Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 2948489 C 2018/08/21

(11)(21) 2 948 489

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2010/12/21

(41) Mise à la disp. pub./Open to Public Insp.: 2011/06/30

(45) Date de délivrance/Issue Date: 2018/08/21

(62) Demande originale/Original Application: 2 785 011

(30) Priorité/Priority: 2009/12/21 (DE10 2009 059 790.5)

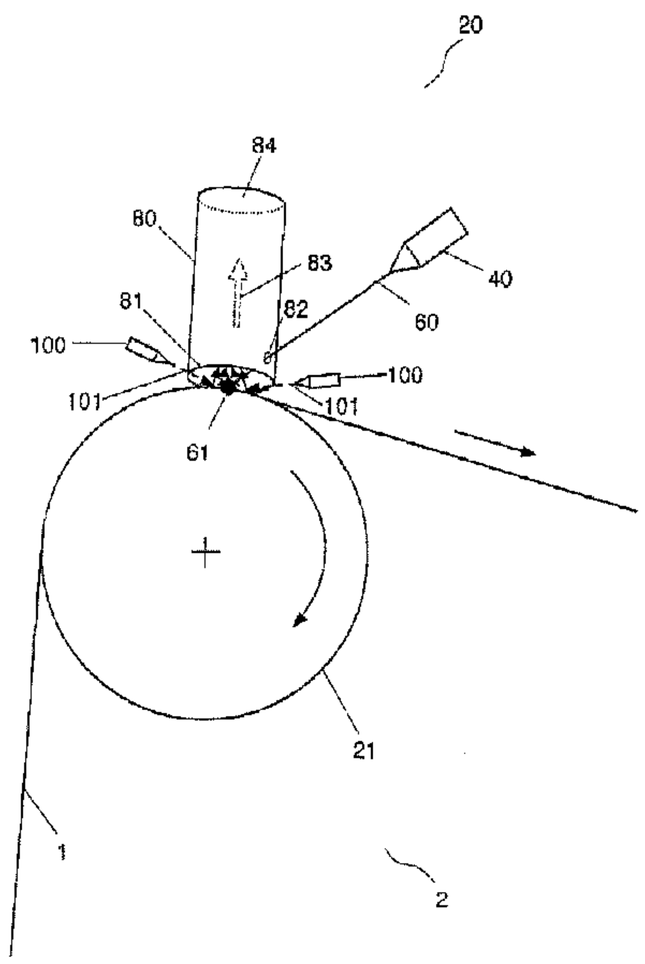
(51) Cl.Int./Int.Cl. *D21F 5/00* (2006.01),
B08B 3/02 (2006.01)

(72) Inventeur/Inventor:
CASPAR, ROMAN, CH

(73) Propriétaire/Owner:
PAPRIMA INDUSTRIES INC., CA

(74) Agent: ANGLEHART ET AL.

(54) Titre : DISPOSITIF DE NETTOYAGE
(54) Title: CLEANING APPARATUS



(57) Abrégé/Abstract:
The invention relates to an apparatus and a method for cleaning a surface, such as a running belt of a drying screen in a paper production installation. The apparatus has at least one cleaning nozzle and at least one cleaning head. The cleaning nozzle generates and directs a high-pressure liquid jet having a point of impact on the surface to be cleaned. The cleaning head has a main opening that faces toward the surface, a discharge opening and at least one device for supplying compressed air in the region of at least one point of impact of at least one high-pressure liquid jet on the surface being cleaned. The device for supplying compressed air creates a redirection of spray water from the surface toward the main opening and creates an airflow that forces the spray water toward the discharge opening. Advantageously, dirt particles are removed from the surface in a controlled manner, reducing the risk of the at least one cleaning nozzle or of the at least one cleaning head from becoming blocked by the sucked-up dirt or by dirt residues. Furthermore, the airflow created by the supplied compressed air reduces the need for suction energy to remove the dirty spray water from the surface.

ABSTRACT

The invention relates to an apparatus and a method for cleaning the running belt (1) of a drying screen in a paper production installation. The apparatus comprises at least one cleaning nozzle (40) for generating a high-pressure jet (60) of a liquid having an incidence point (61) on the running belt, at least one cleaning head (80) having a discharge opening (84) and a main opening (81) that faces towards the running belt (1), wherein the cleaning nozzle (40) is disposed outside the cleaning head (80). In the case of the method according to the invention, the running belt (1) is sprayed with at least one high-pressure jet (60) of a liquid, wherein the cleaning apparatus has a cleaning head (80), which has an interior space, a discharge opening (84), and a main opening (81) that faces towards the running belt (1).

CLEANING APPARATUS

The invention relates to an apparatus and a method for cleaning the running belt of a drying screen of a paper production installation.

Owing to increasingly faster running speeds of paper production installations, there is a requirement for increasingly more powerful cleaning apparatuses for cleaning the drying screen. These apparatuses must not malfunction, must effect highly efficient cleaning, be sparing of resources (water, energy, running-belt material), not only remove dirt particles from the belt but also take them away in a controlled manner and, in addition, dry the drying screen as rapidly as possible after the cleaning operation.

In practice, various solutions are offered for this purpose.

DE 295 17 859 U1 describes a cleaning system that cleans a conveyor belt by means of air jets or liquid jets, which are generated by fixed nozzles, wherein a dirt mist and/or water mist or residual water can be sucked in by a cleaning head (referred to therein as a "suction bell") by means of a negative pressure generated therein, and discharged. The jet nozzles are attached either within or beneath the suction chamber.

DE 693 14 805 T2 describes a cleaning apparatus that, by means of at least one nozzle located in a cleaning head (referred to therein as a "suction nozzle"), generates a liquid jet for cleaning the surface, and applies it to the surface. In addition to the negative pressure generated in the cleaning head, compressed air is supplied at the main opening of the cleaning head, such that it impinges on processing liquid deflected from the surface and on material released from the surface and, acting together with the suction effect of the cleaning head, entrains this processing liquid and material in the direction of the cleaning head.

A disadvantage of the solutions of the state of the art is that the nozzles, insofar as they are disposed within the cleaning head, risk becoming blocked by the sucked-up dirt removed from the cleaned surface. In addition, there is the risk of the cleaning head becoming blocked by the dirt residues that have been detached and sucked up, particularly if the angular nozzles or, also, only parts of the nozzles, are located in the cleaning head. Insofar as the nozzles are attached outside the cleaning head, it has been necessary to increase the distance

between the cleaning-head opening and the surface to be cleaned, in order for the jets to be incident upon the surface to be cleaned. It has been necessary either to accept the greater amount of spray water or dirt produced or to compensate this through increased use of suction energy.

The object of the present invention was to provide an apparatus and a method for cleaning a running belt of a drying screen of a paper production installation that avoid the disadvantages of the state of the art.

The object is achieved by the independent claims. Advantageous developments are defined in the dependent claims.

In particular, the object is achieved by a cleaning apparatus for cleaning the running belt of a drying screen in a paper production installation, comprising at least one cleaning nozzle for generating a high-pressure jet of a liquid having an incidence point on the running belt, at least one cleaning head having a discharge opening and a main opening that faces towards the running belt, wherein the cleaning nozzle is disposed outside the cleaning head.

The running belt is preferably the running belt of a drying screen, or the drying screen per se, and is usually of a porous, air-permeable material in which dirt and paper residues collect easily. The cleaning apparatus according to the invention is also suitable, however, for analogous applications in which a preferably moving surface is to be cleaned.

A cleaning nozzle according to the invention or, also, jet nozzle, is a nozzle that is arranged to generate a jet of a fluid, preferably a jet of a liquid. Preferably, the nozzle is at least one diamond nozzle. Preferably, the cleaning nozzle is arranged to generate a high-pressure jet. Preferably, this pressure is in the range from 250 to 600 bar, particularly preferably in the range from 350 to 560 bar. Quite particularly preferably, the pressure is 450 bar. Preferably, this liquid is water. The diameter of the nozzle opening is preferably in the range from 0.1 mm to 0.3 mm. Particularly preferably, the diameter is approximately 0.15 mm. The cleaning nozzle preferably has a connection hose, which is arranged to supply the fluid used. A high-capacity pump is preferably connected at the other end of the connection hose. Particularly preferably, the supply hose is a Teflon hose. The jet direction - and consequently also the point at which a jet generated by the

cleaning nozzle is incident on the running belt (the incidence point) - can be set. Preferably, the jet direction can be set via the mounting of the cleaning nozzle.

The alignment of a cleaning nozzle according to the invention can preferably be set via two angles. On the one hand, this is the angle W1, enclosed by the notional projection of a high-pressure jet, which can be generated by the cleaning nozzle, and the running direction of the running belt. On the other hand, this is the angle W2, enclosed by the high-pressure jet, which can be generated by the cleaning nozzle, and the surface of the running belt. Preferably, the alignment of a cleaning nozzle according to the invention can be varied, preferably electromechanically and/or hydraulically, preferably during the cleaning process.

The cleaning head is a component already similarly known from the state of the art. Cleaning heads that serve as a suction bell or suction chamber are described in DE 295 17 859 U1 and DE 693 14 805 T2. The cleaning head in this invention is not limited, as in the state of the art, to operation as a suction chamber. Through components described further below, there is also provision for operation of the cleaning head in which dirt and spray water are taken away by means of positive pressure in the interior space of the cleaning head. Preferably, the cleaning head has a round cross-section, and encloses an interior space in which substances, such as the spray water that is produced during the cleaning operation and that entrains dirt with it, and/or dirty air and/or suspended matter can be collected. Furthermore, the cleaning head preferably has a discharge opening, through which the collected substances can be taken away out of the interior space of the cleaning head, or can escape. Preferably, the cleaning head is a tube-like component. A particularly preferred disposition is that the central axis of the cleaning head is located 3-8 mm in front of the tangential line of the drying screen return roll ("dryer fabric return roll") or of any one of the drying screen rolls of the running belt in running motion. Preferably, the cleaning head is disposed perpendicularly in relation to the surface of the running belt. The cleaning head preferably has, at the discharge opening - in the case of a tube, for example at the tube end that faces away from the running belt - a connection piece, at which the cleaning head can preferably be connected to an outflow and/or negative pressure system. Preferably, the connection piece is a quick-closure system. A quick-closure system provides for rapid coupling, decoupling and exchange of the cleaning head. If it requires a repair or a thorough cleaning, it can be decoupled in a time-saving manner. Long downtimes of the cleaning apparatus, and therefore of the paper production installation, are thereby

avoided. Preferably, the cleaning head can be put together, in the manner of a telescope, from a plurality of tube segments.

The opening of the cleaning head that faces towards the running belt is the main opening. Preferably, the diameter of the cleaning head becomes larger towards the main opening. Preferably, the diameter of the main opening is in the range from 50 mm to 400 mm, particularly preferably the diameter is approximately 230 mm. The interior space between the main opening and the discharge opening preferably defines a discharge path for the collected substances. The cleaning head preferably has bends and/or curvatures between the main opening and the discharge opening, such that the discharge opening is preferably located to the side of the running belt. Preferably, the cleaning head has a sealing device at the sealing-head opening. Preferably, this sealing device is a rubber lip that matches the geometry of the opening. Preferably, the cleaning head has closable openings, or inspection openings, in its peripheral surface. Preferably, these closable openings are provided in the region of the cleaning-head end that faces away from the running belt - e.g. in the region of the tube end that faces away from the running belt - particularly preferably in the region of bends and/or curvatures of the cleaning head. The closable openings are preferably designed in such a way that the inside of the cleaning head can be cleaned from outside. The advantage is that, if a moderate blockage occurs, the cleaning head can be easily cleaned from the outside, for example by spray jets.

