ABSTRACT

A device and process to improve the penetration of a permeable flat shaped material by a liquid compound. A printing or dyeing compound or a penetrating agent is put into vibration relative to the permeable flat shaped material. The acceleration maximum of the vibration motion amounts to at least tenfold the acceleration due to the earth's gravity. The alternating field of inertial forces caused by the vibrations and acting on the particles of the printing or dyeing compound to be applied or the penetrating agent or the material has superimposed thereon a static field of forces directed essentially normally to the surface of the permeable flat shaped article. The static field of forces is a static field due to gravity, or an applied static field such as an electrostatic field, or a magnetostatic field. The frequency of vibrations may amount to about 100 hertzian units. The permeable flat shaped material may be treated with ultrasonics. The apparatus may have at least one swing table over which the permeable flat shaped material passes and which is provided with suction channels to secure the permeable flat shaped material or a conveyor belt supporting the flat shaped material. The printing or dyeing compound may be vibrated by a pressure chamber arranged underneath the sheet material containing a gaseous or liquid medium, the internal pressure of the pressure chamber being subjected to periodic fluctuations.

16 Claims, 6 Drawing Figures
Fig. 3

Diagram showing a device with labeled parts:

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SCREEN PRINTER USING VIBRATION TO IMPROVE INK PENETRATION

BACKGROUND OF THE INVENTION

This invention relates to a process to improve penetration of a permeable flat shaped material by a liquid compound or penetrating agent to be applied thereto, as well as to devices to perform the process.

When the surface of a permeable flat shaped material, such as a textile sheet of material, is supplied with a compound to be applied, such as a dye, it is frequently desired that the compound to be applied also penetrates into the permeable flat shaped material. The existing capillary forces are not always sufficient to effect an adequate penetration of the permeable flat shaped material. It is difficult, particularly with thick sheet materials, whose surfaces are printed according to the screen printing process, to attain a good penetration of the sheet material with the compound applied.

Additionally, the edges or outline of the pattern to be printed should be as sharp as possible. Accordingly, in the past a series of measures have been attempted to attain improvement in penetration, i.e. a permeation with dye of the material to be printed. For instance, before the actual printing process, a solvent serving as penetrating agent which should improve penetration of the dye, is applied. However, this has the shortcoming that the sharpness of the edges or outline of the printed pattern suffers under this process.

Furthermore an improvement of penetration has been attempted by using dyes with low viscosity and a high portion of solvents. Here also, the sharpness of the printed pattern suffers. Also, the expenditure in time and energy for the drying process is impractically high.

Furthermore, it is known to blow the dye immediately after application into the sheet material by means of a blower or to suck it in by a vacuum device. However, the operating speed of this arrangement is relatively low, and the advantages are questioned when, e.g. with printing, only part of the surface is supplied with dye, because the air blast or vacuum intake flows through the areas of the sheet material which are not treated with dye.

OBJECTS AND BRIEF DESCRIPTION OF THE INVENTION

Therefore, it is an object of the present invention to facilitate penetration of a printing or dyeing compound applied to the surface of a permeable flat shaped material into the latter and, if necessary, a similar penetration of the flat shaped material with a penetrating agent prior to application of the printing or dyeing compound.

This is attained, according to the invention in that the printing or dyeing compound to be applied, or the penetrating agent, and the permeable flat shaped material are vibrated relative to each other. In this connection it is useful when the maximum acceleration due to the vibration motion is at least tenfold that of acceleration due to gravity.

According to a preferred embodiment of the invention, the permeable flat shaped material is vibrated in a direction essentially normally to the surface thereof to which the compound is applied. The vibration of the permeable flat shaped material results in an alternating field of inertial forces acting on the liquid particles of the printing or dyeing compound to be applied or the penetrating agent. The term "alternating field of inertial forces" is herein intended to refer to the constantly changing forces of inertia acting on each particle of the printing or dyeing compound or penetrating agent. More specifically, as the liquid is vibrated, each liquid particle will vibrate or "oscillate". Thus, each particle will be subjected to repeatedly changing or alternating inertial forces. The amplitude of the resultant vibration of the compound differs from the amplitude of the flat material, thereby causing relative movement between the compound and flat material, and resulting in greater penetration.

