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(54) A METHOD AND A DEVICE FOR CONTROLLING THE OPERATING CONDITIONS OF A WETTING ROLLER, AND RELATED COMPUTER PROGRAM

(57) A method for controlling the operating conditions of a wetting roller (66) to determine whether the wetting degree of the wetting roller (66) is correct.

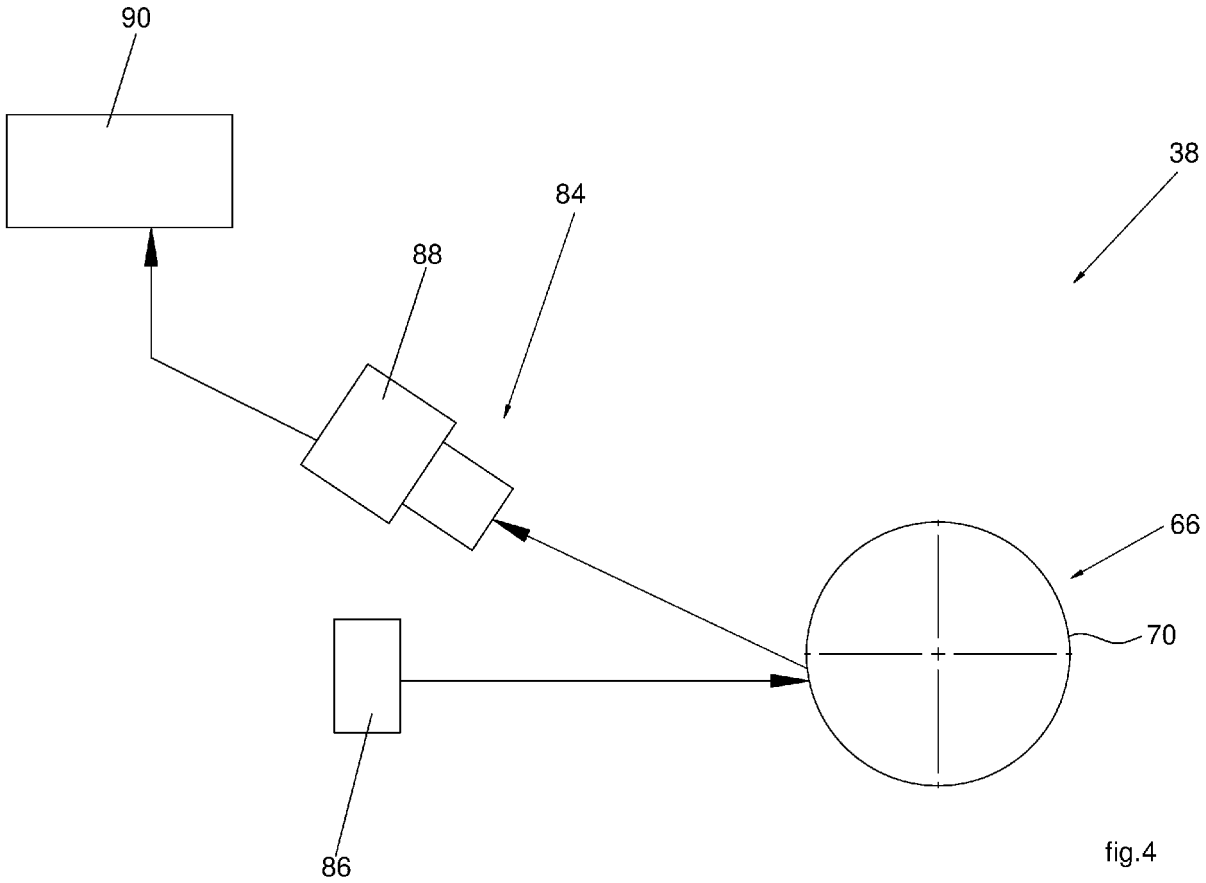

fig.4

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Description

TEXT OF THE DESCRIPTION

Field of the invention

[0001] The present invention relates to a method for controlling the operating conditions of a wetting roller.

[0002] The invention has been developed, in particular, with a view to its application in the production of single-dose capsules (also called pods) for home care, such as laundry detergents, dishwasher detergents, fabric softeners and other compositions used in household appliances.

[0003] According to another aspect, the invention relates to a control device for controlling the operating conditions of a wetting roller and to a machine for producing single-dose capsules including such a control device.

[0004] In the following description, reference will be made to this specific application field without, however, losing generality.

Description of the prior art

[0005] Single-dose capsules are formed by one or more fluid or powder compositions, for example, of laundry or dishwasher detergent, enclosed between two water-soluble films.

