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(54) Apparatus and method for continuously treating a fabric by means of vibration

(57) An apparatus for continuously treating a fabric by means of vibrations comprises a first element (5) for guiding and feeding the fabric (1), a vibration source (19), an element (2; 50; 60; 70) capable of vibrating and associated with the fabric (1), a second element (6) for guiding and feeding the fabric (1), and a third guiding element (2; 50; 60; 70) which is in direct contact with the fabric (1) and is movable therewith; the third guiding element (2; 50; 60; 70) is associated with the vibration source (19) and itself forms the element (2; 50; 60; 70) capable of vibrating; it is subject to vibrations which are transmitted directly to the fabric (1). A method for treating a fabric by means of vibrations is also described.

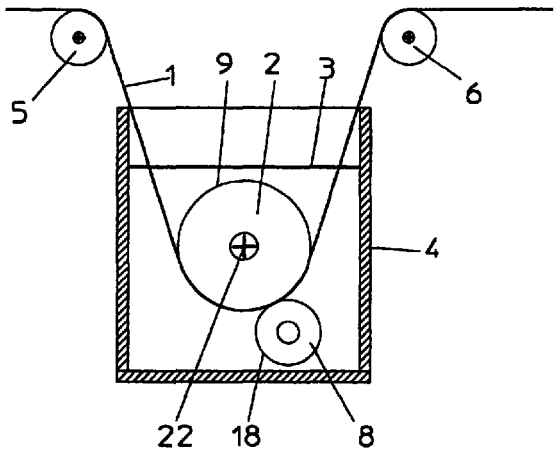

Fig. 1

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Description

[0001] The present invention relates to an apparatus and a method for continuously treating a fabric by means of vibrations which are propagated within a fluid means and are capable of causing substantially undulatory shaking of the fabric, thereby favouring the penetration of the fluid means into the fabric or removal thereof from the fabric.

[0002] The patent application WO 98/15679 relates to a method and a device for the continuous ultrasound washing of textile materials extended on conveyor belts or similar conveying elements. The ultrasound energy is applied to the material to be washed by means of flexural vibrating plates which are arranged in direct contact with the material to be washed, the latter being immersed in a shallow liquid means. The cleaning process may be completed by means of immediate rinsing and, once the liquid has been removed, the ultrasound energy may again be applied by means of contact in order to eliminate a significant portion of liquid retained by the washed material, so as to perform pre-drying. A device capable of implementing the abovementioned process is also described.

[0003] With this known method and device, the fabric, while it is transported in a longitudinal direction by a conveyor belt or a roller, is subjected to perpendicular vibrations, in a transverse plane, by a vibrating plate which has a fixed position.

[0004] This arrangement has various drawbacks. The main drawback is that the fabric is subjected to opposing tensile stresses, respectively imparted by the belt or the conveyor roller, tending to cause it to advance, and by the fixed plate, tending to brake its movement so as to cause it to vibrate perpendicularly in a transverse plane. Basically, the fabric performs stepwise movements, adhering to the plate and being separated from it. These opposing tensile stresses tend to cause damage to the fabric, such as distortion, abrasion and laceration.

[0005] The present invention relates to a method and an apparatus for treating a fabric by means of vibrations which enable the abovementioned drawbacks to be overcome.

[0006] A first aspect of the invention consists in an apparatus for continuously treating a fabric by means of vibrations, said apparatus comprising:

a) first means for guiding and feeding said fabric,
b) a vibration source,
c) means capable of vibrating and associated with said fabric,
d) second means for guiding and feeding said fabric, and
e) third means for guiding said fabric, arranged between said first and second guiding and feeding means, said third guiding means being in direct contact with said fabric and being movable therewith,
characterized in that
f) said third guiding means are associated with said vibration source and themselves form said means capable of vibrating, said third guiding means being subjected to vibrations which are transmitted directly to said fabric.

[0007] According to one embodiment, said apparatus also comprises a bath composed of a fluid means in which said fabric is immersed, said first guiding and feeding means being located upstream of said fluid means and directing said fabric inside said fluid means, said second guiding and feeding means being located downstream of said fluid means and extracting said fabric from said fluid means, said third means for guiding said fabric, which are associated with said vibration source and themselves form said means capable of vibrating, being located inside said fluid means and being subjected to vibrations which are transmitted directly to said fabric while it is immersed in said fluid means.

[0008] Preferably, said third guiding means are formed by a guiding cylinder which is capable of vibrating and comprises a rotor and a stator.

[0009] Advantageously, said rotor has an annular wall which is capable of vibrating and around which said fabric is wound.

[0010] Preferably, said annular wall is made of ferromagnetic material and said vibration source comprises an oscillating magnetic-field generator.

[0011] Advantageously, said oscillating magnetic-field generator is supported by said stator, said stator comprising a cylindrical core made of ferromagnetic material and provided with peripheral longitudinal grooves inside which windings of electrical conductors connected to an alternating-current power supply, at a preseleted frequency, are housed.

[0012] Preferably, said annular wall is made of sheet steel of limited thickness.