According to another useful embodiment of the invention, the permeable flat shaped material is treated with ultrasons, whereby the compound to be applied or the penetrating agent is ultrasonically vibrated.

It is useful to have a static field of forces, essentially normal to the surface of the permeable flat shaped material and acting on the particles of the compound, superimposed on the alternating field of inertial forces which are due to relative motion created between the compound and the flat material caused by the vibrations imparted thereto. This static field of forces may be a gravitational field, if the compound is applied downwardly onto the material, the gravity acting on the compound particles creating a static pressure difference between the surface of the flat shaped material to which the compound is applied and the opposite surface thereof.

Furthermore, electrostatic fields may be used, provided that the compound on which such fields act, comprises electric charge carriers or ferromagnetic particles.

If the process according to the invention is e.g. used with a rotary screen printing material, it is useful to have the squeegee for pressing the compound vibrated. It is also possible to arrange a pressure chamber in the printing table underneath the sheet material in the area of the contact zone between sheet material and the screen. A gaseous or liquid medium within the chamber is periodically pressurized, thereby transmitting vibrations to the sheet material and the compound to be applied. The generation of fluctuations of pressure may be effected by means of an oscillating piston in operative connection with the pressure chamber.

If a magnetic attraction of the squeegee device exists, it is possible to effect the energizing of vibrations by periodic changes of the field intensity of the magnetic system.

A further useful embodiment of the invention consists in effecting the energizing of vibrations by means of an ultrasonic generator. This may be done by inserting an ultrasonic generator into the dye container in the inside of a rotary screen. Also, vibration may be created by vibrating a squeegee blade or roller within the screen.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side view of a rotary screen printing machine employing a first embodiment of the invention.

FIG. 2 is a diagrammatic side view of a rotary screen printing machine employing a second embodiment of the invention.

FIGS. 3 to 6 are diagrammatic views of further embodiments of rotary screen printing machines provided with the devices according to the invention.
DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 the endless rotary printer's blanket or supporting sheet material 2, a guide roller 3 for the printer's blanket, as well as one of the printing devices includes the essential elements of a rotary screen printing machine. The printing device consists of a rotary screen 4, a dye feeding pipe 5 and a roller squeegee 6 within the rotary screen 4, as well as a printing table 7 comprising a magnetic system 8 for magnetically attracting the roller squeegee 6 in a known manner. The sheet material 2 is lifted from the printer's blanket at 9 and is supplied to a drying or steaming device. The lower strand of the printer's blanket 1 runs in direction 10 back to the inlet of the material or to secondary aggregates of the printing machine, such as a washing and a gumming device, in which the sheet material 2 to be printed is glued onto the upper strand of the printer's blanket 1 for transport through the machine.

In the area 11 a vertical vibration of the printer's blanket 1 as well as of the sheet material 2 fixed thereto is caused in direction 13 by a swing table 12 arranged in this area under the printer blanket 1. Because the sheet material 2 is fixed to the printer's blanket by gluing, relatively high vertical forces may be exerted onto the sheet material 2 when choosing the appropriate adhesive before the sheet material lifts from the printer's blanket. The printer's blanket 1 is maintained in contact with the swing table by means of a vacuum channel system consisting of the vacuum grooves 14 and the connecting pipes 15 and 16. At the bottom 17 of the swing table 12 there is positioned a vibration device, e.g. in the form of two contrarotating eccentric-weight means 18. The swing table 12 is furthermore elastically supported by springs 19 on the frame of the machine. Upon rotation of the eccentric weight means 18 the swing table 12 is moved in the vertical direction 13 by rapidly successive vibrations. The printer's blanket 1 held against the swing table 12 by vacuum, and thus the sheet material glued onto the printer's blanket follow the vibratory movement. Since such vibrations have, as generally known, a sine-shaped path, the entire mass moved with the swing table 12 is subjected to a maximum acceleration at points of maximum amplitude of movement.

