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(54) **FEED YARN JOINING SYSTEM**

(71) Applicant: **Saurer Technologies GmbH & Co. KG**, Krefeld (DE)

(72) Inventors: **Markus SCHAUENBURG**, Rechberghausen (DE); **Albert STITZ**, Kuerten (DE)

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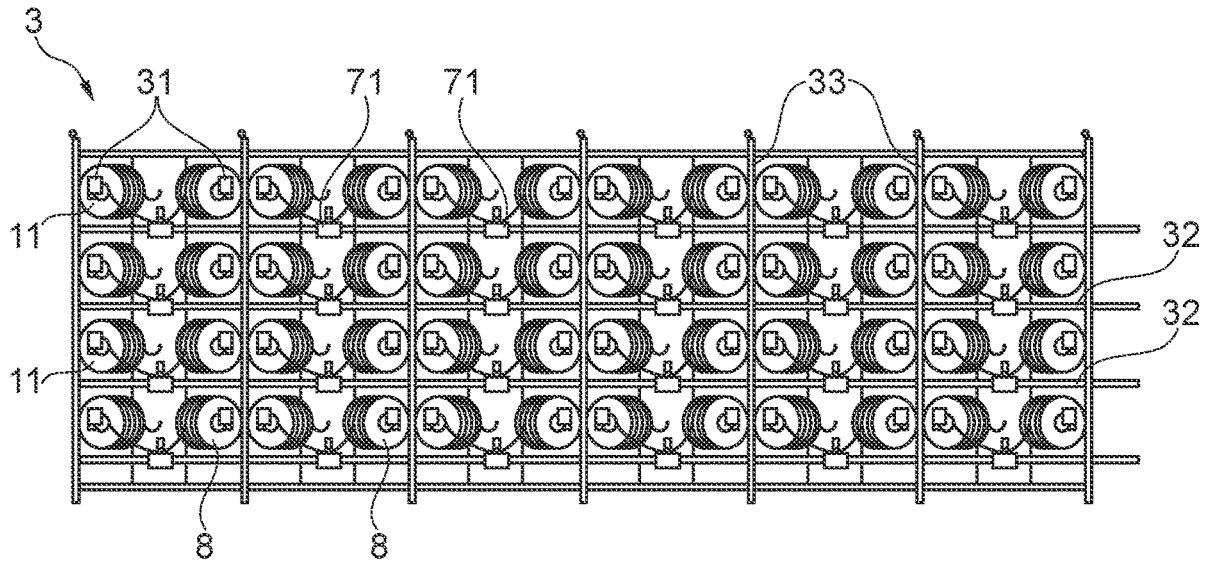
(57) **ABSTRACT**

A feed yarn joining system for joining a yarn tail end of a yarn package to a yarn head end of a reserve package at a package creel including package storage sites for receiving the yarn and reserve packages, with receiving units for receiving the yarn head end and the yarn tail end, positioning units for positioning a yarn portion joined to the yarn tail end and yarn head end in the yarn splicing device, the yarn splicing device for preparing and joining the yarn head end and yarn tail end, and a control unit for initiating the start of the splicing operation and executing the splicing operation. Furthermore, a package creel arrangement with a feed yarn joining system as well as a method of joining a yarn tail end of a yarn package to a yarn head end of a reserve package when using a feed yarn joining system.



