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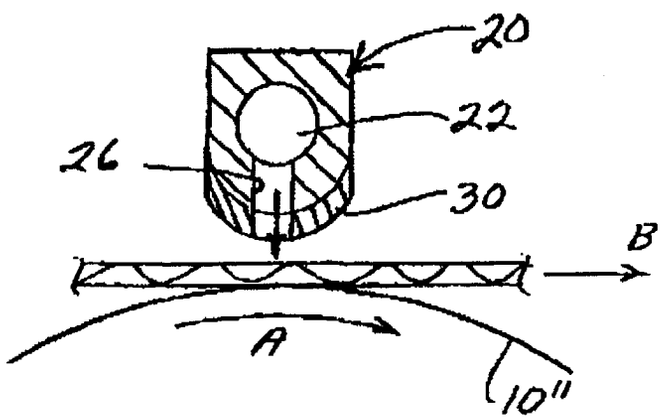
(54) Flexographic printing machine and method of flexographic printing

(57) A flexographic printing machine which comprises a printing cylinder (10") and pressure applying means (20) for, in use, urging material against said printing cylinder (10") to facilitate the transfer of an image to said material, wherein, in use, said pressure applying means (20) ejects a fluid which directly urges said material against said printing cylinder (10"), characterised by a low coefficient of friction material (30), the arrangement being such that, in use, said low coefficient of friction material (30) inhibits damage to warped material passing between said pressure applying means and said printing cylinder.

FIG. 5



EP 1 325 811 A1

Description

[0001] The present invention relates to a flexographic printing machine and to a method of flexographic printing.

[0002] Flexographic printing machines generally comprise a printing cylinder and an impression cylinder, between which material can be passed by feed conveyors in order to imprint an image or images onto the material with water based inks. Both the printing cylinder and impression cylinder are expensive to manufacture. Accordingly, the impression cylinder tends to be made as small in diameter as possible as it is only required to press material onto the printing cylinder. The printing cylinder is generally of much larger diameter in order to hold the necessary image(s). The image (s) is held by a printing plate on the printing cylinder and is transferred directly from the printing plate to the material. The printing plate is generally constructed from metal or plastic. The material may comprise "container blanks" which can be individual sheets of cardboard, more specifically corrugated cardboard.

[0003] Current demand for large stock volumes with high image quality requires that container blanks are fed through the printing machine at speeds of, at present, 1000 feet per minute. This requires the printing cylinder and impression cylinder to rotate at high angular speed. However, the angular speed of the impression cylinder is much higher than that of the printing cylinder due to its smaller diameter.

[0004] Unfortunately, as the impression cylinder is suspended at both ends and is of small diameter it tends to flex in the middle. At the high speeds mentioned above, this flex causes the impression cylinder to oscillate across its axis which is highly undesirable because the resulting printed image is uneven in density, especially as the printing plate has no flexibility to compensate. The oscillation is a function of several parameters, one of which is the speed of the printing machine. So, until now, increasing printing machine speeds to produce more products has had to be balanced with product quality.

[0005] One attempt to address these problems has simply been to increase the diameter of the impression cylinder. Whilst this provides satisfactory results in terms of uniform print density and output, it significantly increases the costs of the printing machine.

[0006] Moreover, if the diameter of the impression cylinder is increased, the feed conveyors at either side of the impression cylinder have to be moved further apart to accommodate this larger diameter. Therefore, the minimum length of container blank that can be handled by the machine is increased. This also means that when individual sheets are being imprinted, they are held less firmly such that the clarity of the printed image may suffer.

[0007] At present, it is difficult to strike a balance between the required output, quality and cost.

[0008] The present invention attempts to address these problems in a direction entirely contrary to the aforementioned.

[0009] According to the present invention there is provided a flexographic printing machine which comprises a printing cylinder and pressure applying means for, in use, urging material against said printing cylinder to facilitate the transfer of an image to said material, characterised in that, in use, said pressure applying means ejects a fluid which directly or indirectly urges said material against said printing cylinder.

[0010] One advantage of this arrangement is that the impression cylinder can be dispensed with altogether, significantly reducing costs of the printing machine. Another advantage is that high press speeds can be maintained without a reduction in print quality. A further advantage of such an arrangement is that a substantially even pressure can be applied across material as it passes through the printing machine. Another advantage is that this pressure can be readily adjusted to accommodate different materials or different print density, for example.

[0011] Preferably, said pressure applying means comprises a substantially flat portion such that, in use, ejected fluid forms a cushion or film of fluid between said material and said pressure applying means.

