(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 763 651 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.01.2021 Bulletin 2021/02

(51) Int Cl.:
B65H 59/38 *(2006.01)* ***B65H 51/20*** *(2006.01)*
B65H 51/30 *(2006.01)*

(21) Application number: **20180925.8**

(22) Date of filing: **18.06.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **11.07.2019 IT 201900011451**

(71) Applicant: **L.G.L. Electronics S.p.A.**
24024 Gandino (Bergamo) (IT)

(72) Inventors:
- **GOTTI, Luca**
  24021 ALBINO BG (IT)
- **PEDRINI, Giovanni**
  24026 LEFFE BG (IT)

(74) Representative: **Modiano, Micaela Nadia et al**
Modiano & Partners
Via Meravigli, 16
20123 Milano (IT)

(54) METHOD FOR FEEDING A PLURALITY OF YARNS UNDER CONTROLLED TENSION TO A TEXTILE MACHINE

(57) A method for feeding a plurality of yarns under controlled tension to a textile machine by way of respective feeders (F1,1, F1,2 ..., FY,X), the tension of the yarn fed by a plurality of feeders (F1,1, F1,2 ..., FY,X) being monitored by respective tension sensors (S1,1, S1,2 ..., SY,X) which are arranged immediately downstream of the feeder and are connected to a control unit which modulates an adjustment parameter of the feeder on the basis of the signal received from the tension sensor (S1,1, S1,2 ..., SY,X) in order to stabilize the tension at an operating tension that can be configured by the user. The feeders (F1,1, F1,2 ..., FY,X) are located on multiple rows (LI, L2, ..., LY) at progressively increasing distances from the textile machine (M), and they undergo a calibration procedure for calibrating the respective operating tensions, in which a same operating tension is set which is equal to a desired tension, on two reference feeders (Fa, Fb) of one of the rows (LI, L2, ..., LY); the real tensions (TRa and TRb) are measured of the yarns (Ha and Hb) fed by the reference feeders (Fa, Fb) by way of respective tension sensors (Za and Zb) which are located immediately upstream of the textile machine (M); backwards-adjusting the operating tensions (TLa and TLb) of the reference feeders (Fa and Fb) so that the respective real tensions (TRa and TRb) correspond to the desired tension; the operating tension of the remaining feeders of the row is set on the basis of a preset function which correlates the position of the feeder with the respective operating tension and, in relation to the reference feeders (Fa and Fb), returns the operating tension values (TLa and TLb) that were adjusted previously.

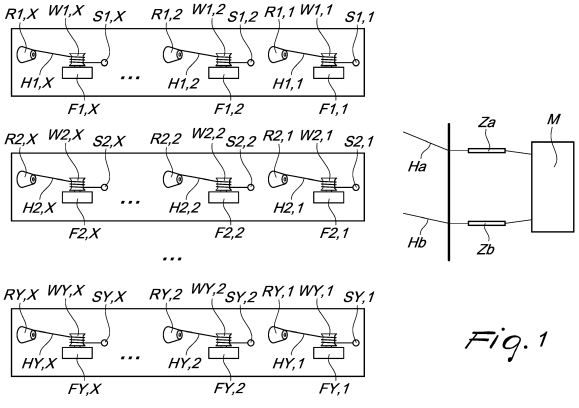

Fig. 1

EP 3 763 651 A1

Description

[0001] The present invention relates to a method for feeding a plurality of yarns under controlled tension to a textile machine.

[0002] As is known, in a generic weaving process, multiple yarns can be fed to a textile machine by way of respective yarn feeders, for example feeders of the "positive" type.

[0003] This type of feeder is provided with a motorized reel, on which the yarn is wound repeatedly (e.g., 3 or 4 windings). When the reel is rotated, the yarn is unwound from a spool and is fed to a textile machine downstream.

[0004] The yarn tension in output from the feeder is monitored continuously by a tension sensor, which can be integrated in the feeder. A control unit, which is also optionally integrated in the feeder, modulates the speed of the reel on the basis of the signal received from the tension sensor, so as to stabilize the tension of the yarn fed to the textile machine at a level that can be set by the user, to the advantage of the quality of the garment.

[0005] As is known, it would be preferable to measure the yarn tension in the immediate vicinity of the textile machine, downstream of any transmission pulleys and yarn guide rings which could alter the real value of the tension with which the yarn enters the textile machine.

[0006] However, in some applications where the number of yarns is very high, e.g., several hundred yarns in processes for feeding yarn to sectional warping machines, the yarns can be arranged very close to each other at the point where they enter the machine. Therefore, there is insufficient space to arrange all the feeders next to each other, if they have an integrated tension sensor.

