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(54) Multi-nip suction press.

(57) The present invention provides a drying apparatus for use in a papermaking machine and comprising at least four press rollers in nip contact with one another in succession in a closed train to define a substantially sealed chamber between the press rollers and chamber end walls. At least one of the press rollers is a hollow roller having a pervious outer wall to support at least one endless felt disposed for advance over an outer support surface of at least some of the rollers and passing through all of the nip contacts. The endless felt is a pervious carrier for a paper sheet to be dried. Resilient support means is provided for at least one press roller. Drive means is also provided for at least one press roller. Conduit means permits air movement through the hollow roller and the chamber. Air displacement means is connected to the conduit means. The air movement passes through the sheet carried on the felt whereby to extract moisture from the sheet and for convection of the moisture by the conduit means.

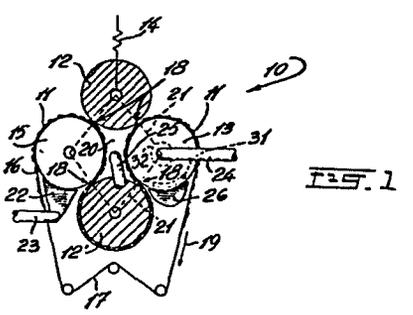

FIG. 1

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MULTI-NIP SUCTION PRESS

The present invention relates to papermaking and especially to pressing a sheet, such as paper, by using at least four press rollers on substantially stationary horizontal axes and in rotating contact with one another as a closed train defining a chamber between the rolls and end seals, for exerting air pressure at a pervious roller surface thereby to induce through drying of a sheet.

In papermaking, a pulp slurry firstly is formed into a sheet by drainage at a circulating endless mesh, secondly the sheet is pressed between rollers for more drainage and thirdly the sheet is heated for final dryness. As in well known in the art, moisture removal by pressing costs less than removal by heating, because pressing utilizes less apparatus and energy than heating does.

The present invention is directed toward improving moisture removal by pressing, for reducing the costly heat requirement, and toward multiple pressing for improving bond of fibers together to yield improved paper strength. Multi-nip pressing is known, including pressure-chamber means for extending pressure beyond a nip, liquid-pressure means urging impervious-belt means against a sheet and press roll for a small arc at a nip. Pressure-pad means also are known for pressing a sheet and felt against a small arc at a nip.

These prior art means have problems, such as difficulty of drainage escape and abrasion of apparatus, that the present invention is aimed to overcome.

An object of the present invention is to overcome problems of prior art and to improve pressing a sheet by providing a method and apparatus with the feature of:
1) improving moisture removal in pressing a sheet, thereby to reduce heat demand and fuel consumption,

by providing at least as many nips as press

rollers and adapted for single and double felting;

2) improving bond of fibers together, for sheet strength,

by squeezing the sheet through at least two nips per press roller and having at least 4 nips;

3) concentrating more nips than heretofore practical, in one paper machine,

by disposing at least four press rollers on substantially stationary horizontal axes and in rolling contact with one another as a closed train;

4) maintaining register nip-to-nip automatically without instrumentation, and independent of roll diameters,

by rolling the surfaces of at least four press rollers together as a closed train;

5) increasing nip pressure progressively, from nip to nip,

by resiliently supporting some press rollers;

6) dampening nip oscillations, that arise normally from variation within felt substances,

by directing the oscillations through interferences of other nips from roll to roll around a closed train back to point of origin;

7) extending pressure on a sheet for a substantial arc of at least one press roller,

by exerting air pressure in a chamber bounded by arcs of press rollers themselves and end seals, the chamber deriving pressure from communication with pump means via any of (a) end seals to the pump, (b) pervious-roll hollow shaft to the pump, (c) external box means to the pump, the air pressure urging moisture from the sheet by through drying;

8) controlling nip pressure in part,

by transmitting load of air pressure at roll arc forming a wall of chamber into positive or negative load at nip deriving from supra or subatmospheric pressure in chamber between rollers;

9) relieving paper stress during pressing,

by supporting a sheet continuously from nip to

nip without open draws;

10) countering centrifugal force on sheet at arc of press roller,

by exerting an opposing air pressure or felt pressure or both at that arc.