[0012] One advantage of this arrangement is that the cushion or film of fluid provides a sufficient surface area so that a lower pressure of fluid is required to exert the same force on the material.

[0013] Advantageously, in use said pressure applying means forms a plurality of cushions or films of fluid.

[0014] Preferably, said pressure applying means comprises a nozzle such that, in use, fluid is ejected substantially in the form of a jet.

[0015] One advantage of such an arrangement is that only a small area of contact between the material and the jet is required for the necessary print finish.

[0016] Advantageously, said pressure applying means comprises a plurality of nozzles.

[0017] Preferably, said pressure applying means comprises an elongate member extending substantially perpendicular to the direction of travel of said material through said flexographic printing machine.

[0018] Advantageously, said flexographic printing machine further comprises an orifice through which, in use, said fluid is ejected.

[0019] Preferably, said flexographic printing machine further comprises a plurality of orifices through which, in use, said fluid is ejected.

[0020] Advantageously, said flexographic printing machine further comprises a land portion, the arrangement being such that, in use, fluid is ejected from said orifice and/or said plurality of orifices into said land portion for diffusion therein.

[0021] Preferably, there is associated a separate land portion with each orifice of the plurality of orifices.

[0022] Container blanks made of cardboard are par-

ticularly susceptible to the problem of warpage, which is frequently caused by uncontrollable ambient moisture levels around the print press. Existing flexographic printing machines have difficulty handling warped blanks and, in at least preferred embodiments, the present invention seeks to address this problem.

[0023] Advantageously, said flexographic printing machine further comprises a low coefficient of friction material, the arrangement being such that, in use, said low coefficient of friction material inhibits damage to warped material passing between said pressure applying means and said printing cylinder.

[0024] One advantage of this arrangement is that the pressure of fluid ejected from the pressure applying means does not have to be high enough to correct any warps in the container blanks. This helps to reduce energy consumption.

[0025] Preferably, said flexographic printing machine further comprises an elongate chamber which, in use, supplies fluid to said orifice or said plurality of orifices.

[0026] Advantageously, said elongate member houses said elongate chamber and said orifice or said plurality of orifices.

[0027] Preferably, said elongate chamber is substantially rectangular in cross section.

[0028] Advantageously, said elongate chamber is substantially circular in cross section.

[0029] Preferably, said flexographic printing machine further comprises a generally flat portion on which said orifice is or said plurality of orifices are located.

[0030] Advantageously, said elongate chamber is substantially triangular in cross section.

[0031] Preferably, said flexographic printing machine further comprises an impression roller, wherein in use, said impression roller is urged onto said material by said fluid so that said impression roller applies a substantially even pressure to said material.

[0032] Advantageously, said impression roller is housed in a chamber which comprises a seat, the arrangement being such that, in use, said impression roller is urged against said seat by said fluid when no material is passing between said impression roller and said printing cylinder.

[0033] Preferably, said flexographic printing machine further comprises feed means.

[0034] Advantageously, said flexographic printing machine further comprises a fluid supply which is arranged, in use, to supply fluid to said pressure applying means.

[0035] Preferably, said fluid comprises a gas.

[0036] According to another aspect of the present invention there is provided a flexographic printing machine comprising a plurality of flexographic printing machines in accordance with the present invention.

[0037] According to another aspect of the present invention there is provided a method of flexographic printing using a flexographic printing machine in accordance with the present invention, which method comprises the steps of:

feeding material to said flexographic printing machine;

urging said material onto said printing cylinder by fluid pressure.

[0038] For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Fig. 1 is a schematic cross-section of part of a known flexographic printing machine;

Fig. 2 is a schematic cross-section of part of a first embodiment of a flexographic printing machine according to the present invention;

Fig. 2-A is a schematic cross-section of part of a second embodiment of a flexographic printing machine according to the present invention;

Fig. 3 is an underneath plan view of the transverse element shown in Fig. 2 taken along line 3-3 of Fig. 2;

Fig. 4 is an underneath plan view of an alternative transverse element to the transverse element shown in Fig. 3;

Fig. 5 is a schematic cross-section of part of a third embodiment of a flexographic printing machine according to the present invention;

Fig. 6 is a schematic cross-section of part of a fourth embodiment of a flexographic printing machine according to the present invention;

Fig. 7 is a schematic cross-section of part of a fifth embodiment of a flexographic printing machine according to the present invention;

Fig. 8 is a schematic cross-section of part of a sixth embodiment of a flexographic printing machine according to the present invention;

Fig. 9-A is a schematic cross-section of part of a seventh embodiment of a flexographic printing machine according to the present invention;

Fig. 9-B is a schematic cross-section of part of a eighth embodiment of a flexographic printing machine according to the present invention;

Fig. 10 is a schematic cross-section of a transverse element of a ninth embodiment of a flexographic printing machine according to the present invention; and

Fig. 11 is a schematic cross-section of the transverse element of Fig. 10 in use.

