various ways as may be preferred and with a greater or lesser number of groups than shown in Fig. 2.

As above mentioned, the pressure differentials may be varied according to the square of the velocity of the paper in ways other than by a master controller located
at the headbox as above described. For example, with cylinder type machines which have no headbox with which a controller such as at 10 could be used, then the arrangement, such as schematically shown in Fig. 5, might be adopted. Here, as indicated, a generator such as a small D.C. generator is driven by one of the drive shafts of the paper machine so as to produce a voltage varying according to the machine speed, which voltage is seconded by a voltmeter type instrument as schematically shown. This instrument may be arranged to rotate a so-called "square-to-linear conversion cam." A pivotally mounted cam follower, as shown at 90, is normally held by a spring against this cam and the cam follower provides a vacuum, opposed to an orifice 91 for bleeding air from an air line 92. The air line 92 comprises an alternative for the above-described air line 12 in Fig. 3 and serves to conduct pressure variations into bellows as at 71 of Fig. 3.

While the invention has been described as applied to the dryer rolls of a paper machine, it will be understood that similar equipment may be used for controlling the removal of condensate in various other forms of rolls which are heated by a condensable fluid such for example as the rolls of paper coating machines, and textile and printing machinery.

While the method of the invention is described above in connection with equipment which functions automatically to carry out the method after the making of predetermined adjustments, it will be understood that in its broader aspects the method might also be carried out by manually adjusting the pressure (differential) control valves so as to vary the pressure differential in proportion to the square of the velocity of the roll surface. However, in the usual large paper machine in which it is advisable to divide the rolls into groups as above explained, there will be so many control valves that accurate manual adjustment would be difficult, particularly in case of high speed paper machines in which for one reason or another the speed may vary from time to time with consequent great changes in the centrifugal force effects requiring readjustment of the valves.

All of certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A method for controlling the removal of condensate from a fluid-heated rapidly-rotating roll to which a condensable heating fluid is admitted and allowed to condense, the condensate being distributed by centrifugal force around on the interior surface of the roll and then being withdrawn, which method comprises: establishing a predetermined differential as between the fluid inlet and outlet pressures and upon varying the speed of rotation of the roll, varying such differential approximately in proportion to the square of the velocity of the surface of the roll.

2. A method for controlling the removal of condensate from rapidly-rotating dryer rolls of a paper machine to which steam is admitted and allowed to condense, the condensate being distributed by centrifugal force around on the interior surface of the rolls and then being withdrawn, which method comprises: establishing a predetermined differential as between the steam inlet and condensate outlet pressures and upon varying the speed of the machine varying such differential approximately in proportion to the square of the velocity of the surface of the rolls.

3. A method for controlling the removal of condensate from steam heated dryer rolls of a Fourdrinier type of paper machine in which the stock under the pressure head in the headbox is discharged from the slice at approximately the speed of travel of the paper over the rolls through the machine, which method comprises: applying suction to withdraw such condensate from the dryer rolls, which suction is effectively varied substantially directly in proportion to variations in said pressure head when said pressure head is varied to vary the discharge velocity at the slice to correspond to the varying speeds.

4. A method for controlling the heating of and rapidly rotating rolls which are heated by introducing a condensable fluid so that the condensate is distributed by centrifugal force around on the interior of the rolls and then withdrawn, which method comprises: introducing such fluid into the rolls under predetermined and fixed but adjustable pressure, establishing a predetermined differential as between the inlet and condensate outlet pressures and upon varying the speed of rotation of the rolls, varying such differential approximately in proportion to the square of the velocity of the surface of the rolls and upon adjusting the inlet pressure, also adjusting the pressure at which the condensate is withdrawn to maintain said differential substantially constant.

5. A method for controlling the heating of, and removal of condensate from, rapidly rotating web dryer rolls which are heated by introducing a condensable fluid into a first group of the rolls from which the condensate is withdrawn and allowed to vaporize at a lower pressure and then is introduced into a second group of the rolls from which the resulting condensed fluid is also withdrawn, which method comprises: establishing a predetermined differential as between the fluid inlet and outlet pressures for said first group of rolls and also for said second group of rolls and upon varying the speed of rotation of the rolls, varying such differential for the first group by by-passing sufficient fluid from the inlets to the first group to the inlet connections for the second group whereby the differential for the first group is varied approximately in proportion to the square of the velocity of the surface speed of the rolls, and varying such differential for the second group by varying the discharge of fluid therefrom to an extent whereby such differential for the second group is also varied approximately in proportion to the square of the said velocity.

6. A method for controlling the heating of, and removal of condensate from, rapidly rotating web dryer rolls which are heated by introducing a condensable fluid into various groups of the rolls at different controlled but adjustable pressures, from which webs the condensate is withdrawn and allowed to vaporize at lower pressures and then is introduced into various other groups of the rolls respectively from which the resulting condensed fluid is also withdrawn, which method comprises: establishing a predetermined pressure differential as between the fluid inlet and outlet pressures for all of said first mentioned groups of rolls and also for said other groups; and upon varying the speed of rotation of the rolls, or upon adjusting said first mentioned pressures, varying such differential for the first mentioned groups by by-passing sufficient fluid from the inlets thereof to the inlet connections for said other groups respectively whereby the differential for the first mentioned groups is varied approximately in proportion to the square of the velocity of the surface speed of the rolls but is maintained substantially constant if said velocity is unchanged; and varying such differential for said other groups by varying the discharge of fluid therefrom to the extent whereby such differential for such other groups is also varied approximately in proportion to the square of said velocity but is also maintained substantially constant if said velocity is unchanged.

7. Apparatus for controlling the heating of and the removal of condensate from rapidly rotating web dryer rolls which are heated by condensable fluid, which apparatus comprises: connections for introducing the fluid and withdrawing the condensate from the rolls; pressure
regulating valve means for normally maintaining a predetermined pressure differential as between the inlet and outlet connections; and means for establishing and maintaining a control medium which varies substantially in proportion to the square of the velocity of the surface speed of the rolls, such valve means being constructed and arranged to be responsive to vary said differential approximately directly in accordance with the variations of said control medium whereby said differential is varied approximately in accordance with the variations of centrifugal force on the condensate in the rolls.

8. Apparatus for controlling the heating of and the removal of condensate from rapidly rotating steam heated dryer rolls of a Fourdrinier type paper machine having a head box with slice for variably feeding stock onto the wire according to the machine speed, which apparatus comprises: connections for introducing the steam and withdrawing the condensate from the rolls; pressure regulating valve means for normally maintaining a predetermined pressure differential as between the inlet and outlet connections; and means for establishing and maintaining a control medium which varies substantially according to the pressure head in the headbox and thus approximately in proportion to the square of the velocity of the surface speed of the rolls, such valve means being constructed and arranged to be responsive to vary said differential directly in proportion to variations of said control medium whereby said differential is varied approximately in accordance with the variations of centrifugal force on the condensate in the rolls.

9. Apparatus for controlling the heating of and the removal of condensate from rapidly rotating web dryer rolls which are heated by condensable fluid, which apparatus comprises: connections for introducing the fluid and withdrawing the condensate from the rolls; pressure regulating valve means for normally maintaining a predetermined pressure differential as between the inlet and outlet connections, but at different pressure levels for different groups of said rolls; means for establishing and maintaining a control medium which varies substantially in proportion to the square of the velocity of the surface speed of the rolls, such valve means being constructed and arranged to be responsive to said control medium to vary said differential for all the roll groups approximately in accordance with the variations of centrifugal force on the condensate in the rolls.

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