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(54) METHOD OF OPERATING A SERVICE ROBOT OF A RING SPINNING MACHINE AND A RING SPINNING MACHINE FOR PERFORMING IT

(57) The invention relates to a method of operating a service robot of a ring spinning machine, in which the service robot is displaceable along a row of spinning units (A) of the spinning machine, each spinning unit (A) comprising a spindle (1), wherein the service robot (4) can be stopped at a specific spinning unit (A) to perform a service operation at the spinning unit (A). The method comprises the following steps - displacing the service robot (4) initially along the row of spinning units (A) to detect a reference position; and - during this displacement of the service robot (4) at least one reference element (H) located between both ends of the row of spinning units (A) is detected by a sensor (A1), wherein the reference element (H) indicates the reference position; and - using the reference position during the operation of the service robot (4) to position the service robot (4) in front of a specific spinning unit (A) of the row of spinning units (A) if the need arises to perform a service operation at the respective spinning unit (A). The invention further relates to a ring spinning machine for performing this method.

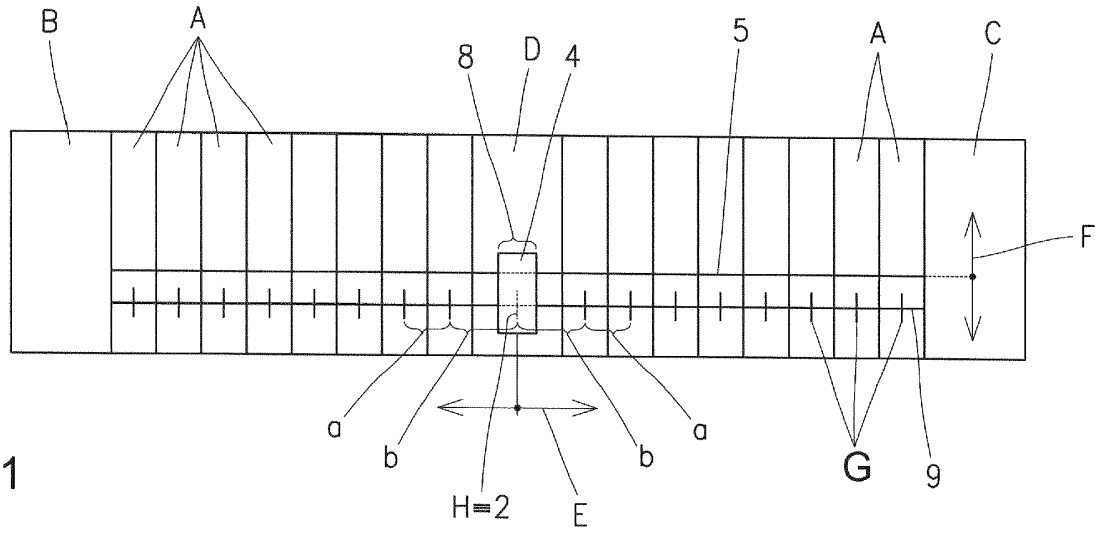

Fig. 1

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Description

Field of the invention

[0001] The invention relates to a method of operating a service robot of a ring spinning machine, in which the service robot is displaceable along a row of spinning units of the spinning machine, each spinning unit comprising a spindle, wherein the service robot can be stopped at a specific spinning unit to perform a service operation at the spinning unit.

[0002] The invention further relates to a ring spinning machine which comprises a row of spinning units arranged next to each other, each spinning unit comprising a spindle, and a service robot which is displaceable along a row of spinning units with an option of stopping at a selected spinning unit to perform a service operation at the spinning unit.

Description of related art

[0003] Ring spinning machines comprise a row of identical spinning units arranged next to each other, each of which comprises a roving drafting device, from which the processed fiber roving is fed to a twisting device, from which the produced yarn is withdrawn and wound in a winding device on a tube carried by a spindle, thereby forming cop, i.e., a tube with a yarn package.

[0004] If a yarn manufacturing process is interrupted, e.g., due to a yarn break, the yarn production at the respective spinning unit must be resumed, which is performed either manually by the machine operator or by an automated service robot.

[0005] Current ring spinning machines are largely hand-operated for several reasons. One reason is the limited workspace for the service mechanisms of a service robot because there is only a short distance between the spinning units (70 and 75 mm). Another reason is the difficulty in solving the functional activities of the service mechanisms without mutual limitation of the service mechanisms in terms of space and time in the limited workspace. Last but not least, manual service is advantageous in many parts of the world also for price reasons. In view of the increasing demand for production cost savings in yarn production, ring spinning machines with a greater number of spinning units are produced. Consequently, the length of the machines is being extended (50m and more), which enables to economically use automatic service robots for servicing the spinning units, wherein from the moment when a failure occurs a service operation must be carried out at all the spinning units along the length of the machine in the shortest possible time. This increases the demands for speed and movement accuracy and the precision of stopping the service robot at the spinning units, which is why it is necessary to know the initial reference position and the direction of movement of the service robot along the row of spinning units.

[0006] On a ring spinning machine with an increasing number of spinning units and an extending length of the machine, the required power output of the drive device of the drafting device is also increased and therefore an intermediate drive is usually arranged in the central part of the machine length to avoid differences in the rotation of long through shafts at the beginning of the machine and at the end of the machine due to elastic deformations caused by torsional load, due to higher torques of the drive device at the beginning of the machine.