[0007] As a consequence, the feeders must be positioned at a certain distance from the warping machine, and they may need to use the signal generated by an external tension sensor which is preferably positioned immediately upstream of the warping machine.

[0008] EP 1901984 B1 discloses a system of this type, in which two tension sensors are used for each yarn, one of which is arranged at the exit of the feeder and can be integrated in it, while the other is arranged at the entry of the textile machine. The control unit, based on an adapted algorithm, controls the feeder by taking account of the tension values measured by both sensors, so as to limit the risk of instabilities arising.

[0009] A drawback of the system described in EP 1901984 B1 is its high cost, in that it envisages using two tension sensors for each yarn.

[0010] Furthermore, in the above-mentioned applications for sectional warping machines and the like, even positioning just the tension sensors at the point where the yarns enter the machine is a difficult matter owing to the reduced spaces.

[0011] The aim of the present invention is to provide a method for feeding a plurality of yarns under controlled tension to a textile machine, which makes it possible to precisely control the tension while considerably reducing the number of tension sensors compared to conventional solutions, like the one described in EP 1901984 B1.

[0012] This aim and other objects, which will become clearer from the description that follows, are achieved by a method having the characteristics recited in the appended claim 1, while the appended dependent claims define other characteristics of the invention which are advantageous, although secondary.

[0013] Now the invention will be described in greater detail, with reference to some preferred but not exclusive embodiments thereof, which are illustrated for the purposes of non-limiting example in Figure 1, which is a schematic illustration of an apparatus for feeding yarn under controlled tension using the method according to the invention.

[0014] With reference to Figure 1, a yarn feeding apparatus 10 comprises a plurality of feeders F1,1, F1,2 ..., FY,X.

[0015] In a way that is known per se, the yarn tension in output from the feeder is monitored continuously by a tension sensor S1,1, S1,2 ..., SY,X which is arranged immediately downstream of the feeder, and optionally incorporated in the feeder itself. The tension sensor is connected to a control unit (not shown), which modulates an adjustment parameter of the feeder on the basis of the signal received from the respective tension sensor, so as to maintain the tension of the yarn fed to the textile machine substantially constant at a level that can be configured by the user, which henceforth is referred to as the operating tension.

[0016] In this embodiment, the feeders F1,1, F1,2 ..., FY,X are all of the "positive" type. As is known, a positive feeder is provided with a motorized reel W1,1, W1,2 ..., WY,X on which a yarn H1,1, H1,2 ..., HY,X is wound repeatedly (e.g., 3 or 4 windings). When the reel is rotated, the yarn is unwound from a spool R1,1, R1,2 ..., RY,X and is fed to a textile machine downstream, e.g., a warping machine M (shown only schematically in Figure 1).

[0017] Therefore, in this type of feeder the adjustment parameter modulated by the control unit is the rotation speed of the reel W1,1, W1,2 ..., WY,X. The rotation speed in fact determines the feeding speed of the yarn and, as a consequence, the operating tension by difference with respect to the speed with which the yarn is taken up by the downstream machine.

[0018] The feeders F1,1, F1,2 ..., FY,X and the respective spools R1,1, R1,2 ..., RY,X are located on a number Y of rows L1, L2, ..., LY, typically substantially horizontal rows which are arranged at different heights. Each row comprises a number X of feeders which are arranged at progressively increasing distances from the warping machine M.

[0019] In the present description, the various elements (spools, feeders, reels, yarns) of each row L1, L2, ..., LY are uniquely identified by a first subscript which varies from 1 to Y, which identifies the number of the row from the topmost row to the bottommost row, and a second

subscript which varies from 1 to X, which identifies the position of the element in the row, from the element closest to the warping machine M to the element furthest away, so as to provide a matrix.

[0020] In practice it has been found that, if all the feeders are set on a same operating tension, then for each one of the yarns H1,1, H1,2 ..., HY,X the real tension measured immediately upstream of the warping machine M is always higher than the operating tension, and is not equal for all the feeders but increases as the distance of the feeder from the warping machine M increases.

[0021] For example, with reference to the first row L1, the real tension of the yarn H1,1 will be higher than the operating tension but lower than the real tension of the yarn HI,2, which in turn will be lower than the real tension of the yarn HI,3, and so on up until the yarn H1,X.

[0022] The same applies for the yarns of the other rows L1, L2, ..., LY.

