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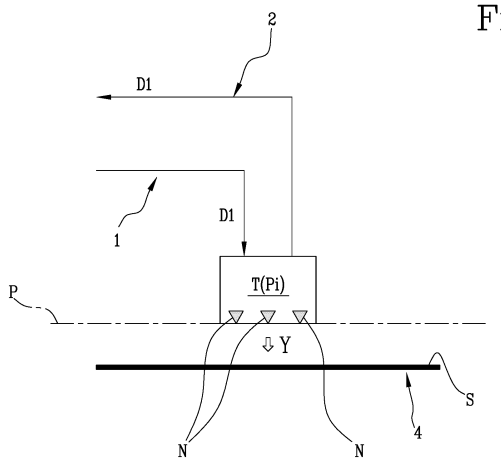
(54) A CLEANING METHOD FOR RECIRCULATING INKJET PRINTING HEADS

(57) Cleaning method for a head T,
wherein the head T comprises a plurality of nozzles N arranged for dispensing ink and located along a plane P, such a plane P delimiting the head T below;
wherein the head T is connected to an ink supply line 1;
wherein the head T is further connected to a recirculation line 2,
wherein, introducing a substance into the supply line 1, such a substance travels the supply line 1, the head T and the recirculation line 2, identifying a first operating direction D1 and determining a first operating mode; and
wherein, in the first operating mode, the substance flows out in part from the head T through the nozzles N in a dispensing direction Y,
comprising the steps of:
- Interrupting the introduction of the substance into the supply line 1;
- Arranging a support 4 having a surface S complementary to the plane P of the head T;
- Putting the surface S of the support 4 in contact with the nozzles N;
- Keeping said surface S in contact with the nozzles N;
- Introducing the substance into the recirculation line 2 at a flow rate Q, such a substance travelling along the recirculation line 2, the head T, and the supply line 1, identifying a second operating direction D2 and determining a second operating mode.
- Maintaining said second operating mode for a predetermined cleaning time Tp.

A cleaning method for a printing bar 5 comprising a plurality of ink recirculating heads T.

Fig.1



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Description

[0001] The present invention relates to a cleaning method for a printing unit.

[0002] In particular, the present invention relates to a cleaning method for a printing unit comprising a printhead or a plurality of printheads. In the second case, the printing unit is typically called a printing bar.

[0003] When decorating substrates by ink-jet printing, one or more printing bars may be employed to dispense a plurality of inks, so as to obtain the desired decorative effects.

[0004] Printing bars for ink-jet decoration are known in the art and typically comprise one or more printheads, provided with ink dispensing nozzles, connected to an ink tank by means of a supply line; furthermore, if the printheads are of the recirculating ink type, such heads are further connected to the tank or to a chamber communicating with the tank through a recirculation line. Through the supply line, the ink is provided to each head and made available for printing operations; through the recirculation line, the ink can return to the tank and be advantageously kept moving, avoiding undesired aggregation or drying phenomena given by the stasis of the ink for a prolonged time.

[0005] Sometimes, however, one or more heads inside a printing bar may suffer malfunctions, mainly at the expense of the nozzles: the nozzles, due to their three-dimensional conformation having a progressive section narrowing, may, for example, suffer clogging due to an ineffective movement of the ink by the recirculation system, or due to the unwanted entry into the head of air coming from the surrounding environment, which air determines the drying of the ink.

[0006] A consequence of the malfunction of one or more printheads inside a printing bar is that the pattern printed on the substrate has unprinted lines at the clogged nozzles and, consequently, a decoration which does not meet the decorative standards required for that object.

[0007] Cleaning methods for clogged nozzles are known in the art, comprising the steps of:

- interrupting the flow of ink, turning off the printing unit;
- removing the damaged printhead(s);
- bringing the damaged printhead(s) to a separate seat, where specific operations occur, called regeneration operations, aimed at restoring the functionality of the head, where possible;
- replacing the damaged head(s) with a new head(s) of the same type, if available.

[0008] However, this method is expensive, as it involves replacing the malfunctioning head(s); furthermore, such a method requires that the printing bar remains inoperative for the time necessary to remove the heads and perform the replacement operations of said heads. In conclusion, this method is time-consuming and expensive.

[0009] Alternatively, a further cleaning method for clogged nozzles is known in the art, comprising the steps of:

- extracting the printing bar from a printing machine;
- positioning an ink collection tray below the printing bar;
- starting a purge procedure during which the ink is put under pressure and forced under pressure through the nozzles, until possibly expelling the clogging created.

[0010] Also in this case, the cleaning method has limits: firstly it is not necessarily decisive and the set pressure may not be sufficient to free the clogged nozzles; moreover, when decisive, the method implies the consumption of a considerable amount of ink, which is collected in the collection tray, but which cannot be introduced into the tank again, as it came into contact with the air.

[0011] An object of the present invention is to provide a cleaning method for a printhead or a printing bar, capable of overcoming the obvious limitations of the prior art.

[0012] In particular, an object of the present invention is to provide a cleaning method for said head or said printing bar capable of restoring the functionality of the nozzles, limiting the interruption of the printing operations as much as possible.

[0013] A further object of the present invention is to offer a cleaning method for said head or said printing bar capable of avoiding unnecessary wastes of ink.

[0014] Further features and advantages of the present invention will become more apparent from the following description, given by way of non-limiting example, of certain embodiments illustrated in the accompanying drawings, wherein:

- Figure 1 shows an operating diagram of a printhead in a first operating mode;
- Figure 2 shows an operating diagram of the head of Figure 1, in a second operating mode;
- Figure 3 shows an operating diagram of a printing bar, in a first operating mode;
- Figure 4 shows an operating diagram of the printing bar of Figure 3 in a second operating mode.

[0015] A first object of the present invention is a cleaning method for a printhead T.

[0016] The method according to the present invention is particularly useful for cleaning a head T comprising a plurality of nozzles N arranged for dispensing ink and located along a plane P; the plane P delimits the head T below and the nozzles N determine the dispensing of ink along a dispensing direction Y, perpendicular to the plane P.