[0013] According to a variant, said annular wall is made of sheet steel of limited thickness and is connected to a series of T-shaped sections arranged radially.

[0014] According to another variant, said annular wall is formed by a metal sheet of moderate thickness, provided with internal longitudinal grooves.

[0015] According to a further variant, said annular wall is formed by a metal sheet of moderate thickness, provided with external longitudinal grooves.

[0016] According to another embodiment, said apparatus comprises an additional roller having a wall located practically in contact with said annular wall of said cylinder, such that said additional roller presses said fabric against said annular wall.

[0017] Advantageously, said rotor is rotatably supported by a fixed shaft to which said stator is integrally joined.

[0018] Preferably, said annular wall is kept in position with respect to two end disks by means of screws and is supported by means of O-rings, said disks being supported by said shaft by means of bearings and O-rings.

[0019] A second aspect of the invention consists in a fabric guiding cylinder comprising a rotor and a stator, characterized in that said rotor has an annular wall which is capable of vibrating and around which said fabric is wound.

[0020] Preferably, said annular wall is made of ferromagnetic material and is associated with an oscillating magnetic-field generator.

[0021] Advantageously, said oscillating magnetic-field generator is supported by said stator, said stator comprising a cylindrical core made of ferromagnetic material and provided with peripheral longitudinal grooves inside which windings of electrical conductors connected to an alternating-current power supply, at a preselected frequency, are housed.

[0022] Preferably, said annular wall is constructed as described further above.

[0023] A third aspect of the invention consists in a method for continuously treating a fabric by means of vibrations, comprising the steps of:

i) feeding said fabric by means of first guiding and feeding means,
ii) generating said vibrations,
iii) subjecting said fabric to vibrations,
iv) feeding said fabric by means of second guiding and feeding means, and
v) guiding said fabric by means of third guiding means arranged between said first and second guiding and feeding means, placing said third guiding means in direct contact with said fabric and causing them to move therewith,
characterized in that
vi) said operations iii) and v) are both performed by said third guiding means, subjecting them to vibrations, and said vibrations are transmitted directly to said fabric.

[0024] Advantageously, said operation vi) is performed in a fluid means.

[0025] In some cases, said fluid means consists of a liquid and/or of a liquid solution.

[0026] In further cases, said fluid means consists of a suspension of a solid substance in a liquid.

[0027] In still further cases, said fluid means consists of a substantially solid substance.

[0028] As a result of the apparatus and the method according to the invention, it is possible to increase the kinetic effect of penetration of a fluid means into the fabric or removal of the fluid means from the fabric.

[0029] This is due mainly to the direct contact between fabric and vibrating guiding means which causes undulatory shaking of the fabric and a parallel pumping action of the fluid means. The vibrating guiding means subject the fabric to alternating displacements and, at the same time, during acceleration, presses the fabric against the surrounding fluid means, increasing the pressure thereof, whereas, during deceleration, they subject it to a sucking action, generating a vacuum in the fluid means.

[0030] The vibrations to which the fabric is subjected cause, moreover, an alternating pulling action in the fabric portions lying, respectively, between the first guiding means and the vibrating guiding means and between the latter and the second guiding means. These alternating pulling actions cause agitation of the fibres, which further favours penetration of the fluid means into the fabric or removal thereof from the fabric.

[0031] In the case where the vibrating guiding means consist of a vibrating cylinder and an additional roller which presses the fabric against the vibrating cylinder is used, the additional roller prevents the displacement of the fabric and the fluid means in the zone of contact with the vibrating cylinder. This results in a considerable increase in the pumping action due to the vibration of the cylinder guiding the fabric.

[0032] Finally, when the vibrating cylinder is provided with an annular wall having external longitudinal grooves, its deformations, due to the vibrations, cause widening and narrowing of the grooves. The fluid means is thus expelled and sucked back into the grooves. This interstitial pumping action ensures that the fabric, when passing in the vicinity of the grooves, is acted on by an alternating flow of fluid means which improves the penetration of the fluid means into the fabric.

[0033] Characteristic features and advantages of the invention will now be illustrated with reference to embodiments shown, by way of a non-limiting example, in the accompanying figures in which:

Fig. 1 is a partially sectioned schematic front view of an apparatus for continuously treating a fabric by means of vibrations, provided in accordance with the invention;
Fig. 2 is a partially sectioned side view of the apparatus according to Fig. 1;
Fig. 3 shows a longitudinally sectioned view, on a larger scale, of a cylinder of the apparatus according to Figs. 1 and 2;
Fig. 4 is a partial view sectioned along the plane indicated by IV-IV in Fig. 3;
Figs. 5, 6 and 7 are cross-sectional views of variants of the cylinder according to Figs. 1-4;
Figs. 8, 9 and 10 show vibration modes of the cylinder according to Figs. 1-4;
Figs. 11, 12 and 13 show effects obtained with the apparatus according to Figs. 1-6;
Fig. 14 shows an additional effect obtained with the cylinder according to Fig. 7.