[0007] On this central part of the length of the ring spinning machine outside the spinning units, a parking position of the service robot is usually arranged, where the service robot is moved during the time when it is not carrying out any service operation, for example, during the operation of joint removal of the cop from the spinning spindles at the spinning units or during the placing of the empty tubes on the spindles and during the joint spinning-in of the spinning units.

[0008] On ring spinning machines comprising a row of spinning units arranged next to each other, wherein a displaceable service robot is positioned relative to the other machine parts, it is necessary to set the service robot to the desired position relative to the respective part of the machine so as to perform the controlling activities of the control device. Whenever the machine or service robot is started, e.g., after a power failure or after repair or when the machine is put into operation for the first time, etc., the service robot must be positioned correctly with respect to the individual spinning points. The disadvantage of the present state is that in the case when the machine is before the start of the machine for some reason situated on the opposite side of the machine, e.g., after the machine has been stopped or when the service robot has been moved by the operator, the service robot must be moved manually or by the machine before the start of the machine or immediately after the start of the machine, over the entire length of the machine, which is time-consuming, especially for machines with a greater number of spinning units, and also results in lower production efficiency.

[0009] The accuracy and precision of the execution of individual service operations at the spinning units by the service robot depend on the fast and precise determination of the position of the service robot on the ring spinning machine, since their execution is usually dependent on a sufficiently accurate adjustment of the individual operating mechanisms of the service robot relative to the respective parts of the specific spinning unit.

[0010] Known are various arrangements for positioning an automatic service robot for providing service operations at the spinning units on a ring spinning machine, as well as methods of performing this positioning.

[0011] From DE 3909746 A1, for example, it is known that the position of the service robot for operating the spinning units during the resumption of the spinning process after a break of yarn being produced on a ring spinning machine is determined by means of induction sen-

sors located on the service robot which sense the position of differently arranged and differently shaped openings formed in a guide rail of the travelling wheels of the service robot, whereby the position of these openings corresponds to the position of the spinning units, as well as to both ends of the machine. Control and communication means then transmit the information between the ring spinning machine, the spinning units and the service robot. The disadvantage of this solution is that in the case of a machine with a plurality of spinning units and therefore with a geater length of the service robot, in order to ensure the right coordination of the position of the service robot with the machine, the service robot must first move to one of the end positions of the service robot on the machine, which prolongs the time needed for the coordination of the positions and also prolongs the time period during which the service robot is not performing any service operations. Another drawback of this arrangement is the fact that more sensors are required for the operation of the service robot.

[0012] EP2305864A1 discloses an embodiment where reference points created near both ends of the machine and in the middle of the machine are sensed by a sensor located on a service assembly. In the course of its travel along the row of spinning units the service assembly measures the distance it has travelled by means of measuring the rotation angle of the rotating part of the drive of the service assembly which correlates with the straight-lined forward movement of the service assembly along the row of spinning units, and the overall path travelled by the service assembly towards a respective spinning unit requesting a service operation is calculated from the rotation angle and the direction of rotation of this measured rotatable portion of the service assembly, from which the control means of the machine determine, on the basis of the speed of the movement of the service assembly, the distance of the service unit from the spinning unit requesting a service operation and determines the position in which the braking procedure of the service assembly is triggered for stopping at the respective spinning unit. Another disadvantage of this solution is the fact that four working areas 3A, 3B or 4A, 4B are created on the machine, separated by the center reference points, where these areas immediately adjoin each other without any parking area provided for the service assembly and thus not allowing parking of the service assembly in the middle of the machine length during the process of group doffing, to prevent collision of the means of the robot for group doffing and the service assembly. During the operation of group doffing the service assemblies must be moved to the end of the mechine, which in the case of ring spinning machines with a great length prolongs the time during which the service assemblies cannot operate after the end of group doffing and the start of the spinning process.

Brief summary of the invention

[0013] The aim of the invention is to remove or at least reduce the disadvantages of the background art.

[0014] The aim of the invention is as well to create a method, in which a service robot of a ring spinning machine can easily find a reference position during the initial displacement of the service robot along the length of the spinning machine.

[0015] The aim of the invention is achieved by a method of operating a service robot of a ring spinning machine, whose principle consists in that it comprises the following steps:

- initial displacement of the service robot along a row of spinning units to detect a reference position; and
- during the displacement of the service robot at least one reference element is detected by a sensor between both ends of the row of spinning units, wherein the reference element indicates a reference position; and
- using the reference position during the operation of the service robot to position the service robot in front of a specific spinning unit of a row of spinning units if the need arises to perform a service operation at the respective spinning unit.

[0016] Advantageously, the service robot detects a spindle by means of an eddy current sensor as a reference element between both ends of the row of spinning units.

[0017] Advantageously, the service robot counts the spindles from the defined position to its position before the spinning unit to perform a service operation.

[0018] Advantageously, the reference element is arranged in a position in which its distance b from the nearest spinning spindle both on the right and on the left is identical and, at the same time, this distance b is greater than the distance a between two adjacent spinning spindles, whereby the spinning spindles and the reference element are detected during the initial displacement of the service robot, and the reference element is detected according to differences in the time intervals and/or the distances between two adjacent spinning spindles and between said nearest spinning spindle and the reference element.

