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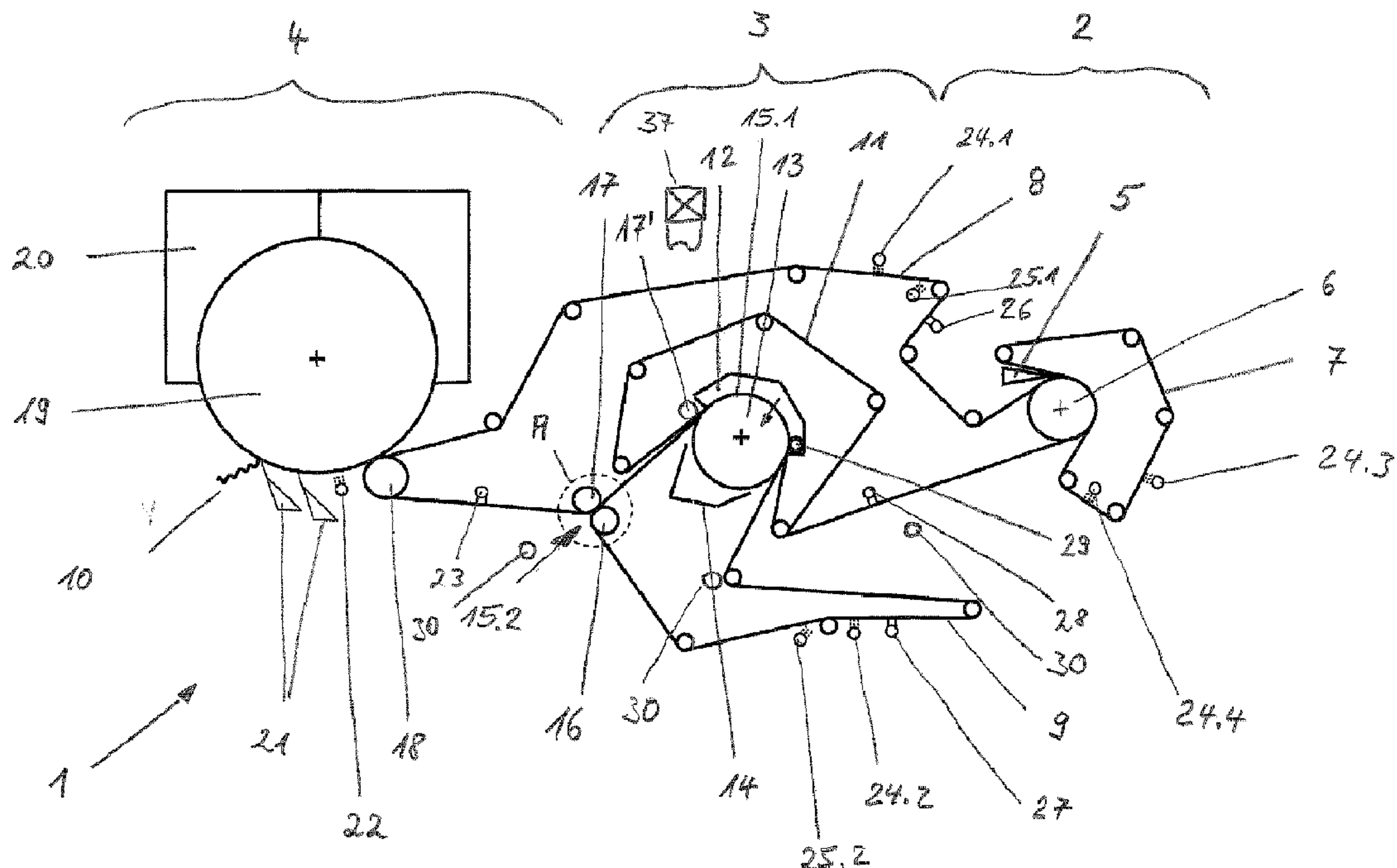
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(54) **Titre : DISPOSITIF ET PROCEDE DE FABRICATION D'UNE BANDE DE MATIERE**

(54) **Title: DEVICE AND METHOD FOR PRODUCING A MATERIAL WEB**



(57) **Abrégé/Abstract:**

A device for dewatering of a fibrous web comprises a first press zone with a length L_1 , through which fibrous web lying between a revolving permeable belt and a revolving permeable support belt is directed, whereby a fluid can flow through the permeable belt,



(57) Abrégé(suite)/Abstract(continued):

web and support belt, at least over a section of L_1 ; a second press zone having a length L_2 following the first zone, the second zone dewatering the web, the web being separated from the support belt after the second zone; and a third press zone following the second zone, the web running with the permeable belt to the third zone. The web is carried through the second zone between two belts having different compressibilities. L_1 is larger than and more than ten times as long as L_2 . The permeable belt is the lower compressibility belt and is directed through the second zone.

Abstract

A device for dewatering of a fibrous web comprises a first press zone with a length L_1 , through which fibrous web lying between a revolving permeable belt and a revolving permeable support belt is directed, whereby a fluid can flow through the permeable belt, web and support belt, at least over a section of L_1 ; a second press zone having a length L_2 following the first zone, the second zone dewatering the web, the web being separated from the support belt after the second zone; and a third press zone following the second zone, the web running with the permeable belt to the third zone. The web is carried through the second zone between two belts having different compressibilities. L_1 is larger than and more than ten times as long as L_2 . The permeable belt is the lower compressibility belt and is directed through the second zone.

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Device and method for producing a material web

The invention relates to a device for dewatering a fibrous web, especially a tissue web, having a first press zone with a press zone length L_1 through which the fibrous web which is arranged between a revolving permeable belt and a revolving permeable support belt is directed. The first press zone is designed so that a fluid can flow through the belt, the fibrous web and the support belt, at least over a section of the press zone length L_1 . In addition the device comprises a second press zone having a press zone length L_2 following the first press zone. The invention further relates to a method for dewatering a fibrous web and a machine to produce a fibrous web.

Such devices are known for the production of voluminous tissue products of high quality. This quality level is also referred to as "premium tissue". In qualities of this type a voluminous sheet structure with good absorptive capacity and high water retention capacity is especially important. In producing premium tissue, quality is at the foreground. The production methods are very expensive and energy intensive. The costs of these tissue products are therefore very high.

Document WO2005/075736 A2 describes a machine and a method for the production of premium tissue. After the forming section the fibrous web is dewatered in a dewatering device with a belt press. For this purpose the fibrous web is arranged between a structured fabric and a belt, for example a felt and is directed over a suction roll. Said suction roll is operated with a high vacuum in order to gently dewater the web by means of the hot air flowing through it, whereby dewatering is supported by

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the belt press. For additional careful dry content increase, an air press or boost dryer are arranged downstream as an option. These devices are very expensive.

An additional possibility of producing premium tissue is offered by the known "through air drying" method (TAD). In this method large volume flows of hot air or superheated steam are pressed through the fibrous web which is arranged on a structured fabric and directed over a large through-flow cylinder. An expensive air-, steam system is necessary. In the forming section a multitude of vacuum pumps with high energy requirement are required.

In addition to the premium tissue there is tissue of standard quality. This quality is produced on so-called Crescent tissue machines. These proven tissue machines are of very simple construction, use little energy and are designed for production. However, the quality of the produced fibrous web is clearly below that of premium tissue. This is true respectively also for the prices.

Both qualities are established in regional world markets. With the changes which have occurred over the last few years in regard to raw material and the energy situation, the requirements of the market in regard to quality and prices of tissue papers have also changed. The markets increasingly demand new tissue qualities which, on the one hand are lower than the premium quality, however are clearly higher than the standard quality, and on the other hand require substantially less energy at lower consumption of high-grade raw materials for the production of the tissue papers.

