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(54) PLATE CYLINDER, METHOD FOR ATTACHING A FLEXOGRAPHIC PRINTING PLATE ONTO A PLATE CYLINDER AND METHOD FOR DETACHING A FLEXOGRAPHIC PRINTING PLATE FROM A PLATE CYLINDER

(57) The present disclosure relates to a plate cylinder (40) for flexographic printing, wherein a first portion of the outer circumferential surface (40) of the plate cylinder (40) comprises suction openings (10) for attaching opposite edges of a flexographic printing plate (20) thereon via suction, said suction openings (10) being configured to communicate with a vacuum source (70), wherein a second portion of the outer circumferential surface (30) of the plate cylinder (40) comprises no suction openings, said second portion occupying, in a circumferential direction of the plate cylinder (40), at least 60%, preferably at least 75% and more preferably at least 90% of the circumferential surface (30) of the plate cylinder (40), and, in a longitudinal direction of the plate cylinder (40), at least 80%, preferably 100% of the circumferential surface (30) of the plate cylinder (40).

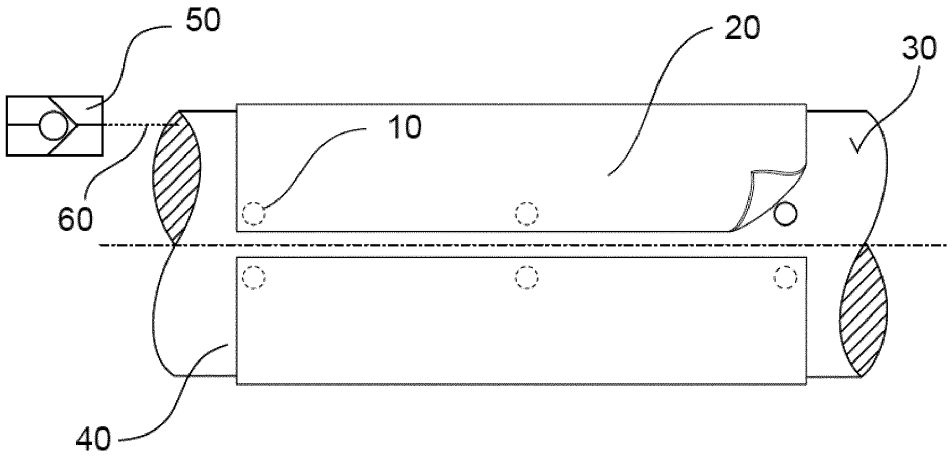

Fig. 8a

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a plate cylinder for flexographic printing, a method for attaching a flexographic printing plate onto a plate cylinder, and a method for detaching a flexographic printing plate from a plate cylinder.

BACKGROUND ART

[0002] In color screen printing, a screening process rasterizes an image to be printed into dots (cf. Fig. 6). A color image is further separated into multiple images, each image comprising the dots of one of the basic colors of a color model that is used for printing. Each printing unit is dedicated to print only one of these colors so that a printing substrate must pass through multiple printing units for producing a color image. These printing units each comprise a printing cylinder including a plate cylinder with a flexographic printing plate attached thereto for transferring ink of one of the basic colors to a printing substrate.

[0003] In order to print an image with accurate colors, the colored dots that are printed onto the substrate need to have the size and location determined by the screening process. Otherwise, the color of an image will shift and appear falsified in the eye of an observer. For example, if colored dots are printed with a larger diameter, the printed image will experience a color shift in the eye of an observer towards red. Further, if the dots of one color are located in an area, where another color should be present, an unintended overlay of the two colors will likewise produce a falsified color.

[0004] One reason for falsified colors during printing is an unintended change in printing pressure between a flexographic printing plate and a printing substrate. This can be caused by surface irregularities that superimpose the relief of a flexographic printing plate, which defines where ink is to be applied onto a printing substrate. While the printing cylinder rotates over a printing substrate, these surface irregularities cause a difference in printing pressure that results in the relief of the flexographic printing plate being compressed to a different degree than required for an accurate printing job. Since the relief of a printing plate generally tapers from the bottom to the top (cf. Fig. 7), a difference in compression results in an increase or decrease of the printing surface so that a color will be overemphasized or underemphasized.

[0005] Another reason for differences of a point of one printing cylinder are residues left on a plate cylinder when changing a flexographic printing plate. These residues will later interfere with the reuse of the plate cylinder or will deteriorate the printing performance in subsequent printing operations. Further, attaching the double stick tape uniformly and without causing surface irregularities that impair the printed image is a cumbersome manual operation.

[0006] This problem has been addresses by a more recent method that involves the use of a self-adhesive printing form attachment layer that includes a self-adhesive photopolymerizable composition to attach the printing plate to the printing cylinder. This method is described in WO 95/19267 A1 and uses a self-adhesive printing form attachment layer instead of a double stick tape. According to this document, the self-adhesive printing form attachment layer can maintain its adherent properties even during continued use and re-use. Residues can easily be removed so that no residual photopolymerizable material remains on the printing form. However, due to the strong adhesive properties, it may in some cases take a certain amount of time to detach a printing plate from the printing cylinder.

[0007] As an alternative to attaching a printing plate to a printing cylinder by means of adhesive, a printing plate may be attached to a printing cylinder via suction. As disclosed, in US 03078796 A, a hollow printing cylinder having a plurality of openings on its outer circumferential surface may be utilized for this purpose. The hollow inside of this cylinder communicates with said openings and, likewise, with a vacuum source through a central hole in the shaft of the cylinder. A printing plate may, hence, be clamped to the outer circumferential surface of the printing cylinder via suction.

[0008] However, it has been found that attaching printing plates to printing cylinders by means of suction may be suitable for offset printing plates, yet not for flexographic printing plates. That is, because the material types utilized for flexographic printing plates are commonly associated with a significantly increased flexibility (i.e., elastic deformability), and may, thus, be deformed when exposed to vacuum provided in suction openings (see Fig. 2a). Surface irregularities resulting from this deformation may, again, lead to inaccurate printing results.

[0009] Moreover, if a printing plate is used which is smaller than the circumferential surface of the printing cylinder equipped with suction openings, a plurality of suction openings may not be covered by said printing plate. In this case, it may be difficult to obtain enough negative pressure inside the remaining suction openings for securely clamping the printing plate to the printing cylinder.

[0010] Known printing cylinders utilizing suction for clamping a printing plate to a circumferential surface thereof may further be disadvantageous with respect to energy consumption. That is, because a vacuum source has to operate continuously in order to maintain the pressure and to safely clamp the printing plate to the printing cylinder.

[0011] Known printing cylinders utilizing suction for clamping a printing plate to a circumferential surface thereof may further be disadvantageous with respect to energy consumption. That is, because leakage flow may occur in a rotary feed through unit necessary to provide

vacuum to the printing cylinder. It should be noted that such leakage flow may eventually be alleviated by regularly replacing sealing elements of the rotary feed through which are subjected to wear. However, such regular replacement of sealing elements may be associated with increased cost.

SUMMARY

[0012] It is an objective to overcome at least one of the above-mentioned disadvantages in a simple but nevertheless effective way.

[0013] The present disclosure relates to a plate cylinder according to claim 1, a plate cylinder according to claim 2, a plate cylinder according to claim 8, a plate cylinder according to claim 10, a method for attaching a flexographic printing plate onto a plate cylinder according to claim 13 and a method for detaching a flexographic printing plate from a plate cylinder according to claim 14. Preferred embodiments are specified in the dependent claims.

