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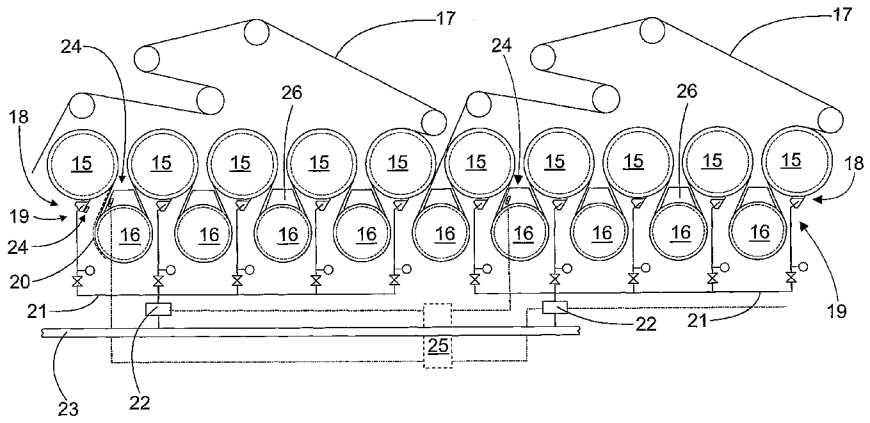
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**(54) Title:** METHOD AND ARRANGEMENT IN TAIL THREADING IN A SINGLE-WIRE DRAW DRYING SECTION OF A WEB-FORMING MACHINE




**(57) Abstract:** The invention relates to a method in tail threading in a single-wire draw drying section of a web-forming machine, which includes consecutive drying groups (14) . In each of which there are drying cylinders (15) and suction hitch rolls (16) and at least part of a drying wire (17) . In the method a doctor apparatus (18) is used in connection with the drying cylinder (15) in the drying group (14), and an air blast in connection with it directed at the opening throat (30) formed by the drying cylinder (15) and the drying wire (17), in order to detach the threading tail (20) from the drying cylinder (15) and to guide it during tail threading. In the drying section the various air blasts are started and stopped at different times, in order to ensure sufficient compressed air. The air blasts in the drying groups (14) are controlled group-specifically independently of each other, in such a way that the air blasts in a drying group (14) are started when the threading tail (20) is verifiably detected in the preceding drying group (14) . The invention also relates to an arrangement in tail threading in a single-wire draw drying section of a web-forming machine.

WO 2007/023209 A1

# METHOD AND ARRANGEMENT IN TAIL THREADING IN A SINGLE-WIRE DRAW DRYING SECTION OF A WEB-FORMING MACHINE

The present invention relates to a method in tail threading in a single-wire draw drying section of a web-forming machine, which includes consecutive drying groups, in each of which there are drying cylinders and suction hitch rolls and at least one drying wire arranged to travel through them, in which method a doctor apparatus is used in connection with the drying cylinder in the drying group, and an air blast in connection with it directed at the opening throat formed by the drying cylinder and the drying wire, in order to detach the threading tail from the drying cylinder and to guide it during tail threading, and in the drying section the various air blasts are started and stopped at different times, in order to ensure sufficient compressed air. The invention also relates to a corresponding arrangement.

European patent 0479748 discloses a web-forming machine's drying section, through which the threading tail is transported without ropeways. In practice, the threading tail progresses supported by the drying wire. However, the threading tail has a tendency to follow the surface of the drying cylinder, even if the drying wire goes towards a suction hitch roll. Therefore a doctor apparatus, in which there are also air blasts to guide the threading tail during tail threading, is used to detach the threading tail from the drying cylinder.

The air blasts are generally only used during tail threading and the air blasts of the consecutive drying groups can be controlled independently of each other. The air blasts are adjusted using magnetic valves, which are operated, for example, by control logic. A tail-threading sequence, the timings of which are calculated and have safety factors added to them, are defined in the logic control. Despite timing the air blasts to ensure sufficient compressed air, the consumption of air

over the entire duration of the threading already forms a limiting quantity. In other words, if the tail threading fails, a new attempt can be made only after the air reservoirs have been filled sufficiently. The problems worsens in proportion to the length of the drying section. In addition, changes in the running speed of the web-forming machine, or in its production will cause increasingly long tail-threading sequences. The changes will also require the tail-threading sequence to be redefined.

