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(54) APPARATUS AND METHOD FOR WINDING OF WEBS

VORRICHTUNG UND VERFAHREN ZUM WICKELN VON BAHNEN

APPAREIL ET PROCEDE D'ENROULEMENT DE BANDES CONTINUES

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EP-A- 0 514 226
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Description

FIELD OF THE INVENTION

[0001] The invention relates to an apparatus and a method for winding of webs.

BACKGROUND OF THE INVENTION

[0002] In general, webs such as thin polyester foils or other sheet materials are manufactured in a continuous process and the final products are wound up on rolls for storage and transportation.

[0003] During the operation of winding the web on a roll, it is wished to ensure a homogeneous winding on the roll (i.e. without wrinkles or puckers) and to trap as less as possible air between each web layer on the roll.

[0004] The problem is particularly acute for (ultra) thin films with thickness as low as the micron size and speeds up to 1000 m/min.

[0005] In the prior art, webs, especially in case of thin ones, are usually wound at high velocities (i.e. more than a few hundred meters per minute) with the help of a nip roller (also called packroll) to prevent excessive air entrainment.

[0006] Examples of web winding apparatuses are disclosed in DE 43 43 173 and EP 514 226.

SUMMARY OF THE INVENTION

[0007] Researches have shown that:

(aa) to keep the amount of air entrainment under a certain level at high speed operation, the most effective way is to reduce the diameter of packroll ;
(bb) if the packroll (or its covering) is softer than the winding roll and too much air is entrained, then the problem can be solved by using harder materials for the packroll ;
(cc) the amount of entrainment air is not very effectively reduced by increasing the nip loading and if said loading is increased too much, other winding problems can occur.

[0008] Furthermore, the researches have shown that there may be practical problems or limitations in reducing the size of packrolls, for example, the packroll may become too flexible if it is too thin. However, it is suggested to design slender packrolls because of its importance in air entrainment. The researches lead to the proposal of two examples of possible design changes. The first example proposes a slender roll between a roll and a winding roll, the web passing from the roll to the slender roll and then to the winding roll. The second example proposes a slender roll between two rolls and a winding roll, the web passing from one of those rolls to the slender roll and then to the winding roll.

[0009] However, to put those principles into practice, there are several practical problems to be solved. A first problem is to ensure the correct position of the slender roll between the roll(s) and the winding roll since the slender roll becomes flexible due to its low diameter. Another problem is to ensure that the tangential speed of the slender roll and of the rolls is identical at each point there between over their length in order to avoid friction on the web. Another problem is to ensure the spreading of the web before winding it on the winding roll, i.e. wrinkles may remain on the web once wound on the winding roll. A further problem is to allow an easy initiation of the winding of the web: the difficulty consists in passing the web between the roll and the slender roll and between the slender roll and the winding roll. Another further problem is to apply a pressure distribution over the width of the winding roll that results in a uniform air exclusion.

[0010] The purpose of the present invention is to provide an apparatus and a method for winding webs on winding rolls which overcome these problems.

[0011] The object of the present invention is to provide an apparatus and a method for winding of webs on winding rolls ensuring a good and uniform air exclusion, no distortion of the web, a good spreading of the web as well as an easy initiation of the winding thereby improving the speed and the quality of the winding.

[0012] The object is achieved with an apparatus according to claim 1 and a method according to claim 16. Preferred embodiments are defined in the depending claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Figures 1a to 1e are schematic side views of the rolls of an apparatus according to the invention, illustrating the operating of said apparatus ;
Figure 2 is a schematic side view showing the mechanical links between the rolls and the carriages ;
Figure 3 is a schematic side view of the lower parts of the supports, which interlock ;
Figure 4 is a schematic side view for an alternative embodiment of the invention;
Figure 5 is a schematic side view for another alternative embodiment of the invention ;
Figure 6a and 6b show alternative possibilities to thread up the web through the rolls of an apparatus according to the invention ;
Figure 7 is a schematic view for another embodiment of the invention ;
Figure 8 is a further schematic view of the embodiment of fig. 7 ;
Fig.9 is a top view of the embodiment of fig. 7 ;
Fig.10 is an enlarged side view of the embodiment of fig. 7 ;
Fig.11 shows the displacement possibilities of one roll according to the embodiment of fig. 7 ;
Figure 12 is a further schematic view of the embod-

iment of fig. 7 ;

Fig. 13 represents one possible thread up procedure for the embodiment of fig. 7 ;

Fig. 14 represents one possible roll change procedure for the embodiment of fig. 7 ;

Fig. 15 represents another embodiment of the invention ;

Fig. 16 represents still another embodiment of the invention ;

DETAILED DESCRIPTION OF THE INVENTION

[0014] Figs. 1a to 1e show the operation of a preferred embodiment of an apparatus according to the invention from the open state allowing the initiation of the winding on the winding roll till the working position for ensuring a winding of high quality for thin webs (down to about a micron for polyester webs) at high speeds (up to 1000 m/min).

[0015] Fig. 1a shows an apparatus according to the present invention in open position. A web 1 such as a polyester foil arrives from a conveyance direction indicated by arrow F. As the apparatus is in open position, the web is diverted towards a winding roll 2 (located in a lower position) via, for example, an idle roll 10 (which is fixed). The path between idle roll 10 and winding roll 2 is free in order to allow an easy initiation of the winding of web 1 on winding roll 2, either manually or by automatic means. A first set of rolls (3, 8, 9) is provided on one side of said path. Said first set of rolls is carried by a first movable carriage 11 (not shown). A second set of rolls (4, 5, 6, 7) comprising a slender roll 5, is provided on the side opposite to said first set of rolls with respect to said path. Said second set of rolls is carried by a second movable carriage 12 (not shown).

[0016] Once the winding of web 1 on winding roll 2 is initiated, first carriage 11 is moved towards the portion of web 1 extending between idle roll 10 and winding roll 2, till a position in which roll 3 abuts web 1. This situation is illustrated in fig. 1b. Before abutting web 1, roll 3 is preferably caused to rotate with a tangential speed and in a direction substantially corresponding to those of the displacement of web 1. Rolls 8 and 9 are shown not abutting web 1, however, it may be the case.

[0017] Once at the stage of fig. 1b, second carriage 12 is moved towards web 1 till a defined position in which roll 3 and roll 4 are narrow, but not into contact with each other. This situation is illustrated in Fig. 1c. For sparing operating time, this step (i.e. moving second carriage 12 towards web 1) may be realized simultaneously with the previous one consisting in the displacement of carriage 11 towards web 1. The simultaneous displacement of first carriage 11 and second carriage 12 is indeed preferred. In the position of Fig. 1c, slender roll 5 is preferably located under roll 4 slightly towards roll 3, i.e. slender roll 5 abuts roll 4 but does not abut roll 3. Neither roll 4 nor slender roll 5 abut web 1. Rolls 8 and 9 of the first carriage 11 and rolls 6 and 7 of the second carriage 12 are located so as to form a jaw having been closed on the web. More precisely, roll 7 of the second carriage 12 is located substantially between roll 8 and roll 9 of the first carriage 11, and preferably in a narrow fashion but without being into contact with them. Roll 6 of the second carriage 12 is substantially located under roll 8 of the first carriage 11and preferably close to the latter. Thus, web 1 is caused to abut roll 9 and to pass from roll 9 on roll 7, from roll 7 on roll 8, from roll 8 to roll 6 so as to form waves. The jaw defined by rolls 6, 7, 8 and 9, when closed onto web 1, isolates the winding tension from the incoming tension, which might be too low or too high. It is possible to vary the number of rolls forming said jaw. Further, before abutting web 1, rolls 6, 7, 8 and 9 are preferably caused to rotate each with a tangential speed and in a direction corresponding to that of web 1 (so as to avoid friction between said rolls and web 1) ; so, excessive tension on web 1 at the moment of being abutted by said rolls (which could arise if said rolls were idle rolls) are avoided. For web 1 having a width up to 2 meters and being conveyed at a speed up to 1000 meters/min, it is advantageous for rolls 6, 7, 8 and 9 having a diameter of about 120 millimeters. Preferably, roll 6 is horizontally spaced from roll 3 so that web 1 passes from roll 6 to roll 3 in a substantially horizontal fashion. Furthermore, roll 3 and roll 4 are preferably interlocked in this position in order to avoid relative change of position between them as it will be described in relation with Fig. 3.

[0018] Once at the stage of Fig. 1c, roll 4 is preferably caused to rotate with a tangential speed corresponding to the speed of web 1 and in the same direction than roll 3. As a result, roll 4 causes slender roll 5 to rotate by friction driving because slender roll 5 abuts roll 4. Slender roll 5 is then moved upwards along the circumference of roll 4 until it abuts roll 3 through web 1. Hence, slender roll 5 is in abutment both with roll 3 (through web 1) and roll 4, and, as a consequence, slender roll 5 is precisely positioned by those rolls 3 and 4. Web 1 passes now from roll 3 to slender roll 5 and then to winding roll 2. The axis of slender roll 5 and the axis of winding roll 2 are preferably contained in a substantially vertical plane. This situation is illustrated in Fig. 1d.

[0019] Once at the stage of Fig. 1d, the block formed by carriages 11 and 12 is lowered (i.e. the whole roll assembly) till slender roll 5 abuts winding roll 2, preferably at its top. This situation is illustrated in Fig. 1e. As it can be taken from Fig. 1e, rolls 3 and 4 do not abut winding roll 2. This lowering may be achieved e.g. by a main carriage (not shown) movable vertically, on which carriages 11 and 12 are slidably mounted in the horizontal direction (to allow their displacement towards web 1 mentioned in relation with Fig. 1a to Fig. 1c). Just before slender roll 5 abuts winding roll 2, preferably at a distance of about 10 millimeters, the driving in rotation of rolls 3 and 4 is preferably stopped so as to act now as idle rolls ; this may be classically achieved by disengagement of a clutch mechanism. When the apparatus

is in position of Fig. 1e, it is in nominal position for winding efficiently web 1 on winding roll 2 and slender roll 5 acts as a nip roller.

[0020] During each of these steps from Fig. 1a to Fig. 1e, the rotation speed of winding roll 2 is preferably varied so as to keep a substantially constant tension of web 1 as the length of the path of web 1 varies during the deviation of web 1 by the various rolls of the apparatus. For instance, this may be achieved by controlling the rotation speed of winding roll 2 as a function of the force exerted by web 1 on roll 6, during the steps described in relation with fig. 1c, 1d and 1e.

[0021] Referring now to Fig. 2, we will now describe the mechanism for ensuring the correct positioning of slender roll 5 between rolls 3 and 4. Fig. 2 shows only a part of the apparatus relatively to rolls 3 and 4 and slender roll 5 when the apparatus is in the position of Fig. 1c. Slender roll 5 (its axis is referenced 31) is held on each end through a corresponding double acting pressure cylinder 19. More precisely, each end of slender roll 5 is articulated on the end of the rod 20 of a respective pressure cylinder 19. Pressure cylinders 19 preferably extend substantially vertically with their rods 20 extending downwards. Each pressure cylinder 19 is preferably fixed on the end of a respective arm 27, which is linked to carriage 12 via a respective pivot link 28. Pivot links 28 are preferably arranged in the middle region of arms 27. The opposed end of each arm 27 is linked on the rod 26 of a respective pressure cylinder 25 via a pivot link 29. Pressure cylinders 25 are both linked on carriage 12 via respective pivot links 30. Pressure cylinders 25 preferably extend substantially horizontally. This construction allows to change the horizontal and vertical position of slender roll 5 by controlling pressure cylinders 19 and 25. Thus, when passing from the position of Fig. 1b to the position of Fig. 1c, slender roll 5 is positioned correctly under roll 4, i.e. without slender roll 5 abutting web 1, by causing rods 20 and 26 of pressure cylinders 19 and 25 to the extended position. Then, to pass from the position of Fig. 1c to the position of Fig. 1d, rods 20 are caused to retract and thus, slender roll 5 runs along the circumference of roll 4 until it abuts also roll 3 through web 1 ; during this operation, pressure in pressure cylinders 25 is controlled in known manner in order to maintain slender roll 5 in abutment on roll 4 without excessive strength. Preferably, once slender roll 5 abuts roll 3, no pressure is anymore applied to pressure cylinder 25 so that slender roll 5 is positioned only by rolls 3 and 4 through the pulling forces of pressure cylinders 19.