[0014] The present disclosure provides a plate cylinder for flexographic printing. The plate cylinder comprises a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction. The suction openings are configured to communicate with a vacuum source. The number of said suction openings equals or exceeds 10.000, and the cross-sectional area of each suction opening is equal to or below 1 mm^2. Preferably, the number of said suction openings equals or exceeds 15.000, and the cross-sectional area of each suction opening is equal to or below 0,66mm^2. More preferably, the number of said suction openings equals or exceeds 20.000, and the cross-sectional area of each suction opening is equal to or below 0,5mm^2.

[0015] In principle, a certain suction area, which equals the cross-sectional area of each suction opening multiplied with the number of suction openings, must be provided in order to safely clamp a printing plate to a printing cylinder. It may, hence, be possible to obtain the required suction area by providing a small or medium number of suction openings (i.e.,10 or 100, respectively) each of which is associated with a cross sectional area having of a medium or high value (e.g., 1000 mm^2 or 100 mm^2, respectively). However, in accordance with the present invention, the required suction area may be obtained by significantly increasing the number of suction openings, while simultaneously significantly decreasing the cross-sectional area of each of the suction openings. As a result, elastic deformations of the printing plate in portions of the printing plate facing a suction opening may be reduced. Hence, surface irregularities with respect to the printing plate may be alleviated, and the printing result may be increased.

[0016] The present disclosure further provides a plate cylinder for flexographic printing, preferably the above-described plate cylinder. The plate cylinder comprises a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction. The suction openings are configured to communicate with a vacuum source. At least some of the plurality of suction openings are equipped with magnetically operable, normally closed valves. Each of the valves is configured to be brought into an opened state by bringing a ferromagnetic material or a permanently magnetic material in close proximity thereof. The term "close proximity" includes distances such as 0,1mm, 1 mm, 10 mm, or 50 mm.

[0017] The above-described plate cylinder may be advantageous because the valves allow vacuum openings that do not face a flexographic printing plate (e.g., due to reduced size of the flexographic printing plate with respect to the circumferential surface of the plate cylinder) to remain in a closed state. In other words: the above-described plate cylinder allows obtaining a state in which only the openings facing a flexographic printing plate disposed on the circumferential surface of the plate cylinder are communicating with a vacuum source. Due to this configuration, it may be possible obtain enough negative pressure inside the suction openings communicating with the vacuum source, such that the printing plate may be securely clamped to the plate cylinder.

[0018] The above-described plate cylinder is preferably configured such that suction openings provided in peripheral portions of the plate cylinder are equipped with magnetically operable, normally closed valves, and wherein suction openings provided in central portions of the plate cylinder are not equipped with such valves.

[0019] The latter arrangement allows combining the above-described advantage of securely clamping a flexographic printing plate (e.g., a flexographic printing plate having reduced size with respect to the circumferential surface of the plate cylinder) to the plate cylinder, while saving manufacturing cost. In this context, it should be noted that, in use, suction openings in central portions of a plate cylinder are more likely to face a flexographic printing plates than suction openings in peripheral portions of the plate cylinder.

[0020] Preferably, the above-described plate cylinder is provided with a flexographic printing plate on its outer circumferential surface. In this case, either the flexographic printing plate comprises a permanently magnetic component, and each of the valves comprises at least one actuator having a ferromagnetic component, or, the flexographic printing plate comprises a ferromagnetic component, and each of the valves comprises at least one actuator having a permanently magnetic component. Both of these arrangements are advantageous in that the flexographic printing plate is configured to actuate the valves such that only the valves facing the printing plate are enabled to communicate with the vacuum source.

[0021] Preferably, the flexographic printing plate provided with the above-described plate cylinder comprises an attaching surface configured to be attached to the

circumferential surface of the plate cylinder, wherein the permanently magnetic component or the ferromagnetic component, respectively is homogeneously distributed over the entire attaching surface of the flexographic printing plate. For example, permanently magnetic spheres such as neodymian spheres having a diameter of 0,1 mm or lower, or spheres made of ferritic steel having a diameter of 0,1 mm or lower, may be provided and equally distributed on the lower surface of the flexographic printing plate. The density of these spheres may, e.g., be 10 spheres/cm^2, 1.000 spheres/cm^2 or 100.000 spheres/cm^2. Alternatively or additionally, the permanently magnetic component or the ferromagnetic component (e.g., the above-mentioned spheres) may be compounded into the material of the flexographic printing plate, thereby obtaining a volumetric distribution thereof.

[0022] The above-mentioned homogeneous distribution of the permanently magnetic component or the ferromagnetic component, respectively, may be associated with the advantage of an increased reliability with respect to the opening performance of the valves. Also, varying the position of the flexographic printing plate with respect to the plate cylinder does not negatively affect the opening performance of the valves.

[0023] The present disclosure further provides a plate cylinder for flexographic printing, preferably one of the above-described plate cylinders. The plate cylinder comprises: a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction, a vacuum source accommodated in the plate cylinder and configured to communicate with the plurality of suction openings, and a rotary feed-through-unit configured to supply electrical current and/or a chemical component to the vacuum source. Preferably, the rotary feed-through unit is also configured to admit transfer of control and/or measurement signals.

[0024] Accommodating the vacuum source in the plate cylinder may be desirable in view energy consumption. That is, if electrical current and/or a chemical component is transferred via a rotary feed-through-unit instead of air (which is volatile and challenging to transfer via a rotary feed-through without leakage), the efficiency ratio of the plate cylinder (and particularly the efficiency of the rotary feed-through-unit) may be increased.

[0025] Preferably, the rotary feed-through-unit of the above-described plate cylinder is a brushless unit configured to transfer energy via induction. The absence of brushes (which is enabled by utilizing the principle of inductive energy transfer) is advantageous because brush-related wear phenomena are avoided.

[0026] The present disclosure further provides a plate cylinder for flexographic printing, preferably one of the above-described plate cylinders. The plate cylinder comprises a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction. The plate cylinder is configured to, in a state in which each of the suction openings is covered by a flexographic printing plate, hold initially applied vacuum inside the suction openings even in absence of continuous suction of a vacuum source, thereby fastening the flexographic printing plate to the plate cylinder.

[0027] The above-described arrangement advantageously allows a flexographic printing plate to be fastened to the plate cylinder for a long period of time, thereby simultaneously facilitating a rather simple and cheap layout.

[0028] The above-described plate cylinder preferably comprises a vacuum reservoir configured to communicate with the plurality of suction openings. The reservoir occupies at least 30% of the plate cylinder's volume. More preferably, the reservoir occupies at least 50 % of the plate cylinder's volume. Most preferably, the reservoir occupies at least 90% of the plate cylinder's volume. The plate cylinder's volume is defined to correspond to the volume of fluid which is being displaced if the plate cylinder is fully immersed in a container of fluid (in a state in which all openings are blocked and in which no flexographic printing plate is attached thereto).

[0029] A reservoir as described above advantageously promotes upholding a high degree of vacuum inside the suction openings, even if a small amount of air (accidentally) permeates into portions of the plate cylinder having vacuum.

[0030] Preferably, the above-described plate cylinder comprises a connector configured to be reversibly connected to a vacuum source in order to establish fluidic communication between the vacuum source and the suction openings. The fluidic connection is preferably established via the reservoir. The connector is configured to prohibit gas-flow therethrough when it is not connected to the vacuum source. Examples for such a connector comprise a check valve, such as a ball check valve, a solenoid valve, or a ball tap.

