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(71) Applicant: **INVENTECH EUROPE AB** [SE/SE]; Science Park, Jönköping, 553 18 (SE).

(72) Inventors: **EKLIND, Martin**; Målskog Ekelund 1, 555 94 Jönköping (SE). **STABERG, Joakim**; Oxtorgsgatan 16, lgh 1306, 553 17 Jönköping (SE). **WALSTRÖM, Rolf**; Korgebovägen 81, 553 08 Jönköping (SE).

(74) Agent: **STRÖM & GULLIKSSON AB**; P.O. Box 4188, SE-203 13 Malmö (SE).

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(54) Title: DEVICE AND METHOD FOR IN-LINE THREAD TREATMENT

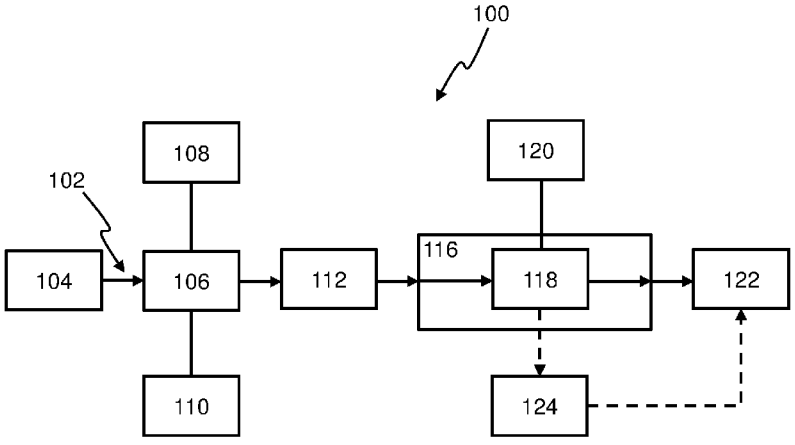

Fig. 1

(57) Abstract: A device and method for in-line treatment of a thread are disclosed. The device comprises treatment and fixation units located downstream a thread feeding unit. A thread consuming system comprising a thread consuming device, such as an embroidery machine and/or a weaving machine and/or a sewing machine and the device is also disclosed.

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DEVICE AND METHOD FOR IN-LINE THREAD TREATMENT

FIELD OF THE INVENTION

The present invention relates to a device and method for providing in-line treatment of elongated substrates, such as coating treatment of thread. The invention also relates to thread consuming system containing such device.

BACKGROUND ART

Existing devices for treatment of thread in thread consuming devices, such as within sewing and embroidery applications, require continuous, in-line movement of the thread through the device. Such devices normally achieve this movement using a motor located downstream a treatment unit which pulls or hauls the thread through the treatment unit. For example, US 2009/0241819 A1 to Tseng discloses a thread coloring device wherein the motor for pulling the thread is located downstream the coloring unit, i.e. the motor is operating on the already colored thread. WO 2013/039447 A1 discloses a coating device for coating an elongated substrate with a thread feeding means that is also located downstream the coating device relative the thread movement.

However, in these devices the thread may experience undesired pulling forces which cause the thread to move irregularly for example, by jerking forwards. This behaviour is mainly influenced by the e-modulus of the thread, which in turn is influenced by the temperature of the thread, as well as by the friction at different positions in the system and the tension of the thread at different positions. By influencing these parameters the undesired irregular movement may in some cases be significantly reduced. However, such reduction of irregular movement has so far only been possible in a small window of operation where the above parameters has been adjusted and optimized for this purpose.

The undesired pulling forces are caused by changes in thread length and size as it passes into and out of the treatment unit, friction experienced by the thread, operation of the machine by the user, or combinations thereof. If the uneven movement is not measured accurately and taken into account, the

consequences in applications dealing with in-line coloring of threads will be uneven treatment of the thread, poor appearance of the pattern being embroidered by a downstream thread consuming device, and inaccurate measurements of thread consumption.

It would be desirable to provide an improved device for providing even treatment of thread for use in thread consuming devices, such as embroidery machines or sewing machines.

SUMMARY

According to one aspect of the invention, there is provided a device for in-line treatment of thread for use with a thread consuming device such as an embroidery or sewing machine, comprising at least one thread feeding unit, and a treatment unit located downstream the at least one thread feeding unit for applying a coating material to the thread as the thread from the thread feeding unit passes the treatment unit. Preferably, the device also comprises a fixation unit for fixing the applied coating material to the thread prior to thread consumption by means of the thread consumption device. The fixation unit is arranged in series downstream the treatment unit.