[0039] Referring to Fig. 1, first and second stages of a conventional, prior art rotary printing machine are illustrated schematically. Fig. 1 is particularly illustrative of a flexographic printing machine which imprints very high resolution, multi-coloured images on either a web, or a succession of individual sheets such as "container blanks".

[0040] Sheets of material 11 to be imprinted are typi-

cally conveyed to the nip between printing cylinder 10 and impression cylinder 12 by a feed conveyor 14. Such feed conveyors are well known in the printing art, and disclosed for example in US-A-5 782 183. However, it will be noted that material 11 in Fig. 1 is illustrated as being conveyed on the bottom reach 16a of the conveyor against which they are held by a pressure differential above and below the material 11. It will also be understood that conveyors 14, 14' and 14" may be replaced by conveyors which convey the material 11 on their upper reaches 16b, and that for certain applications, one or all of the conveyors may be replaced by pairs of feed rollers (not shown). As the diameters of impression cylinders have increased for reasons hereinbefore described, the feed conveyors, or pairs of feed rollers, must be moved farther and farther away from each other.

[0041] Referring to Fig. 2 there is shown a printing cylinder which is generally identified by reference numeral 10" and which is shown as having a conventional printing plate 18 which rotates in the direction of arrow A and imprints images on material 11. Material 11 is illustrated as being one of a continuous series of individual sheets of or blanks, such as container blanks, which pass through one or more printing stages.

[0042] On the side of the material 11 which is opposite to printing plate 18, there is disposed a transverse element 20 which extends across the width of the machine generally perpendicular to the direction of travel of material 11. Transverse element 20 may be referred to as an elongate element or "beam" since it does not rotate, and it extends as a stationary element across the lateral extent or width of the printing machine between side walls 25 of the machine as shown schematically in Fig. 3.

[0043] Transverse element 20 includes a longitudinally extending chamber 22. In use, chamber 22 is supplied with a gas, such as air, at superatmospheric pressure from a compressor or other source of pressurised gas. The compressed gas in chamber 22 flows out through one or more passages 26 to one or more orifices 28. Orifices 28 are located adjacent the backside of material 11 and directly opposite to the point at which material 11 is contacted by printing plate 18. The fluid pressure of the gas urges material 11 against the printing plate 18, which helps to ensure an even pressure across the width of material 11, thus achieving a good quality print whilst maintaining high throughput. The pressure is also easily variable by applying different pressures for different types of material.

[0044] Transverse element 20 has a rectangular cross section and chamber 22 is a groove in the beam covered by a sealed cap or strip 23.

[0045] Referring to Fig. 2-A the transverse element 20 is of circular cross section, and may be a hollow tube of metal or plastic composition. Orifices 28 and passages 26 comprise one or more ports 28' which direct the pressurised gas against the backside of material 11. In use, the transverse element 20 operates in a similar fashion to the transverse element 20 of Fig. 2.

[0046] Referring to Figs 3 and 4, orifices 28 may comprise a series of individual openings or ports 28', or they may be in the shape of one or more elongated slots 28". That is, depending upon the size, shape and weight of material 11 and the pressure in chamber 22, the number of orifices 28 extending along the longitudinal length of the transverse element 20 may be preferred to be a large plurality of small, individual ports 28', or one or more slots 28". Also, transverse element 20 may be composed of any suitable metal, or even plastic, so long as it is sufficiently rigid to extend across the width of the machine.

[0047] Referring to Fig. 5, transverse element 20 is illustrated as including layer 30 of low coefficient of friction composition, such as well known plastics materials. Layer 30 is positioned between the material 11 and transverse element 20. If the material 11 is sufficiently warped, bent, creased or otherwise distorted and non-planar such as to instantaneously contact transverse element 20, it will instead contact layer 30. Thus, damage to the material 11 is inhibited. '

[0048] Referring to Fig. 6, the orifices 28 may include enlarged areas or lands 32 such that, in use, when the high pressure gas is ejected from passages 26 it is diffused in the land area 32 by expansion. This forms a "cushion" or film of gas between material 11 and the transverse element 20. Of course, it will be apparent that lands 32 my be formed directly in the transverse element 20, as in Fig. 6, or in layer 30 as in Fig. 5.