According to the above features, broadly, the present invention provides an apparatus for use in a papermaking machine and comprises in combination at least four press rollers, on substantially stationary horizontal axes, rolling in nip contact with one another as a closed train to define a substantially sealed chamber between press rollers and end walls. At least one of the press rollers is hollow with pervious curved wall to support at least one endless felt disposed for travel along a curved support surface of at least some of the rollers and passing through all of the nip contacts. The endless felt is a pervious carrier for a paper sheet to be dried. Resilient support means is provided for at least one press roller. Conduit means permits air movement through the hollow roller and chamber. Air displacement means is connected to the conduit means.

In operation, air is urged through the sheet at roll pervious periphery wrapped by felt and sheet, whereby to extract moisture from the sheet and for convection of the moisture by conduit means.

The method according to the present invention comprises the steps of:

providing at least four press rollers in nip contact with one another in succession as a closed train to define a substantially sealed chamber between said press rollers and chamber end walls;

entering a moist pulp sheet supported on at least one endless felt into a nip between a first and a second roller;

advancing said sheet and felt into a nip between said first roller and a third roller;

advancing said sheet and felt into a nip between said third and a fourth roller;

advancing said sheet and felt into a nip between said fourth and said second roller, said nips applying pressure on said felt and pulp sheet passing therebetween;

exerting air pressure in a sealed void formed by said rollers;

displacing moisture in said sheet and felt by pumping air through a porous rim of at least one roller; and

discharging said sheet between said fourth roller and said second roller.

Location of a press roller along the closed train helps to determine whether a roller should be pervious or impervious, hard or soft surfaced, bigger or smaller than mating rollers. These distinctive qualities of rollers along a closed train are somewhat analogous to the distinctive qualities of elements along a ring of an organic chemical molecule. Also, a closed train of press rollers according to the present invention may be joined to another closed train to form a chain press somewhat as organic chemical rings may be joined to form a chain molecule.

In choice of roller surface, it is well known for example that having at least one press roller of a nip as soft surfaced will prolong felt life, while using a granite press roller in direct contact with a damp sheet will let a sheet release after the nip. Choice of suitable roller surface in this new combination for single and double felting would be apparent to those skilled in the art.

Some parts necessary for operation of the present combination are well known and therefore are not detailed or shown herein. They are (a) return mesh runs as to guide rolls, stretch rolls and felt-cleaning means, (b) felt carrying rolls not counted herein as press rollers,

(c) framing, (d) resilient mounting of press rollers, (e) drive means. Also, nip contact between rollers is understood herein to mean through felting and during operation through a sheet as well.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic illustration of an example of a multi-nip suction press of the present invention;

FIGURE 2 is a schematic illustration of a still further example of the multi-nip suction press of the present invention; and

FIGURE 3 is a schematic illustration of a still further example of the multi-nip suction press as utilized in a double felted press.

Referring now to the drawings and more particularly to Figure 1, there is shown the multi-nip suction press or drying apparatus of the present invention, as generally illustrated at 10. This apparatus is for utilization in a papermaking machine for pressing and drying a sheet of pulp stock 11. The press comprises at least four press rollers, herein stationary solid rollers 12 and 12', plus rollers 13 and 15. Roller 12 may be resiliently biased by biasing means schematically illustrated at 14. In this embodiment roller 12 touches the sheet directly and would preferably be of granite for sheet release. Rollers 13 and 15 could be soft surfaced while roller 12' could be hard surfaced. At least one of the rollers, herein roller 15 is a hollow roller having a pervious outer wall 16 in registry with endless belt 17 which is a pervious carrier of the paper stock of sheet 11 to be dried.

The four press rollers 12, 12', 13 and 15 are in close contact with one another in a succession as a closed train whereby to define nips at the area of contact therebetween and these are indicated by reference numeral 18.

Thus, the four rollers will define four nips which will apply pressure on the endless felt and paper stock passing therebetween.

The endless felt 17 advances as indicated by arrow 19 and is a pervious carrier for the paper sheet whereby air may pass therethrough to convect water out of the pulp stock. One of the rollers has a drive connected thereto, by means well known in the art, for imparting rotation to all of the four rollers.