[0006] Single-dose capsules are becoming increasingly popular due to their ease of use for the user, and they also have a positive impact on sustainability as they are a way to reduce detergent waste as each capsule contains the precise dose of detergent for one load.

[0007] Single-dose capsules are generally produced by forming recesses in a first water-soluble film, filling the recesses with fluid or powder compositions, applying a second water-soluble film over the first water-soluble film, and binding the first and second water-soluble films together to seal the compositions between the two water-soluble films.

[0008] Water-soluble films are typically formed from polyvinyl alcohol (PVA) or a derivative of PVA, and are designed to be soluble in cold water. These water-soluble films are not heat-sealable like thermoplastic films used for packaging food items.

[0009] Binding of the water-soluble films is typically accomplished by wetting one of the two water-soluble films and pressing the films together around the recesses containing the compositions.

[0010] The wetting phase of the water-soluble film is a key point in the single-dose capsule formation process. Since water-soluble films are specifically designed to dissolve upon contact with water, it is critical that the water-soluble film is wetted by a precise amount of water, which should be high enough to achieve proper sealing of the capsules, which prevents leakage of the compositions, but low enough to prevent the dissolution of water-soluble films.

[0011] In machines for producing single-dose capsules, the wetting of one of the water-soluble films is carried out by a wetting roller rotating around a horizontal axis, and having an outer surface on which a layer of water is deposited. The water-soluble film is advanced into contact with the outer surface of the wetting roller and during rotation of the wetting roller some of the water retained on the outer surface of the roller is released to the water-soluble film.

[0012] A more or less prolonged stop of the rotation of the wetting roller, for example during machine stops or maintenance operations, tends to cause unsuitable wetting conditions on the roller surface. In particular, prolonged stops of the machine cause the drying and hardening of the outer surface of the wetting roller, which require long start-up times and waste of material during the start-up of the machine.

[0013] Machines according to the state of the art do not provide an automatic system which checks the distribution of water on the surface of the wetting roller. The control of the correct quantity and uniformity of the water on the wetting roller is left to the experience and sensitivity of the operator.

[0014] When the machine restarts, especially after a more or less prolonged machine stop, the time necessary for the wetting roller to return to ideal operating conditions for correct operation is not known, and during the transient defective capsules or large quantities of waste may be produced.

[0015] The problems caused by the stopping of the wetting roller are so severe that many manufacturers keep the wetting roller running even when the machine is stopped.

Object and summary of the invention

[0016] The object of the present invention is to provide a method for controlling the operating conditions of a wetting roller which overcomes the problems of the prior art.

[0017] According to the present invention, this object is achieved by a method having the characteristics forming the subject of claim 1.

[0018] According to another aspect, the invention relates to a device for controlling the operating conditions of a wetting roller having the characteristics of claim 5, a machine for producing single-dose capsules including this control device, and a computer program having the characteristics of claim 10.

[0019] Preferred embodiments of the invention form the subject of the dependent claims.

[0020] The claims form an integral part of the disclosure provided here in relation to the invention.

Brief description of the drawings

[0021] The present invention will now be described in detail with reference to the attached drawings, given purely by way of non-limiting example, in which:

- Figure 1 is a schematic view of a machine for producing single-dose capsules,
- Figures 2 and 3 are schematic views of possible embodiments of a wetting roller,
- Figure 4 is a schematic view of a device for controlling the operating conditions of a wetting roller, and
- Figures 5 and 6 are graphs illustrating the distribution of the degrees of gray in a digitized image of the surface of the wetting roller, respectively, in a condition of dry roller and wet roller.

Detailed description

[0022] With reference to Figure 1, a machine for producing single-dose capsules is indicated by the reference number 10.

[0023] The machine 10 comprises a forming surface 12 having a plurality of cavities 14, continuously movable in a machine direction MD. In the embodiment shown in Figure 1 the forming surface 12 is the outer cylindrical surface of a drum 16 rotating about a horizontal axis A. In a possible embodiment, the forming surface 12 may be the outer surface of a closed-loop belt.

[0024] The machine 10 comprises a first feeding unit 18 configured to feed a first continuous water-soluble film 20 onto the forming surface 12. The first continuous water-soluble film 20 is unwound from a first reel 22 and is fed to the forming surface 12 at a first position 24.

[0025] The first continuous water-soluble film 20 is held on the forming surface 12, for example, by suction, while moving in the machine direction MD, and is deformed within recesses 14 of the forming surface 12.

[0026] The machine 10 comprises a second feeding unit 28 configured to feed a second water-soluble film 30 unwound from a second reel 34 onto the forming surface 12 at a second position 32 located downstream of the first position 24 with respect to the machine direction MD.