[0049] The applicant has found that, depending on the pressure of gas in chamber 22, the exit velocity of the gas from orifices 28 or lands 32, and the total volumetric flow rate of the gas, apparatus in accordance with the present invention may be caused to operate in different modes. For example and referring to Fig. 7, high velocity jet(s) 36 may be directed against the backside of the material 11 whereby it is primarily the dynamic fluid pressure of the gas jet(s) 36 which urges material 11 against printing plate 18 on the printing cylinder 10". Such jet(s) of gas 36 may be produced by utilising narrow passages 26, and/or high velocity nozzles 38, and/or the use of high pressure chambers 22. At the same time, as shown schematically in Fig. 8, transverse element 20 may be positioned closer to the backside of material 11 so as to form a film or cushion of pressurised gas between material 11 and the adjacent surface of transverse element 20. In this embodiment passages 26 may be made larger, and/or a land 32 may be provided so as to diffuse the gas over a larger surface area and form the film or cushion. In either mode, whether the fluid jet mode or the fluid film mode, it will be apparent that it is pressurised gas which contacts the backside of material 11 and urges it against the printing plate 18 of the printing cylinder 10"; i.e. as opposed to the rotating impression cylinder of the prior art. As shown in Figs. 9-A and 9-B, the film mode may also be prompted by the provision of multiple

passages 26 along the direction of material movement, and the film may be formed with a land area 32' as illustrated in Fig. 9-B.

* * *

[0050] In each of the foregoing illustrative embodiments, the material to be printed is maintained out of contact with a solid element solely by virtue of the pressure from the gas, except of course for the possible non-planar portions as previously explained. Fig. 10 schematically illustrates a further embodiment of the present invention in which the material to be printed does contact a solid element, but where the solid element is urged against the material to be printed by fluid pressure.

[0051] Referring to Figs. 10 and 11, numeral 20 continues to indicate a transverse element as previously described, and numeral 22 continues to indicate a chamber of compressed gas. However, numeral 40 indicates an impression roller that, in use, can rotate freely, such as ball or elongated element. Impression roller 40 is mounted in a chamber 42 in transverse element 20, and it will be understood that the impression roller 40 can be solid or hollow as shown. The compressed gas from high pressure chamber 22 is conducted to chamber 42 by one or more passages 44, and it will be noted that the diameter of the upper portion of chamber 42 is slightly larger than that of impression roller 40. The bottom portion of chamber 42 is of the same diameter as impression roller 40 such that, in use, impression roller 40 acts as a valve head which seats on a valve seat 46 when no material 11 is passing between impression roller 40 and printing cylinder 10". This inhibits the escape of gas from the chamber 42. However, when material 11 passes between impression roller 40 and printing cylinder 10" the impression roller 40 is shifted slightly and the valve is opened. The pressurised gas around the upper portion of impression roller 40 in chamber 42 urges impression roller 40 onto material 11. The impression roller 40 also rotates freely in the chamber 42 and offers little resistance to the passage of material 11 whilst maintaining pressure on the same. Pressure is also applied substantially evenly along the length of impression roller 40 which is transferred to material 11. This helps to reduce uneven print quality and inhibits "whipping" of impression roller 40. When the valve is opened the pressure of the gas which escapes around the sides of impression roller 40 also helps to urge the material 11 onto the printing cylinder 10".

[0052] It will be appreciated that various modifications can be made to the embodiments described above. For example, other shapes of cross section of the transverse element 20 could be employed. The chamber 22 need not be located as close to the orifices 28; for example, the chamber 22 may located some distance away from the material 11, and connected via tubes to orifices near material 11.

[0053] For avoidance of doubt, the term "backside" as used herein is the side of material 11 opposite that which is to be imprinted. The material 11 may also be fed to the bottom portion of a printing cylinder, below which a conventional impression cylinder is normally positioned and where, in accordance with the present invention, transverse element 20 may be located.

[0054] The present invention therefore provides the following features:

F1. A flexographic printing machine which comprises a printing cylinder (10") and pressure applying means (20) for, in use, urging material against said printing cylinder (10") to facilitate the transfer of an image to said material, characterised in that, in use, said pressure applying means (20) ejects a fluid which directly or indirectly urges said material against said printing cylinder (10").

F2. A flexographic printing machine as set out in F1, wherein said pressure applying means (20) comprises a substantially flat portion such that, in use, ejected fluid forms a cushion or film of fluid (37) between said material and said pressure applying means (20).