[0023] According to the invention, in order to feed all the yarns at a same desired tension measured immediately upstream of the warping machine M, the feeders F1,1, F1,2 ..., FY,X are preliminarily subjected to a calibration procedure to calibrate the respective operating tensions, which comprises the following steps:

- setting a same operating tension, equal to a desired tension, on at least two reference feeders Fa, Fb of at least one of the rows L1, L2, ..., LY, where the subscripts a and b identify two generic positions in the row which are comprised between 1 and X;
- measuring the real tensions TRa and TRb of the yarns Ha and Hb fed by the at least two reference feeders Fa, Fb by way of respective tension sensors Za and Zb which are located immediately upstream of the warping machine M;
- backwards-adjusting the operating tensions TLa and TLb of the reference feeders so that the respective real tensions TRa and TRb correspond to the desired tension;
- setting the operating tension of all the remaining feeders of the row on the basis of a preset function which correlates the position of the yarn feeder with the respective operating tension and, in relation to the reference feeders Fa and Fb, returns the operating tension values TLa and TLb that were adjusted previously.

[0024] Preferably, at the beginning of the calibration procedure all the feeders F1,1, F1,2 ..., FY,X, and not just the two reference feeders Fa, Fb, can be preliminarily set to the desired tension.

[0025] For the purposes of example, if the feeders of the row are all arranged at the same distance between them, the function can be a linear function given by the following formula:

$$(i-a)/(b-a) = (TLi-TLa)/(TLb-TLa)$$

where i is the position of the feeder on which the operating tension is to be set within its row, and is therefore comprised between 1 and X, and TLi is the operating tension that needs to be set on such feeder.

[0026] Advantageously, especially if the calibration is based on a linear function, the positions a and b correspond to the two extreme positions of the row, that is to say, positions 1 and X, so as to minimize error in the construction of the mathematical function.

[0027] In an embodiment, the operating tensions on the feeders of a preselected reference row are adjusted, the same values are set on the feeders of one or more of the other rows, e.g., the two or three closest rows, or on all the other rows.

[0028] In the latter case, for example, the skilled person will be able to appreciate that by using only two tension sensors Za and Zb to measure the real tensions TRa and TRb of two yarns Ha and Hb immediately upstream of the warping machine M, it is possible to control all the feeders of the matrix, the number of which is given by the product X*Y.

[0029] Preferably in this case, one of the intermediate rows, more preferably one of the central rows, is used as a reference row. In this manner, if there are slight discrepancies between the rows (e.g., average tensions that increase from the top row to the bottom row, or vice versa), the operating tensions are calibrated on intermediate values.

[0030] In an alternative embodiment, the method is repeated on all the rows. In this case, the number of tension sensors to be arranged at the entry to the warping machine M will be equal to 2*Y.

[0031] In yet another embodiment, the operating tension values set on the feeders of one row are applied on the feeders of one or more of the other rows using a "scaling factor", on the basis of a preset function that takes account of the differences that are normally present between different rows.

[0032] It should likewise be noted that the method according to the invention could likewise be applied to accumulator feeders, i.e., feeders in which the yarn is wound on a drum so as to form a stock, and is unwound when needed by the downstream machine. The control unit adjusts the braking intensity applied by braking means which act by friction on the yarn at the exit of the drum, on the basis of to the signal received from a tension sensor, so as to maintain the tension of the yarn fed, i.e. the operating tension, substantially constant at the level set by the user. In this case, therefore, the adjustment parameter is the braking intensity applied to the brake.

[0033] Mixed solutions could also be envisaged, using some positive feeders and some accumulator feeders.

[0034] As the person skilled in the art will be able to appreciate, the method described herein is particularly

indicated and easily implementable in textile feeding apparatuses that use yarns that are all mutually homogeneous, as is the case with the warping machines to which the embodiment described herein refers.

[0035] Some preferred embodiments of the invention have been described, but obviously the person skilled in the art may make various modifications and variations within the scope of protection of the claims.

[0036] In particular, the mathematical function on which the calibration is based can be other than a simple linear function, e.g., if the feeders are not all equally spaced apart or, empirically, it is found that the operating tension necessary in order to have the desired tension immediately upstream of the machine does not increase linearly with the distance. In this case, for example, a different mathematical function can be applied, or a function built empirically and leveled off in each instance on the operating tensions TLa and TLb that are programmed at the positions a and b on the basis of the values of the respective measured real tensions TRa and TRb.

[0037] In this regard, if for a linear function it is sufficient to base the calibration method on two positions a and b, if a more complex function is adopted, the construction of such function can be based on measurements of the real tension made on a greater number of yarns, e.g., the two end positions plus one or two intermediate positions in the row, by adding sensors.