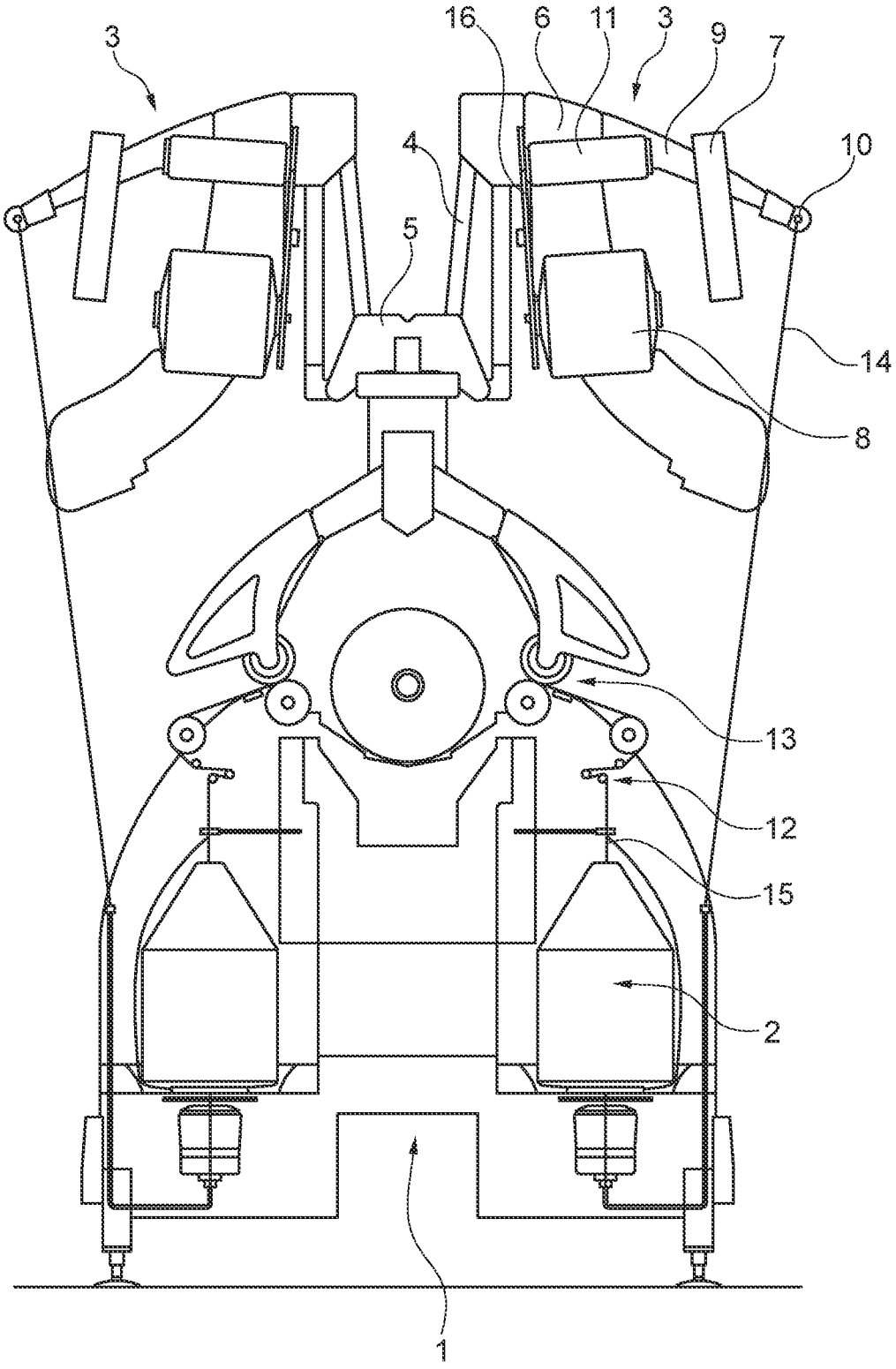


Fig. 1

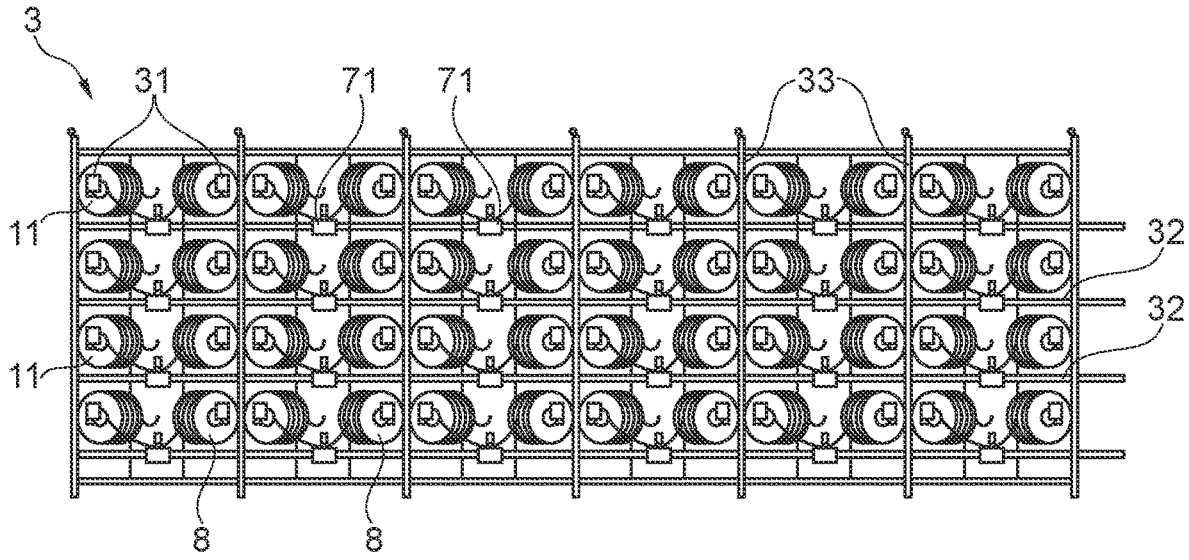


Fig. 2

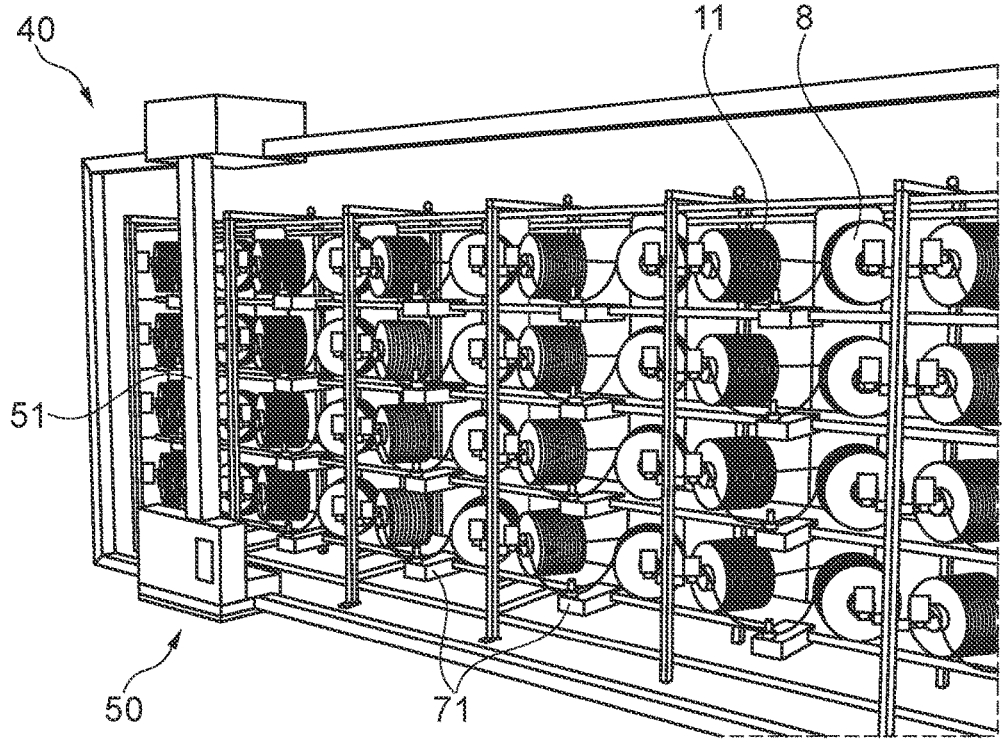


Fig. 3

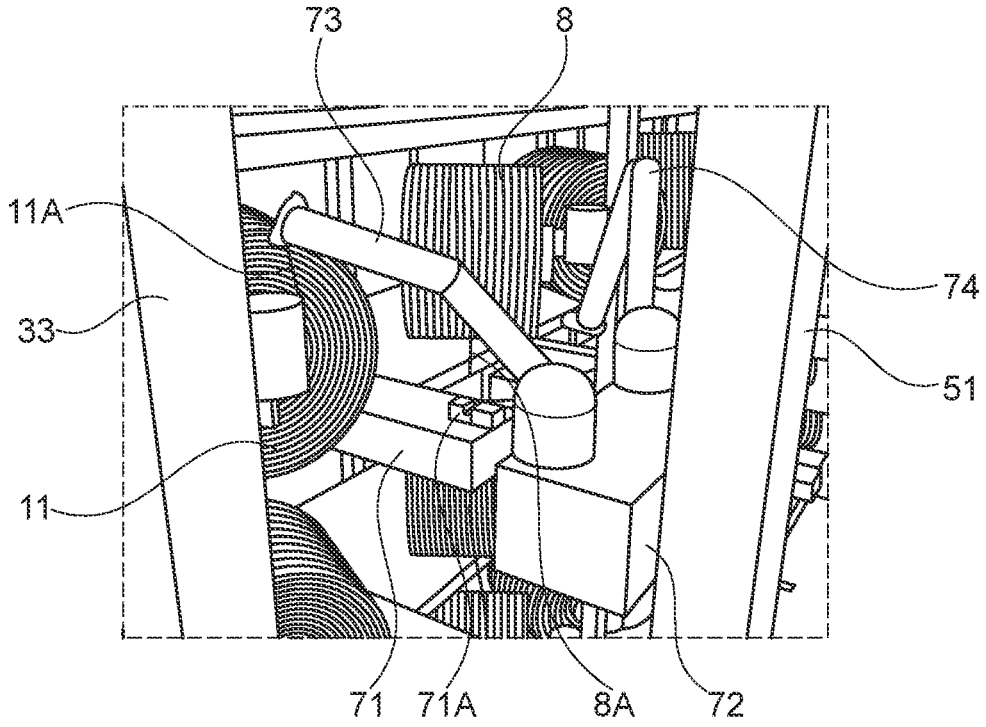


Fig. 3A

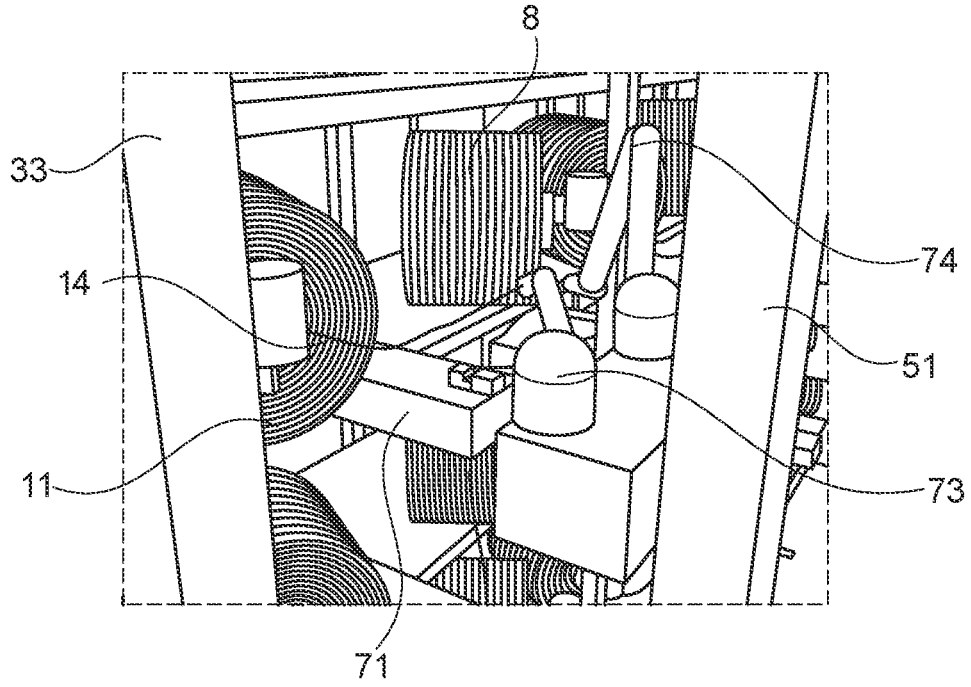


Fig. 3B

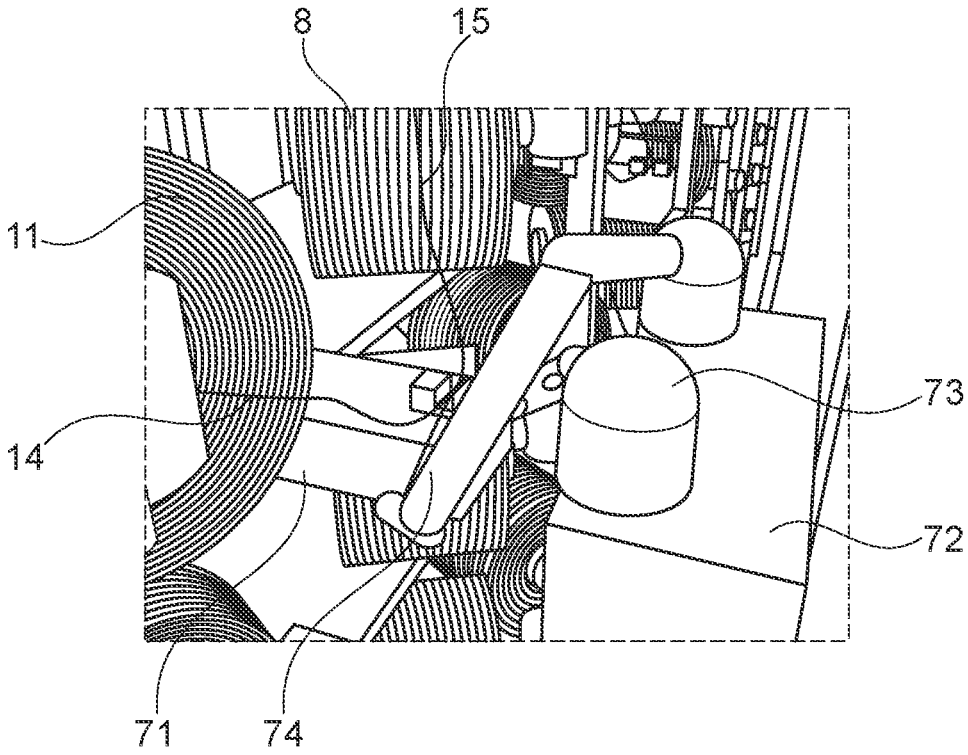


Fig. 3C

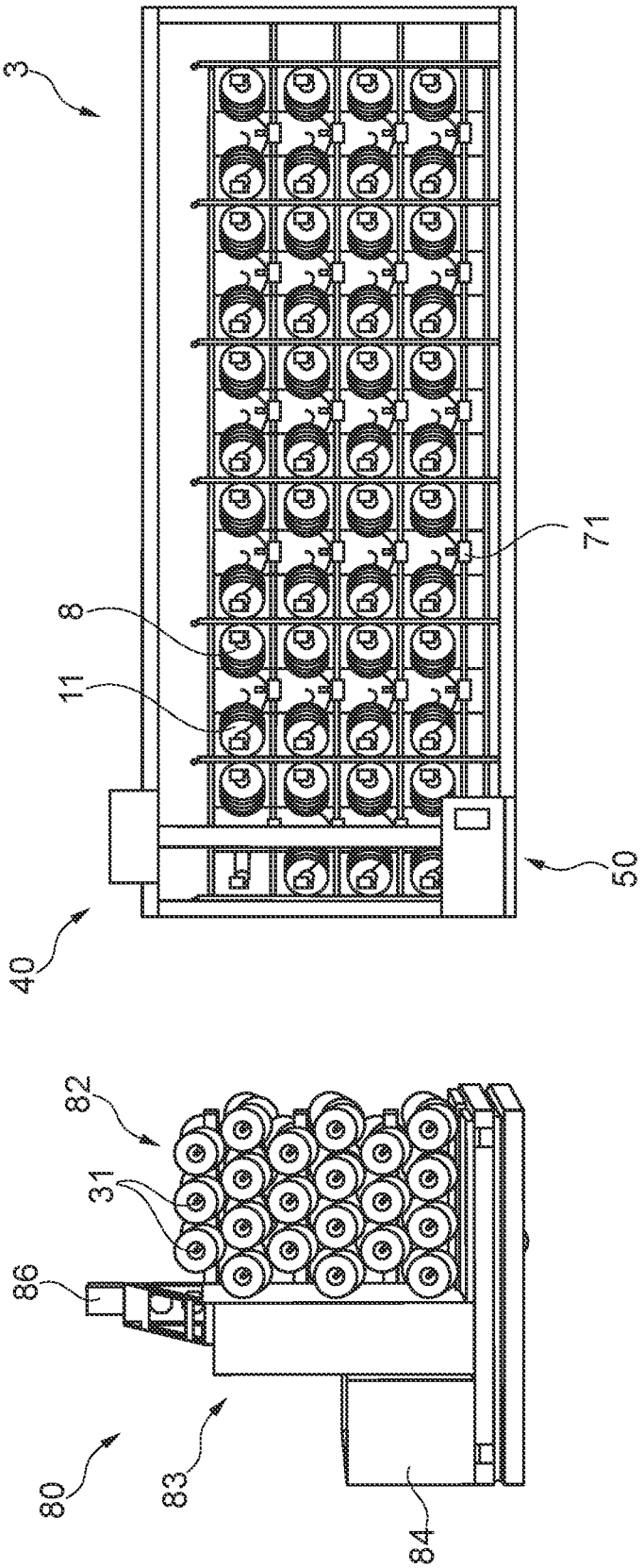


Fig. 4

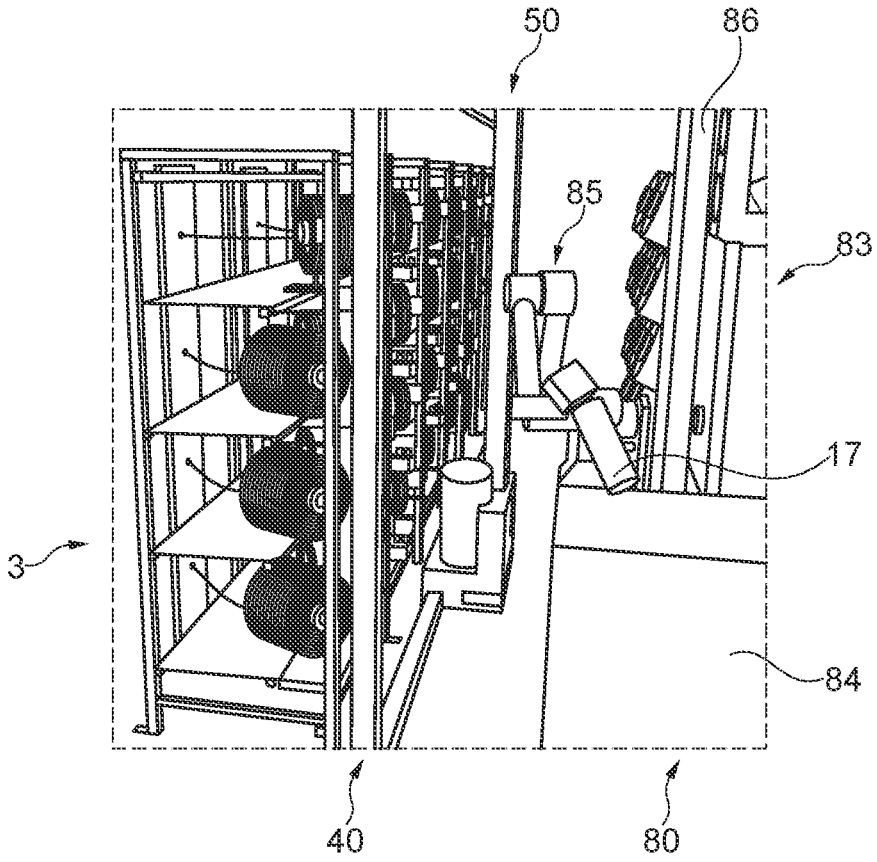


Fig. 4A

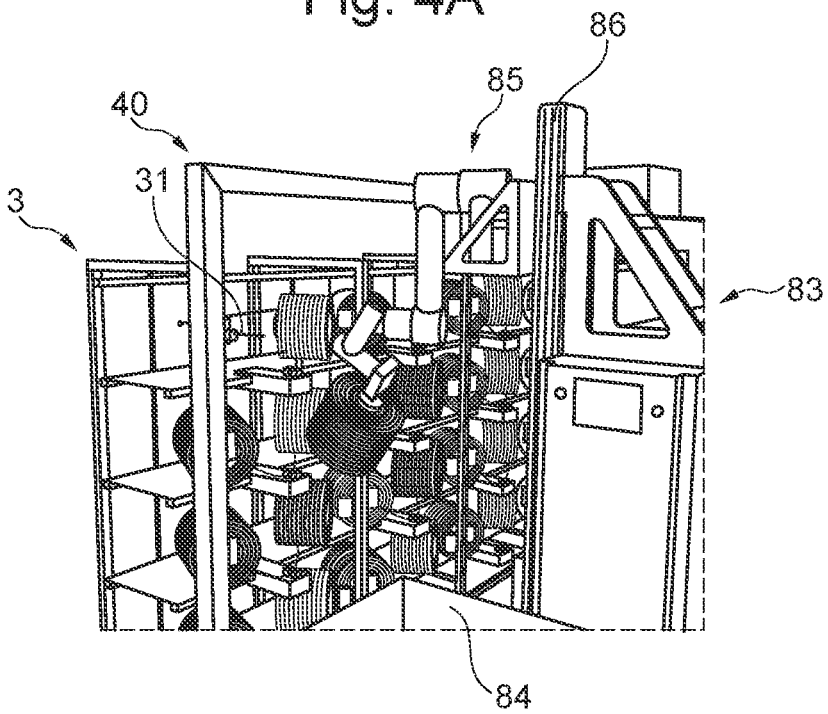


Fig. 4B

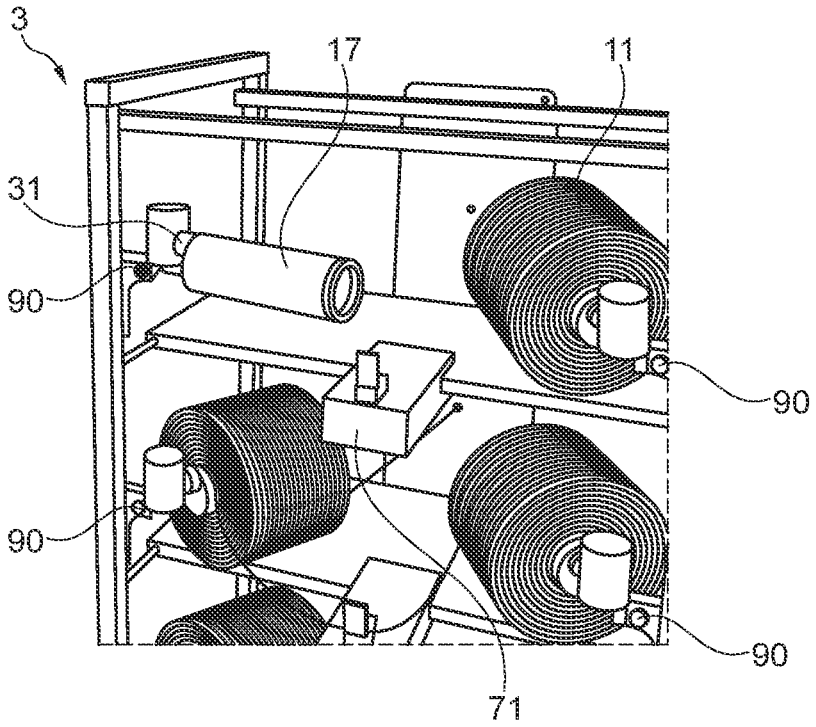


Fig. 4C

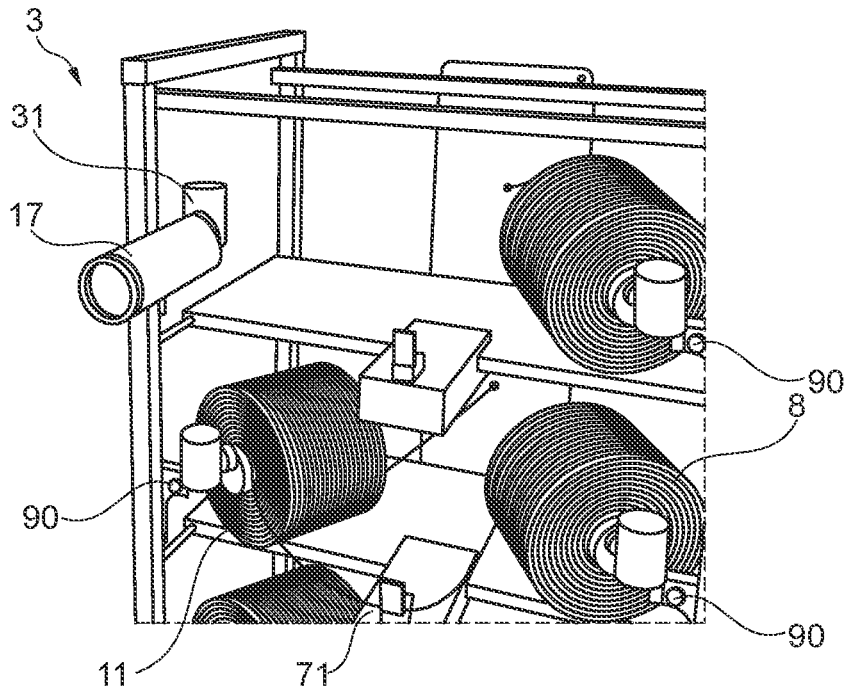


Fig. 4D

FEED YARN JOINING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This claims priority from Luxembourg Application No. LU502347, filed Jun. 23, 2022, the disclosure of which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to a feed yarn joining system for joining a yarn tail end of a yarn package to a yarn head end of a reserve package in the region of a package creel arrangement exhibiting at least two package storage sites for receiving the yarn package and reserve package. The invention also relates to a package creel arrangement with a feed yarn joining system and a method of joining a yarn tail end of a yarn package to a yarn head end of a reserve package by the feed yarn joining system.

BACKGROUND OF THE INVENTION

[0003] Package creels are normally used for receiving a plurality of fully wound feed yarn packages whose feed yarn is fed to a textile machine for the processing thereof. Such a package creel may be arranged on a cabling machine, as a web package creel or as a warping creel, for example. Such package creels have in common that they normally exhibit at least two package storage sites, for example bobbin mandrels—also referred to as creeling mandrels—for the accommodation of a feed yarn package each, wherein the first feed yarn package, from which the feed yarn underlying the process is drawn off, is referred to as a yarn package and the second feed yarn package, from which no yarn has yet been drawn off, is referred to as the reserve package. To achieve a continuous or uninterrupted unwinding operation after emptying or unwinding the yarn package, in advance of the unwinding the yarn tail end of the yarn package is joined to the yarn head end of the reserve package so that, following the joining of the yarns, the yarn from the reserve package immediately unwinds once the yarn unwinds from the yarn package. As soon as the yarn in the processing operation is drawn from the reserve package, the reserve package becomes the yarn package. The emptied yarn package or the yarn package tube is replaced by a new feed yarn package which correspondingly now forms the reserve package. The joining of the yarn head end of the reserve package to the yarn tail end of the yarn package is known to be achieved by a yarn joining device which is also known as a splicer.

[0004] The patents DE 2 048 529 A1 and EP 2 196 424 A1 both disclose a yarn joining device which can be displaced along at least one package creel by an operator. However, it is not possible to achieve a fully automatic splicing operation by this means. Manual splicers are also known which are carried and used by an operator to join the yarns.

SUMMARY OF THE INVENTION

[0005] An aspect of the invention is based on the problem to provide a feed yarn joining system which fully automatically joins the feed yarns arranged on the packages, in other words joins the yarn tail end of the yarn package to the yarn head end of the reserve package. Furthermore, an aspect of the invention is based on the problem to provide a package creel arrangement with a corresponding feed yarn joining system as well as a method for the fully automatic joining of the yarn head end of the reserve package to the yarn tail end of the yarn package by such a feed yarn joining system.