[0027] The machine 10 comprises a dosing apparatus 36 configured to dispense metered quantities of at least one fluid composition into the recesses of the first continuous water-soluble film 20. The dosing apparatus 36 is located in an intermediate position between the first position 24 and the second position 32. After the recesses of the first continuous water-soluble film 20 have been filled with the fluid compositions, the second continuous water-soluble film 30 is applied onto the first continuous water-soluble film 20, so as to enclose the metered amounts of fluid compositions contained in the recesses between the first and the second continuous water-soluble films 20, 30. The dosing apparatus 36 comprises at least one dosing unit 50 having respective nozzles 58 connected to a fluid delivery system via a line 62.

[0028] The machine 10 comprises a wetting unit 38 configured to wet a surface of the second continuous water-soluble film 30 upstream of said second position 32. The wetting unit 38 is configured to wet the surface of the second continuous water-soluble film 30, which will be placed in contact with the first continuous water-soluble film 20. The first and second continuous water-soluble films 20, 30 are water-bonded to each other along contact areas surrounding the recesses containing the metered fluid compositions.

[0029] The machine 10 comprises a longitudinal cutter 40 and a transversal cutter 42, which cut the first and second continuous water-soluble films 20, 30 so as to form single-dose capsules, which are collected on an outlet conveyor 44. The scraps of the water-soluble films originating from the longitudinal and transversal cuts are removed by a scrap suction device 46.

[0030] The wetting unit 38 comprises a wetting roller 66 and a film guide device 64 configured to guide the second continuous water-soluble film 30 so that it passes into contact with the outer surface of the wetting roller 66.

[0031] With reference to Figure 2, in a possible embodiment the wetting roller 66 may comprise an outer tubular member 68 having an outer surface 70. The outer tubular member 68 may be made of an elastically deformable waterpermeable material, for example, polyvinyl alcohol (PVA), which allows the passage of water in a radial direction from the inside to the outside. The wetting roller 66 may comprise an inner central element 74 formed, for example by a metal shaft, connected to a water supply line 78 via a rotating connector. The water supply line 78 is connected to a water tank 82.

[0032] With reference to Figure 3, in a possible embodiment the wetting roller 66 may have an outer surface 70 of hydrophilic material, for example felt. A lower part of the wetting roller 66 may be immersed in the water contained in a tray 72.

[0033] Referring to Figure 4, the wetting unit 38 comprises a control device 84 configured to control the operating conditions of the wetting roller 66. The control device 84 comprises an infrared illuminator 86 configured to illuminate the outer surface 70 of the wetting roller 66 with infrared radiation, and a sensor 88 sensitive to infrared radiation and configured to receive infrared radiation reflected from the outer surface 70 of the wetting roller 66.

[0034] The control device 84 is based on the fact that the outer surface 70 of the wetting roller 66 has a substantially different reflectivity of the infrared radiation when the outer surface 70 is dry or wet.

[0035] Tests carried out by the Applicant have shown that when the outer surface 70 of the wetting roller 66 is illuminated with infrared radiations having wavelengths included in the range 1450 nm $\pm$ 200 nm, the film of water present on the outer surface 70 of the wetting roller 66 absorbs almost all of the infrared radiation, while the outer surface 70 of the wetting roller 66 in dry conditions reflects a substantial portion of the infrared radiation.

[0036] Thus, by illuminating the outer surface 70 of the wetting roller 66 with infrared radiation with wavelengths concentrated around 1450 nm and by acquiring the reflected image with a sensor, for example, an infrared optical sensor, reliable information on the state of wetting of the outer surface 70 of the wetting roller 66 is obtained.

[0037] The sensor 88 may be a SWIR camera. SWIR cameras are sensitive to infrared radiation with a wavelength between 1400 - 3000 nm. The sensor 88 may be a matrix or a line scan camera.

[0038] The sensor 88 is configured to provide a signal indicative of the intensity of infrared radiation reflected by the outer surface 70 of the wetting roller 66.

[0039] In a possible embodiment, the sensor 88 may be configured to acquire an image, for example, a digital image, of at least one part of the outer surface 70 of the wetting roller 66, formed by a matrix of pixels wherein each pixel is associated with a respective outer surface area 70 of the wetting roller 66, and wherein each pixel has an intensity value indicative of the intensity of infrared radiation reflected from the respective outer surface area 70 of the wetting roller 66.

[0040] The signal supplied by the sensor 88 is sent to a processing unit 90 equipped with an image processing program configured to generate information indicative of the intensity of the infrared radiation reflected by the outer surface 70 of the wetting roller 66, and to determine the operating conditions of the wetting roller 66 as a function of said information.

[0041] The information indicative of the intensity of the infrared radiation reflected by the outer surface 70 may be the average value of the intensity of the infrared radiation reflected by various areas of the outer surface 70 of the wetting roller 66.