[0038] Obviously, the rows do not necessarily all have to have the same number of feeders.

[0039] Furthermore, although the embodiment illustrated shows the feeders arranged on multiple rows, obviously the method can also be applied to the case where only one row of feeders is present.

[0040] The disclosures in Italian Patent Application No. 102019000011451 from which this application claims priority are incorporated herein by reference.

[0041] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A method for feeding a plurality of yarns under controlled tension to a textile machine by way of respective feeders (F1,1, F1,2 ..., FY,X), the tension of the yarn (H1,1, H1,2 ..., HY,X) fed by each one of said feeders being monitored by a respective tension sensor (S1,1, S1,2 ..., SY,X) which is located immediately downstream of the feeder and is connected to a control unit which is adapted to modulate an adjustment parameter of the feeder on the basis of the signal received from the tension sensor (S1,1, S1,2 ..., SY,X), so as to keep the tension of the yarn delivered to the textile machine (M) substantially constant at an operating tension that can be set by the user, said feeders (F1,1, F1,2 ..., FY,X) being located on at least one row (LI, L2, ..., LY) at progressively increasing distances from the textile machine (M), **characterized in that** said feeders (F1,1, F1,2 ..., FY,X) undergo a calibration procedure for calibrating the respective operating tensions, which comprises the following steps:

   - setting a same operating tension, equal to a desired tension, on at least two reference feeders (Fa, Fb) of at least one of the rows (LI, L2, ..., LY);
   - measuring real tensions (TRa and TRb) of the yarns (Ha and Hb) fed by said at least two reference feeders (Fa, Fb) by way of respective tension sensors (Za and Zb) which are located immediately upstream of said textile machine (M);
   - backwards-adjusting the operating tensions (TLa and TLb) of the reference feeders (Fa and Fb) so that the respective real tensions (TRa and TRb) correspond to said desired tension;
   - setting the operating tension of all the remaining feeders of the row on the basis of a preset function which correlates the position of the yarn feeder with the respective operating tension and, in relation to said reference feeders (Fa and Fb), returns the operating tension values (TLa and TLb) that were adjusted previously.

2. The method according to claim 1, **characterized in that** said function is a linear mathematical function.

3. The method according to claim 1 or 2, **characterized in that** said at least two reference feeders (Fa and Fb) are arranged at the ends of the row.

4. The method according to claim 1, wherein said feeders (F1,1, F1,2 ..., FY,X) are arranged on a plurality of rows (LI, L2, ..., LY), **characterized in that** said calibration procedure is performed on a predetermined reference row, and the same operating tensions are set on the feeders of at least one of the other rows.

5. The method according to claim 4, **characterized in that** one of the intermediate rows is used as a reference row.

6. The method according to claim 1, **characterized in that** said calibration procedure is performed on all the rows.

7. The method according to claim 1, **characterized in that** each one of said feeders (F1,1, F1,2 ..., FY,X) is provided with a motorized reel (W1,1, W1,2 ...,

WY,X), of which the speed is controlled by said control unit and on which the yarn (H1,1, H1,2 ..., HY,X) that is adapted to be fed to said textile machine (M) is wound repeatedly, said adjustment parameter being the rotation speed of the reel (W1,1, W1,2 ..., WY,X).

8. The method according to claim 1, **characterized in that** each one of said feeders (F1,1, F1,2 ..., FY,X) comprises a drum on which the yarn (H1,1, H1,2 ..., HY,X) is wound so as to form a stock, and from which it is unwound when needed by the downstream machine, and braking means which act by friction on the yarn (H1,1, HI,2 ..., HY,X) at the exit of the drum and which are controlled in terms of braking intensity by said control unit, said adjustment parameter being the braking intensity applied to said braking means.