[0006] The feed yarn joining system according to an embodiment of the invention is used for joining the yarn tail end of a yarn package to the yarn head end of a reserve package, wherein the packages providing the feed yarn are taken up and mounted for this purpose in package storage sites of a package creel arrangement.

[0007] To join the yarn tail end of the yarn package to the yarn head end of the reserve package, the feed yarn joining system provides a yarn splicing device and a transport device. This yarn splicing device is a customary, generally known device which is sufficiently known as regards its structure and functioning. For example, the yarn splicing device may be a pneumatic yarn splicing device in which the yarns are spliced to one another by a pneumatic system. Alternatively, said yarn splicing device may be a thermal yarn splicing device wherein the yarns are spliced to one another by the application of heat. Also conceivable is a so-called wet splicer in which the yarn is joined by the application of a liquid or aerosol-containing gaseous fluid. A combination of such yarn splicing devices may also come into question, such as for example a pneumatic, thermal yarn splicer wherein a gaseous fluid warmed to a predetermined or predeterminable temperature is applied to and used for the yarn joining operation. The fluid may be selected as required from the quantity of known fluids suitable for yarn joining.

[0008] The transport device is used for detecting the yarn head end of the reserve package and the yarn tail end of the yarn package and transporting said packages into the yarn splicing device of the feed yarn joining system wherein the yarns are placed in position by the yarn splicing device in the customary manner by the use of a holding device, for example, and subsequently are prepared in a defined manner.

[0009] The transport device permits in detail the detection of the yarn tail end of the yarn package and the yarn head end of the reserve package and their reliable arrangement in the yarn splicing device, so that a reliable joining between the yarn tail end and the yarn head end can be achieved automatically by the yarn splicing device. By this a continuous, non-interrupted unwinding of the feed yarn can then be guaranteed and a standstill, and consequently a production interruption, can thereby be avoided. Overall, the feed yarn joining system according to an embodiment of the invention thus guarantees a reliable automatic joining of the yarn tail end of the yarn package to the yarn head end of the reserve package, and thus the non-interrupted operation of the workstation.

[0010] The provision of the transport device by which the yarn head end of the reserve package and the yarn tail end of the yarn package are detected and transported into the yarn splicing device, wherein a sensor system can be provided to detect the yarn tail end and/or the yarn head end, is achieved by a first receiving device to receive the yarn tail end of the yarn package and a second receiving device to receive the yarn head end of the reserve package in conjunction with a first positioning unit to position a yarn portion joined to the yarn head end in the yarn splicing device as well as a second positioning unit to position a yarn portion joined to the yarn tail end in the yarn splicing device. According to an embodiment of the invention, at least the first receiving unit and the first positioning unit or the second receiving unit and the second positioning unit provide a