[0017] The head T is connected, firstly, to a supply line 1; furthermore, the head T is connected to a recirculation

line 2.

[0018] In a normal operating condition of the head T, i.e., in a first operating mode, illustrated in Figure 1, introducing the ink into the supply line 1, said ink travels along the supply line 1, then crosses the head T and, subsequently, travels along the recirculation line 2, identifying a first operating direction D1.

[0019] The ink, introduced inside the head T according to the first operating mode, in part travels along the recirculation line 2 after passing through the head T and in part flows out from the nozzles N, if actuated: the ink is dispensed in the dispensing direction Y through the nozzles N.

[0020] Preferably, a substrate is located below the ink-dispensing nozzles N, and on which such ink is deposited, for example, to make a decoration on said substrate.

[0021] Preferably, in the first operating mode, the substance introduced into the supply line 1 is the ink; however, other substances similar in consistency and/or function can be intuitively introduced into the supply line 1.

[0022] At times, however, the ink introduced into the supply line 1 and passing through the head T may clog the nozzles N: one or more nozzles N, if clogged, do not allow the ink to flow out in the desired dispensing direction Y.

[0023] In detail, in fact, the nozzles N inside a head T typically have a funnel shape, with a wider inlet opening, facing the inside of the head T and arranged to collect and convey the circulating ink between supply branch 1 and recirculation branch 2, and a narrower outlet opening, facing the substrate to be decorated: such a narrower opening represents a critical element which can cause, precisely due to the particular shape, the stagnation of ink, bringing it to drying, or the formation of air bubbles or the entry of impurities of even very small dimensions, which may however be sufficient to block the outlet opening of the nozzle N.

[0024] Advantageously, the cleaning method according to the present invention allows to free the clogged nozzles N from the circulating ink in the first operating direction D1.

[0025] Advantageously, the cleaning method according to the present invention allows to free the clogged nozzles from air bubbles or impurities blocking one or more nozzles N, without the need to remove the head T from its normal operating location.

[0026] In particular, the cleaning method according to the present invention comprises the steps of:

- Interrupting the introduction of ink into the supply line 1 ;
- Arranging a support 4 having a surface S on the plane P of the head T;
- Putting the surface S of the support 4 in contact with the nozzles N, so as to occlude the nozzles N to prevent both the outflow of liquid and the entrance of air;
- Keeping said surface S in contact with the nozzles N;
- Introducing a substance into the recirculation line 2 at a flow rate Q, such a substance travelling along the recirculation line 2, the head T, and the supply line 1, identifying a second operating direction D2 and determining a second operating mode.
- Maintaining said second operating mode for a predetermined cleaning time Tp.

[0027] In detail, firstly, the introduction of the ink into the supply line 1 is interrupted: thereby, the first operating mode is interrupted and the ink no longer flows according to the first operating direction D1.

[0028] Therefore, a support 4 is arranged, having a surface S which, preferably but not necessarily, is at least partially complementary to the plane P of the head T. That is, at least one portion of the surface S of the support 4, if placed in contact with the head T at the plane P, does not allow the outflow of ink from the nozzles N, clogged and unclogged, nor does it allow the entrance of air through the nozzles N.

[0029] Various geometries of the support 4 can be intuitively employed, as long as they comprise said surface S.

[0030] The support 4 is thus positioned in contact with the head T, at the plane P and, therefore, at an outlet portion of the nozzles N, as illustrated in Figure 2.

[0031] A further step of the method according to the present invention is represented by the introduction of a substance into the recirculation line 2: the substance introduced into the recirculation line 2 travels along said recirculation line 2, then passes through the head T and, subsequently, travels along the supply line 1, identifying a second operating direction D2; that is, the method according to the present invention envisages the head T to operate according to a second operating mode.

[0032] Therefore, the second operating direction D2 is substantially opposite relative to the first operating direction D1.

[0033] However, in the second operating mode, the substance does not flow out in part from the nozzles N, which are blocked from the surface S of the support 4: in fact, by placing the surface S or a portion thereof in contact with the head T at the plane P, the nozzles N, both functioning and non-functioning, are clogged and the dispensing of the introduced substance in the dispensing direction Y is prevented.

[0034] The substance introduced can be the same ink introduced in the first operating mode, or a different ink, or a different substance or compound, having features and/or functionalities similar to the ink.

[0035] If the substance introduced into the recirculation line 2 is ink, the method according to the present invention advantageously allows to clean a head T, using the same ink introduced in the first operating mode.

[0036] Finally, the method according to the present invention envisages that the support 4 is kept in contact with the head T for a predetermined cleaning time Tp.

[0037] The method according to the present invention

advantageously allows to free the nozzles N from dried ink, unwanted impurities or air bubbles blocking the nozzles N themselves.

[0038] In particular, the surface S of the support 4 is kept in contact with the head T at the plane P and, consequently, at the outlet opening of the nozzles N; thanks to the circulation of the substance in the second operating direction D2, the dried ink, the unwanted impurities, the air bubbles or other elements blocking the nozzles N themselves, can be advantageously led out of the clogged nozzles N through the inlet opening of said nozzles N.

[0039] Once out of the clogged nozzle(s) N, the blocked elements are moved in the second operating direction D2 and led out of the head T through the supply channel 1.

[0040] The support 4 employed can intuitively assume different geometries and shapes, as long as they are configured to block the nozzles N at the plane P.

[0041] Furthermore, the support 4 can intuitively consist of various types of materials.

[0042] In a first embodiment, the support 4 is a plate-like support 4, of dimensions equal to or greater than the dimensions of the head T in the plane P.

[0043] In the preferred but not exclusive embodiment of the present invention, the support 4 is a sheet 4 of polymeric material, preferably impermeable, and able to best adapt to the plane P of the head T and, therefore, able to block the outlet opening of the nozzles N: said sheet 4 has an upper surface S of equal or greater dimensions relative to the head T in the plane P.