[0031] The present disclosure further provides a plate cylinder for flexographic printing, preferably the plate cylinder as described above. In this plate cylinder, a first portion of the outer circumferential surface of the plate cylinder comprises suction openings for attaching opposite edges of a flexographic printing plate thereon via suction, said suction openings being configured to communicate with a vacuum source. A second portion of the outer circumferential surface of the plate cylinder comprises no suction openings. The second portion occupies, in a circumferential direction of the plate cylinder, at least 60%, preferably at least 75% and more preferably at least 90% of the circumferential surface of the plate cylinder, and, in longitudinal direction of the plate cylinder, at least 80%, but preferably 100% of the circumferential surface of the plate cylinder.

[0032] In other words, the suction openings of the plate cylinder are arranged on the cylinder so that they are covered by the two circumferential ends of a flexographic printing plate. As a result, the flexographic printing plate is mounted at its circumferential ends to the printing plate

with the two ends being in contact with the plate cylinder.

[0033] Preferably, the above-described plate cylinder comprises exactly two suction openings, said openings being elongated openings, wherein both openings are arranged such that the longer sides thereof are oriented in a longitudinal direction of the plate cylinder, and wherein the distance between the openings in a circumferential direction is less than 50%, preferably less than 20% and more preferably less than 10% of the plate cylinder's outer circumferential length. The elongated openings may extend, in a longitudinal direction of the plate cylinder, along more than 60%, preferably more than 80% and most preferably along more than 90% of the outer circumferential surface of the plate cylinder.

[0034] In a modification of the above-described plate cylinder, exactly three, four, five, six, eight, or any other number of preferably elongated openings below 30 may be provided instead of exactly two elongated openings.

[0035] The above-described plate cylinders allow for attaching a flexographic printing plate thereon by fixing, in a circumferential direction, only two opposite end portions thereof via suction. Hence, a low number of suction openings is required, and manufacturing costs of the plate cylinder may be reduced. Further, a lower number of suction openings requires less power and capacity for the suction source that provides the vacuum.

[0036] The present disclosure further provides a method for attaching a flexographic printing plate onto one of the plate cylinders described above. The method comprises the steps: attaching a vacuum source to the connector; depositing a flexographic printing plate onto the outer circumferential surface of the plate cylinder, the flexographic printing plate thereby sealing the plurality of suction openings; and detaching the vacuum source from the connector, thereby trapping the vacuum in a volume provided by the channel between the openings and the check valve such that the flexographic printing plate is attached to the plate cylinder. The advantages which may be associated with this method correspond to the advantages described in the context of the respective plate cylinder.

[0037] The present disclosure further provides a method for detaching a flexographic printing plate from a plate cylinder. The flexographic printing plate used in this method is flexible, comprises polymeric resin and is configured to be reversibly attached to the plate cylinder by means of adhesive bonding. The plate cylinder comprises a plurality of openings on a circumferential surface thereof. The openings communicate with a fluid source configured to provide pressurized fluid to said openings. The method comprises the steps: in the state of a flexographic printing plate being attached to the plate cylinder, providing pressurized fluid, preferably pressurized gas, to at least one of said openings; and detaching the flexographic printing plate from the plate cylinder. Preferably, the step of providing pressurized fluid to at least one of said openings is being terminated as soon the pressure in at least one of the openings drops.

[0038] The above-described method advantageously supports detaching the flexographic printing plate from the plate cylinder. Thereby, damage of the flexographic printing plate due to an increased detaching force may be avoided.

[0039] Preferably, during the step of providing pressurized fluid to at least one of said openings, pressurized fluid is provided only to openings provided in portions of the plate cylinder which correspond to peripheral portions of the flexographic printing plate. This variant of the method is particularly advantageous, because the process of manually detaching a flexographic printing plate from a plate cylinder is commonly started in peripheral portions of the flexographic printing plate.

[0040] Preferably, during the step of providing pressurized fluid to at least one of said openings, the pressure of the pressurized fluid is being steadily increased. Thereby, it may be possible to determine a specific amount of pressure which is high enough for promoting the detaching process, but low enough such that the flexographic printing plate is not being harmed.

[0041] The fluid used in the above-described method may comprise or exclusively consist of a gas, preferably N2, CO2 or a noble gas, configured to preserve bonding capacity of the plate cylinder and/or of the flexographic printing plate.

[0042] The above-described plate cylinders may be configured to simultaneously serve as printing cylinders (i.e., to replace the printing cylinder). Alternatively, the respective plate cylinders may be hollow cylinders configured to serve as an intermediate sleeve disposable between a printing cylinder and a flexographic printing plate.

BRIEF DESCRIPTION OF DRAWINGS

[0043]

Fig. 1a depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 1b depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 2a depicts the displacement of a flexographic printing plate resulting from a relatively large diameter of suction openings;

Fig. 2b depicts the displacement of a flexographic printing plate resulting from a relatively small diameter of suction openings;

Fig. 3 depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 4 depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 5 depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 6 depicts a picture rasterized as dots in preparation for flexographic printing.

Fig. 7 depicts an enlarged view of a relief of a flexographic printing plate.

Fig. 8a depicts an embodiment of a plate cylinder for flexographic printing;

Fig. 8b depicts an embodiment of a plate cylinder for flexographic printing;

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0044] Embodiments of the invention will hereinafter be explained in detail, by way of nonlimiting example only, with reference to the accompanying drawings. Like reference signs appearing in different figures denote identical, corresponding or functionally similar elements, unless indicated otherwise.

[0045] An embodiment of a plate cylinder 10 for flexographic printing in accordance with the present disclosure is depicted in Fig. 1a. Another embodiment of the plate cylinder 10 for flexographic printing in accordance with the present disclosure is depicted in Fig. 1b. The plate cylinder 10 of the embodiment depicted in Fig. 1a is configured to simultaneously serve as printing cylinder (i.e., to replace the printing cylinder). The plate cylinder 10 of the embodiment depicted in Fig. 1b is a hollow cylinder configured to serve as an intermediate sleeve disposable between a printing cylinder and a flexographic printing plate 20. Both the plate cylinder 10 depicted in Fig. 1a and the plate cylinder 10 depicted in Fig. 1b comprise a plurality of suction openings 40 provided on the outer circumferential surface 30 of the plate cylinder 10 for attaching a flexographic printing plate 20 thereon via suction. The suction openings 40 are configured to communicate with a vacuum source 70 which is not displayed. The number of suction openings 40 equals or exceeds 10.000. The cross-sectional area of each suction opening is equal to or below 1 mm^2. It is noted that, in favour of visibility, Fig. 1a and Fig. 1b represent simplified images showing fewer suction openings 40. Further, the cross-sectional areas of the respective suction openings 40 are not to scale.

[0046] In the embodiments depicted in Fig. 1a and Fig. 1b, respectively, at least some of the plurality of suction openings 40 are equipped with magnetically operable, normally closed valves 100 (not shown). The valves 100 are configured to be brought into an opened state by bringing a ferromagnetic component 110 or a permanently magnetic component, respectively in close proximity thereof. The flexographic printing plate 20 attached to the plate cylinder comprises a permanently magnetic component or a ferromagnetic component 110, respectively. Hence, the suction openings 40 which are covered by the flexographic printing plate 20 are provided with vacuum. The suction openings 40 which are not covered by the flexographic printing plate 20 remain, however, in a closed state.

[0047] The plate cylinders 10 of the embodiments depicted in Fig. 1a and Fig. 1b, respectively are configured to hold initially applied vacuum inside the suction openings 40 in absence of continuous suction, thereby fastening the flexographic printing plate. For this purpose, the plate cylinders 10 are provided with connectors 50 configured to be reversibly connected to a vacuum source 70 (not shown) in order to establish communication between the vacuum source 70 and the suction openings 40. Each of the connectors 40 is configured to substantially prohibit gas-flow therethrough as long as it is not connected to the vacuum source 70.

