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(54) **Device for individually actuating open-end spinning rotors**

(57) Device for individually actuating the rotation of the open-end spinning rotor (1) in which the shank of the rotor is supported with a "twin disc" device in which one or more of the bearings of the parallel shafts of the "twin

disc" support consist of the individual actuation motor, giving the rotary motion to both of the shafts of the "twin disc" support that in turn transmit it to the shank (2) of the rotor (1).

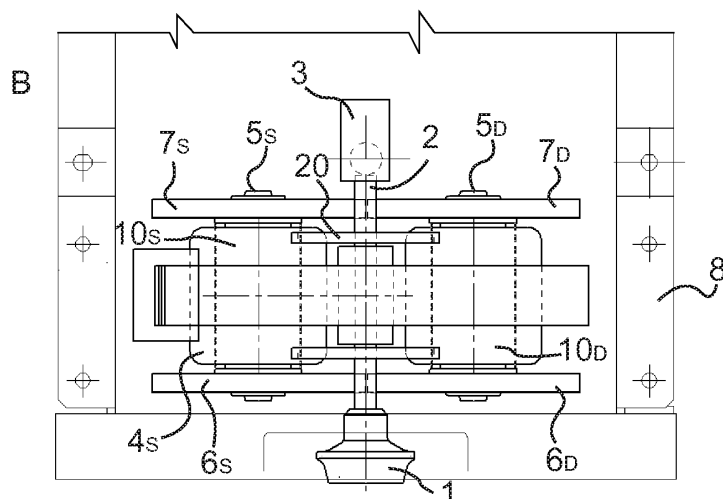


Fig. 2

Description

[0001] The present invention refers to "open-end" spinning, i.e. rotor spinning. Open-end spinners generally consist of a plurality of individual spinning units, aligned on the two fronts of the machine, and served by common service units. The spinning unit is essentially made up of a spinning rotor, which produces thread by twisting said singularised fibres of a rove that are supplied to it by a feeding group, and of a collection unit that takes the yarn from the rotor and takes it to wind in a bobbin, on which the thread is wound in coils by a thread guide device that distributes it with axial back and forth motion on the outer surface of the bobbin itself set in rotation.

[0002] The productivity of the open-end spinning machine is strictly dependent upon the rotation speed of the spinning rotor, having to produce yarn with a well defined number of twists per metre. In the evolution of open-end technology, the rotation speed of the rotors has substantially increased to over 150,000 revs/min in the most recent open-end spinners.

[0003] In established open-end technology, the actuation of the rotors of the open-end spinning units, aligned with one another on the two fronts of the machine, is carried out by common driving belts that run axially according to the front of the machine and that exert a tangential dragging on the shafts - commonly known as shanks - behind the spinning rotors with which said belts are kept in contact by pressure rollers, commonly known as guide pulleys. Such a type of actuation brings some consequences with it. The rotation speed of the spinning rotors arranged along the front of the machine is not the same from the top to the bottom of the machine, but tends to decrease especially for long machines.

[0004] As the distance increases from the actuation point of the driving belts, which run axially according to the front of the machine and transmit drive torque to the spinning units aligned along such a front, their tension progressively decreases with the increase in distance from the actuation point, and with it thus varies the transmissible torque. Such a difference translates into a different number of twists given to the yarn in the spinning units arranged along the front of the machine. This drawback occurs significantly with the rotor in steady running state, but to an even greater extent with the rotor in a transient phase.

[0005] With such an actuation set-up, every spinning unit is equipped with braking and clutch devices to operate individually on the single spinning unit, disengaging it from the common actuations during the transient phase, according to an "off-on" logic.

[0006] Such a type of actuation of the spinning rotors with common drive belts does a good job of meeting the requirements of high rotation speeds of the rotor, but it has substantial drawbacks for other aspects of open-end spinning. Such defects depend upon the corresponding rigidity of the actuation ratios between the various members of the machine, especially pronounced in the tran-

sient phases, of starting and reattachment of the thread after each time it breaks, but also and above all by the fact that the increase in speed to current values has led to an exponential increase in energy consumption of the transmission as a whole.

