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⑤④ **Multi-nip suction press.**

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⑦③ Proprietor: **Webster, David Richan**  
**32 Forden Avenue Westmount**  
**Montreal Quebec, H3Y 2Y8 (CA)**

⑦② Inventor: **Webster, David Richan**  
**32 Forden Avenue Westmount**  
**Montreal Quebec, H3Y 2Y8 (CA)**

⑦④ Representative: **Lepeudry-Gautherat, Thérèse**  
**et al**  
**ARMENGAUD JEUNE CABINET LEPEUDRY 6,**  
**rue du Fg. St-Honoré**  
**F-75008 Paris (FR)**

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## Description

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 previous 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 is 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.

Document US—A—4.124.942 refers to a conditioner type of system disposed after a dryer for the purpose of increasing, decreasing or equalizing the moisture content in a web. On figure 4, a central zone is created between rolls 2, 2' and 4, but there is no pressure differential between said zone and the interior of the upper roll 4, where the web passes. As a result, gas cannot flow across that part of web: drying could not be carried out. On figure 5, a central zone is created between porous rolls 32 and 33, and gas flows from the central zone to rolls 33, through the web W. However, a press felt—which is of importance in removing moisture by pressing—could not be satisfactorily utilized in conjunction with these rolls.

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 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, the invention provides a four nip press for drying a web of material comprising four rollers, each mounted for rotation about respective axes, said four rollers being positioned relative to each other such that each roller is in contact with two other rollers forming nips therebetween to thereby provide a closed train of rollers, means defining with said four rollers an enclosed central zone into which said web is received through a first of said nips and passing circumferentially over at least one of said rollers in the central zone and discharged therefrom through a second of said nips; said at least one roller being a porous cylinder and having a hollow interior; and means for providing a circulation of gas in said enclosed central zone and in the interior of said at least one press roller, characterized in that said four rollers are press rollers so adapted that water is squeezed out of the web by said nips, in that said second nip is formed between said porous cylinder being at least one press roller and a non-porous second press roller, means resiliently urging together said porous cylinder being at least one press roller and said non-porous second press roller, and in that said means for providing a circulation of gas comprise either gas inlet means or outlet means connected to the central zone and either gas exhaust means or inlet

means, respectively connected to the interior of said press roller, such that said gas will flow from said central zone to the interior of said press roller through said web, or vice versa, in order to remove water from said web, said press including a papermaking press felt supporting said web and said papermaking press felt being porous allowing the gas to pass therethrough between the central zone and the interior of said at least one press roller, said papermaking press felt with respect to said at least one press roller being downstream of the web with respect to the direction of gas flow through said web, said web and said papermaking press felt passing circumferentially over said non-porous second press roller exteriorly of said central zone with said web being between said papermaking press felt and said non-porous second press roller.

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.

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 par-

ticularly 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 surfaces 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, (here 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 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 four nip press for drying a web of material

(11) comprising four rollers (15, 12', 13, 12) each mounted for rotation about respective axes, said four rollers being positioned relative to each other such that each roller is in contact with two other rollers forming nips (18) therebetween to thereby provide a closed train of rollers, means (21) defining with said four rollers an enclosed central zone (20) into which said web is received through a first of said nips and passing circumferentially over at least one (15) of said rollers in the central zone and discharged therefrom through a second of said nips; said at least one roller being a porous cylinder and having a hollow interior; and means for providing a circulation of gas in said enclosed central zone (20) and in the interior of said at least one press roller (15), characterized in that said four rollers (15, 12', 13, 12) are press rollers so adapted that water is squeezed out of the web (11) by said nips (18), in that said second nip is formed between said porous cylinder being at least one press roller (15) and a non-porous second press roller (12'), means (14) resiliently urging together said porous cylinder being at least one press roller (15) and said non-porous second press roller (12'), and in that said means for providing a circulation of gas comprise either gas inlet means or outlet means (25) connected to the central zone (20) and either gas exhaust means (22, 23) or inlet means (24), respectively connected to the interior of said press roller (15), such that said gas will flow from said central zone to the interior of said press roller through said web (11), or vice versa, in order to improve water from said web, said press including a papermaking press felt (17) supporting said web and said papermaking press felt (17) being porous allowing the gas to pass therethrough between the central zone (20) and the interior of said at least one press roller (15), said papermaking press felt (17) with respect to said at least one press roller (15) being downstream of the web with respect to the direction of gas flow through said web, said web and said papermaking press felt (17) passing circumferentially over said non-porous second press roller (12') exteriorly of said central zone (20) with said web being between said papermaking press felt (17) and said non-porous second press roller (12').