[0034] Figs. 1 and 2 show an apparatus for continu-

ously treating a fabric 1 by means of vibrations. The apparatus comprises two motorized rotating rollers 5 and 6 which guide and feed the fabric 1. The rotating rollers 5 and 6 are located respectively upstream and downstream of a treatment tank 4 containing a fluid bath 3, for example consisting of a liquid and/or a liquid solution such as a chemical compound suitable for cleaning or shrinking or dyeing the fabric, a cleansing liquid and/or solvent, or a suspension of water and abrasive compounds or a substantially solid substance formed by abrasive means such as sand or dust. The rotating roller 5 is located at the inlet of the treatment tank 4 and causes the fabric. 1 to be immersed in the fluid means 3. The rotating roller 6 is located at the outlet of the treatment tank 4 and extracts the fabric 1 from the fluid means 3. The tank 4 has, mounted inside it, a cylinder 2 which guides the fabric 1 and is capable of vibrating. The cylinder 2 comprises a rotor 20 and a stator 21 (Figs. 3 and 4).

[0035] The rotor 20 is rotatably supported (in a idle manner) by a fixed shaft 22. The rotor 20 has an annular wall 9 which is capable of vibrating and around which the fabric 1 is wound. The annular wall 9 is made of ferromagnetic material and has, associated with it, a vibration source 19 comprising an oscillating (or pulsating) magnetic-field generator. The annular wall 9 is kept in position with respect to two end disks 23 by means of screws 24 and is supported by means of O-rings 12. The disks 23 are rotatably supported by the shaft 22 by means of two roller bearings 13 and two O-rings 14. The annular wall 9 is made of sheet metal of limited thickness, for example, it is made of steel with 4% Si and has a thickness of between about 1 and 3 mm, for example about 1.5 mm.

[0036] The shaft 22 is fixed to a wall 25 of the tank 4 by means of a bolt 26 and is mounted on a hatch 27 by means of an 0-ring 28.

[0037] The stator 21 is integrally joined to the shaft 22 by means of an interference connection, not shown, and a Seeger ring 35 and supports the oscillating magnetic-field generator 19. The generator 19 comprises a cylindrical core 30 made of ferromagnetic material and provided with peripheral longitudinal grooves 31 and windings of electrical conductors 10 housed in the grooves 31. The electrical windings 10 are connected to an alternating-current power supply 7, at a preselected frequency, by means of terminals 11 and a cable 16. The cable 16 passes through an internal hole 15 of the shaft 22.

[0038] A single-phase, two-phase or three-phase alternating current with a frequency of between 50 and 2000 Hz, for example 1600 Hz, is used to supply the windings 10.

[0039] When the windings 10 have an alternating current at the preselected frequency flowing through them, they generate a magnetic field oscillating (or pulsating) radially at the specific frequency. The magnetic field may be formed with two, four or more poles. The oscillating magnetic field generates, in turn, radially pulsating magnetostrictive forces which act on the annular wall 9 of the cylinder 2 and deform it, causing it to vibrate. The deformations of the wall 9 are essentially radial and correspond to its natural vibration frequencies, as shown in Figs. 8-10.

[0040] When the apparatus is operating, the fabric 1 is guided by the roller 5 so as to enter into the treatment tank 4. Inside the tank 4, the fabric 1 is immersed in the fluid means 3 and is wound around the wall 9 of the vibrating cylinder 2 which is made to vibrate by the action of the oscillating magnetic field 19. The fabric 1 is kept in contact with the wall 9 of the vibrating cylinder 2 by the pulling tension exerted by the rollers 5 and 6. The tension may be set to a predefined constant value by means of a different speed of rotation of the rollers 5 and 6. The fabric 1 is guided along its path through the tank 4 by the vibrating wall 9 of the rotor 20 which is mounted idle on the shaft 22 and is free to rotate about it. Then, the cylinder 2 causes the fabric 1 to vibrate and guides it, moving together with it. This prevents scoring and damaging of the fabric.

[0041] The annular wall 9 of the cylinder 2 transmits the vibrations directly to the fabric 1 which is in contact with it. The fabric 1 and wall 9 thus vibrate in unison and thus perform an alternating movement away from and towards the axis of the cylinder 2. In so doing they alternately compress the fluid means 3 and create a vacuum in the fluid means, producing, in the fluid means, pressure waves which are propagated radially towards the outside the tank 4. This thus produces a combined action consisting of an undulating shaking movement of the fabric and radial (parallel) pumping of the fluid means (Fig. 11) which favours the penetration of the fluid means into the fabric.

[0042] The vibrations of the fabric also cause an alternating pulling action (Fig. 12) in the fabric portions lying, respectively, between the roller 5 and the vibrating cylinder 2 and between the vibrating cylinder 2 and roller 6. This causes agitation of the fibres which favours the penetration of the fluid means into the fabric or its removal from the fabric.

[0043] The tank 4 has, mounted inside it, an additional roller 8 (Figs. 1 and 2) having a wall 18 located practically in contact with the wall 9 of the cylinder 2. The roller 8 presses the fabric 1 against the vibrating cylinder 2, preventing radial displacement of the fabric and the fluid means in the zone of contact with the vibrating cylinder 2, in the manner of an anvil. Thus the roller 8 induces a tangential (perpendicular) pumping action (Fig. 13) and amplifies significantly the pumping action due to vibration of the cylinder 2 alone.