As the acceleration forces act in the vertical direction, the particles of the compound applied to the surface of the sheet material in the printing devices are subjected to strong forces due to inertia which may amount to a thousandfold of the earth's gravitational force. These forces due to inertia cause at the lower points of movement of the particles of the compound a penetration downwards of the particles of the compound. As the forces due to inertia directionally act in each particle of the compound, penetration is effected nearly exclusively in this vertical direction. The sharpness of contour of the printed pattern therefore is not damaged. A screen printing machine usually has several printing devices. Thus, instead of a single swing table 12 in the area of the outlet of the sheet material, swing tables may be arranged following each printing device.

In FIG. 2 the essential elements of a rotary screen printing machine are referenced in the same manner as in FIG. 1: Printer's blanket 1, sheet material 2, guide roller 3, rotary screen 4 with dye feeding pipe 5 and roller squeegee 6, printing table 7 with magnetic system 8.

After each printing device the sheet material 2 is vibrated ultrasonically by ultrasonic generators 22 over an area 20 in which the printer's blanket 1 passes over a support 21. The compound applied to the sheet material 2 thereby has imparted thereto an intensive vibration movement. Thus, high acceleration values and therewith forces are imparted to the dye applied to the sheet material 2. The migration of the dye, in particular within the capillaries formed within the sheet material, thereby is greatly improved and an increased penetration through the sheet material 2 takes place. The acceleration values resulting from treatment with ultrasonic vibration may amount to a hundred thousandfold of the acceleration due to earth's gravity. As a generator of ultrasonics or supersonics the known magnetorestrictive generators, oscillators, crystal transmitters or sound transmitters may be used.

In the embodiments according to FIGS. 1 and 2 not only the alternating field of forces (caused by the vibrations) acts on the particles of the compound, but also the forces due to gravity, i.e. the weight of the particles. These gravity forces form a static (or constant) field, the direction of which is directed downward, or if the material is arranged horizontally, vertical to the surface (or plane) of the material. Thus, the static field is superimposed on the alternating field, thereby intensifying the penetration by vibration and capillary forces.

Instead of or in addition to the field of gravity, other static forces may be employed to aid in penetration of the compound into the sheet material, such as an electrostatic field or a magnetostatic field.

In FIG. 3 reference numeral 4 shows the rotary screen. Under the latter a thick sheet material 2, e.g. a carpet, passes on a printer's blanket 1 in the direction 23, while at the same time the rotary screen 4 rolls on the sheet material 2 in the circumferential direction 24. A printing table 7 is provided underneath the rotary screen 4, in which printing table 7 the electromagnet system 8 is arranged. In the inside of the rotary screen 4 the dye feeding pipe 5 is arranged, supporting a squeegee sheet metal plate 26 by means of fasteners 25. At the end of a known type flexible squeegee sheet metal plate 26 a weight 27 responsive to magnetic attraction of electromagnet system 8 is provided. Contact pressure between the squeegee sheet metal plate 26 and screen 4 is caused by the electromagnetic system 8. This squeegee sheet metal plate 26 is vibrated vertically, e.g. by a vibration impulse of the dye feeding pipe 5 in the direction 28. During these vibrations the end 29 of the squeegee sheet metal plate 26 remains in contact with the rotary screen 4. Due to the vibration of plate 26, periodic fluctuations of pressure are caused in the compound to be applied, thereby facilitating penetration of the dye into the sheet material. The vibration of the dye feeding pipe 5 is usefuly effected with frequencies to a maximum of 100 hertzian units. The weight 27 may also be replaced by a roller squeegee, wherein the squeegee sheet-metal plate 26 rubs tangentially such roller squeegee, and the roller squeegee rolls on the rotary screen 4 under the effect of the magnetic field.

FIG. 4 is a longitudinal section of the printing device of FIG. 3, and similar reference numerals are used. The dye feeding pipe 5 is supported at both of its ends by
oscillators 31, effecting synchronous vibrations of equal amplitude in the direction 32, thereby vertically vibrating the dye feeding pipe 5 along the total length thereof. At the ends of the rotary screen 4 the heads 33 of the screen are provided; the right screen head (as viewed in FIG. 4) supporting the gear 34 mating with a corresponding gear 35.