[0019] Advantageously, the reference element is detected at an intermediate drive of the spinning machine.

[0020] Advantageously, if the service robot before detecting the reference element arrives at the end of the row of spinning units of the spinning machine, the service robot changes direction and continues in detecting the reference element.

[0021] Advantageously, the method is performed before starting the operation of the service robot such as after switching it on or after a power cut.

[0022] The ring spinning machine for performing the method comprises

- a row of spinning units arranged next to each other, each spinning unit comprising a spindle,
- a service robot which is displaceable along the row of spinning units with an option of stopping at a selected spinning unit in order to perform a service operation at the spinning unit; whereby
- the service robot is provided with a sensor for sensing the position of the service robot along the row of spinning units,
- at least one reference element is arranged between both ends of the row of spinning units as a reference position of the service robot along the row of spinning units, wherein the reference position is used during operation of the service robot for positioning the service robot before a specific spinning unit of the row of spinning units in need of a service operation; and
- a controller adapted to displace the service robot initially along the row of spinning units in order to detect the defined position.

[0023] Advantageously, the service robot comprises an eddy current sensor as a sensor and the reference element is by its outer geometrical configuration identical or close to the outer geometrical configuration of the detected part of the spinning spindles. Advantageously, the reference element is arranged in a position in which its distance from the nearest spinning spindle both on the right and on the left is identical and, at the same time, this distance is greater than the distance between two adjacent spinning spindles.

[0024] Advantageously, the sensor of the position of the service robot is associated with the area below the lower surface of a spindle bench.

[0025] Advantageously, the reference element is made of the same or approximately the same material as the detected part of the spinning spindles.

[0026] Advantageously, the reference element is situated with respect to the longitudinal axis of the ring spinning machine and the height of the ring spinning machine in the same position as is situated the part of the spinning spindles being sensed.

[0027] Advantageously, the service robot is further provided with a sensor for detecting the end of the row of spinning units.

[0028] Advantageously, the reference element is arranged on the structure of the intermediate drive arranged between both ends of the row of spinning units, where a parking area of the service robot is situated.

[0029] Advantageously, the service robot and the control device are interconnected by a communication line for transmitting information about the numbers of the spinning units, the total number of the spinning units on the machine, the location of the auxiliary drive with the reference element in the service robot, whereby the service robot is provided with means for storing and processing this information.

[0030] The advantage of this solution is the fact that in the case of a very long ring spinning machine with a plurality of spinning units in whose central part is arranged an intermediate drive near which is arranged a parking position of the service robot, to which the service robot is moved when performing the group doffing of wound cops, whereby near this intermediate drive is also arranged a reference position of the control device, which is formed in an exemplary embodiment by a synchronizing "false" spindle located on the intermediate drive mechanism. From this parking position, which is at the same time a reference position, the service robot moves to the right or to the left towards the spinning units requesting service operations, thereby shortening the distance and also the time for moving the service robot to the spinning unit requesting service operations, thus improving the efficiency of the service robot utilization as compared with the background art, in which the reference position is created at the beginning an/or at the end of the machine, which is manifested also during the initialization of the service robot when the machine is started up for the first time or when the service robot is restarted after repair, after a power cut, after being shifted manually by the machine operator, etc. The determination of the position of the service robot relative to the entire row of spinning points, as well as to the reference point, is carried out by means of a sensor arranged on the service robot which senses a gap between adjacent spindles and a gap between the spinning spindles and the reference point and which is also able to determine the direction of the movement of the service robot. Another advantage of the solution according to the invention is the fact that the lower part of the mounting of the spinning spindles at the spinning units below the spindle bench is sensed as already existing place of the machine construction. A further advantage is the fact that the reference point is sensed in the form of a "false" spindle which is in terms of geometry and material identical or very similar to a functional spinning spindle at the spinning units, which means that the detection of all the operating spindles as well as of the synchronizing "false" spindle can be carried out by one common sensor, whereby the identification of the "false" spindle is made possible due to its distance from the production spinning spindles, which is different from the distance between the individual production spinning spindles. The advantage of the invention is also the fact that it allows a substantial acceleration of the initialization of the service robot relative to the entire row of spinning units, or, more specifically, allows quick synchronization of the position of the control device relative to the reference point and to the entire row of spinning units.

Brief description of the drawings

[0031] The invention is schematically represented in the drawing, wherein

Fig. 1 shows a schematic arrangement of a ring spinning machine with a row of spinning units ac-

cording to the invention;

Fig. 2 shows an arrangement of a parking position on a ring spinning machine with a reference element "false spindle" and a parked service robot with sensing sensors arranged on it;

Fig. 3 shows an arrangement of an end portion of the ring spinning machine with an end machine marker being sensed and with a service robot and, finally; and

Fig. 4 is a cross-secton of a ring spinning machine with an automatic service robot and sensors according dotted line IV-IV in Fig. 3.