[0044] The fabric 1, steeped with fluid means, is extracted from the tank 4 by the roller 6 which guides it towards the outlet of the treatment apparatus.

[0045] Fig. 5 shows a guiding cylinder 50 which is capable of vibrating and which is a variant of the cylinder 2. The cylinder 50 has a rotor 53 comprising an

annular wall 51 made of sheet steel of limited thickness and connected to a series of T-shaped sections 52 arranged radially. When an oscillating magnetic field similar to that of the cylinder 2 is present, the annular wall 51 vibrates in the manner of the annular wall 9.

[0046] Fig. 6 shows a guiding cylinder 16 which is capable of vibrating and which forms another variant of the cylinder 2. The cylinder 16 has a rotor 63 comprising an annular wall 61 formed by a metal sheet of moderate thickness, for example about 10 mm, provided with internal longitudinal grooves 62. When an oscillating magnetic field similar to that of the cylinder 60 is present, the annular wall 61 of the cylinder 60 is subjected to essentially torsional vibrations.

[0047] Fig. 7 shows a guiding cylinder 70 which is capable of vibrating and which is a further variant of the cylinder 2. The cylinder 70 has a rotor 73 comprising an annular wall 71 formed by a metal sheet of moderate thickness, for example about 10 mm, provided with external longitudinal grooves 72. When an oscillating magnetic field similar to that of the cylinder 2 is present, the annular wall 71 of the cylinder 70 is subject to several (radial and torsional) vibration modes.

[0048] When the annular wall 71 vibrates and is deformed, the grooves 72 expand and contract. This thus results in an interstitial pumping action of the fluid (liquid) means present inside them (Fig. 14). The fabric which passes in the vicinity of the grooves is acted on by an alternating flow which improves the penetration of the fluid means into the fabric.

[0049] The vibrations of the cylinder 2, or 50, 60, 70, may be obtained by means of radially oscillating or pulsating magnetic forces which deform the annular wall 9, or 51, 61, 71, as described further above, or by means of similar systems, for example, by means of a variable twisting moment which produces torsional vibrations of the annular wall or by causing vibration of the rotor by means of displacement of its axis of symmetry.

[0050] A cylinder capable of guiding the fabric and vibrating, such as the cylinder 2, or one of the cylinders 50, 60, 70, may be used to dry the fabric downstream of the roller 6. In this case, the drying cylinder is located inside a chamber containing air.

Claims

1. Apparatus for continuously treating a fabric (1) by means of vibrations, said apparatus comprising:

a) first means (5) for guiding and feeding said fabric (1),
b) a vibration source (19),
c) means (2; 50; 60; 70) capable of vibrating and associated with said fabric (1),
d) second means (6) for guiding and feeding said fabric (1), and
e) third means (2; 50; 60; 70) for guiding said fabric (1), arranged between said first and second guiding and feeding means (5, 6), said third guiding means (2; 50; 60; 70) being in direct contact with said fabric (1) and being movable therewith,
characterized in that
f) said third guiding means (2; 50; 60; 70) are associated with said vibration source (19) and themselves form said means (2; 50; 60; 70) capable of vibrating, said third guiding means (2; 50; 60; 70) being subjected to vibrations which are transmitted directly to said fabric (1).

2. Apparatus according to Claim 1, characterized in that it also comprises a bath composed of a fluid means (3) in which said fabric (1) is immersed, said first guiding and feeding means (5) being located upstream of said fluid means (3) and directing said fabric (3) inside said fluid means (3), said second guiding and feeding means (6) being located downstream of said fluid means (3) and extracting said fabric (1) from said fluid means (3), said third means (2; 50; 60; 70) for guiding said fabric (1), which are associated with said vibration source (19) and themselves form said means (2; 50; 60; 70) capable of vibrating, being located inside said fluid means (3) and being subjected to vibrations which are transmitted directly to said fabric (1) while it is immersed in said fluid means (3).

3. Apparatus according to one of Claims 1 and 2, characterized in that said third guiding means (2; 50; 60; 70) are formed by a guiding cylinder (2; 50; 60; 70) which is capable of vibrating and comprises a rotor (20; 53; 63; 73) and a stator (21).

4. Apparatus according to Claim 3, characterized in that said rotor (20; 53; 63; 73) has an annular wall (9; 51; 61; 71) which is capable of vibrating and around which said fabric (1) is wound.

5. Apparatus according to Claim 4, characterized in that said annular wall (9; 51; 61; 71) is made of ferromagnetic material and said vibration source (19) comprises an oscillating magnetic-field generator.

6. Apparatus according to Claims 3 and 5, characterized in that said oscillating magnetic-field generator (19) is supported by said stator (21), said stator (21) comprising a cylindrical core (30) made of ferromagnetic material and provided with peripheral longitudinal grooves (31) inside which windings of electrical conductors (10) connected to an alternating-current power supply (7), at a preselected frequency, are housed.