The apparatus according to the invention has at least one cleaning nozzle, which is attached outside the cleaning head. This cleaning nozzle is preferably located outside an airflow that is present in the interior space of the cleaning head and that, during operation, carries with it a mixture of dirt and water. The cleaning nozzle is thus protected against soiling by dirt and water of the airflow. Particularly preferably, a cleaning nozzle is disposed outside the cleaning head and outside the notional extension of the cleaning head between the main opening and the running belt. Preferably, a cleaning nozzle attached outside the cleaning head is at a greater distance from the running belt than is the main opening. Preferably, the cleaning head can be adjusted rotationally, particularly preferably translationally, relative to at least one of these cleaning nozzles present. Preferably, the distance and/or the orientation of at least one cleaning nozzle can be altered relative to the cleaning head. Preferably, at least one cleaning nozzle attached outside the cleaning head is at a minimum distance of greater than zero, preferably in the range from 0.1 mm to 500 mm, particularly

preferably 1 mm to 250 mm, quite particularly preferably 2 mm to 90 mm, furthermore quite particularly preferably 3 mm to 80 mm, furthermore quite particularly preferably 5 mm to 70 mm, and furthermore quite particularly preferably 10 mm to 60 mm, from the outer surface of the cleaning head. Particularly preferably, the nozzle opening is at this just mentioned minimum distance from the outer surface of the cleaning head. Preferably, the cleaning nozzle is disposed such that a fluid jet generated by the cleaning nozzle bridges a preferably free distance outside the cleaning head before this jet goes into the inside of the cleaning head. Preferably, the cleaning nozzle is not in direct contact with the cleaning head. Preferably, the cleaning nozzle is connected to the cleaning head, preferably solely via a mounting that preferably projects from the outer wall of the cleaning head.

Owing to the described disposition of the cleaning nozzle - including the nozzle retaining nut - outside the cleaning head, the cleaning nozzle is not exposed to an airflow present in the interior space of the cleaning head. Owing to the cleaning nozzle and, in particular, the nozzle opening being disposed outside, and not inside, the cleaning head, the path of this airflow is not blocked. There is free servicing access to the cleaning nozzles present. The nozzles also do not become blocked by the suspended matter, or dirt matter, in the air, which draws along with it, in particular, an airflow present within the cleaning head. In addition, it is thereby possible to use a cleaning head of a simple design, without internally attached mountings, cavities or screw-on bushings or similar for cleaning nozzles, on which the dirt collects. As a result, the cleaning head is easier to clean.

The cleaning head and the cleaning nozzles present - also, in the case of further embodiment examples described later, the respectively further described components - can also be used in other cleaning apparatuses. During the cleaning operation, the cleaning head, together with the components attached thereto, is preferably at a distance of 5 mm to 20 mm from the running belt. Particularly preferably, this distance is approximately 10 mm.

In a further embodiment example of the present invention, the wall of the cleaning head has at least one inlet opening, and at least one cleaning nozzle is aligned such that a high-pressure jet from the cleaning nozzle is incident upon the running belt from outside through one of the inlet openings present .

An inlet opening is, for example, a small hole, a bore, oblique bore, a gap running preferably parallel to the cleaning-head axis that is perpendicular to the plane of the running belt (for example: the tube central axis if, preferably, the cleaning head is a tube-like component), a recess or other passage, which has at least the diameter of the high-pressure jet. The diameter of such an inlet opening lies in the range of, preferably, 0.1 mm to 200 mm, particularly preferably 0.125 mm to 100 mm, quite particularly preferably 0.15 to 10 mm, furthermore quite particularly preferably 0.15 mm to 3 mm. At least one such inlet opening is located in the wall of the cleaning head. Through such an inlet opening, a high-pressure jet can be guided through into the interior space of the cleaning head from outside. The incidence point of the cleaning nozzle disposed outside the cleaning head can thus be set to a point on the running belt that is located within the contour of the projection of the geometry of the main opening onto the running belt. Without the inlet opening, such a point would be covered by the lateral wall of the cleaning head when the cleaning head is brought, with the main opening, immediately adjacent to the running belt. An inlet opening can also be covered, for example, by an adhesive tape, such that a cleaning jet then subsequently shoots a hole through the adhesive tape and, consequently, the inlet opening has a diameter that is precisely matched to the diameter of the cleaning jet.

The inlet opening makes it possible, in spite of the cleaning head being attached close to the running belt, for at least one jet to be incident upon the running belt at a point preferably located in the airflow of the cleaning head, preferably within the inner contour of the main opening of the cleaning head on the running belt that is projected onto the running belt. Dirt and waste water can thus be collected, and preferably taken away, directly at the place of origin, without there being a large gap between the main opening and the running belt, through which, on the one hand, dirt can emerge and, on the other hand, the preferably used power for generating an airflow present in the cleaning head would no longer be concentrated on the place of origin of the dirt and suspended matter (or similar). At the same time, the cleaning nozzles attached outside the cleaning head are located at a position that is protected from soiling. At the same time, this disposition provides for smaller diameters of the cleaning head and of the main opening and, consequently, a much simpler design and greater effect of an airflow, present in the cleaning head, upon the region of the incidence points of cleaning jets present. Energy savings are the positive consequence. It is furthermore advantageous that the incidence points of the high-pressure jets -

depending on the size of the inlet openings in the cleaning head - are still easily adjustable, or settable. Cleaning can even be realized by means of a swirl jet from outside the cleaning head. The entire system is flexibly adaptable to various requirements.

In a further embodiment example of the present invention, when more than one cleaning nozzle is present the cleaning nozzles are distributed around the cleaning head and are aligned such that the high-pressure jets generated by the cleaning nozzles are incident upon a region of the running belt that lies inside the notional projection of the contour of the main opening onto the running belt.

Preferably, the cleaning nozzles are distributed around the cleaning head at equal distances from one another. Particularly preferably, the cleaning nozzles are distributed around more than half the circumference of the cleaning head. Particularly preferably, three cleaning nozzles are disposed. Preferably, the number of cleaning nozzles present is equal to the number of inlet openings present. Preferably, the cleaning nozzles are aligned such that, respectively, only one cleaning nozzle is assigned to an inlet opening. Advantageously, the cleaning nozzles are aligned such that the high-pressure jets generated are incident upon the running belt from differing directions, preferably on a line parallel to the running direction of the running belt. Advantageously, the cleaning nozzles are aligned onto a small, preferably elliptical area on the running belt in the range from, preferably, 1 mm^2 to 8 mm^2, particularly preferably from 2 mm^2 to 4 mm^2, preferably in the region of the central axis of the main opening.

Thus, only a small area becomes wetted by the liquid, and the jet energy is applied in a concentrated manner. Preferably, all incidence points of the high-pressure jets are located within a circular area having a radius of preferably 5 cm, particularly preferably 16 mm, quite particularly preferably 5 mm.

Preferably, the cleaning nozzles are aligned onto points that are at a respective distance from one another of not more than 1 cm, preferably not more than 5 mm, particularly preferably not more than 3 mm, quite particularly preferably not more than 2 mm.

Since only a small region of the running belt is sprayed, only a small area of the running belt becomes wetted with liquid, and the jet energy is concentrated onto a small area. This increases the cleaning power and, at the same time, a

subsequent autonomous drying, or a drying performed by means of a drying device, can be performed more effectively, since only a small region has to be dried. An effective drying is very advantageous for a drying screen, since a drying screen that has not been dried thoroughly and uniformly can give rise to water marks in the newly produced paper web, and the quality of the paper is thereby impaired.

Preferably, in the case of three cleaning nozzles being used, the cleaning nozzles are aligned such that, preferably, the first two cleaning nozzles are opposite one another, transversely in relation to the running direction of the running belt, and are preferably aligned onto two points whose notional connecting line is preferably parallel to the running direction of the running belt and has a length in the range from preferably 0.5 mm to 3 mm, particularly preferably 1 mm to 2 mm. For the nozzles, an angle W1 is set in the range of preferably x ± 45°, particularly preferably x ± 15°, quite particularly preferably x ± 5°, wherein x=90° for one nozzle and x=270° for the nozzle opposite. The third cleaning nozzle is aligned onto a third point. Preferably, the third point is located in the running direction of the running belt, preferably after the incidence point of the first two cleaning nozzles, at a distance of preferably 0.5 mm to 3 mm, particularly preferably 1 mm to 2 mm. Preferably, W1 for the alignment of the third nozzle is 180 ± 5°, particularly preferably 180 ± 2.15°, quite particularly preferably 180 ± 0.1°. For one of the cleaning nozzles present, W2 lies, respectively, in the range from preferably 5° to 85°, particularly preferably 10° to 60°, quite particularly preferably 15° to 45°.

In a further embodiment example of the present invention, the cleaning nozzles are aligned such that the high-pressure jets have a common incidence point on the running belt.

Preferably, the high-pressure jets are aligned approximately onto a common incidence point.

In a further embodiment example of the present invention, at least one of the cleaning nozzles present is arranged to generate a laminar high-pressure jet.

In a further embodiment example of the present invention, the cleaning apparatus has a temperature control unit for controlling the temperature of the high-pressure jets.

The temperature control unit is preferably disposed in the region of the high-capacity pump. Preferably, the temperature control unit has a flow heater for controlling the temperature of the high-pressure jets.

In a further embodiment example of the present invention, the temperature control unit has a heat exchanger. In a further embodiment example of the present invention, at least one device for supplying compressed air is disposed in the region of at least one incidence point of at least one high-pressure jet on the running belt.

The device for supplying compressed air is preferably a preferably annular hollow body (torus, or "doughnut"), which preferably has a connection for a compressed-air hose, particularly preferably a duct for supplying compressed air from a compressed-air pump or compressed-air source to the hollow body. Preferably, the device for supplying compressed air is disposed at a distance of between 25 mm and 250 mm, particularly preferably between 100 mm and 130 mm from at least one incidence point. Preferably, it is disposed on the same side of the running belt on which the cleaning nozzle is disposed. Preferably, the shape of the hollow body matches the shape of the main opening of the cleaning head. The device for supplying compressed air is: preferably disposed at the main opening; preferably fastened to the main opening without a space; preferably realized in one structural unit with the cleaning head.

In a further embodiment example of the present invention, the device for supplying compressed air has at least one air-supply opening, wherein the air-supply openings are disposed such that the supplied compressed air forms an air curtain by which the liquid bouncing off the running belt is deflected in the direction of the main opening.

Air-supply openings are preferably small holes and/or gaps. Preferably, they have a diameter in the range from preferably 0.1 mm to 1.5 mm, particularly preferably 0.3 mm to 1 mm, and quite particularly preferably between 0.35 mm and 0.8 mm, particularly preferably a diameter of approximately 0.4 mm. In the case of a preferred embodiment of the device for supplying compressed air as a preferably annular hollow space, compressed air can be supplied into the hollow space via the connection that is present, and then out of the hollow space through the air-supply openings. Preferably, the air-supply openings are disposed and aligned

such that the gap between the device for supplying compressed air and the running belt can be shielded by compressed air.

In a further embodiment example of the present invention, the device for supplying compressed air is disposed such that air-supply openings, which are aligned substantially onto a point within a notional extension of the cleaning head, are distributed around the edge of the main opening.

Preferably, a hollow body, which matches the shape of the main opening and which is preferably disposed at the edge of the main opening, is provided with air-supply openings. Preferably, the hollow body is disposed at the main opening outside the cleaning head. Preferably, the hollow body encircles the cleaning head. The air-supply openings are preferably disposed such that they enclose, with the plane of the running belt, an angle of between 15° and 45°, particularly preferably an angle of approximately 30°. They are aligned such that the individual compressed-air jets converge towards the central axis of the cleaning head. Preferably, 6 to 30, particularly preferably approximately 12 air-supply openings are disposed, preferably at equal distances from one another, in the device for supplying compressed air.

In a further embodiment example of the present invention, a device for supplying at least one water jet is provided inside the cleaning head, wherein the generated water jets are aligned substantially in a direction towards the discharge opening.