F3. A flexographic printing machine as set out in F2, wherein in use said pressure applying means (20) forms a plurality of cushions or films of fluid 37).

F4. A flexographic printing machine as set out in F1, F2 or F3, wherein said pressure applying means (20) comprises a nozzle (38) such that, in use, fluid is ejected substantially in the form of a jet, (36).

F5. A flexographic printing machine as set out in F4, wherein said pressure applying means (20) comprises a plurality of nozzles (38).

F6. A flexographic printing machine as set out in any preceding feature, wherein said pressure applying means (20) comprises an elongate member (20) extending substantially perpendicular to the direction of travel of said material through said flexographic printing machine.

F7. A flexographic printing machine as set out in F6, further comprising an orifice (28; 28'; 29") through which, in use, said fluid is ejected.

F8 . A flexographic printing machine as set out in F6 or F7, further comprising a plurality of orifices (28; 28'; 28") through which, in use, said fluid is ejected.

F9. A flexographic printing machine as set out in F6,F7 or F8, further comprising a land portion (32), the arrangement being such that, in use, fluid is ejected from said orifice and/or said plurality of orifices (28; 28'; 28") into said land portion (32) for diffusion therein.

F10 . A flexographic printing machine as set out in F8 and F9, wherein there is associated a separate land portion (32) with each orifice of the plurality of orifices.

F11. A flexographic printing machine as set out in any preceding feature, further comprising a low coefficient of friction material (30), the arrangement being such that, in use, said low coefficient of fric-

tion material (30) inhibits damage to warped material passing between said pressure applying means and said printing cylinder.

F12. A flexographic printing machine as set out in any of F6 to F11, further comprising an elongate chamber (22) which, in use, supplies fluid to said orifice or said plurality of orifices.

F13. A flexographic printing machine as set out in F12, wherein said elongate member (20) houses said elongate chamber (22) and said orifice or said plurality of orifices (28; 28'; 28'').

F14. A flexographic printing machine as set out in F12 or F13, wherein said elongate chamber (22) is substantially rectangular in cross section.

F15. A flexographic printing machine as set out in F12 or F13, wherein said elongate chamber (22) is substantially circular in cross section.

F16. A flexographic printing machine as set out in F15, further comprising a generally flat portion on which said orifice is or said plurality of orifices are located.

F17. A flexographic printing machine as claimed in F12 or F13, wherein said elongate chamber (22) is substantially triangular in cross section.

F18. A flexographic printing machine as set out in any preceding feature, further comprising an impression roller (40), wherein in use, said impression roller (40) is urged onto said material by said fluid so that said impression roller (40) applies a substantially even pressure to said material.

F19. A flexographic printing machine as set out in F18, wherein said impression roller (40) is housed in a chamber (42) which comprises a seat (46), the arrangement being such that, in use, said impression roller (40) is urged against said seat (46) by said fluid when no material is passing between said impression roller (40) and said printing cylinder (10'').

F20. A flexograpbic printing machine as set out in any preceding feature, further comprising feed means.

F21. A flexographic printing machine as set out in any preceding feature, further comprising a fluid supply which is arranged, in use, to supply fluid to said pressure applying means.

F22 . A flexographic printing machine as set out in any preceding feature, wherein said fluid comprises a gas.

F23. A flexographic printing machine, comprising a plurality of flexographic printing machines as set out in any preceding feature.

F24. A method of flexographic printing using a flexographic printing machine as set out in any of F1 to F23, which method comprises the steps of:

feeding material to said flexographic printing machine;

urging said material onto said printing cylinder by fluid pressure.

Claims

1. A flexographic printing machine which comprises a printing cylinder (10'') and pressure applying means (20) for, in use, urging material against said printing cylinder (10'') to facilitate the transfer of an image to said material, wherein, in use, said pressure applying means (20) ejects a fluid which directly urges said material against said printing cylinder (10''), **characterised by** a low coefficient of friction material (30), the arrangement being such that, in use, said low coefficient of friction material (30) inhibits damage to warped material passing between said pressure applying means and said printing cylinder.

2. A flexographic printing machine as claimed in Claim 1, wherein said pressure applying means (20) comprises a substantially flat portion such that, in use, ejected fluid forms a cushion or film of fluid (37) between said material and said pressure applying means (20).

3. A flexographic printing machine as claimed in Claim 2, wherein in use said pressure applying means (20) forms a plurality of cushions or films of fluid (37).