The invention is intended to create a new type of method for tail threading in the drying section of a web-forming machine, by means of which the control of the air blasts will be easier and more precise than previously. In addition, the invention is intended to create a new type of arrangement for tail threading in the drying section of a web-forming machine, by means of which the air consumption can be kept as low as possible, without, however, endangering the success of the tail threading. The characteristic features of the method according to the present invention are stated in the accompanying Claim 1. Correspondingly, the characteristic features of the arrangement according to the invention are stated in the accompanying Claim 9. According to the invention, the air blasts of the drying groups are controlled according to the real location of the threading tail, so that predefined tail-threading sequences are unnecessary. In other words, the air blasts operate only when required. Not only the starting of the air blasts, but also the stopping of the air blasts takes place according to the real location of the threading tail. This means that safety factors are unnecessary, or at least can be considerably smaller than usual. The air consumption during the entire tail threading will therefore remain smaller, without an accumulation of consumption. The arrangement according to the invention is simple and can be easily fitted in connection with different kinds of drying groups. Various components can be used to define the location of the threading tail. Despite the simple

components, the use of the arrangement achieves precise control of the air blasts. At the same time, control logic is often unnecessary, which reduces the purchase and operating costs of the arrangement. In addition, the arrangement is not disturbed by changes in production speed, for example, so that when changes occur the previous redefinitions of the tail-threading sequences are unnecessary.

In the following, the invention is examined in greater detail with reference to the accompanying drawings showing some applications of the invention, in which

Figure 1 shows a side view of a web-forming machine,
Figure 2a shows two consecutive drying groups equipped with the arrangement according to the invention,
Figure 2b shows a detail of Figure 2a, seen against to the machine direction,
Figure 3a shows the timings and durations of the air blasts according to the prior art,
Figure 3b shows the timings and durations of the air blasts controlled according to the invention,
Figure 4 shows a partial enlargement of the arrangement according to the invention in a single-wire draw drying section.

Figure 1 shows a side view of one, as such, conventional web-forming machine. The method and arrangement according to the invention can be utilized not only in paper machines, but also in board machines and similar. For example, for manufacturing paper, a paper machine includes two or more consecutive sub-totalities. In the paper machine of Figure 1, the as such known sub-totalities are a wire section 10, a press section 11, a drying section 12, and a finishing section 13. The arrangement according to the invention is particularly intended for use in tail threading in the single-wire draw drying section 12 of a web-forming machine. Generally, the drying section 12

includes consecutive drying groups 14, of which there are a total of nine in the paper machine of Figure 1. Figure 2a shows two consecutive drying groups 14, in each of which there are drying cylinders 15 and suction hitch rolls 16, as well as at least one drying wire 17 arranged to travel through them. The size, number, and mutual positions of the drying cylinders and suction hitch rolls can vary in different tail-threading group arrangements. According to the invention, the drying section is divided into tail-threading groups, the formation of which can vary. According to the invention, a tail-threading group comprises drying cylinders, suction hitch rolls, and other equipment located in connection with them, as well as at least part of the drying-wire circulation, or of two drying-wire circulations. In addition, the tail-threading means in the tail-threading group are arranged to operate as groups, which can be controlled and adjusted group-specifically. In other words, a tail-threading group can differ from known wire groups. Thus, according to the invention, it is possible to select 2 - 5, preferably 3 - 4 suction hitch rolls for an adjustable tail-threading group. In that case, the construction of the arrangement will remain simple and the number of required components will remain reasonable. However, the definition of the tail-threading groups remains free, allowing the construction of the arrangement to be varied in different parts of the drying section. On the other hand, it is also advantageous to define the tail-threading groups according to the wire groups, as in the applications shown. In other words, each adjustable tail-threading group includes only one drying wire. In that case however, the gaps of the wire groups will permit the threading tail to be tensioned by increasing the differences in traction between consecutive wire groups, which will improve the runnability of the web-forming machine, for example, in problem situations.

The actual arrangement includes a doctor apparatus 14 arranged in connection with the drying cylinder 15 in the drying group

14, together with blowing means 19 fitted to it for guiding the threading tail during tail threading. In Figure 4, the blowing means 19 are fitted specifically to the doctor apparatus 18. On the other hand, the blowing means can be located more freely in connection with the doctor apparatus, for example, placed on the front side of the doctor beam. More specifically, the blowing means are in order to create an air blast aimed at the opening through 30 formed by the drying cylinder 15 and the drying wire 17 and thus to detach the threading tail 20 from the drying cylinder 15 and to guide it during tail threading. Figure 4 uses an arrow to show schematically the air blast, by means of which the threading tail 20 is detached from the drying cylinder 15 and guided to follow the drying wire 17, instead of the drying cylinder 15. According to the invention, the air blast is directed in a single-wire draw along the surface of the drying cylinder of the opening throat formed by the drying cylinder and the drying wire. Thus in a single-wire draw, air blasts that may be directed elsewhere will needlessly increase the consumption of air, without bringing any further advantage to the tail threading.

Figure 2a shows the air-distribution channels 21 of the blowing means, which terminate in air-distribution means (not shown) placed in the doctor apparatus 18. In each drying group, the air-distribution channels are connected to each other and are connected by magnetic valves 22 to the frame compressed-air pipe 23. Thus, by operating the magnetic valves the air blasts are controlled group-specifically, in such a way that the various air blasts in the drying section are arranged to start and stop at different times, in order to ensure sufficient compressed air.