The device for supplying at least one water jet is preferably a preferably annular body, which is located in the cleaning head and which preferably has holes as small water nozzles. Pressurized water can be supplied into the body, and escapes through the holes present. They have a diameter, preferably, of 0.5 mm to 1.5 mm, particularly preferably of approximately 0.8 mm. Preferably, the holes are aligned such that they generate a water jet that extends substantially parallel to the inner wall of the cleaning head in the direction of the airflow within the cleaning head. The device for supplying at least one water jet is preferably attached to the inner wall of the cleaning head and is preferably extended around the inner wall. It is arranged such that, insofar as possible, it does not substantially reduce, as a result of its structural shape, the airflow inside the cleaning head. Preferably, it is disposed over the inlet openings present for the high-pressure jets. It is preferably provided as a rinsing device.

In a further embodiment example of the present invention, a device for supplying compressed air is provided inside the cleaning head.

The possible embodiments of the device, just described, for supplying at least one water jet also apply to the supply of compressed air attached within the cleaning head. The device for supplying compressed air, however, preferably has a connection for supplying compressed air. Particularly preferably, compressed air can be supplied via a duct. Preferably, the holes are aligned, and preferably as small compressed-air nozzles, such that they generate at least one compressed-air jet, which extends substantially parallel to the inner wall of the cleaning head in a direction towards the discharge opening, i.e. preferably in the direction of an airflow generated in the cleaning head, or which, particularly preferably, extends substantially spirally along the inner wall of the cleaning head and propagates towards the discharge opening. Preferably, for the spiral course of the compressed air, the holes are disposed slightly obliquely relative to a notional transverse plane through the cleaning head.

Particularly preferably, the described device for supplying at least one water jet and the supply of compressed air attached within the cleaning head are realized in one structural unit. The cleaning head is preferably attached, at the discharge opening, to a collection system for discharging dirt and spray water.

In a further embodiment example of the present invention, the cleaning apparatus has a drier unit spaced apart from the cleaning head in the running direction of the running belt.

The drier unit preferably has means for drying the running belt. Preferably, the drier unit is at the same position transversely in relation to the running belt as the points on the running belt that are aimed at by the cleaning nozzles present. Particularly preferably, the drier unit is disposed at the same position transversely in relation to the running belt as the centre point of the main opening, i.e. disposed in a line with the centre point of the main opening, parallel to the running direction. Preferably, the drier unit is attached to the cleaning head.

In a further embodiment example of the present invention, the drier unit has at least one air nozzle directed onto the running belt.

Preferably the air nozzles present are each attached, preferably in groups, to a mounting, through which the air nozzles present can be aligned onto the running belt. Preferably, the drier unit has a plurality of air nozzles in a row, preferably a plurality of rows, along the running direction of the running belt. Particularly preferably, the drier unit has two rows of air nozzles along the running direction of the running belt, each row preferably having two air nozzles. Preferably, differing rows are disposed with an offset relative to one another.

The air nozzles present on the drier unit are preferably arranged to generate an airflow that is narrow at the nozzle opening and is wide at a greater distance from the air nozzle, particularly preferably a conical airflow. Preferably, they are arranged to generate an air-pressure jet, particularly through compressed air in the range from preferably 0.5 bar to 6 bar, particularly preferably through compressed air of approximately 4 bar. They are preferably disposed in such a way that the air jets generated are incident upon the regions wetted with liquid by the cleaning nozzles.

In a further embodiment example of the present invention, when more than one air nozzle is present, the air nozzles present are disposed such that they are aligned onto the running belt from at least two differing directions.

Preferably, the air nozzles present are disposed such that the jet profiles additionally overlap, at least partially. Particularly preferably, the air nozzles present are disposed such that they are aligned onto a common surface from at least two differing directions.

In a further embodiment example of the present invention, at least the cleaning head and at least one of the cleaning nozzles present are attached to a carrier device and can be moved transversely in relation to the running direction of the running belt.

The object is furthermore achieved by a method according to the invention for cleaning a running belt of a drying screen in a paper production installation having a cleaning apparatus, wherein the cleaning apparatus has a cleaning head, which has an interior space, a discharge opening, and a main opening that faces towards the running belt, comprising the step
- spraying the running belt with at least one high-pressure jet of a liquid, which is

preferably generated by a cleaning nozzle at a position outside the cleaning head.

Owing to the high-pressure jet being generated at a position outside the cleaning head, the dirt and/or suspended matter etc. collected by the cleaning head cannot soil the cleaning nozzle. In particular, an airflow preferably present in the interior space of the cleaning head cannot soil the cleaning nozzle with entrained dirt and/or suspended matter etc.

In the case of a further preferred method, the cleaning head additionally has at least one inlet opening in the wall of the cleaning head, and at least one high-pressure jet sprays onto the running belt from outside through one of the inlet openings present in the cleaning head.

The spraying through the cleaning head allows the main opening to be positioned very close to the belt. Nevertheless, the high-pressure jets present can be sprayed onto the running belt at a preferably acute angle located between the surface normal in respect of the running belt and the high-pressure jet. If the main opening is located close to the running belt, such that there is only a small gap, of preferably 5 mm to 20 mm, particularly preferably 8 mm to 14 mm, quite particularly preferably of approximately 10 mm between the running belt and the edge of the main opening, on the one hand the spray water and the produced dirt is collected by the covering of the surface that is just being cleaned. On the other hand, in the case of preferred generation of a negative pressure at the discharge opening of the cleaning head, the negative pressure effecting an airflow as a suction from the main opening towards the discharge opening, in the case of equal suction power a stronger suction exists close to the origin of the spray water and the dirt. Moreover, in the case of particularly preferred generation of a positive pressure in the region of the interior space of the cleaning head close to the main opening by means of a device for supplying compressed air, the airflow generated as a result is substantially greater in the direction of the discharge opening, since escape of the air through the now small gap between the main opening and the running belt is substantially prevented.

In the case of a further preferred method, when the running belt is sprayed by more than one high-pressure jet the high-pressure jets spray from differing directions onto the running belt.

Preferably, the high-pressure jets spray onto the belt such that the jets penetrate concomitantly into the various depressions and/or pores of the running belt. Particularly preferably, the high-pressure jets spray a line parallel to the running direction of the running belt, such that a point of the running belt is cleaned by high-pressure jets from differing directions by the motion of the running belt in a preferably short interval of time. Preferably, the high-pressure jets present spray onto a region located close to the centre of the outline of the main opening projected onto the running belt. The high-pressure jets preferably effect an approximately localized cleaning of the running belt.

In the case of a further preferred method, the high-pressure jets are incident on the running belt at a common incidence point.

Preferably, as a result, the running belt is cleaned simultaneously at one point by high-pressure jets from differing directions.

In the case of a further preferred method, in addition the liquid provided for the high-pressure jets is heated .

Preferably, the liquid is heated to a range of between 20° and 200°. Particularly preferably, the liquid is heated to approximately 60°. Consequently, there is substantially less capillary action in the screen, and the after-drying is thereby substantially assisted.

In the case of a further preferred method, in addition a negative-pressure source is connected to the discharge opening of the cleaning head, such that an airflow is generated, from the main opening in the direction of the interior of the cleaning head.

The airflow imitates the principle of the vacuum cleaner. The cleaning head used here could be compared, exemplarily, with a wet vacuum cleaner. Preferably, the suction effect also causes the air and/or the water present on the other side of the running belt from the cleaning head to be sucked up. The negative-pressure source is, for example, a suction pump.

In the case of a further preferred method, the airflow takes away dirt and/or used water.

Dirt is, in particular, the dirt particles detached from the running belt by the cleaning operation.

Preferably, the airflow conveys dirt and/or used water away, preferably via a tube system of the carrier device. Preferably, the used water is prepared for reuse.

In the case of a further preferred method, in addition compressed air is supplied via a device for supplying compressed air in the region of at least one incidence point, such that the liquid bouncing off the running belt is diverted towards the main opening by the supplied compressed air.

Preferably, the compressed air is supplied at the main opening. Preferably, the compressed air is supplied such that an air curtain forms around the high-pressure jets incident upon the running belt. Preferably, compressed air is supplied at the main opening via a multiplicity of air-pressure jets, the supplied compressed air preferably converging towards the centre of the main opening and preferably generating a strong airflow towards the discharge opening of the cleaning head. Preferably, spray water, which, as known from experience, diverges parallel to the surface of the running belt, and preferably dirt, which mixes with the spray water, are deflected into the cleaning head by the supplied compressed air. Preferably, use is made of compressed air in the range from preferably 1 bar to 600 bar, preferably 3 bar to 30 bar, particularly preferably 5 bar to 12 bar, quite particularly preferably approximately 6 bar. These ranges preferably also apply to compressed air that is supplied by a device for supplying inside the cleaning head and/or that is used by one or more air nozzles of a drier unit for drying the running belt. The devices for supplying compressed air and the drier unit are preferably arranged for the use of corresponding pressures.

In the case of a further preferred method, as a result of the supplying of compressed air, a positive pressure is generated in the region of at least one incidence point, wherein the positive pressure also spreads into the interior space of the cleaning head and generates an airflow that takes away the bouncing-off liquid through the interior space of the cleaning head.

The positive pressure is preferably in the same ranges as the compressed air supplied to generate the air curtain.

The region of at least one incidence point is preferably the space included by the generated air curtain. Preferably, the region of at least one incidence point is approximately the main opening of the cleaning head.

The spreading of the positive pressure into the interior space of the cleaning head is preferably effected as far as the discharge opening, after which an air pressure that is slightly over or equal to the ambient air pressure, or normal pressure, ensues. Thus, the air pressure preferably decreases in the interior space of the cleaning head, from the region of at least one incidence point as far as the discharge opening, since an equalization of positive pressure and the ambient air pressure is effected via the discharge opening.

It has been discovered, surprisingly, that the supplying of compressed air can result in such a positive pressure being generated in the region of at least one incidence point, and that this positive pressure generates an airflow through the interior space of the cleaning head. This airflow is sufficient to transport dirt and spray water as far as the discharge opening. The positive pressure, as it were, forces the dirt and the spray water out of the cleaning head, in the direction of the discharge opening. In this case, for example, even a vertical transport path contrary to gravity, of more than 50 cm, can be bridged with a pressure of approximately 6 bar.

Moreover, it is particularly advantageous in this case if the cleaning head is at a short distance from the running belt. This short distance is rendered possible, preferably, by the inlet openings present in the cleaning head. Contrary to the expectation of persons skilled in the art, an airflow, which is caused by the positive pressure and by which dirt and spray water can be taken away to the discharge opening, ensues in the interior space of the cleaning head, in spite of the inlet openings that are preferably present. A person skilled in the art would expect that the generated positive pressure escapes through the inlet openings and/or the gap between the main opening of the cleaning head and the running belt, and consequently does not generate a sufficient airflow inside the cleaning head, and would thus disregard the generation of a positive pressure in the interior space of the cleaning head. A great advantage of this type of generation of an airflow in the interior space of the cleaning head is that, preferably, it is possible to dispense with devices for generating a negative pressure, thus, for example, suction pumps. Positive-pressure sources are usually already present in the (paper production) factory, but negative-pressure sources are seldom

present. Preferably, it is also possible to combine the generation of a positive pressure in the interior space of the cleaning head and the connecting of a negative-pressure source to the discharge opening, as a result of which the airflow in the interior space can be boosted, although an additional component (negative-pressure source) is required for this purpose.

In the case of a further preferred method, in addition at least one water jet, which takes away dirt and used water, is generated inside the cleaning head.

The water jet is preferably generated in the direction of the airflow within the cleaning head. Preferably, a multiplicity of water jets are generated within the cleaning head, preferably in the form of a ring on the inner wall of the cleaning head. Preferably, dirt deposits on the inner wall of the cleaning head are detached by the at least one water jet and taken further in the direction of the airflow. Preferably, a water pressure of 4 bar to 6 bar, particularly preferably a water pressure of 5 bar, is used for this purpose.