Detailed Description of the invention

[0032] The invention will be described with reference to an exemplary embodiment of a ring spinning machine comprising at least one row of spinning units A arranged next to each other, as is shown in Fig. 1. A main drive B is arranged at one end of the machine, whereby an endpiece C of the machine is arranged at the opposite end of the machine. At least one intermediate drive D or an intermediate drive mechanism, is located between both ends of the row of spinning units. In the illustrated exemplary embodiment, there is one intermediate drive D and is situated in the central part of the machine.

[0033] Along the row of spinning units A is arranged in a bi-directional displaceable manner in the direction of the arrow E a service robot 4 provided with unillustrated means for performing service operations at the spinning units A. In the embodiment in Figs. 2 and 3, the service robot 4 moves along a running rail 3 which is arranged along the entire length of the ring spinning machine and can be stopped at a selected spinning unit A requesting a service operation. Fig. 4 is a cross-secton of a ring spinning machine according dotted line IV-IV in Fig. 3.

[0034] For providing proper service operations by the service robot 4 at the spinning units A it is essential for the position of the service robot 4 to be initialized before starting the actual service operations at the spinning units A, i.e. coordinated or synchronized with the row of spinning units A relative to an initial, reference position on the machine, so that, to put it differently, the service robot 4 can orient itself on the machine.

[0035] After this initialization, the control unit, or the respective controller, can commence controlling the process of the activities of the service robot 4 along the row of spinning units A, e.g., the direction of the movement of the service robot 4 along the row of spinning units A, the speed of movement, the process of stopping or determining the position of the particular spinning unit A at which service operation is to be performed, scheduling the sequence of operations at the individual spinning units A, etc. This initialization of the position of the service robot 4 must be done after each start-up of the machine or after the service robot 4 has been manually moved along its running rail or after restarting the service robot 4 on which service activity has been performed outside the machine, etc.

[0036] The spinning unit as such is principally well-known and therefore it will only be described in a simplified manner. Those parts, elements and nodes of the spinning unit that are of significance to the present invention will be described in greater detail.

[0037] Each spinning unit A of the ring spinning machine comprises an unillustrated roving drafting device, below which a yarn twisting and winding device is arranged. From an unillustrated supply package a roving is fed to a drafting device from which the yarn being formed passes through a guide eyelet, a balloon limiter and then through a traveller circulating around the circumference of the ring which is mounted in a holder which is mounted on a ring bench 5, wherepon the produced yarn after passing through the traveller is wound on a tube which is placed on a rotating spindle 1, thereby forming the cop. The yarn package on the tube is formed by a stepwise reversible vertical movement of the ring bench 5 in the vertical direction F. The spindle 1 is usually driven in its lower part by a flat belt from the drive shaft and is rotatably mounted in a closed bearing body G which is mounted on a fixed spindle bench 9. In the central part of the machine is arranged an intermediate drive D near which is provided a parking position 8 of the service robot 4. A reference element H of the position of the service robot 4 is arranged on the intermediate drive D, formed, for example, by a "false" spindle 2, which is in the area of the intermediate drive D of the machine, or in the area of the parking position 8 of the service robot 4 arranged in a defined position which is with respect to the longitudinal axis of the machine and the height of the machine the same as the position of the production spinning spindles 1. The service robot 4 moves to the parking position 8, for example during the process of group doffing of the wound cops, putting empty tubes onto the spindles 1, spinning-in, etc., whereby the service robot 4 moves from the parking position 8 to the right or to the left towards the spinning units A requesting a service operation.

[0038] Arranged on the service robot 4 are the first and second sensors A1, A2 of the position of the service robot 4 along the row of spinning units A. The first sensor A1 is adapted to sense the presence of the individual spinning spindles 1 of the row of spinning units A as well as the presence of the reference element H, here, for example, the "false" spindle 2, during the movement of the service robot 4 along the row of spinning units A. The second sensor A2 is adapted to sense the vertical surface 30 of the guide rail of the running rail 3 of the service robot 4. To improve the detection of the range of the working movement of the service robot 4 along the machine, the vertical surface 30 of the guide rail of the running rail 3 is provided with an end marker, e.g., with an opening 7 at the beginning and the end of the row of spinning units A, for example 3 to 4 pitches between the

spinning spindles 1 before the last (end) spinning spindle 1 on the respective side of the row of spinning units A.

[0039] The running rail 3 is further provided at its initial and end parts with a mechanical safety stop 6 which limits the range of movement of the service robot 4 from the central part of the machine to the ends. The end marker (opening 7) at both ends of the running rail 3 constitutes end reference positions of the service robot 4 and at the same time determines a point for starting the braking of the service robot 4 before stopping at the first or last spinning unit A of the respective row of spinning units A, or for changing the direction of movement of the service robot 4 into the opposite direction.

[0040] The reference element H in the form of the "false" spindle 2 is mounted in the holder on the body of the intermediate drive D in the area of the parking position and at the level of the height of the production spindles 1 at the spinning units A.