Within this specification, all references to upstream and/or downstream should be interpreted as relative positions during normal operation of the device, i.e. when the device is operating to treat an elongated substrate, such as a thread, continuously moving through the device in a normal operating direction. Hence, an upstream component is arranged such that a specific part of the thread passes it before it passes a downstream component.

The present inventors have found that by placing at least one thread feeding unit upstream the treatment and fixation units, the risk for the thread to jerk forward in an irregular, undesirable manner is greatly reduced. A thread having a very smooth, consistent coating is thereby obtained. Further, additional thread feeding units should preferably not be placed directly downstream the treatment unit and upstream the fixation unit, as the thread feeding unit will

contact the thread with unfixed coating material leading to possible smearing and other detrimental effects on the coating quality of the thread.

As used herein, a thread may be glass fiber thread; a thread of wool; a thread of cotton; a synthetic thread; a metallic thread; a thread being a mixture of wool, cotton, polymer, or metal; a yarn; a filament; or any elongated substrate that is intended and/or being suitable for being applied with a coating material in a thread consuming device.

The device may, but need not, comprise a thread supplier for holding the thread to be supplied to the thread feeding unit. Preferably, the thread supplier is a thread bobbin or a reel of thread.

In some embodiments, the thread feeding unit of the device comprises an electric motor.

According to an embodiment, a control unit is connected to the thread feeding unit. The control unit may be used to adjust any number of settings as required by user preferences or external circumstances for example, thread type and quantity. It is preferred however, that the control unit is configurable to adjust the speed of the thread through the thread feeding unit.

The device may also comprise a thread consumption measurer connected to the thread feeding unit. A non-limiting example of a thread consumption measurer is an encoder wheel. Measuring the thread consumption in this manner can permit a very high accuracy determination of the quantity of thread that will be treated, or coated. The measurement also facilitates better feedback and consistent pace of the thread which in turn leads to a smoother, consistently treated thread, as well as improved embroidery or sewing pattern for these applications.

In an embodiment, the thread consumption measurer is a thread speed measurer. Preferably, the thread speed measurer is located adjacent to the treatment unit. Even more preferably, the thread speed measurer is located adjacent to where the thread commences passing the treatment unit. Measuring the thread speed just before the treatment unit facilitates control of the treatment process.

According to an embodiment, the treatment unit in the device forms a coating unit comprising an electrospray unit and/or one or more inkjet units. Examples of coating units are disclosed in US 2009/0241819 A1 and WO 2013/039447 A1 which are hereby incorporated by reference in their entirety. Many coating materials are suitable for use in the treatment unit. In a preferred embodiment, the coating material is a coloring material whereby the treatment unit operates as a coloring unit. It is preferred that the coloring material is a liquid. Preferred liquids are inks or dyes or combinations thereof. For example, disperse dyes may be used in combination with polyester threads. In other embodiments latex inks, solvent inks, and/or UV curable inks may be used.

In some embodiments, the fixation unit comprises a heating unit, a drying unit, UV radiation unit, and/or a unit that discharges an electron beam or charged particle beam. Any combination of the above-mentioned units is also possible. Suitable components of the fixation unit may be heating elements, hot air or steam, IR radiation sources, UV radiation sources, or combinations of them. Other possible components of the fixation unit include electron beam generators, charged particle beam generators, microwave generators, and/or laser sources.

The term “fixation” should throughout this specification include step of processing a material, such as a dye or an ink, from a pre-state to a fixed state. For example, fixation includes both drying and curing. Preferably, the fixation unit is configured to subject the coating material, and hence also the thread, to a certain amount of air flow.

According to yet another embodiment, the device further comprises a thread buffer unit located downstream the treatment unit. When present, the thread buffer unit will allow coated thread to buffer under tension. The force applied to the thread by the thread buffer unit determines the thread tension, which in most cases will vary along the thread path. Hence, the exact construction of the thread buffer may provide different tensions at different positions along the thread. In an alternative embodiment, the thread buffer unit is constructed so that the force applied to the thread is determined by gravity. The

thread buffer unit advantageously allows control of thread tension through the treatment unit without requiring use of traditional thread tension washers or tiles. Avoiding use of washers or tiles is also advantageous since the thread used in the device may not be suitably lubricated, for example by wax- or silicone-based lubricants, and thread tension washers work poorly on non-lubricated threads. Rather, the thread tension is controlled by adjusting the force in the thread buffer unit which pulls the thread through the treatment unit as described above.