2. A four nip press as defined in claim 1, wherein the first nip is defined by the first (15) and fourth (12) press rollers, the first press roller being said at least one of one of said press rollers such that the first press roller is hollow and the wall thereof is porous, the web re-enters the central zone at the third nip formed between the second press roller (12') and the third press roller (13), the web passing circumferentially over the third roller in the central zone and is discharged through a fourth nip formed between the third press roller (13) and the fourth press roller (12).

3. A four nip press as defined in claim 2, wherein the third press roller (13) also is a porous cylinder having a hollow interior, gas inlet means (25) being connected to said central zone (20) and gas exhaust means (22, 23) being connected to

the interiors of said first (15) and third (13) press rollers or vice versa.

4. A four nip press as defined in claim 1, wherein the means for maintaining the web in circumferential contact with the at least one press roller includes a second papermaking felt (17, 31) with said papermaking felts sandwiching the web (11) at the first of said nips and carrying the web over the circumference of the said at least one press roller (15) within the central zone (20).

5. A four nip press as defined in claim 4, wherein said felt (17, 31) is an endless felt.

#### Patentansprüche

1. Eine Vierspaltenpresse für die Trocknung einer Bahn aus Material (11) mit vier Walzen (15, 12', 13, 12), die jeweils um zugehörige Achsen drehbar angeordnet und so zueinander positioniert sind, daß jede Walze in Kontakt mit zwei anderen Walzen steht und Spalte (18) zwischen ihnen ausgebildet werden, wodurch eine geschlossene Walzenanordnung gebildet wird, mit Mitteln (21), die mit diesen vier Walzen einen geschlossenen Zentralbereich (20) definieren, in den die Bahn durch einen ersten der Spalte hineingelangt, umfänglich um zumindest eine (15) der Walzen in den Zentralbereich läuft und diesen durch einen zweiten der Spalte verläßt, wobei die zumindest eine Walze ein poröser Zylinder ist und eine innere Ausnehmung hat, und mit Mitteln für die Zirkulation eines Gases in dem geschlossenen Zentralbereich (20) und dem Inneren von zumindest einer Druckwalze (15), dadurch gekennzeichnet, daß die vier Walzen (15, 12', 13, 12) Druckwalzen sind und so angeordnet sind, daß Wasser aus der Bahn (11) durch die Spalte (18) herausgedrückt wird, daß der zweite Spalt zwischen dem porösen Zylinder, der zumindest ein Druckzylinder (15) ist, und einem nicht porösen zweiten Druckzylinder (12') ausgebildet ist, daß Mittel (14) für ein elastisches Zusammenpressen des porösen Zylinders, der mindestens eine der Druckwalzen (15) ist und dem nicht porösen zweiten Druckzylinder (12') vorgesehen sind, und daß die Mittel für die Zirkulation eines Gases entweder eine Einlaßeinrichtung oder eine Auslaßeinrichtung (25) für das Gas aufweisen, die mit dem Zentralbereich (20) und entweder einer Gasabführeinrichtung (22, 23) oder einer Gaszuführeinrichtung (24) verbunden ist, welche jeweils mit dem Inneren der Druckwalze (15) in Verbindung steht, so daß das Gas aus dem Zentralbereich in das Innere der Druckwalze durch die Bahn (11) hindurch oder umgekehrt strömt um Wasser aus dieser Bahn abzuführen, wobei die Presse einen Preßfilz für Papierherstellung (17) umfaßt, auf dem die Bahn aufliegt und dieser Preßfilz für die Papierherstellung (17) porös ist, damit das Gas durch ihn hindurch zwischen den Zentralbereich (20) und das Innere der zumindest einen Druckwalze (15) strömen kann, und wobei dieser Preßfilz für die Papierherstellung (17) hinsichtlich der zumindest einen Druckwalze (15) bewegungsabwärts der Bahn in Bezug auf die Strömungs-

richtung des Gases durch die Bahn ist und die Bahn und der Preßfilz für die Papierherstellung (17) umfänglich über die nicht poröse zweite Preßwalze (12') außerhalb des Zentralbereichs (20) laufen, wobei die Bahn sich zwischen dem Preßfilz für die Papierherstellung (17) und der nicht porösen zweiten Preßwalze (12') befindet.