suction unit, which can be a suction tube with a suction mouth, associated with the yarn package or with the reserve package respectively, each being displaceable between a receiving position and a depositing position, which can be displaceable in a linear manner or along a curve in the route and/or being pivotable.

[0011] In an alternative or additional manner, at least the first or second receiving unit is provided by a stationary or fixed suction unit, which can be a suction tube with a suction mouth, wherein the first or second positioning unit respectively associated with this receiving unit is displaceable between the receiving position and depositing position, being displaceable which can be in a linear manner or along a curve in the route and/or being pivotable. The first or second receiving unit respectively and the associated first or second positioning unit respectively are actively connected such that a yarn detected by the first or second receiving unit respectively is transferred or taken over by the associated first or second positioning unit respectively and can be positioned by it in the yarn splicing device. Such a functionally actively connected transport device is known in principle from open-end spinning machines, for example.

[0012] The use of a displaceable suction unit, which can be a suction tube with a suction mouth, for receiving the yarn tail end as well as the yarn head end, is characterised by the fact that it can be reliably guaranteed that by the multifunctionally designed suction unit the corresponding end of the yarn can be received in the yarn tail end receiving position and positioned in the yarn tail end receiving position in the yarn splicing device. The suction tube can have a sensor device for detecting yarn, by which it is possible to detect the arrangement of the one end of the yarn on or in the suction unit, which can be in the suction tube or in the region of the suction mouth, so that malfunctions can be reliably avoided both during receiving of the yarn end or yarn start, and in the arrangement of these on and in the yarn splicing device. Also, the suction unit can exhibit a clamping device for clamping the detected yarn inside the suction unit. Such clamping devices are well known, for example, from the area of take-up bobbins producing textile machines such as winding machines and open-end spinning machines.

[0013] To produce a high yarn joining quality of yarn tail end and yarn head end, it can be important to position the yarn tail end and yarn head end in the yarn splicing device, which can be inside a splicing channel of the yarn splicing device. According to a development of the invention, it is envisaged that the feed yarn joining system provides for a third and fourth positioning unit for the defined positioning of the opened ends of the respective yarn in the splicing prism. The third and fourth positioning unit serve respectively to pull the prepared ends of the respective yarns, as far as possible free of twist, in other words of the yarn tail end and yarn head end, so far into the splicing channel of the splicing prism that they are arranged substantially at the same level parallel alongside one another in the splicing channel, but are oriented in opposing directions. The third and fourth positioning units can each be provided such that they execute a defined withdrawal of the respective ends of the yarns such that these arrive parallel to one another in the splicing channel for arrangement as required. The third and fourth positioning units can also be part of the yarn splicing device.