[0041] The distance of the reference element H of the position of the service robot 4, that is the "false" spindle 2 in the illustrated exemplary embodiment, i.e. the "false" spindle 2, from the active part of the sensor A1 is the same as the distance of the production spindles 1 from the active part of the sensor A1, see Fig. 2. In the direction of the longitudinal axis of the ring spinning machine the distance b between the reference element H, that is the "false" spindle 2 in the illustrated exemplary embodiment, and the closest production spindle 1 from both the right and left sides of the row of spinning units A is larger than the distance a between two adjacent production spindles 1. In the embodiment shown, the distance b is at least twice as large than the distance a. Thus, the reference element H, that is, in the illustrated exemplary embodiment, the "false" spindle 2, is in terms of the material and structure identical or very close to the production spindles 1, which means that the same detection properties of the sensor A1 are maintained in the production spindles 1, as well as in the reference element H. In an embodiment not shown, the reference element H is formed by a metal pin or roller mounted in the corresponding position on the body of the intermediate drive D of the machine.

[0042] The device according to the invention operates in such a manner that during putting the ring spinning machine into operation after the previous shutdown or after moving the service robot 4 manually along the running rail 3, or after the installation of the service robot 4 on which service activities have been performed outside the machine, etc., the service robot 4 automatically begins to move initially from its random and precisely not defined position in the direction of the row of spinning units A towards one end of the row of spinning units A. During this movement, the service robot 4 detects by means of the sensor A1 the presence of the production spindles 1 which is determined by means of the set distance a of two adjacent production spindles 1 depending on the speed of the movement of the service robot. If during this movement of the service robot 4, the reference element H is detected by the sensor A1, because a greater distance b between adjacent spindles 1 and 2 is detected by the sensor than the corresponding distance a between adjacent production spindles 1, or, in other words, the distance which corresponds to the set distance b of the reference element H (the "false" spindle 2) from the closest production spindle 1, the spindle thus detected is registered as a reference element (the "false" spindle 2) in the area of the intermediate drive D and the parking position 8 and the control system, or the respective controller, now knows exactly where the service robot 4 is situated and past how many spinning units A it has travelled, because it counts the spinning units A past which it has travelled, and so it determines the number of the spinning units A of the row of spinning units A both to the right and and to the left from the reference element H. The information about the total number of the spinning units and the location of the intermediate drive D with the reference element H is sent to the service robot 4 through a communication line, such as a CAN bus, from the control unit of the machine after switching on the power supply of the robot and/or the machine. As a result, the service robot 4 knows the number of the spinning units A on one side of the machine, the number of spinning units A before the reference element H and after the reference element H and also knows the numbers of the spinning units at the end marker, whereby the service robot 4 is provided with means for storing and processing this information for the operation of the service robot, and therefore for the synchronization of the machine with the service robot 4 it is not necessary to wait until the reference element H has been found by the service robot 4.

[0043] If during the above-mentioned movement of the service robot 4 the end marker (the opening 7) in the end part of the running rail 3 of the machine, or, in other words, the end of the row of spinning units A, is first detected by the sensor A2, the service robot 4 travels to the position at the last spinning unit (detects the last production spindle 1), or, more specifically, travels to the end of the row of spinning units A, where the direction of movement of the service robot is changed, whereupon the service robot continues to detect the reference element H in the opposite direction of its movement. On the basis of this, the control unit, or the respective controller, finds out that the service robot 4 is at the particular end of the row of spinning units A, whereby from the direction of the movement from which the service robot 4 has travelled to the particular end of the row of spinning units A it is determined which end (right, left) of the row of spinning units A it is.

[0044] In any case, the service robot 4 travels from its previously not defined position to a defined position a substantially shorter distance before it is found with certainty where the service robot 4 along the row of spinning units currently is situated. This information about the defined position of the service robot 4 is transmitted to the control unit (controller) and the position of the service robot 4 along the row of spinning units A is thus known with certainty, i.e. is synchronized, according to the ref-

erence element H, or according to the machine end (by the end marker, or the opening 7). This makes it possible for the control unit, or the controller, to start the activities of the service robot 4 along the row of spinning units A a lot earlier than is the case with the prior art. In addition, whenever the service robot 4 passes past the reference element H this is recorded and thus the defined determination of the position, i.e. synchronization of the service robot 4 and the row of spinning units A, is continuously maintained.

[0045] At the same time, during the movement of the service robot 4 along the row of spinning units A also the production spindles 1 are continuously detected and counted, namely with respect to the path travelled by the service robot 4 between two adjacent production spindles 1, or, to put it differently, with respect to the time interval between the registration of the presence of two adjacent production spindles 1.

[0046] The distance b between the reference element H and the two closest production spindles 1 both from the right and left sides is greater than the distance a between two adjacent production spindles 1, and so the time interval between the detection of the reference element H and the production spindle 1 closest to it with the service robot 4 moving along the machine at a constant speed is longer than the time interval between the detection of two production spindles 1 arranged next to each other. Preferably, the sensor according to CZ patent application no. PV 2018-49 is used as a sensor A1 of the reference element H and the production spindles 1, which is, in addition, able to determine also the direction of movement of the service robot 4 from the course of its signal when detecting consecutive spinning units A along which the service robot 4 moves. If necessary, the direction of movement of the service robot is determined by the control unit or the controller, e.g., from the data of the frequency converter of the drive of the service robot 4 which serves as additional input information for the control of movement of the service robot 4 along the row of spinning units A. This information and the information from the sensors A1 and A2 makes it possible for the control unit to perform fast and accurate positioning, including the inicialization process after starting the machine, after the start-up of the service robot 4, after a power failure, etc. During this process of positioning first are detected the reference position and the reference element H for the coordination of the position of the service robot 4 with respect to the row of spinning units A on the machine, which enables to control the movement of the service robot 4 with respect to the row of spinning units A requesting a service operation and to perform the positioning of the service robot 4 with respect to the spinning units A. The above-mentioned counting of the spinning units A, along which the service robot 4 has travelled is, for example, advantageous for the control of the service robot 4 since the service robot 4 or a control device or a controller, etc., counts the spinning units A or the production spindles 1 beginning from the reference element H, in other words, from the defined position, as far as to the desired position of the service robot 4 in front of the specific spinning unit A requesting a service operation, and so it is not necessary to measure the distance travelled by the service device 4 or measure the duration of the travel of the service robot for fast and precise positioning of the service robot 4 relative to a specific spinning unit A in the row of spinning units A along the entire length of the spinning units A.