[0044] Preferably, said sheet 4 made of polymeric material is at least partially flexible: thanks to the at least partial flexibility, the polymeric sheet is able to adapt in a further versatile manner to any constructive tolerances of the head T and/or of the nozzles N, preventing the outflow of the substance during the second operating mode.

[0045] In order to further improve the adhesion of the support 4 to the head T, the method according to the present invention comprises the step of:

- starting from an internal pressure Pi of the head T, varying such an internal pressure Pi, after the step of interrupting the introduction of the substance into the supply line 1.

[0046] In fact, during the first operating step, an internal pressure Pi is detectable inside the head T: such an internal pressure Pi is preferably lower than the pressure of the surrounding environment and is arranged to prevent the ink from dripping in the absence of a dispensing command and to prevent the entry of external air into the nozzles N.

[0047] A device for detecting and adjusting the internal pressure Pi can be functionally connected to the head T: said device for detecting and adjusting the internal pressure Pi is configured to detect the pressure inside the head T and to modify such an internal pressure value Pi.

[0048] The method according to the present invention, comprising the step of modifying and, in particular, decreasing the internal pressure Pi of the heads T below an initial value of internal pressure Pi, confers the technical advantage of creating an internal depression such as to keep the support 4 stably in contact with the heads T at the plane P.

[0049] That is, by increasing the depression inside the head T, a suction force is generated on the support 4 at the plane P, which suction keeps the support 4 adhered to the heads T for the cleaning time Tp.

[0050] The internal pressure Pi can then be returned to the initial value, to allow the release of the support 4 away from the plane P at the end of cleaning the nozzles N.

[0051] Different internal pressures Pi and, in particular, different depression values can be achieved, allowing to obtain the suction or, in other words, the retention of the support 4 at the plane P. Advantageously, the method according to the present invention comprising the step of varying the internal pressure Pi, as indicated, allows to keep supports 4 having different materials, thicknesses and, consequently, weights adhered to the plane P, not being limited to a single type of support 4.

[0052] The internal pressure Pi, on the other hand and as can be intuited, can also be increased to a value higher than the initial one. The variation of the internal pressure Pi can be obtained after the step of introducing the substance into the recirculation line 2; that is, the variation of the internal pressure Pi can be obtained while the head T is operating in the second operating mode.

[0053] In addition or alternatively to the step of varying the internal pressure Pi of the head T, the method according to the present invention can comprise the step of:

- wetting the surface S of the support 4, after the step of arranging the support 4.

[0054] Preferably, but not exclusively, the step of wetting the surface S of the support 4 is prior to the step of positioning the surface S of the support 4 in contact with the nozzles N. Alternatively, the step of wetting the surface S of the support 4 can occur simultaneously with the step of placing the surface S in contact with the nozzles N.

[0055] The technical advantage achieved by said step of wetting the surface S of the support 4 is that the adhesive capacity of the support 4 to the head T and, in particular, to the nozzles N, is improved.

[0056] In a non-exclusive embodiment, the surface S is wetted with a substance having physical-chemical features similar to the ink or substance circulating through the head T, so as to improve compatibility and promote adhesion.

[0057] A plurality of substances can, intuitively, be used to wet the surface S of the support 4; the ink itself can be used to wet the surface S of the support 4.

[0058] Advantageously, decreasing the internal pressure Pi of the head T and/or wetting the surface S, the support 4 is kept stably in contact with the head T, pre-

venting the outflow of the ink or substance during the second operating mode.

[0059] The method according to the present invention, in addition or alternatively to the previously described steps, can comprise the step of

- Changing the substance flow rate Q, after the step of introducing the substance into the recirculation line 2.

[0060] As described above, in the second operating mode the substance is introduced into the recirculation line 2 at a flow rate Q: increasing the flow rate Q, and in particular increasing the flow of substance through the head T, it is advantageously possible to complete cleaning operations when said head T has a plurality of clogged nozzles N. Furthermore, by increasing said flow rate Q, it is advantageously possible to complete the cleaning operations when said head T has one or more nozzles N clogged by blocking elements of particularly large dimensions.

[0061] Therefore, the method according to the present invention, comprising the step of increasing the introduction flow rate Q of the substance into the recirculation line 2, advantageously allows to obtain the cleaning of a head T having several clogged nozzles N and/or having one or more nozzles N clogged by blocking elements of considerable size.

[0062] The flow rate Q can be increased for the entire cleaning time Tp, for a time less than the cleaning time Tp, or periodically during the cleaning time Tp, in the second operating mode of the head T.

[0063] In the event of particularly severe clogging conditions of the nozzles N, for example if the majority of the nozzles N are clogged by blocking elements, the method according to the present invention further comprises the step of:

- Moving or further stirring the substance moving in the second operating direction D2, for a movement time Tm, after the step of introducing the substance into the recirculation line 2.

[0064] The movement or stirring of the moving substance preferably, but not exclusively, occurs through mechanical actuators connected to the nozzles N.

[0065] In the first operating mode, the mechanical actuators are activated to generate drops subsequently dispensed from the nozzles N in the dispensing direction Y, so that they are deposited on the substrate to be decorated.

[0066] The aforesaid mechanical actuators can advantageously also be activated in the second operating mode before, simultaneously or after the introduction of the substance into the recirculation line 2: activated in the second operating mode, the mechanical actuators further move the ink or the substance circulating in the second operating direction D2; moreover, the mechanical actuators can contribute to the breakage of the blocking elements, thanks to the vibrations transmitted internally to the head T and, in particular, to the nozzles N.

[0067] The mechanical actuators are preferably, but not exclusively, of the piezoelectric type and are connected to a respective electrical circuit: said mechanical actuators are typically connected to the printheads of the prior art and are, consequently, of the type known to the person skilled in the art.

[0068] Therefore, the method according to the present invention allows to complete cleaning operations of a head T having one or more clogged nozzles N quickly, exploiting known devices in the field of printing with ink-jet heads T and avoiding the waste of said ink.