[0042] The processing unit 90 may also be configured to determine a difference between a maximum value and a minimum value of the intensity of the infrared radiation reflected by the outer surface 70 of the wetting roller 66, which is indicative of the uniformity of the film of water present on the outer surface 70.

[0043] Figures 5 and 6 are graphs which report on the x-axis the intensity value I of the reflected infrared radiation, and on the y-axis the number of pixels N of the image which have the intensity value I.

[0044] The intensity value I may vary from zero for zeroreflected radiation (corresponding to black in a gray scale) to a maximum value corresponding to 100% of the reflected radiation (corresponding to white in a gray scale) .

[0045] The mean value of the graphs along the x-axis indicates the mean value of the intensity of the infrared radiation reflected by the outer surface 70 of the wetting roller 66. The graph of Figure 5 refers to the image of a completely dry outer surface 70, and the graph of Figure 6 refers to the image of a correctly wetted outer surface 70. The average value of the graphs indicated with Im is indicative of the average wetting degree of the outer surface 70. For example, it is possible to gradually vary the degree of wetting and identify the corresponding mean value Im to identify the relationship between the mean value Im and the degree of wetting. In this way, it is possible to identify a threshold value of the Im above which it is believed that the wetting roller is wet enough to operate. This threshold value varies according to the equipment and processes involved, and may be identified by a satisfactory level of welding between the sheets verified, for example, with any known standard method. The difference between the maximum and minimum intensity values, indicated with Imax and Imin, is indicative of the uniformity of the film of water present on the outer surface 70.

[0046] The processing unit 90 compares the mean intensity value Im with a predetermined reference range. The wetting conditions of the outer surface 70 of the wetting roller 66 are considered correct if the mean intensity value Im is included in the pre-established reference range. Conversely, the wetting conditions of the outer surface 70 of the wetting roller 66 are considered incorrect if the average intensity value Im is outside the predetermined reference range.

[0047] The processing unit 90 may also compare the difference D between the intensity values Imax and Imin with a predetermined reference range. The conditions of wetting uniformity of the outer surface 70 of the wetting roller 66 are considered correct if the difference D between the intensity values Imax and Imin is included in the predetermined reference range. Conversely, the conditions of wetting uniformity of the outer surface 70 of the wetting roller 66 are considered incorrect if the difference D between the intensity values Imax and Imin is outside the predetermined reference range.

[0048] Using this method it has been determined that after a prolonged stop of the machine, which causes the wetting roller 66 to become completely dry, the average time required to restore the wetting roller 66 to an operating condition is about 45 min.

[0049] The information provided by the control device 84 may be used to generate an alarm signal in the event that the detected degree of wetting of the outer surface 70 of the wetting roller 66 is outside the correct operating range.

[0050] The information provided by the control device 84 may also be used in feedback to control the supply of water to the wetting roller 66, thereby increasing the degree of wetting of the outer surface 70 of the wetting roller 66 when a trend is detected of reducing the wetting degree and, conversely, so as to reduce the wetting degree of the outer surface 70 of the wetting roller 66 when a tendency to increase the wetting degree is detected.

[0051] One of the advantages of the method and of the device according to the present invention is that the optical detection of the reflected infrared radiation is not influenced by humidity or by the lighting conditions of the environment.

[0052] Furthermore, the method and the device according to the present invention allow the control of both the wetting degree and the uniformity of the wetting degree on the outer surface of the wetting roller.

[0053] The control device according to the present invention may be used together with a device which controls the quantity of water applied to the film of water-soluble material downstream of the wetting unit 38, which

may, for example, be made as described in the European patent application EP21182827 by the same Applicant. The use of a device controlling the wetting roller operating conditions together with a device that detects the amount of water applied to the water-soluble film provides an integrated control of the process and the product, which optimizes the quality of the finished products and analytically controls the evolution of the process variables in real time.

[0054] Of course, without prejudice to the principle of the invention, the details of construction and the embodiments can be widely varied with respect to those described and illustrated, without thereby departing from the scope of the invention as defined by the claims that follow.

Claims

1. A method for controlling the operating conditions of a wetting roller (66) having an outer surface (70), comprising:

   - illuminating the outer surface (70) with infrared radiation,
   - receiving the infrared radiation reflected from the outer surface (70) by means of a sensor (88) sensitive to infrared radiation, and
   - processing the signals emitted by said sensor (88), generating information indicative of the intensity of the infrared radiation reflected from the outer surface (70), and determining the operating conditions of the wetting roller (66) as a function of said information.