[0014] The arrangement of the yarn splicing device, the first and second receiving unit and/or the first and second positioning unit in the region of the package creel arrangement can in principle be done in any way and quantity. According to a development of the invention, it is envisaged that they are arranged on a common carrying frame. The common carrying frame may be that on which the package storage sites are arranged in order to receive the feed and reserve packages. As an alternative, the common carrying frame may differ from this. The arrangement on a common carrying frame allows it to be positioned jointly in respect of the package creel or the yarn package and reserve package arranged on the package creel, so that the yarn tail end of the yarn package can be reliably joined to the yarn head end of the reserve package by the feed yarn joining system. According to an embodiment, the carrying frame may be arranged stationary in the region of the package storage sites, or according to an alternative embodiment in which the common carrying frame is different to the carrying frame holding the package storage sites, the latter may be displaced along the package creel, so that it can then be used as required at selected package storage sites of the package creel to join the yarn head end of a reserve package and the yarn tail end of a yarn package. The carrying frame according to another embodiment can be provided such that it forms a two-dimensional guide system exhibiting a guide frame tensioning a displacement plane within which guide frame the common carrying frame can be moved in a defined manner, and which can be displaced. In other words, the guide frame can form an x-y displacement plane for the common carrying frame.

[0015] Also, the common carrying frame can be fixed to the package creel or can be fixable and releasable non-destructively or may be a fixed part of the package creel.

[0016] In the case of the advantageously envisaged provision of the first and second receiving unit as suction units to receive the yarn tail end or yarn head end at the yarn package or reserve package respectively, and which can be for their displacement into the yarn splicing device, it is necessary to supply the suction units with corresponding suction air. Basically according to an embodiment it is possible to equip the feed yarn joining system with a corresponding suction device comprising a source of suction air.

[0017] According to an alternative embodiment of the invention, the feed yarn joining system may exhibit a coupling unit for connection to a source of suction air. According to this embodiment of the invention, the feed yarn joining system can if necessary be connected via the coupling unit with, for example, a central exhaust suction device to the package creel or to a textile machine, so that a separate suction device for the feed yarn joining system can be avoided. Additionally, this embodiment of the invention permits the feed yarn joining system to be mobile subject to the package creel or textile machine having connection possibilities to the exhaust suction device in order to supply the feed yarn joining system. The feed yarn joining system may be supplied with suction air via the coupling unit, if required.

[0018] According to a further embodiment of the invention, it is envisaged that the yarn splicing device, the first and second receiving unit and/or the first and second positioning unit are mounted adjustably on the common carrying frame. According to this embodiment of the invention, the individual units are displaceable on the common carrying frame, for example adjustable together in one plane in their position

relative to one another, so that these can be positioned optimally with respect to the package storage sites and the feed yarn packages stored by the package storage sites, so that it is possible in a reliable manner to join the yarn tail end to the yarn head end.

[0019] According to a further development, a plurality of yarn splicing devices, first and second receiving units and first and second positioning units are arranged on the carrying frame, the arrangement being such that each package creel level having at least a yarn package and reserve package can be assigned or delivered one of the yarn splicing devices, first and second receiving units and first and second positioning units for a yarn joining operation. It is further contemplated that the number of yarn splicing devices, first and second receiving units and first and second positioning units are assigned to a number of bobbin creel levels in which at least one yarn package and associated reserve package are arranged. Corresponding to the number of bobbin creel levels or the levels each of which has at least one arrangement comprising yarn package and associated reserve package, these can thus be assigned a yarn splicing device, first and second receiving unit and first and second positioning unit. For example, the bobbin creel may comprise three bobbin creel levels with at least one yarn package and associated reserve package, wherein each level is assigned a yarn splicing device, a first and second receiving unit and a first and second positioning unit for executing the splicing operation of the yarn tail end of the yarn package with the yarn head end of the reserve package.

[0020] To control the units of the feed yarn joining system, a control unit is provided which according to a further embodiment of the invention is connected for communication purposes to a further control unit such as, for example a package creel control unit, a control unit of a handling unit handling the package creel or a control unit superordinate to the package creel. The connection for communication purposes may normally be implemented by cable and/or wirelessly. A communication link between the control units allows recourse the existing electronic units of the package creel such as, for example, to a sensor system linked to the package creel control unit. By this it is possible to improve the handling of the yarns to be joined such as, for example, when catching the ends of the yarns and transferring them into the yarn splicing device. In an alternative embodiment of the invention, the control unit of the feed yarn joining system is integrated into the package creel control unit, into the other control unit, or into the superordinate control unit, so that it is quite possible to do without a separate control unit.

[0021] The control unit is provided to initiate the start of the splicing operation and to execute the splicing operation by correspondingly activating the first and second receiving unit, the first and second positioning unit and the yarn splicing device in a defined manner by the control unit. The initiation of the start of the splicing operation is based on triggering information. This type of triggering information may be generated automatically by the control unit according to an embodiment. According to an alternative embodiment, the triggering information can be directed to the control unit. Such triggering information may be determined according to requirements. For example, such triggering information may consist of information about a calculated time of the unwinding or emptying of the yarn package, about an observed unwinding of the yarn package which has taken place, or about a planned or executed equipping of a package storage site with a yarn package or reserve package. By initiating the process, the feed yarn joining system can be reserved promptly for the implementation of at least one splicing operation. According to an embodiment, the control unit is provided to use the initiation of the start of the splicing operation to set a defined number of splicing operations and/or a defined sequence of splicing operations to be undertaken.

[0022] According to an embodiment, the control unit is linked for communication purposes with an input unit, via which an operator manually triggers a signal to the control unit to initiate the start of the splicing operation. The transmitted triggering signal accordingly contains the triggering information sent to the control unit to initiate the start of the splicing operation.

[0023] The triggering information may generally contain information on the site or the working position of the package creel at which the splicing operation is to be executed. Alternatively, this information can be transmitted separately before, simultaneously with, or after the generation or transmission of the triggering information of the control unit. The information about the site or working position of the package creel can be entered manually by the operator at the input unit or generated by way of automatically detected site or position information regarding the future or already effected unwinding of a yarn package. In addition, the site or position information may be transmitted additionally or alternatively to a control unit of a unit transporting the feed yarn joining system, such as for example the above-described movable carrying frame or may be set by it automatically.

[0024] According to a further embodiment of the invention, a driverless transport vehicle is provided on which at least the first and second receiving unit as well as the first and second positioning unit, and further possibly the yarn splicing device, are arranged. The driverless transport vehicle according to an embodiment of the present invention is provided to drive to the yarn package autonomously in order to execute the splicing operation and in which can be to automatically set its destination—in other words, which yarn package it should travel to. Driverless transport vehicles are well known. They are controlled in a collective, centrally or individually, in order to travel to defined positions or sites. In the case of collective control, at least two driverless transport vehicles are linked for communication purposes with one another so that any destinations within the collective are coordinated and set for the individual transport vehicles. For this, each driverless transport vehicle has a control unit wherein the control units of the transport vehicles are interlinked for communication purposes without the integration of superordinate control being necessary in order to exchange information for the coordinated and efficient setting of destinations and travel to them. Conversely, the destinations and also the travel routes of the driverless transport vehicles in the case of central control are coordinated by it. Alternatively, each driverless transport vehicle can be equipped to automatically set its destination and travel route. This may be achieved if the driverless transport vehicle has a sensor system by which the package creel checks for imminently unwinding feed yarn packages, whereupon the sensor system also is linked for communication purposes to the control unit of the driverless transport vehicle and the control unit is designed, based on the

information detected by the sensors, to analyse and determine for which yarn package when and which action is to be carried out, for example the next action such as splicing. Alternatively or additionally, this information can be transmitted according to a further embodiment by a control unit which is arranged outside the driverless transport vehicle and is linked for communication purposes to the control unit of the driverless transport vehicle.

[0025] According to a further embodiment, the driverless transport vehicle has a package changeover unit with a gripper unit for loading and unloading the package creel. The gripper unit is movable in multiple dimensions on the driverless transport vehicle in order for example to fill the package storage sites as required with new feed yarn packages or to remove empty feed yarn packages. By this, further automation of the process can be achieved. Such a gripper unit is sufficiently well known. In this case, the gripper unit may be provided in a further development to initially pull off an unwinding aid that is detachably attached to the tube during the loading and unloading of the package creel before removing an unwound yarn package or its tube from the package creel, to temporarily store it at a defined site and, after filling the package storage site with a reserve package, to remove the unwinding aid from the intermediate buffer and place it on the reserve package or the tube thereof. The unwinding aid is a yarn guide which can be detachably fixed to the tube end of the yarn package or reserve package and by which the yarn of the yarn package can be guided in an improved manner and pulled from it. The intermediate buffer is a device which is suitable to temporarily receive the unwinding aid. The intermediate buffer can be arranged on the package creel and/or on the driverless transport vehicle.

[0026] Furthermore, the driverless transport vehicle may be equipped with a package buffer which has at least two package storage sites which each are provided for storing a feed yarn package, whether filled or empty. A package storage site can be provided with a filled feed yarn package while the other package storage site is free. By this it can be ensured that as part of the execution of a splicing operation a full feed yarn package or yarn package is available and arranged in the package creel, and the unwound yarn package or yarn package tube can be removed.