[0069] Advantageously, if ink is introduced in the second operating mode, the method according to the present invention allows to complete the cleaning operations of the head T using the same circulating ink during the normal operating condition.

[0070] Therefore, the method according to the present invention allows the rapid and effective cleaning of a head T, both placed inside a printing machine, and previously extracted from the printing machine: in the latter case the cleaning operation of the head T takes the name of regeneration of the head T in the known art.

[0071] Therefore, advantageously, the method according to the present invention allows to regenerate a head T quickly and effectively and to make it functional again and, therefore, placeable in a printing machine. Advantageously, moreover, the method according to the present invention allows to recover heads T having particularly severe clogging conditions of the nozzles N, which otherwise would be definitively discarded. Advantageously, in conclusion, the method according to the present invention allows to reduce the number of definitively discarded malfunctioning heads T, consequently reducing the pollutants coming from the ink-jet printing sector.

[0072] The present invention further relates to a cleaning method for a printing bar 5, comprising a plurality of ink recirculating heads T.

[0073] Each head T inside the printing bar 5 is of the type described above: therefore, the head T comprises a plurality of nozzles N arranged for dispensing ink and located along a plane P, such a plane P delimiting each head T and, consequently, the printing bar 5 below.

[0074] With reference to Figure 3, each head T inside the printing bar 5 is, firstly, connected by means of a supply branch 11 to a common supply branch 10 of a supply line 1.

[0075] Furthermore, each head T inside the printing bar 5 is connected by means of a recirculation branch 21 to a common recirculation branch 20 of a recirculation line 2.

[0076] In a first operating mode, introducing the ink into the supply line 1, such ink travels along the common supply branch 10, then the supply branches 11 until reaching each head T; then, the ink crosses the head T

and, subsequently, travels along the recirculation branches 21 until reaching the common recirculation branch 20 of the recirculation line 2. Therefore, in the first operating mode, it is possible to identify a first operating direction D1 corresponding to the direction followed by the ink introduced into the supply line 1.

[0077] In the first operating mode, the ink in part flows out from the nozzles N of one or more heads T, when actuated, and in part travels along the recirculation line 2 following the first operating direction D1.

[0078] In a non-exclusive embodiment, illustrated in Figure 3, the common supply branch 10 of the supply line 1 is connected to an ink collection tank 6, situated upstream of the supply line 1 considering the first operating direction D1.

[0079] The recirculation line 2 is also connected to said tank 6, or to a chamber connected to said tank 6 and not shown in the figure: in detail, the tank 6 is located downstream of the recirculation line 2 considering the first operating direction D1.

[0080] In the first operating mode, the ink is moved from the tank 6 along the supply line 1, through the head(s) T, and along the recirculation line 2, to then be introduced into the tank 6 again.

[0081] However, both the supply line 1 and the recirculation line 2 may not be functionally connected to the same tank 6, but may draw from different tanks, not shown in the attached figures. Alternatively, tanks can be understood as the supply line 1 and the recirculation line 2 themselves. The movement of the ink according to the first operating direction D1 occurs by means known in the art.

[0082] For example, the movement of the ink according to the first operating direction D1 can occur by means of devices detecting the pressure in input and in output from the heads T, such devices allowing to establish a pressure difference between the inlet and the outlet of the heads T such as to determine the flow of the ink in the first operating direction D1. Preferably, but not exclusively, the movement of the ink occurs by means of a circulation pump 3, operating in a first configuration C1: in the first configuration C1, the circulation pump 3 is configured to move the ink from the tank 6 towards the supply line 1 and from the heads T towards the recirculation line 2. That is, the circulation pump 3 in the first configuration C1 is configured to determine the circulation of the ink in the first operating direction D1.

[0083] The cleaning method of the printing bar 5 according to the present invention comprises the steps of:

- Interrupting the introduction of ink into the supply line 1;
- Arranging a support 4 having a surface S on the plane P;
- Putting the surface S of the support 4 in contact with the nozzles N, so as to occlude the nozzles N;
- Keeping said surface S in contact with the nozzles N;
- Introducing the ink into the recirculation line 2 at a flow rate Q, such ink travelling along the common recirculation section 20 and the recirculation branches 21 of the recirculation line 2, the head T, the supply branches 11 and the common section 10 of the supply line 1, identifying a second operating direction D2 and determining a second operating mode;
- Maintaining the second operating mode for a predetermined cleaning time Tp.

[0084] In detail, firstly, the introduction of the ink into the supply line 1 is interrupted: thereby, the first operating mode is interrupted and the ink no longer flows according to the first operating direction D1.

[0085] Therefore, the support 4 is arranged, having a surface S at least partially complementary to the plane P of the heads T. That is, at least one portion of the surface S of the support 4, if placed in contact with the heads T of the printing bar 5 at the plane P, does not allow the outflow of ink from the nozzles N, clogged and unclogged.

[0086] Various geometries of the support 4 can be intuitively employed, as long as they comprise said surface S.

[0087] The support 4 is thus positioned in contact with the printing bar 5 at the plane P of the heads T.

[0088] Subsequently, the method according to the present invention envisages the introduction of the ink into the recirculation line 2: the ink introduced into the recirculation line 2 travels along the common recirculation branch 20, then the recirculation branches 21 and passes through the heads T; then, the ink travels along the supply branches 11 and the common supply branch 10 of the supply line 1, identifying a second operating direction D2 and determining a second operating mode.

[0089] If the recirculation line 2 is connected to the tank 6, the ink introduced in the second operating mode is the same used in the first operating mode.

[0090] If the recirculation line 2 is instead connected to a different tank 6, the ink introduced can be of a different type relative to that employed in the first operating mode; alternatively, a different substance can be introduced in the second operating mode.

[0091] The introduction of the ink into the recirculation line 2 can occur, in an embodiment, by modifying the inlet and outlet pressures of the heads T and creating an opposite pressure gradient, relative to that obtained in the first operating mode.