It is therefore the objective of the current invention to specify a solution for cost-effective production of tissue papers of intermediate quality. In addition, the tissue machine for the production of tissue papers of intermediate quality is to be designed flexible so that it is possible through speedy modification of the machine to produce premium qualities as well as also standard and intermediate qualities.

Accordingly, there is provided a device for dewatering of a fibrous web, especially a tissue web is suggested, having a first press zone with a press zone length L_1 , through which the fibrous web which is arranged lying between a revolving permeable belt and a revolving permeable support belt is directed, whereby the first press zone is designed so that a fluid can flow through the permeable belt, the fibrous web and the support belt, at least over a section of the press zone length L_1 and with a second press zone having a press zone length L_2 following the first press zone. The invention is characterized in that the fibrous web is carried through the second press zone between two belts having different compressibilities.

On the one hand this solution offers the advantage that dewatering of the fibrous web in the second press nip is implemented gently and efficiently. Due to the different compressibility of the belts in the second press nip it is ensured that the fibrous web adapts to the surface structure of the belt with the lower compressibility, while being pressed against it in the press nip by the belt with the higher compressibility. Because of this different compressibility or softness with simultaneously present elastic behavior of the belt with higher compressibility an intimate contact, uniform across

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the area is created between the fibrous web and the belts. This is ensured in particular also if a belt with a structured surface having pockets or indentations is utilized. This uniform contact favors dewatering, thereby achieving a higher dry content in the tissue web. The energy consumption of the entire production process can thereby be substantially reduced. A three-dimensional structure of the fibrous web and its surface is produced or respectively maintained with the inventive solution while at the same time achieving a high dry content.

This advantage makes it possible to reduce the volume flow of the fluid flowing through the fibrous web in the first press nip and thereby reduce the energy consumption by 25% compared to the premium quality.

Even though the quality compared to the premium quality is lower, it is still substantially better than the standard quality. Tests have shown that the thickness of the fibrous web is somewhat less than with the premium quality, but is however still 50% higher than with standard tissue.

In a preferred embodiment the belt with the higher compressibility which is directed through the second press zone is a felt. A particularly suitable felt is a felt which is consistent with the so-called Vector technology of the applicant. A felt in accordance with this technology comprises a woven base fabric onto which a nonwoven layer consisting of felt fibers – a so-called Vector layer – is applied onto the side facing the fibrous web. The fibers of this layer are aligned three-dimensionally and have a count of greater than 30 dtex, especially greater than 67 dtex, preferably greater than 100 dtex. Or even greater than 140 dtex. This has the advantage that the felt is very open

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and therefore easily dewatered. The air permeability is less than 80 cfm, especially less than 40 cfm, preferably less than 25 cfm.

Moreover, the three-dimensional arrangement of the coarse fibers in the Vector layer provide the felt with good resilience when running through the press nip. The felt is hereby compressed and springs back after the press nip, almost to its original thickness. The Vector layer may have a base weight range of 100 g/m² to 500 g/m². The Vector layer is covered preferably by at least one structure of laid fibers consisting of finer fibers which comes into contact with the fibrous web. These finer fibers have a count of less than 30dtex, especially less than 12 dtex, preferably less than 4detex.

In a practical embodiment an additional layer is provided between the at least one structure of laid fibers and the Vector layer whose fibers possess a count which is between the count of the fibers in the Vector layer and those in the laid fibrous structure which is in contact with the fibrous web. The count of the fibers in the additional layer is for example between 8 and 15 detx, preferably 10 detx.

In an additional preferred embodiment the belt with the lower compressibility which is directed through the second press zone is a belt having a structured surface and/or is a TAD-fabric. The belt with lower compressibility can preferably comprise a woven structure and/or a nonwoven structure, for example a structured membrane.

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It is advantageous if the permeable belt of the first press nip has a structured surface and/or is in the embodiment of a TAD-fabric. The permeable belt can preferably comprise a woven structure and/or a non-woven structure, for example a structure membrane.

A structured belt in accordance with the invention is designed so that the fibrous web itself receives a surface structure through the structure of the structured surface of the belt, thereby improving the quality of the tissue web.

According to a practical embodiment, the permeable belt of the first press nip provides the belt with the lower compressibility of the second press zone and is directed through same. This brings the advantage that the fibrous web can remain on the structured surface of the permeable belt and does not have to be transferred. This provides a high specific volume and the structure in the fibrous web.

The device for dewatering a fibrous web is preferably part of a tissue machine, whereby the permeable belt runs through the forming section of the tissue machine and the fibrous web is created and formed on this belt. The fibrous web remains advantageously on the permeable belt until the transfer to a drying cylinder to complete drying of the fibrous web. The transfer of the fibrous web occurs in a press zone which is formed by a press roll and a Yankee drying cylinder. For premium tissue the press roll is a smooth press roll without suction, and for an intermediate tissue quality it is a suction equipped suction press roll.

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The inventive solution can also be used in a twin wire former. In this type of former the fibrous web is transferred to a carrier belt after the forming section. The fibrous web is expediently transferred to the permeable belt.

It is advantageous if the belt with the lower compressibility has a coarser surface and/or a higher air permeability than the belt having the higher compressibility or greater softness.

In an additional embodiment the belt with the lower compressibility is a fine fabric with a thread density of the warp threads greater than 14.1 threads (Fd) per cm (36 threads/inch), especially equal or greater than 17.3 threads (Fd) per cm (44 threads/inch), preferably greater than 22 threads (Fd) per cm (56 threads/inch). This permits uniform close contact of the fibrous web with the fabric and the felt, thereby achieving a high dry content after the press.

It is advantageous if the belt with the lower compressibility is a finer fabric and the weft threads have a diameter of less than or equal to 0.45 mm, especially less than or equal to 0.41 mm, preferably less than or equal to 0.35 mm and advantageously less than or equal to 0.35 mm and the warp threads have a diameter of less than or equal to 0.40 mm, especially less than or equal to 0.35 mm, preferably less than or equal to 0.30 mm. The fabric thickness is in the range of 0.5 to 1 mm.

In a practical embodiment the belt with the lower compressibility is a fine fabric having an air permeability greater than 14.16 m³/min (500 cfm), especially greater than 15.58 m³/min (550 cfm), preferably equal or greater than 17 m³/min (600 cfm).

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This is especially advantageous if the fine fabric runs through the first and the second press nip.

It is advantageous if the belt with the lower compressibility is a fine fabric, whereby at least the side contacting the paper has a contact area of equal or greater than 20%, preferably equal or greater than 25%, especially greater than 27%. This is especially advantageous if the fibrous web is transferred directly from the fabric to the Yankee drying cylinder. At the areas of these contact points the fibrous web is pressed onto the surface of the drying cylinder. The stability of these press zones is hereby increased and thereby also the stability of the fibrous web. This allows use of cost-effective raw materials at constant stabilities. This contact area can be obtained by sanding or crimping of the fabric. With tissue webs of intermediate quality the contact area may be in a range of 20 to 32%.

In an additional embodiment the belt with the lower compressibility is a fine fabric with a structured surface. This has raised and indented zones, whereby the indented zones form pockets.

The raised and indented zones are arranged uniformly on the fabric surface. Ornament structures can be superimposed.

The belt with the lower compressibility is preferably a fine fabric, whereby the surface portion of the raised zones of the paper-contact side is equal or greater than 20%, preferably equal or greater than 25%, especially equal or greater than 27%.