[0022] During winding, i.e. in the position of Fig. 1e, pressure cylinders 19 remain retracted to keep both ends of slender roll 5 in abutment with rolls 3 and 4 regardless of the width of winding roll 2.

[0023] As regards rolls 3 and 4, they are both rotatably mounted on respective supports 13 and 14, their axis being referenced 17 and 18. Supports 13 and 14 cooperate so as to define an interlocking mechanism for interlocking roll 3 with roll 4 as already mentioned : this will be described more precisely in relation with Fig. 3. Supports 13 are slidably mounted in the vertical direction on carriage 11 (the guiding means are not shown) and are vertically positioned through e.g. double acting pressure cylinders 21. Similarly, supports 14 are slidably mounted in the vertical direction on carriage 12 (the guiding means are not shown) and are vertically positioned through e.g. pressure cylinders 23. So, pressure cylinders 21 and 23 extend parallel and vertically with their respective rods 22 and 24 extending downwards. Pressure cylinders 19, 21 and 23 automatically take up the diameter increase of winding roll 2. However, they are only used for to lift rolls 3 and 4 and slender roll 5 over a defined detected distance corresponding to e.g. a few millimeters. After that, it is the whole block formed of carriages 11 and 12 which is lift over said defined height and blocked in this new position while pressure cylinders 19, 21 and 23 maintain rolls 3 and 4 in abutment with slender roll 5 and slender roll 5 in abutment with winding roll 2. From there on, pressure cylinders 19, 21 and 23 again take up the diameter variation of winding roll 2 until being retracted again from said defined distance after what the whole block is again lifted and so on.

[0024] Referring to Fig. 3, we will now describe the interlocking mechanism of roll 3 with roll 4, which is active in the state of the apparatus shown in Fig. 1c to 1e, Fig. 3 is a schematic side view showing the lower part. of support 13 carrying roll 3 (its axis being referenced 17) and the lower part of support 14 carrying roll 4 (its axis being referenced 18). The lower part of support 13 exhibits an arm 13a extending laterally towards support 14. A groove 15 is arranged at the free end of arm 13a. The lower part of support 14 exhibits an arm 14a extending laterally towards support 13. A nose 16 is arranged on the free end of arm 14a. The shape of the free end of arm 14a matches the shape of the free end of arm 13a and, more particularly, nose 16 fits groove 15. Nose 16 has preferably a beveled edge to facilitate the engagement with groove 15. Thus, when the apparatus comes to the position of Fig. 1c, support 13 and support 14 interlock. Furthermore, both supports 13 and 14 are maintained interlocked e.g. by way of means acting on carriages 11 and 12 so as to avoid lateral disengagement from one another. In this way, both supports 13 and 14 form one rigid block : horizontal or vertical relative vibrations between support 11 and support 12 are eliminated.

[0025] We will now describe the relationship between rolls 3 and 4, slender roll 5 and winding roll 2 from the mechanical point of view. When the apparatus is in the position of Fig. 1e, i.e. the nominal position for winding efficiently, slender roll 5 acts as a nip roller. The diameter of slender roll 5 is preferably as small as possible in order to minimize the air entrainment between web 1 and winding roll 2. Thus, slender roll 5 becomes flexible over its length and, in the absence of rolls 3 and 4, may bend

and vibrate on winding roll 2 while winding. Resonance may even occur. Both, the bending and vibrating of slender roll 5 would adversely result in tangential speed differences between slender roll 5 and winding roll 2 inducing friction on web 1, variations of tension in web 1 and bad effects as regard the spreading of web 1 as well as regards the air entrainment. Thus, it is preferred to avoid the bending and vibrating of slender roll 5 while winding. For that purpose, rolls 3 and 4 flank slender roll 5 on its upper half circumference so as to sandwich it between them and winding roll 2 while winding. Further, rolls 3 and 4 are preferably more rigid than slender roll 5 in order to be able to support slender roll 5 : that is preferably obtained with rolls 3 and 4 having a greater diameter than slender roll 5. Rolls 3 and 4 preferably have each a diameter being one to six times, preferably three times, the diameter of slender roll 5. Preferably, rolls 3 and 4 have the same diameter and are positioned at the same vertical level. Further, the surface of roll 3, which is wrapped by web 1 (in this embodiment), is advantageously smooth ; preferably, its surface is metallic and polished, its roughness Rt (i.e. the difference between the highest and lowest point of the surface) being lower or equal to 25 μm. In that case, web 1 floats on the aerodynamic boundary layer without contacting the surface of roll 3. This results in a spreading effect. Similarly, the surface of roll 4 is advantageously smooth similarly to roll 3. Slender roll 5 consists preferably in a core with an elastic coating, which conforms itself to the surface of winding roll 2. For slender roll 5 having a width up to 2 meters and web 1 being conveyed at a speed up to 1000 meters/min, it is advantageous for slender roll 5 having a diameter of about 50 millimeters and for rolls 3 and 4 having a diameter of about 150 millimeters each. Thus, rolls 3 and 4 allow to position precisely slender roll 5 between them and, as a consequence, slender roll 5 is correctly positioned on winding roll 2 and further, rolls 3 and 4 provide dynamic stability while winding.

[0026] The distance between slender roll 5 and winding roll 2 in Fig. 1d is preferably small so that the time needed to pass from the position of Fig. 1d to the position of Fig. 1e is low, and thus, it limits the time during which slender roll 5 may possibly bend or vibrate under rolls 3 and 4 as it is not in abutment with winding roll 2 yet. The mechanism for ensuring the correct positioning of slender roll 5 between rolls 3 and 4 will be more precisely described in relation with Fig. 3.

[0027] Since supports 13 and 14 are preferably interlocked when arriving in position of Fig. 1c as already mentioned and remain interlocked in the subsequent steps (corresponding to Fig. 1d and 1e), relative movement, more particularly vibrations, between rolls 3 and 4 are avoided while winding and thus, it avoids unwished bending and vibrations of slender roll 5 that may be induced by said relative movement or vibrations between rolls 3 and 4.

[0028] Further, the apparatus is designed so as to avoid, when in position of Fig. 1e, lateral movement, more particularly lateral vibrations, of the block formed by carriages 11 and 12 with their supports 13 and 14 being interlocked, and thus of rolls 3 and 4 and slender roll 5, relatively to winding roll 2. However, the vertical position of the unit formed by rolls 3 and 4 and slender roll 5 adapts to the diameter of winding roll 2 while increasing during the winding as it was described in relation with Fig. 2. Pressure cylinders 21 and 23 are preferably of pneumatic type in order to define an adjustable contact pressure between winding roll 2 and slender roll 5 and to absorb the eventual vertical vibrations. Pressure cylinders 19 are also preferably of the pneumatic type. As already mentioned, web 1 preferably passes substantially horizontally from roll 6 to roll 3 so that eventually remaining vertical movements or vibrations of roll 3 and slender roll 5 (due to the run out of winding roll 2) do not cause substantial variation of tension in web 1 as it would be the case if web 1 is fed vertically to roll 3.

[0029] In the position of Fig. 1e, efforts relative to slender roll 5 are distributed as follows.

[0030] The weight W of rolls 3 and 4 (which are interlocked) is supported by winding roll 2 via slender roll 5. Roll 3 and roll 4 have preferably the same weight. However, at least a small amount ΔW of their weight W is preferably supported by pressure cylinders 21 and 23 disposed at each end of said rolls 3 and 4, said pressure cylinders pulling upwards half of that amount, i.e. $\Delta W/2$, at each end. Preferably, amounts ΔW are selected so as to be sufficient for obtaining that the pressure exerted by slender roll 5 on winding roll 2 is maximal in the middle of slender roll 5 and decreases progressively towards its edges. Nevertheless, the pulling forces $\Delta W/2$ of pressure cylinders 21 and 23 are limited so that slender roll 5 remain in abutment with winding roll 2 over the whole width of web 1. As a consequence, the efficiency of slender roll 5 for diminishing the air entrainment between web 1 and winding roll 2 is further improved as it favors the expulsion of the air caught between web 1 and winding roll 2 from the middle towards the edges of web 1 in the abutment region of slender roll 5 with winding roll 2. In practice, the pulling upward force of $\Delta W/2$ developed by pressure cylinders 21 and 23 on each end are preferably obtained by feeding pressure cylinders 21 and 23 of a differential type (at each end) with a first pressure (a) inducing an upward constant force of W/2 and with a second pressure (b) inducing a downward force of $(W/2 - \Delta W/2)$: thus, the resultant force on each end of rolls 3 and 4 is $\Delta W/2$ directed upwards.

[0031] As regards the abutment of slender roll 5 on rolls 3 and 4, the reaction forces of slender roll 5 on rolls 3 and 4 due to at least a part of the weight of rolls 3 and 4 supported by winding roll 2 via slender roll 5 are preferably maintained as low as possible, rolls 3 and 4 just avoiding the bending and vibrating of slender roll 5 as well as ensuring its correct positioning. Thus, compression of web 1 between slender roll 5 and roll 3 is maintained low and, as a result, avoids to harm web 1. From that point of view, the angle between the half-plane de-

limited by the axis of slender roll 5 and comprising the axis of roll 3 and the half-plane delimited by the axis of slender roll 5 and comprising the axis of roll 4 is preferably as low as possible, e.g. 130°. As a result, the efforts of slender roll 5 on rolls 3 and 4 are minimized for a given effort exerted from winding roll 2 on slender roll 5 if relevant.

[0032] In practice, winding roll 2 bows slightly downward due to its own weight and due to the fact it is supported on its ends. However, if designed properly, winding roll 2 is more rigid than slender roll 5 and than rolls 3 and 4, and consequently, winding roll 2 bows less downward than might do slender roll 5 and rolls 3 and 4. So, in fact, rolls 3 and 4 and slender roll 5 bow of the same amount than winding roll 2 which continue to support slender roll 5 at least over the width of web 1 as previously described. However, it is preferred that pressure cylinders 19 develop an upward force at each end of slender roll 5 sufficient for ensuring that both end regions of slender roll 5 abut rolls 3 and 4 for any width of winding roll 2.

[0033] It is preferred that slender roll 5 abuts the top of winding roll 2 as shown in Fig. 1e (or, in another embodiment, that winding roll 2 abuts the top of slender roll 5). Thus, the tangential speed of winding roll 2 and slender roll 5 as well as the tangential speed of slender roll 5 and roll 3 are substantially identical for each point on the width of web 1, and so no frictions on web 1 are generated. This is not obtained if slender roll 5 abuts laterally winding roll 2, (thus, rolls 3 and 4 flank slender roll 5 laterally). Indeed, rolls 3 and 4 bow each downward of substantially a same fixed amount (if they are identically designed) and winding roll 2 bows downward with another amount which furthermore varies as its diameter increases due to web 1 wound on it. As a consequence, rolls 3 and 4 do not position correctly slender roll 5 on winding roll 2 over its whole length and it results in differences of tangential speed vectors between roll 3 and slender roll 5 and between slender roll 5 and winding roll 2, thus inducing friction on web 1. Further, slender roll 5 may even slightly vibrate as slender roll 5 is no more correctly sandwiched on all its length between rolls 3 and 4 on one hand and winding roll 2 on the other hand.

