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(54) **ROPE KNOTTING ARRANGEMENT**

(57) A rope knotting arrangement is described comprising a first rope path (27) having first clamping means (31), a second rope path (28) having second clamping means (33), and knot forming means (8), wherein the knot forming means (8) and the rope paths (27, 28) are moveable relative to each other.

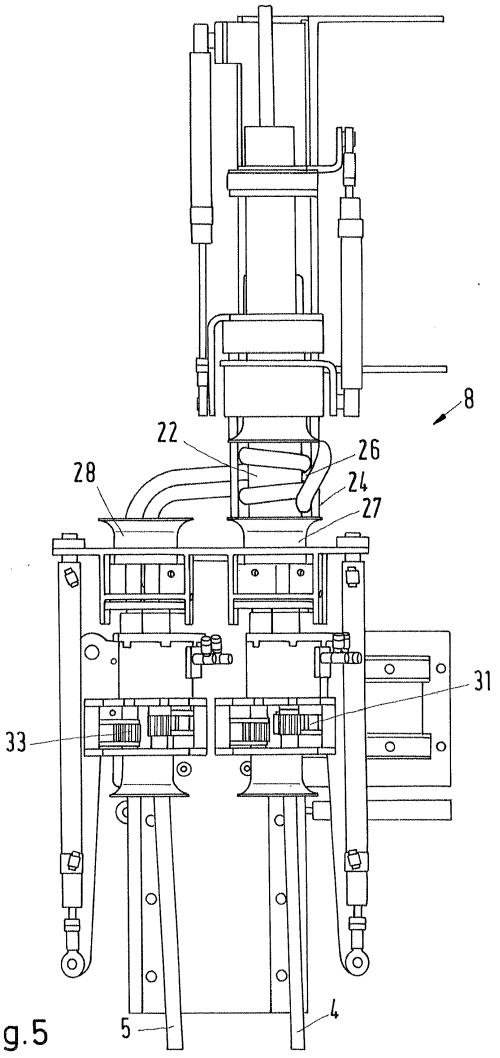

Fig.5

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Description

[0001] The present invention relates to a rope knotting arrangement.

[0002] A rope in the textile industry is formed by a bundle of a larger number of threads. The threads are to be processed simultaneously, for example in a rope-dying process.

[0003] A certain length of a rope is wound on a so-called "ball". When the rope is completely unwound from the ball, it is necessary to connect the trailing end of this rope to a leading end of another rope. In a typical rope process the number of ropes involved typically ranges between 12 and 40 or even more and the batch change, i.e. knotting the heads of the new ropes to the tail of the running-out ropes must be done for all of them in a time as quick as possible, in order to save time and reduce wastes. This requires a relevant number of operators to work simultaneously on this task.

[0004] In addition, the handling of this process determines several quality problems, such as uneven tensions of the ropes and therefore quality decay.

[0005] The object underlying the invention is to facilitate processing of ropes.

[0006] This object is solved with a rope knotting arrangement comprising a first rope path having first clamping means, a second rope path having second clamping means, and knot forming means, wherein the knot forming means and the rope paths are moveable relative to each other.

[0007] In such a rope knotting arrangement a rope can run through the first rope path until the ball is almost completely unwound. A fresh rope is held in readiness to be knotted to the first rope. To this end the second rope is guided through the second rope path and can be applied to the knot forming means which serve for the preparation of the knot forming. By means of knot forming means it is then possible to form automatically a knot between the first rope and the second rope and the rope processing can be continued. Thereafter, the knot forming means is shifted to the second rope path so that the second rope can run through the second rope path and through the knot forming means, wherein the first rope path is used to insert another rope and to make it ready for a further knotting process once the end of the rope passing through the second rope path approaches. In an alternative embodiment the knot forming means can remain stationary wherein the first and the second rope path are moved in relation to the knot forming means.

[0008] In an embodiment of the invention the knot forming means comprise a rope passage in a rope cover which is connected to a rope cover actuator. The rope cover is thus moveable in relation to the rope passage. This means, that the leading end of a fresh rope can be arranged around the rope cover without affecting the other rope running through the rope passage. When a knot is to be formed, the rope cover is actuated and comes free from the fresh or new rope, so that the new rope can come into contact with the old rope to form the knot. The knot forming preparation requires only that an operator guides the leading edge of the new rope in a certain way around the rope cover. However, since this handling of the leading end of the new or fresh rope can be performed in the time in which the old rope is processed and runs through the rope passage, the operator has enough time to perform this step of operation with the necessary accuracy.

[0009] In an embodiment of the invention the knot forming means comprise at least a rod outside the rope cover which is connected to a rod actuator, wherein a gap is provided between the rope cover and the rod. The operator can now guide the leading end of the fresh rope not only around the rope cover and through the gap between the rope cover and the rod, but he can guide the fresh rope in addition outside the rod which facilitates the knot forming. In a preferred embodiment two rods are provided, one for each rope path.