According to the invention, the arrangement includes means 24 for verifiably detecting the threading tail 20 in the drying group 14 and the means 24 are arranged to control the blowing means 19 group-specifically depending on the various drying

groups 14, in such a way that the air blasts in a drying group start when the threading tail 20 has been verifiably detected in the preceding drying group. In other words, the air blasts are started in a drying group 14 when the threading tail 20 is detected in the preceding drying group 14. For example, the air blasts of the drying group R4 are started when the threading tail is detected in the drying group R3. More specifically, the air blasts are started in the application, when the threading tail 20 is detected in the immediately preceding drying group 14 or in the drying group 14 preceding that. Detection earlier than this will only increase the consumption of air, without an noticeable advantage. Detection from the preceding drying group or from the two preceding drying groups is advantageous, if the drying groups are short and/or the production speed is high. In practice, in most cases it is quite sufficient if the threading tail is detected in the drying group immediately preceding the drying group in question.

When the actual and real-time position of the threading tail is used to control the air blasts, precise control is created in a simple manner. In addition, the arrangement operates with the same reliability despite various changes and above all the air consumption is substantially smaller than previously. The air consumption is also reduced by using the method according to the invention to also shut off the air blasts. More specifically, the air blasts are shut off in the drying group once the threading tail has been detected in the subsequent drying group. Thus the calculatory control values and safety factors are unnecessary. On the other hand, when the threading tail is in the subsequent drying group, it is possible to be certain that the tail threading has succeeded. The reliability of the arrangement can be further improved by shutting off the air blasts only once the position of the threading tail at the runnability device of the subsequent drying group, for example, the suction box or suction hitch roll, is ascertained to be as desired. This property will be returned to in greater detail

later. In Figure 2a, the control data obtained from the devices of the first drying group is transmitted to the magnetic valves of the subsequent drying group, and vice versa. In this case, the electronic control-data network is shown by a line of dots and dashes. In addition to the direct control, it is also possible to use control logic 25, in which case the control can be adjusted comprehensively and specific limit values and data recording, for example, can be set for it. The means and the magnetic valves can also be connected to the machine-control system.

Figure 2a shows in greater detail two consecutive drying groups and part of the arrangement fitted in connection with them. According to the invention, the threading tail 20 is detected at the location of the first drying cylinder 15 of the drying group 14 in Figure 2a. Thus the success of the tail threading can be ensured and sufficient time will be left for the control of the air blasts. In addition, the means 24 are arranged in each drying group 24 (Figure 2a), but only in one location. In practice, the air blasts in the first drying group are started, once the tail threading is commenced between the press section and the drying section. The air blasts in the second drying group are started, once the threading tail is detected in the first drying group and the control of the air blasts is continued using the same principle through the entire drying group.

In Figure 1, the consecutive drying groups are also numbered individually R1 - R9, in addition to the general reference number 14. The same reference numbers are also repeated in Figures 3a and 3b. Figure 3a shows the air-blast durations controlled using a known web-threading sequence. In particular, the safety factors and the delaying behaviour of the threading tail create a continual increase in the air-blast times, which leads to an enormous total amount of air in the tail threading in the drying section. In the graph, the horizontal time lines shown the duration of the air blasts of each drying group.

Figure 3b shows the durations of the air blasts of the same drying group when controlled using the method according to the invention. In other words, the air blasts are started and stopped according to the real position of the threading tail. Thus the air blasts are correctly timed and only operate for the time required. In addition, the control is not influenced by the length of the drying section or the number of drying groups or by changes in production conditions. In addition, the total amount of air is less than half that of the known amount. As it is therefore unlikely that the supply of compressed air will run out, a new tail threading attempt can be made immediately after an unsuccessful one. In addition, there are many fewer air blasts operating at the same time compared to the prior art, so that smaller design values for the total amount of air in new drying sections can be selected.

Figure 2a also shows one alternative for the location of the means. The means 24 are arranged in connection with the drying wire 17 on the opposite side of it to the threading tail 20. In other words, the threading tail is detected through the drying wire, so that the progress of the threading tail remains undisturbed. The means 24 are preferably arranged attached to the runnability device 26 fitted in connection with the first suction hitch roll 16 of the drying section. Thus it is easy to support the means on already existing structure. In addition, the runnability devices are generally very close to the drying wire, so that it is easy to position the means precisely. Usually the runnability device in question is blow box, the operate of which is, as such, known.