[0034] In another preferred embodiment, it is proposed the same apparatus than the one described up to now, but with modified steps compared to those of Fig. 1a to Fig 1e. Initial position of the apparatus is the one of Fig. 1a. Displacement of first carriage 11 and second carriage 12 are similarly executed than described previously for passing from Fig. 1a to Fig. 1c, but lateral displacement distances are modified so that the apparatus reaches the state of Fig. 4 instead of the one of Fig. 1c. Then, slender roll 5 is moved along roll 4 until it contacts roll 3, as previously described for passing from Fig. 1c to Fig. 1d. Then, the block formed by first carriage 11 and second carriage 12 (with their supports 13 and 14 being interlocked as previously) is laterally shifted in order to go in the position of Fig. 1d and then, to the position of Fig. 1e.

[0035] In a further preferred embodiment, it is proposed a similar apparatus, which allows to gain space following the horizontal direction. In the embodiment shown in relation with Fig. 1a to 1e, 3 is laterally shifted with respect to rolls 8 and 9 which are shown substantially vertically aligned. Similarly, roll 4 and slender roll 5 are laterally shifted with respect to rolls 6 and 7 which are also shown substantially aligned. Thus, when the apparatus is in open state as in Fig. 1a, it takes some place in the horizontal direction. It is for example possible to mount roll 3 on one carriage and rolls 8 and 9 on a further carriage, both being movable laterally. Similarly, roll 4 and slender roll 5 may be mounted on one carriage while rolls 6 and 7 are mounted on a further carriage, both being movable laterally. Thus, when the apparatus is in open condition as illustrated in the previous embodiment by Fig. 1a, it is possible to align approximately vertically rolls 3, 8 and 9 on one side of the path of web 1 between idle roll' 10 and winding roll 2 and it is possible to align approximately vertically rolls 4, 6 and 7 on the other side of said path. Thus, it is possible to spare the horizontal distance previously separating rolls 8 and 9 from roll 3 and the horizontal distance separating roll 4 and slender roll 5 from rolls 6 and 7. Then, both carriages carrying roll 3 and rolls 8 and 9 may be simultaneously moved toward web 1 to abut it and then (or eventually simultaneously) both carriages carrying roll 4, slender roll 5 and rolls 8 and 9 may be simultaneously moved toward web 1untill that rolls 3 and 4 and slender roll 5 are in the position previously illustrated in Fig. 1c. At this stage, rolls 8 and 9 and rolls 6 and 7 form the previously mentioned jaw closed on web 1, but said jaw is then substantially vertically aligned with rolls 3 and 4 and slender roll 5 as shown in Fig. 5. Roll 6 is slightly above rolls 3 and 4 as regards the vertical position. From this position on, the carriage of rolls 8 and 9 and the carriage of rolls 6 and 7 are simultaneously shifted in the horizontal direction to get to the position depicted in Fig. 1c and then the subsequent steps of the previous embodiment are normally carried out. However, before operating said shift, it is possible to realize previously the step described for passing from the position of the apparatus described in Fig. 1c to the position of Fig. 1d in the previous embodiment.

[0036] In the different embodiments described previously, when the apparatus is in the nominal winding position (i.e. position shown in fig. 1e), web 1 passes between roll 3 and slender roll 5 and then between slender roll 5 and winding roll 2. Alternately, it is possible to thread up web 1 through a different path in the device comprising rolls 3 and 4 and slender roll 5 for winding web 1 on winding roll 2.

[0037] For instance, as shown in fig. 6a, web 1 may first pass between roll 4 and slender roll 5, then between roll 3 and slender roll 5 and finally between slender roll 5 and winding roll 2. In this case, the apparatus has pref-

erably an open position in which slender roll 5 is located on one side of the path of web 1 in course of winding on winding roll 2 and rolls 3 and 4 are located on the other side of the path of web 1 in course of winding on winding roll 2. Then, when the apparatus is caused to its nominal winding position (e.g. by moving rolls 3 and 4 and slender roll 5 towards winding roll 2 the location of which may be fixed, or by moving slender roll 5 and winding roll 2 towards rolls 3 and 4 the location of which may be fixed), web 1 will be accordingly threaded up.

[0038] As shown in fig. 6b, web 1 may also directly pass between slender roll 5 and winding roll 2, without passing between roll 3 and slender roll 5 or between roll 4 and slender roll 5. In this case, the apparatus has preferably an open position in which rolls 3 and 4 and slender roll 5 are all located on a same side of the path of web 1 in course of winding on winding roll 2. Further, rolls 3 and 4 and slender roll 5 preferably have their relative locations already corresponding to those in the nominal winding position. Then, when the apparatus is caused to its nominal winding position (e.g. by moving rolls 3 and 4 and slender roll 5 towards winding roll 2 the location of which may be fixed, or by moving winding roll 2 towards slender roll 5 and rolls 3 and 4 the location of which may be fixed), web 1 will be accordingly threaded up.

[0039] In the embodiments of fig. 6a and 6b, the apparatus preferably still have means for positioning automatically slender roll 5 between rolls 3 and 4 in the nominal winding position. Further, in case winding roll 2 is movable, it is preferably winding roll 2 which moves during winding in the nominal winding position, in order to adapt to the diameter of winding roll 2.

[0040] In the embodiments described in relation with fig. 1 to 5, web 1 passes between roll 3 and slender roll 5 and then between slender roll 5 and winding roll 2, when the apparatus is in the nominal winding position. Further, rolls 3 and 4 and slender roll 5 are movable from the open position to the nominal winding position, the location of winding roll 2 being fixed. There are alternate possibilities to define the rolls the location of which is fixed or movable in order to allow an easy thread up. For instance, it is possible to have the location of roll 4 and slender roll 5 being fixed (however, the apparatus preferably still has means for positioning automatically slender roll 5 between rolls 3 and 4 in said nominal winding position) and roll 3 and winding roll 2 movable in order to get into the nominal winding position. Then, it is preferably winding roll 2 which moves during winding in the nominal winding position, in order to adapt to the diameter of winding roll 2.

[0041] It is to be understood that in the described embodiments of the invention, the three roll system comprising rolls 3 and 4 and slender roll 5 for winding web 1 on winding roll 2 may be used independently from the jaw formed by rolls 6, 7, 8 and 9.

[0042] The invention is also well suited for an arrangement of the rolls 3, 4 and 5 in a substantially horizontal (e.g. +/-10°, especially +/-5°, preferably exactly horizontal) plane, corresponding to some existing production lines.

[0043] Fig. 7 discloses an horizontal rolls arrangement. The film passes between rolls 3 and 5, then between rolls 5 and 2, the arrow indicating the rotation of winding roll 2. In the case represented, the first roll (3) is the upper roll while the second roll (4) is the lower roll. This planar arrangement is well suited for wide lines, typically 5 to 15m wide, especially 7 to 11m wide. In such a case, the diameter of roll 5 can be varied, to be for example 150-300mm, preferably 200-280mm, while the diameter of rolls 3 and 4 can be for example 300-900mm, preferably 420-500mm. The constitutive materials can be the same as previously disclosed. Rolls 4 and 5 can be of any type, including double-cylinders constrained rolls. The rolls can also be segmented or made of separated rolls.

[0044] In case of the horizontal arrangement, the rolls 3, 4 and 5 can be arranged according to the embodiment of fig.8. As represented in fig.8, there is, one carriage 32 carrying rolls 4 and 5, while roll 3 is mounted on a separate carriage 33, preferably slidably mounted on carriage 32. Carriage 32 is itself slidably mounted on carriage 34. Carriage 34 is the machine carriage, which is retracted as the diameter of the winding roll 2 increases. The arrows indicate the displacement of each carriage.

[0045] Fig.9 is a top view of the above embodiment. Roll 5 is equipped with end-axles or shafts 35a and 35b, which are themselves mounted on sliding tables.36a and 36b. The sliding tables comprise each two sliding rails, perpendicular to each other. Thus, each of the axles 35and 35b is able to move freely in the two dimensions, since the sliding table is an idle sliding table. The table is linked with carriage 32. This allows, when roll 5 abuts on winding roll 2, to have a uniform contact with rolls 3, 4 and 2 by auto-centering of the roll 5 with respect to rolls 3, 4 and 2.

[0046] Fig. 10 is an enlarged side view of the above embodiment. The shaft 35a extends first into roll 5 for a sufficient length, e.g. between 1 and 3 times the diameter of roll 5. Shaft 35a and roll 5 are connected through (rolling) bearings (not shown). Shaft 35a is connected at its other extremity to the sliding table 36a. Sliding table is schematically represented by two elements, one being secured to carriage 32 and the other representing the sliding element. The connection between shaft 35a and sliding table 36a is done through a ball-joint 37a. This ball-joint allows to ensure a full angular freedom between the table and the shaft, so as to guarantee the self-aligning function of roll (5) with respect to rolls (3), (4) and (2). Shaft 35a is connected to a lever 38a. The aim of the lever is to apply a bending moment to shaft 35a and consequently to roll 5. The lever is connected at its other extremity to a displacing piston 39a. The displacing piston 39a, preferably a pressure cylinder, displaces one extremity of the lever 28a according to arrow

F1. In turn, the lever will exert a bending moment on the shaft 35a and consequently roll 5, represented by arrow F2. Displacing piston 39a is also further connected to a sliding rail 40a, which can freely move along a line (which is substantially horizontal as the third half-plane). Sliding table 36a and sliding rail 40a are connected by an articulated bar 41a. The displacement possibilities are schematically represented fig. 11., where A1 and A2 represent the initial positions of the piston 39a and ball-joint 37a, A3 and A4 after a translation and A3 and A5 after a further rotation. Thus, the free movement of roll 5 to auto-center between rolls 3, 4 and 2 is not impaired by the bending mechanism comprised of lever 38a and piston 39a, which simply follows roll 5 displacement.

[0047] The same arrangement is also available for the other shaft 35b ; both arrangements are actuated in a parallel way, or according to distinct procedures, if required.

[0048] It should be noted that this embodiment can be applied to any system, not necessarily in an horizontal arrangement. It can notably be adapted to the system depicted in figures 1-6.

[0049] Fig. 12 represents a further embodiment, in which the roll is equipped with a system similar to the system disclosed above with respect to the cylinders 19 and 25. In the instant case, cylinders 42a and 43a are fixed on carriage 32. These cylinders allow to apply horizontal and vertical forces on the extremities of roll 5.

[0050] In nominal winding position, cylinders 39a,b and 42a,b may apply respectively bending moments and forces in the horizontal plane, preferably both together in order to bring roll 5 in intimate and uniform contact with rolls 3 and 4 over their entire length, Rolls 3 and 4 may indeed have a non-straight bending line, to which roll 5 has to conform.

[0051] In roll change configuration, it is useful too that cylinders 39a,b and 42a,b apply bending moments and forces in the horizontal plane. As a matter of fact, during this step, roll 5 is turning at its nominal speed, which is quite high, but will not be abutting winding roll 2. In such a case, there is a risk of vibration that could be detrimental to the overall stability and hence to film quality. When binding moments and horizontal forces are applied, roll 5 is forced towards rolls 3 and 4, over its entire length, thus reducing drastically the vibrations.

[0052] In thread up mode, when roll 3 is in the retracted position, cylinders 43a,b may exert a vertical force to press roll 5 in contact with rolls 4 and 2.

[0053] Fig. 13 represents one possible thread up procedure.