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According to one advantageous embodiment of the invention, the belt with the lower compressibility is a fine fabric with a structured surface of fewer than 77.4 pockets per cm^2 (500 pockets per inch^2), advantageously less than 38.7 pockets per cm^2 (250 pockets per inch^2), especially preferably with equal or fewer than 31 pockets per cm^2 (200 pockets per inch^2), in particular fewer than 28 pockets per cm^2 (180 pockets per inch^2), preferably less than 23 pockets per cm^2 (150 pockets per inch^2).

Depending upon requirement, a belt with the lower compressibility in the form of a fine fabric having a structured surface of more than 23 pockets per cm^2 (150 pockets per inch^2), in particular more than 69.7 pockets per cm^2 (450 pockets per inch^2) can be used. Applications are also possible in which very finely structured fabrics, having up to 154.8 pockets per cm^2 (1000 pockets per inch^2) are used.

For the production of toilet paper for example a fine fabric is used as belt, having a structured surface comprising up to 69.7 pockets per cm^2 (450 pockets per inch^2), in particular 55.7 pockets per cm^2 (360 pockets per inch^2). Depending upon the quality requirements the lower value of the number of pockets can be between 46.4 pockets per cm^2 (300 pockets per inch^2) and 3.87 pockets per cm^2 (25 pockets per inch^2).

In the production of fibrous webs for kitchen rolls a fine fabric with a structured surface is appropriately used as the belt with the lower compressibility, which has fewer than 40.3 pockets per cm^2 (260 pockets per inch^2) and more than 3.87 pockets

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per cm² (25 pockets per inch²). For a greater water absorption capacity the number of pockets is preferably between 31 pockets per cm² (200 pockets per inch²) and 23.2 pockets per cm² (150 pockets per inch²).

In an additional embodiment, the belt with the higher compressibility has a dynamic modulus for compressibility "G" of equal or higher than 0.5 N/mm², especially higher than 2 N/mm², preferably higher than 4 N/mm². In a practical case the dynamic modulus for compressibility can be equal or higher than 0.05 kN/mm², in particular higher than 1 kN/mm², preferably higher than 4 kN/mm². This dynamic modulus for compressibility "G" is a measure for the resilience or recovery properties of the belt.

The dynamic modulus for compressibility is consistent with the quotient from the pressure tension (N/mm²) and the relative change in thickness (-) of the felt during compression. These values can be determined with the assistance of a measuring device. The measuring device for example, has two plungers which are pressed against each other and each having a respective area A. The belt, or respectively felt sample is compressed between the plungers with a constant force F. The occurring change in thickness delta D is hereby measured by means of a position measuring system of a plunger. The dynamic modulus for compressibility is calculated from $G=F/A/(\text{delta } D)$. With this measuring method the dynamic modulus for compressibility can be determined for the belt with the high as well as for the belt with the low compressibility.

The belt may be new or run in when measurements are taken.

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Moreover it is advantageous if the belt with the higher compressibility has a dynamic stiffness K^* of less than 100000 N/mm, in particular less than 90000 N/mm and preferably equal or less than 70000 N/mm. The dynamic stiffness K^* (N/mm) is a measurement for the compressibility, whereby the compressibility provides the change in thickness of a belt in mm per force (N).

The dynamic stiffness K^* is calculated from the reciprocal value of the compressibility. The compressibility is hereby the quotient from the change in thickness ΔD and the force, measured with the aforementioned measuring device.

In a practical embodiment the permeable support belt of the first press zone provides the belt having the higher compressibility of the second press zone and is directed through same. This embodiment provides stable web travel, good runability and a cost-effective solution.

In an additional embodiment the permeable support belt does not have a structured surface and/or is in the embodiment of a felt.

In an additional embodiment of the invention the fluid which flows through the belt, the fibrous suspension, and at least in sections of the press zone length L_1 through the support belt is in the form of air and/or hot air and/or steam.

In accordance with a practical embodiment, press zone length L_1 is larger than press zone length L_2 . Press zone length L_1 in particular is more than ten times as long as press zone length L_2 , preferably twenty times as long as press zone length L_2 ,

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in particular thirty as long as press zone length L_2 . In a preferred embodiment the first press zone has for example a press zone length L_1 of 1200 mm.

In the first press nip gentle dewatering occurs at a low pressing power. A higher pressing power is applied in contrast in the second press nip. In addition to the technological advantages, this combination has the effect that the belt with the higher compressibility is cleaned by the higher, momentary press impulse. This is especially advantageous for a felt.

According to a preferred embodiment the first press zone is provided by a permeable press element and a permeable opposite element. The permeable press element is preferably in the embodiment of a press belt and/or a press shoe.

The press belt consists of a belt having a tensile strength, preferably a woven fabric or a spiral screen or a metal screen or a perforated metal belt or a belt consisting of a composite material. In order to produce the press pressure the press belt is tensioned with 40 kN/m to 60 kN/m and is directed over the suction roll or the curved surface.

To provide the fluid a pressure hood is allocated to the press element in a preferred embodiment. The fluid can have overpressure or can be provided with ambient pressure.

According to an additional preferred practical embodiment the opposite element consists of a roll or a chest with curved or flat contact surface.

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The opposite element in the first press zone is preferably suction equipped. For producing tissue webs of intermediate quality the vacuum applied to the opposite element is 0.4 to 0.3 bar and is thereby lower than for the production of premium tissue where the applied vacuum is in the range of 0.6 to 0.5 bar. This reduces the operating costs substantially. Here it is advantageous if the fluid in the pressure hood is provided with no, or very little overpressure. This avoids leakages.

In an additional preferred embodiment of the invention the second press zone consists of a press element and a opposite element.

The opposite element of the second press zone is preferably in the embodiment of a smooth and/or hard roll.

The surface of this roll is provided by a roll cover, whereby the thickness of said cover is approx. 15 mm. The surface has a hardness of 0 to 5 P&J, preferably 0 to 1 P&J. In an additional embodiment the surface has grooves which are arranged progressing spirally or parallel in circumferential direction.

An additional embodiment provides that the press element of the second press zone consists of a shoe roll, comprising a press shell and a press shoe.

In a preferred practical embodiment the press element of the second press zone consists of a soft roll. The surface of the roll can have a hardness of 30 to 33 P&J. This roll also consists of a roll core with a roll cover.

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The thickness of the roll cover is in the range of 18 to 25 mm, preferably 19 to 21 mm. The roll cover is selected so that – due to water absorption - the hardness becomes softer during operation of the roll by 4 to 5 P&J points.

In order to ensure good dewatering the press element has a blind bored and grooved surface. The grooves can be arranged preferably progressing spirally or parallel in circumferential direction.

In a practical embodiment a bored suction roll can be the press element of the second press zone.

The line force of the second press zone is preferably in a range of 20 kN/m to 90 kN/m.

The second press zone has a nip length in the range of 20 mm to 250 mm, preferably a length equal or greater than 40 mm.

In a preferred arrangement the opposite element of the second press zone is allocated to the belt having the lower compressibility.

In an additional preferred arrangement the press element of the second press zone is allocated to the belt having the higher compressibility.

In an additional possible embodiment the opposite element of the second press zone is allocated to the opposite element of the first press zone to form the second press zone. This represents an especially cost effective solution, since the opposite element of the

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first press zone simultaneously serves as press element of the second press zone. One press element can therefore be eliminated. For this scenario the opposite press element of the first press zone serving as the press element of the second press zone can be equipped with suction, at least in the area of the second press zone.