[0010] In an embodiment of the invention the rope cover actuator and the rod actuator are connected to common control means, wherein the control means activate the rod actuator after the rope cover actuator. In other words, when the rod cover is removed the leading end of the fresh rope makes a first contact with the trailing end of the old rope. In a second step, when the rod is removed, there is a second contact between the leading end of the fresh rope with the old rope, so that a flat knot is created, in particular in form of an square knot or reef knot.

[0011] In an embodiment of the invention the first clamping means are connected to a first clamping means actuator and the second clamping means are connected to a second clamping means actuator, wherein the clamping means actuators are connected to the control means. Thus, the operation of the clamping means actuators can be synchronized with the operation of the rope cover actuator and the rod actuator. The clamping means can be used to hold the ropes or part of the ropes during the knot forming process.

[0012] In an embodiment of the invention the control means comprise rope end detection means. This means that the control means can detect that the end of the old rope approaches. The control means can stop the further pulling of the old rope from the ball and can start the knot forming process with the leading end of the fresh or new rope.

[0013] In an embodiment of the invention the control means is connected to a knot finishing sensor. The knot finishing sensor indicates that the knot has been formed with sufficient strength. As soon as the knot forming process has been completed, it is possible to continue the rope processing, wherein the trailing end of the old rope draws or pulls the leading end of the new rope through the rope processing, like a dying process.

[0014] In an embodiment of the invention the knot finishing sensor comprises a force sensor. The force sensor can detect the force with which one of the clamping

means of both clamping means is actuated. When this force exceeds a predetermined value, the knot forming process has been finished and the knot is created with sufficient strength.

[0015] Alternatively or additionally, the knot finishing sensor comprises a stroke length sensor. The clamping means pull the rope to tighten the knot. When the clamping means cannot reach an end or bottom position, the control means acknowledges that the knot is properly tensioned.

[0016] In an embodiment of the invention a rope storage is arranged downstream the knot forming means. The rope storage can be used to keep a certain length of the rope for processing. This length can be processed during the knot forming. Thus, a continuous rope processing can be achieved.

[0017] In an embodiment of the invention the rope storage comprises an outlet drive at an outlet. The outlet drive can be used to control the tension of the rope downstream the knotting arrangement. In this case the rope can further be processed with a predetermined tension, which is beneficial to achieve a good quality of the rope. It should be noted that the outlet drive can even be used without a knotting arrangement to control the tension of the rope. It can even be used without a rope storage so that the tension of the rope is controlled when the rope is further processec.

[0018] In an embodiment of the invention the rope storage comprises an inlet drive at an inlet, wherein the inlet drive and the outlet drive are operable independently of each other. The inlet drive can be used to "fill" the rope storage in that it supplies the rope faster than the outlet drive withdraws the rope from the rope storage. Once the rope storage is sufficiently filled, both drives can be operated at the same speed. During the knot forming process the inlet drive stops operation or operates with a reduced speed, so that the knot forming process can be performed with stationary or almost stationary rope ends. The inlet drive can, however, be used to tighten the knot.

[0019] In an embodiment of the invention a pulley is arranged between the inlet and the outlet. The rope is guided between the inlet drive, the pulley, and the outlet drive. This allows for a stable operation of the rope storage.

[0020] In an embodiment of the invention the inlet drive and/or the outlet drive comprises a wheel equipped with lamellae, wherein each lamella has a recess at a radially outer end. The recess takes the rope, so that a good engagement between the drive and the rope is achieved.

[0021] In an embodiment of the invention the recesses of adjacent lamellae are offset from one another in a direction of an axis of rotation of the respective drive. This means that the rope meanders between the lamellae which increases the engagement between the rope and the drive.

[0022] A preferred embodiment of the invention will now be described in more detail with reference to the drawing, wherein:

Fig. 1 shows an overview over a rope knotting arrangement,

Fig. 2 shows details of a rope storage,

Fig. 3 shows an enlarged view of knot forming means,

Fig. 4 shows an arrangement of two rope paths and corresponding clamping means,

Fig. 5 shows the rope path and the knot forming mean in preparation of forming a knot,

Fig. 6 shows part of the knot forming,

Fig. 7 shows a later stage of the knot forming,

Fig. 8 shows finishing of the knot forming, and

Fig. 9 shows the propagation of the knot to the rope processing.

[0023] In all Figures the same elements are denoted with the same reference numerals.

[0024] Fig. 1 schematically shows a rope knotting arrangement 1 in which a first ball 2 and a second ball 3 are arranged in a creel. A first rope 4 is wound on the first ball 2 and a second rope 5 is wound on the second ball 3.

[0025] In the arrangement shown in Fig. 1 the first rope 4 is processed, i.e. it is taken out of the rope knotting arrangement 1 at a point 6 to be supplied to a processing unit, for example a rope-dying machine.