Step 1 (fig.13a). The web 1 passes between roll 3 and rolls 4 and 5, carriage 33 carrying roll 3 being in upper position. The web is next rolled on core 2', passing first on an auxiliary roll 46b. A turret comprises cores 2 and 2', and auxiliary rolls 45a and 46b. This allows manual thread up by the upper side of the turret.

Step. 2 (fig.13b). Carriage 34 is moved closed to roll 2, so that rolls 4, 5 and 2 are in contact. At that time, the line speed can be, e.g., 150 m/min.

Step 3 (fig.13c). Carriage 33 is lowered to have roll 3 in contact with roll 5. At that time, the line speed can be increased.

Step 4 (fig.13d). Carriage 32 is moved back from core 2 and the turret is rotated by 360° counter-clock wise.

Step 5 (fig.13e). Carriage 32 is moved again towards roll 2 ; a cutting mechanism (not shown) is actuated in a classical manner to cut the web and cause it to be wound on core 2.

[0054] It would also possible to have the following sequence : step 1 ; step 4, step 2, step 3 ; or step 1 ; step 4, step 3, step 2.

[0055] Fig. 14 represents one possible roll change procedure.

Step 1 (fig.14a). Carriage 32 is moved back from wound roll 2.

Step 2 (fig.14b). The turret is rotated 180° counter-clock wise.

Step 3 (fig.14c). Carriage 32 is moved again towards core 2' ; a cutting mechanism (not shown) is actuated in a classical manner to cut the web and cause it to be wound on core 2'.

[0056] In still another embodiment, a driving torque is applied to at least one of the rolls 3, 4 and 5, under the nominal state, so as to prevent shear forces acting on the film where the later is nipped. This embodiment is distinct from the one disclosed above with respect to fig. 1a, 1b or 1c (in which the rolls are caused to rotate for the purposes of a start procedure in order to avoid any tearing of the web). This allows to overcome rolling friction.

[0057] Fig. 15 discloses such an embodiment. The system is here a "vertical" system. Web 1 passes between rolls 3 and 5. Roll 4 (the roll not in direct contact with the web) is coupled to a pulley 48, driven by driving belt 49. Belt 49 is itself driven by pulley 50, itself again driven by belt 51. Belt 51 is driven by pulley 52, connected to the shaft of a motor (not shown), itself fixed on carriage 12. Two articulated levers 49a and 51a support pulley 50 and allow to tighten the belts. More precisely, lever 49a has one end articulated to roll 4 and the other one to lever 51a. The later is further articulated at the same location as the center of pulley 52. This system follows roll 4 displacement without significantly increasing its inertia mass. The inertial mass remains thus constant.

[0058] Further, in case the diameters of both pulleys 48 and 50 are identical, there will be no influence of the possible vertical displacement of roll 4 (due to e.g. roll 2 run out) on the rotational speed of roll 4.

[0059] This rolling friction-reducing apparatus can be

adapted to any of the above-disclosed devices (vertical or horizontal).

[0060] Various modifications can be brought to the instant invention without departing from its scope. For example, it is possible to have additional rolls in contact with rolls 3 and 4. This is shown in fig. 16. In fact, any multiple rolls arrangement can be applied.

[0061] Of course, the invention is not limited to the embodiments descrived above.

Claims

1. An apparatus for winding at least one web (1) on a winding roll (2), comprising at least a first roll (3), a second roll (4) and a third roll (5) parallel to one another and to said winding roll (2), said apparatus having a nominal winding position in which:

   - said first and second rolls (3, 4) and said winding roll (2) are each in contact with said third roll (5) ;
   - there is no contact between said first roll (3) and said second roll (4), between said first roll (3) and said winding roll (2) and between said second roll (4) and said winding roll (2) ;
   - a first angle defined between a first half-plane delimited by the axis of said third roll (5) and comprising the axis (17) of said first roll (3) and a second half-plane delimited by the axis of said third roll (5) and comprising the axis (18) of said second roll (4) is smaller than 180° ;
   - a second angle defined between a third half-plane delimited by the axis of said third roll (5) and comprising the axis of said winding roll (2) and a fourth half-plane delimited by the axis of said third roll (5) and comprising an intersection line is greater than 90°, said intersection line being defined as the intersection between the bisector plane of said first angle and the plane comprising the axis (17) of said first roll (3) and the axis (18) of said second roll (4),

   characterized in that in said nominal winding position :

   a driving torque is applied to at least one of said first, second and third rolls (3, 4, 5) as to rotate in the direction of said web (1) in order to compensate for the rolling resistance of said apparatus.

2. The apparatus according to claim 1, **characterized in that** in said nominal winding position, said third roll (5) auto-centers with respect to said winding, first and second rolls (2, 3, 4).

3. The apparatus according to claim 1 or 2, **characterized in that** said first, second and third rolls (3, 4, 5) are free to move along a direction not perpendicular to said third half-plane and preferably substantially parallel to said third half-plane.

4. The apparatus according to any one of claims 1 to 3, wherein, in said nominal winding position, the driving means of at least one of said first, second and third rolls (3, 4, 5) comprises a belt and pulleys system.

5. The apparatus according to claim 4, **characterized in that** said system comprises a pulley (48) on said at least one driven roll, said pulley being connected via a belt (49) to a second pulley (50), itself being connected via a belt (51) to a third pulley (52), said third pulley (52) being driven by a motor.

6. The apparatus according to claim 5, **characterized in that** pulleys (48) and (50) are joined by a lever (49a) while pulleys (50) and (52) are joined by lever (51a), the said levers being articulated at pulley (50), whereby pulley (50) can move freely with respect to pulleys (48), and (52).

7. The apparatus according to claim 6, **characterized in that** lever (49a) is substantially perpendicular to the common direction along which said first, second and third rolls (3, 4, 5) are free to move, and preferably substantially perpendicular to said third half-plane.

8. The apparatus according to claim 6 or 7, **characterized in that** lever (51a) is substantially perpendicular to lever (49a).

9. The apparatus according to any one of claims 5 to 8, **characterized in that** pulleys (48) and (50) have the same diameter.

10. The apparatus according to any one of claims 4 to 8, **characterized in that** the total mass of lever (49a), pulleys (48) and (50) and belt (49) is less than 10% of the mass of said at least one driven roll.

11. The apparatus according to any one of claims 4 to 10, **characterized in that** the motor of said system is stationary.

12. The apparatus according to anyone of claims 1 to 11, **characterized in that**:

    said web (1) passes between said first and third rolls (3, 5) and then between said third roll (5) and said winding roll (2), but not between said second roll (4) and said third roll (5), and
    at least one of said second roll (4) and first roll (3) is driven and said third roll (5) is caused to

run along the circumference of said second roll (4) or first roll (3) whereby said second roll (4) or first roll (3) causes said third roll (5) to rotate by friction driving in the direction and at a tangential speed corresponding substantially to those of said web (1).

13. The apparatus according to claim 12, characterized meanly said second roll (4) is driven.

14. The apparatus according to claim 12, **characterized in that** both first and second rolls (3, 4) are driven.

15. The apparatus according to any one of claims 1 to 14, **characterized in that** said third half-plane is substantially vertical.

16. The apparatus according to any one of claims 1 to 14, **characterized in that** said third half-plane is substantially horizontal.

17. A method for winding at least one web (1) on a winding roll (2), using an apparatus according to any one of claims 1 to 16.

Patentansprüche

1. Gerät zum Aufwickeln mindestens einer Bahn (1) auf eine Aufwickelrolle (2) mit mindestens einer ersten Rolle (3), einer zweiten Rolle (4) und einer dritten Rolle (5), die parallel zueinander und zu der Aufwickelrolle (2) sind, wobei das Gerät eine nominale Aufwickelposition aufweist, in welcher:

- die erste und die zweite Rolle (3, 4) und die Aufwickelrolle (2) jeweils in Kontakt mit der dritten Rolle (5) sind;
- zwischen der ersten Rolle (3) und der zweiten Rolle (4), zwischen der ersten Rolle (3) und der Aufwickelrolle (2), und zwischen der zweiten Rolle (4) und der Aufwickelrolle (2) kein Kontakt besteht;
- ein erster Winkel, der durch eine erste Halbebene, die durch die Achse der dritten Rolle (5) begrenzt ist und die Achse (17) der ersten Rolle (3) enthält, und eine zweiten Halbebene, die durch die Achse der dritten Rolle (5) begrenzt ist und die Achse (18) der zweiten Rolle (4) enthält, definiert ist, kleiner ist als 180°; und
- ein zweiter Winkel, der durch eine dritte Halbebene, die durch die Achse der dritten Rolle (5) begrenzt ist und die Achse der Aufwickelrolle (2) enthält, und eine vierte Halbebene, die durch die Achse der dritten Rolle (5) begrenzt ist und eine Schnittlinie enthält, definiert ist, größer ist als 90°, wobei die Schnittlinie als Schnitt der Halbierungsebene des ersten Winkels mit der Ebene, die die Achse (17) der ersten Rolle (3) und die Achse (18) der zweiten Rolle (4) umfasst, definiert ist,

dadurch gekennzeichnet, dass

in der nominalen Aufwickelposition:

eine Antriebsdrehkraft an mindestens einer der ersten, zweiten und dritten Rolle (3, 4, 5) für eine Rotation in Richtung der Bahn (1) angelegt ist, um den Rollwiderstand des Gerätes zu kompensieren.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass**

sich in der nominalen Aufwickelposition die dritte Rolle (5) bezüglich der Aufwickel-, ersten und zweiten Rolle (2, 3, 4) auto-zentriert.

3. Gerät nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die erste, zweite und dritte Rolle (3, 4, 5) frei sind, um sich entlang einer Richtung, die nicht senkrecht zu der dritten Halbebene und vorzugsweise im wesentlichen parallel zu der dritten Halbebene ist, zu bewegen.

4. Gerät nach einem der Ansprüche 1 bis 3, wobei,

in der nominalen Aufwickelposition, die Antriebsvorrichtung an mindestens einer der ersten, zweiten und dritten Rolle (3, 4, 5) ein Riemen- und Scheibensystem umfasst.

5. Gerät nach Anspruch 4, **dadurch gekennzeichnet, dass**

das System eine Scheibe (48) an der mindestens einen angetriebenen Rolle aufweist, wobei die Scheibe über einen Riemen (49) mit einer zweiten Scheibe (50) verbunden ist, die selbst wiederum Ober einen Riemen (51) mit einer dritten Scheibe (52) verbunden ist, wobei die dritte Scheibe (52) durch einen Motor angetrieben ist.

6. Gerät nach Anspruch 5, **dadurch gekennzeichnet, dass**

die Scheiben (48) und (50) durch einem Hebel (49a) verbunden sind, während die Scheiben (50) und (52) mit einem Hebel (51a) verbunden sind, und die Hebel an der Scheibe (50) zusammenlaufen, wobei sich die Scheibe (50) bezüglich der Scheiben (48) und (52) frei bewegen kann.

7. Gerät nach Anspruch 6, **dadurch gekennzeichnet, dass**

der Hebel (49a) im wesentlichen senkrecht zu der allgemeinen Richtung, entlang welcher die erste, zweite und dritte Rolle (3, 4, 5) frei sind, sich zu bewegen, und vorzugsweise im wesentlichen senk-

recht zu der dritten Halbebene ist.

8. Gerät nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass**
der Hebel (51a) im wesentlichen senkrecht zu dem Hebel (49a) ist.

9. Gerät nach einem der Ansprüche 5 bis 8, **dadurch gekennzeichnet, dass** die Scheiben (48) und (50) den gleichen Durchmesser aufweisen.