According to one aspect, a thread buffer unit for a thread consuming device is therefore provided, wherein the thread buffer unit is configured to pull thread in a forward direction, and to apply a tension to the thread. The thread buffer unit may comprise a buffer arm having one end at which the thread is guided. The opposite end may be pivotally attached to a support, such that the position of the thread guiding end may be adjusted. The force applied to the buffer arm will consequently determine the tension of the thread.

According to a yet further aspect, a thread consuming system, comprising a thread consuming device such as a sewing machine, a weaving machine, or an embroidery machine, is provided. The thread consuming system comprises a thread buffer unit according to the aspect described above.

According to an aspect, a thread consuming system is provided. The thread consuming system comprises a thread consuming device, e.g. a sewing machine, an embroidery machine, or a weaving machine. The thread consuming system also comprises a device for in-line treatment of thread as presented above.

According to yet another aspect of the invention, there is provided a method for in-line treatment of thread upstream a thread consuming device. The method comprises the steps of feeding the thread from a thread feeding unit to a treatment unit, and applying a coating material to the thread as the thread passes the treatment unit. Preferably, the method may also comprise the step of fixing the applied coating material to the thread before the thread is consumed by the thread consuming device.

In an embodiment, the method further comprises the step of supplying the thread to the thread feeding unit. The thread may be supplied from any

suitable source for example, a thread bobbin or a reel of thread as described above in relation to the device of the invention.

In another embodiment, the method also comprises the step of adjusting the speed of the thread through the thread feeding unit.

The method may further comprise the step of measuring the amount of thread consumed during feeding. As described above in the description of the device, this permits a very high accuracy determination of the quantity of thread that will be treated and leads to a smoother, consistently treated thread.

According to an embodiment, the step of measuring the amount of thread consumed during feeding may be performed by measuring the speed of the thread prior to applying the coating material. Preferably, the speed is measured immediately prior to applying the coating material to the thread. This avoids a large discrepancy between measured movement and actual movement of the thread when passing the treatment unit as described above with respect to the device of the invention.

In some embodiments, the coating material is a coloring material. The coloring material may be a liquid. While the liquid is not intended to be particularly limited, preferably the liquid is selected from a dye, an ink, or a combination thereof.

According to another embodiment, the step of fixing the applied coating material to the thread comprises at least one of heating the thread, applying an air stream to the thread, radiating the thread with UV or IR light, or applying an electron beam or charged particle beam to the thread.

The method may further comprise the step of tensioning the thread after applying coating material to the thread. Tensioning the thread advantageously avoids use of thread tension washers or tiles as described above in the device of the invention.

In yet another embodiment, the method further comprises one or more processing steps after tensioning the thread. Such processing steps may e.g. comprise a step of cleaning the thread, and/or a step of lubricating the thread, and/or a step of further feeding of the thread.

According to some embodiments, the method further comprises the step of embroidering, weaving, or sewing the treated thread to a substrate. As described above, sewing, weaving and embroidery techniques are well known to a person skilled in the art. The substrate is preferably a textile, fabric or cloth. The step of embroidering, weaving, or sewing the treated thread to a substrate may occur after the one or more processing steps are performed. If there are no processing steps performed after tensioning the thread, the embroidery, weaving, or sewing step may be performed directly after tensioning of the thread.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic view of a device and method for continuous in-line coloring of thread according to a preferred embodiment of the invention.

Figure 2 shows a thread feeding unit according to an embodiment.

DETAILED DESCRIPTION

As previously mentioned, an aspect of the invention relates to a device for in-line treatment of thread for use with a thread consuming device, such as an embroidery machine, a weaving machine, or a sewing machine comprising at least one thread feeding unit, a treatment unit located downstream the at least one thread feeding unit for applying a coating material to the thread as the thread from the thread feeding unit passes the treatment unit, and preferably also a fixation unit for fixing the applied coating material to the thread prior to embroidery, weaving, or sewing of the thread. In a preferred embodiment, the treatment unit is a coloring unit, and the device for in-line coloring of thread may thus comprise additional units arranged downstream the coloring unit for ensuring coloring quality and sewability of the thread. Such additional units may e.g. include a cleaning unit, a lubrication unit, an additional thread feeding unit, etc.