The second aspect of the invention to solve the objective is a method to dewater a fibrous web, especially a tissue web, whereby the fibrous web is directed through a first press zone with a press zone length L_1 , arranged lying between a revolving permeable belt and a revolving permeable support belt, whereby a fluid flows through the belt, the fibrous web and the support belt, at least over a section of the press zone length L_1 and is subsequently dewatered in a second press zone having a press zone length L_2 . The method is characterized in that the fibrous web is led through the second press zone between two belts which have different compressibilities.

According to the invention it is advantageous if the fluid first flows through the belt, then through the fibrous web and then through the support belt.

In a preferred embodiment of the method the water in the fibrous web is drained in the first press zone through mechanical pressing power and/or displacement dewatering and/or through thermal drying.

In accordance with an additional design form the fibrous web is dewatered in the second press zone by means of a mechanical pressing power and through the supporting effect of the belt with the higher compressibility. Due to the intimate

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contact of the fibrous web with the belt with the higher compressibility, capillary effects can be utilized for a better dewatering result.

The third aspect of the invention to solve the objective relates to a machine for the production of a fibrous web especially a tissue web, comprising the press zone according to the first aspect of the invention, as well as a third press zone consisting of a press element and a drying cylinder, in particular a Yankee cylinder, through which the fibrous web (10) is directed together with clothing, whereby the machine includes additional devices which make it possible to realize various machinery concepts consisting of a selection and/or combination of the three press zones.

According to a preferred practical embodiment of the invention, the additional devices consist of a selection of at least one of the elements - guide rolls, adjustment rollers with web guides, tension rollers with tensioning devices, belt cleaning devices, cantilever devices. The tissue machine is therefore equipped more comprehensively than would be required for the individual types and qualities. The machine frame for example includes mounts for the additional devices, for example for the rolls, which are required only for the production of standard qualities, but not for the production of premium qualities.

It is also advantageous if the frame can be cantilevered, which means, the frame includes a cantilever support extending transversely to the machine which, during a replacement of the clothing carries and supports the drive-side frame so that a new, seamless clothing can be installed in a short time period. This solution is advantageous especially when using a fabric with a structured surface as provided by the invention,

since these fabrics are seamless because of detrimental markings. Without cantilevering, fabric replacement would be very time consuming.

These additional devices therefore allow rapid modification of the machine according to the requirements for the production of tissue papers of standard quality (Fig. 4), intermediate quality (Fig. 1 and premium quality (Fig. 3) possible.

A machine equipped in this manner allows the producer of tissue paper to quickly react to market changes. Products with acceptable price-quality ratios can therefore be produced.

The fourth aspect of the invention to solve the objective relates to a device for dewatering of a fibrous web, the device comprising: a first press zone with a press zone length L_1 , through which fibrous web, which is arranged lying between a revolving permeable belt and a revolving permeable support belt, is directed, whereby the first press zone is designed so that a fluid can flow through the permeable belt, the fibrous web and the support belt, at least over a section of the press zone length L_1 ; a second press zone having a press zone length L_2 following the first press zone, the second press zone dewatering the fibrous web and the fibrous web being separated from the support belt after the second press zone; and a third press zone following the second press zone, the fibrous web running with the permeable belt to the third press zone, wherein the fibrous web is carried through the second press zone between two belts which have different compressibilities, and the press zone length L_1 is larger than press zone length L_2 , wherein the permeable belt provides the belt with the lower compressibility of the second press zone and is directed through the second press zone, and wherein the press zone length L_1 is more than ten times as long as press zone length L_2 .

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The fifth aspect of the invention to solve the objective relates to a method to dewater a fibrous web, the method comprising: dewatering the fibrous web through a first press zone with a press zone length L_1 , arranged lying between a revolving permeable belt and a revolving permeable support belt, whereby a fluid flows through the belt, the fibrous web and the support belt at least over a section of the press zone length L_1 ; subsequently dewatering the fibrous web in a second press zone having a press zone length L_2 , the fibrous web being separated from the support belt after the second press zone; and subsequently dewatering the fibrous web in a third press zone, the fibrous web running with the permeable belt to the third press zone, wherein the fibrous web is led through the second press zone between two belts which have different compressibilities and the press zone length L_1 is larger than the press zone length L_2 , wherein the permeable belt provides the belt with the lower compressibility of the second press zone, and is directed through the second press zone, and wherein the press zone length L_1 is more than ten times as long as press zone length L_2 .

Additional characteristics and advantages result from the following description of preferred embodiment examples with reference to the drawings:

Figure 1 a first embodiment of a tissue machine with an inventive device,

Figure 2 an enlarged illustration of a section of detail A of Figure 1,

Figure 3 a second embodiment of a tissue machine for the production of tissue paper of premium quality,

Figure 4 a third embodiment of a tissue machine for the production of tissue paper of standard quality,

Figure 5 Illustration of a section of a structured fabric.

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Figure 1 illustrates a tissue machine for the production of tissue paper of intermediate quality and of premium quality. Machine 1 consists of a forming section 2, an inventive device 3 and a drying section 4. Tissue web 10 is formed in forming section 2. For this purpose a fibrous stock suspension is sprayed by a headbox 5 into a gap which is formed by a permeable belt 8 and an outer forming wire 7. Both clothings 7,8 are directed over a forming roll 6 whereby the fibrous suspension is dewatered and the tissue web 10 is formed. Forming roll 6 is a full jacket roll. Dewatering of fibrous web 10 occurs only through the outer wire. Permeable belt 8 is in the embodiment of a fabric with a structured surface. This has raised and indented zones, whereby the indented zones form pockets. The raised and indented zones are arranged uniformly on the fabric surface. Ornament structures can also be superimposed. During forming of fibrous web 10 in the area of forming roll 6 the pockets are filled with paper fibers of the fibrous stock suspension. This causes pillow-type voluminous zones in the tissue web 10 in the areas of the pockets. Structured fabric 8 has equal or fewer than 55.7 pockets per cm^2 (360 pockets per inch^2). In this example structured fabric 8 is a single ply, 4-strand fabric with a warp thread density of 20.9 threads per cm (53 threads/inch). The permeability is 700 cfm. The warp threads have a diameter of 0.30 mm and the weft threads have a diameter of 0.35 mm. Contact area 33 of fabric 8 with a flat surface, as for example the surface of Yankee drying cylinder 19 is 25%. Fabric 8 is endless, in other words it has no seam.

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Formed tissue web 10, is transported through the entire tissue machine 1 lying on fabric 8 up to the transfer to the surface of the Yankee drying cylinder 19.

After forming section 2, the tissue web is directed to the first press zone of device 3 which consists of the first and a second press zone. In device 3 the tissue web is dewatered to a dry content of above 35%. First press zone 15.1 is formed by a suction roll 13 and by a permeable press element – a press belt 11. Tissue web 10 is carried through first press zone 15.1 between the structured fabric 8 and a felt 9. The pressing pressure is generated by press belt 11 which is tensioned at 50 kN/m and amounts to approximately 71 kPa at a suction roll diameter of for example 1.4 m. First press zone 15.1 is designed so that a fluid, in this case heated air, can flow through tissue web 10 during the pressing procedure. A hood 12 is provided for the supply of heated air. Hood 12 includes a steam shower 29 at the beginning of first press zone 15.1 for optional addition of steam. The flow direction (arrow) for the air and the steam is very important. The heated air flows first through press belt 11, then through structured fabric 8, then through tissue web 10 and after that through a permeable support belt, a felt 9. The heated air with the water from tissue web 10 is sucked off by suction roll 13. The vacuum is in the range of 0.3 to 0.4 bar.