A substantially sealed chamber 20 is defined in the area between the rollers 12, 12', 13 and 15 and between chamber end walls 21, (herein shown in phantom line). In order to achieve air movement between the pervious hollow roller 15 and the chamber 20, there is provided suitable conduit means which may be constructed in several ways. As shown in Figure 1, an air box 22 is mounted in an external sealed relationship with another surface of the roll 15, and a conduit 23 is connected to the box 22 for the convection of air with moisture herein. Similarly, the roll 13 may be a pervious roller and may have a conduit 24 connected thereto for the convention of air and moisture. Rotation of roll 13 is accommodated at stationary conduit 24 by well known rotary joint means 32. A further conduit 25 is connected to one of the end walls 21 for the ingress of air under pressure. Thus, the chamber 20 will force air through the pulp stock and felt 17 passing through the pervious outer wall of rolls 13 and 15 thereby forcing moisture out of the pulp stock, through to the endless felt 17 and into the hollow rolls 13 and 15 for convention of air and moisture by conduits 23 and 24. It is pointed out that the roller 13 is suitably sealed in its opened area by means such as a solid shoe 26. By shoe 26 being external to roller 13, the rim of 13 remains continuously shielded from atmospheric pressure and the shoe is more accessible than an internal seal 31 would be.

In its operation, as the pulp stock enters the multi-nip press, water is squeezed out at a first nip. The pulp stock is then subjected to a suction by the hollow roller 15 in its travel area within the chamber 20. Thereafter the pulp stock is again squeezed at a second and third nip and enters into the chamber 20 for a second travel while subjected to a suction along a surface area of the second press roller 13. Thus, the paper stock exits the multi-nip press in a drier condition than possible with known prior art multi-nip press devices.

Referring now to Figure 2 there is shown another example of the conduit means. As herein shown, a single hollow roller is provided with a pervious surface and resiliently biased against three other rollers. For example, roller 28 may be a granite solid roller and rollers 29 and 30 may be rubber rollers. Air is exhausted from the chamber 20 via the exhaust conduit 25 and this causes an ingress of air, as shown by arrows 30 through the felt 17 and the paper stock which is located between the felt and a large outer surface portion of the pervious roller 27 causing moisture to be drawn within the roller 27 and exhausted through conduit 25 via the central chamber 20. The invention should not be limited to the combinations of the air convection means disclosed herein, as other arrangements of air convection are possible.

Referring now to Figure 3, there is shown the invention as utilized in a double felted press. As herein shown, a second endless felt 31 is driven in an endless manner about the rollers 12, 12', 13 and 15 and in registry with the other endless felt 17. The pulp stock 11 is trapped between the felts. Both endless felts are of a porous construction. The operation of the double felted press, for the removal of moisture of the pulp stock, is the same as that disclosed for Figure 1.

It is within the ambit of the present invention

to cover any obvious modifications of the examples of the preferred embodiment described herein. For example, the multi-nip suction press may comprise six rollers defining a chamber therebetween with air being injected into the chamber and out of four pervious rollers. In a still further foreseeable arrangement there may be provided seven rollers, three axially aligned with two pairs of granite rollers in nip contact between these whereby to define two sealed chambers with the exhaust being made through three pervious rollers and air fed to both of the chambers.

In another example of seven rollers in accordance with the invention there may be one roller fixed centrally, three plain rollers at substantially 120 degree locations in external nip contact therewith, two pervious rollers each in nip contact with two of the three plain rollers and one sealing roller in nip contact with two of the three plain rollers whereby to define chamber means at substantially 120 degree directions outside the roller fixed centrally.

CLAIMS

1. A drying apparatus for use in a papermaking machine comprising,

at least four press rollers in nip contact with one another in succession as a closed train to define a substantially sealed chamber between said press rollers and chamber end walls,

at least one endless felt disposed for advance along an outer support surface portion of at least some of said rollers and passing through all of said nip contacts, said endless felt being a pervious carrier for a paper sheet to be dried,

at least one of said press rollers supporting said felt being a hollow roller having a pervious outer wall,

said nips applying pressure on said felt and paper sheet passing therebetween,

said endless felt being a pervious carrier for a paper sheet to be dried,

resilient support means for at least one press roller,

drive means for at least one press roller,

conduit means for air movement through said hollow roller and said chamber,

air displacement means connected to said conduit means, said air movement passing through said sheet carried on said felt whereby to extract moisture from said sheet and for convection of same by said conduit means.

2. An apparatus as claimed in claim 1 wherein said conduit means comprises an air box in external sealed and sliding contact with said pervious roller, and a conduit for joining said box to said air displacement means.