The means can be formed of very many different kinds of component. However, the means preferably consist of pressure-sensor elements, the construction of which withstands well the demanding conditions of the drying section (Figure 2b). In addition, the use of pressure-sensor elements will easily achieve a sufficient accuracy through the drying wire. According to the

invention, the pressure-sensor elements 27 in the drying group 14 consist of two pressure sensors, one of which pressure sensors 28 being fitted at the location of the threading tail 20 and the other pressure sensor 29 to the side of the threading tail 20, in order to define the reference pressure. In other words, if the pressure level suddenly changes, it is possible to verify that the threading tail is at the drying group in question. In practice, it is a question of a single sensor, which has a built-in reference sensor, which uses the ambient air pressure as the reference pressure. On the other hand, it is possible to use two pressure sensors connected to each other, one of which is at the side of the path of the threading tail and acts as a reference sensor. This avoids possible problems in determining the pressure difference, which may arise, for example, from the drying wire becoming blocked.

The pressure difference is thus used to control the air blasts of the subsequent drying group. The air blasts are started at precisely the correct time, independently of the running speed of the web-forming machine. Correspondingly, when the necessary pressure difference is achieved in the pressure-sensor elements of the subsequent drying group when the threading tail arrives there, the air blasts in the preceding drying group are stopped on the basis of the pressure difference. By using the simple and precise control in question, the simultaneously presence of several air blasts can be minimized. In addition, the air consumption used in tail threading is minimized. At the same time, the correctly-timed operation of the air blasts is ensured, independently of the production speed of the web-forming machine, or the length of the drying section.

The threading tail can also be detected in a manner differing from that described a above. In Figure 2a, a sensor is fitted as the means in connection with the doctor apparatus, and can be an optical sensor or some distance sensor, for example an ultrasonic sensor. In other words, the sensor is used to detect

the presence of the threading tail on surface of the drying wire. Instead of the doctor apparatus, such a contactless sensor can event be installed on the frame construction of the web-forming machine, at the side of the drying group. Such a sensor can be easily installed and serviced, even while the machine is running.

According to the invention, the threading tail is detected using two separate principles. In other words, in order to detect the threading tail at least some of the drying groups include two different kinds of means operating of different operating principles. A pressure sensor is reliable in operation and can also be used to detect the location of the threading tail (Figure 2b). Particularly when the air blasts of the preceding drying group are shut off, a pressure sensor makes it possible to know that the threading tail is in the correct position against the drying wire and is well tensioned with the aid of retaining vacuums formed by a suction box fitted in a pocket and a suction hitch roll. On the other hand, measurements based on radiation will quickly provide information on the presence of the threading tail, even though the tensioning of the threading tail is still uncompleted at the location of the pressure sensor in the drying wire. Thus the air blasts in the subsequent drying group can be started. On the basis of the above, it is preferable to use sensors of two different types in a drying group, to detect the threading tail. Such means are preferably located in connection with the doctor apparatus, or even outside the web-forming machine. Stated generally, the means are radiation sensors, the operation of which is based on the detection of radiation reflected from the threading tail. Such radiation sensors include the aforementioned ultrasonic and optical sensors.

**CLAIMS**

1. Method in tail threading in a single-wire draw drying section of a web-forming machine, which includes consecutive drying groups (14), in each of which there are drying cylinders (15) and suction hitch rolls (16) and at least one drying wire (17) arranged to travel through them, in which method a doctor apparatus (18) is used in connection with the drying cylinder (15) in the drying group (14), and an air blast in connection with it directed at the opening throat (30) formed by the drying cylinder (15) and the drying wire (17), in order to detach the threading tail (20) from the drying cylinder (15) and to guide it during tail threading, and in the drying section the various air blasts are started and stopped at different times, in order to ensure sufficient compressed air, characterized in that the air blasts in the drying groups (14) are controlled group-specifically independently of each other, in such a way that the air blasts in a drying group (14) are started when the threading tail (20) is verifiably detected in the preceding drying group (14).

2. Method according to Claim 1, characterized in that the air blasts in a drying group (14) are started when the threading tail (20) in the drying group (14) immediately preceding the drying group (14), or in the drying group (14) preceding that, or in the press section (11) preceding the drying section (12).

3. Method according to Claim 1 or 2, characterized in that the air blasts in the drying group (14) are stopped when the threading tail (20) is detected in the subsequent drying group (14).

4. Method according to any of Claims 1 - 3, characterized in that the air blasts are stopped in a drying group (14) when the location of the threading tail (20) in a runnability device

(26) belonging to the subsequent tail-threading group is verified to be as desired.

5. Method according to any of Claims 1 - 4, characterized in that the threading tail (20) is detected at the location of the first drying cylinder (15) of the drying group (14).

6. Method according to any of Claims 1 - 5, characterized in that the threading tail (20) is detected using two different principles.

7. Method according to any of Claims 1 - 6, characterized in that the drying section (12) is divided into adjustable tail-threading groups (14), from each of which 2 - 5, preferably 3 - 4 suction hitch rolls (16) are selected.