[0007] The specific drawbacks of the conventional system are the following:

- lack of the possibility of accurately controlling the speed of the rotor during the reattachment step, which must take place at partial speed (at the steady running speed it would be impossible). In order to have constant quality in the joints it is important that, at the moment of reattachment, the speed of the rotor is the same irrespective of the axial coordinate of the spinning unit. Indeed, it is necessary to take into account that the tension of the common drive belts progressively decreases as the distance from the actuation head increases, and with it the transmissible torque thus varies. Currently the reduction in speed in the reattachment phase takes place in an approximate manner by operating on the "off-on" brake of the rotor, without the accuracy that would actually be wished;
- lack of the possibility of controlling the acceleration ramp of the rotor once reattachment has occurred, in the same way that other parameters are controlled (feeding of the band and extraction of the thread, through specific devices of the service trolley dedicated to reattachment);
- high energy consumption with exponential growth as the working speed increases, due to the dissipation of energy of the drive belt that undergoes a considerable amount of small flexing at each rotor and guide pulley, as well as at the drive pulleys at the head and the return pulleys at the tail of the machine. As the speed increases, both the rotation speed of the pulleys and the tensions to be applied to the belts to transmit the greater power required correspondingly increase;
- very great noise due both to the many members rotating at high speeds and the load applied to their bearings, and to the aerodynamic noise due to the linear motion of the belt along the machine at speeds that exceed 70 m/sec;
- braking problems of the spinning rotor: it should stop in a very short time and before the spinning unit is opened. In conventional open-end spinning units the actuation of the brake and of the detachment of the shank of the rotor from the belt are simultaneous with the opening of the rotor, with the danger that can derive from this;
- quick wearing of the brake blocks that act on the shank of the rotor, with frequent laborious and costly replacements, and above all non-uniform behaviour during transients; this drawback is not easy to identify, apart from by controlling the quality of the joint of each spinning unit and/or the percentage success

of the joints;

- dirtying of the motion transmission system: belt, guide pulleys, rotor and pulleys. Fibres and dust including that coming from the wearing of the brake blocks, deposit on the moving belts and spread into all of the members of the machine. It therefore becomes necessary to have frequent and expensive cleaning operations, especially in the transmission area, as well as replacement of the belts due to their rapid deterioration.

[0008] In order to overcome such drawbacks, the most recent tendency for the high speed actuation of the spinning rotors is therefore towards individual motorisation of the rotor of each open-end spinning unit.

[0009] In the state of the art the proposals relative to individual motorisation are recent and numerous, for example in patents US 4,916,891, US 6,516,601, US 6,590,307 and US 6,668,536, in patent applications US 2005/0279076 and US 2007/0132329, in patent applications DE 10 2005 023517, DE 10 2006 043376, WO 2003/038166, WO 2005/075719 and WO 2008/000335.

[0010] In order to make such individual actuation at 150,000 revs/min and above, there are currently technological problems due to the high speed. With regard to direct actuation with an electric motor, the direct motorisation of the rotor requires a motor with a supply frequency of 2500 Hz and above, and it has also been proposed, as an alternative to the electric motor, to use air turbines connected to the shank of the rotor. A significant obstacle to extensive application of such proposals of individual motorisations is currently the reliability of the bearings actuated at such rotation speeds in continuous service; many of the aforementioned prior art documents concern the use of contact-free magnetic bearings, to support the motor and the spinning rotor directly coupled together.

[0011] The present invention relates to a device for individually motorising the spinning rotor, i.e. "open-end", to operate at high speeds.

[0012] The purpose of the present invention is to make a device for individually motorising the open-end spinning rotor, which overcomes the drawbacks of the devices proposed in the state of the art and allows greater reliability, efficiency and yield of the spinner and quality of the yarn to be obtained.

[0013] In order to more clearly outline the problems tackled and the technical solutions proposed with the present invention we thus refer, in the following description, to an individual actuation set-up, as an example and not for limiting purposes, with the explicit premise that it can also have advantageous use with different motors.

[0014] The individual actuation device for open-end spinning units according to the invention is defined, in its essential components, in the first claim whereas its variants and preferred embodiments are specified and defined in the dependent claims.

[0015] In order to illustrate the characteristics and ad-

vantages of the present invention more clearly, it is described with reference to its typical embodiments shown in figures 1 to 3 as an example and not for limiting purposes.