[0026] The second rope 5 is held ready. When the first ball 2 has completely been unwound, the trailing end of the first rope 4 is knotted to the leading end of the second rope 5. To this end, the rope knotting arrangement 1 comprises an arrangement 7 of two rope paths and knot forming means 8 which will be explained later. Furthermore, the rope knotting arrangement 1 comprises a rope storage 9 which will likewise be explained later on.

[0027] The rope storage 9 comprises an input drive 10 at an inlet of the rope storage 9 and an outlet drive 11 at an outlet of the rope storage 9. A pulley 12 is arranged between the inlet drive 10 and the outlet drive 11. The pulley 12 is moveable along a vertical stand 13.

[0028] The inlet drive 10 comprises a wheel 14 equipped with lamellae 15. Each lamella comprises a recess 16 at a radially outer end. The recesses 16 of adjacent lamellae 15 are offset from one another in a direction parallel to an axis of rotation of the inlet drive 10.

[0029] The outlet drive 11 is likewise connected to a wheel 17 having lamellae 18 which have recesses 19 which are offset from one another in the direction of the axis of rotation. Thus, the rope 4 which is guided over the wheel 14 of the inlet drive 10 and over the wheel 17

of the outer drive 11 is forced to meander through the recesses 16, 19 of the two wheels 14, 17, so that the rope 4 is sufficiently engaged with the wheels 14, 17.

[0030] The inlet drive 10 and the outlet drive 11 can be operated independently of each other. In order to fill the rope storage 9 the inlet drive 10 runs faster than the outlet drive 11. Once the rope storage 9 is sufficiently filled with the rope 4, both drives 10, 11 are operated at the same speed. During a knot forming process the inlet drive 10 stops or is operated with a low speed whereas the outlet drive 11 operates with the same speed or a slightly slower speed than before.

[0031] The outlet drive 11 is not only used to withdraw the rope 4 out of the rope storage 9. It can in addition be used to control the tension of the rope 4 which is beneficial for further processing of the rope 4.

[0032] It is even possible to use a rope storage 9 without inlet drive 10 and to use the outlet drive 11 only, in particular to control the tension of the rope 4.

[0033] It should be noted that a drive like the outlet drive 11 can be used without rope storage 9 to control the tension of the rope 4 in a downstream process. In this case the processing of the rope 4 can be interrupted during the knot forming process.

[0034] It is even possible to use a drive like the outlet drive 11 without knot forming means 1 and with or without rope storage just to control the tension of the rope 4.

[0035] The outlet drive 11 and/or the inlet drive 10 can have forms different from the embodiment shown as long as the enable sufficient engagement with the rope 4.

[0036] Fig. 3 shows the knot forming means 8 in more detail. The knot forming means 8 comprise a funnel 20 at an inlet end. A rope (not shown) is guided through the funnel 20 along a rope passage which ends at an upper end 21 of the knot forming means.

[0037] The knot forming means 8 comprise a rope cover 22 which is connected to a rope cover actuator 23. Thus, the rope cover 22 can be moved from a position shown in Fig. 3 in which the rope passage is covered by the rope cover 22 into a position in which the rope passage is uncovered.

[0038] Furthermore, the knot forming means 8 comprise a rod 24 outside the rope cover 22 which is connected to a rod actuator 25. A gap 26 is provided between the rod 24 and the rope cover 22. The rod 24 can be retracted under the action of the rod actuator 25 so that a fresh rope which has been arranged on a side of the rod 24 opposite to the rope cover 22 can after a corresponding movement of the rope cover 22 reach an "old" rope running through the rod passage.

[0039] The knot forming means 8 is used to prepare the leading end of the new rope by guiding it around the rope cover 22 while the machine is still running and the "old" rope still runs through the rope passage. The leading end of the new rope is guided around the rope cover 22, through the gap 26 and around the rod 24 as will be explained later.

[0040] Fig. 4 shows two rope paths, more precisely a first rope path 27 and a second rope path 28. A first shear device 29 is provided for the first rope path 27 and a second shear device 30 is provided for the second rope path 28. Furthermore, first clamping means 31 are provided for the first rope path 27 which first clamping means 31 are connected to a first clamping means actuator 32 which can move the first clamping means 31 along the first rope path 27.

[0041] Second clamping means 33 are provided for the second rope path 28. The second clamping means 33 are connected to a second clamping means actuator 34 which can move the second clamping means 33 in a direction parallel to the second rope path 28.

[0042] Fig. 5 shows the preparation of a knot forming process in more detail.

[0043] Rope 4 runs through the first rope path 27 and through the knot forming means 8. Rope 4 is withdrawn from the first ball 2 by means of the inlet drive 10. The rope storage 9 is filled in this stage of operation.