[0027] According to an embodiment of the present invention, the package storage site which carries the filled feed yarn package can be provided by a normal bobbin mandrel, which further can be equipped with retractable and extendable clamping elements in order to reliably hold the feed yarn package or package tube. The package storage site, which is designed to receive the empty feed yarn package or unwound yarn package or package tube respectively, can be provided by a package container which can receive at least one or a defined number of unwound package tubes. Alternatively, the package storage site which receives the unwound package tube can also be provided by a normal bobbin mandrel and consequently can also store filled feed yarn packages.

[0028] According to a further embodiment, the package buffer with the package storage sites and/or each individual package storage site can be manually or automatically arranged rotatably on the driverless transport vehicle. This permits improved access to individual package storage sites, notably if a plurality of package storage sites are provided. The automated rotational movement can be initiated by a control unit which can be an additional control unit arranged on the driverless transport vehicle, the control unit of the driverless transport vehicle and/or a control unit sited externally. To execute the rotational movement a drive arranged on the driverless transport vehicle, which can be a rotary drive, may be provided which is linked for communication purposes to the control unit. Alternatively or additionally, according to an embodiment the rotational movement may be initiated via the gripper unit, which moves the package buffer, for example, from a defined resting position into another. For this, the package buffer can have a rotary bearing with defined resting positions.

[0029] An embodiment of the invention also solves the problem by a package creel arrangement with a package creel comprising at least two package storage sites, one package storage site for receiving a yarn package and the other package storage site for receiving a reserve package, wherein the package creel arrangement exhibits a feed yarn joining system in a manner according to an embodiment of the invention as described above, or in a further developed manner. A corresponding package creel arrangement is characterised by the fact that the processing effort does not come to a standstill after the unwinding or emptying of a yarn package as the yarn tail end of the yarn package is promptly reliably linked to the yarn head end of a reserve package.

[0030] The package storage sites can be provided as required. In principle, each package storage site is to be provided such that at least one yarn package can be received and after emptying can be replaced by a new feed yarn package. Each package storage site can have in known manner a bobbin mandrel which is provided for interacting with a feed yarn package.

[0031] According to an embodiment, each package storage site has a signal unit for signalling a current operating state with reference to the unwinding characteristics of the yarn package stored on the package storage site. The signal unit can be a display unit by which the current operating state can be displayed visually, for example by the use of different light colours, light pulses, letters, symbols, graphics and/or codes, which can be machine-readable codes. A colour display by which the proper operation of the unwinding of the yarn package can be indicated by a first light colour, for example a green light, an unwinding malfunction is indicated by a second light colour different from the first light colour, which can be an orange or yellow light, and an unwinding interruption is indicated by a third light colour different to the first and second light colour, which can be a red light. The colour display can be a multi-coloured LED unit.

[0032] According to an embodiment of the invention, each package storage site, which can be each bobbin mandrel, can be moved, and which can be pivoted, between an operating position and a changeover position. This permits the optimal orientation of the feed yarn joining system with respect to the package storage sites or bobbin mandrels and the feed yarn packages stored therein or arranged thereon. The mobility, which can be the ability to pivot, between the operating position and the changeover position, by which improved accessibility is possible from outside the package creel arrangement, permits where necessary simply and conveniently by the removal of empty package tubes and their manual or automatic equipping with full or wound feed yarn packages. The rotary movement can be achieved in a manner as described above for the package buffer or by generally known methods.

[0033] It is further contemplated for the bobbin creel to provide a sensor system to detect the emptying of a yarn package and/or a changeover of the running yarn from an unwinding yarn package to a reserve package, which then defines the yarn package, and/or the position of the bobbin mandrel. The sensor system may, for example, consist of sensors assigned to each package storage site or pair of package storage sites provided for storing a yarn package and associated reserve package, or a sensor monitoring all the package storage sites or a plurality of sensors monitoring a defined number of package storage sites. For example, this may comprise one or more cameras. By this the emptying of a yarn package and thus the necessity for the replacement of the empty yarn package by a reserve package may be recognised promptly and reliably. The sensor system can be linked for communication purposes with a control unit, which initiates the swivelling of the bobbin mandrel carrying the empty yarn package. The position of the bobbin mandrel may also be monitored by the sensor system. The control unit may be the package creel control unit, the control unit of the handling unit handling the package creel, or the control unit superordinate to the package creel. Furthermore, the sensor system may be linked to the display unit described above for communication purposes. By this the display unit can be caused, for example, to display or signal in colour the emptying of the yarn package.

[0034] According to a further aspect of the present invention, the problem is solved by a method of joining a yarn tail end of a yarn package to a yarn head end of a reserve package in the region of a package creel arrangement exhibiting at least two adjacent package storage sites for receiving the yarn package and reserve package by a previously described feed yarn joining system according to an embodiment of the invention or a further development thereof. The method has the following steps:

[0035] initiate the splicing operation,

[0036] activate the first and second receiving unit for seeking and receiving the yarn tail end of the yarn package and the yarn head end of the reserve package,

[0037] activate the first and second positioning unit for positioning the received yarn tail end and received yarn head end in the yarn splicing device,

[0038] activate the yarn splicing device for preparing the yarn tail end and yarn head end by the yarn tail end preparation system associated with the yarn splicing device, and

[0039] activate the yarn splicing device for joining the prepared yarn tail end and yarn head end.

[0040] For seeking the yarn tail end of the yarn package and the yarn head end of the reserve package, corresponding sensors may be used for example, which specify the corresponding positioning of the ends of these yarns to the feed yarn joining system, so that they can be detected by the envisaged suction units, received there and transferred into the yarn splicing device by the positioning units. With the positioning units, the respective ends of the yarns are transferred into the yarn splicing device in which they are prepared in known manner, which can be selected, then cut to length and which can be opened via a suitable yarn tail end preparation system, i.e. they are prepared such that they are to the greatest extent freed of their yarn twist.

[0041] To produce the optimal yarn join, the prepared yarn tail end and prepared yarn head end are subsequently drawn far enough into the splicing channel of the splicing prism of the yarn splicing device to allow them at approximately the same level parallel to one another to be arranged in the splicing channel, but exhibiting an opposing orientation. Subsequently in a pneumatically designed yarn splicing device compressed air is fed into the splicing channel via a corresponding inlet opening, this air resulting in an interlacing of the fibres of the two ends of the yarns, by which a yarn join, and thus a continuous yarn, is produced.

[0042] According to an embodiment of the method, promptly before or at the same time as the step of initiating the splicing operation a step takes place involving the filling, which can be immediately beforehand, of an emptied package storage site with a reserve package.

[0043] Generally the filling of an emptied package storage site can take place at any time, but promptly before the time of achieving the full unwinding or emptying of the yarn package. By "promptly", such sufficient advance time before the moment of achieving the full unwinding or emptying of the yarn package is meant, so that before the time of achieving the complete unwinding or emptying of the yarn package in any case the steps of filling the emptied package storage site and the steps of effecting the spliced join between the yarn tail end of the yarn package and the yarn head end of the reserve package have taken place. Only in this way can it be reliably ensured that the yarn tail end of the yarn package is joined to the yarn head end of the reserve package well before the complete unwinding or emptying of the yarn package, by which a production interruption can safely be avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] Embodiment examples of the invention are explained below with reference to the drawing. The drawing shows:

[0045] FIG. **1** a schematic illustration of a side view of a cabling machine provided on both sides with workstations in the longitudinal direction of the machine,

[0046] FIG. **2** a schematic illustration of a rear view of a package creel with a plurality of package storage sites,

[0047] FIG. **3** a schematic illustration of a perspective view of the package creel shown in FIG. **2** with a service unit which can travel along the package creel,

[0048] FIG. **3**A a schematic illustration of an enlarged perspective view of a working position of the service unit shown in FIG. **3**,

[0049] FIG. **3**B a schematic illustration of an enlarged perspective view of a further working position of the service unit shown in FIG. **3**,

[0050] FIG. **3**C a schematic illustration of an enlarged perspective view of an additional working position of the service unit shown in FIG. **3**,

[0051] FIG. **4** a schematic illustration of a perspective view of the package creel shown in FIG. **3** with a driverless transport vehicle operating the package creel,

[0052] FIG. **4**A a schematic illustration of a perspective view of a working position of the driverless transport vehicle shown in FIG. **4**, and

[0053] FIG. **4**B a schematic illustration of a perspective view of a further working position of the driverless transport vehicle shown in FIG. **4**,

[0054] FIG. **4**C a schematic illustration of an enlarged perspective view of an intermediate position of a package storage site of the package creel shown in FIG. **3**,

[0055] FIG. **4**D a schematic illustration of an enlarged perspective view of a changeover position of the package storage site of the package creel shown in FIG. **3**.

DETAILED DESCRIPTION

[0056] In the following description of embodiment examples, the same or similar reference signs are used for the elements shown in the various figures that have a similar action, in which case the descriptions of these elements are to a large extent not repeated.

[0057] FIG. **1** shows an embodiment example of the present invention. In a schematic illustration, a side view of a textile machine provided as a cabling machine **1** is shown with workstations on both sides in the longitudinal direction of the machine, on whose upper side the package creels **3** which operate the respectively opposing machine sides are pivotably mounted. The package creel **3** associated with an individual cabling spindle **2** is, for example, mounted pivotably by a four-arm joint **4** on the upper side of a machine frame **5**.

[0058] The package creel **3** contains a carrying plate **6** on which to both sides respectively a substantially vertically oriented holding plate **16** is fastened which bears two vertically superimposed and forwardly oriented creeling mandrels defining package storage sites **31** for fitting on to a feed yarn package provided as a yarn package **11** and a feed yarn package provided as a reserve package **8**. The creeling mandrels are positioned to rise obliquely at the front at an angle in the region of 5° to 10° from the horizontal, in order to ensure a secure seating of the fitted-on feed yarn packages **8**, **11**.