[0048] Fig. 2a depicts the displacement of a flexographic printing plate 20 resulting from a relatively large diameter of suction openings 40. Fig. 2b depicts the displacement of a flexographic printing plate 20 resulting from a relatively small diameter of suction openings 40. In both cases, the flexographic printing plate 20 is attached to an outer circumferential surface 30 of the plate cylinder 10. As becomes apparent from Fig. 2a, a relatively large diameter of suction openings (resulting in a relatively large cross-sectional area thereof) leads to the presence of dents in the flexographic printing plate 20 which have a relatively large depth d. It is noted that the manifestation of dents may be associated with the large cross-sectional area of the suction holes 40 on one hand, and with the flexibility of the material used for flexographic printing plates 40 on the other hand. Hence, as depicted in Fig. 2b, a rather small cross-sectional area of the suction holes 40 (resulting from a relatively small diameter thereof) leads to the presence of dents having a significantly lower depth d. Therefore, the outer circumferential surface of the flexographic printing plate 20, which comprises the printing relief, has a more constant radius. A more constant radius, again, leads to constant printing pressure. Thus, a more accurate printing result may be achieved.

[0049] Fig. 3 depicts an embodiment of a plate cylinder 10 for flexographic printing comprising a plurality of suction openings 40 provided on its outer circumferential surface 30 for attaching a flexographic printing plate 20 thereon via suction. The plate cylinder 10 further comprises a vacuum source 70 accommodated in the plate cylinder 10 and configured to communicate with the plurality of suction opening 40. The plate cylinder 10 further comprises a rotary feed-through-unit 80a,80b configured to supply electrical current to the vacuum source 70. The rotary feed-through-unit 80a, 80b is a brushless unit configured to transfer energy via induction. The rotary feed-through-unit 80a,80b comprises an inductive energy receiving member 80a, and an inductive energy providing member 80b. The inductive energy receiving member

80a is provided inside the plate cylinder 10 and is configured to receive electrical current from the inductive energy providing member 80b. The inductive energy receiving member 80a is electrically connected to the vacuum source 70 accommodated in the plate cylinder 10 via connection wiring 71. The inductive energy receiving member 80a may be a coil or like. Likewise, the inductive energy providing member 80b may be a coil or the like. The inductive energy providing member 80b is electrically connected to an energy source 81. The energy source 81 is configured to provide electrical energy. Preferably, the electrical energy source 81 is configured to provide alternating current. The plate cylinder 10 depicted in Fig 3 is configured to hold initially applied vacuum inside the suction openings 40 also in absence of continuous suction by a vacuum source 70, thereby fastening the flexographic printing plate 20 to the plate cylinder 10. The plate cylinder 10 of Fig. 3 further comprises a vacuum reservoir 90 configured to communicate with the plurality of suction openings 40. In the embodiment depicted in Fig. 4, the vacuum reservoir 90 occupies at least 70% of the plate cylinder's 10 volume. The plate cylinder 10 further comprises a connector 50 configured to be reversibly connected to a vacuum source 70 (not displayed) in order to establish communication between the vacuum source and the suction openings via the reservoir. The connector 50 is configured to prohibit gas-flow therethrough as long as it is not connected to the vacuum source 70.

[0050] Fig. 4 depicts an embodiment of a plate cylinder 10 for flexographic printing comprising a plurality of suction openings 40 provided on its outer circumferential surface 30 for attaching a flexographic printing plate 20 thereon via suction. The plate cylinder 10 depicted in Fig 4 is configured to hold initially applied vacuum inside the suction openings 40 also in absence of continuous suction by a vacuum source 70, thereby fastening the flexographic printing plate 20 to the plate cylinder 10. The plate cylinder 10 of Fig. 4 further comprises a vacuum reservoir 90 configured to communicate with the plurality of suction openings 40. In the embodiment depicted in Fig. 4, the vacuum reservoir 90 occupies at least 70% of the plate cylinder's 10 volume. The plate cylinder 10 further comprises a connector 50 configured to be reversibly connected to a vacuum source 70 (not displayed) in order to establish communication between the vacuum source and the suction openings via the reservoir. The connector 50 is configured to prohibit gas-flow therethrough as long as it is not connected to the vacuum source 70.

[0051] Fig. 5 depicts an embodiment of a plate cylinder 10 for flexographic printing. The plate cylinder 10 of the embodiment depicted in Fig. 5 comprises a plurality of suction openings 40 provided on its outer circumferential surface 30 for attaching a flexographic printing plate 20 thereon via suction. The suction openings 40 are configured to communicate with a vacuum source 70 (not displayed). Some of the plurality of suction openings 40 are equipped with magnetically operable, normally closed valves 100,100'. The valves 100, 100' are configured to be brought into an opened state by bringing a ferromagnetic material in close proximity thereof. The flexographic printing plate 20 provided on the outer circumferential surface 30 of the plate cylinder 10 comprises a ferromagnetic component 110. Each of the valves 100, 100' comprises at least one actuator 101 having a permanently magnetic component. In the embodiment of Fig. 5, the actuator is a ball 101 which is pre-stressed by a resilient element 102 in a closed state. Reference sign 100 depicts a valve 100 which is in a closed state because no ferromagnetic material 110 has been brought in close proximity of the actuator 101. Reference sign 100', however, depicts a valve which is in an open state, because a ferromagnetic component comprised by the flexographic printing plate 20 has been brought into close proximity thereof. In the embodiment depicted in Fig. 5, the flexographic printing plate 20 comprises an attaching surface configured to be attached to the circumferential surface 30 of the plate cylinder 10. The permanently magnetic component 110 is homogeneously distributed over the entire attaching surface of the flexographic printing plate 20.

[0052] Fig. 8a depicts another embodiment of a plate cylinder 40 for flexographic printing in accordance with the present disclosure. In the plate cylinder 40, a first portion of the outer circumferential surface 30 of the plate cylinder comprises suction openings 10 for attaching opposite edges of a flexographic printing plate 20 thereon via suction. In the depicted embodiment, six suction openings 10 are provided, three of which are arranged along the longitudinal direction of the plate cylinder 40, respectively. Preferably, the respective three suction openings 10 are equally spaced from each other. In other words, two rows of suction openings 10 are provided, each row for mounting one circumferential end of a printing plate. Preferably, the rows are oriented in a longitudinal direction of the plate cylinder 40. In the depicted first embodiment, the circumferential distance between the two rows of suction openings 10 is less than 20% of the outer circumferential length of the plate cylinder 40.

[0053] The suction openings 10 are configured to communicate with a vacuum source (not displayed). As depicted in Fig. 8a, a connector 50 having a check valve may be provided, yet such a connector is optional. In the depicted embodiment, a second portion of the outer circumferential surface of the plate cylinder comprises no suction openings. In the depicted embodiment, the second portion occupies, in a circumferential direction of the plate cylinder, about 90% of the circumferential surface of the plate cylinder, and, in a longitudinal direction of the plate cylinder, 100% of the circumferential surface of the plate cylinder. However, any other ratio of coverage listed above is applicable.