[0047] In the illustrated exemplary embodiment, only one reference element H is arranged in the row of spinning units A. In an embodiment not shown, two reference elements H, or even more, are arranged in the row of spinning units A, which is especially advantageous in the case of very long ring spinning machines which comprise in one row of spinning units A as many as over 1 000 units A. In that case, a higher number of reference elements H in the row of spinning units A contributes to fast initialization of the service robot 4 on the machine, or, to put it more specifically, relative to the row of spinning units A. Naturally, with a plurality of spinning units A arranged next to each other, the number of intermediate drives D and, if necessary, the number of parking positions 8 of the service robot is also adequately increased.

Reference numbers

[0048]

1	Spinning spindle
2	False spindle
3	Running rail of the service robot
30	Vertical surface of the running rail of the service robot
4	Service robot
5	Ring bench
6	Stop
7	Opening
8	Parking position of the service robot
9	Spindle bench
A	Spinning unit
A1	First sensor
A2	Second sensor
B	Main drive
C	End-piece
D	Intermediate drive
E	Direction of the service robot 4 movement
F	Vertical direction of ring bench 5
G	Bearing body
H	Reference element

Claims

1. A method of operating a service robot of a ring spinning machine,

   • wherein the service robot is displaceable along

a row of spinning units (A) of a spinning machine, each spinning unit (A) comprising a spindle (1), wherein the service robot (4) can be stopped at a specific spinning unit (A) in order to perform a service operation at the spinning unit (A);

characterized in that it comprises the following steps:

• displacing the service robot (4) initially along the row of spinning units (A) in order to detect a reference position; and
• during the displacement of the service robot (4) detecting by means of an eddy current sensor (A1) at least one reference element (H) located between both ends of the row of spinning units (A), wherein the reference element (H) indicates a reference position; and
• using the reference position during the operation of the service robot (4) to position the service robot before a specific spinning unit (A) of the row of the spinning units (A) in case of need of a service operation at the particular spinning unit (A).

2. The method according to claim 1, **characterized in that** the service robot (4) detects a spindle (1) by means of an eddy current sensor (A1) as a reference element (H) between both ends of the row of spinning units (A).

3. The method according to any of claims 1 or 2, **characterized in that** the service robot counts the spindles (1) from the defined position to its position before the spinning unit (A) to perform a service operation.

4. The method according to any of claims 1 to 3, **characterized in that** the reference element (H) is arranged in a position in which its distance (b) from the nearest spinning spindle (1) both on the right and on the left is identical and, at the same time, this distance (b) is greater than the distance (a) between two adjacent spinning spindles (1), whereby the spinning spindles (1) and the reference element (H) are detected during the initial displacement of the service robot (4), and the reference element (H) is detected according to differences in the time intervals and/or the distances between two adjacent spinning spindles (1) and between said nearest spinning spindle (1) and the reference element (H).

5. The method according to any of claims 1 to 4, **characterized in that** the reference element (H) is detected at an intermediate drive (D) of the spinning machine.

6. The method according to any of claims 1 to 5, **characterized in that** if the service robot (4) before detecting the reference element (H) arrives at the end of the row of spinning units (A) of the spinning machine, the service robot (4) changes direction and continues in detecting the reference element (H).

7. The method according to any of claims 1 to 6, **characterized in that** the method is performed before starting the operation of the service robot (4) such as after switching it on or after a power cut.

8. A ring spinning machine for performing the method according to any of claims 1 to 7, comprising:

• a row of spinning units (A) arranged next to each other, each spinning unit (A) comprising a spindle (1),
• a service robot (4) which is displaceable along the row of spinning units (A) with an option of stopping at a selected spinning unit (A) in order to perform a service operation at the spinning unit (A); whereby
• the service robot (4) is provided with a sensor (A1) for sensing the position of the service robot (4) along the row of spinning units (A),
• at least one reference element (H) is arranged between both ends of the row of spinning units (A) as a reference position of the service robot (4) along the row of spinning units (A), wherein the reference position is used during operation of the service robot (4) for positioning the service robot (4) before a specific spinning unit (A) of the row of spinning units (A) in need of a service operation; and
• a controller adapted to displace the service robot (4) initially along the row of spinning units (A) in order to detect the defined position.

9. The ring spinning machine according to claim 8, **characterized in that** the service robot (4) comprises an eddy current sensor (A1) as a sensor and the reference element (H) is by its outer geometrical configuration identical or close to the outer geometrical configuration of the detected part of the spinning spindles (1).