2. Presse nach Anspruch 1, bei der der ersten Spalt zwischen der ersten (15) und der vierten (12) Preßwalze definiert ist, wobei die erste Preßwalze die zumindest eine der Druckwalzen ist, so daß die erste Druckwalze hohl und ihre Wand porös ist, wobei die Bahn am dritten Spalt, der zwischen der zweiten Preßwalze (12') und der dritten Preßwalze (13) ausgebildet ist, wieder in den Zentralbereich einläuft und die Bahn umfänglich über die dritte Walze in den Zentralbereich gelangt und durch einen vierten Spalt ausläuft, der zwischen der dritten Preßwalze (13) und der vierten Preßwalze (12) ausgebildet wird.

3. Presse nach Anspruch 2, bei der auch die dritte Druckwalze (13) ein poröser Zylinder ist und einen hohlen Innenraum aufweist, wobei das Gaszuführungsmittel (25) mit dem Zentralbereich (20) verbunden sind und Gasauslaßmittel (22, 23) mit den Innenräumen der ersten (15) und dritten (13) Preßwalze verbunden sind oder umgekehrt.

4. Presse nach Anspruch 1, bei der die Mittel für die Anlage der Bahn um umfänglichem Kontakt mit der mindestens einen Druckwalze ein zweites Papiermaschinenfilz (17, 31) aufweist, wobei die Papiermaschinenfilze am ersten der Spalte beidseitig an der Bahn (11) anliegen und diesen über den Umfang der mindestens einen Druckwalze (15) innerhalb des Zentralbereichs (20) tragen.

5. Presse nach Anspruch 4, bei der der Filz (17, 31) ein endloser Filz ist.

#### Revendications

1. Une presse à quatre intervalles de compression pour sécher une nappe de matière (11), comprenant quatre rouleaux (15, 12', 13, 12) montés chacun de manière à tourner autour d'axes respectifs, les quatre rouleaux précités étant positionnés l'un par rapport à l'autre de telle sorte que chaque rouleau soit en contact avec deux autres rouleaux en formant entre eux des intervalles de compression (18) de manière à créer ainsi un train de rouleaux fermé, un moyen (21) définissant avec les quatre rouleaux précités une zone centrale fermée (20) dans laquelle ladite nappe est reçue au travers d'un premier desdits intervalles, pour passer circonférentiellement sur au moins un (15) desdits rouleaux dans la zone centrale et pour être déchargée de celui-ci au travers d'un second desdits intervalles; ledit rouleau au moins prévu étant un cylindre poreux et comportant un volume intérieur creux; et des moyens pour assurer une circulation de gaz dans ladite zone centrale fermée (20) et à l'intérieur dudit rouleau de compression au moins prévu (15), caractérisée en ce que lesdits quatre rouleaux (15, 12', 13, 12) sont des rouleaux de compression adaptés de manière à expulser de

l'eau de la nappe (11) par compression dans ledits intervalles (18), en ce que ledit second intervalle est formé entre ledit cylindre poreux, qui constitue le premier rouleau de compression (15) au moins prévu, et un second rouleau de compression non poreux (12'), un moyen (14) poussant élastiquement l'un contre l'autre ledit cylindre poreux formant un rouleau de compression (15) et ledit second rouleau de compression non poreux (12') et en ce que ledit moyen assurant une circulation de gaz comprend un moyen d'entrée ou un moyen de sortie de gaz (25) relié à la zone centrale (20) et soit un moyen d'échappement de gaz (22, 23) soit un moyen d'entrée de gaz (24), respectivement reliés avec l'intérieur dudit rouleau de compression (15), de telle sorte que ledit gaz s'écoule de ladite zone centrale vers l'intérieur dudit rouleau de compression au travers de ladite nappe (11), ou inversement, de manière à enlever l'eau de ladite nappe, ladite presse comprenant un feutre de compression (17) pour fabrication de papier qui supporte ladite nappe et ledit feutre de presse de fabrication de papier (17) étant poreux en permettant au gaz de le traverser entre la zone centrale (20) et l'intérieur dudit rouleau de compression au moins prévu (15), ledit feutre de presse de fabrication de papier (17) étant situé en aval dudit rouleau de compression au moins prévu (15), en considérant la direction d'écoulement du gaz au travers de ladite nappe, ladite nappe et ledit feutre de presse de fabrication de papier (17) passant circonférentiellement sur ledit second rouleau de compression non poreux (12') à l'extérieur de ladite zone centrale (20), ladite nappe étant située entre ledit feutre de presse de fabrication de papier (17) et ledit second rouleau de compression non-poreux (12').