In the case of a further preferred method, in addition compressed air, which takes away dirt and used water, is supplied inside the cleaning head.

The action of the previously described at least one water jet is preferably achieved in like manner by supplied compressed air inside the cleaning head. Particularly preferably, the action is boosted by the combined supplying of compressed air and at least one water jet. The used water and the detached dirt particles are preferably taken away through the discharge opening, preferably into a collection duct. This collection duct is preferably washed out from time to time by fixed nozzles.

In the case of a further preferred method, the compressed air is supplied in the interior of the cleaning head such that an air vortex forms.

Preferably the air vortex is generated through the use of a multiplicity of compressed-air nozzles in the interior of the cleaning head, which spray compressed air onto the inner wall of the cleaning head in a slightly oblique manner, such that it propagates in a slightly spiral manner in the direction of the airflow in the interior of the cleaning head. This effect preferably causes the water and dirt that are present to be swirled and taken away by the airflow. Preferably,

a venturi effect is generated by at least one alteration of the cross-section of the cleaning head in the interior of the cleaning head.

In the case of a further preferred method, in addition, after the running belt has been sprayed by at least one high-pressure jet of a liquid, the running belt is dried by a drier unit located downstream in the running direction.

Preferably, the partial region of the running belt that has been newly cleaned is dried by the drier unit.

In the case of a further preferred method, the drier unit sprays at least one compressed-air jet onto at least one region of the running belt.

Preferably, at least one conical compressed-air jet is generated by means of a correspondingly arranged nozzle. The compressed air removes the water present in the running belt, or the liquid used for cleaning the running belt.

In the case of a further preferred method, when more than one compressed-air jet is used the compressed-air jets spray onto regions of the running belt from at least two differing directions.

Preferably, the various compressed-air jets are incident upon the belt such that depressions and/or pores present in the running belt are sprayed with compressed air from differing directions. Preferably, a point on the running belt is sprayed in succession of time - owing to its motion relative to the drier unit - by the drier unit with compressed air from differing directions. The angle (analogous to W2) included by the air jets and the surface of the running belt is preferably in the range of between 15° and 45°, particularly preferably it is 30°. The pressure used to generate these air jets is preferably in a range from 0.5 bar to 6 bar, particularly preferably it is 4 bar.

In the case of a further preferred method, when more than one compressed-air jet is used the regions of the running belt sprayed by the compressed-air jets overlap, at least partially.

By means of the described method, it is possible to clean the running belt with a minimum expenditure of energy for the generation of compressed air and high-pressure jets, and with a minimum water consumption.

The invention is now to be illustrated further, by way of example, with reference to drawings, wherein:

Figure 1 shows a sketch of an apparatus according to the invention, having a cleaning head and a cleaning nozzle disposed outside the cleaning head,

Figure 2 shows a sketch of an apparatus according to the invention, having a cleaning head and a cleaning nozzle disposed outside the cleaning head, wherein the cleaning head has an inlet opening for the high-pressure jet generated by the cleaning nozzle,

Figures 3a and 3b show a sketch of an apparatus according to the invention, having a cleaning head, a cleaning nozzle disposed outside the cleaning head, and a device for supplying compressed air in the region of the incidence point of the high-pressure jet on the running belt, without (3a) and with (3b) an inlet opening for the high-pressure jet,

Figure 4 shows a cross-section of an apparatus according to the invention, having a cleaning head, a plurality of cleaning nozzles disposed outside the cleaning head, a device for supplying compressed air in the region of the incidence point of the high-pressure jet on the running belt, a device for supplying water jets in the interior of the cleaning head, and a device for supplying compressed air in the interior of the cleaning head,

Figure 5 shows a representation of an apparatus according to the invention, which additionally has a drier unit,

Figure 6 shows a representation of an apparatus according to the invention, which additionally has a drier unit, but which does not have a device for supplying compressed air in the region of the incidence point of the high-pressure jet on the running belt, and

Figure 7 shows an auxiliary sketch, which, in a manner that is neither true to scale nor angle-preserving, illustrates the definition for angles of the alignment in respect of one or more nozzles.

Shown in Figure 1 is a portion of a paper production installation 2, denoted by a running belt 1 (drawn in cross-section only) running over a roll 21. The cleaning apparatus 20 according to the invention is shown in a slightly perspective representation. In this embodiment example, it consists of a cleaning head 80, which is shown here as a portion of a cylinder. The cleaning head 80 is open at the underside. This opening is the main opening 81. The cleaning head is disposed perpendicularly at a distance of 35 mm above the running belt. Further, a cleaning nozzle 40 is part of the cleaning apparatus 20, which cleaning nozzle is aligned onto the running belt and disposed outside the cleaning head 80. A hose (not shown) connects the cleaning nozzle 40 to a high-pressure pump (not shown). Here, the incidence point 61 and the central axis of the cleaning head are located on the tangential line of the running belt 1 running off the roll 21.

During operation of the cleaning apparatus 20, an airflow 83 is set in the interior of the cleaning head by means of a pump connected to the discharge opening 84 or other means for generating a suction - these components are not shown here. As a result, an airflow 83, indicated by a broken-line arrow, is produced in the interior. Air, indicated by broken-line arrows in the direction of the main opening 81, is sucked in through the main opening 81 from outside the tube. At the same time, a high-pressure jet 60 consisting of water is generated by means of the cleaning nozzle 40 and pump means, not represented. This high-pressure jet has a diameter of 0.15 mm, sprays onto the running belt 1 and is incident there at the incidence point 61.

Owing to this disposition, the high-pressure jet 60 cleans soiling from the belt at the incidence point 61. Since the running belt 1 is moving, it is thus cleaned continuously. The dirt particles detached from the running belt 1 and the spray water produced during the cleaning operation are collected by the cleaning head and taken away by the airflow 83. The detached dirt particles are thus not redeposited on the belt, and the majority of the water used for cleaning can continue to be used for cleaning, after reprocessing. Owing to the cleaning nozzle 40 being disposed outside the cleaning head 80, the cleaning nozzle is not exposed to the airflow 83 carrying dirt particles. This disposition therefore prevents the cleaning nozzle 40 from being soiled by detached dirt particles.

Shown in Figure 2 is a cleaning apparatus according to the invention similar to that of Figure 1, with the difference that an inlet opening 82 is now provided in the cleaning head. This inlet opening 82 is an oblique bore having the diameter 0.25 mm. An additional difference, compared with Figure 1, is that the cleaning head is now disposed at a distance of 10 mm from the running belt.

During operation of the cleaning apparatus 20, an airflow 83 is again generated inside the cleaning head 80, and a high-pressure jet 60 is generated (see description relating to Figure 1). A difference in this case, however, is that the high-pressure jet 60 is incident upon the running belt 1 at the incidence point 61 through the inlet opening 82 and, consequently, also through the main opening 81.

Owing to the presence of the inlet opening 81, it is possible, in this embodiment example, for the cleaning head 80 to be at a lesser distance from the running belt. The airflow 83 resulting from the suction thus acts yet more strongly at the incidence point 61, the place of origin of the spray water and of the dirt particles. Both the spray water and the dirt particles can therefore be taken away more effectively via the cleaning head 80. Moreover, the cleaning nozzle 40 is now even better protected against soiling by the dirt particles, since the cleaning head 80 acts like a protective shield for the cleaning nozzle 40.

Shown in Figure 3a is the cleaning apparatus 20 according to the invention similar to that of Figure 1, with the essential difference that there are now additionally disposed two devices 100 for supplying compressed air 101 in the region of the incidence point 61. These devices are indicated as air-pressure nozzles 100. The air-pressure nozzles are each fed via a hose (not shown),

which carries compressed air. Here, the incidence point 61 and the central axis of the cleaning head are located in front of the tangential line of the running belt 1 running off the roll 21, at a point at which the running belt 1 bears on the roll.

During operation of the cleaning apparatus 20, the air-pressure nozzles each spray an air-pressure jet 101 against the running belt, such that the spray water, which, during operation, usually carries away with it the detached dirt particles and sprays them away from the incidence point 61, substantially parallel to the running belt 1, is incident upon the air-pressure jets 101. The spray water rebounds from the air-pressure jets 101 and is thus directed in the direction of the main opening 81. The air jets 101, likewise, are deflected via the running belt 1 in the direction of the main opening 81. The coincidence of the air jets 101 and of the air jets deflected at the material web generates a positive pressure, which generates an airflow 83 substantially vertically upwards inside the cleaning head 80. By means of this airflow 83, the collected dirt and spray water is forced upwards to the discharge opening 84, and through the latter.

The additionally attached device 100 for supplying compressed air 101 enables the spray water and the detached dirt particles to be deflected in the direction of the main opening 81. The airflow 83 generated in this case can therefore very effectively capture this spray water and these dirt particles. The spray-water losses and the risk of re-soiling of the running belt 1 or of the cleaning nozzle 40 by detached dirt particles are greatly reduced. Moreover, simultaneous shielding of the spray water and dirty water, and of its removal, is achieved solely through the use of compressed air. There is no need for negative pressure inside the cleaning head 80 in order to suck up spray water and dirty water.

Shown in Figure 3b is a cleaning apparatus 20 according to the invention similar to that of Figure 3a, with the difference that the cleaning jet 60 sprays onto the running belt 1 through an inlet opening 82, and this allows the main opening 81 to be positioned closer to the incidence point 61, the spraying angle of the cleaning jet 60 onto the running belt 1 being the same.

During operation of the cleaning apparatus 20, an even stronger airflow 83 can be produced through the just small gap between the cleaning head and the running belt 1, since the positive pressure produced in the region of the main opening 81 by the compressed air jets 101 is forced yet more strongly to equalize to the ambient pressure via the discharge opening 84, and not via a different

path. Moreover, yet more advantageously, dirty water and spray water are actually collected directly by the cleaning head 80.

A further embodiment example of the cleaning apparatus 20 according to the invention is represented in Figure 4. The figure depicts a view of the interior of the cleaning head 80 (diameter: 228 mm; distance from the running belt 1, not shown: 10 mm) and of the components attached thereto:

- Attached at the main opening 81 is a device 100 for supplying compressed air 101. This device is an annular hollow body, which is attached to the outer radius of the cleaning head 80 and surrounds the main opening 81, having drilled holes, as air-supply openings 102 having the diameter 0.8 mm, at equal distances from one another. The holes are drilled at an angle of 30° relative to the plane of the running belt 1. This hollow body is a tube bent to form a ring, whose ends are welded to one another in an airtight manner, and into which there are drilled holes, as air-supply openings, and a connection hole for supplying compressed air. For the purpose of producing one of these air-supply openings, the tube constituting the ring is first bored through completely by a bore made on the outside of the ring, such that one bore produces two holes in the tube envelope. The exit hole on the inside of the ring is aligned obliquely downwards onto the centre point of the ring. The burr on this hole is therefore not on the tube surface located in the hollow space of the ring, but on the outer surface. As a result, the burr can be removed cleanly. The other, opposing hole in the tube cross-section is closed by welding. In this way, a clean bore is obtained, which can serve as an air-supply opening. If a hole having a burr located in the hollow space of the ring were to be used, impurities in the compressed air could attach to the burr over time, and the hole would become blocked after a certain period of time.
- The cleaning head has two lateral inlet openings 82.
- Attached directly over the inlet openings 82, as a device 120 for supply water jets 121 in the interior of the cleaning head 80, is a hollow annular body having drilled holes, as water-jet openings 122 having the diameter 0.8 mm, at equal distances from one another. The holes are drilled vertically upwards and parallel to the inner wall of the cleaning head 80. A water connection 123 is present on the annular body.
- Attached over the device 120 for supplying water jets 121 is a hollow annular body, as a device 140 for supplying compressed air 141 in the interior of the cleaning head 80, having drilled holes, as air-supply openings 142 having

the diameter 0.8 mm, at equal distances from one another. The holes are drilled vertically upwards and parallel to the inner wall of the cleaning head 80. A compressed-air connection 143 is present on the annular body.