[0044] An operator has taken the leading end of the second rope 5 and guided it around the rope cover 22 through gap 26, on the outside of rod 24, back through gap 26 and again back into the second rope path 28 to an extent so that the clamping means 33 can clamp the leading end of the second rope 5. It is, however, not absolutely necessary that the leading end is guided back into the second rope path 28. More precisely, the leading end of the new rope 5 is guided in a first winding around the rope cover 22 over the complete periphery, then guided through the gap 26 between the rod 24 and the rope cover 22, over the outer side of rod 24 and again in a second winding over the complete periphery around the rope cover 22, however, in opposite direction to the first winding so that the end of rope 5 runs almost parallel to the incoming section of rope 5. Both windings run through the gap 26.

[0045] A possible way to perform the preparation is that the operator takes the leading end of the second rope 5 out of the second rope path 28, and guides it winding clockwise and downwards for one and a quarter revolutions around the rope cover 22. During this phase, the leading end should be taken twice trough the gap 26, and then looped around the rod 24 counterclockwise. A complete revolution around the rod cover 22 shall be performed, counterclockwise, and again passing through gap 26, being careful doing this passing downwards underneath the previous revolution of rope 5 itself. The excess of leading end shall be taken back into the second rope path 28 to an extent so that the clamping means 33 can clamp the leading end of the second rope 5. It is, however, not absolutely necessary the leading end is guided back into the second rope path 28.

[0046] All actuators 23, 25, 32, 34 are connected to common control means which are not shown. The control means control the actuation of the actuators 23, 25, 32, 34 in a controlled sequence. This sequence is initiated when the control means detect that the trailing end of the first rope 4 approaches. To this end, it is possible to have

end detection means, for example a sensor. This actuation can, however, be initiated by an operator.

[0047] When the end of the first rope 4 approaches, the first rope 4 is clamped by the first clamping means 31. The second rope 5 is clamped by the second clamping means 33. The rope cover 22 is moved, so that a section 35 of the second rope 5 has the chance to contact the first rope 4 when the second rope 5 is pulled by the second clamping means 33 under the action of the second clamping means actuator 34. This situation is shown in Fig. 7. The second rope 5 comes into engagement with the first rope 4 and forms a loop 36 at the first rope 4. However, in this instant the second rope 5 is still guided around the rod 24.

[0048] In Fig. 8 the next step is shown in which the rod 24 has been retracted and the loop 36 of the first rope 4 has come into engagement with the section 35 of the second rope 5. A knot 38 in form of a figure of eight is created which is a very strong knot. When the first rope is sheared or cut by the first shear device 29, it can be further pulled as shown in Fig. 9. The first rope 4 pulls the second rope 5 through the knot forming means 8. During or after knot forming the knot forming means 8 and the two rope paths 27, 28 have been shifted in relation to each other, so that the knot forming means 8 which have previously been aligned with the first rope path 27 now are aligned with the second rope path 28. This can be achieved by shifting the knot forming means 8 or by shifting the rope paths 27, 28 or by shifting both the knot forming means 8 and the rope paths 27, 28.

[0049] It is possible that a single stroke of the second clamping means actuator 34 is not sufficient to properly tension the knot 38. If this is the case, the second clamping means 33 unclamp rope 5 and the second clamping means actuator 34 moves back the second clamping means 33. The second clamping means 33 clamp the rope 5 again to pull it further down again and again, until the rope 5 is tensioned enough.

[0050] This condition can be detected by means of a tension sensor (not shown) which is connected to the control means. However, in an additional or alternative possibility the second clamping means actuator 34 can be used to detect the sufficient tensioning of the knot 38. The second clamping means actuator 34 is operated with a maximum force. When this force is not sufficient to move the second clamping means 33 over the complete stroke length, this is an indication that the tensioning force is sufficient.

[0051] The same is obviously true for the first clamping means 31 and the first clamping means actuator 32.

[0052] As soon as the condition shown in Fig. 8 has been reached, i.e. that the knot 38 has been formed, the rope cover 22 and the rod 24 can be moved back into their initial positions, so that an operator can immediately start with the preparation of a new knot to be formed.

[0053] During the forming of the knot 38 the inlet drive 10 is stopped. It is even possible to slightly rotate the inlet drive 10 in a backward direction to lower the tension of the first rope 4 which in some cases facilitates the forming of the knot.

[0054] The outlet drive 11 can be used as a tension controller for the rope which is supplied to a processing machine.

[0055] The rope knotting arrangement 1 is shown having two rope paths 27, 28. However, it is possible to use a rope knotting arrangement having more than these two rope paths 27, 28.

[0056] Since the knotting is finally performed automatically, all knots have the same quality and the tension of all rope can be maintained constant resulting in a uniform quality of the rope processing.

[0057] Furthermore, the need for a large number of operators is eliminated. Although a processing machine can continue working, safety aspects are given since during the knot preparation the operator has not the risk to come in contact with a running rope.

[0058] A reduction of product waste is achieved.

Claims

1. Rope knotting arrangement (1) comprising a first rope path (27) having first clamping means (31), a second rope path (28) having second clamping means (33), and knot forming means (8), wherein the knot forming means (8) and the rope paths (27, 28) are movable relative to each other.