10. The ring spinning machine according to claim 8 or 9, **characterized in that** the reference element (H) is arranged in a position in which its distance (b) from the nearest spinning spindle (1) both on the right and on the left is identical and, at the same time, this distance (b) is greater than the distance (a) between two adjacent spinning spindles (1).

11. The ring spinning machine according to claim 8 to 10, **characterized in that** the sensor (A1) of the position of the service robot (4) is associated with the area below the lower surface of a spindle bench (9).

12. The ring spinning machine according to any of claims 8 to 11, **characterized in that** the reference element (H) is made of the same or approximately the same material as the detected part of the spinning spindles (1).

13. The ring spinning machine according to any of claims 8 to 12, **characterized in that** the reference element (H) is situated with respect to the longitudinal axis of the ring spinning machine and the height of the ring spinning machine in the same position as is situated the part of the spinning spindles (1) being sensed.

14. The ring spinning machine according to any of claims 8 to 13, **characterized in that** the service robot (4) is further provided with a sensor (A2) for detecting the end of the row of spinning units (A).

15. The ring spinning machine according to any of the claims 8 to 14, **characterized in that** the reference element (H) is arranged on the structure of the intermediate drive (D) arranged between both ends of the row of spinning units (A), where a parking area of the service robot (4) is situated.

16. The ring spinning machine according to any of claims 8 to 15, **characterized in that** the service robot (4) and the control device are interconnected by a communication line for transmitting information about the numbers of the spinning units (A), the total number of the spinning units on the machine, the location of the auxiliary drive (D) with the reference element (H) in the service robot (4), whereby the service robot (4) is provided with means for storing and processing this information.