- In the uppermost region of the drawing, the cleaning head 80 has a bend of 90°.
- Attached outside the cleaning head 80 are two opposing cleaning nozzles 40 for generating laminar high-pressure jets 60.

During operation of the cleaning apparatus 20, the cleaning nozzles 40 each spray a high-pressure jet 60, consisting of water, at a pressure of 450 bar, onto a common incidence point 61 from two differing directions. The high-pressure jets 61 clean the belt. Furthermore, compressed air 101 (shown, exemplarily, only for two air-supply openings 102, even if compressed air 101 flows out of all air-supply openings 102) is supplied, via the air-supply openings 102, into the annular body of the device 100 for supplying compressed air 101. The individual jets of compressed air 101 produced in this case converge towards the vertical central axis of the cleaning head 80, and together form an air curtain 103, which encloses the produced spray water between the cleaning head 80 and the running belt 1. Furthermore, the compressed air 101 is itself deflected and then acts in the direction of the interior space of the cleaning head 80. A strong vertical upcurrent (only partially indicated by broken-line arrows, wherein an arrow tip does not denote the end of the airflow) is produced in the interior of the cleaning head 80 as a result of the positive pressure in the interior of the cleaning head 80 that is generated by the compressed air of the air curtain 103. Owing to the small gap between the running belt 1 and the main opening 81, the positive pressure results in an airflow 83 in the direction of the discharge opening 84, which airflow is sufficiently strong to carry dirt and spray water as far as the discharge opening. The spray water (represented, exemplarily, by wavy, continuous lines going up from the incidence point 61), which normally diverges along the plane of the running belt 1, is blocked by the air curtain 103 and is diverted vertically upwards into the cleaning head 80. Water is supplied into the annular body of the device 120 for supplying water jets 121. The individual water jets 121 that are then produced generate a rinsing of the inner wall of the cleaning head 80. The water pressure used in this case is 5 bar. Compressed air is supplied into the annular body of the device 140 for supplying compressed air 141. The individual compressed-air jets 141 that are then produced drive the water and the detached dirt particles forwards in the direction of the discharge opening 84.

The cleaning through the use of more than one high-pressure jet 60 is more effective than the cleaning by only one jet. The high-pressure jets 60 penetrate into pores and depressions of the running belt 1 from differing directions, as a result of which a more thorough cleaning is achieved. The fact that the device 100 for supplying compressed air 101 is realized as a hollow annular body having air-supply openings 102 allows an air curtain 103 to be created, which surrounds the spray water. Because of the devices 120 and 140 shown here, for supplying water jets 121 and compressed air 141, respectively, the interior space and the inner walls of the cleaning head 80 are kept clean.

Illustrated exemplarily in Figure 5 is a cleaning apparatus 20 according to the invention, which, unlike the previously shown cleaning apparatuses 20, has three cleaning nozzles 40 (only two are visible, one being covered) for generating laminar high-pressure jets 60, and three inlet openings 82 (only one is visible, two being covered) in the cleaning head 80. One is aligned contrary to the running direction of the running belt 1 and the other two are aligned opposite one another, transversely in relation to the running belt 1. The incidence points 61 of the three high-pressure jets 60 are located approximately at the tangential point of the running belt 1 and the roll 21, and they are located at a distance of, respectively, 2 mm from one another in a line along the running direction of the running belt 1. Also illustrated, exemplarily, is a carrier device 180, having a collection duct system integrated therein. Unlike the previously shown cleaning apparatuses 20, the cleaning apparatus 20 shown here is equipped with a drier unit 160. This drier unit has four air nozzles 161 along the running direction of the running belt 1, which are each aligned with an offset onto the running belt 1 from two differing directions, or having two differing angles of incidence.

During operation of the cleaning apparatus 20, the air nozzles 161 spray conically shaped air jets 162 onto the running belt 1, and thus dry the region of running belt 1 that has just been cleaned and that is therefore wet. The angle enclosed by the air jets and the surface of the running belt 1 is 30°. The jets are generated by compressed air having a pressure of 4 bar. The spray and rinsing water collected and diverted through the cleaning head 80, and the detached dirt particles, are washed out of the collection duct system by means of rinsing jets and scrapers. During the cleaning operation, the cleaning apparatus is moved transversely in relation to the running belt 1, along the carrier device 180, by means of a motor.

The described alignment of the high-pressure jets 60 allows the available jet energy to be concentrated onto a small area. The drier unit downstream from the cleaning components ensures a rapid drying of the cleaned running belt 1. Owing to the air nozzles 161 being disposed along the run of the belt, an air curtain of wide extent is generated in the running direction.

Illustrated exemplarily in Figure 6 is a cleaning apparatus 20 according to the invention, which, unlike the cleaning apparatus of Figure 5, does not have inlet openings 82 in the cleaning head 80. The main opening 81 is therefore at a greater distance from the running belt 1, in order that the high-pressure jets 60 generated by the cleaning nozzles 40 can be incident upon the running belt 1 in an unimpeded manner. There is also no device 100 for delivering compressed air 101. Further, the drier unit 162 is equipped with six air nozzles 161, which are offset in relation to one another.

In this embodiment, the spray water and the detached dirt particles are sucked up in the cleaning head 80 solely by a suction - the airflow 83 - which also draws air out of the area around the main opening 81 (which area is indicated by a truncated cone bounded by a broken line).

This simplified embodiment is a less expensive variant of the cleaning apparatus 20. The use of six air nozzles 161 instead of four in the drier unit 160 provides for even more rapid drying of the region of the running belt 1 that has just been cleaned. However, the new acquisition of a vacuum pump may be necessary.

Figure 7 shows which angles W1 and W2 can be adjusted for the purpose of aligning the cleaning nozzles 40. Three high-pressure jet nozzles 40 are shown, which each spray a high-pressure jet 60 onto three differing incidence points 61. Broken lines indicate both the running direction 11 of the running belt (with an arrow) and the projections 62 of the high-pressure jets onto the running belt 1. W1 in each case is the angle 63 between the running direction and the projection, W2 in each case is the angle 64 between the running-belt surface and the high-pressure jet.

By means of the invention newly presented here, it is possible for the first time to provide a cleaning apparatus that, through the individual features, but also through the interaction of the features, renders possible significant progress in, for example, drying-screen cleaning. For example, continuous cleaning of the

drying screen without an intermediate drying-out phase is possible for the first time. For example, owing to the small region on which the cleaning jets are incident on the running belt, in combination with the cleaning head being positionable close to the running belt - possible because of the inlet openings - the cleaning apparatus achieves highly efficient cleaning with, at the same time, effective removal - by the positive pressure - of the dirt and, in addition, the drying unit effects rapid after-drying of the running belt - the only small region that is wetted being conducive thereto. This cleaning apparatus is markedly distinguished from the state of the art, however, not only by the interaction of these inventive features, but also even by the use of only one of these features or of single features.

References

1	running belt
2	paper production installation
11	running direction
20	cleaning apparatus
21	roll
40	cleaning nozzle
60	high-pressure jet
61	incidence point
62	projection of the high-pressure jet onto the running belt surface
63	W1
64	W2
71	heat exchanger
80	cleaning head
81	main opening
82	inlet opening
83	airflow
84	discharge opening
100	device for supplying compressed air
101	compressed air
102	air-supply opening
103	air curtain
120	device for supplying water jets
121	water jet
122	water-jet opening
123	water connection
140	device for supplying compressed air
141	compressed air
142	air-supply opening
143	compressed-air connection
160	drier unit
161	air nozzle
162	compressed-air jet
180	carrier device

CLAIMS

1. A cleaning apparatus, comprising:

at least one cleaning nozzle configured to generate and direct a high-pressure liquid jet having a point of impact on a surface to be cleaned, said cleaning nozzle arranged to direct the high-pressure liquid jet to strike the surface at the point of impact at an acute angle with respect to the surface, generated spray water diverging in a direction substantially parallel to the surface;

at least one cleaning head having a main opening that faces towards the surface, a discharge opening and at least one device for supplying compressed air disposed in the region of the point of impact of the high-pressure liquid jet, on the surface; and

wherein the at least one device for supplying compressed air directs the compressed air against the surface in the region of the point of impact of the high-pressure liquid jet, the spray water being incident on the compressed air as the spray water diverges in the direction substantially parallel to the surface, the compressed air acting on the diverging spray water to redirect the spray water and dirt particles carried with the spray water from the surface toward the main opening of said cleaning head, the compressed air and its own deflection from the surface generating an airflow that forces the redirected spray water and dirt particles toward the discharge opening of said cleaning head.

2. The cleaning apparatus according to claim 1, wherein the compressed air directed against the surface by said at least one device for supplying compressed air generates a positive pressure in the region of the at least one point of impact, said generated positive pressure spreading into said cleaning head at the main opening.

3. The cleaning apparatus according to any one of claims 1 to 2, further comprising a drying unit spaced apart from the at least one cleaning head in a moving direction of the surface.

4. The cleaning apparatus according to any one of claims 1 to 3, wherein the at least one device for supplying compressed air comprises a hollow annular body at the main opening of the cleaning head.

5. The cleaning apparatus according to any one of claims 1 to 3, wherein the at least one device for supplying compressed air comprises a hollow annular body inside the cleaning head.

6. The cleaning apparatus according to any one of claims 1 to 5, wherein the at least one device for supplying compressed air comprises a first pipe configured to supply compressed air at the main opening of the cleaning head and a second pipe configured to supply compressed air inside the cleaning head.

7. The cleaning apparatus according to claim 6, wherein the second pipe directs compressed air to extend substantially spirally along an inner wall of the cleaning head in a direction of the airflow, thereby generating an air vortex inside the cleaning head.

8. The cleaning apparatus according to any one of claims 1 to 7 including a spray apparatus inside the cleaning head configured to produce water jets directed away from the main opening of the cleaning head.

9. The cleaning apparatus according to any one of claims 1 to 4, wherein the at least one device for supplying compressed air comprises a first pipe configured to supply compressed air at the main opening of the cleaning head and a second pipe configured to supply compressed air inside the cleaning head, the second pipe directing compressed air to extend substantially spirally along an inner wall of the cleaning head in a direction of the airflow, thereby generating an air vortex inside the cleaning head, the cleaning apparatus further including a spray apparatus inside the cleaning head configured to produce water jets directed away from the main opening of the cleaning head.

10. The cleaning apparatus according to any one of claims 1 to 9, wherein the acute angle at which the high-pressure liquid jet strikes the surface at the point of impact is between 5° and 85°.

11. The cleaning apparatus according to claim 10, wherein the acute angle is between 10° and 60°.

12. The cleaning apparatus of claim 10, wherein the acute angle is between 15° and 45°.

13. A method for cleaning a conveyor belt of a drying screen in a paper production system comprising:

spraying at least one high-pressure liquid jet onto a point of impact on the conveyor belt, including directing the high-pressure liquid jet to strike the conveyor belt at the point of impact at an acute angle with respect to the conveyor belt, whereby generated spray liquid diverges in a direction substantially parallel to the conveyor belt;

directing a source of compressed air towards the point of impact of the liquid jet on the conveyor belt, the diverging spray liquid ricocheting off the conveyor belt in the direction substantially parallel to the conveyor belt being incident upon the compressed air;

acting on the diverging spray liquid with the compressed air to redirect the spray liquid from the conveyor belt towards a main opening of a cleaning head; and

generating with the compressed air directed against the conveyor belt a positive pressure at the area of the at least one point of impact that spreads into the interior space of the cleaning head so as to generate an airflow inside the cleaning head that transports the redirected spray liquid towards the discharge opening of the cleaning head.