[0059] On the carrying plate **6**, a support arm **9** is fixed with a forward orientation which carries a yarn deflection eye **10** in order to deflect the yarn **14** drawn from the yarn package **11** to the lower machine region of the workstation, i.e. towards the cabling spindle **2**. Corresponding with the normal cabling process, this yarn **14** is united with the yarn **15** in the region of a yarn guide eye, said yarn **15** being pulled overhead from a feed yarn package located inside the cabling spindle **2**. Above the cabling spindle **2** there are customarily mounted a yarn delivery unit **12** and a yarn winding unit **13**.

[0060] On the support arm **9**, a feed yarn joining unit **7** of the feed yarn joining system is arranged which here exhibits a (not shown) yarn splicing device as well as a transport device for receiving the yarn head end of the reserve package **8** and the yarn tail end of the yarn package **11**. The transport device comprises a first and second receiving unit for receiving a yarn head end of the reserve package **8** and a yarn tail end of the yarn package **11**. Furthermore, the transport device is equipped with a first and second positioning unit by which the received ends of the yarns can be arranged in a (also not shown here) yarn splicing device of the feed yarn joining unit **7**. The yarn splicing device is equipped in the normal manner for preparing and joining the ends of the yarns. For example, a preparation unit for the defined preparation and opening of the ends of the yarns as well as a splicing channel to which compressed air can be applied with a splicing prism is provided for the pneumatic interlacing of the yarn tail ends arranged in the splicing channel. Furthermore, the yarn splicing device comprises a holding unit for setting the starts and ends respectively of the yarns as well as a further positioning unit, by which before being joined the starts and ends respectively of the yarns can be withdrawn in a defined manner so that they are arranged adjacent to one another in the splicing channel.

[0061] To guarantee continuous processing without a standstill of the workstation of the cabling machine **1** in the event the yarn package **11** is emptied, the yarn tail end **11**A of the yarn package **11** and the yarn head end **8**A of the reserve package **8** are detected by the feed yarn joining system through (not shown) first and second receiving units and placed in the yarn splicing device by the first and second positioning unit where they are joined to one another in the known manner. After the full unwinding of the yarn **14** from the yarn package **11**, the remaining empty package tube is then removed and a full feed yarn package fitted on, whose yarn head end can be joined by the feed yarn joining system to the yarn tail end of the yarn package previously serving as the reserve package **8**.

[0062] FIGS. **2** to **6** illustrate further embodiments. FIG. **2** shows in this connection a schematic illustration of a rear view of a package creel **3** serving a web machine, for example, with a plurality of package storage sites **31**, wherein respective package storage sites **31** are provided as creeling mandrels for receiving a feed yarn package, wherein depending on the use the feed yarn package defines the yarn package **11** or the reserve package **8**.

[0063] The package creel **3** is provided by a frame with several spaced frame elements **32** and vertical frame elements **33**, wherein intermediate spaces included by the horizontal and vertical frame elements **32**, **33** form working positions in which a yarn package **11** and a reserve package **8** are arranged respectively. Respective package storage sites **31** or creeling mandrels respectively are arranged on the vertical frame elements **33** in a manner opposing the intermediate space. By this the existing construction area of the intermediate space can be used efficiently and the intermediate space can be kept as small as possible.

[0064] In a respective intermediate space or at a respective working position, a yarn splicing device **71** is arranged associated with a feed yarn joining system according to an embodiment, said yarn splicing device **71** being fixed to the horizontal frame elements **32** in the intermediate space centrally between the package storage sites **31** for the more efficient use of the construction area. Other arrangements of the package storage sites **31** and the yarn splicing device **71** in a respective intermediate space are conceivable, but necessitate a larger construction area. The yarn splicing device **71** may furthermore as an alternative be arranged outside the intermediate space at another unit, as described in more detail with a further embodiment by way of example (not shown).

[0065] FIG. **3** shows the package creel **3** illustrated in FIG. **2** with a carrying frame **40** that is arranged opposing the package creel **3** which provides a guide frame for a service unit **50** serving all working positions of the package creel **3**. The service unit **50** is arranged displaceably on the carrying frame along the package creel **3** inside a travel plane tensioned by the guide frame.

[0066] As is shown in detail in FIGS. **3** to **3**C, the service unit **50** has a vertical guide **51** on which a carrying unit **72** associated with the feed yarn joining system is arranged displaceably in the vertical direction. The carrying unit **72** bears a jointed first suction unit **73** and a separate jointed second suction unit **74**, which are each provided to rotate or pivot respectively around a rotational axis running parallel to the travel axis of the carrying unit **72**. The first suction

unit **73** and second suction unit **74** are provided to detect the yarn head end **8**A of the reserve package **8** and the yarn tail end **11**A of the yarn package **11**, to receive it and to position it in defined manner in a splicing prism **71**A of the yarn splicing device **71**. The first suction unit **73** and second suction unit **74** accordingly form a first and second receiving unit respectively as well as a first and second positioning unit respectively in the sense of an embodiment of the present invention.

[0067] FIG. **4** shows a schematic illustration of a perspective view of the package creel **3** shown in FIG. **3** with a driverless transport vehicle **80** serving the package creel **3**. The transport vehicle **80** comprises a wheeled transport platform **81** on which a package buffer **82** is arranged with a plurality of package storage sites **31** which are each equipped with feed yarn packages. The package storage sites **31** of the package buffer **82** are provided by inclined creeling mandrels which are arranged on a package buffer carrying frame.

[0068] The transport platform **81** also bears a package buffer **82** in the form of a container **84** which can be for receiving package tubes **17** or emptied yarn packages **11** respectively. Between the container **84** and the package buffer **82** there is a handling unit **83** for handling the package buffer **82**, the feed yarn packages **8** received therein, the container **84** and the package tubes **17** to be placed therein. The handling unit **83** has a multi-jointed gripper unit **85** such as a robot arm, for example, which can be displaced in linear manner in the vertical direction along a guide rail **86** of the handling unit **83** (FIGS. **4**A and **4**B).

[0069] As shown in FIGS. **4**A and **4**B, a package storage site **31** of the package creel **3** can be operated by the handling unit **83**, in that a package tube **17** is gripped by the gripper unit **85** and placed in the container **84**. Subsequently, the gripper unit **85** detects a feed yarn package from the package buffer **82** of the transport vehicle **80** in order to place it on the empty package storage site **31** on which previously the package tube **17** was mounted. The newly placed feed yarn package in this case forms the reserve package **8** at the working position of the package creel **3**, whose yarn head end **8**A is subsequently joined by the feed yarn joining system in a manner as described above to the yarn tail end **11**A of the adjacent yarn package **11** at the working position of the package creel **3**.

[0070] The respective package storage site **31** of the package creel **3**, as shown in FIGS. **4**C and **4**D, is pivotable from an operating position into a changeover position. FIG. **4**C shows an intermediate position of the package tube **17** as well as an operating position of the adjacent yarn package **11** at the working position of the package creel **3**. The intermediate position is consequently a position between the operating position and the changeover position shown in FIG. **4**D.

[0071] FIGS. **4**C and **4**D further show that the package storage sites **31** are equipped with a display unit **90** for displaying the current operating state. The display unit **90** of the package storage site **31**, which bears the empty package tube **17**, is set to red light, in contrast to which package storage sites **31** equipped with feed yarn packages show a green light. The red light display enables direct signalling and recognition of a package storage site **31**, at which a new feed yarn package is to be equipped. The green light signals a proper operating state at the respective package storage site **31**.

[0072] Alternatively, the display unit **90** is used according to an embodiment (not shown) for displaying the current operating state of the respective package storage site **31** or the working position of the package creel **3** respectively. Thus the package storage sites **31** equipped with feed yarn packages are displayed with green light, wherein proper operation of the yarn package **11** in the form of its unwinding and proper operation of the reserve package **8** in the form of an existing yarn join between the yarn tail end **11**A of the yarn package **11** and the yarn head end **8**A of the reserve package **8** is displayed. The yellow light or orange light display the package storage sites **31** equipped with feed yarn packages in which a yarn join between the yarn head end **8**A and the yarn tail end **11**A has not been made or still needs to be made. Package storage sites **31** set to a red light indicate emptied yarn packages **11** and/or missing feed yarn packages.

[0073] According to an embodiment which is not shown, the feed yarn joining system alternatively to the embodiment examples described above may be realised in that at least a yarn splicing device **71** is provided on the service unit **50** by which the quantity of yarn splicing devices **71** required for the package creel **3** can be reduced considerably. In this alternative embodiment, the yarn splicing device **71** is positioned between the first suction unit **73** and the second suction unit **74** in order to allow easy parallel placement of the yarn portions of the yarns **14**, **15** of the yarn package **11** and of the reserve package **8** in the splicing prism **71**A of the yarn splicing device **71**. The yarn splicing device **71** with the first suction unit **73** and the second suction unit **74** is provided displaceably on the vertical axis of the service unit **50** in order to be able to service different levels of the package creel **3**, in which a plurality of pairs of package storage sites are arranged to receive respectively a yarn package **11** and a reserve package **8** adjacent thereto. Alternatively, the service unit **50** may exhibit a plurality of yarn splicing devices **71** arranged on the service unit **50** with an associated first suction unit **73** and second suction unit **74**, wherein the number can correspond to the number of package creel levels in which in the horizontal direction a plurality of yarn packages **11** and adjacent reserve packages **8** are arranged, in this case four levels. Each package creel level is thus assigned a yarn splicing device **71** with a first suction unit **73** and a second suction unit **74** for executing a splicing operation. By this the times taken for conducting various splicing operations can be reduced and consequently productivity increased. The yarn splicing device **71** and the associated first suction unit **73** and second suction unit **74** can be relatively displaceable in respect of one another in order to further increase the efficiency of the splicing operation. For example, the yarn splicing device **71** may be displaceable on the vertical axis in a defined manner, in order to bring the yarn portions tensioned by the first suction unit **73** and second suction unit **74** into the splicing channel of the yarn splicing device **71**.