4. A flexographic printing machine as claimed in Claim 1, 2 or 3, wherein said pressure applying means (20) comprises a nozzle (38) such that, in use, fluid is ejected substantially in the form of a jet (36).

5. A flexographic printing machine as claimed in Claim 4, wherein said pressure applying means (20) comprises a plurality of nozzles (38).

6. A flexographic printing machine as claimed in any of Claims 1 to 5, wherein said pressure applying means (20) comprises an elongate member (20) extending substantially perpendicular to the direction of travel of said material through said flexographic printing machine.

7. A flexographic printing machine as claimed in Claim 30, further comprising an orifice (28; 28'; 28'') through which, in use, said fluid is ejected.

8. A flexographic printing machine as claimed in Claim 7, further comprising a plurality of orifices (28; 28'; 28'') through which, in use, said fluid is ejected.

9. A flexographic printing machine as claimed in Claim 6, 7 or 8, further comprising a land portion (32), the arrangement being such that, in use, fluid is ejected from said orifice and/or said plurality of orifices (28;

28'; 28'') into said land portion (32) for diffusion therein.

10. A flexographic printing machine as claimed in Claims 8 and 9, wherein there is associated a separate land portion (32) with each orifice of the plurality of orifices.

11. A flexographic printing machine as claimed in any of Claims 1 to 10, further comprising an elongate chamber (22) which, in use, supplies fluid to said orifice or said plurality of orifices.

12. A flexographic printing machine as claimed in Claim 11, wherein said elongate member (20) houses said elongate chamber (22) and said orifice or said plurality of orifices (28; 28'; 28'').

13. A flexographic printing machine as claimed in Claim 11 or 12, wherein said elongate chamber (22) is substantially rectangular in cross section.

14. A flexographic printing machine as claimed in Claim 11 or 12, wherein said elongate chamber (22) is substantially circular in cross section.

15. A flexographic printing machine as claimed in Claim 14, further comprising a generally flat portion on which said orifice is or said plurality of orifices are located.

16. A flexographic printing machine as claimed in Claim 11 or 12, wherein said elongate chamber (22) is substantially triangular in cross section.

17. A flexographic printing machine as claimed in claim 1, wherein said low coefficient of friction material is positioned between said material and said pressure applying means.

18. A flexographic printing machine as claimed in claim 1 or 17, wherein said low coefficient of friction material is mounted on said pressure applying means.

19. A flexographic printing machine as claimed in claim 1, 17 or 18, wherein said low coefficient of friction material comprises a convex surface that faces said material.

20. A flexographic printing machine as claimed in any preceding Claim, further comprising a fluid supply which is arranged, in use, to supply fluid to said pressure applying means.

21. A flexographic printing machine as claimed in any preceding Claim, wherein said fluid comprises a gas.

22. A method of flexographic printing using a flexographic printing machine as claimed in any of Claims 1 to 21, which method comprises the steps of:

feeding material to said flexographic printing machine;
directly urging said material onto said printing cylinder with fluid pressure; and
inhibiting damage to warped material passing between said pressure applying means and said printing cylinder with a low coefficient of friction material.