8. Method according to Claim 7, characterized in that each adjustable tail-threading group (14) includes only one drying wire (17).

9. Arrangement in tail threading in a single-wire draw drying section of a web-forming machine, which includes consecutive drying groups (14), in each of which there are drying cylinders (15) and suction hitch rolls (16) and at least one drying wire (17) arranged to travel through them, which arrangement includes a doctor apparatus (18) is used in connection with the drying cylinder (15) in the drying group (14), and blowing means (19) fitted in connection with it, to form an air blast directed at the opening throat (30) formed by the drying cylinder (15) and the drying wire (17), in order to detach the threading tail (20) from the drying cylinder (15) and to guide it during tail threading, and in the drying section the various air blasts are arranged to start and stop at different times, in order to ensure sufficient compressed air, characterized in that the arrangement includes means (24) for detecting the threading tail (20) in the drying group (14) and

that the means (24) are arranged to control the blowing means ((19) group-specifically in the various drying groups (14), in such a way that the air blasts start in a drying group when the threading tail (20) has be verifiably detected in the drying group (14) preceding it.

10. Arrangement according to Claim 9, characterized in that the means (24) are arranged in each drying group (14).

11. Arrangement according to Claim 9 or 10, characterized in that, in order to detect the threading tail, at least some of the drying groups (14) include two different kinds of means (24) operating on different operating principles.

12. Arrangement according to any of Claims 9 - 11, characterized in that the means (24) are arranged in connection with the drying wire (17), on the opposite side of it to the threading tail (20).

13. Arrangement according to Claim 12, characterized in that the means (24) are arranged attached to a runnability device (26) fitted in connection with the first suction hitch roll (16) of the drying group.

14. Arrangement according to Claim 12 or 13, characterized in that the means (24) consist of pressure-sensor elements (27).

15. Arrangement according to Claim 14, characterized in that, in the drying group (14), the pressure-sensor elements (27) consist of two pressure sensors, one pressure sensor (28) of which is arranged at the location of the threading tail (20), and the other pressure sensor (29) is arranged to the side of the threading tail (20) to define the reference pressure.

16. Arrangement according to any of Claims 9 - 11, characterized in that the means (24) are arranged in connection with the doctor apparatus (18).

17. Arrangement according to Claim 16, characterized in that the means (24) are radiation sensors (31), the operation of which is based on the detection of radiation reflected from the threading tail (20).