[0054] Fig. 8b depicts another embodiment of a plate cylinder 40 for flexographic printing in accordance with the present disclosure. The plate cylinder 40 depicted in Fig. 8b comprises exactly two elongated suction openings 10. Both of these elongated suction openings 10 are

arranged such that the longer sides thereof are oriented in a longitudinal direction of the plate cylinder 40. The distance between the openings in a circumferential direction is less than 20% of the outer circumferential length of the plate cylinder 40. The elongated suction openings 10 extend, in a longitudinal direction of the plate cylinder 40, along more than 80% of the outer circumferential surface of the plate cylinder 40. As depicted in Fig. 8b, a connector 50 having a check valve may be provided, yet such a connector is optional.

[0055] While various example embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example and are not to be understood as a limitation. It will be apparent to persons skilled in the relevant art(s) that various changes in form and detail can be made therein. Thus, the present disclosure should not be limited by any of the above described exemplary embodiments but should be defined only in accordance with the following claims and their equivalents.

[0056] Further, the purpose of the Abstract is to enable the Patent Office and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The Abstract is not intended to be limiting as to the scope of the example embodiments presented herein in any way. It is also to be understood that any procedures recited in the claims need not be performed in the order presented.

[0057] While this specification contains specific embodiment details, these should not be construed as limitations on the scope of any disclosures or of what may be claimed, but rather as descriptions of features specific to particular embodiments described herein. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[0058] Having now described some illustrative embodiments and embodiments, it is apparent that the foregoing is illustrative and not limiting, having been presented by way of example.

[0059] The devices and methods described herein may be embodied in other specific forms without departing from the characteristics thereof. The foregoing embodiments are illustrative rather than limiting of the described systems and methods. Scope of the apparatuses and methods described herein is thus indicated by the appended claims, rather than the foregoing description, and changes that come within the meaning and range of equivalence of the claims are embraced therein.

Claims

1. Plate cylinder for flexographic printing,
wherein a first portion of the outer circumferential surface of the plate cylinder comprises suction openings for attaching opposite edges of a flexographic printing plate thereon via suction, said suction openings being configured to communicate with a vacuum source,
wherein a second portion of the outer circumferential surface of the plate cylinder comprises no suction openings, said second portion occupying, in a circumferential direction of the plate cylinder, at least 60%, preferably at least 75% and more preferably at least 90% of the circumferential surface of the plate cylinder, and, in a longitudinal direction of the plate cylinder, at least 80%, preferably 100% of the circumferential surface of the plate cylinder.

2. The plate cylinder of claim 1, comprising exactly two suction openings, said openings being elongated openings,
wherein both openings are arranged such that the longer sides thereof are oriented in a longitudinal direction of the plate cylinder, and
wherein the distance between the openings in a circumferential direction is less than 50%, preferably less than 20% and more preferably less than 10% of the plate cylinder's outer circumferential length.

3. Plate cylinder for flexographic printing, preferably the plate cylinder of one of the preceding claims, comprising a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction, said suction openings being configured to communicate with a vacuum source,
wherein the number of said suction openings equals or exceeds 10.000, and
wherein the cross-sectional area of each suction opening is equal to or below 1 mm^2.

4. Plate cylinder for flexographic printing, preferably the plate cylinder of one of the preceding claims, the plate cylinder comprising a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction, said suction openings being configured to communicate with a vacuum source,
wherein at least some of the plurality of suction openings are equipped with magnetically operable, normally closed valves, said valves being configured to be brought into an opened state by bringing a ferro-

magnetic material or a permanently magnetic material in close proximity thereof.

5. The plate cylinder of claim 4, wherein suction openings provided in peripheral portions of the plate cylinder are equipped with said magnetically operable, normally closed valves, and
wherein suction openings provided in central portions of the plate cylinder are not equipped with such valves.

6. The plate cylinder of claim 4 or 5, further being provided with a flexographic printing plate on its outer circumferential surface,
wherein said flexographic printing plate comprises a permanently magnetic component, and
wherein each of the valves comprises at least one actuator having a ferromagnetic component.

7. The plate cylinder of claim 6, wherein the flexographic printing plate comprises an attaching surface configured to be attached to the circumferential surface of the plate cylinder, and
wherein the permanently magnetic component is homogeneously distributed over the entire attaching surface of the flexographic printing plate.

8. The plate cylinder of claim 4 or 5, said plate cylinder being provided with a flexographic printing plate on its outer circumferential surface,
wherein said flexographic printing plate comprises a ferromagnetic component, and
wherein each of the valves comprises at least one actuator having a permanently magnetic component.

9. The plate cylinder of claim 8, wherein the flexographic printing plate comprises an attaching surface configured to be attached to the circumferential surface of the plate cylinder, and
wherein the ferromagnetic component is homogeneously distributed over the entire attaching surface of the flexographic printing plate.

10. Plate cylinder for flexographic printing, preferably the plate cylinder of one of the preceding claims, said plate cylinder comprising
a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction,
a vacuum source accommodated in the plate cylinder and configured to communicate with the plurality of suction openings, and
a rotary feed-through-unit configured to supply electrical current and/or a chemical component to the vacuum source.

11. The plate cylinder of claim 10, wherein the rotary feed-through-unit is a brushless unit configured to transfer energy via induction.

12. Plate cylinder for flexographic printing, preferably the plate cylinder of one of the preceding claims, the plate cylinder comprising
a plurality of suction openings provided on its outer circumferential surface for attaching a flexographic printing plate thereon via suction,
wherein, in a state in which each of the suction openings is covered by a flexographic printing plate, the plate cylinder is configured to hold initially applied vacuum inside the suction openings in absence of continuous suction, thereby fastening the flexographic printing plate.

13. The plate cylinder of claim 12, further comprising a vacuum reservoir configured to communicate with the plurality of suction openings,
wherein the reservoir occupies at least 30% of the plate cylinder's volume.

14. The plate cylinder of claim 12 or 13, further comprising a connector configured to be reversibly connected to a vacuum source in order to establish communication between the vacuum source and the suction openings, preferably via the reservoir,
wherein the connector is further configured to prohibit gas-flow therethrough as long as it is not connected to the vacuum source.

15. Method for attaching a flexographic printing plate onto the plate cylinder of one of the preceding claims, the method comprising:

attaching a vacuum source to the connector;
depositing a flexographic printing plate onto the outer circumferential surface of the plate cylinder, the flexographic printing plate thereby sealing the plurality of suction openings;
detaching the vacuum source from the connector, thereby trapping the vacuum in a volume provided by the channel between the openings and the check valve such that the flexographic printing plate is attached to the plate cylinder.

16. Method for detaching a flexographic printing plate from a plate cylinder, preferably from the plate cylinder of one of the preceding claims, the flexographic printing plate being flexible, comprising polymeric resin and being configured to be reversibly attached to the plate cylinder by means of adhesive bonding, wherein the plate cylinder comprises a plurality of openings on a circumferential surface thereof, said openings communicating with a fluid source configured to provide pressurized fluid to said openings, the method comprising:

in the state of a flexographic printing plate being attached to the plate cylinder, providing pressurized fluid, preferably pressurized gas, to at least one of said openings; and
detaching the flexographic printing plate from the plate cylinder.

17. The method of claim 16, wherein, during the step of providing pressurized fluid to at least one of said openings, pressurized fluid is provided only to openings provided in portions of the plate cylinder which correspond to peripheral portions of the flexographic printing plate.

18. The method of one of claims 16 or 17, wherein, during the step of providing pressurized fluid to at least one of said openings, the pressure of the pressurized fluid is being steadily increased.

19. The method of claim 18, wherein the step of providing pressurized fluid to at least one of said openings is being terminated as soon the pressure in at least one of the openings drops.