[0092] Preferably, but not exclusively, the introduction of the substance into the recirculation line 2 is obtained by bringing the circulation pump 3, when present, from the first configuration C1 to a second configuration C2: in the second configuration C2, the circulation pump 3 operates by moving the ink from the recirculation line 2 to the supply line 1. The passage from the first configuration C1 to the second configuration C2 of the circulation pump 3 is also called inversion operation.

[0093] If the circulation pump 3 is of bidirectional type, then such a pump 3 is already arranged to determine the

movement of the ink both in the first operating direction D1 and in the second operating direction D2.

[0094] In the event of a non-bidirectional circulation pump 3, the pump 3 is preferably integrated with a system comprising a circuit and one or more valves, of the type known in the art, configured to reverse the inlet and outlet of the circulation pump 3.

[0095] Finally, the method according to the present invention envisages that the support 4 is kept in contact with the heads T of the printing bar 5 for a predetermined cleaning time Tp.

[0096] The method according to the present invention advantageously allows to free the nozzles N of the printing bar 5 from dried ink, unwanted impurities or air bubbles blocking the nozzles N themselves.

[0097] In particular, the surface S of the support 4 is kept in contact with the printing bar 5 at the plane P and, consequently, at the outlet opening of the nozzles N; thanks to the circulation of the ink, or other substance, in the second operating direction D2, the dried ink, the unwanted impurities, the air bubbles or other elements blocking the nozzles N themselves, can be advantageously led out of the clogged nozzles N through the inlet opening of said nozzles N.

[0098] Once out of the clogged nozzle(s) N, the blocked elements are moved in the second operating direction D2 and led out of the heads T through the supply line 1.

[0099] A filter can advantageously be positioned downstream of the head T considering the second operating direction D2 so as to collect the blocking elements from the nozzles N, so that they are not in the supply line 1 or in the recirculation line 2 when the printing bar 5 returns to operating in the first operating mode.

[0100] The support 4 employed can intuitively assume different geometries and shapes, as long as they are configured to block the nozzles N of the printing bar 5. Similarly to what has been stated for the head T, the support 4 can intuitively consist of various types of materials; preferably, the support 4 is of a plate-like type; preferably, the support 4 is a sheet of polymeric material; preferably, the polymeric sheet is flexible and impermeable.

[0101] Furthermore, the support 4 can be modular, that is, it can comprise several units functionally or physically connected to each other.

[0102] The support 4 is manually kept in contact with the printing bar 5 for the preset cleaning time Tp.

[0103] In order to further improve the adhesion of the support 4 to the printing bar 5, the method according to the present invention comprises the step of:

- starting from an internal pressure Pi of the heads T, varying such an internal pressure Pi,

after the step of interrupting the introduction of the ink into the supply line 1.

[0104] In fact, during the first operating step, an internal pressure Pi is detectable inside the head T: such an internal pressure Pi is preferably lower than the pressure of the environment surrounding the printing bar 5 and is arranged to allow the outflow of the ink from the nozzles N and to prevent or, however limit, the entry of air into the nozzles N.

[0105] A device for detecting and adjusting the internal pressure Pi can be functionally connected to the heads T.

[0106] Advantageously, therefore, the method according to the present invention comprises the step of modifying and, in particular, decreasing the internal pressure Pi of the heads T below an initial value of internal pressure Pi: the technical advantage obtained from said lowering the internal pressure Pi is that an internal depression is created such as to keep the support 4 stably in contact with the printing bar 5.

[0107] In addition or alternatively to the step of varying the internal pressure Pi of the heads T, the method according to the present invention can comprise the step of:

- wetting the surface S of the support 4, after the step of arranging the support 4.

[0108] Preferably, but not exclusively, the step of wetting the surface S is prior to the step of positioning the surface S of the support 4 in contact with the nozzles N. Alternatively, the step of wetting the surface S of the support 4 can occur simultaneously with the step of placing the surface S in contact with the nozzles N.

[0109] The technical advantage achieved by said step of wetting the surface S of the support 4 is that the adhesive capacity of the support 4 relative to the printing bar 5 is improved.

[0110] In a non-exclusive embodiment, the surface S is wetted with a substance having physical-chemical features similar to the ink or substance circulating through the heads T, so as to promote adhesion to the support 4. A plurality of substances can, intuitively, be used to wet the surface S of the support 4; the ink itself can be used to wet the surface S of the support 4.

[0111] Advantageously, decreasing the internal pressure Pi of the heads T and/or wetting the surface S, the support 4 is kept stably in contact with the printing bar 5, preventing the outflow of the ink during the second operating mode.

[0112] The method according to the present invention, in addition or alternatively to the previously introduced steps, can comprise the step of

- Changing the value of the ink flow rate Q,

after the step of introducing the ink into the recirculation line 2.

[0113] As described above, in the second operating mode the ink is introduced into the recirculation line 2 at a flow rate Q: increasing the flow rate Q, and therefore increasing the flow of substance through the heads T, it is

advantageously possible to complete cleaning operations when the heads T have a plurality of clogged nozzles N. Furthermore, increasing said flow rate Q, it is advantageously possible to complete the cleaning operations when the printing bar 5 has one or more nozzles N clogged by blocking elements of particularly large dimensions.

[0114] Furthermore, the step of increasing the ink introduction flow rate Q allows to cope with any pressure drops which could occur due to the size, structure and geometry of the printing bar 5 and, in particular, of the supply 1 and recirculation 2 lines.

[0115] The flow rate Q can be increased for the entire cleaning time Tp, for a time less than the cleaning time Tp, or periodically during the cleaning time Tp. In the event of particularly severe clogging conditions of the nozzles N, for example if the majority of the nozzles N are clogged by blocking elements, the method according to the present invention further comprises the step of:

- Moving or further stirring the ink moving in the second operating direction D2, for a movement time Tm, after the step of introducing the ink into the recirculation line 2.

[0116] The movement or stirring of the moving ink preferably, but not exclusively, occurs through mechanical actuators connected to the nozzles N.