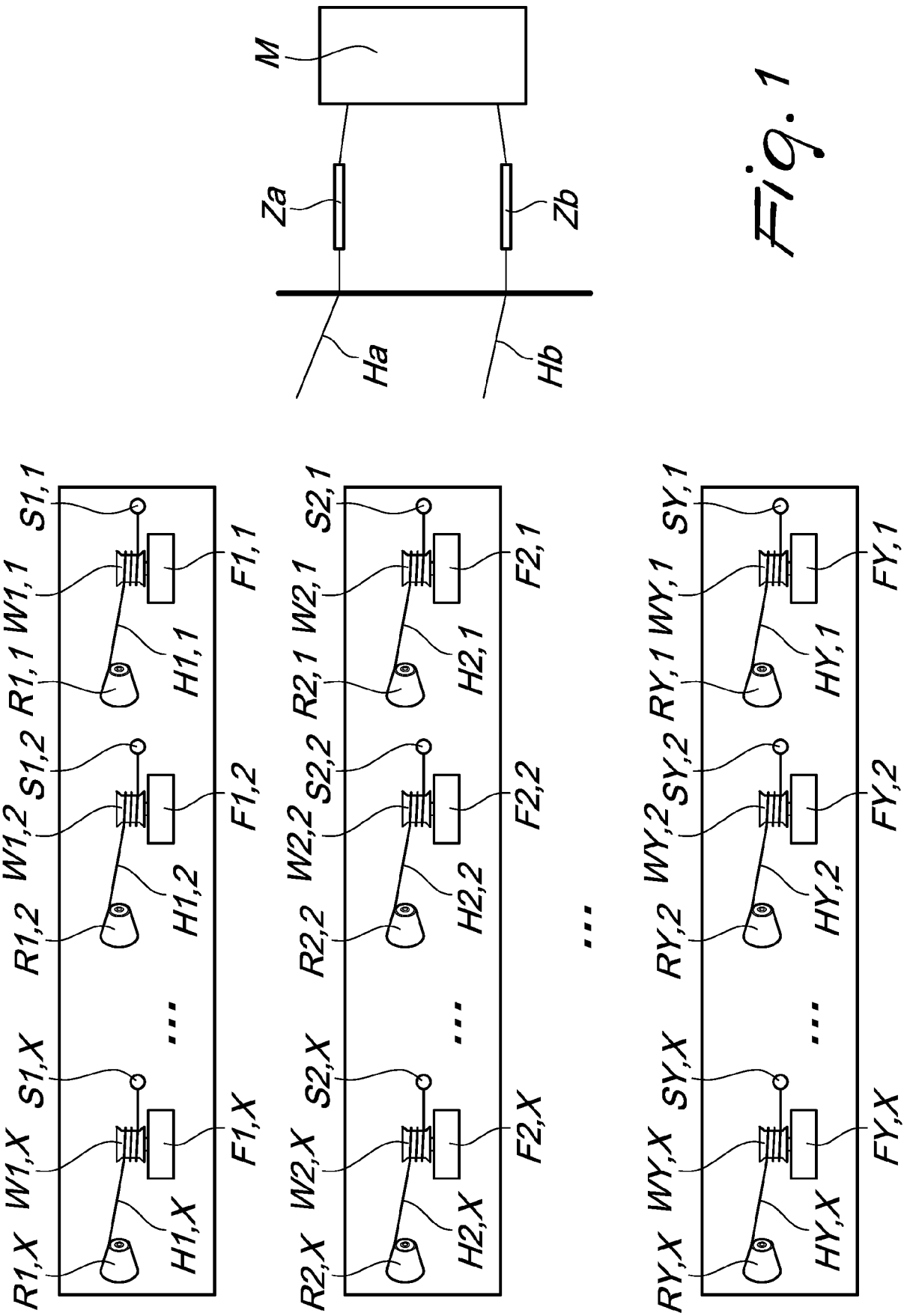
M
Za
Zb
Ha
Hb
R1,X W1,X S1,X R1,2 W1,2 S1,2 R1,1 W1,1 S1,1
H1,X H1,2 H1,1
F1,X F1,2 F1,1
R2,X W2,X S2,X R2,2 W2,2 S2,2 R2,1 W2,1 S2,1
H2,X H2,2 H2,1
F2,X F2,2 F2,1
RY,X WY,X SY,X RY,2 WY,2 SY,2 RY,1 WY,1 SY,1
HY,X HY,2 HY,1
FY,X FY,2 FY,1

Fig. 1

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 18 0925

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 573 027 A1 (LGL ELECTRONICS SPA [IT]) 27 March 2013 (2013-03-27) * paragraph [0002] * * paragraph [0004] * * paragraph [0006] - paragraph [0007] * * paragraph [0017] - paragraph [0018] * * paragraph [0025] - paragraph [0026] * -----	1-8	INV. B65H59/38 B65H51/20 B65H51/30

TECHNICAL FIELDS SEARCHED (IPC)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 November 2020	Guisan, Thierry

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 18 0925

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-11-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2573027 A1	27-03-2013	CN 103010835 A	03-04-2013
		EP 2573027 A1	27-03-2013

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1901984 B1 **[0008] [0009] [0011]**
- IT 102019000011451 **[0040]**