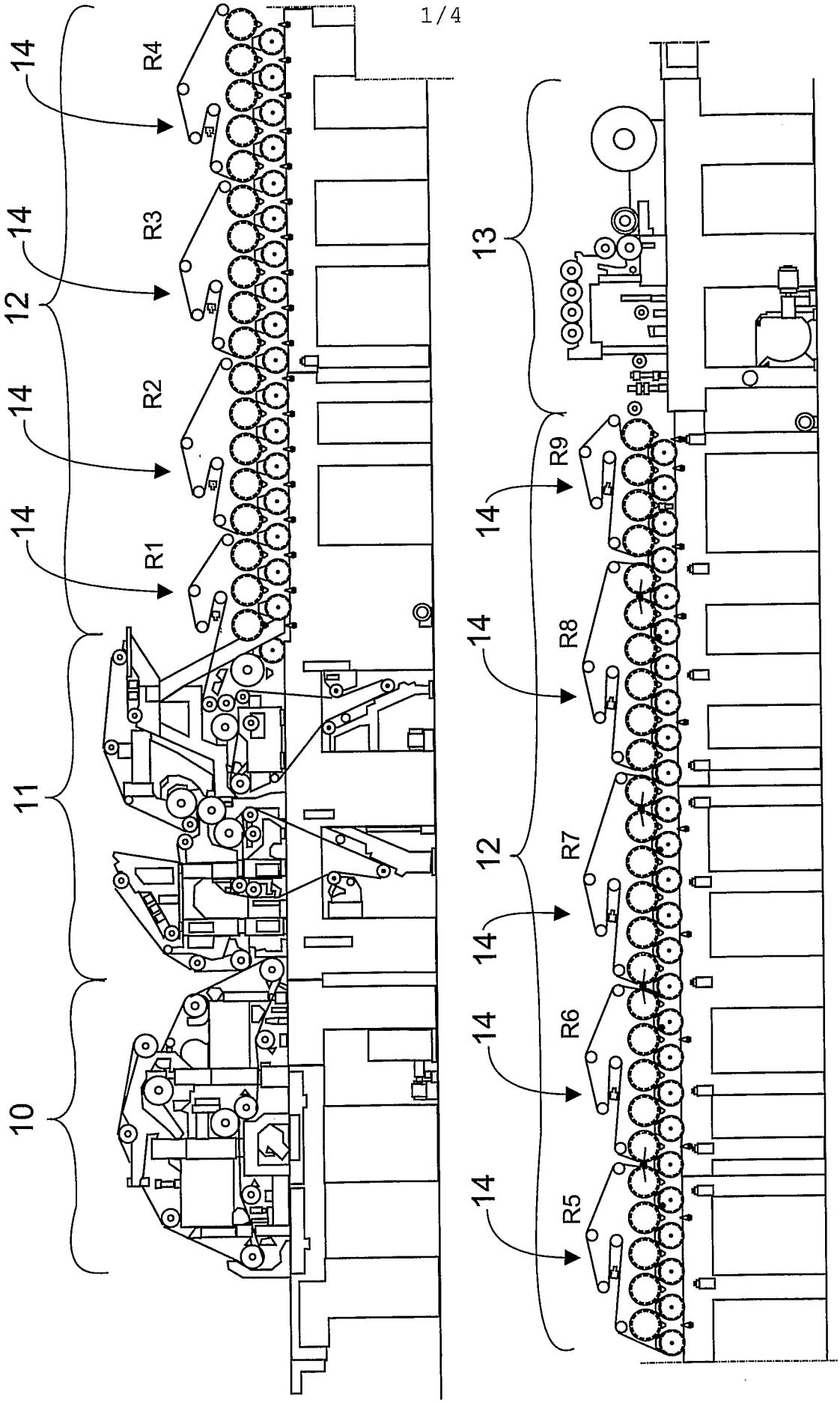



Fig. 1

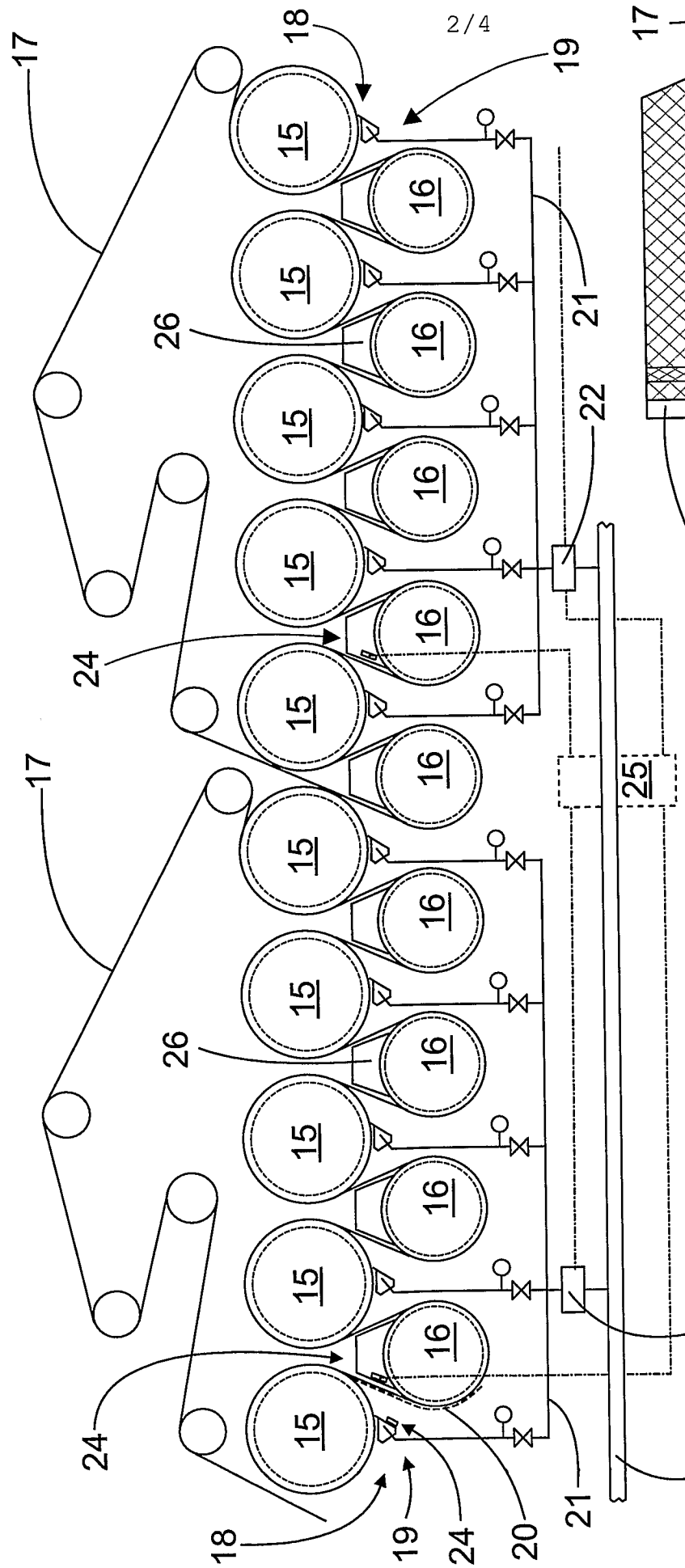



Fig. 2a

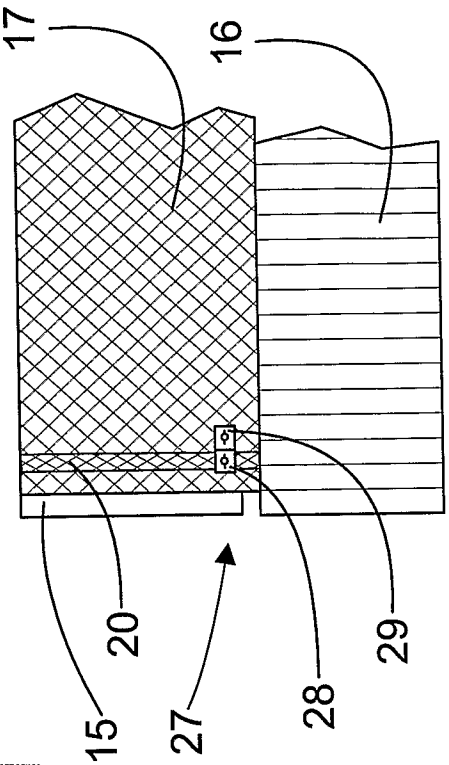



Fig. 2b

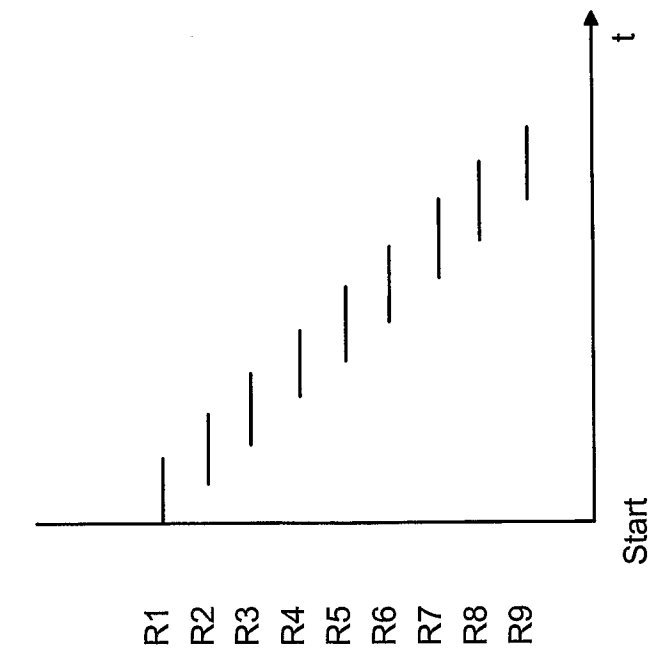