2. Rope knotting arrangement according to claim 1, **characterized in that** the knot forming means (8) comprise a rope passage in a rope cover (22) which is connected to a rope cover actuator (23).

3. Rope knotting arrangement according to claim 2, **characterized in that** the knot forming means (8) comprise at least a rod (24) outside the rope cover (22) which is connected to a rod actuator (25), wherein a gap (26) is provided between the rope cover (22) and the rod (24).

4. Rope knotting arrangement according to claim 3, **characterized in that** the rope cover actuator (23) and the rod actuator (25) are connected to common control means, wherein the control means activate the rod actuator (25) after the rope cover actuator (23).

5. Rope knotting arrangement according to claim 4, **characterized in that** the first clamping means (31) are connected to a first clamping means actuator (32) and the second clamping means (33) are connected to a second clamping means actuator (34), wherein the clamping means actuators (32, 34) are connected to the control means.

6. Rope knotting arrangement according to claim 5,

characterized in that the control means comprise rope end detection means.

7. Rope knotting arrangement according to claim 5 or 6, **characterized in that** the control means is connected to a knot finishing sensor.

8. Rope knotting arrangement according to claim 7, **characterized in that** the knot finishing sensor comprises a force sensor.

9. Rope knotting arrangement according to claim 7 or 8, **characterized in that** the finishing sensor comprises a stroke length sensor.

10. Rope knotting arrangement according to any of claims 1 to 9, **characterized in that** a rope storage (9) is arranged downstream the knot forming means (8).

11. Rope knotting arrangement according to claim 10, **characterized in that** the rope storage (9) comprises an outlet drive (11) at an outlet.

12. Rope knotting arrangement according to claim 11, **characterized in that** the rope storage (9) comprises an inlet drive (10) at an inlet, wherein the inlet drive (10) and the outlet drive (11) are operable independently of each other.

13. Rope knotting arrangement according to claim 12, **characterized in that** a movable pulley (12) is arranged between the inlet and the outlet.

14. Rope knotting arrangement according to claim 12 or 13, **characterized in that** the inlet drive (10) and/or the outlet drive (12) comprises a wheel (14, 17) equipped with lamellae (15, 18), wherein each lamella (15, 18) has a recess (16, 19) at a radially outer end.

15. Rope knotting arrangement according to claim 14, **characterized in that** the recesses (16, 19) of adjacent lamellae are offset from one another in a direction of an axis of rotation of the respective drive (10, 11).