[0074] According to a further, alternative embodiment (not shown), at least the feed yarn joining unit **7**, provided by the yarn splicing device **71** and the transport device comprising the first and second receiving unit as well as the first and second positioning unit, is arranged on the driverless transport vehicle **80**. By this the service units **50** to be provided for each package creel **3** may be dispensed with.

[0075] The feed yarn joining system comprises a control unit (not shown) which is coupled by wire or wirelessly at

least to the components which are to be activated of the feed yarn joining unit **7**. To execute the splicing operation, the control unit is provided by corresponding activation of the first and second receiving unit, the first and second positioning unit and the yarn splicing device **71**. The control unit may be positioned as needed. According to an embodiment, the control unit is integrated into the control unit of the package creel **3** or forms a common control unit with it. According to a further embodiment, the control unit is arranged on the service unit **50** and is arranged according to a further alternative embodiment on the driverless transport vehicle **80**. In a further alternative, the control unit is integrated into the control unit of the service unit **50** or the driverless transport vehicle **80** or forms a common control unit with it. The control unit according to a further embodiment forms an integral part of a mobile terminal that is carried and/or operated by an operator.

[0076] Independently of the arrangement site, the control unit is provided to initiate or cause the splicing operation to start based on its own analysis or after receiving a triggering signal. According to one embodiment, the control unit is designed to undertake an analysis of received information based on which a time for unwinding or emptying the yarn package **11** can be predicted or determined. Depending on the information from this analysis, the control unit initiates the start of the splicing operation. The start of the splicing operation can be initiated at a point which is sufficiently distant from the time of achieving the unwinding or emptying of the yarn package **11**, in order to guarantee the continuous operation of the working position. For example, the start of the splicing operation is initiated immediately on receiving the information that a package storage site **31** of the package creel **3** has been equipped with a new feed yarn package. Alternatively, the control unit is coupled to an investigative unit which determines the quantity of yarn present on the yarn package **11**, based on which an unwinding time for the yarn package **11** is determined, depending on which the splicing operation is initiated by the control unit.

[0077] The feed yarn joining system automatically enables the initiation and execution of the splicing operation, wherein after initiating the splicing operation the first and second receiving unit are activated to seek and receive the yarn tail end **11**A of the yarn package **11** and the yarn head end **8**A of the reserve package **8**. The first and second positioning unit are then activated for positioning the received yarn tail end **11**A and the received yarn head end **8**A in the yarn splicing device **71**. Subsequently, the yarn splicing device **71** is activated to prepare the yarn tail end **11**A and the yarn head end **8**A by the yarn tail end preparation system associated with the yarn splicing device. Finally, the yarn splicing device **71** is activated to join the respectively prepared yarn tail end **11**A to the yarn head end **8**A.

List of reference signs

1	Cabling machine
2	Cabling spindle
3	Package creel
4	Four-arm joint
5	Machine frame
6	Carrying plate
7	Feed yarn joining unit

-continued

List of reference signs

8	Reserve package
8A	Thread start at reserve package
9	Support arm
10	Yarn deflection eye
11	Yarn package
11A	Yarn tail end of yarn package
12	Yarn delivery unit
13	Yarn winding unit
14	Yarn of yarn package
15	Yarn of reserve package
16	Holding plate
17	Package tube
31	Package storage site
32	Horizontal frame element
33	Vertical frame element
40	Carrying frame
50	Service unit
51	Vertical guide
71	Yarn splicing device
71A	Splicing prism
72	Carrying unit
73	First suction unit
74	Second suction unit
80	Driverless transport vehicle
81	Transport platform
82	Package buffer
83	Handling unit
84	Container
85	Gripper unit
86	Guide rail
90	Display unit

1. A feed yarn joining system for joining a yarn tail end of a yarn package to a yarn head end of a reserve package in a region of a package creel arrangement having at least two adjacent package storage sites for receiving the yarn package and the reserve package, the feed yarn joining system comprising:

a first receiving unit for receiving the yarn head end of the reserve package;

a second receiving unit for receiving the yarn tail end of the yarn package;

a first positioning unit for positioning a yarn head portion joined to the yarn head end in a yarn splicing device;

a second positioning unit for positioning a yarn tail portion joined to the yarn tail end in the yarn splicing device;

the yarn splicing device, is provided to prepare the yarn head end and the yarn tail end and splice them together during a splicing operation; and

a control unit for executing the splicing operation by a corresponding activation of the first receiving unit, the second receiving unit, the first positioning unit, the second positioning unit and the yarn splicing device;

wherein the control unit is provided to initiate a start of the splicing operation.

2. The feed yarn joining system according to claim **1**, wherein the control unit is linked for communication purposes to an input unit via which an operator manually triggers a signal to the control unit to initiate the start of the splicing operation.

3. The feed yarn joining system according to claim **1**, wherein the control unit is linked for communication purposes to an investigation unit to determine a quantity of yarn present on the yarn package and is trained to determine an unwinding and/or changeover point of an unwound yarn

package based on a determined quantity of yarn for initiating the start of the splicing operation.

4. The feed yarn joining system according to claim **1**, wherein the first receiving unit and the first positioning unit or the second receiving unit and the second positioning unit are provided by a moveable suction unit, which is associated with the yarn package or the reserve package, between a receiving position for receiving the yarn tail end or the yarn head end respectively, and a depositing position for placing the yarn tail end or the yarn head end, respectively.

5. The feed yarn joining system according to claim **4**, wherein the moveable suction unit includes a sensor unit for detecting a presence and/or absence of the yarn tail end or the yarn head end in the moveable suction unit.

6. The feed yarn joining system according to claim **4**, further including a coupling unit for coupling and uncoupling of the moveable suction unit to or from a source of suction air.

7. The feed yarn joining system according to claim **4**, further including a clamping device for clamping the yarn tail end or the yarn head end inside the moveable suction unit.

8. The feed yarn joining system according to claim **1**, wherein the yarn splicing device, the first receiving unit, the second receiving unit, the first positioning unit and the second positioning unit are arranged on a common carrying frame, wherein the common carrying frame is provided within a plane tensioned by a guide frame.

9. The feed yarn joining system according to claim **1**, further including a driverless transport vehicle on which at least the first receiving unit, the second receiving unit, the first positioning unit, the second positioning unit and the yarn splicing device are arranged, wherein the driverless transport vehicle is provided to run autonomously to a site of the splicing operation which is to be executed.

10. The feed yarn joining system according to claim **9**, wherein the driverless transport vehicle carries a handling unit with a gripper unit for loading and unloading the package creel arrangement, and wherein the gripper unit is movable in multiple dimensions.

11. The feed yarn joining system according to claim **10**, wherein the driverless transport vehicle carries a package buffer with at least two package storage sites, wherein a first one of the at least two package storage sites is equipped with a reserve package and a second one of the at least two package storage sites is free, wherein the handling unit for removing and positioning the yarn package is provided on the second one of the at least two package storage sites and for removing and positioning the reserve package is provided in a package creel position of the removed yarn package by the gripper unit.

12. A package creel arrangement with a package creel comprising at least two package storage sites, wherein a first one of the at least two package storage sites is provided for receiving a yarn package and a second one of the at least two package storage sites is provided for receiving a reserve package, and the feed yarn joining system according to claim **1**.

13. The package creel arrangement according to claim **12**, wherein the at least two package storage sites are arranged moveably between an operating position and a changeover position.

14. A method of joining a yarn tail end of a yarn package to a yarn head end of a reserve package in a region of a package creel arrangement having at least two adjacent package storage sites for receiving the yarn package and the reserve package by the feed yarn joining system according to claim **1**, the method comprising:

initiating the splicing operation;

activating the first receiving unit and the second receiving unit for seeking and receiving the yarn tail end of the yarn package and the yarn head end of the reserve package;

activating the first positioning unit and the second positioning unit for positioning the received yarn tail end and the received yarn head end into the yarn splicing device;

activating the yarn splicing device for preparing the yarn tail end and the yarn head end by yarn tail end preparation means associated with the yarn splicing device; and

activating the yarn splicing device for joining the prepared yarn tail end and the prepared yarn head end.

15. The method according to claim **14**, wherein promptly before, or with the step of initiating the splicing operation, filling an emptied package storage site with a reserve package.

16. The feed yarn joining system according to claim **4**, wherein the moveable suction unit is pivotable or linearly displaceable.

17. The feed yarn joining system according to claim **4**, wherein the moveable suction unit comprises a suction tube with a suction mouth.

18. The feed yarn joining system according to claim **8**, wherein the common carrying frame is adjustable within the plane tensioned by the guide frame.

19. The package creel arrangement according to claim **13**, wherein the at least two package storage sites are pivotable between the operating position and the changeover position.

20. The method according to claim **15**, wherein the step of filling takes place immediately before the step of initiating the splicing operation.

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