14. The method of claim 13 further comprising heating the liquid prior to spraying the at least one high-pressure liquid jet.

15. The method of claim 13 or 14, further comprising generating at least one water jet inside the cleaning head that transports dirt and liquid entering into the main opening towards the discharge opening.

16. The method of any one of claims 13 to 15, further comprising directing a second source of compressed air inside the cleaning head to transport dirt and liquid entering into the main opening towards the discharge opening.

17. The method of claim 16 wherein directing the second source of compressed air includes directing the second source of compressed air to extend substantially spirally along an inner wall of the cleaning head in a direction of the airflow, thereby generating an air vortex in the interior space of the cleaning head.

18. The method of any one of claims 13 to 17, further comprising drying the running belt after spraying the at least one high-pressure liquid jet.

19. The method of any one of claims 13 to 18, further comprising supplying a source of suction at the discharge opening.

20. The method of any one of claims 13 to 19, wherein the source of compressed air is directed to form a ring of compressed air.

21. A method of producing paper in a paper production machine having a drying screen comprising:

disposing a paper web on the drying screen;

drying the paper web on the drying screen;

removing the paper web from the drying screen;

spraying at least one high-pressure liquid jet onto a point of impact on a bare conveyor belt of the drying screen, including directing the high-pressure liquid jet to strike the conveyor belt at the point of impact at an acute angle with respect to the conveyor belt, whereby generated spray liquid diverges in a direction substantially parallel to the conveyor belt;

directing a source of compressed air towards the point of impact of the liquid jet on the bare conveyor belt, the diverging spray liquid ricocheting off the bare conveyor belt in the direction substantially parallel to the conveyor belt being incident on the compressed air;

acting on the diverging spray liquid with the compressed air to redirect the spray liquid from the conveyor belt towards a main opening of a cleaning head; and

generating with the compressed air directed against the conveyor belt a positive pressure at the area of the point of impact that spreads into the interior space of the cleaning head so as to generate an airflow inside the cleaning head that transports the redirected spray liquid towards the discharge opening of the cleaning head.

22. The method of claim 21 further comprising heating the liquid prior to spraying the at least one high-pressure liquid jet.

23. The method of claim 21 or 22 further comprising generating at least one water jet inside the cleaning head that transports dirt and liquid entering into the main opening towards the discharge opening.

24. The method of claim 21 or 22 further comprising directing a second source of compressed air inside the cleaning head to transport dirt and liquid entering into the main opening towards the discharge opening.

25. The method of claim 24 wherein directing the second source of compressed air includes directing the second source of compressed air to extend substantially spirally along an inner wall of the cleaning head in a direction of the

airflow, thereby generating an air vortex in the interior space of the cleaning head.

26. The method of any one of claims 21 to 25, further comprising drying the conveyor belt after spraying the at least one high-pressure liquid jet.

27. The method of any one of claims 21 to 26, further comprising supplying a source of suction at the discharge opening.

28. The method of any one of claims 21 to 27, wherein the source of compressed air is directed to form a ring of compressed air.