7. Apparatus according to Claim 5, characterized in that said annular wall (9) is made of sheet steel of

limited thickness.

8. Apparatus according to Claim 5, characterized in that said annular wall (51) is made of sheet steel of limited thickness and is connected to a series of T-shaped sections (52) arranged radially.

9. Apparatus according to Claim 5, characterized in that said annular wall (61) is formed by a metal sheet of moderate thickness, provided with internal longitudinal grooves (62).

10. Apparatus according to Claim 5, characterized in that said annular wall (71) is formed by a metal sheet of moderate thickness, provided with external longitudinal grooves (72).

11. Apparatus according to Claim 3, characterized in that said rotor (20; 53; 63; 73) is rotatably supported by a fixed shaft (22) to which said stator (21) is integrally joined.

12. Apparatus according to Claims 4 and 11, characterized in that said annular wall (9) is kept in position with respect to two end disks (23) by means of screws (24) and is supported by means of O-rings (12), said disks (23) being supported by said shaft (22) by means of bearings (13) and O-rings (14).

13. Apparatus according to Claims 3 and 4, characterized in that it comprises an additional roller (8) having a wall (18) located practically in contact with said annular wall (9; 51; 61) of said cylinder (2), such that said additional roller (9) presses said fabric (1) against said annular wall (9; 51; 61).

14. Guiding cylinder (2; 50; 60; 70) for a fabric (1), comprising a rotor (20; 53; 63; 73) and a stator (21), characterized in that said rotor (20; 53; 63; 73) has an annular wall (9; 51; 61; 71) which is capable of vibrating and around which said fabric (1) is wound.

15. Guiding cylinder (2; 50; 60; 70) according to Claim 14, characterized in that said annular wall (9; 51; 61; 71) is made of ferromagnetic material and is associated with an oscillating magnetic-field generator (19).

16. Guiding cylinder (2; 50; 60; 70) according to Claims 14 and 15, characterized in that said oscillating magnetic-field generator (19) is supported by said stator (21), said stator (21) comprising a cylindrical core (30) made of ferromagnetic material and provided with peripheral longitudinal grooves (31) inside which windings of electrical conductors (10) connected to an alternating-current power supply, at a preselected frequency, are housed.

17. Guiding cylinder (2; 50; 60; 70) according to Claim 15, characterized in that said annular wall (9) is made of sheet steel of limited thickness.

18. Guiding cylinder (2; 50; 60; 70) according to Claim 15, characterized in that said annular wall (51) is made of sheet steel of limited thickness and is connected to a series of T-shaped profiles (52) arranged radially.

19. Guiding cylinder (2; 50; 60; 70) according to Claim 15, characterized in that said annular wall (61) is formed by a metal sheet of moderate thickness, provided with internal longitudinal grooves (62).

20. Guiding cylinder (2; 50; 60; 70) according to Claim 15, characterized in that said annular wall (71) is formed by a metal sheet of moderate thickness provided with external longitudinal grooves (72).

21. Guiding cylinder (2; 50; 60; 70) according to Claim 14, characterized in that said rotor (20; 53; 63; 73) is rotatably supported by a fixed shaft (22) to which said stator (21) is integrally joined.

22. Guiding cylinder (2; 50; 60; 70) according to Claims 14 and 21, characterized in that said annular wall (9) is kept in position with respect to two end disks (23) by means of screws (24) and is supported by means of O-rings (12), said disks (23) being supported by said shaft (22) by means of bearings (13) and O-rings (14).

23. Method for continuously treating a fabric by means of vibrations, comprising the steps of:

i) feeding said fabric by means of first guiding and feeding means,
ii) generating said vibrations,
iii) subjecting said fabric to vibrations,
iv) feeding said fabric by means of second guiding and feeding means, and
v) guiding said fabric by means of third guiding means arranged between said first and second guiding and feeding means, placing said third guiding means in direct contact with said fabric and causing them to move therewith,
characterized in that
vi) said operations iii) and v) are both performed by said third guiding means, subjecting them to vibrations, and said vibrations are transmitted directly to said fabric.

24. Method according to Claim 23, characterized in that said operation vi) is performed in a fluid means.

25. Method according to Claim 24, characterized in that said fluid means consists of a liquid and/or of a liq-

uid solution.

26. Method according to Claim 24, characterized in that said fluid means consists of a suspension of a solid substance in a liquid.