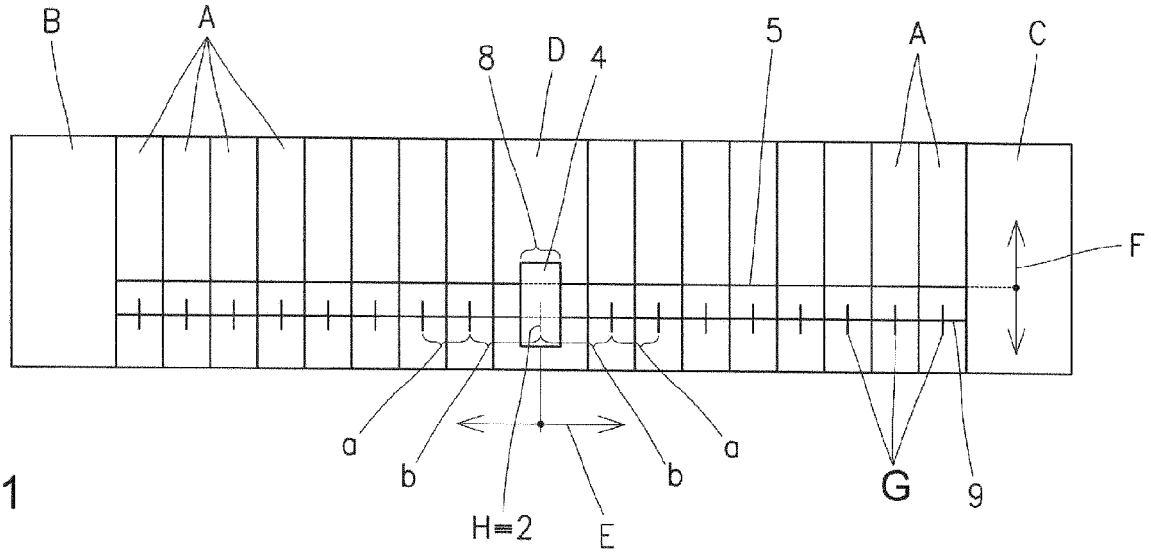

Fig. 1

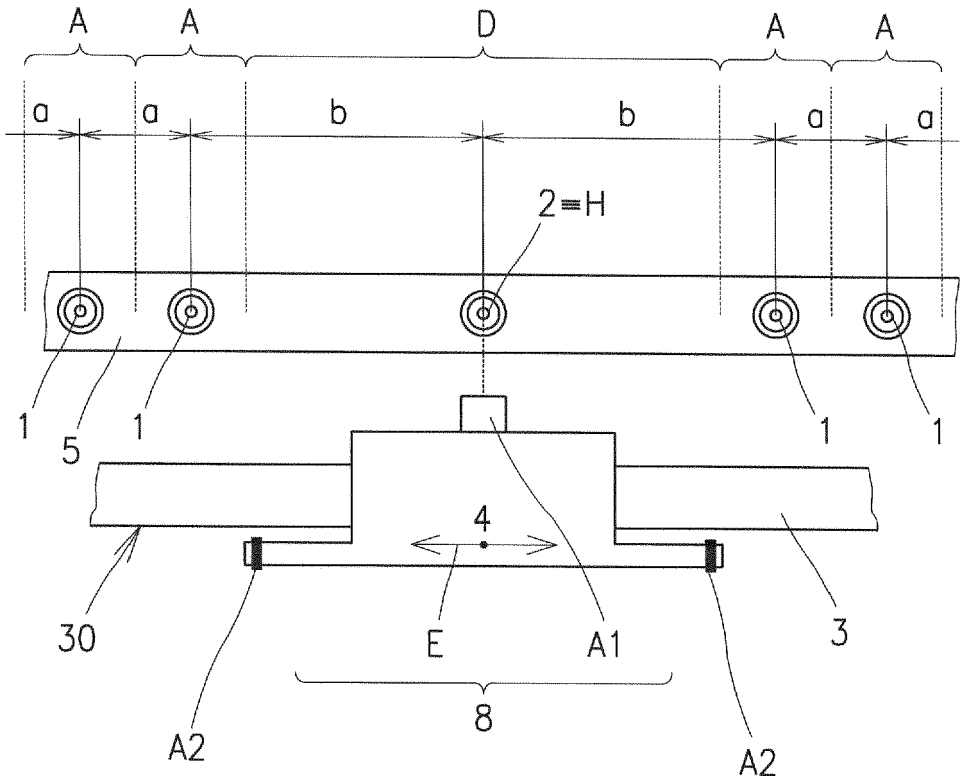

Fig. 2

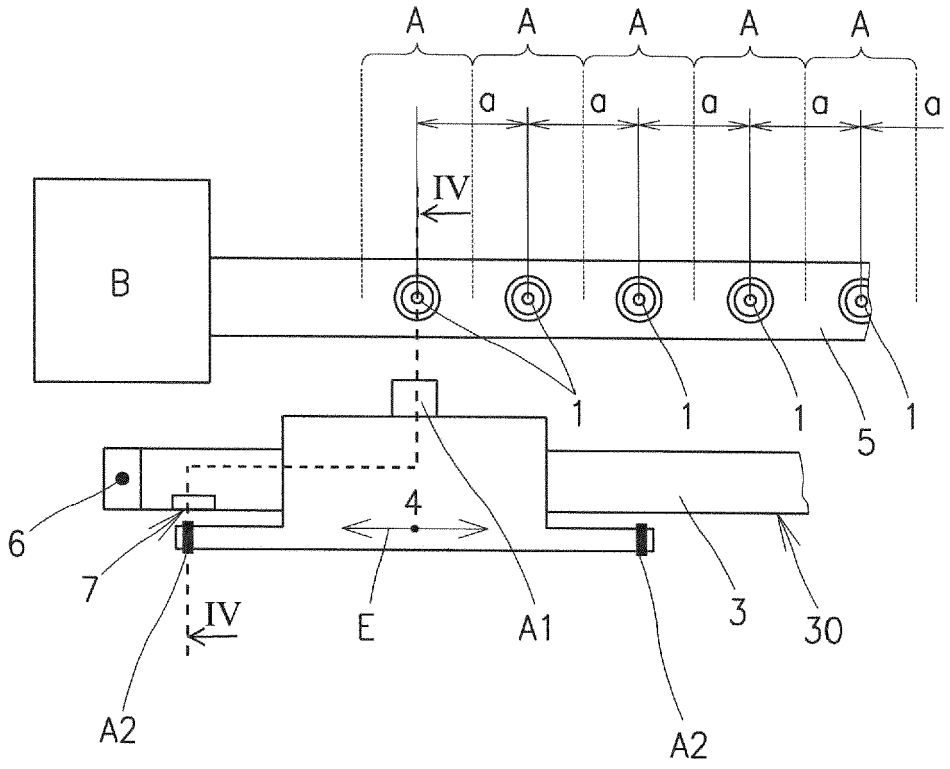

Fig. 3

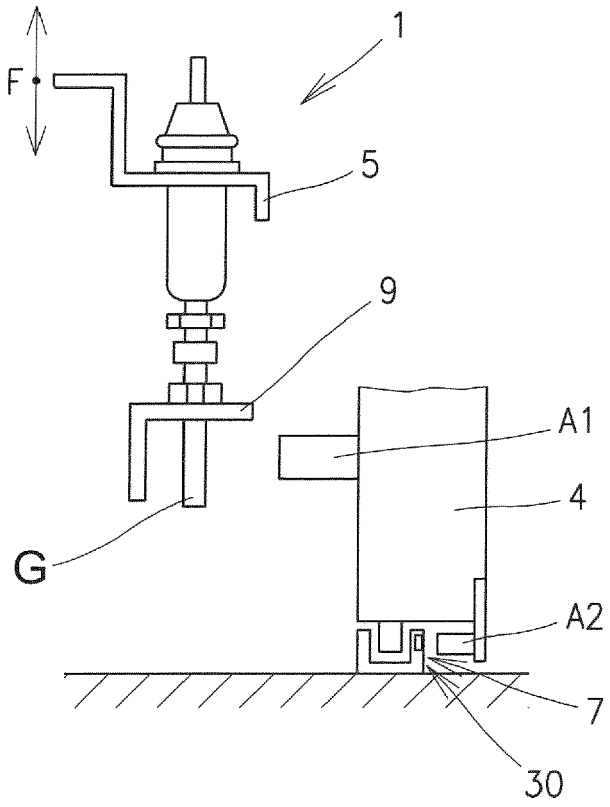

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 19 18 8011

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Place of search	Date of completion of the search	Examiner
Munich	10 December 2019	Humbert, Thomas

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