[0117] The aforesaid mechanical actuators, described above, can advantageously be activated in the second operating mode before, simultaneously or after the introduction of the ink into the recirculation line 2: activated during the second operating mode, the mechanical actuators further move the ink circulating in the second operating direction D2; moreover, the mechanical actuators can contribute to the breakage of the blocking elements, thanks to the vibrations transmitted internally to the head T and, in particular, to the nozzles N.

[0118] The mechanical actuators are preferably, but not exclusively, of the piezoelectric type and are connected to a respective electrical circuit: said mechanical actuators are typically connected to the printheads of the prior art and are, consequently, of the type known to the person skilled in the art.

[0119] A control system 7 can also be configured to detect various parameters of interest for the cleaning operation of the printing bar 5. The parameters of interest preferably, but not exclusively, comprise the inlet and outlet pressure from the heads T, the configuration of the circulation pump 3, the internal pressure Pi of the heads T and/or the flow rate Q of the ink: a plurality of devices for detecting, comparing with reference values and modifying such parameters of interest can be configured to communicate with the control system 7. Such devices are of the type known in the art. The control system 7 can also be configured to communicate with a display 8 for display and selection: through the display 8, an operator can start and monitor the progress of the cleaning operations, and, furthermore, select, compare and modify the parameters of interest. Therefore, the method according to the present invention allows to complete cleaning operations of a printing bar 5 having one or more clogged nozzles N quickly, exploiting known devices in the field of printing with ink-jet heads and avoiding the waste of said ink.

[0120] The method according to the present invention further allows the rapid and effective cleaning of a printing bar 5 while it is connected to a printing machine: once the first operating mode is interrupted, the printing bar 5 can be extracted from the printing machine through sliding guides. In this case, the printing bar 5 can be subjected to cleaning operations according to the present method, without being removed from the printing machine and without the heads with clogged nozzles N being removed, regenerated and replaced.

[0121] Advantageously, moreover, the method according to the present invention allows to clean heads T inside the printing bar 5 having particularly severe clogging conditions of the nozzles N, which otherwise would be definitively discarded.

[0122] Advantageously, in conclusion, the method according to the present invention allows to reduce the number of definitively discarded malfunctioning heads T, consequently reducing the pollutants.

Claims

1. A cleaning method for a head T,

wherein the head T comprises a plurality of nozzles N arranged for dispensing ink and located along a plane P, such a plane P delimiting the head T below;
wherein the head T is connected to an ink supply line 1;
wherein the head T is further connected to a recirculation line 2,
wherein, in a normal operating condition of the head T, the ink travels along the supply line 1, the head T and the recirculation line 2, identifying a first operating direction D1 and determining a first operating mode; and wherein, in the first operating mode, the ink flows out at least in part from the head T through the nozzles N in a dispensing direction Y, **characterised in that** it comprises steps of:

- Interrupting the introduction of ink into the supply line 1;
- Arranging a support 4 having a surface S on the plane P of the head T;
- Putting the surface S of the support 4 in contact with the nozzles N, so as to occlude the nozzles N;
- Keeping said surface S in contact with the

nozzles N;
- Introducing a substance into the recirculation line 2 at a flow rate Q, such a substance travelling along the recirculation line 2, the head T, and the supply line 1, identifying a second operating direction D2 and determining a second operating mode.
- Maintaining said second operating mode for a predetermined cleaning time Tp.

2. The method according to claim 1, comprising the step of:

- Changing the value of the substance flow rate Q, after the step of introducing the substance into the recirculation line 2.

3. The method according to claim 1, comprising the step of:

- Starting from an internal pressure Pi of the head T, varying such an internal pressure Pi, after the step of interrupting the introduction of the substance into the supply line 1.

4. The method according to claim 1, comprising the step of:

- Wetting the surface S of the support 4, after the step of arranging the support 4.

5. The method according to claim 1, comprising the step of:

- Moving or further stirring the substance moving in the second operating direction D2, for a movement time Tm, after the step of introducing the substance into the recirculation line 2.

6. A cleaning method for a printing bar 5 comprising a plurality of ink recirculating heads T,

wherein each head T comprises a plurality of nozzles N arranged for dispensing ink and located along a plane P, such a plane P delimiting the head T and the printing unit 5 below;
wherein each head T is connected by means of a supply branch 11 to a common supply branch 10 of a supply line 1;
wherein each head T is further connected by means of a recirculation branch 21 to a common recirculation branch 20 of a recirculation line 2, wherein, in a normal operating condition of the printing bar 5, the ink travels along the common recirculation branch 10 and the supply branches 11 of the supply line 1, the head T, the recirculation branches 21 and the common recirculation branch 20 of the recirculation line 2, identifying a first operating direction D1 and determining a first operating mode. wherein, in the first operating mode, the ink flows out at least in part from at least one head T through the nozzles N in a dispensing direction Y, **characterised in that** it comprises the steps of

- Interrupting the introduction of ink into the supply line 1;
- Arranging a support 4 having a surface S on the plane P;
- Putting the surface S of the support 4 in contact with the nozzles N;
- Keeping said surface S in contact with the nozzles N;
- Introducing the ink into the recirculation line 2 at a flow rate Q, such ink travelling along the common recirculation section 20 and the recirculation branches 21 of the recirculation line 2, the head T, the supply branches 11 and the common section 10 of the supply line 1, identifying a second operating direction D2 and determining a second operating mode;
- Maintaining the second operating mode for a predetermined cleaning time Tp.

7. The method according to claim 6, comprising the step of:

- Changing the ink flow rate Q, after the step of introducing the ink into the recirculation line 2; and/or
- Starting from an internal pressure Pi of the head T, varying such an internal pressure Pi, after the step of interrupting the introduction of the ink into the supply line 1.