In FIG. 5 the same reference numerals are used as in FIGS. 3 and 4. Instead of a squeegee sheet metal plate, a roller squeegee 36 is provided. The vibration impulse is not effected by movement of the dye feeding pipe 5, but rather by the pressure chamber 37 provided in the printing table 7. The printing table 7 is covered with a metal foil 38 which is connected at the ends 39 thereof with the printing table 7 by means of backing strips. In the pressure chamber 37 there is a pressure medium e.g. liquid or air. This pressure medium is connected to an oscillating piston, not shown in the drawings by a feeding pipe 40. The piston causes periodic fluctuations of pressure in the mentioned medium. Thereby, vibration is transmitted through the metal foil 38 and the printer's blanket 1 onto the sheet material 2 and the compound to be applied 30 within the rotary screen 4, thereby resulting in increased penetration.

In FIG. 6 again previous reference numerals are used. However, the printing of a thick sheet material is accomplished without the use of a magnet field as in the embodiments according to FIGS. 3, 4 and 5. Within the rotary screen 4 a dye container 41 is arranged near the dye feeding pipe 5. The bottom part of dye container 41 is sealed to the rotary screen 4 by means of two lips 42. In dye container 41 the dye reaches a level 43. In the dye is positioned an ultrasonic generator 44, whereby the dye is ultrasonically vibrated, thereby penetrating deeply into the sheet material at 45 through the rotary screen cylinder 4. Underneath the rotary screen 4 the sheet material 2 supports a printing table 7 in the form of a box girder having a groove 46 at its surface. The breadth 47 of groove 46 is at least equal to the distance between lips 42.

A particularly useful variation of the invention is that the vibrations or treatment with supersonic of the sheet material is not effected in the printing machine but in a subsequently added steaming and drying device.

Furthermore, the sheet material may be impregnated with penetrating agent before the printing. The penetration of the sheet material with the penetrating agent according to the process of the invention may be intensified, e.g. by a swing table or with an ultrasonic treatment.

Furthermore, the printed sheet material may be treated with a diluent for the compound to be applied, e.g. by depositing an aerosol in the area which is vibrated. Thereby penetration is furthermore facilitated.

Also, the present invention may be used in a rotary screen printing machine with flat screen or in some other device, where sheet materials or generally a permeable flat shaped article (e.g. a foam plastics mat) is supplied with a compound to be applied which should penetrate into the flat shaped material.

We claim:
1. In a system for applying viscous or liquid printing compound onto a flat shaped material permeable to said compound, said system including a rotary screen printing machine having a perforated rotary cylinder screen, means for forcing said printing compound through the perforations in said screen onto said material, and means for moving said compound in a longitudinal direction to be contacted by the periphery of said cylinder screen, the improvement comprising:
   means for increasing the penetration of said printing compound into said material comprising means for creating relative vibrations between said material and said printing compound for creating alternating inertial forces acting on the particles of said printing compound to cause said printing compound particles to further penetrate into said material; and
   means for superimposing static forces on said alternating inertial forces, and thereby on said printing compound particles, to increase the relative movement between said printing compound and said material, said static forces being in a direction substantially normal to the plane of said material, said means for superimposing static forces comprising means for imparting an electrostatic field to said printing compound.
2. A system as claimed in claim 1, wherein said material is moved horizontally, and wherein said means for creating relative vibrations comprises means to create relative vibrations between said material and said printing compound in a vertical direction.
3. In a system for applying viscous or liquid printing dye onto a flat shaped material permeable to said dye, said system including a rotary screen printing machine having a perforated rotary cylinder screen, a squeegee positioned within said screen for pressing said printing dye through the perforations in said screen onto said material, a dye feeding pipe supporting said squeegee for feeding said dye to the inner surface of said screen adjacent said squeegee, and means for moving said material in a longitudinal direction to be contacted by the periphery of said cylinder screen, the improvement comprising:
   means for increasing the penetration of said printing dye onto said material comprising means for creating relative vibrations between said material and said printing dye for creating alternating inertial forces acting on the particles of said printing dye to cause said printing dye particles to further penetrate into said material, said means for creating relative vibrations comprising means located on the same side of said material as said screen for imparting vibratory movement directly to only said printing dye during the application of said printing dye to said material, said means for imparting vibratory movement comprising means for vertically reciprocating said dye feeding pipe.
4. In a system for applying viscous or liquid printing dye onto a flat shaped material permeable to said dye, said system including a rotary screen printing machine having a perforated rotary cylinder screen, dye container means positioned within said screen for forcing said printing dye through the perforations in said screen onto said material, and means for moving said material in a longitudinal direction to be contacted by the periphery of said cylinder screen, the improvement comprising:
   means for increasing the penetration of said printing dye onto said material comprising means for creating relative vibrations between said material and said printing dye for creating alternating inertial forces acting on the particles of said printing dye to
cause said printing dye particles to further penetrate into said material, said means for creating relative vibrations comprising means located on the same side of said material as said screen for imparting vibratory movement directly to only said printing compound during the application of said printing dye to said material, said means for imparting vibratory movement comprising ultrasonic generator means immersed in said dye in said dye container.