27. Method according to Claim 24, characterized in that said fluid means consists of a substantially solid substance.

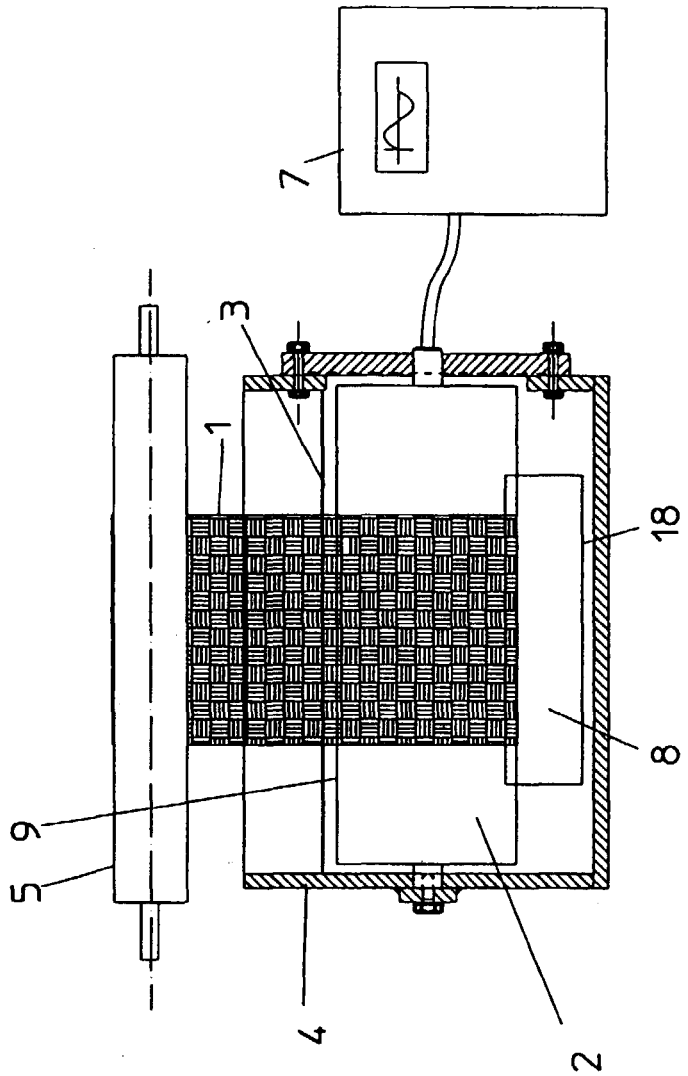