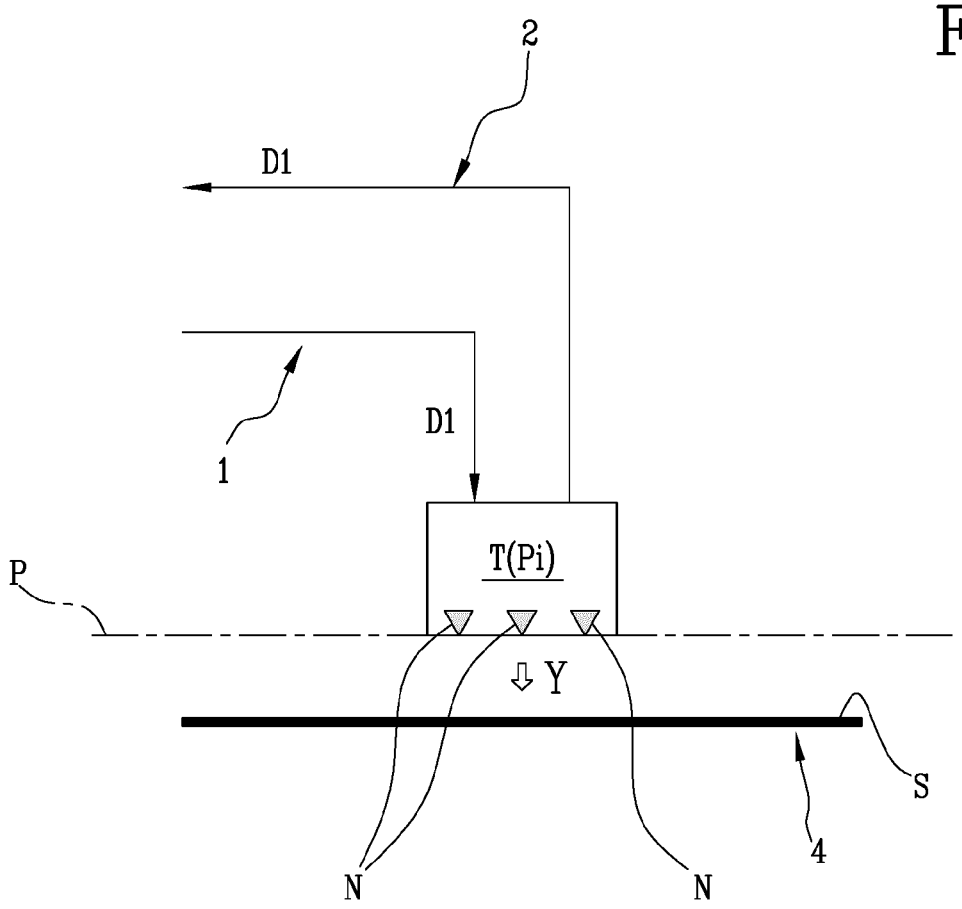
8. The method according to one among claims 6 or 7, comprising the step of:

- Wetting the surface S of the support 4, after the step of arranging the support 4.

9. The method according to one between claims 6 or 8, further comprising the steps of:

- Moving or further stirring the ink moving in the second operating direction D2, for a movement time Tm, after the step of introducing the ink into the recirculation line 2.

Fig.1



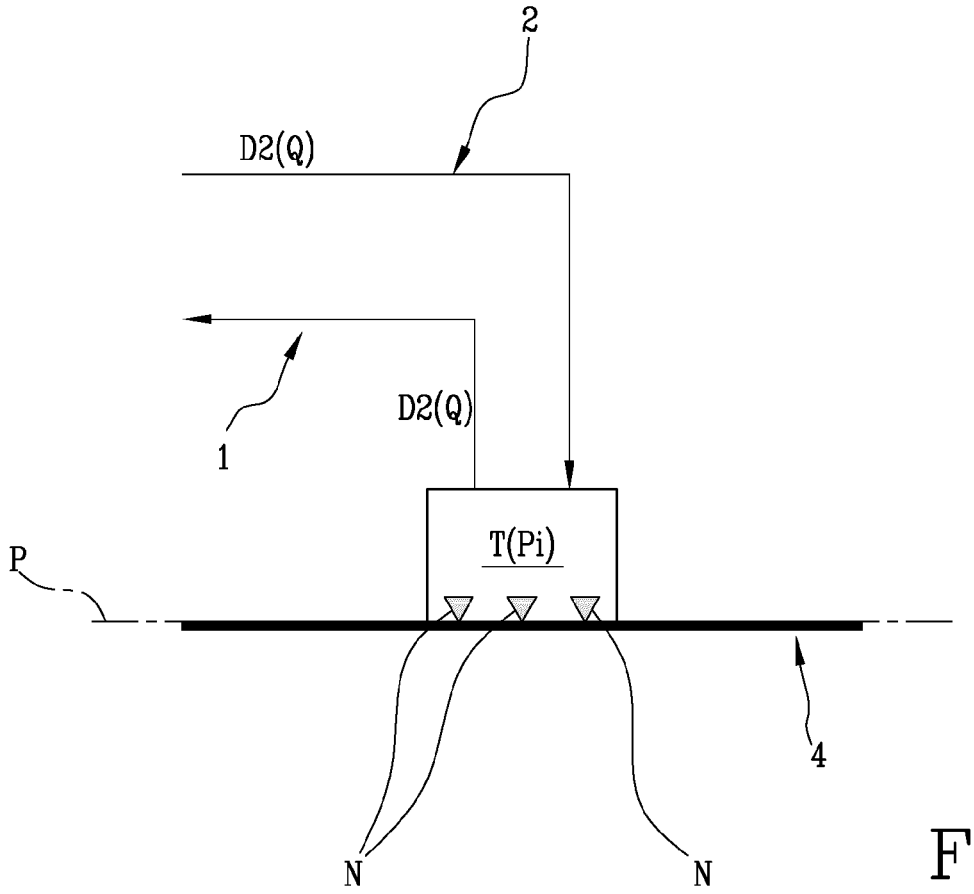
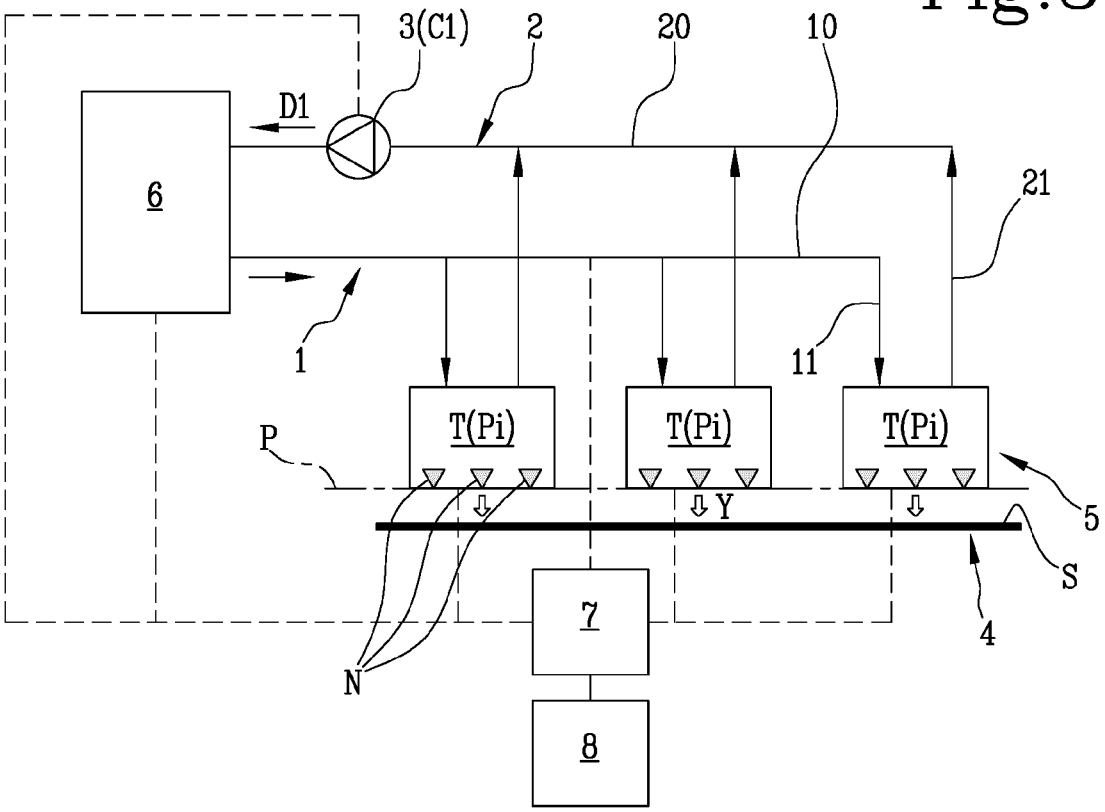