10. Gerät nach einem der Ansprüche 4 bis 8, **dadurch gekennzeichnet, dass**
das Gesamtmasse des Hebel (49a), der Scheiben (48) und (50) und des Riemens (49) weniger als 10 % der Masse der mindestens einen angetriebenen Rolle beträgt.

11. Gerät nach einem der Ansprüche 4 bis 10, **dadurch gekennzeichnet, dass**
der Motor des Systems fest ist.

12. Gerät nach einem der Ansprüche 1 bis 11, **dadurch gekennzeichnet, dass**:

die Bahn (1) zwischen der ersten und der dritten Rolle (3, 5) und dann zwischen der dritten Rolle (5) und der Aufwickelrolle (2), aber nicht zwischen der zweiten (4) und der dritten Rolle (5) verläuft, und
mindestens eine der zweiten (4) und ersten Rolle (3) angetrieben ist, und die dritte Rolle (5) dazu veranlasst ist, entlang des Umkreises der zweiten (4) oder ersten Rolle (3) zu laufen, wobei die zweite (4) oder die erste Rolle (3) die dritte Rolle (5) dazu veranlasst, sich durch Reibungsantrieb in eine Richtung und mit einer Tangentialgeschwindigkeit zu drehen, die im wesentlichen denen der Bahn (1) entsprechen.

13. Gerät nach Anspruch 12, **dadurch gekennzeichnet, dass**
nur die zweite Rolle (4) angetrieben ist.

14. Gerät nach Anspruch 12, **dadurch gekennzeichnet, dass**
beide, die erste und die zweite Rolle (3, 4), angetrieben sind.

15. Gerät nach einem der Ansprüche 1 bis 14, **dadurch gekennzeichnet, dass**
die dritte Halbebene im wesentlichen vertikal ist.

16. Gerät nach einem der Ansprüche 1 bis 14, **dadurch gekennzeichnet, dass**
die dritte Halbebene im wesentlichen horizontal ist.

17. Verfahren zum Aufwickeln mindestens einer Bahn (1) auf eine Aufwickelrolle (2), wobei
ein Gerät nach einem der Ansprüche 1 bis 16 verwendet wird.

Revendications

1. Appareil pour enrouler au moins un voile ou feuil (1) sur un rouleau d'enroulement (2), comprenant au moins un premier rouleau (3), un deuxième rouleau (4) et un troisième rouleau (5) parallèles les uns aux autres et audit rouleau d'enroulement (2), ledit appareil présentant une position nominale de bobinage dans laquelle :

lesdits premier et deuxième rouleaux (3, 4) et ledit rouleau d'enroulement (2) sont chacun en contact avec ledit troisième rouleau (5) ;
il n'y a aucun contact entre ledit premier rouleau (3) et ledit deuxième rouleau (4), entre ledit premier rouleau (3) et ledit rouleau d'enroulement (2) et entre ledit deuxième rouleau (4) et ledit rouleau d'enroulement (2) ;
un premier angle défini entre un premier demi-plan délimité par l'axe dudit troisième rouleau (5) et comprenant l'axe (17) dudit premier rouleau (3) et un deuxième demi-plan délimité par l'axe dudit troisième rouleau (5) et comprenant l'axe (18) dudit deuxième rouleau (4) est inférieur à 180° ;
un deuxième angle défini entre un troisième demi-plan délimité par l'axe dudit troisième rouleau (5) et comprenant l'axe dudit rouleau d'enroulement (2) et un quatrième demi-plan délimité par l'axe dudit troisième rouleau (5) et comprenant une ligne d'intersection est supérieur à 90°, ladite ligne d'intersection étant définie comme l'intersection entre le plan bi-sectoriel dudit premier angle et le plan comprenant l'axe (17) dudit premier rouleau (3) et l'axe (18) dudit deuxième rouleau (4),

caractérisé en ce que dans ladite position nominale de bobinage :

un couple moteur est appliqué à au moins l'un desdits premier, deuxième et troisième rouleaux (3, 4, 5) de façon à tourner dans la direction dudit voile (1) afin de compenser la résistance au roulement dudit appareil.

2. Appareil selon la revendication 1, **caractérisé en ce que** dans ladite position nominale de bobinage, ledit troisième rouleau (5) se centre automatiquement par rapport auxdits rouleau d'enroulement (2), premier et deuxième rouleaux (3, 4).

3. Appareil selon la revendication 1 ou 2, **caractérisé en ce que** lesdits premier, deuxième et troisième rouleaux (3, 4, 5) sont libres de se déplacer le long d'une direction non perpendiculaire audit troisième demi-plan et de préférence sensiblement parallèle audit troisième demi-plan.

4. Appareil selon l'une quelconque des revendications 1 à 3, dans lequel, dans ladite position nominale de bobinage, les moyens d'entraînement d'au moins l'un desdits premier, deuxième et troisième rouleaux (3, 4, 5) comprend un système de courroie et de poulies.

5. Appareil selon la revendication 4, **caractérisé en ce que** ledit système comprend une poulie (48) sur ledit au moins un rouleau entraîné, ladite poulie étant reliée par l'intermédiaire d'une courroie (49) à une deuxième poulie (50), elle-même étant reliée par l'intermédiaire d'une courroie (51) à une troisième poulie (52), ladite troisième poulie (52) étant entraînée par un moteur.

6. Appareil selon la revendication 5, **caractérisé en ce que** les poulies (48) et (50) sont jointes par un levier (49a) alors que les poulies (50) et (52) sont jointes par un levier (51a), lesdits leviers étant articulés à la poulie (50), de telle manière que la poulie (50) puisse se déplacer librement par rapport aux poulies (48) et (52).

7. Appareil selon la revendication 6, **caractérisé en ce que** le levier (49a) est sensiblement perpendiculaire à la direction commune le long de laquelle lesdits premier, deuxième et troisième rouleaux (3, 4, 5) sont libres de se déplacer, et de préférence sensiblement perpendiculaire audit troisième demi-plan.

8. Appareil selon la revendication 6 ou 7, **caractérisé en ce que** le levier (51a) est sensiblement perpendiculaire au levier (49a).

9. Appareil selon l'une quelconque des revendications 5 à 8, **caractérisé en ce que** les poulies (48) et (50) présentent le même diamètre.

10. Appareil selon l'une quelconque des revendications 4 à 8, **caractérisé en ce que** la masse totale du levier (49a), des poulies (48) et (50) et de la courroie (49) est inférieure à 10 % de la masse dudit au moins un rouleau entraîné.

11. Appareil selon l'une quelconque des revendications 4 à 10, **caractérisé en ce que** le moteur dudit système est fixe.

12. Appareil selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que**:

ledit voile feuil (1) passe entre lesdits premier et troisième rouleaux (3, 5) et ensuite entre ledit troisième rouleau (5) et ledit rouleau d'enroulement (2), mais pas entre ledit deuxième rouleau (4) et ledit troisième rouleau (5), et
au moins l'un desdits deuxième rouleau (4) et premier rouleau (3) est entraîné et ledit troisième rouleau (5) est contraint de se déplacer le long de la périphérie dudit deuxième rouleau (4) ou premier rouleau (3) de telle manière que ledit deuxième rouleau (4) ou premier rouleau (3) contraigne ledit troisième rouleau (5) à tourner par entraînement par frottement dans la direction et à une vitesse tangentielle correspondant sensiblement à celle dudit voile (1).

13. Appareil selon la revendication 12, **caractérisé en ce que** seulement ledit deuxième rouleau (4) est entraîné.

14. Appareil selon la revendication 12, **caractérisé en ce qu'**à la fois le premier et le deuxième rouleaux (3, 4) sont entraînés.

15. Appareil selon l'une quelconque des revendications 1 à 14, **caractérisé en ce que** ledit troisième demi-plan est sensiblement vertical.

16. Appareil selon l'une quelconque des revendications 1 à 14, **caractérisé en ce que** ledit troisième demi-plan est sensiblement horizontal.

17. Procédé pour enrouler au moins un voile ou feuil (1) sur un rouleau d'enroulement (2), en utilisant un appareil selon l'une quelconque des revendications 1 à 16.

FIG_1a

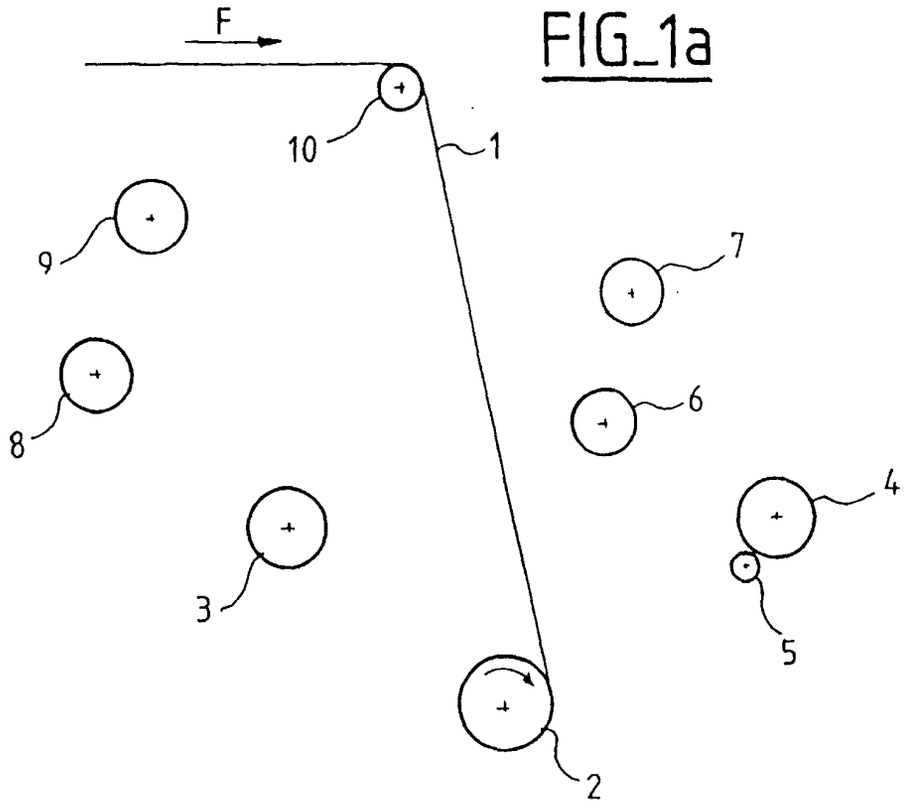
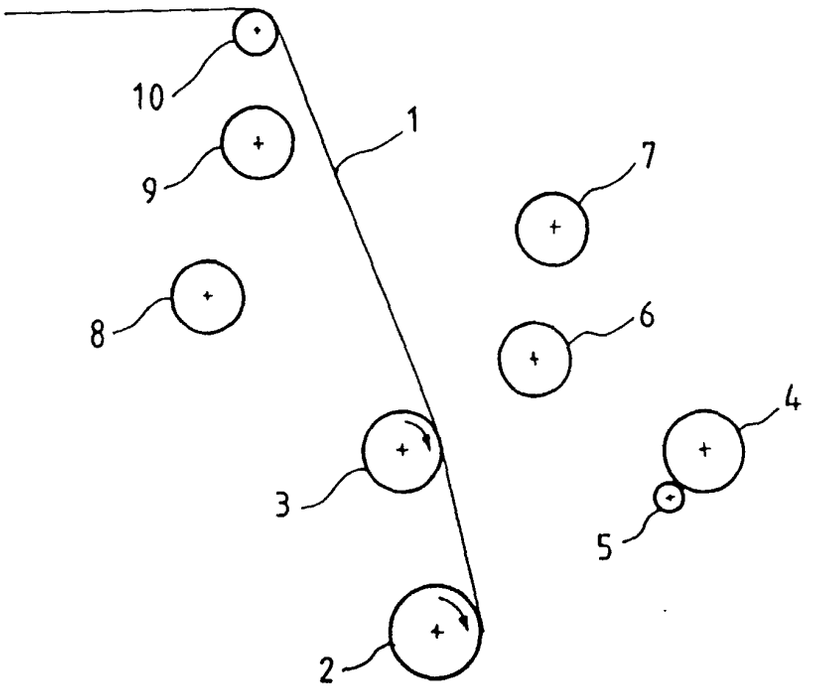