Fig. 2

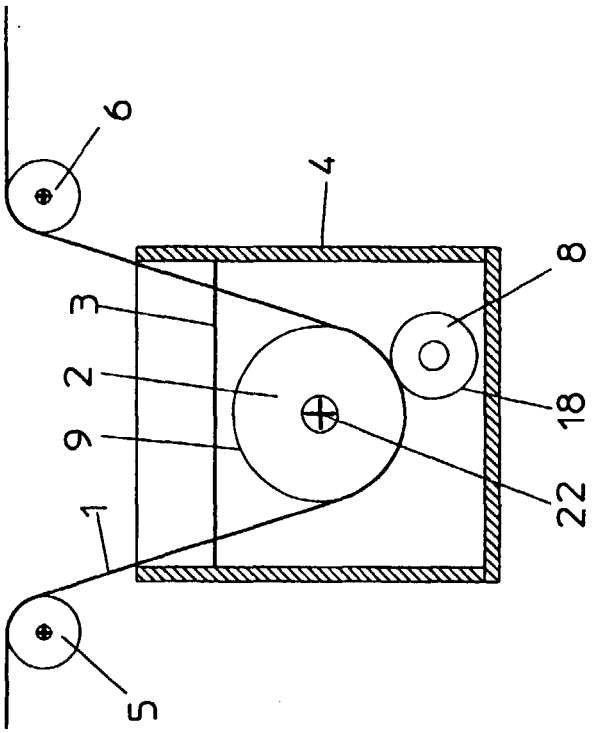

Fig. 1

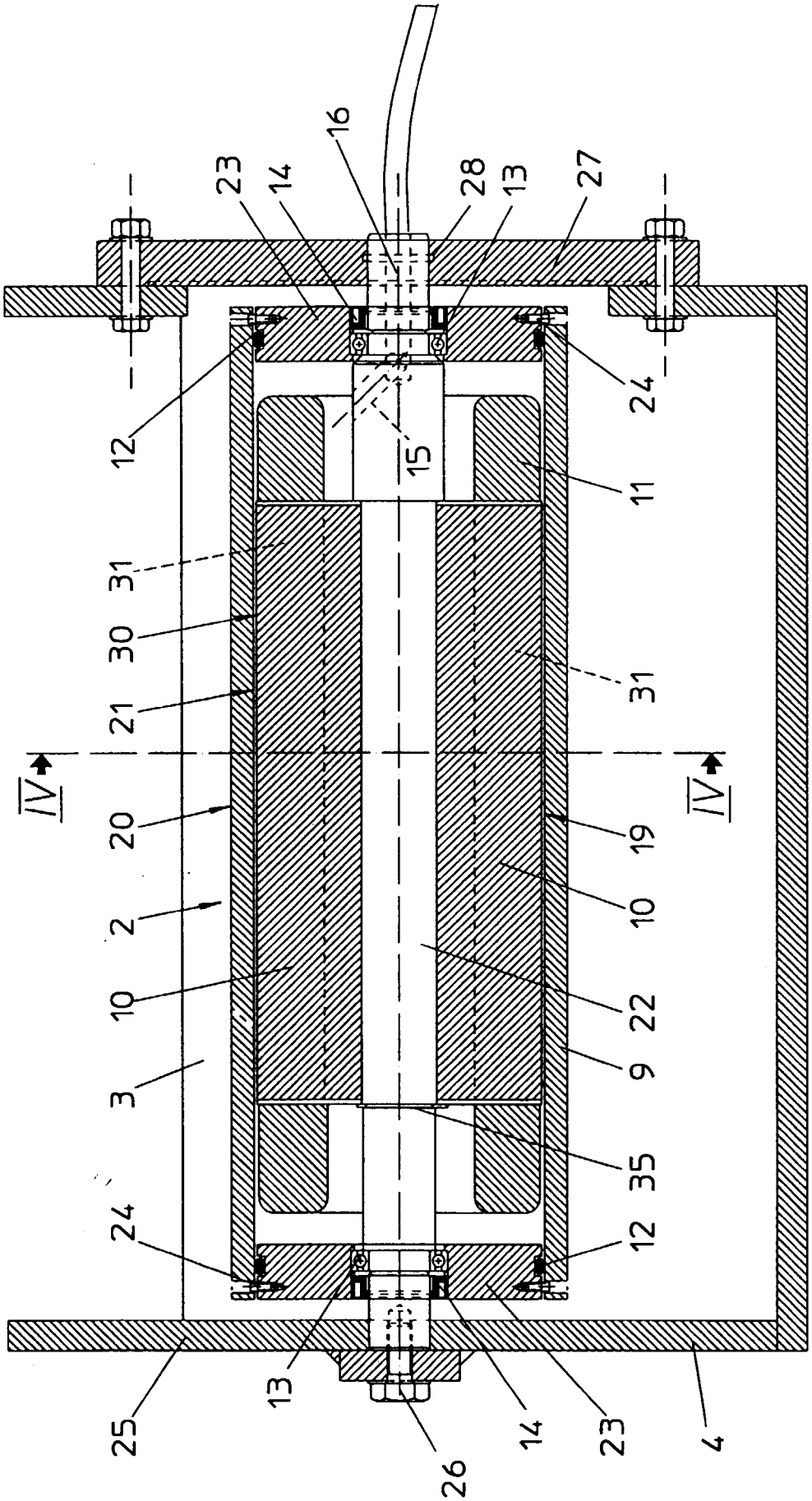
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Fig. 3