Support belt 9 is in the embodiment of a felt in accordance with Vector technology. A felt according to this technology comprises a woven base fabric onto which a nonwoven so-called Vector layer consisting of coarse felt fibers is applied onto the side facing the fibrous web. The fibers of this layer are arranged three-dimensionally

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and have a count of more than 67 dtex. This means coarse fibers are used to produce this layer. This has the advantage that this felt layer is very open and can therefore be easily dewatered. The air permeability of this layer is in the range of 80 cfm. The air permeability of the felt is approximately 20 cfm.

Moreover, the three-dimensional arrangement of the coarse fibers in the Vector layer give the felt good resilience when running through the press nip. The felt is hereby compressed and springs back after the press nip, almost to its original thickness. The Vector layer may have a base weight range of 100 g/m² to 500 g/m². The Vector layer is covered preferably by at least one structure of laid fibers consisting of finer fibers which comes into contact with the fibrous web.

Felt 9 has high resiliency characteristics. The dynamic modulus for compressibility "G" is equal or higher than 0.5 N/mm². The dynamic stiffness K* of felt 9 is less than 100000 N/mm.

A collecting tank 14 is provided at the uncovered section of suction roll 13 to remove the thrown off water.

After first press zone 15.1 the dewatered tissue web 10, arranged between structured fabric 8 and felt 9 is directed for additional dewatering through second press zone 15.2. This press zone 15.2 is formed by two rolls 16, 17. Lower roll 16 which comes into contact with felt 9 is a soft, blind bored and grooved roll. The surface of the roll can have a hardness of 30 to 33 P&J. This roll consists preferably of a roll core with a

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roll cover. The thickness of the roll cover is around 20 mm. The roll cover is selected so that – due to water absorption - the hardness becomes softer during operation of the roll by 4 to 5 P&J points. Lower roll 16 which comes into contact with felt 9 can also be in the embodiment of a suction press roll to increase the dewatering efficiency. In this case roll 16 is connected to a vacuum system which is not illustrated here.

Opposite element 17 of the second press zone is preferably in the embodiment of a smooth and/or hard roll. The surface of this roll is provided by a roll cover, whereby the thickness of said cover is approx. 15 mm. The surface has a hardness in the range of 0 to 1 P&J.

The line force of the second press (15.2) zone is preferably in a range of 20 kN/m to 90 kN/m. Depending on the design of the press zone (15.2) the maximum pressing pressure is in the range between 2 to 3.5 MPa. Important influential parameters are softness of clothings (8, 9) and the rolls (16, 17, 17'), as well as their diameters.

The maximum pressing pressure of second press zone (15.2) is greater than the maximum pressing pressure of first press zone (15.1).

An additional embodiment provides that opposite element 17' of second press zone 15.2 conspires with opposite element 13 of first press zone 15.1, thereby forming the second press zone in cooperation with opposite element 13 of the first press zone.

Beside the first and the second press nip 15.2 which is formed by opposite element 17 and press element 16 an additional third press nip is provided in an additional

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embodiment which is formed by roll 17' and opposite element 13 of the first press zone.

After second press zone 15.2 the tissue web 10 is separated from felt 9. Tissue web 10 runs together with structured fabric 8 to a third press nip which is formed by a suction roll 18 and Yankee drying cylinder 19. In this press nip the fibrous web is pressed against the surface of the Yankee cylinder only in the area of the contact area (20% to 32%) of structured fabric (8). The tissue web is separated from fabric 8 and transferred to the hot drying cylinder surface 19. Further drying takes place there and in the area of a hot air hood 20. Finally, tissue web 10 is creped by means of a scraper 21 and taken off the drying cylinder surface 19. A coating applicator nozzle 22 which is already known is provided at drying cylinder 19 to apply a medium.

This tissue machine 1 comprises a cantilevered device 37 which makes fast replacement of clothing possible and thereby renders machine 1 for the production of another tissue quality in another machine configuration convertible.

Moreover, this machine 1 comprises guide rolls 30, 31, 32 which are not required for the illustrated machine configuration, but are provided already for other configurations.

Figure 2 shows press zone 15.2 in an enlarged illustration. Felt 9 is directed away from tissue web 10 which is lying on the structured fabric 8. Structured fabric 8 has a lower compressibility than felt 9.

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Since felt 9 is softer than fabric 8, good contact is established - also in the area of the pockets of fabric 8 – between tissue web 10 and felt 9. This favors dewatering thereby achieving a higher dry content of the tissue web.

Figure 3 illustrates the machine configuration which is required to produce tissue webs of premium quality. The machine configuration illustrated in Figure 1 was hereby modified through removal or opening of the second press zone 15.2. The remaining machine elements and clothing are consistent with those in Figure 1. This also applies to the component identifications.

Figure 4 illustrates a machine configuration for the production of tissue webs of standard quality. For this, both press zones 15.1, 15.2 were removed or bypassed. Structured fabric 8 from Figure 1 and Figure 3 was replaced by a felt 8. The only press nip is formed by suction press roll 18 and drying cylinder 19. This configuration requires the least energy, however produces tissue webs with the lowest specific volume.

Figure 5 is a schematic illustration of a structured fabric in which the crimps were sanded in order to enlarge the contact area. In this example the side contacted by the paper and the opposite side are sanded. It is however appropriate if only the paper contact side is sanded.

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Component identification

- 1 Machine
- 2 Forming section
- 3 Device
- 4 Drying section
- 5 Headbox
- 6 Forming roll
- 7 Outer forming wire
- 8 Permeable belt
- 9 Permeable support belt
- 10 Paper web, fibrous web, tissue web
- 11 Permeable press element, press belt
- 12 Hood
- 13 Opposite element, suction roll
- 14 Collecting tank
- 15.1 First press zone
- 15.2 Second press zone
- 16 Press element, suction roll
- 17 Opposite element
- 17' Opposite element
- 18 Suction press roll, press roll
- 19 Drying cylinder, Yankee
- 20 Hot air hood
- 21 Scraper
- 22 Coating applicator nozzle

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- 23 Suction element
- 24.1 Shower
- 24.2 Shower
- 24.3 Shower
- 24.4 Shower
- 25.1 Shower
- 25.2 Shower
- 26 Suction tube
- 27 Suction tube
- 28 Wet suction box
- 29 Steam shower
- 30 Guide-, adjustment- and tension rollers
- 31 Guide-, adjustment- and tension rollers
- 32 Guide-, adjustment- and tension rollers
- 33 Contact area
- 34 Weft thread
- 35 Warp thread
- 36 Sanded zone
- 37 Cantilever support

What is claimed is:

1. A device for dewatering of a fibrous web, the device comprising:
 - a first press zone with a press zone length L_1 , through which fibrous web, which is arranged lying between a revolving permeable belt and a revolving permeable support belt, is directed, whereby the first press zone is designed so that a fluid can flow through the permeable belt, the fibrous web and the support belt, at least over a section of the press zone length L_1 ;
 - a second press zone having a press zone length L_2 following the first press zone, the second press zone dewatering the fibrous web and the fibrous web being separated from the support belt after the second press zone; and
 - a third press zone following the second press zone, the fibrous web running with the permeable belt to the third press zone,wherein the fibrous web is carried through the second press zone between two belts which have different compressibilities, and the press zone length L_1 is larger than press zone length L_2 ,
 - wherein the permeable belt provides the belt with the lower compressibility of the second press zone and is directed through the second press zone, and
 - wherein the press zone length L_1 is more than ten times as long as press zone length L_2 .
2. The device according to claim 1, wherein the belt with the higher compressibility, which is directed through the second press zone, is a felt.
3. The device according to claim 1 or 2, wherein the belt with the lower compressibility, which is directed through second press zone, is a belt having a structured surface and/or is a TAD-fabric.
4. The device according to claim 1, wherein the permeable belt has a structured surface and/or is in the form of a TAD-fabric.