Fig.2

Fig.3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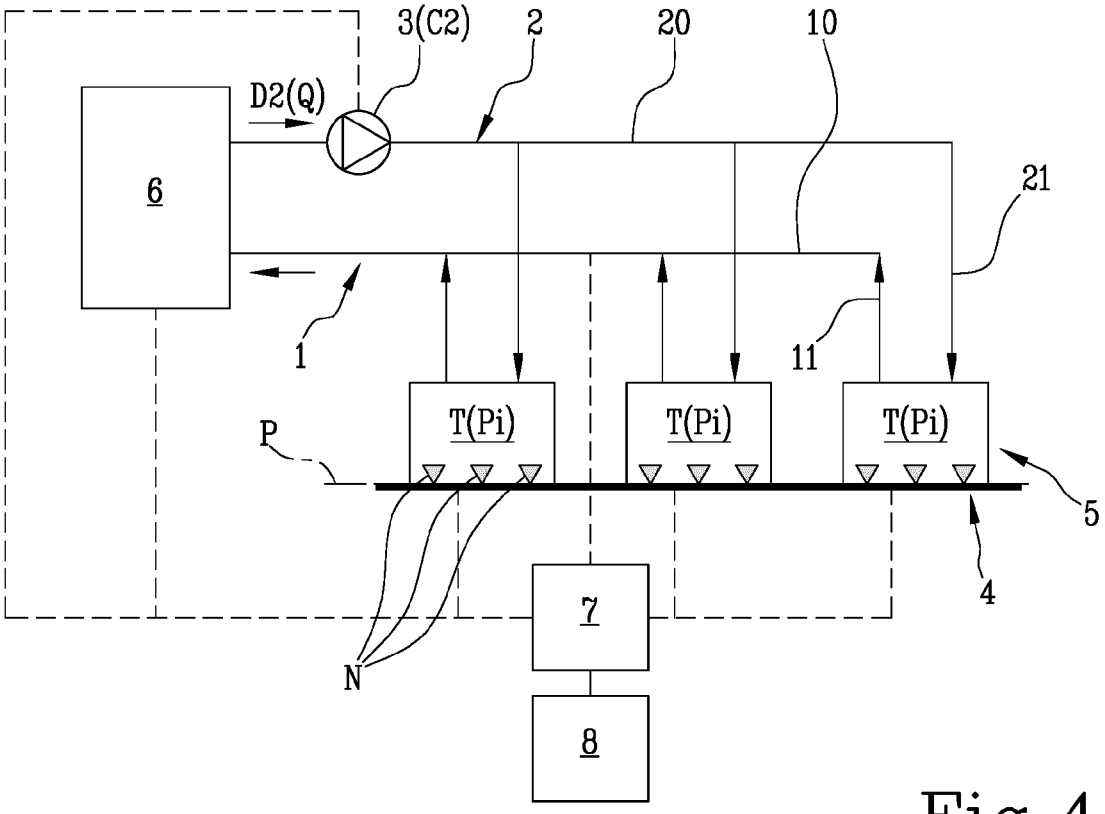
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D2(Q)
6
21
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T(Pi)
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T(Pi)
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7
N
8

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 8848

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 February 2025	João, César

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24-02-2025

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