20. the method of one of claims 16 to 19, wherein the fluid comprises a gas, preferably N2, CO2 or a noble gas, configured to preserve bonding capacity of the plate cylinder and/or of the flexographic printing plate.

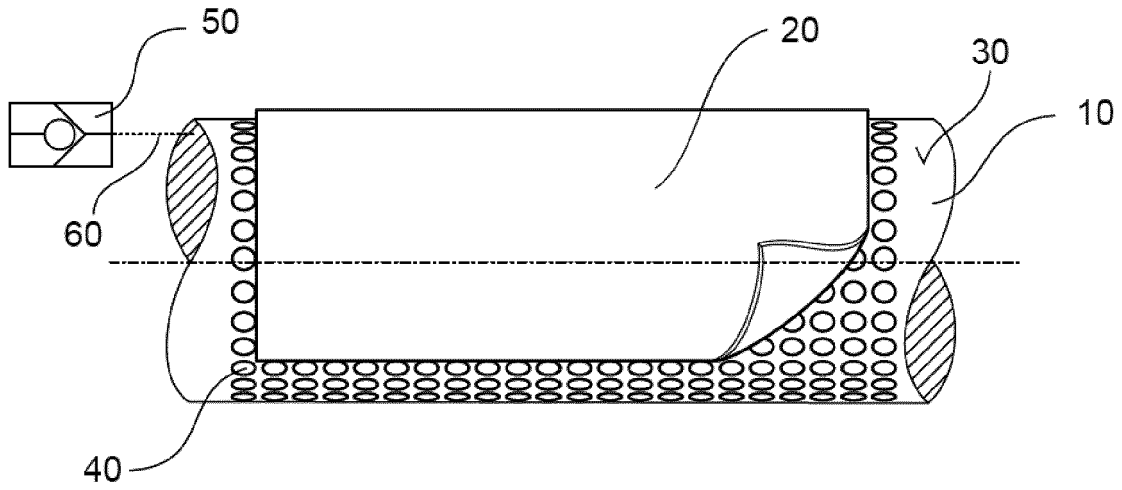

Fig.1a

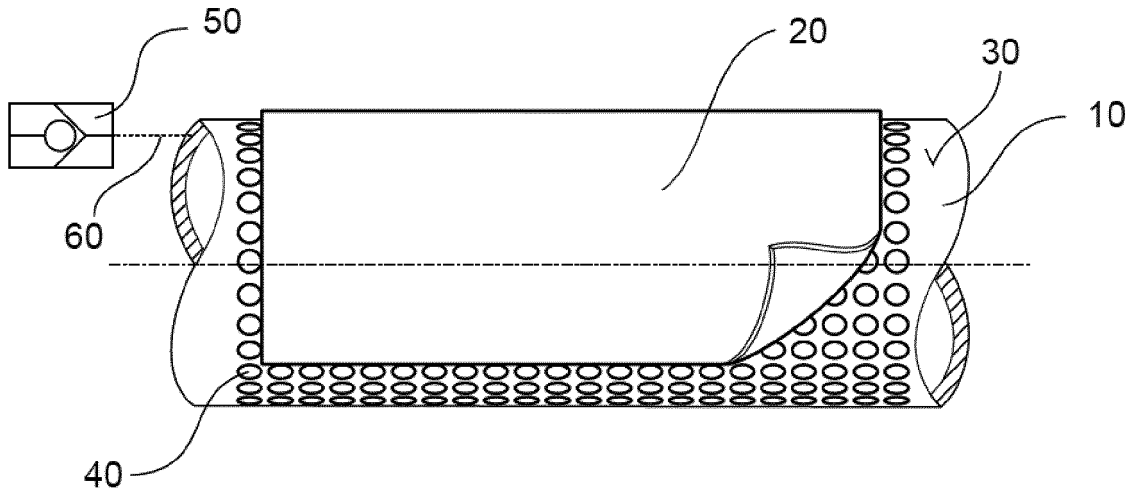

Fig.1b

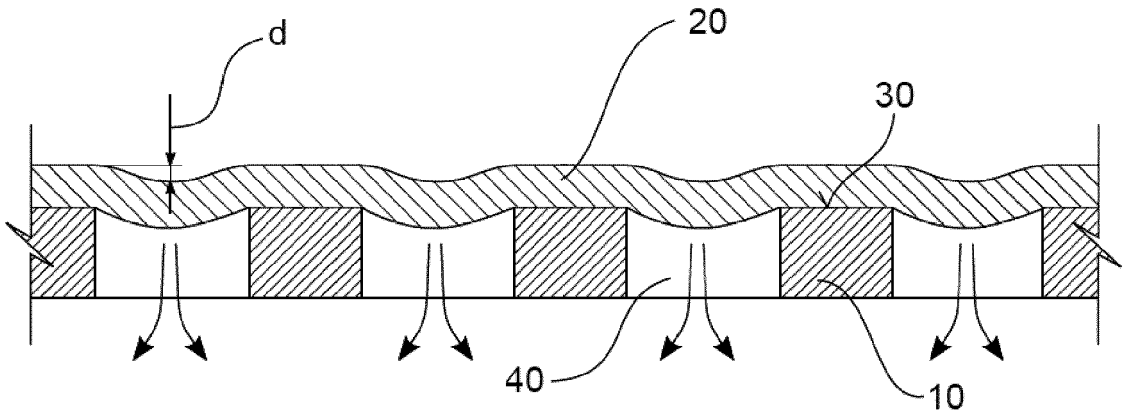

Fig.2a

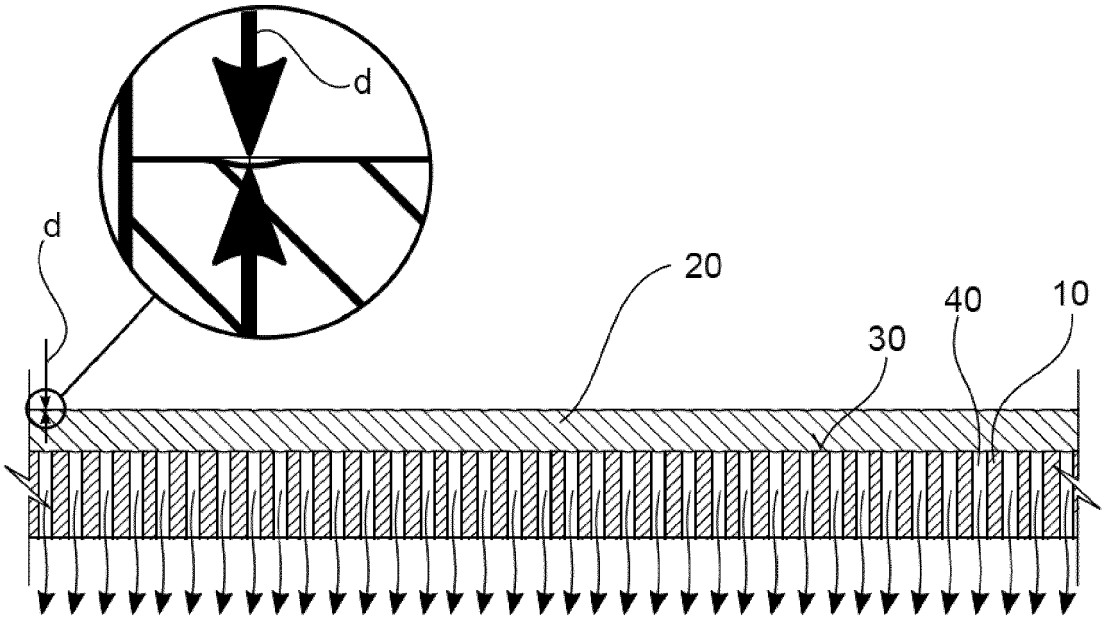

Fig.2b

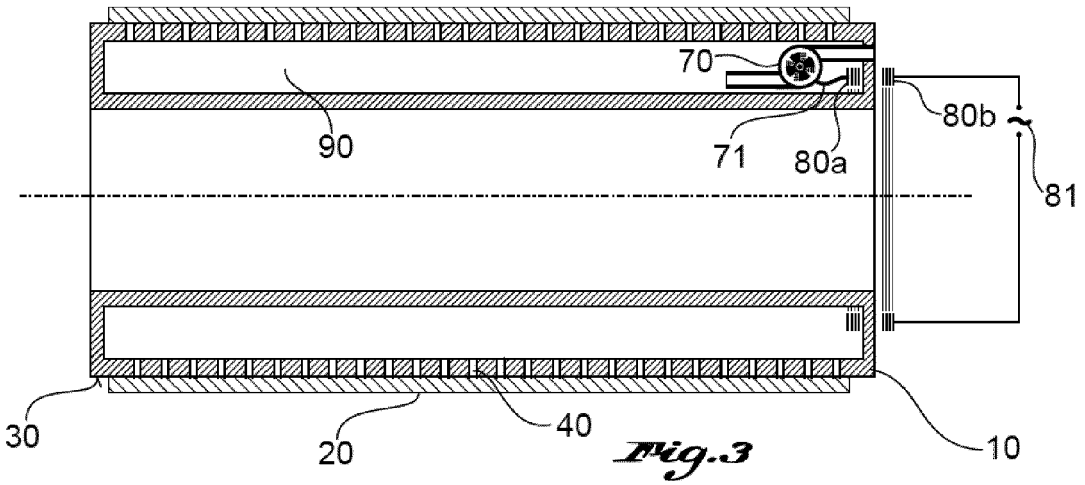

Fig.3

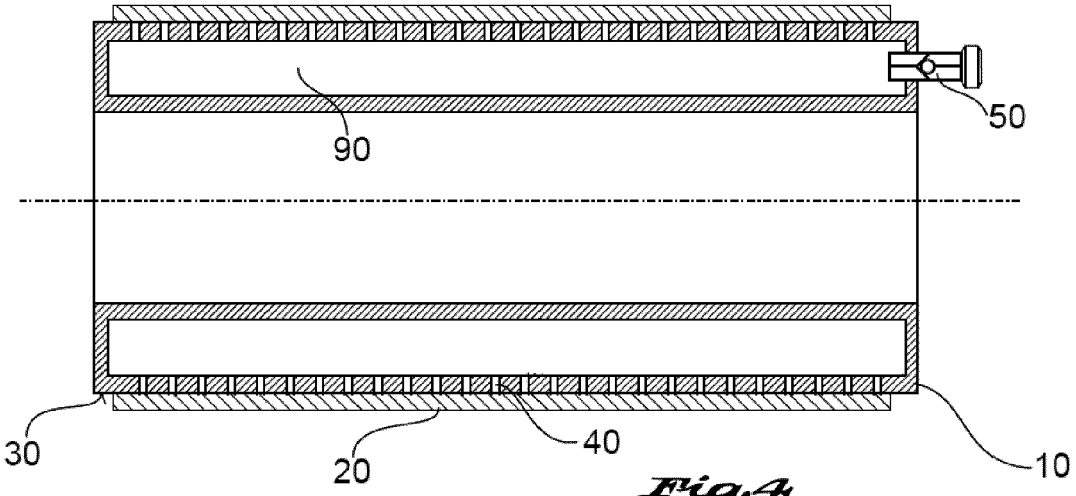

Fig.4

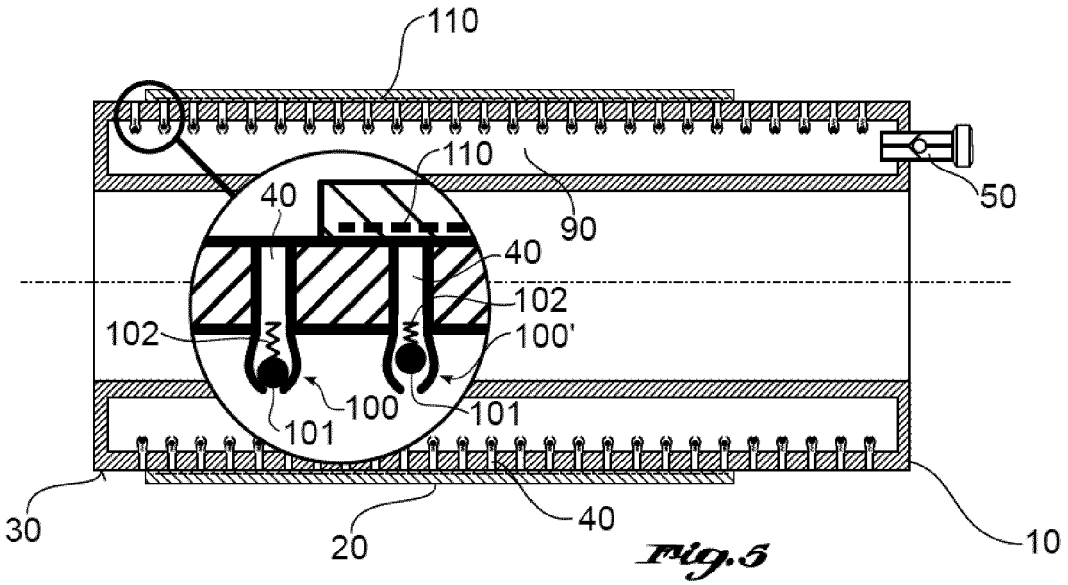

Fig.5

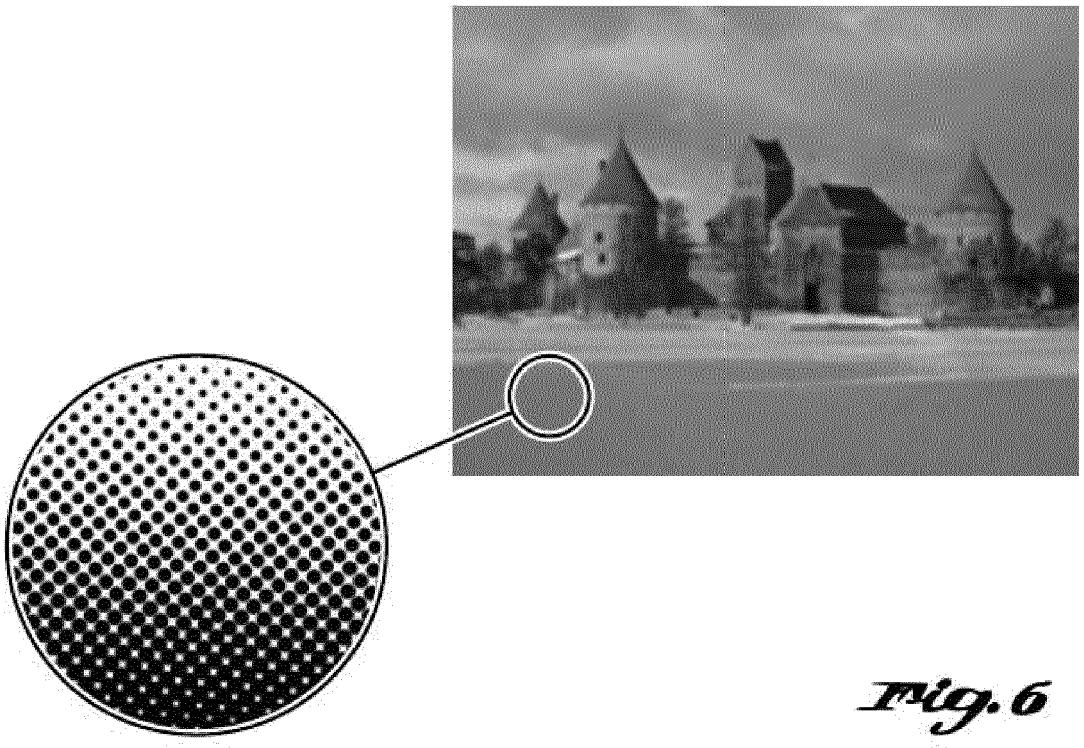

Fig. 6

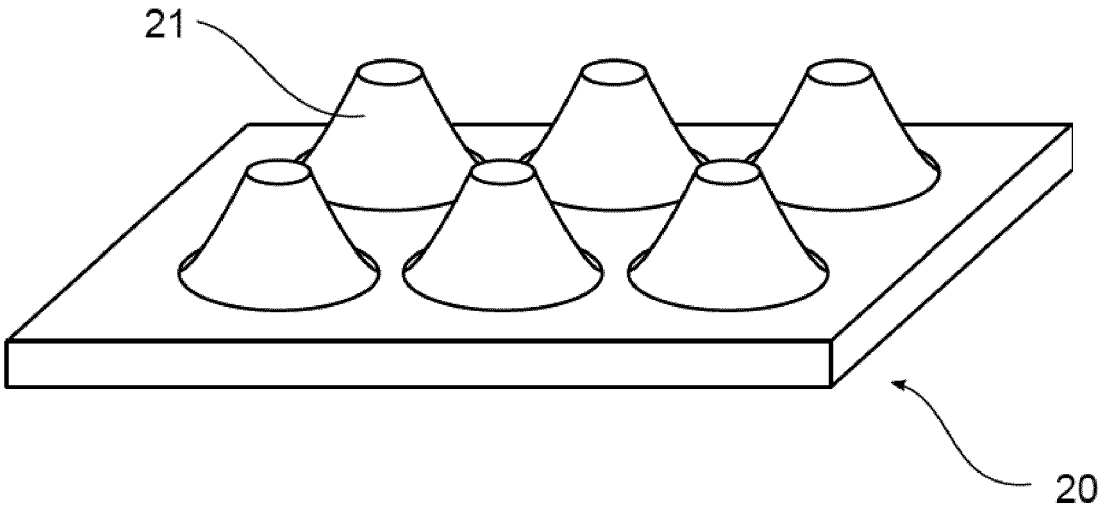

Fig. 7

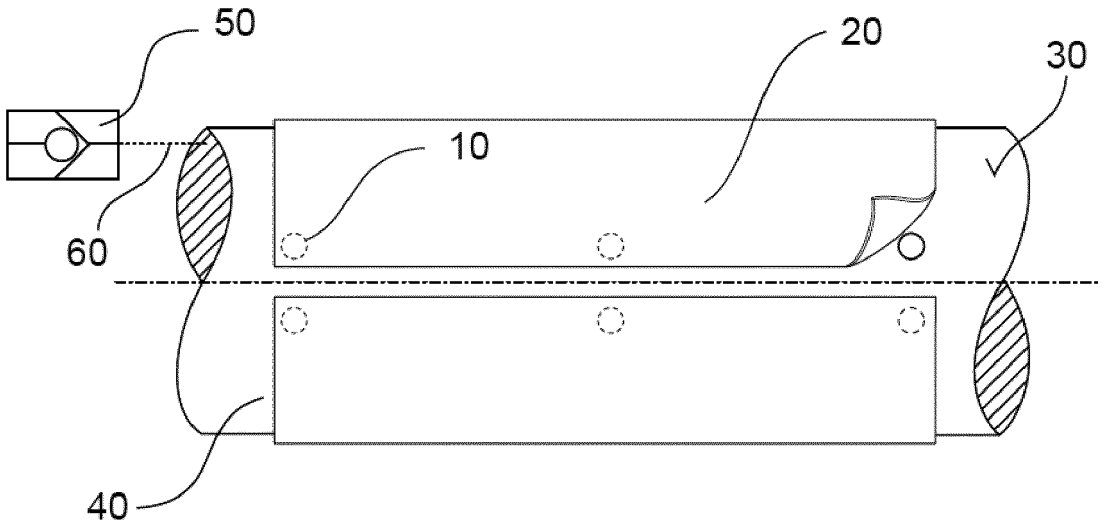

Fig. 8a

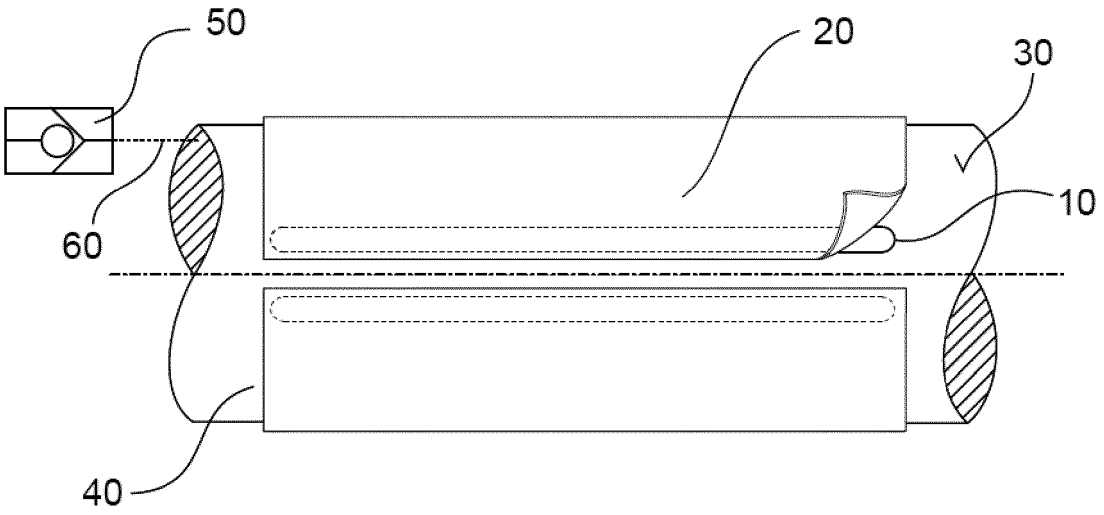

Fig. 8b

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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 4639

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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
Munich	24 June 2020	Bellofiore, Vincenzo

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 4639

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 June 2020	Bellofiore, Vincenzo

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Application Number
EP 19 19 4639

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 19 19 4639

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-3

   Plate cylinder for flexographic printing with an improved arrangement of suction openings.

   ---

2. claims: 4-9

   Plate cylinder for flexographic printing comprising suction openings provided with magnetically operable valves.

   ---

3. claims: 10, 11

   Plate cylinder for flexographic printing provided with means for supplying electrical current and/or a chemical component to a vacuum source.

   ---

4. claims: 12-15

   Plate cylinder for flexographic printing provided with means for discontinuous suction and method for attaching a flexographic printing plate onto the plate cylinder.

   ---

5. claims: 16-20

   Method for detaching a flexographic printing plate reversibly attached to a plate cylinder by means of an adhesive.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 19 4639

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