5. The device according to any one of claims 1 to 4, wherein the belt with the lower compressibility is a fine fabric with a thread density of warp threads greater than 14.1 threads (Fd) per cm (36 threads/inch).
6. The device according to claim 5, wherein the thread density of the warp threads is equal to or greater than 17.3 (Fd) per cm (44 threads/inch).
7. The device according to claim 6, wherein the thread density of the warp threads is greater than the 22 threads (Fd) per cm (56 threads/inch).
8. The device according to any one of claims 1 to 7, wherein the belt with the lower compressibility is a fine fabric having an air permeability greater than 14.16 m³/min (500 cfm).
9. The device according to claim 8, wherein the air permeability is greater than 15.58 m³/min (550 cfm).
10. The device according to claim 9, wherein the air permeability is greater than 17 m³/min (600 cfm).
11. The device according to any one of claims 1 to 10, wherein the belt with the lower compressibility is a fine fabric, in which at least the side contacting the paper has a contact area of equal or greater than 20%.
12. The device according to claim 11, wherein the contact area is equal to or greater than 25%.
13. The device according to claim 12, wherein the contact area is greater than 27%.

14. The device according to any one of claims 1 to 13, wherein the belt with the lower compressibility is a fine fabric with a structured surface with raised and indented zones, whereby the indented zones form pockets.

15. The device according to claim 14, wherein the raised and indented zones are arranged uniformly on the fabric surface.

16. The device according claims 14 or 15, wherein the belt with the lower compressibility is a fine fabric with a structured surface of fewer than 77.4 pockets per cm^2 (500 pockets per inch^2).

17. The device according to claim 16, wherein the number of pockets is less than 38.7 pockets per cm^2 (250 pockets per inch^2).

18. The device according to claim 17, wherein the number of pockets is equal to or less than 31 pockets per cm^2 (200 pockets per inch^2).

19. The device according to claim 18, wherein the number of pockets is fewer than 28 pockets per cm^2 (180 pockets per inch^2).

20. The device according to claim 19, wherein the number of pockets is fewer than 23 pockets per cm^2 (150 pockets per inch^2).

21. The device according to any one of claims 14 to 20, wherein the belt with the lower compressibility is a fine fabric, in which the surface portion of the raised zones of the paper-contact side is equal or greater than 20%.

22. The device according to claim 21, wherein the surface portion of the raised zones is equal to or greater than 25%.

23. The device according to claim 22, wherein the surface portion of the raised zones is equal to or greater than 27%.
24. The device according to any one of claims 1 to 23, wherein the belt with the higher compressibility has a dynamic modulus for compressibility equal or higher than 0.5 N/mm².
25. The device according to claim 24, wherein the dynamic modulus for compressibility is equal to or higher than 2 N/mm².
26. The device according to claim 25, wherein the dynamic modulus for compressibility is equal to or higher than 4 N/mm².
27. The device according to any one of claims 15 to 23, wherein the permeable support belt provides the belt having the higher compressibility of the second press zone and is directed through the second press zone.
28. The device according to any one of claims 1 to 3, wherein permeable support belt does not have a structured surface and/or is in the form of a felt.
29. The device according to claim 1, wherein the fluid is one of air, hot air, steam and an air-steam mixture.
30. The device according to any one of claims 1 to 29, wherein the press zones length L_1 is greater than twenty times as long as the press zone length L_2 .
31. The device according to claim 1, wherein the first press zone is provided by a permeable press element and a permeable opposite element.
32. The device according to claim 31, wherein the permeable press element is a press belt and/or a press shoe.

33. The device according to claim 32, wherein the press belt consists of a woven fabric or a spiral screen or a metal screen or a perforated metal belt or a belt consisting of a composite material.

34. The device according to any one of claims 31 to 33, wherein a pressure hood is allocated to the press element.

35. The device according to any one of claims 31 to 34, wherein the opposite element consists of a roll or a chest with curved or flat contact surface.

36. The device according to any one of claims 31 to 35, wherein the opposite element is suction equipped.

37. The device according to claim 1, wherein the second press zone consists of a press element and an opposite element.

38. The device according to claim 37, wherein the opposite element is in the form of a smooth roll and/or the opposite element has a hardness of 0 to 5 P&J or 0 to 1 P&J.

39. The device according to claim 37 or 38, wherein the opposite element has a hardness of 0 to 5 P&J.

40. The device according to claim 39, wherein the hardness is 0 to 1 P & J.

41. The device according to any one of claims 37 to 40, wherein the press element consists of a shoe roll, comprising a press shell and a press shoe.

42. The device according to any one of claims 37 to 41, wherein the press element has a hardness of 30 to 33 P&J.

43. The device according to any one of claims 37 to 42, wherein the press element has a blind bored and grooved surface and/or is in the form of a suction press roll.

44. The device according to any one of claims 37 to 40, wherein the opposite element is allocated to the belt having the lower compressibility.

45. The device according to any one of claims 37 to 42, wherein the press element is allocated to the belt having the higher compressibility.

46. A machine for the production of a fibrous web comprising the device of claim 1, wherein the third press zone comprises a press element and a drying cylinder through which fibrous web is directed together with a clothing, and wherein the machine further comprises a plurality of devices for defining at least one of a selection and a combination of the three press zones.

47. The machine according to claim 46, wherein the drying cylinder is a Yankee cylinder.

48. The machine according to claim 46 or 47, wherein the additional devices consist of at least one of guide rolls, adjustment rollers with web guides, tension rollers with tensioning devices, belt cleaning devices and cantilever devices.

49. A method to dewater a fibrous web, the method comprising:

dewatering the fibrous web through a first press zone with a press zone length L_1 , arranged lying between a revolving permeable belt and a revolving permeable support belt, whereby a fluid flows through the belt, the fibrous web and the support belt at least over a section of the press zone length L_1 ;

subsequently dewatering the fibrous web in a second press zone having a press zone length L_2 , the fibrous web being separated from the support belt after the second press zone; and

subsequently dewatering the fibrous web in a third press zone, the fibrous web running with the permeable belt to the third press zone,

wherein the fibrous web is led through the second press zone between two belts which have different compressibilities and the press zone length L_1 is larger than the press zone length L_2 ,

wherein the permeable belt provides the belt with the lower compressibility of the second press zone, and is directed through the second press zone, and

wherein the press zone length L_1 is more than ten times as long as press zone length L_2 .

50. The method according to claim 49, wherein the fluid first flows through the permeable belt then through the fibrous web and then through the support belt.