FIG_1b



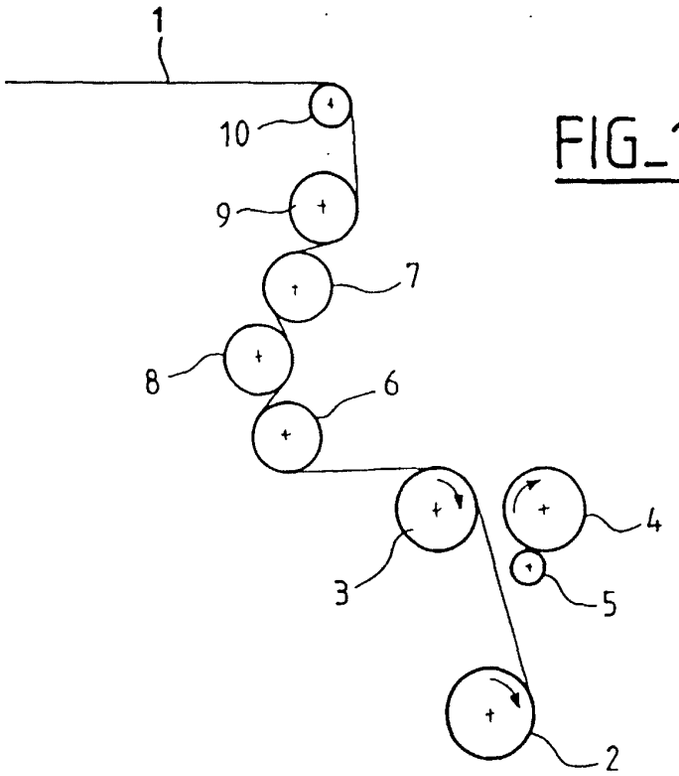


FIG_1c

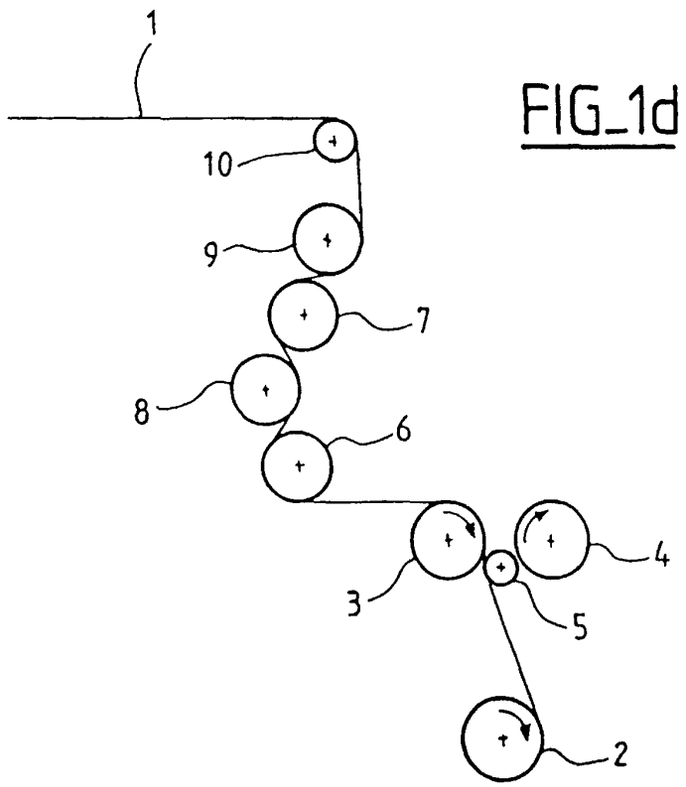


FIG_1d

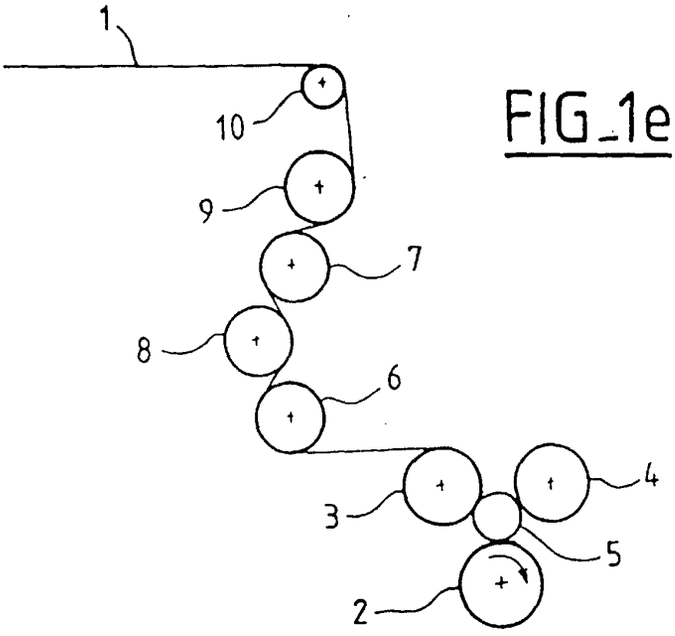

1
10
9
7
8
6
4
3
5
2

FIG_1e

FIG_2

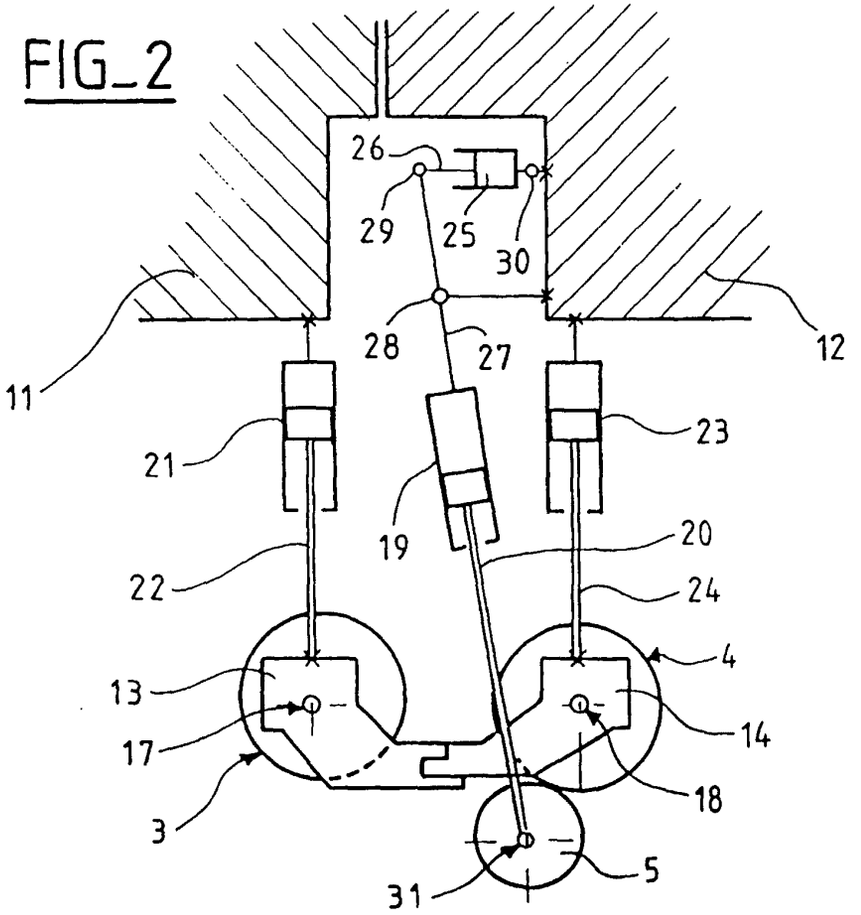

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FIG_3

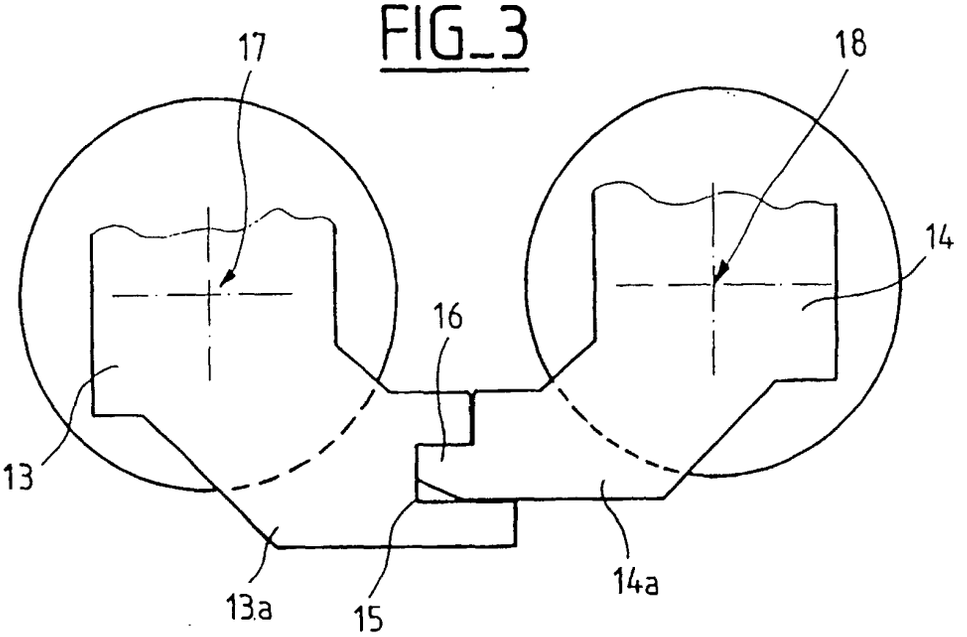


FIG_4

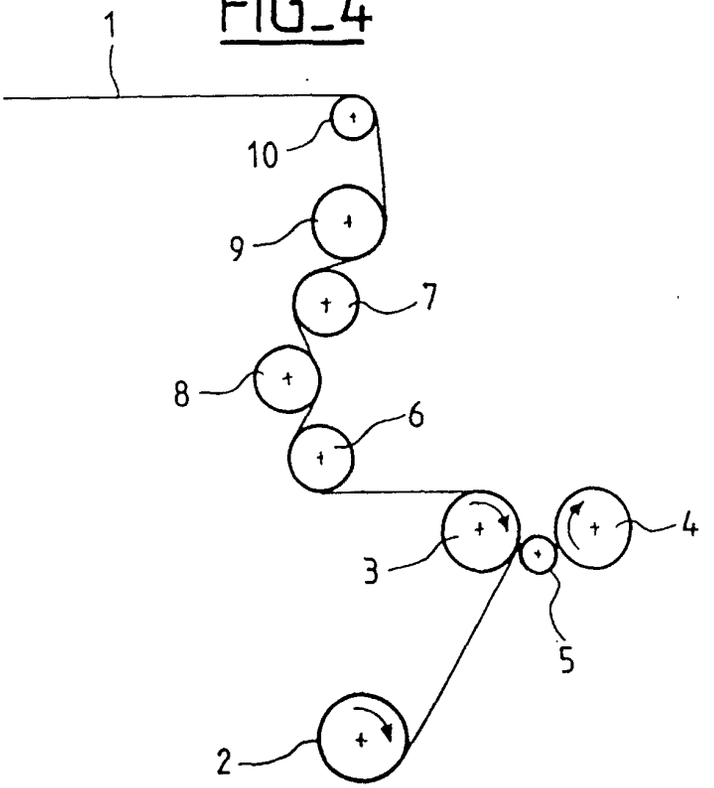


FIG_5

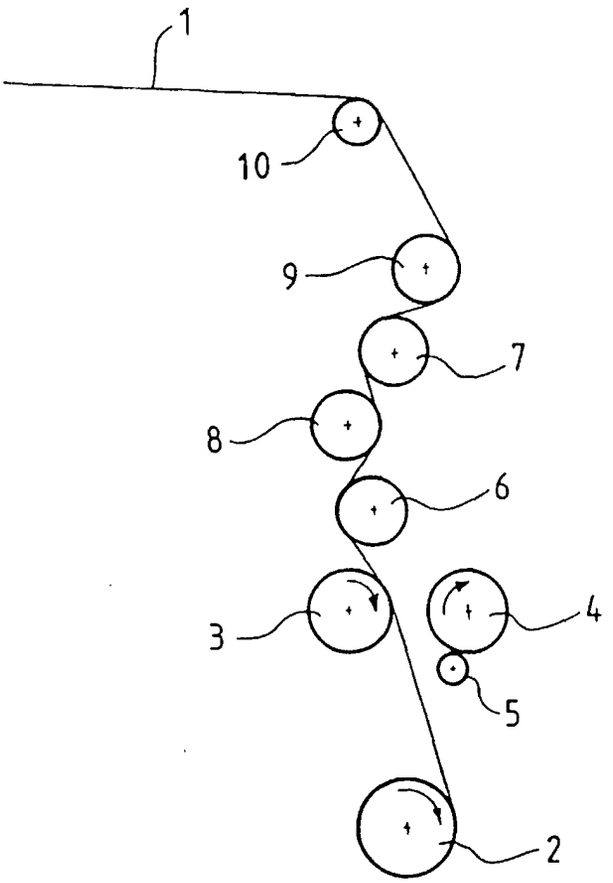


FIG_6a

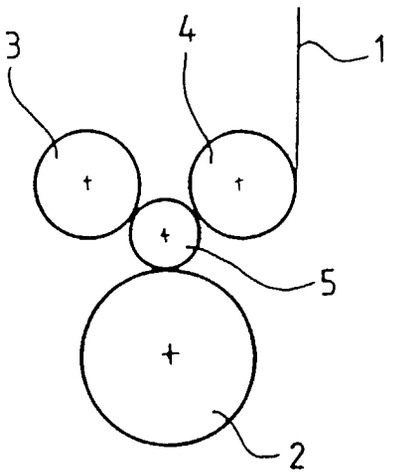
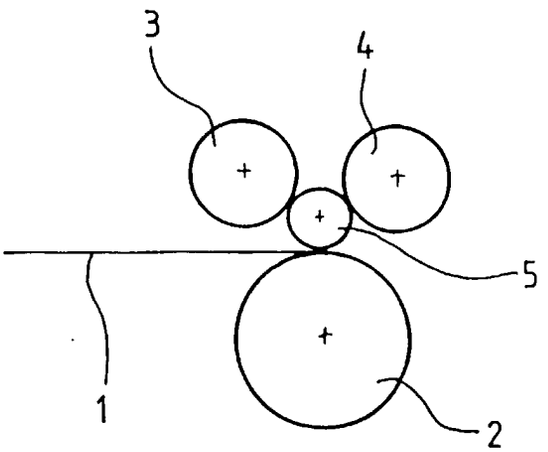