2. Une presse à quatre intervalles de compres-

sion telle que définie dans la revendication 1, dans laquelle le premier intervalle est défini par le premier (15) et le quatrième (12) rouleau de presse, le premier rouleau de presse étant creux et sa paroi étant poreuse, la nappe pénétrant à nouveau dans la zone centrale dans le troisième intervalle formé entre le second rouleau de presse (12') et le troisième rouleau de presse (13), la nappe passant circonférentiellement sur le troisième rouleau dans la zone centrale et étant déchargée au travers d'un quatrième intervalle formé entre le troisième rouleau de presse (13) et le quatrième rouleau de presse (12).

3. Une presse à quatre intervalles de compression telle que définie dans la revendication 2, dans laquelle le troisième rouleau de presse (13) est également un cylindre poreux comportant un volume intérieur creux, un moyen d'entrée de gaz (25) étant relié à ladite zone centrale (20) et les moyens d'échappement de gaz (22, 23) étant reliés aux volumes intérieurs desdits premier (15) et troisième (13) rouleaux de presse, ou inversement.

4. Une presse à quatre intervalles de compression telle que définie dans la revendication 1, dans laquelle le moyen pour maintenir la nappe en contact circonférentiel avec le premier rouleau de presse comprend un second feutre de fabrication de papier (17, 31), lesdits feutres de fabrication de papier étant placés de chaque côté de la nappe (11) dans le premier intervalle de compression et transportant la nappe sur la circonférence dudit premier rouleau de presse (15) à l'intérieur de la zone centrale (20).

5. Une presse à quatre intervalles de compression telle que décrite dans la revendication 4, dans laquelle ledit feutre (17, 31) est un feutre sans fin.

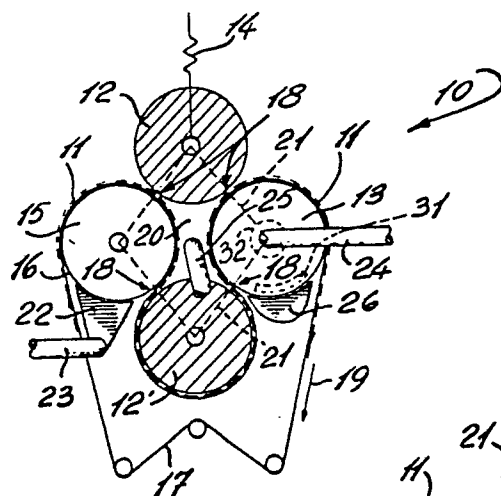


FIG. 1

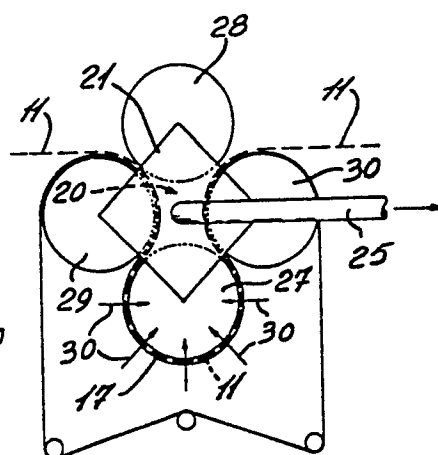


FIG. 2

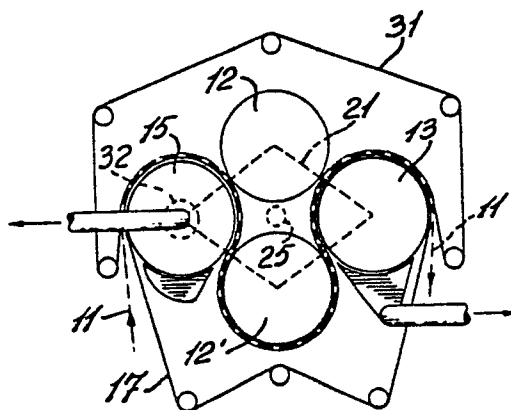


FIG. 3