A schematic of the device and method according to one embodiment of the invention will now be described with reference to figure 1. The device for in-line treatment of thread comprises a thread supplier 104 for holding a thread 102. A thread feeding unit 106 draws the thread 102 from the thread supplier 104 and

feeds the thread 102 to a treatment unit 112. In the shown embodiment, the treatment unit 112 is a thread coloring unit. A control unit 108 and a thread consumption measurer 110, e.g. in the form of a thread speed measurer, are connected to the thread feeding unit 106. As the thread 102 moves through or passes the coloring unit 112, a coloring material (not shown) is applied to the thread 102 by the coloring unit 112. After coloring of the thread 102, thread feeding unit 106 continues to feed the thread 102 to fixation unit 116 where unfixed coloring material is fixed to thread 102, at least to some extent. The thread 102 passes a thread buffer unit 118 applying a tension to the thread 102, and pulling the thread 102 forward. The thread buffer unit 118 applies a pulling force to the thread 102 downstream the treatment unit 112 (i.e. upstream the buffer unit 118 and downstream the thread feeding unit 106). The thread buffer unit 118 may be arranged between the treatment unit 112 and the fixation unit 116, even more preferably somewhere along the extension of the fixation unit 116. A controlling unit 120 is connected to the thread buffer unit 118 and is adapted to apply a tension in the thread 102, e.g. by means of a buffer arm in accordance with the embodiment described above. A thread consuming device 122 then receives the thread 102 from thread buffer unit 118 for embroidery, weaving, or sewing of the thread 102 as desired. In the method described in figure 1, thread 102 may also pass from the thread buffer unit 118 to one or more processing units 124 before the thread 102 moves to thread consuming device 122. Such additional processing steps may be provided by a cleaning unit, a lubrication unit, etc.

In other embodiments two or more thread feeding units 106 are provided, of which at least one is arranged upstream the coloring unit 112. Additional feeding units 106 may be arranged downstream the coloring unit 112, e.g. after the fixation unit 116. Preferably, such additional feeding units may be arranged close to the thread consuming device 122. This is advantageous in that the thread consuming device 122 needs to apply a very little force for pulling the thread forward, which is desired.

The coloring unit 112 is preferably an inkjet unit configured to discharge a predetermined quantity of liquid onto the thread passing through the coloring unit 112, the thread 102 being feed by means of the thread feeding unit 106. The predetermined quantity may be calculated during operation, such that the exact amount of liquid may be based on thread speed, thread tension, temperature, a predetermined coloring pattern, etc.

An example of a thread feeding unit 106 is shown in more detail in figure 2. The thread 102 is entering the thread feeding unit 106 from a thread supply (not shown), and is guided by a wheel 106a. The rotational axis of the wheel 106a is connected to an encoder wheel used for measuring the length of the thread 102 passing through the thread feeding unit 106. Hence, the encoder wheel will rotate with the wheel 106a and an associated sensor will measure the movement of the thread 102. A pair of driven rollers 106b,c are arranged downstream the encoder wheel 106a, whereby the thread 102 passes through the nip formed between the rollers 106b,c. Preferably, at least one of the rollers 106b,c are spring biased towards the other one of said rollers 106b,c. The rollers 106b,c are preferably driven by one or more electrical motors (not shown). In a specific embodiment, the rollers 106b, c are connected to each other by means of gears. A pivotally supported lever arm 106d may be arranged downstream the two rollers 106b,c for tensioning the thread 102. The position of the lever arm 106d may also be controlled for moving the thread into and out from the normal thread position during operation. A final guide roller 106e is arranged downstream the lever arm 106d for ensuring the desired vertical position of the thread 102, as well as the desired position in the horizontal direction.

Various modifications of the thread feeding unit 106 are possible. For example, the driven rollers 106b, c may be arranged upstream the wheel 106a (and hence also upstream the encoder wheel). In such embodiment, the wheel 106a may also act as a thread guide whereby the provision of the lever arm 106d may be omitted.

Preferably, the coloring unit 112 is synchronized with the feeding unit 106. This may be achieved by triggering discharge from the coloring unit 112 upon a signal from the encoder wheel as mentioned above.