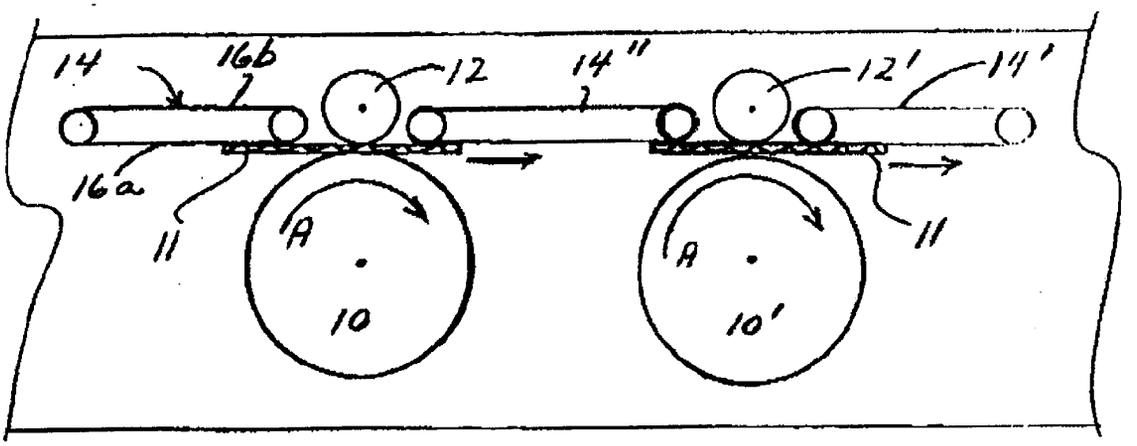


FIG. 1 PRIOR ART

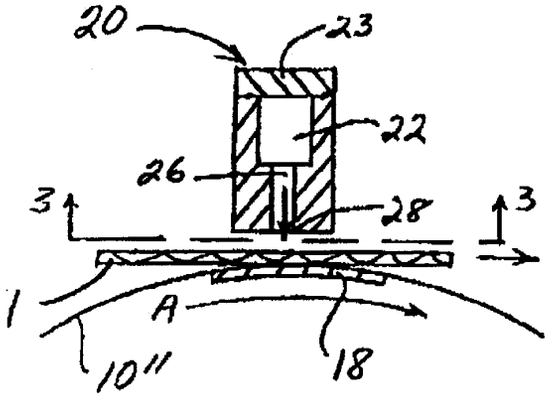


FIG. 2

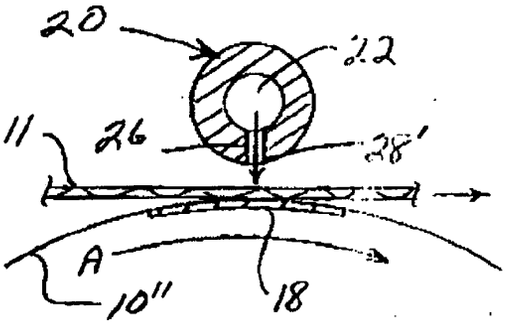


FIG 2-A

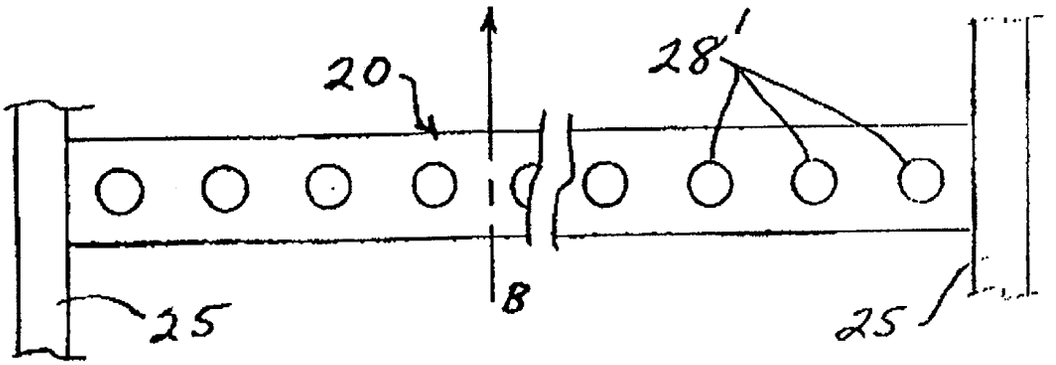


FIG. 3

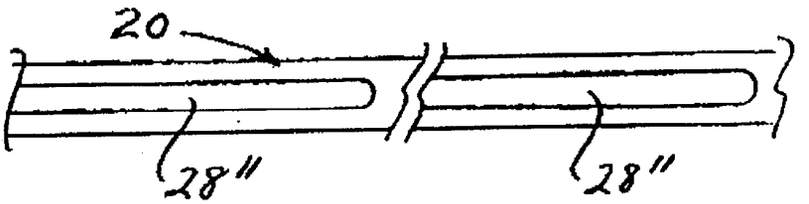
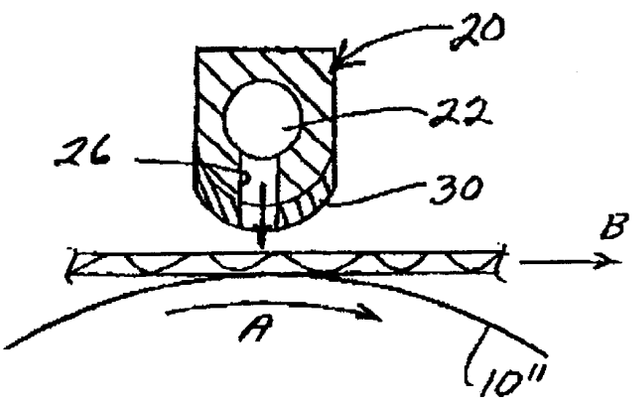