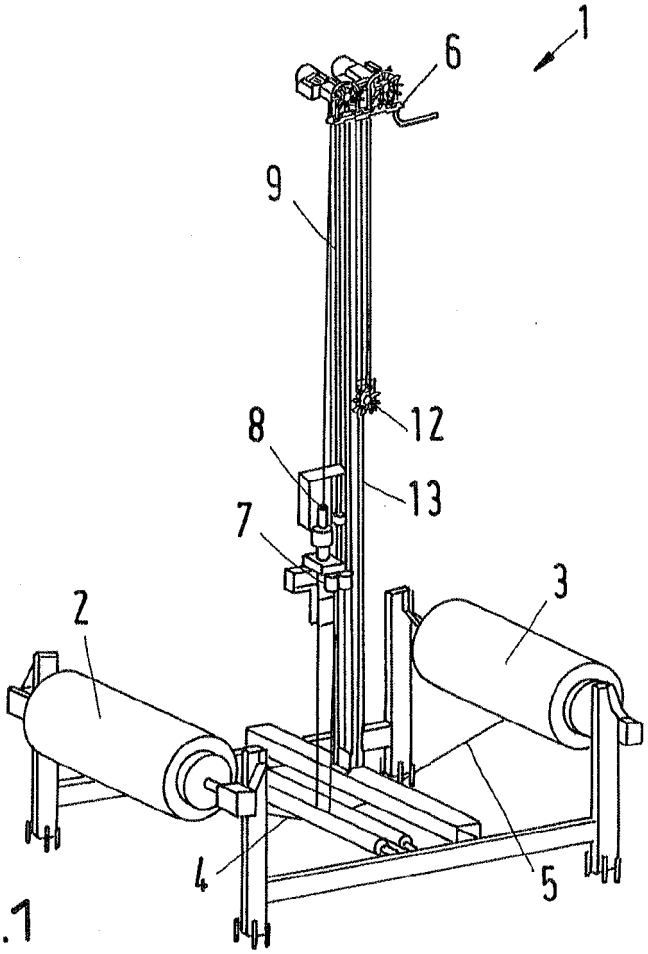

Fig.1

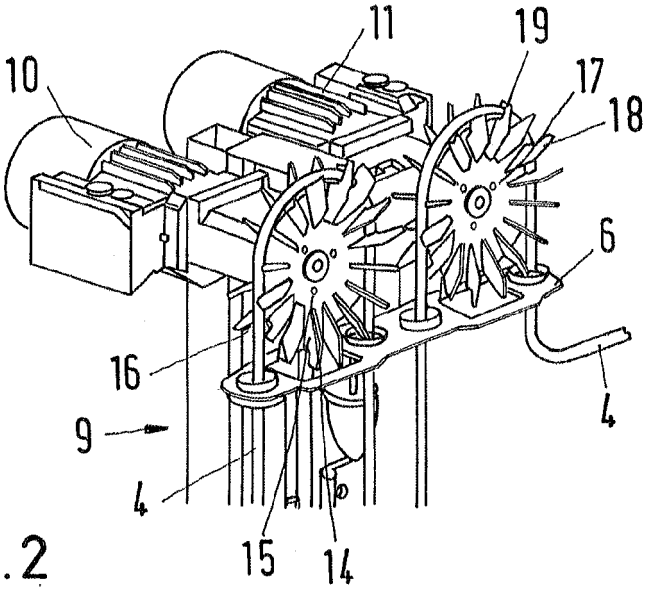

Fig.2

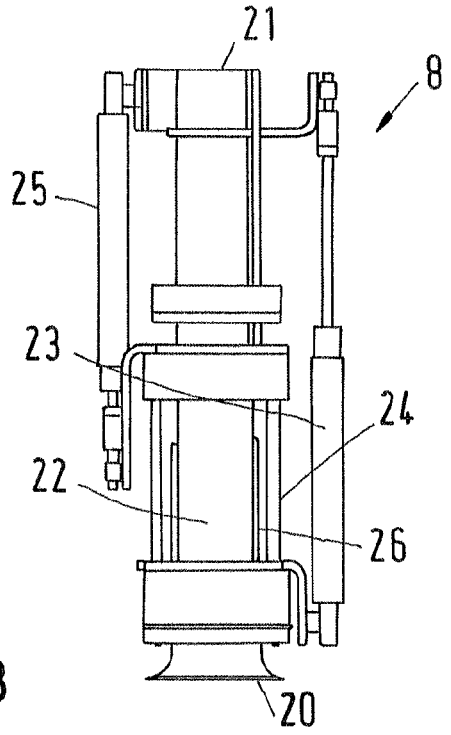

Fig.3

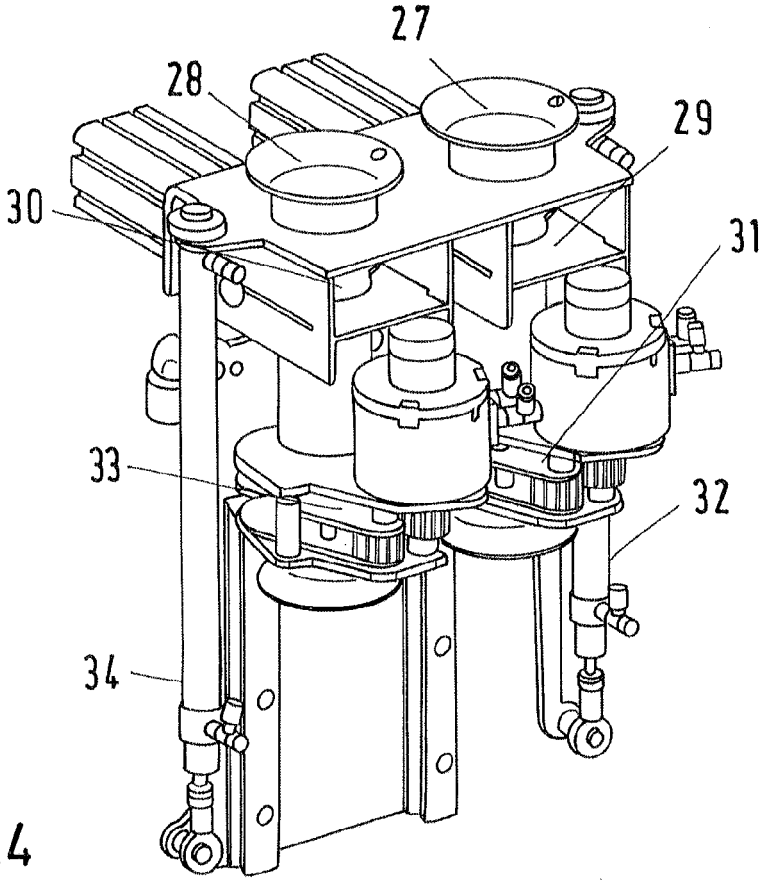

Fig.4

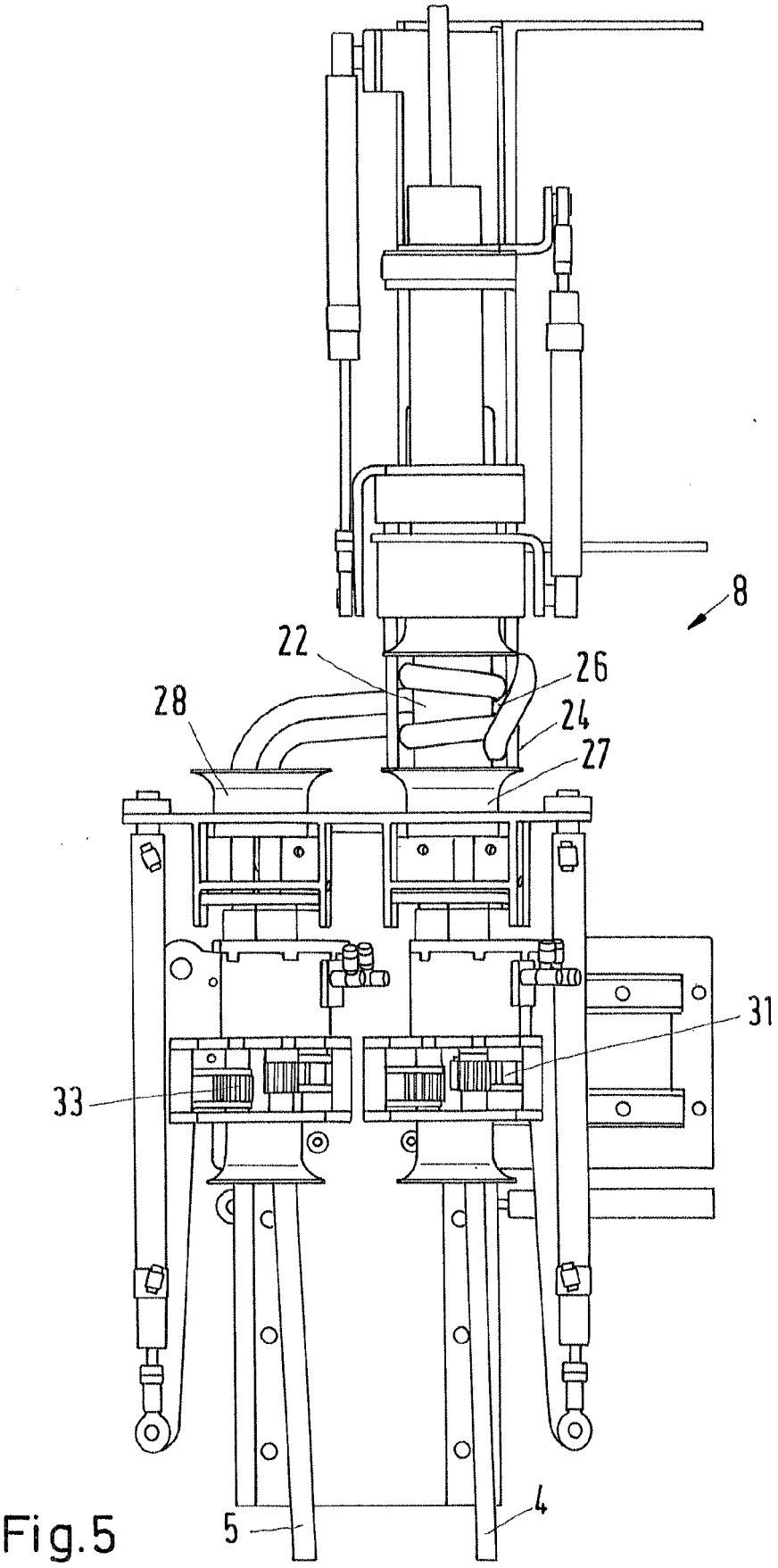

Fig.5

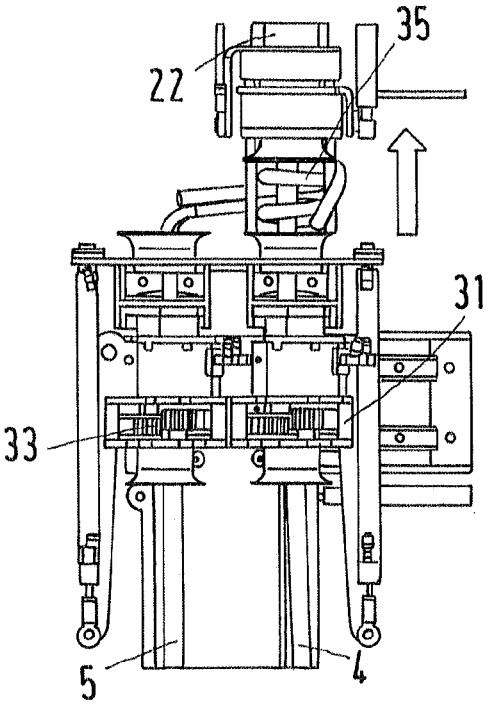

Fig.6

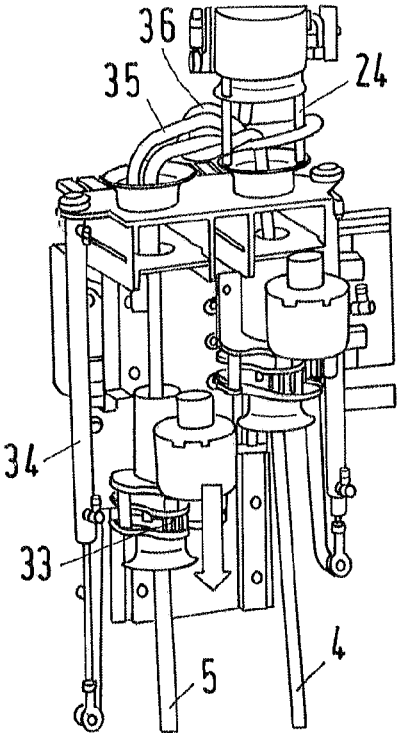

Fig.7

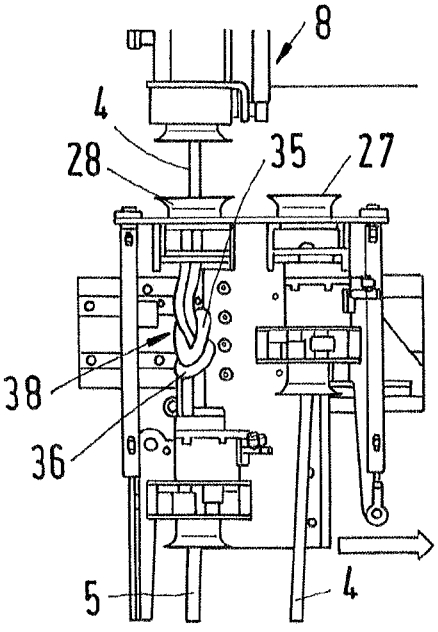

Fig.8

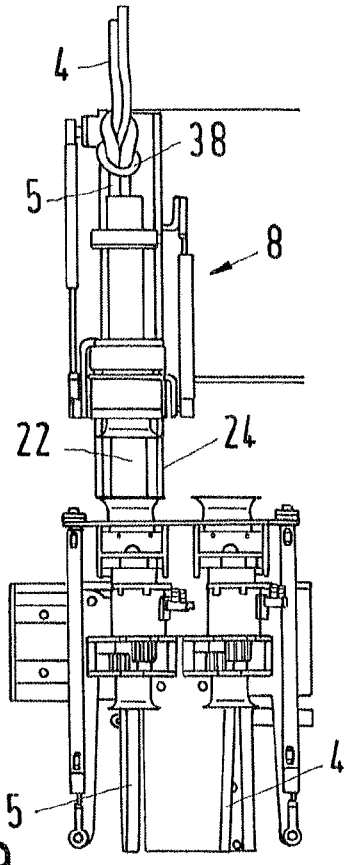

Fig.9

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 8444

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 4 984 436 A (NUERK SIEGFRIED [DE]) 15 January 1991 (1991-01-15) * the whole document *	1-7,9,10 8	INV. B65H69/04 B65H51/20
X Y	US 3 892 432 A (INGUS GEORGE A) 1 July 1975 (1975-07-01) * the whole document *	1-4,10 11-13	
X	EP 1 524 341 A1 (BENNINGER AG MASCHF [CH]) 20 April 2005 (2005-04-20) * paragraphs [0025], [0029], [0031], [0033]; figures 2-20 *	1-5	