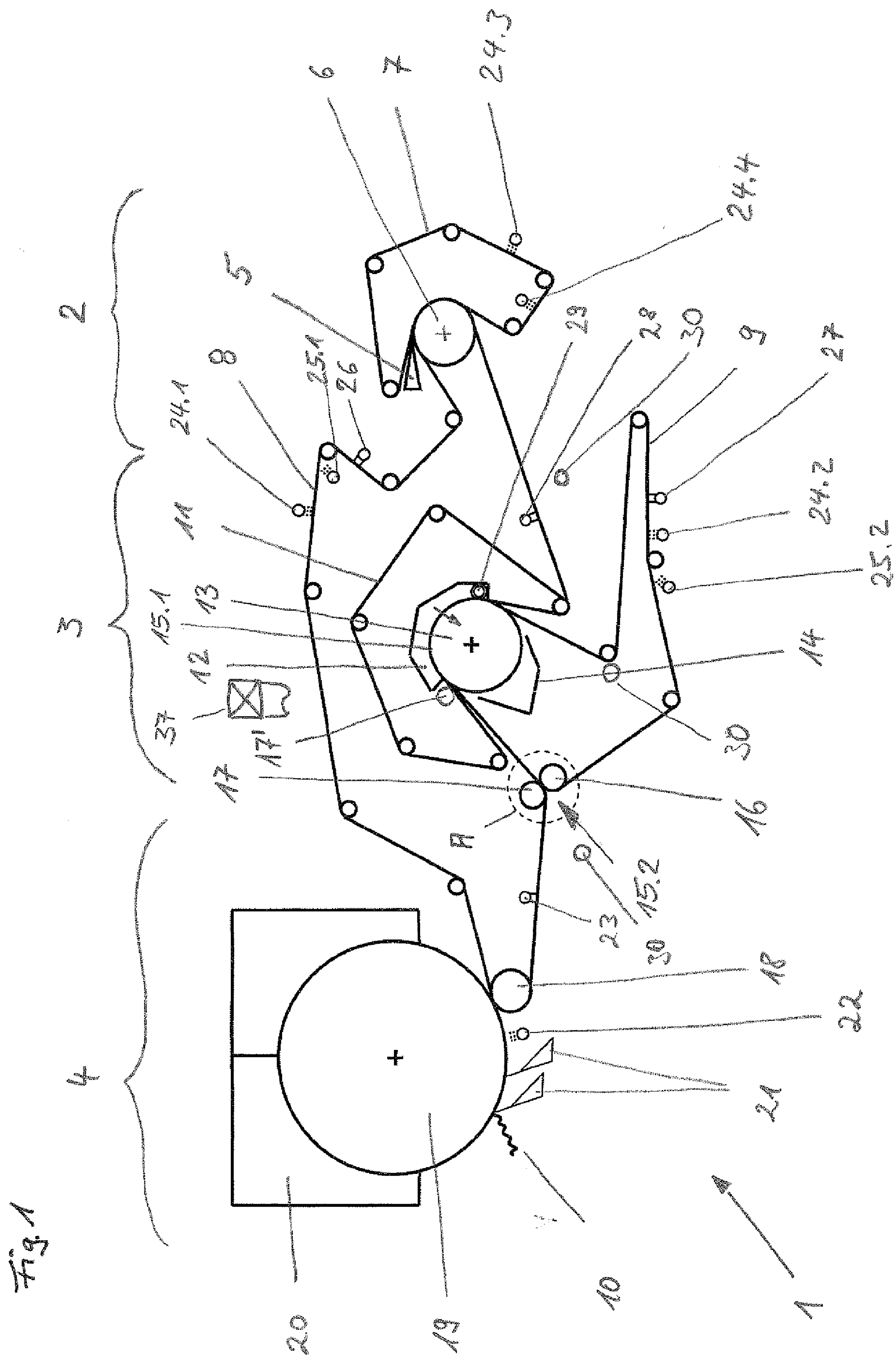
51. The method according to claim 49 or 50, wherein the fluid is one of air, hot air, steam and an air-steam mixture.

52. The method according to any one of claims 49 to 51, wherein water in the fibrous web is drained in the first press zone through at least one of mechanical pressing power, displacement dewatering and thermal drying.

53. The method according to claim 49, wherein the fibrous web is dewatered in second press zone by means of a mechanical pressing power and through the supporting effect of the belt with the higher compressibility.

54. The method according to claim 49, wherein the second press zone is formed by a roll nip.

55. The method according to any one of claims 49 to 54, wherein the fibrous web is carried through the second press zone with the permeable belt and/or the permeable support belt.



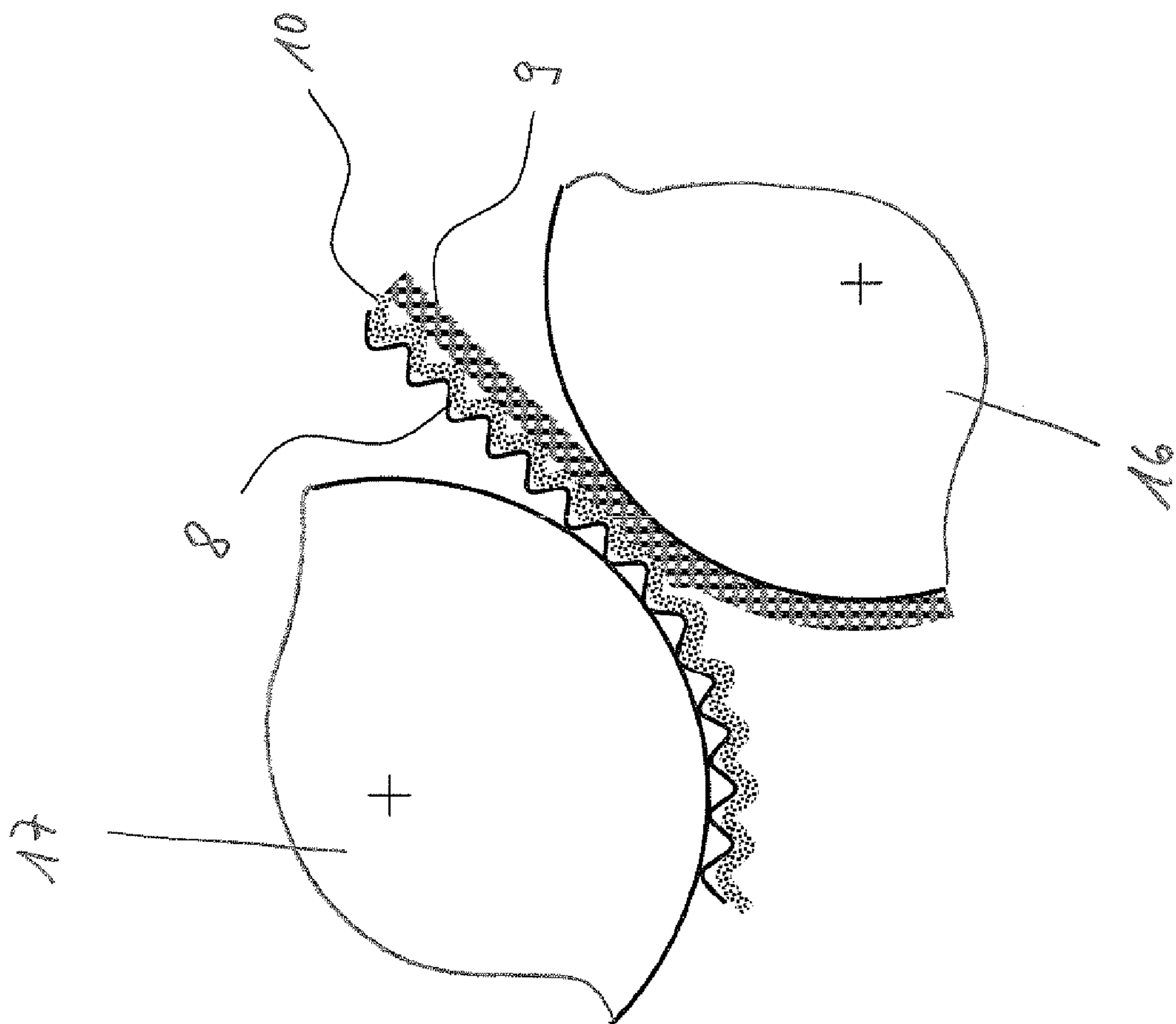
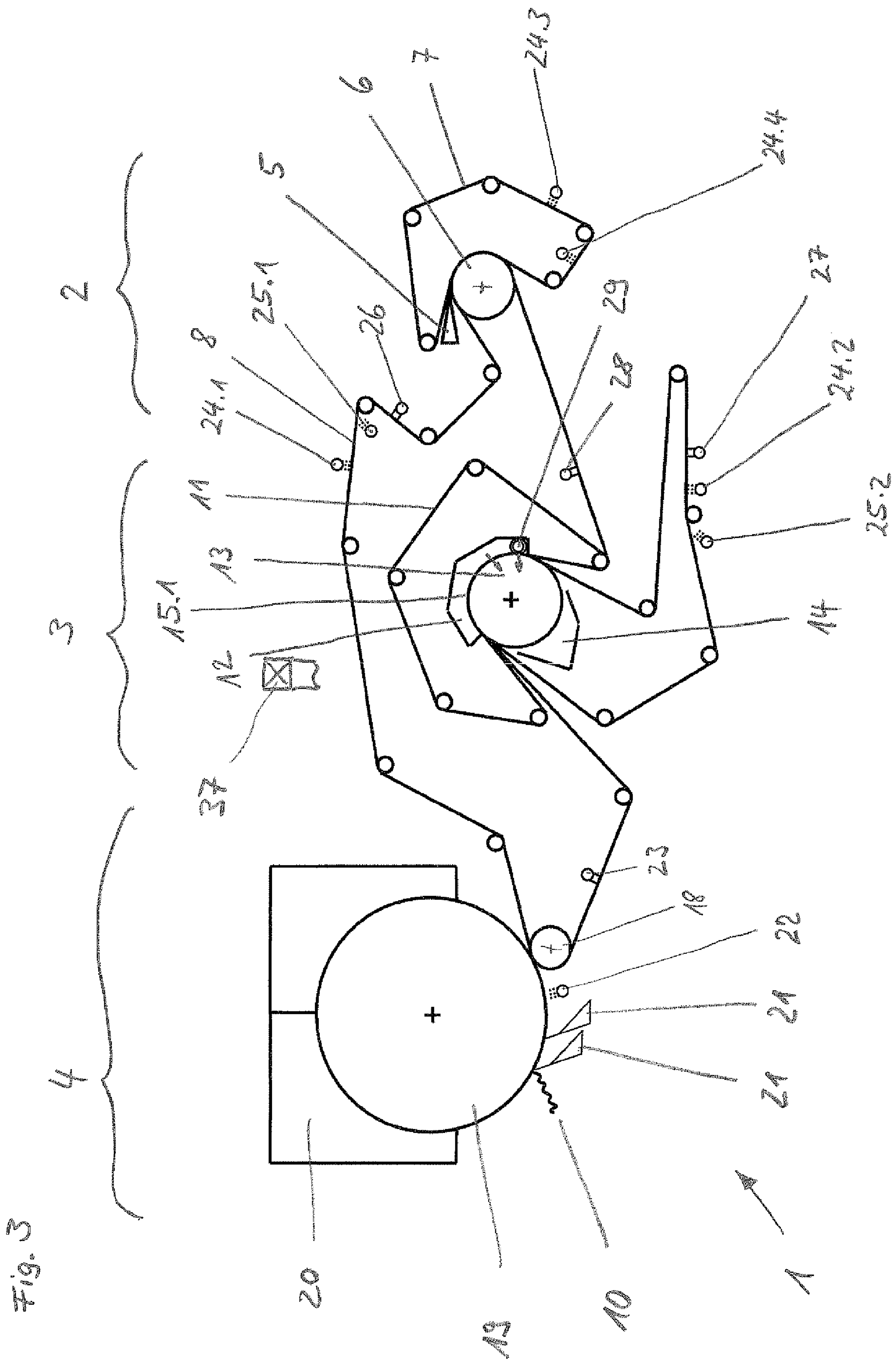