Although the present invention has been described above with reference to specific embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the invention is limited only by the accompanying claims.

In the claims, the term "comprises/comprising" does not exclude the presence of other elements or steps. Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by e.g. a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly advantageously be combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. The terms "a", "an", "first", "second" etc do not preclude a plurality. Reference signs in the claims are provided merely as a clarifying example and shall not be construed as limiting the scope of the claims in any way.

CLAIMS

1. A device for in-line treatment of thread for use with a thread consuming device such as an embroidery machine, a weaving machine, or a sewing machine, comprising:

a thread feeding unit (106);

a treatment unit (112) located downstream the thread feeding unit (106), said treatment unit (112) is configured to dispensing a coating material to the thread as the thread from the thread feeding unit passes the treatment unit (112); and

a fixation unit (116) for fixing the applied coating material to the thread prior to thread consumption by means of the thread consuming device.

2. The device according to claim 1, wherein the treatment unit (112) is a coloring unit.

3. The device according to any one of the preceding claims, wherein the treatment unit (112) comprises one or more discharge nozzles, such as inkjets and/or one or more electrospray units.

4. The device according to any one of claims 1 to 3, wherein the thread feeding unit (106) comprises an electric motor.

5. The device according to any one of claims 1 to 4, further comprising a control unit (108) connected to the thread feeding unit (106).

6. The device according to claim 5, wherein the control unit (108) is configurable to adjust the speed of the thread as the thread passes the thread treatment unit (112).

7. The device according to claim 5 or 6, wherein the control unit (108) is configurable to control the treatment unit (112) based on the thread speed.

8. The device according to any one of claims 1 to 7, wherein the thread feeding unit (106) comprises a thread consumption measurer (110).

9. The device according to claim 8, wherein the thread consumption measurer (110) is an encoder wheel.

10. The device according to any one of claims 2 to 3, wherein the coloring material is a liquid.

11. The device according to claim 10, wherein the liquid is selected from a dye, an ink, or a combination thereof.

12. The device according to claim 1, wherein the fixation unit (116) comprises a heating unit, a drying unit, a UV or IR radiation unit, and/or a unit that discharges an electron beam or charged particle beam, or any combination thereof.

13. The device according to any one of the preceding claims, further comprising a thread buffer unit (118) located downstream the treatment unit (112).

14. The device according to claim 13, further comprising a thread tension controlling unit (120) connected to the thread buffer unit (118).

15. The device according to any one of the preceding claims, further comprising an additional thread feeding unit arranged downstream the treatment unit (112).

16. A thread consuming system (100), comprising a thread consuming device such as an embroidery machine, a sewing machine, or a weaving machine, and the device according to any one of claims 1 to 15.

17. A method for in-line treatment of thread upstream a thread consuming device, comprising the steps of:

feeding the thread from a thread feeding unit to a treatment unit;

applying a coating material to the thread as the thread passes the treatment unit;

fixing the applied coating material to the thread before the thread is consumed by the thread consuming device.

18. The method of claim 17, further comprising the step of supplying the thread to the thread feeding unit.

19. The method according to any one of claims 17 to 18, further comprising the step of measuring, and optionally adjusting the speed of the thread as the thread passes the thread treatment unit.

20. The method according to any one of claims 17 to 19, further comprising the step of measuring the amount of thread consumed during feeding.

21. The method according to any one of claims 17 to 20, wherein the coating material is a liquid coloring material.

22. The method according to claim 21, wherein the liquid is selected from a dye, an ink, or a combination thereof.

23. The method according to claim 17, wherein fixing the applied coating material to the thread comprises at least one of heating the thread, applying an air

stream to the thread, radiating the thread with UV or IR light, or applying an electron beam or charged particle beam to the thread.

24. The method according to claim 23, further comprising the step of tensioning the thread while applying a coating material to the thread.