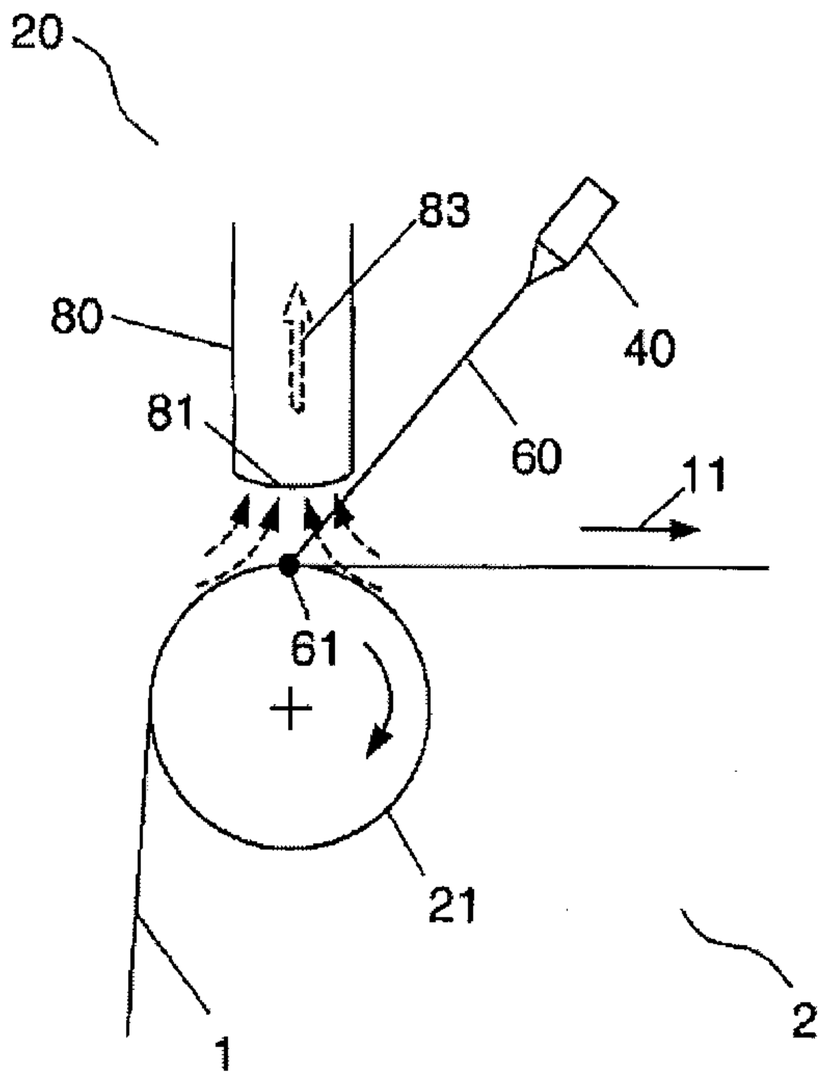


Figure 1

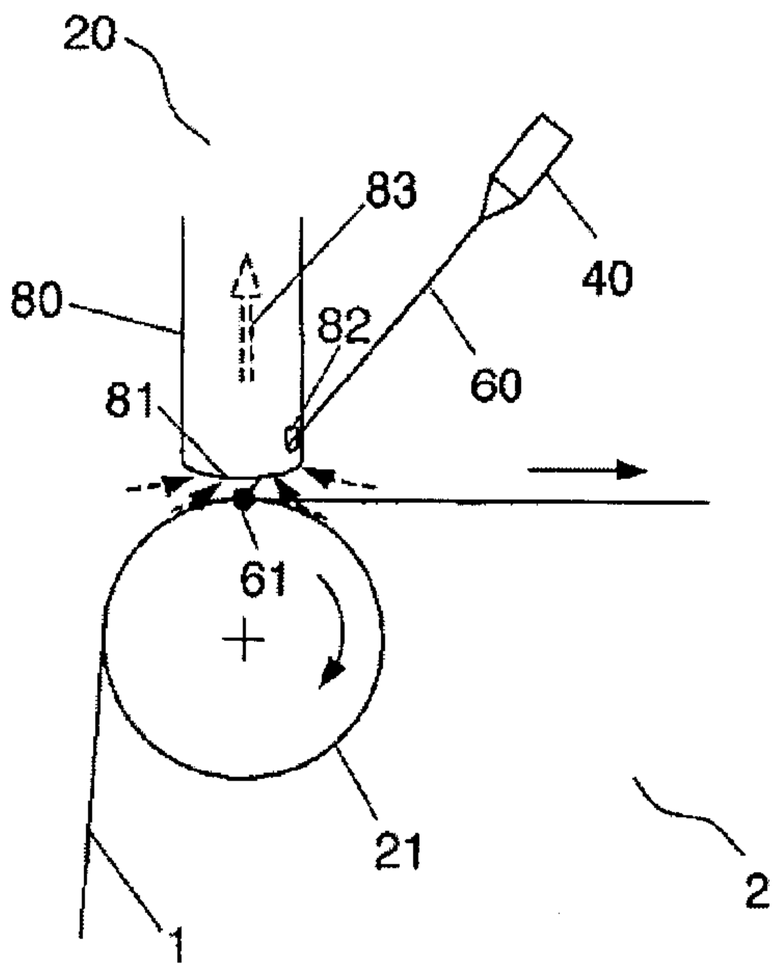


Figure 2

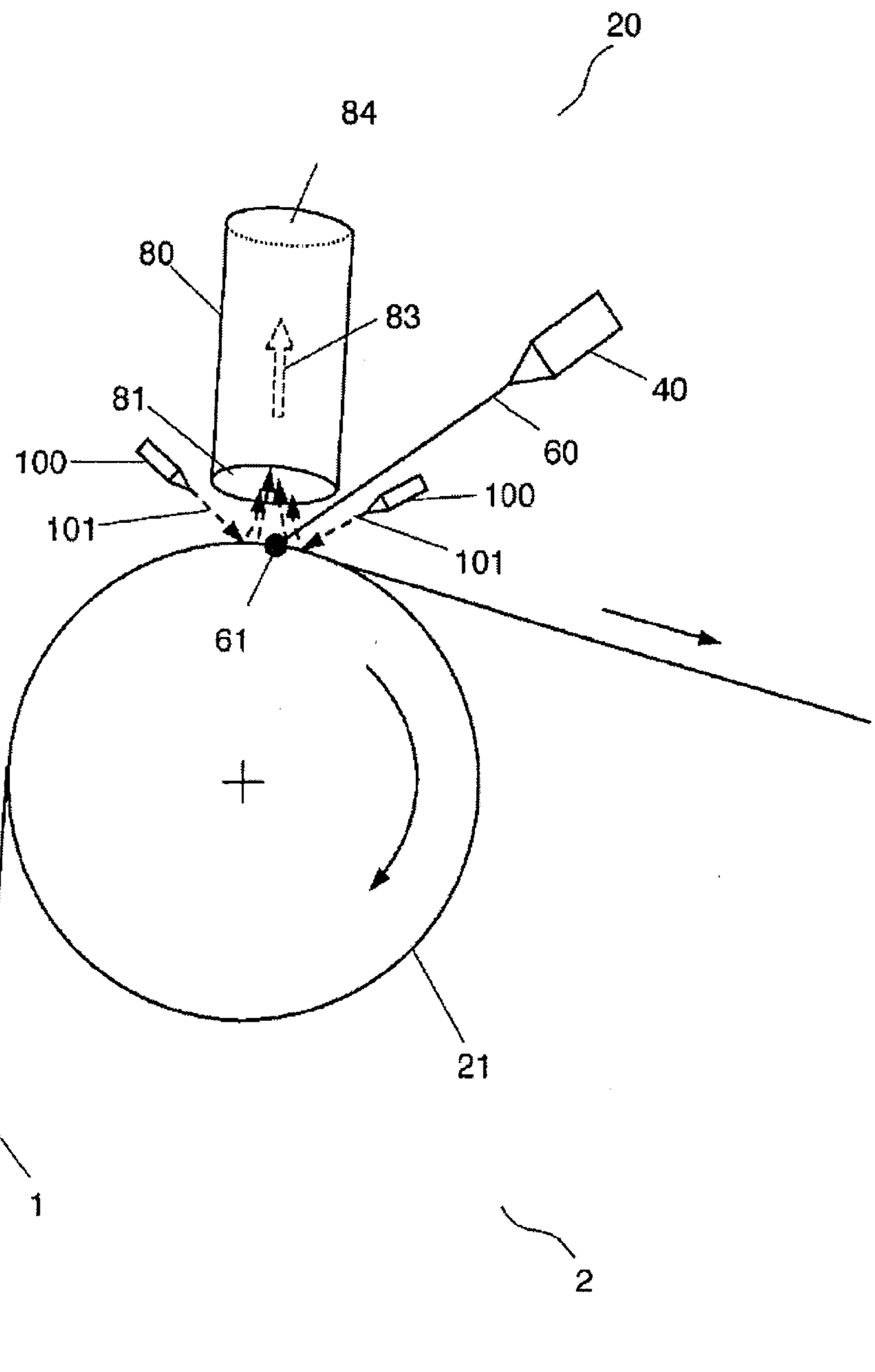


Figure 3a

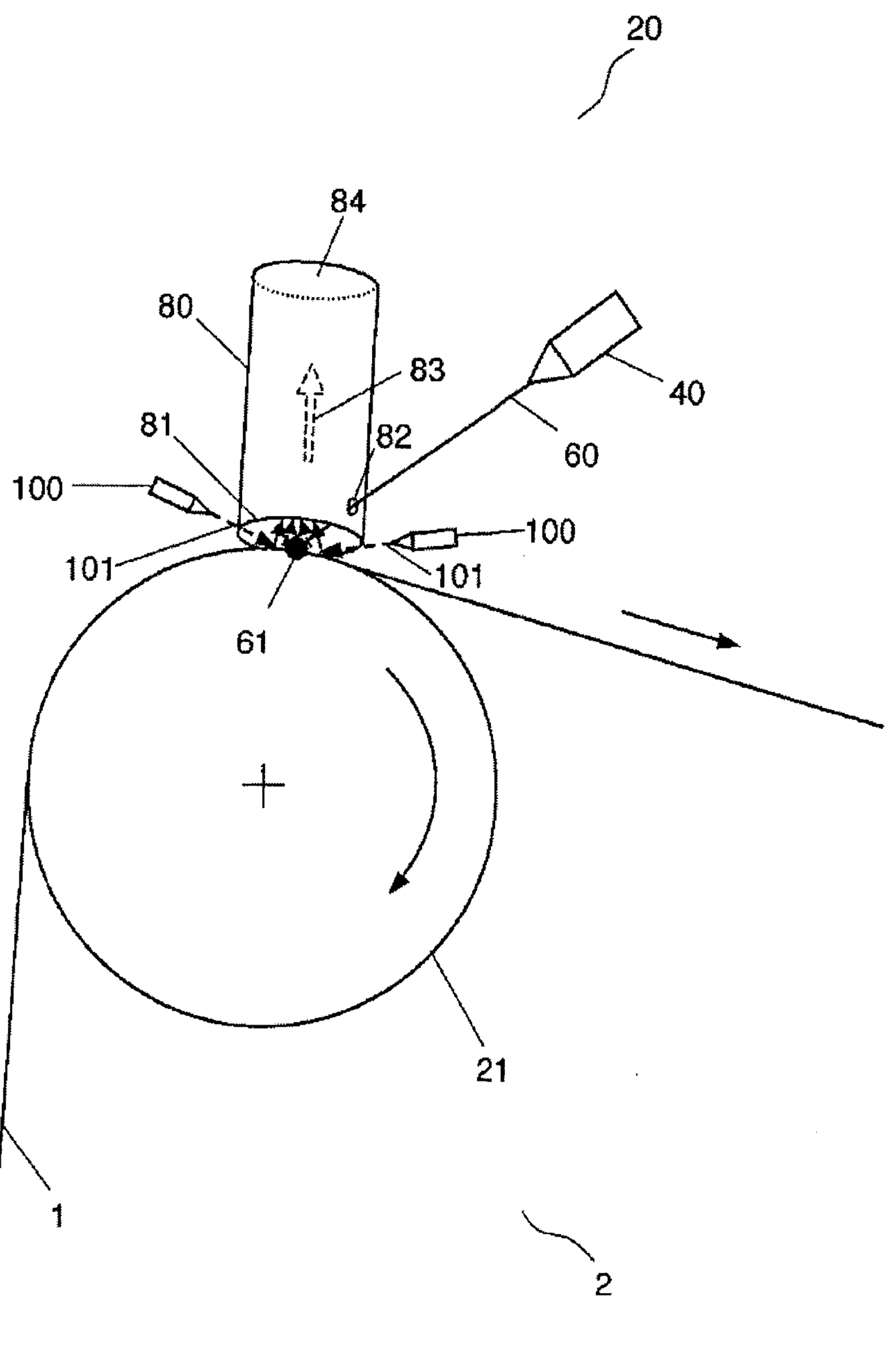


Figure 3b

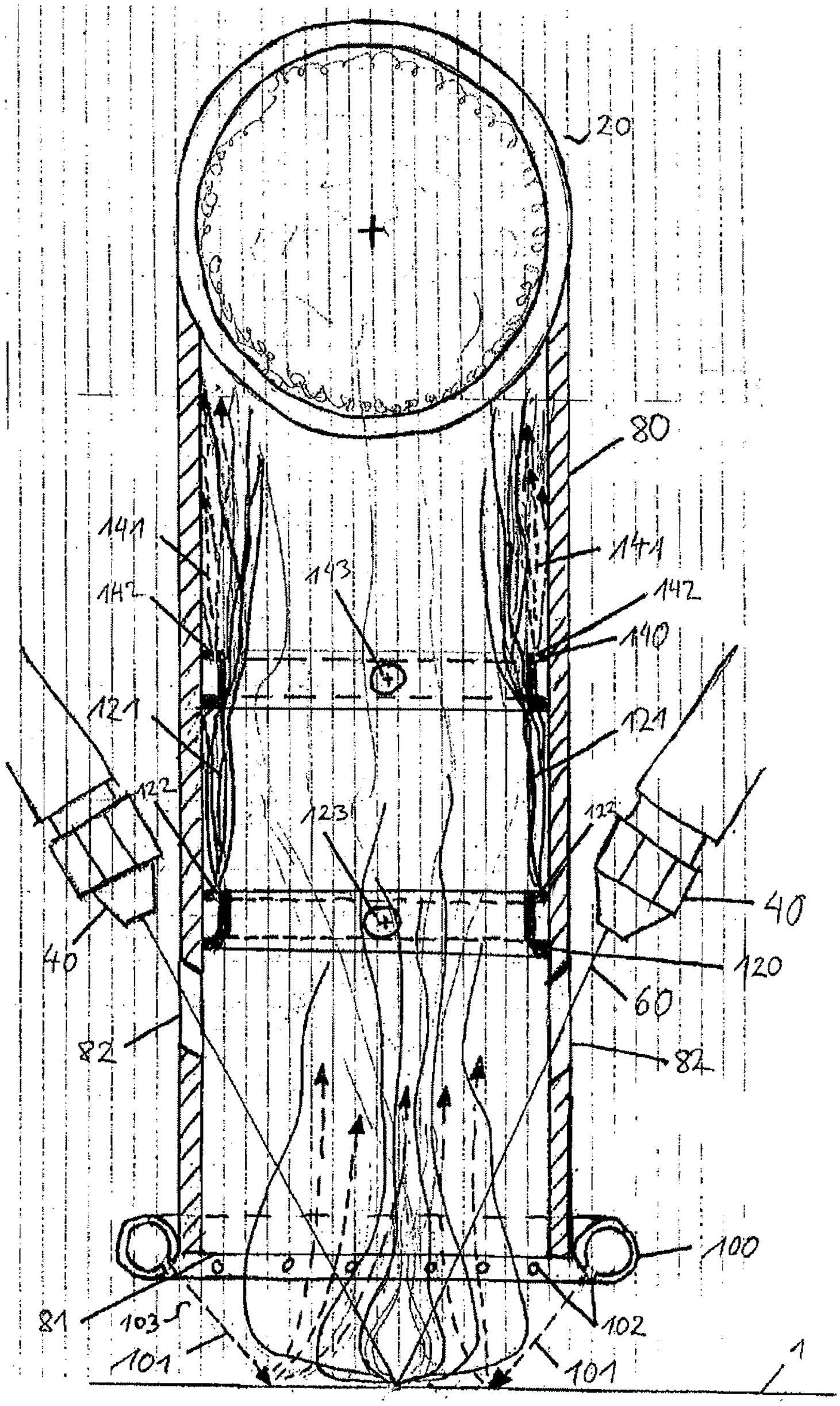