X A	US 4 531 385 A (JACOBSSON KURT A G [SE]) 30 July 1985 (1985-07-30) * column 4, lines 53-66; figures 1,2 * * column 5, line 49 - column 6, line 68; figures 3-8 *	1,10 6	
Y	US 5 437 182 A (PLASCHY MARTIN [CH] ET AL) 1 August 1995 (1995-08-01) * column 5, line 31 - column 6, line 51 *	8	
Y	JP H04 28671 A (BANDO CHEMICAL IND) 31 January 1992 (1992-01-31) * abstract; figure 2 *	11-13	
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A	DE 23 26 132 A1 (PFROMMER JUN BRUNO) 12 December 1974 (1974-12-12) * figures 1,3 *	10-15	

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TECHNICAL FIELDS SEARCHED (IPC)

B65H
D03J
D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 July 2020	Pussemier, Bart

CATEGORY OF CITED DOCUMENTS

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EP 19 20 8444

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 July 2020	Pussemier, Bart

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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)

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Application Number
EP 19 20 8444

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 19 20 8444

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9

   Rope knotting arrangement wherein the knot forming means comprise a rope passage in a rope cover which is connected to a rope cover actuator.

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2. claims: 10-15

   Rope knotting arrangement wherein a rope storage is arranged downstream the knot forming means.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 20 8444

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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