t
Start
R1
R2
R3
R4
R5
R6
R7
R8
R9

Fig. 3b

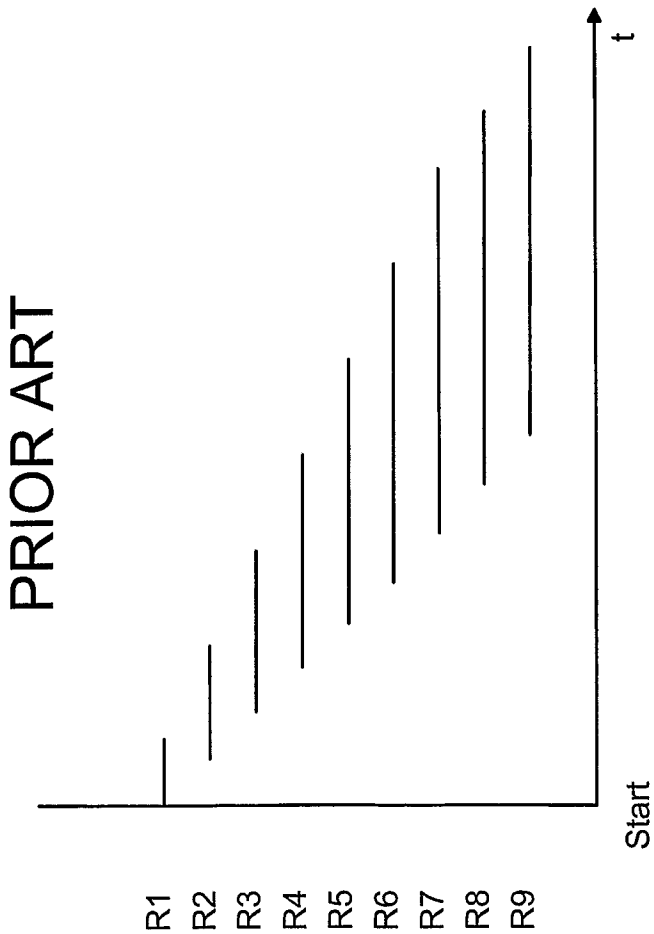

PRIOR ART
t
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R1
R2
R3
R4
R5
R6
R7
R8
R9