2. The method of claim 1, comprising acquiring an image of at least one part of the outer surface (70), formed by a pixel matrix wherein each pixel is associated with a respective area of the outer surface (70), wherein each pixel has an intensity value indicative of the intensity of the infrared radiation reflected by the respective area of the outer surface (70), determining an average value (Im) of the intensity of said pixels of said image and determining the degree of wetting of the outer surface (70) as a function of said average value (Im) .

3. The method of claim 2, comprising determining a difference (D) between a maximum and a minimum value (Imax, Imin) of the intensity of said pixels of said image, and determining the uniformity of the degree of wetting of the outer surface (70) as a function of said difference (D).

4. The method of any of the preceding claims, comprising illuminating the outer surface (70) with infrared radiations having wavelengths between 1250 nm and 1650 nm.

5. The method of claim 3 or claim 4, comprising determining a time necessary to bring the wetting roller (66) to an operating condition in which said average value (Im) and said difference (D) are included in respective predetermined ranges.

6. A device for controlling the operating conditions of a wetting roller (66) having an outer surface (70), comprising:

   - an infrared illuminator (86) configured to illuminate the outer surface (70) with infrared radiation,
   - a sensor (88) configured to receive the infrared radiation reflected from the outer surface (70), and
   - a processing unit (90) configured to process the signals from said sensor (88) and to generate information indicative of the intensity of the infrared radiation reflected by the outer surface (70) and to determine the operating conditions of the wetting roller (66) according to said information.

7. The device of claim 6, wherein said processing unit (90) is configured to acquire from said sensor (88) an image of at least one part of the outer surface (70), formed by a pixel matrix wherein each pixel is associated with a respective area of the outer surface (70) and wherein each pixel has an intensity value indicative of the intensity of the infrared radiation reflected by the respective area of the outer surface (70), and wherein said processing unit (90) is configured to determine an average value (Im) of the intensity of said pixels of said image and to determine the degree of wetting of the outer surface (70) as a function of said average value (Im) .

8. The device of claim 7, wherein said processing unit (90) is configured to determine a difference (D) between a maximum and a minimum value (Imax, Imin) of the intensity of said pixels of said image and for determining the uniformity of the degree of wetting of the outer surface (70) as a function of said difference (D) .

9. A machine (10) for producing single-dose capsules comprising a device for controlling the operating conditions of a wetting roller (66) according to any of claims 6-8.

10. A computer program comprising instructions which, when the program is executed by a computer, cause the computer to perform the method of any of claims 1-5.

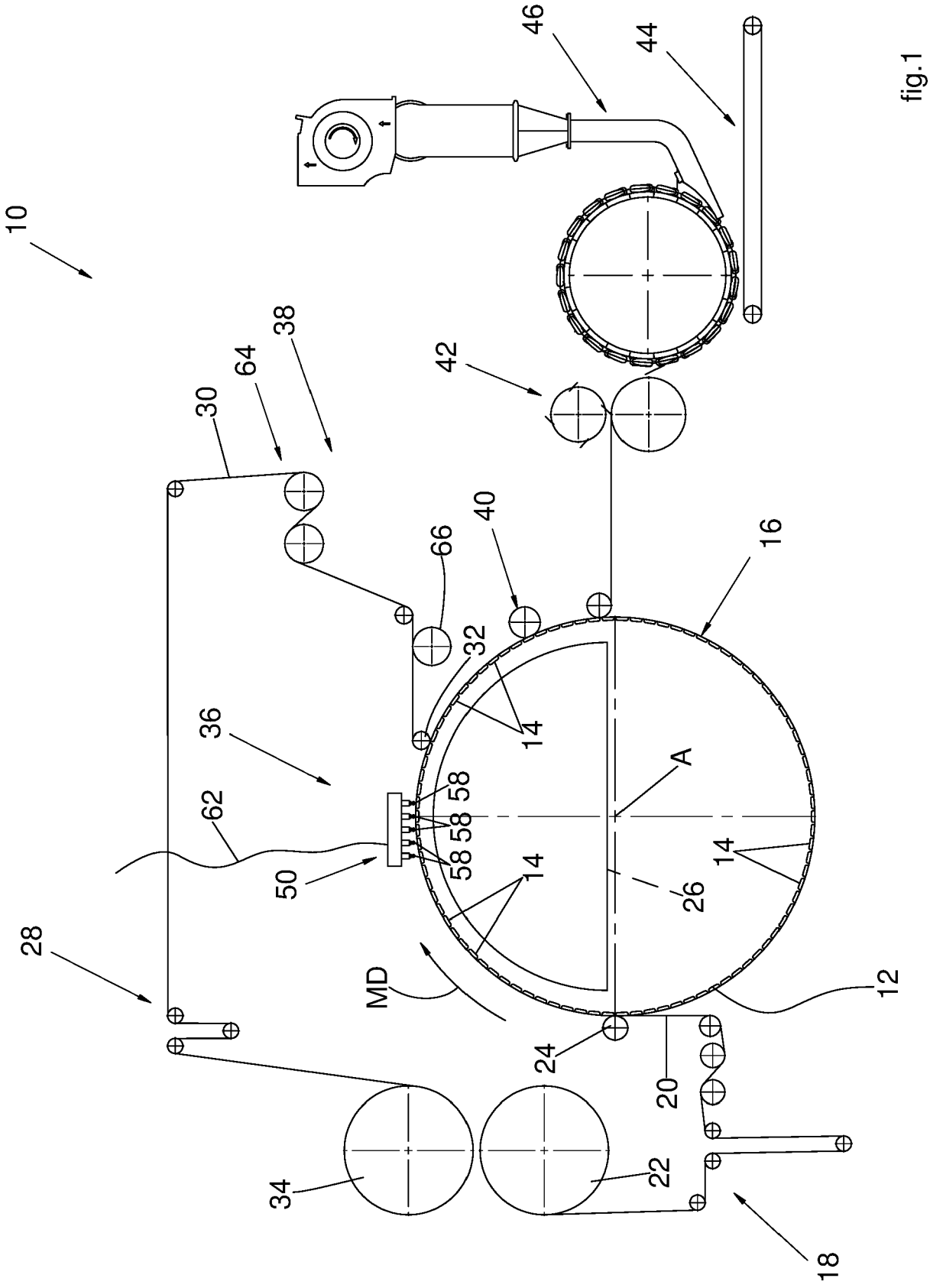
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fig.1