FIG_6b



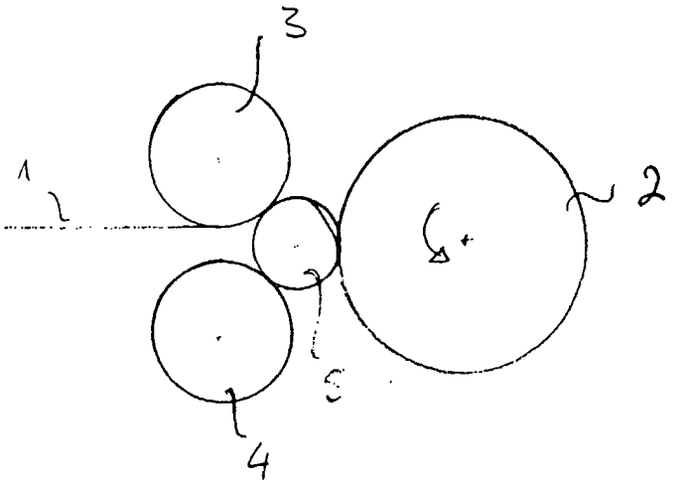


fig. 7

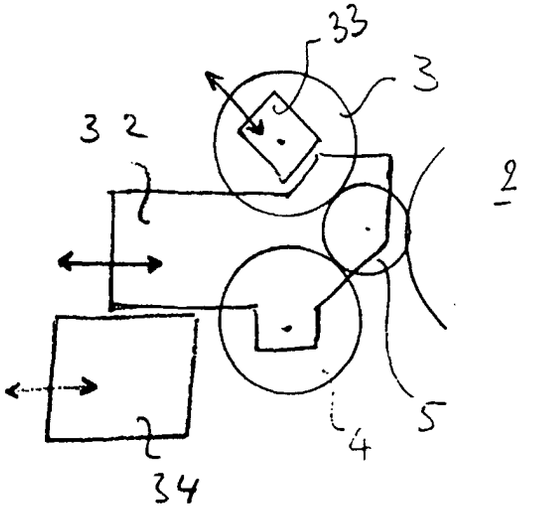


fig. 8

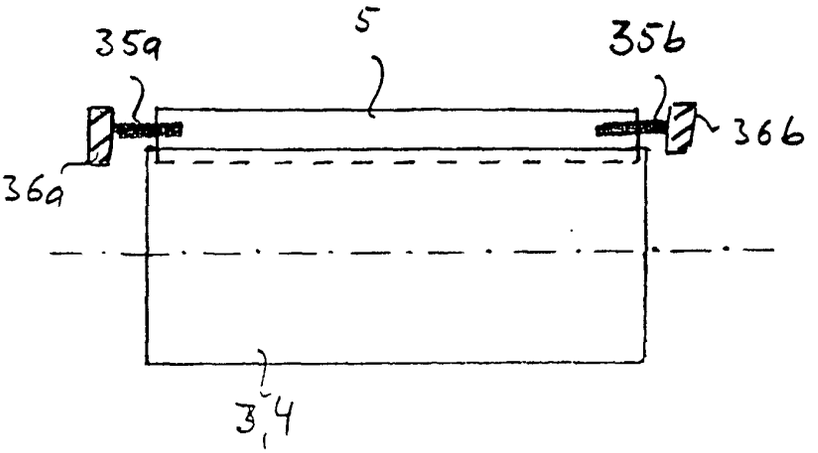


fig. 9

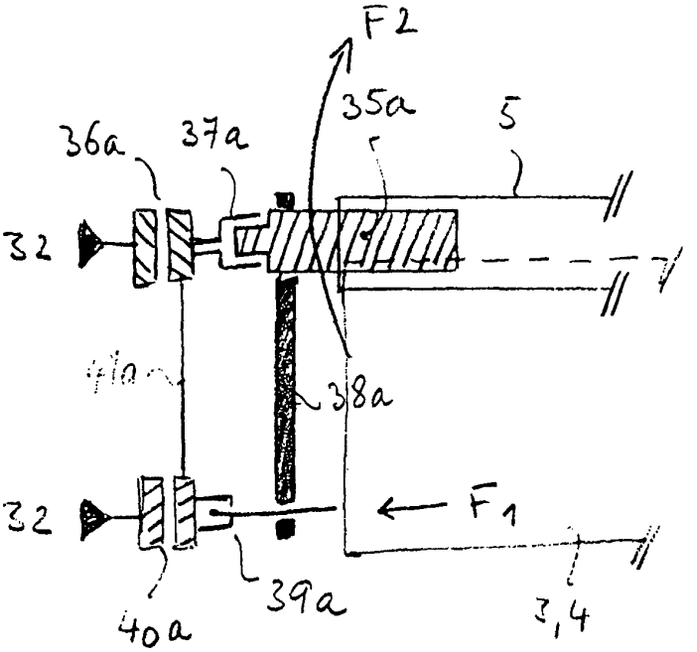


fig. 10

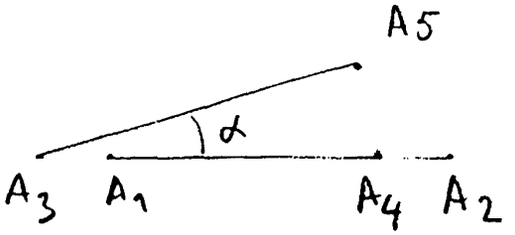


fig. 11

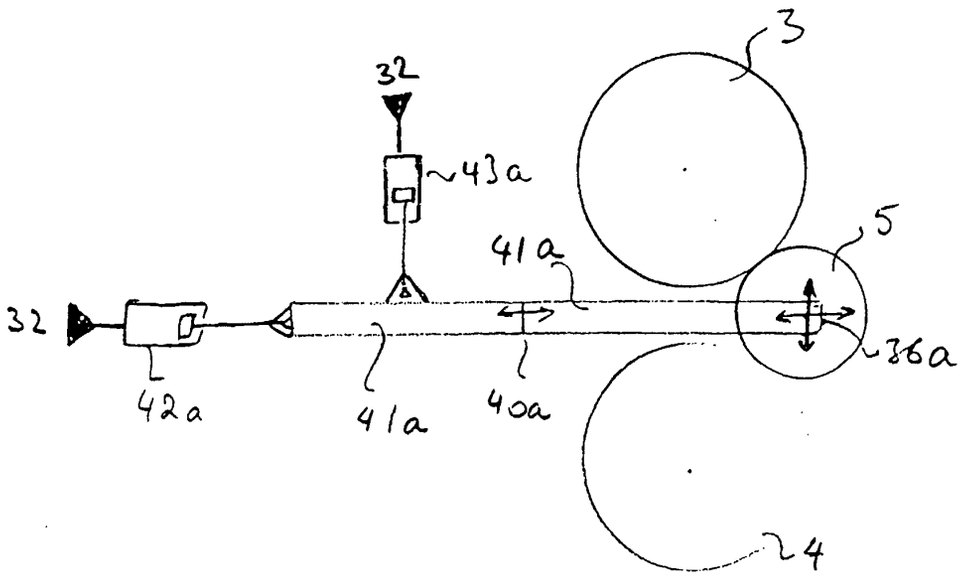


fig 12

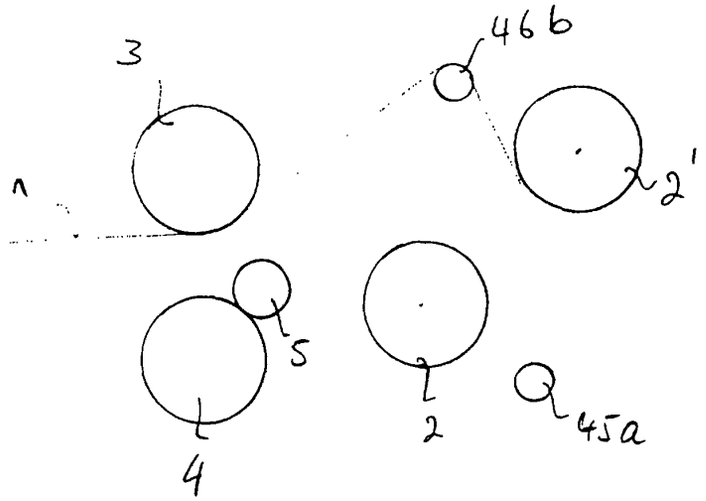


fig 13a

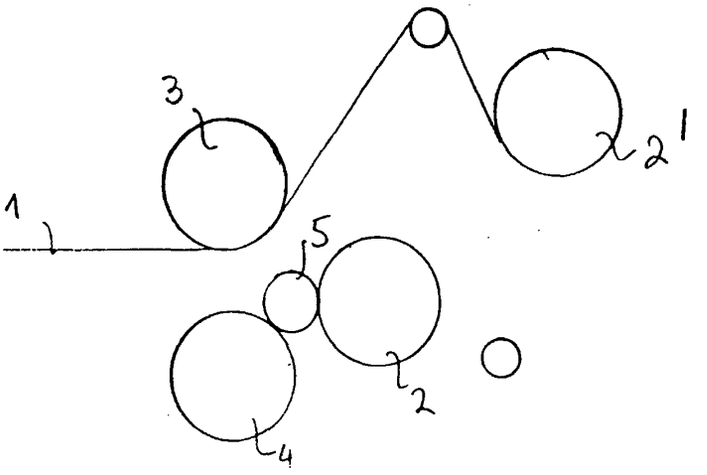


fig. 13b