5. In a system for applying viscous or liquid printing compound onto a flat shaped material permeable to said compound, said system including a rotary screen printing machine having a perforated rotary cylinder screen, means to force said printing compound through the perforations in said screen onto said material, and means for moving said material in a longitudinal direction to be contacted by the periphery of said cylinder screen, the improvement comprising:

means for increasing the penetration of said printing compound into said material comprising means for creating relative vibrations between said material and said printing compound for creating alternating inertial forces acting on the particles of said printing compound to cause said printing compound particles to further penetrate into said material, said means for creating relative vibrations comprising means located on the same side of said material as said screen for imparting vibratory movement directly to only said printing compound during the application of said printing compound to said material, said vibratory movement imparting means comprising means to move said printing compound in a vertical direction.

6. In a process for applying a viscous or liquid printing compound onto a flat shaped material permeable to said printing compound, by forcing said printing compound through the perforations in a perforated rotary cylinder screen of a rotary screen printing machine onto said material while moving said material in a longitudinal direction to be peripherally contacted by said cylinder screen the improvement comprising:

increasing the penetration of said printing compound into said material by:

creating relative vibrations, between said material and said printing compound, thereby creating alternating inertial forces acting on the particles of said printing compound to cause said printing compound particles to further penetrate into said material; and

superimposing static forces on said alternating inertial forces, and thereby on said printing compound particles, to increase the relative movement between said printing compound and said material, said static forces being in a direction substantially normal to the plane of said material, said static forces being superimposed by applying an electrostatic field to said compound.

7. A process as claimed in claim 6, wherein said printing compound is a dye.

8. A process as claimed in claim 7, wherein said material is moved horizontally, and said relative vibrations are created in a vertical direction.

9. In a process for applying a viscous or liquid printing compound onto a flat shaped material permeable to said printing compound, by forcing said printing compound through the perforations in a perforated rotary cylinder screen of a rotary screen printing machine onto said material while moving said material in a longitudinal direction to be peripherally contacted by said cylinder screen the improvement comprising:

increasing the penetration of said printing compound into said material by:

creating relative vibrations, between said material and said printing compound, thereby creating alternating inertial forces acting on the particles of said printing compound to cause said printing compound particles to further penetrate into said material, said step of creating relative vibrations comprising imparting vibratory movement directly to only said printing compound.

10. A process as claimed in claim 9, wherein said printing compound is a dye.

11. A process as claimed in claim 9, wherein said material is moved horizontally, and wherein said vibratory movement is imparted to said printing compound in a vertical direction.

12. A process as claimed in claim 9, wherein said vibratory movement is imparted to said printing compound after said printing compound is applied to said material.

13. A process as claimed in claim 12, wherein said vibratory movement is imparted to said printing compound by subjecting said printing compound to ultrasonic energy.

14. A process as claimed in claim 9, wherein said vibratory movement is imparted to said printing compound during the application of said printing compound to said material.

15. A process as claimed in claim 14, wherein said printing compound is a dye supplied from a dye feeding pipe to the inner surface of said perforated rotary cylinder screen and forced through said perforations of said screen by a squeegee resiliently supported by said dye feeding pipe, and said vibratory movement is imparted to said dye by vertically reciprocating said dye feeding pipe.

16. A process as claimed in claim 14, wherein said printing compound is a dye positioned in a dye container within said perforated rotary cylinder screen, said dye contacting the inner surface of said screen, and said vibratory movement is imparted to said dye by ultrasonically vibrating said dye.

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