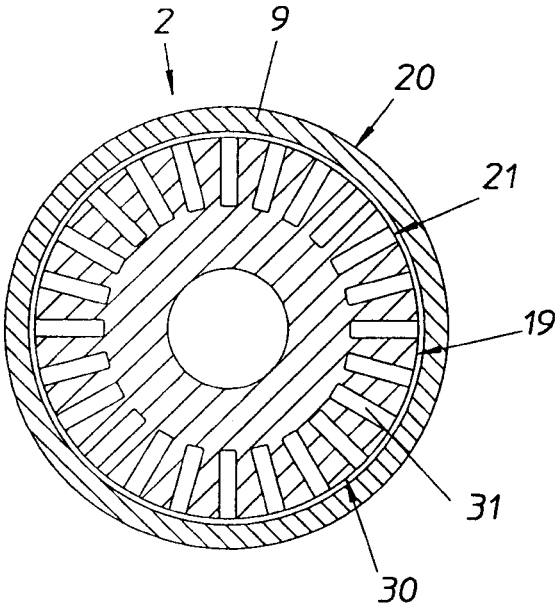

Fig.4

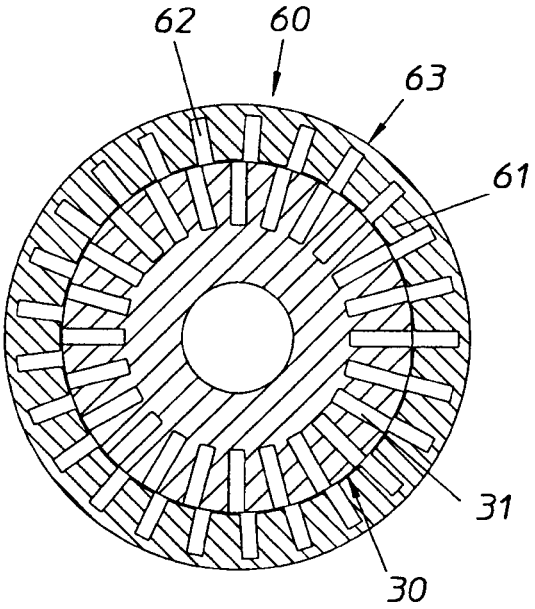

Fig.6

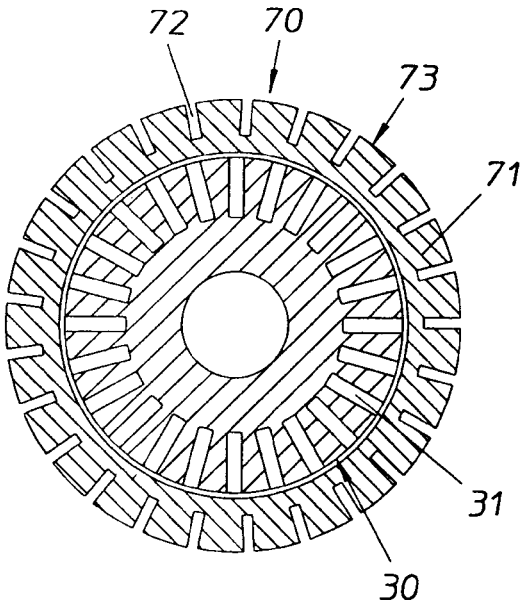

Fig.7

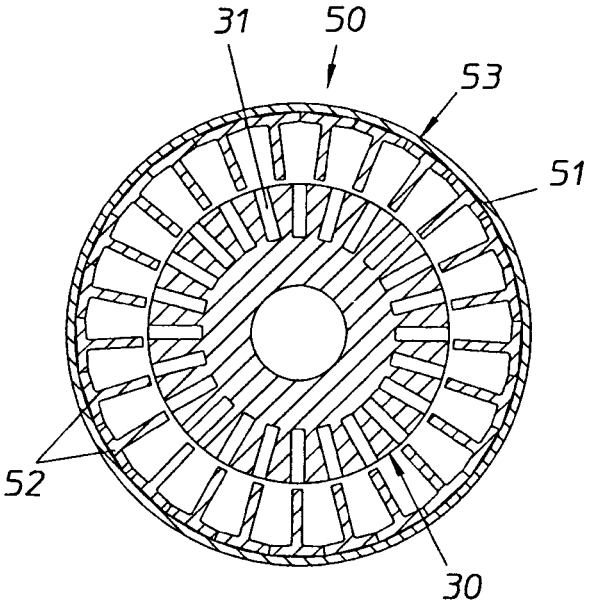

Fig.5

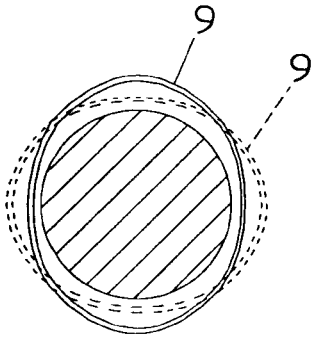

Fig.8

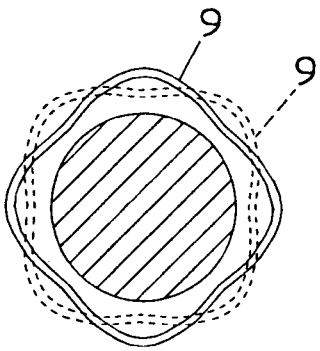

Fig.9

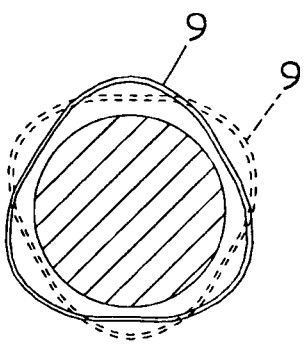

Fig.10

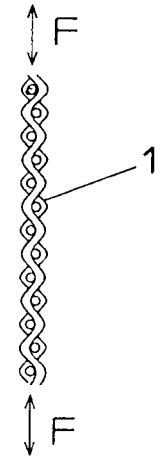

Fig.12

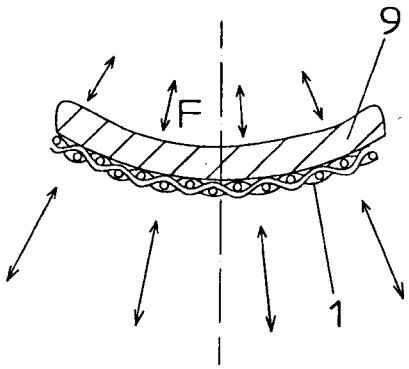

Fig.11

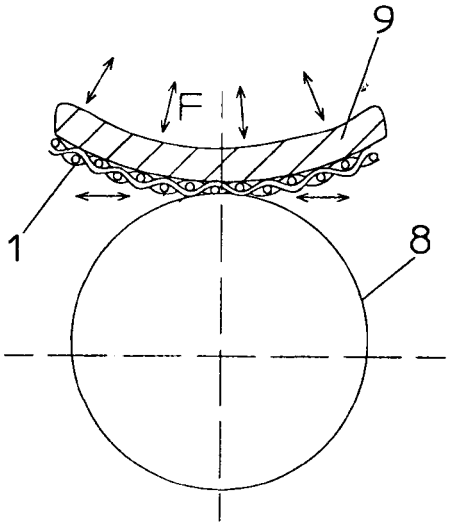

Fig.13

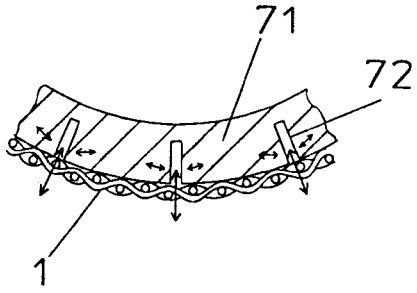

Fig.14