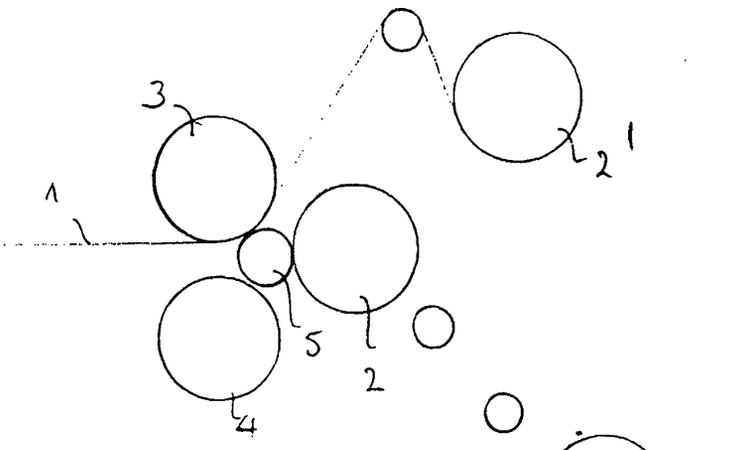


fig. 13c

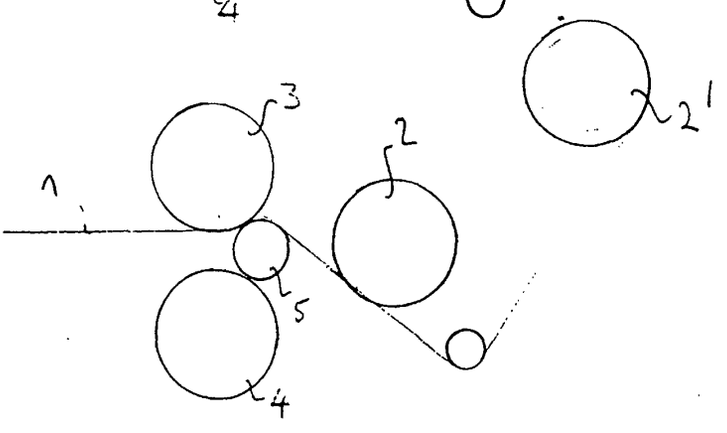


fig. 13d

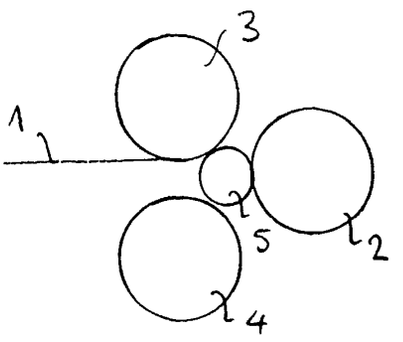


fig. 13e

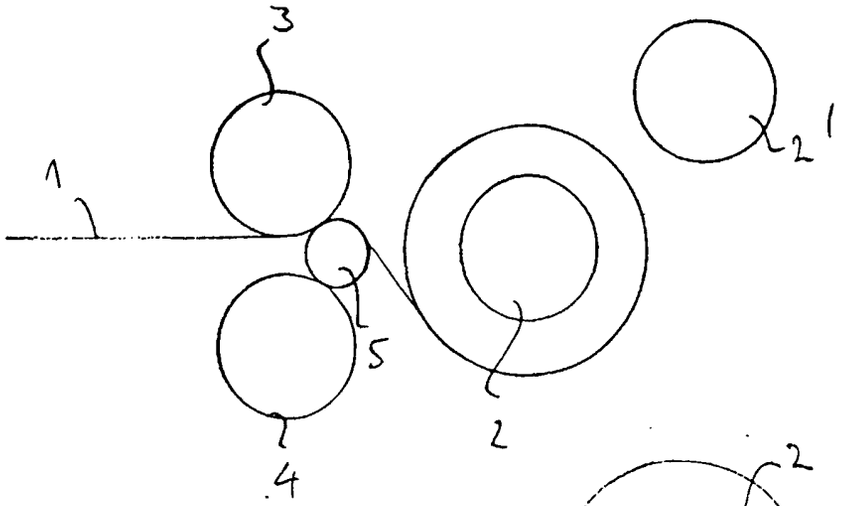


fig. 14a

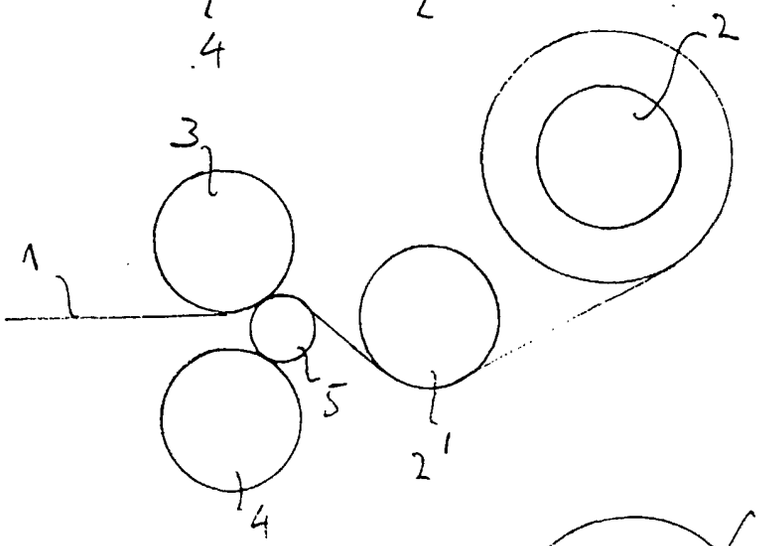


fig. 14b

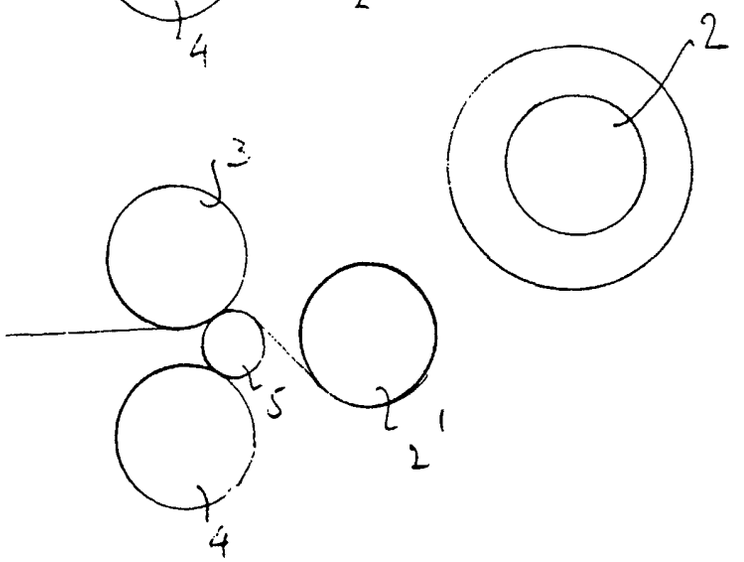


fig. 14c

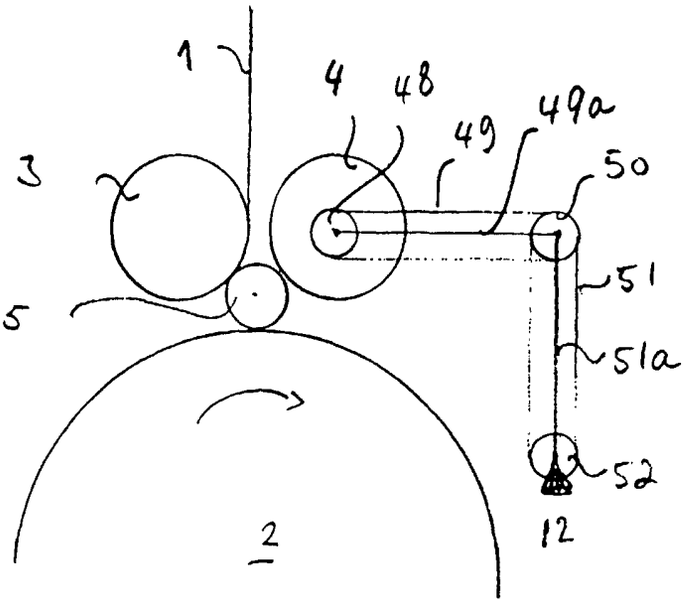


fig. 15

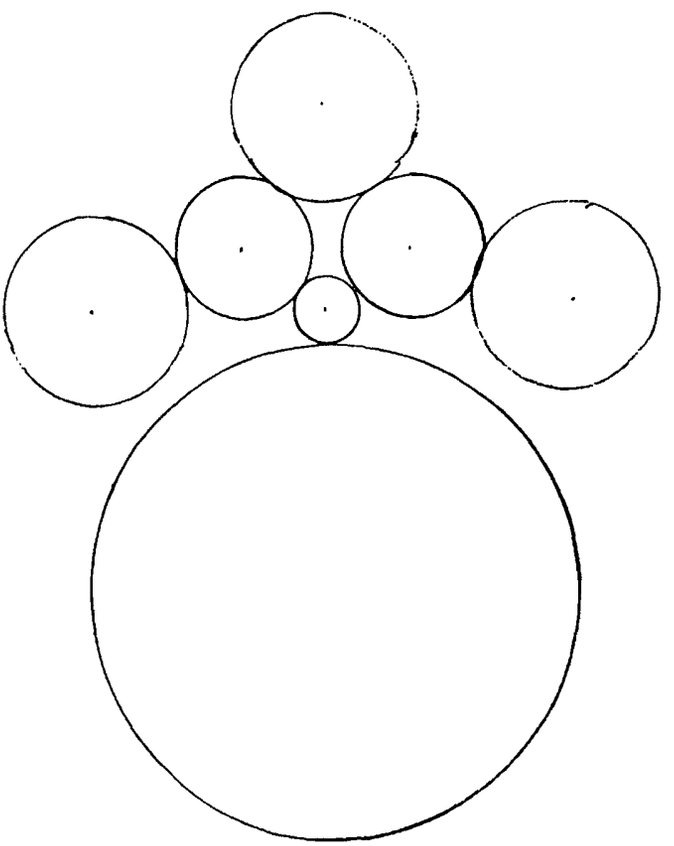


fig. 16