Fig. 3a

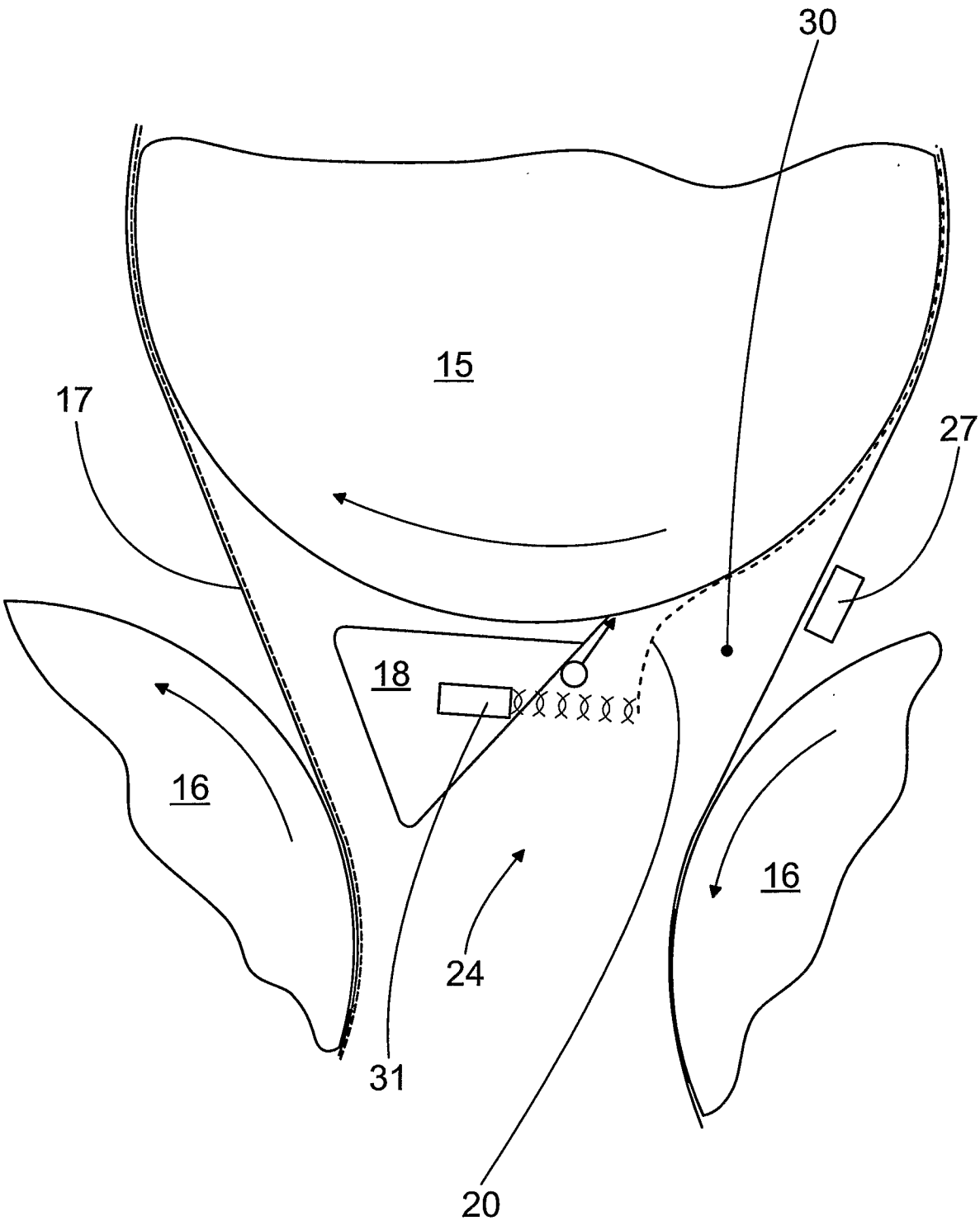



Fig. 4

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/FI2006/050362

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: D21F, D21G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5987777 A (GOEBEL WERNER et al.) 23 November 1999 (23.11.1999) | 1 - 17 |
| A | EP 1057932 A2 (VOITH SULZER PAPIERTECH PATENT - VOITH PAPER PATENT GMBH) 06 December 2000 (06.12.2000) | 1 - 17 |
| A | FI 93038 B (VALMET PAPER MACHINERY INC) 31 October 1994 (31.10.1994) | 1 - 17 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 10 November 2006 (10.11.2006) | 11 December 2006 (11.12.2006) |


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**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

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