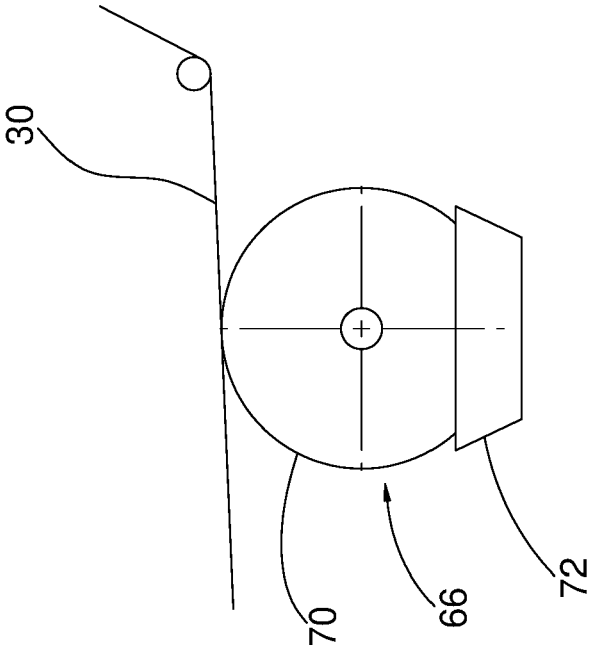

fig.3

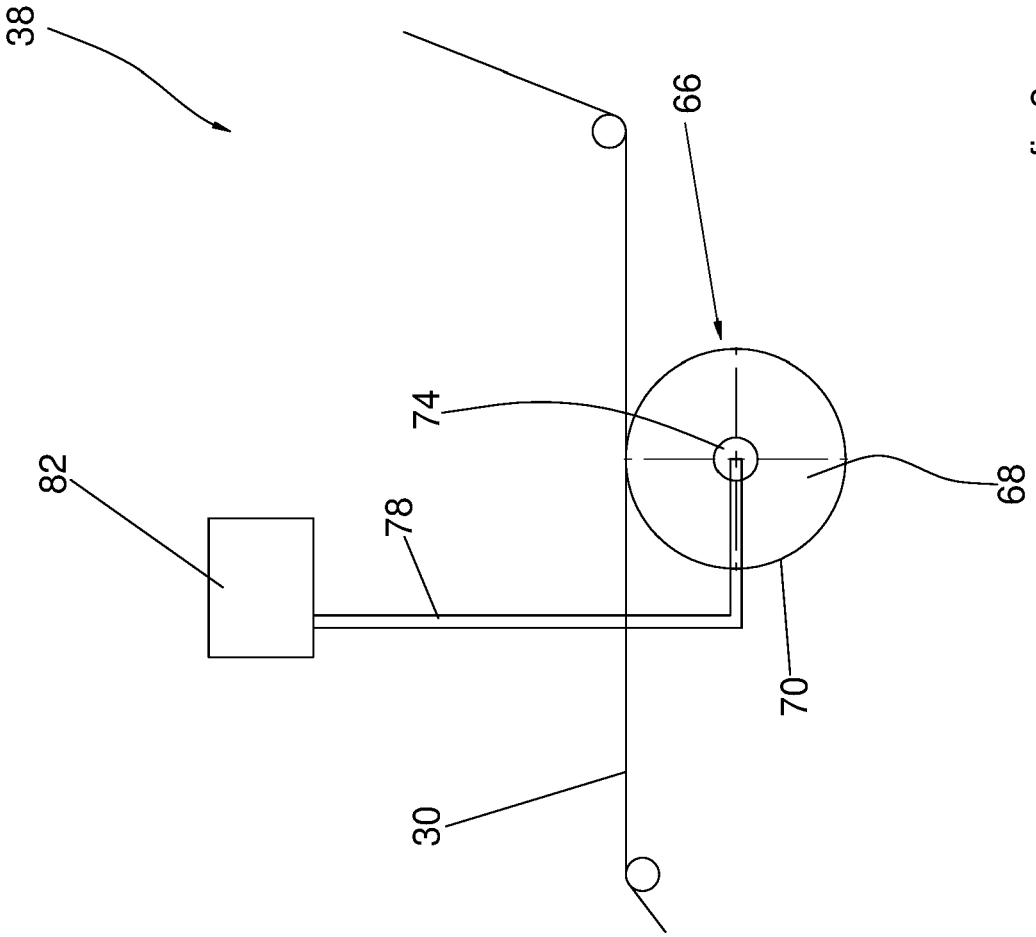

fig.2

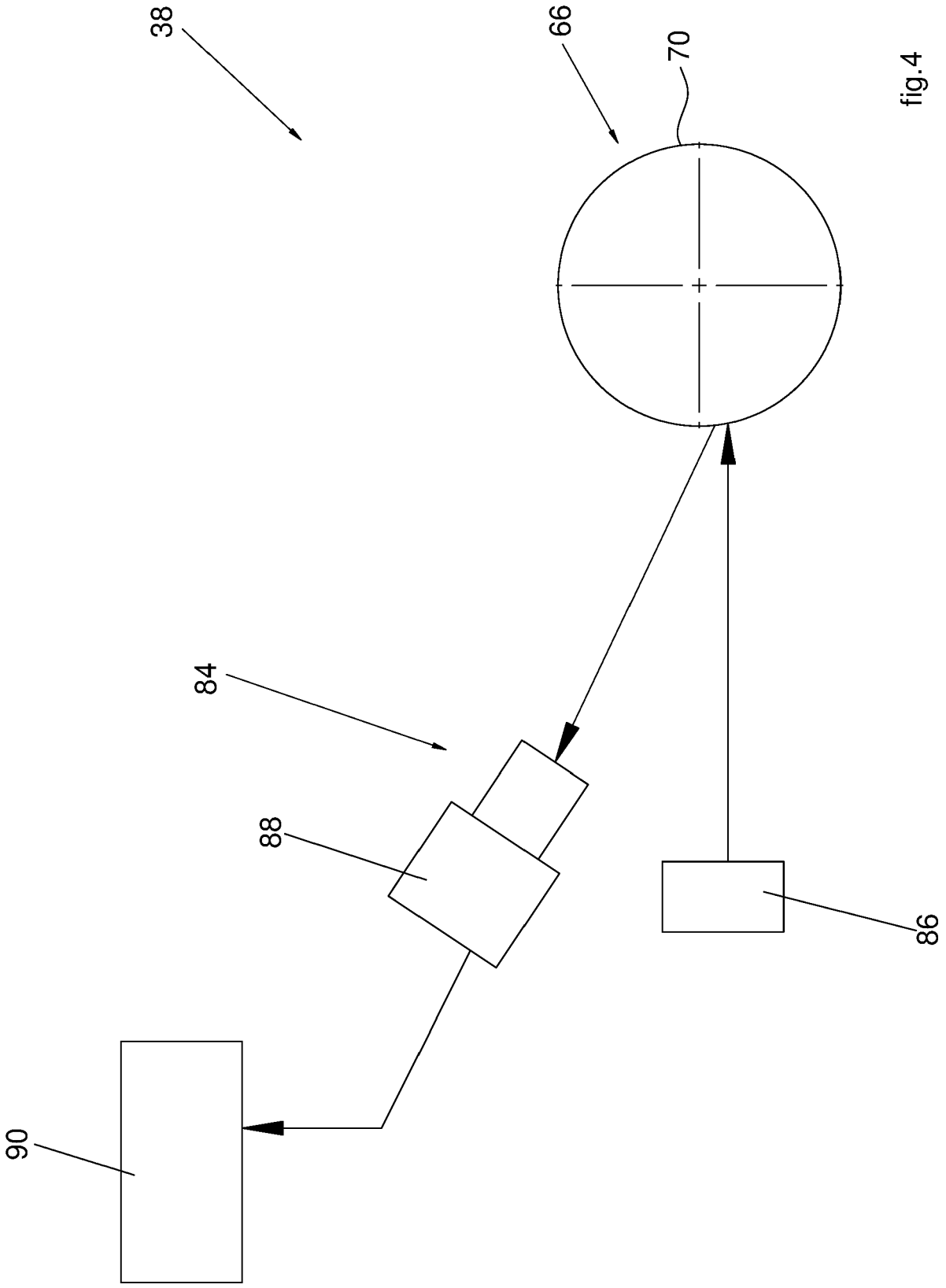

fig.4

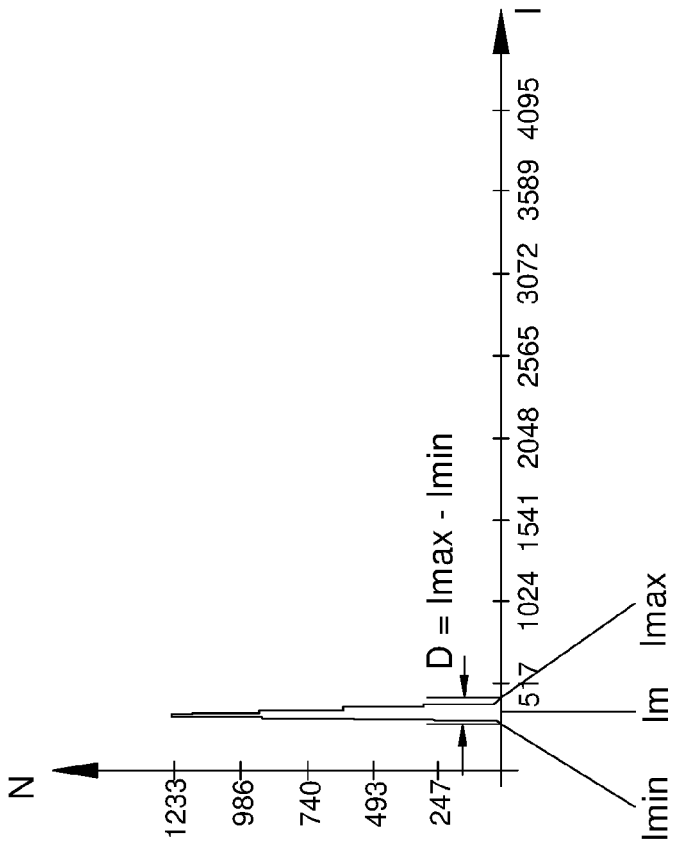