FIG. 4

FIG. 5



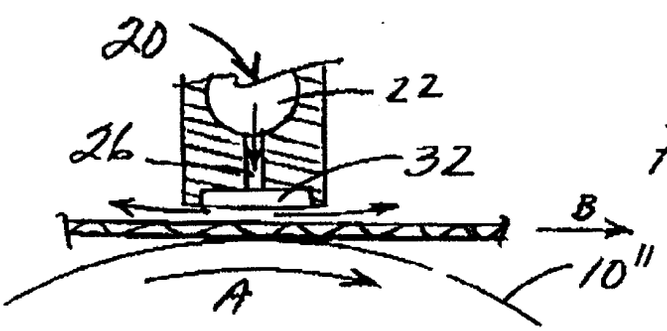


FIG. 6

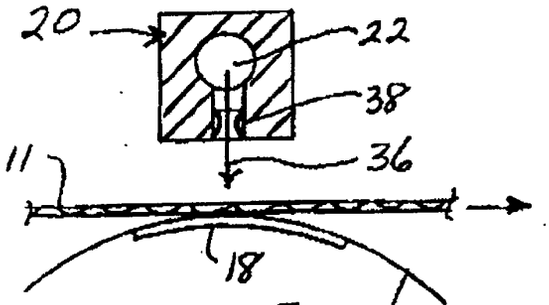


FIG. 7

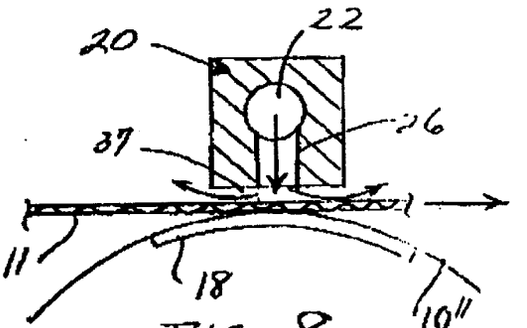


FIG. 8

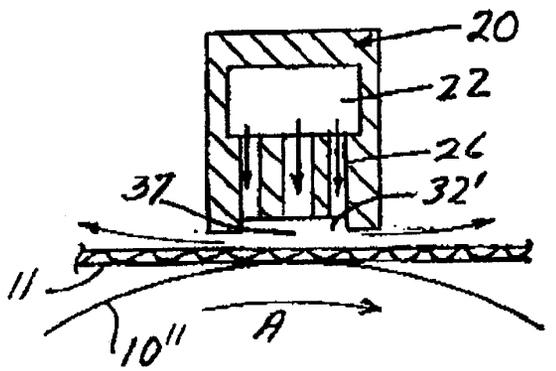


FIG. 9-A

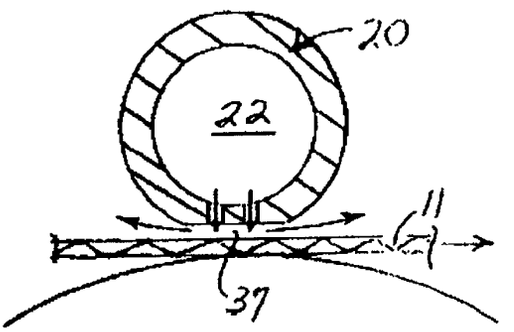


FIG. 9-B

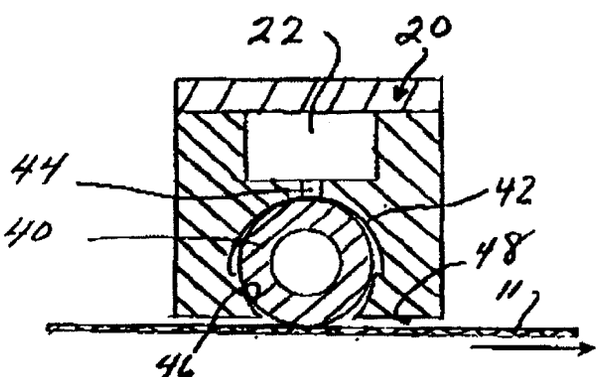


FIG. 11

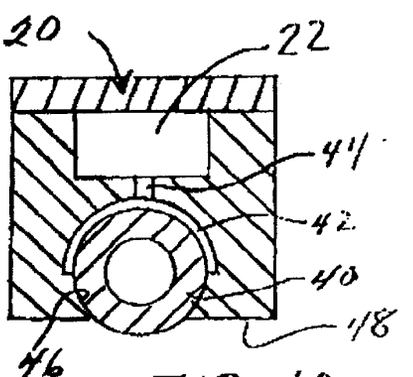


FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 03 07 5667

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