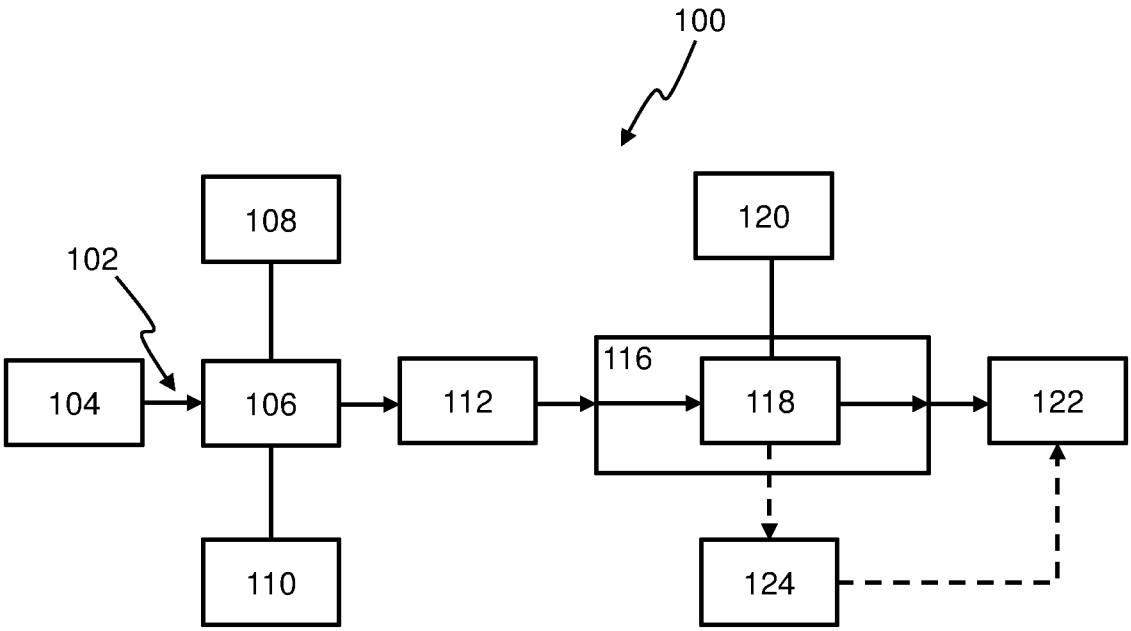
100
108
120
102
104
106
112
116
118
122
110
124

Fig. 1

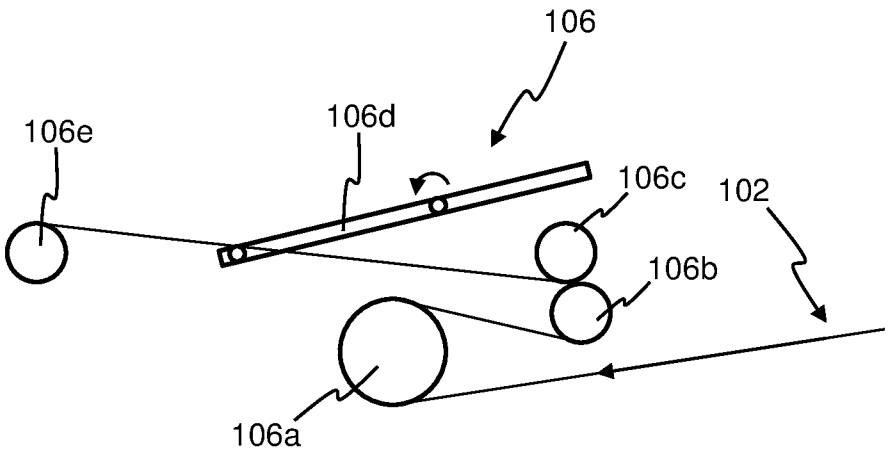
106
106e
106d
106c
102
106b
106a

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050589

A. CLASSIFICATION OF SUBJECT MATTER

IPC: 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: B41J, D03J, D04B, D05B, D05C, D06B, D06P

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 20090241819 A1 (TSENG SHUI-CHUN), 1 October 2009 (2009-10-01); whole document --	1-24
Y	US 20070245940 A1 (WAHLSTROM ROLF), 25 October 2007 (2007-10-25); paragraph [0042]; figure 1 --	1-24
A	US 6189989 B1 (HIRABAYASHI HIROMITSU ET AL), 20 February 2001 (2001-02-20); whole document --	1-24
A	US 20140349034 A1 (STABERG JOAKIM ET AL), 27 November 2014 (2014-11-27); whole document --	1-24

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

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08-09-2016	09-09-2016

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Lisa Sellgren Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20030135931 A1 (SHAW HENRY), 24 July 2003 (2003-07-24); whole document -- --------	1-24

International application No.
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Continuation of: second sheet

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D04B 35/22 (2006.01)

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