Fig. 2

Detail A



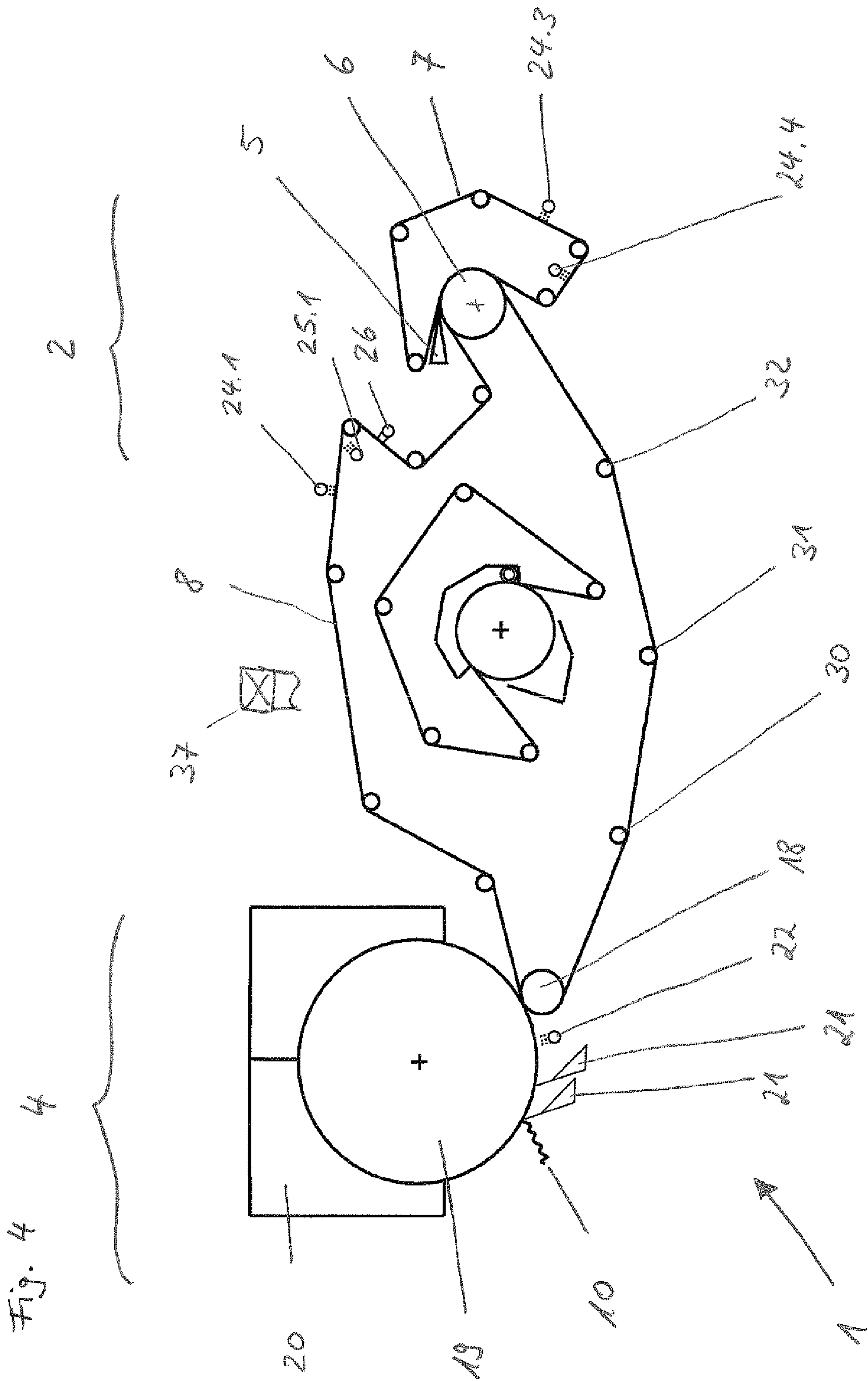


Fig 5