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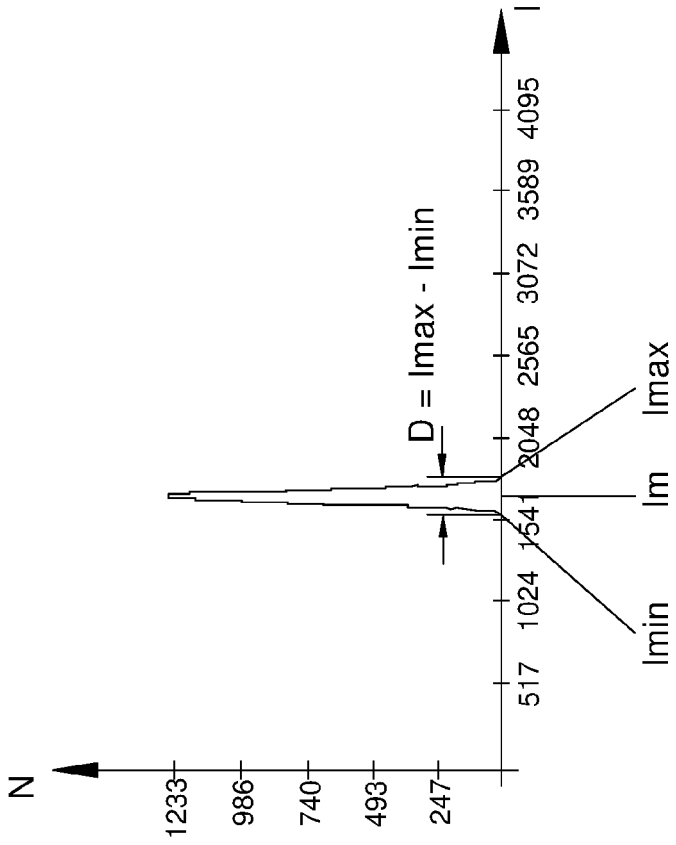
fig.6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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 2217

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G01B
B05C
B65B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 August 2023	Yazici, Baris

CATEGORY OF CITED DOCUMENTS

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