Figure 4

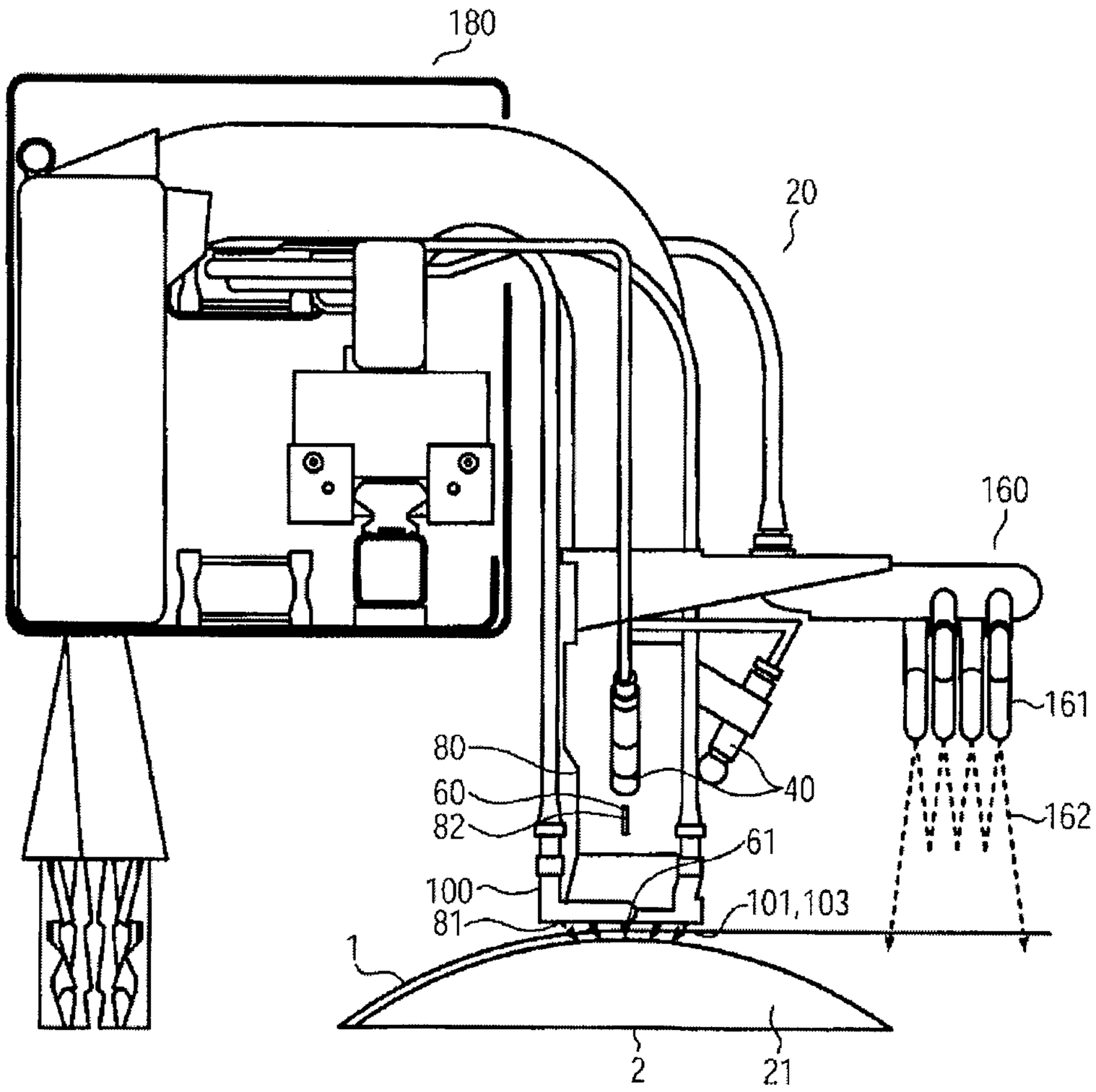


Figure 5

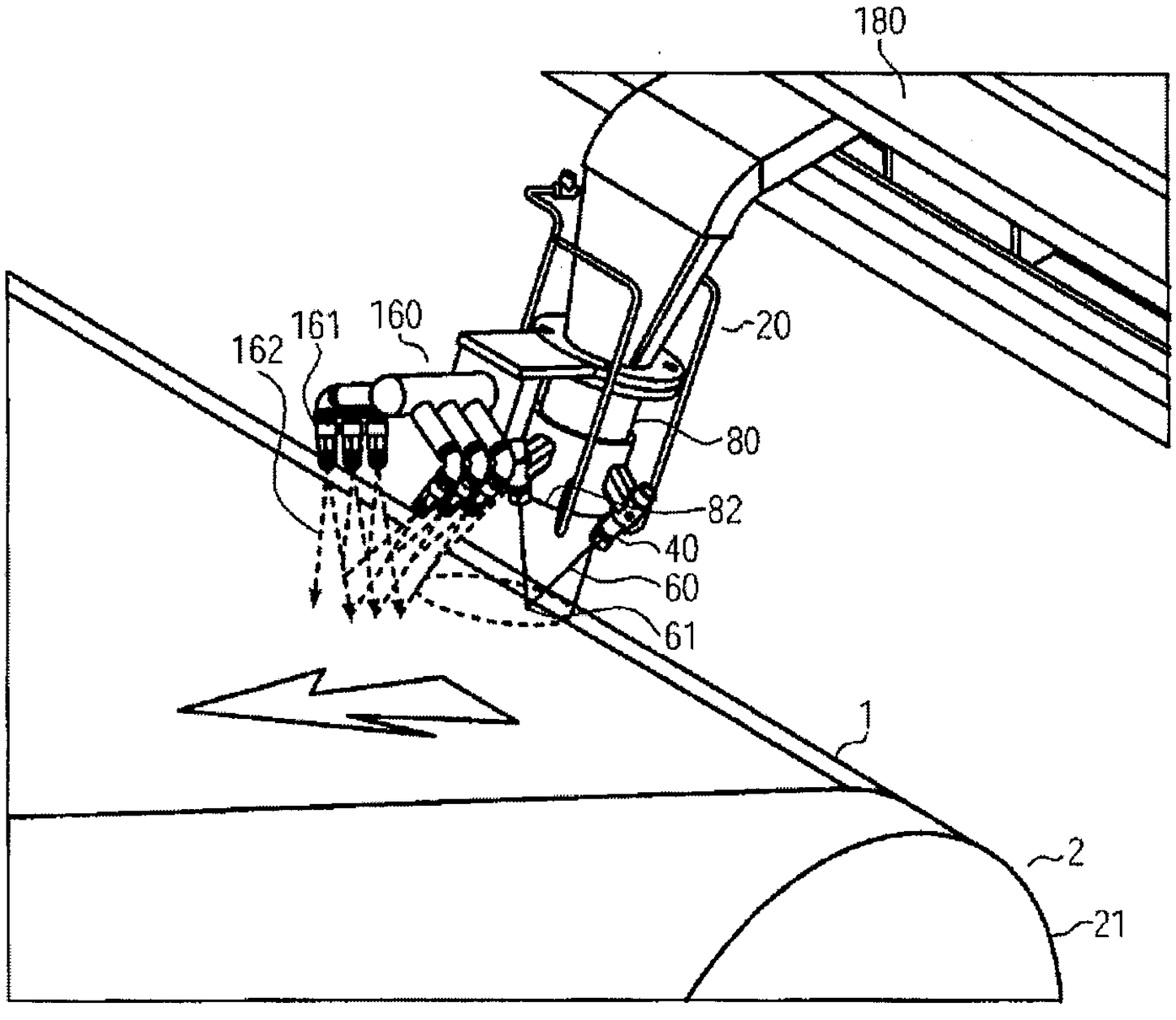


Figure 6

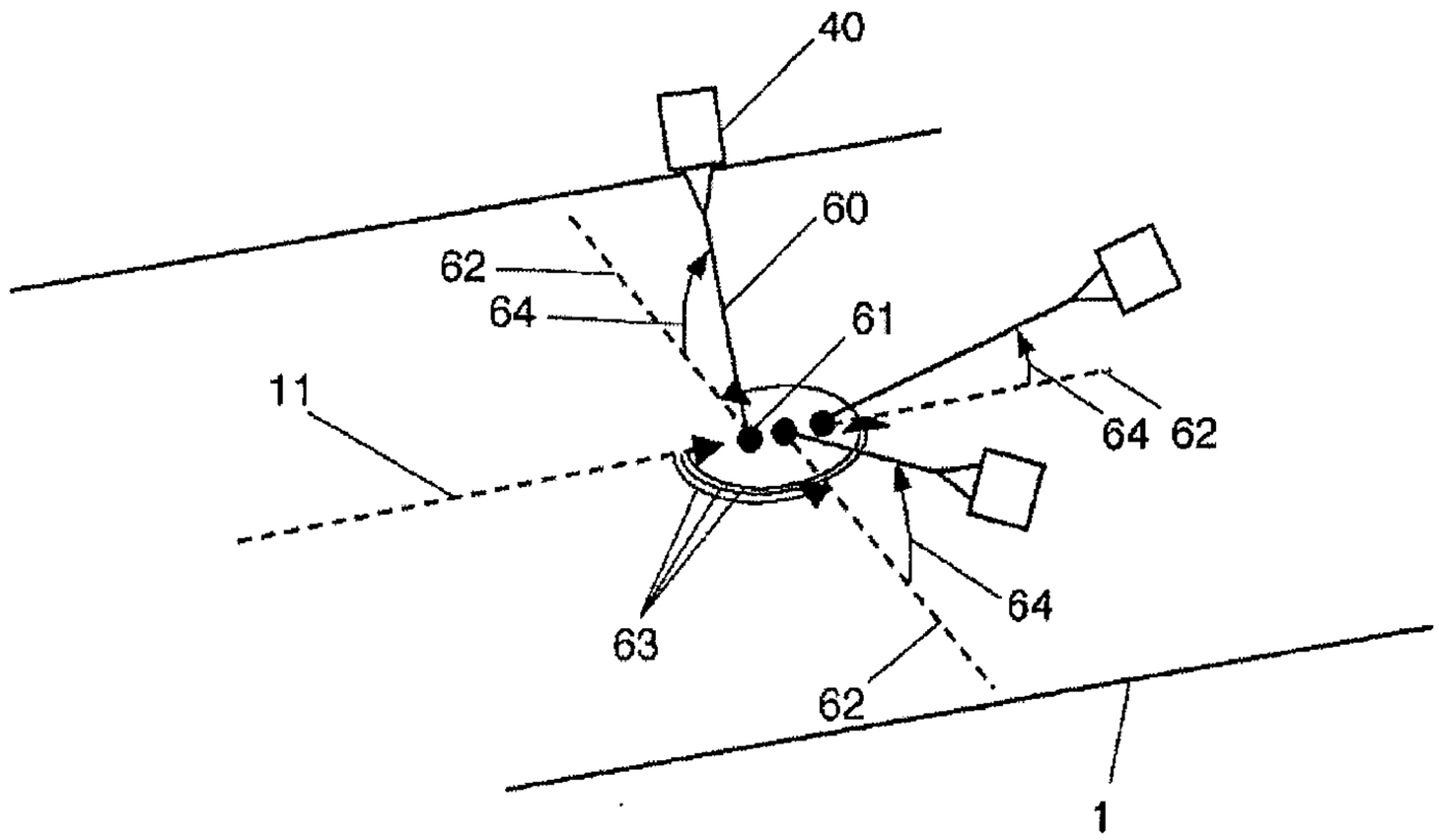
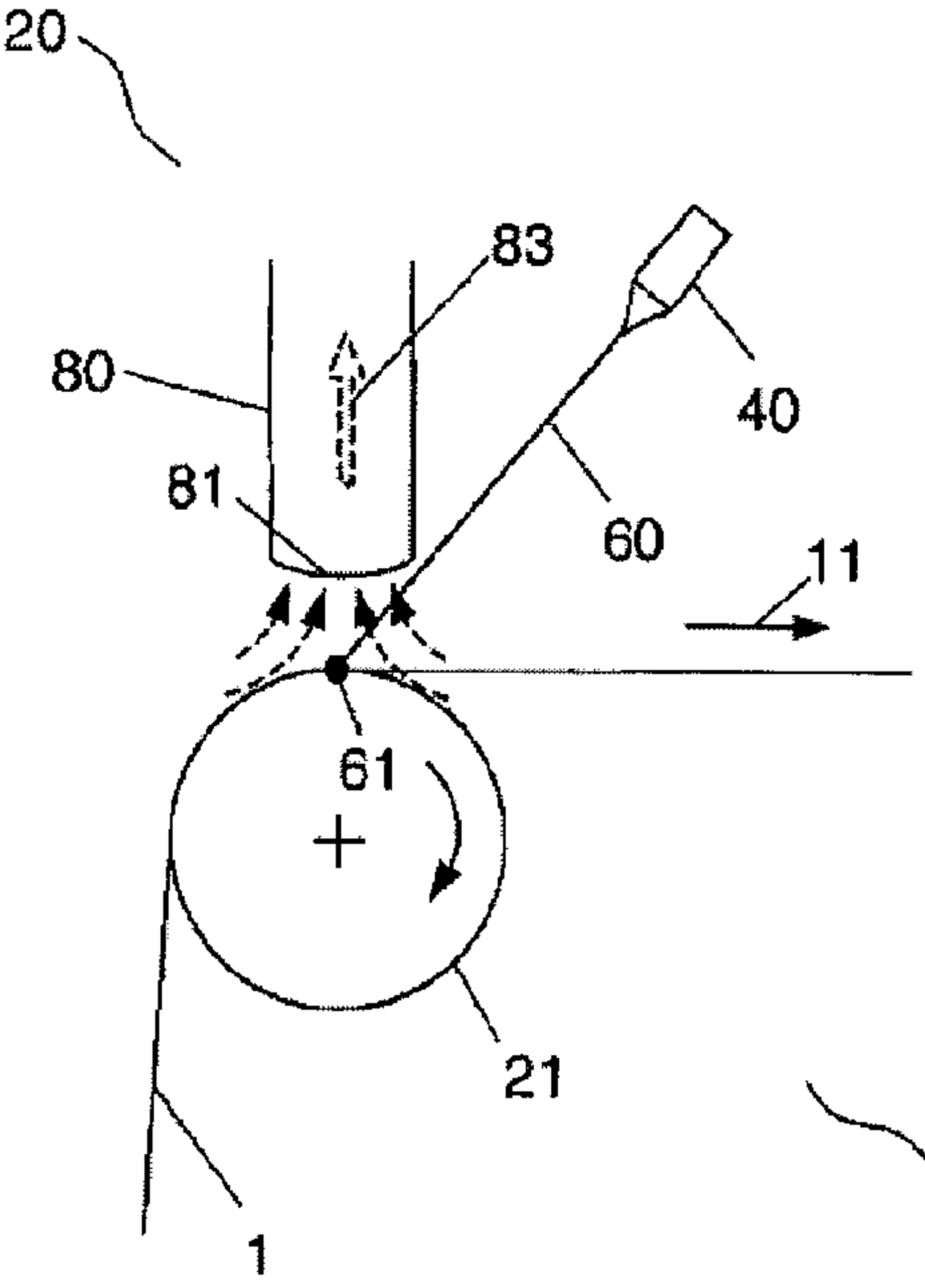


Figure 7


20
83
80
40
81
60
11
61
21
1
2