3. An apparatus as claimed in claim 1 wherein said conduit means comprises a peripheral seal internal of said

pervious roller, and a conduit joining said pump to said pervious roller by a rotary seal centrally located at said pervious roller.

4. An apparatus as claimed in claim 1 wherein said conduit means comprises a peripheral seal external of said pervious roller, and a conduit joining said pump to said pervious roller by a rotary seal centrally located at said pervious roller.

5. An apparatus as claimed in claim 1 wherein two of said press rollers are resiliently biased toward one another and in nip contact with said other pair of opposed rollers.

6. An apparatus as claimed in claim 1 wherein said conduit means comprises a conduit connected to said sealed chamber for displacing air therein.

7. An apparatus as claimed in claim 1 wherein said air displacement means is a pump.

8. A method of drying a pulp sheet by pressing comprising the steps of:

providing at least four press rollers in nip contact with one another in succession as a closed train to define a substantially sealed chamber between said press rollers and chamber end walls;

entering a moist pulp sheet supported on at least one endless felt into a nip between a first and a second roller;

advancing said sheet and felt into a nip between said first roller and a third roller;

advancing said sheet and felt into a nip between said third and a fourth roller;

advancing said sheet and felt into a nip between said fourth and said second roller, said nips applying pressure on said felt and pulp sheet passing therebetween;

exerting air pressure in a sealed void formed by said rollers;

displacing moisture in said sheet and felt by pumping air through a porous rim of at least one roller; and

discharging said sheet between said fourth roller and said second roller.

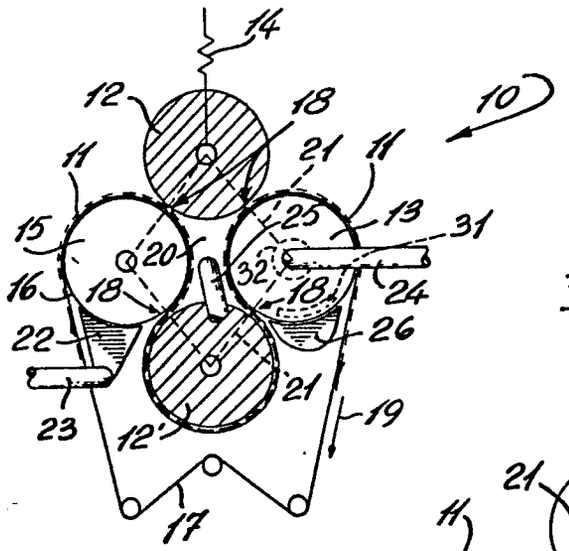

Fig. 1

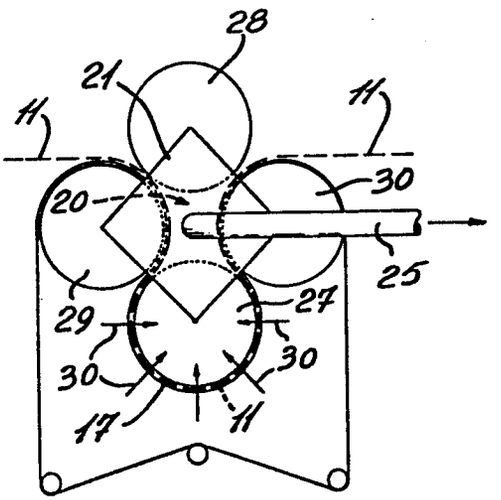

Fig. 2

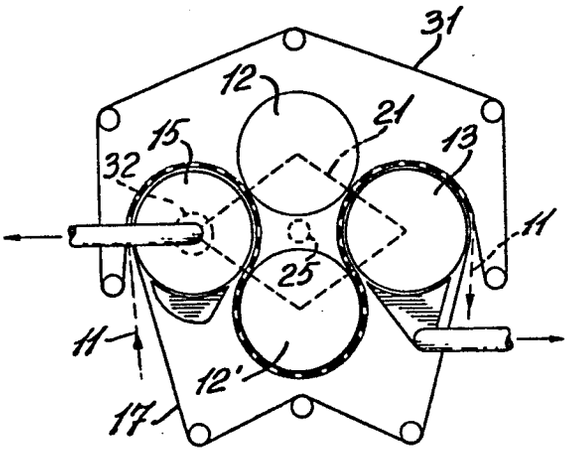

Fig. 3