[0016] The individual actuation set-up of the open-end spinning rotor is schematically illustrated in a front view in the figures marked A, in a view from above in the figures marked B and in a side view from the left in the figures marked C. Such a set-up makes use of a support of the spinning rotor already known in the field and commonly known as "twin disc", for example according to patents US 4,916,891 and WO 2003/038166. Such a support consists of two underlying supports each consisting of a pair of coaxial discs and of an upper guide pulley that presses the shank of the rotor against the two pairs of discs. The axles of the spinning rotor, of the two pairs of support discs and of the guide pulley are parallel.

[0017] Concerning this, it should be noted that, in the "twin disc" support system, when it is said that the two axles are parallel we mean that they are "substantially parallel", since in reality the provision is taken to mount them slightly askew so as to generate an axial force on the rotor in rotation that keeps it pressed against its axial bearing behind and prevents it making any axial movement. This therefore applies when the pair of discs with parallel axles of the "twin disc" support is described.

[0018] According to these prior art documents, the "twin disc" support is used by actuating it with a single motor connected to the upper guide pulley, in the case of patent US 4,916,891, or else connected to one of the pairs of the support discs, in the case of WO 2003/038166.

[0019] In these prior art documents, it is found that the shank of the spinning rotor O-E receives drive torque from a single rotating member and must, in turn, keep the other two members in rotation, transmitting to them the drive torque necessary to overcome their resistance. In such embodiments such two idle members therefore constitute a brake to the rotation of the spinning rotor.

[0020] In particular, in the different embodiments of the present invention they have been represented hereafter:

- in figures 1A,B,C with a single motor and the support discs of the "twin disc" coplanar and facing one another according to their outer circumference, and connected with a motion transmission belt to the other pair of discs,
- in figures 2A,B,C with two motors, one for each of the pairs of support discs of the "twin disc", coplanar and facing one another according to their outer circumference,
- in figures 3A,B,C with two motors, one for each of the pairs of support discs of the "twin disc", which are not coplanar, but are axially staggered; such an embodiment allows the resting level of the shank of the rotor on the "twin disc" to be raised, avoiding it jamming between the two discs.

[0021] The figures of the aforementioned three embodiments, according to the three front, plan and side views, show the essential components of the invention: motors, twin-disc support, spinning rotor with the relative shank, guide pulley and support structure of the spinning unit, wherein the references D and S indicate the right and left elements.

[0022] With reference to figures 2A,B,C of the embodiment with two motors, the following elements are shown:

- 1) cup of the spinning rotor to be set in rotation at high speed,
 - 2) cylindrical shank of the spinning rotor that rests on the rear on an
 - 3) axial bearing to keep the rotor at a certain axial coordinate,
 - 4_S) stator of the first motor (on the left) that contains the support bearings of its
 - 5_S) axle and of the left twin-disc support,
 - 4_D) stator of the second motor (on the right) that contains the support bearings of its
 - 5_D) axle and of the right twin-disc support, the axles 5 being parallel to one another and parallel to the axle of the shank 2,
 - 6_S and 6_D) left and right front discs of the twin disc support, on which the shank 2 of the spinning rotor 1 rests, integral with the axle of their motor,
 - 7_S and 7_D) left and right rear discs of the twin disc support, on which the shank 2 of the spinning rotor 1 rests, integral with the axle of their motor,
- (As stated above, in figures 1-2 the right and left discs are arranged coplanar and facing one another according to their outer circumference, whereas in figure 3 they are not coplanar, but axially staggered and brought closer together so that the distance between their axles is less than their diameter),
- 8) fixed support structure of the overall actuation device,
 - 9) guide pulley on the shank 2 of the spinning rotor 1 to keep the rotor horizontal and permanently rested on the twin disc support of the discs 6_{S,D}, 7_{S,D}, pressing on the shank of the rotor with its peripheral discs 20 rotating idly around an axle 21, parallel to the axles 5 of the discs 6_{S,D}, 7_{S,D}. Such an axle 21 is carried by a support bar 22 hinged at a fixed pin 23 and pressed downwards with a spring 24, to hold the shank 2 permanently resting,
 - 10_S) rotor of the first left motor,
 - 10_D) rotor of the second right motor.

[0023] The "twin disc" support device of the shank 2 of the spinning rotor 1 is schematically analogous to the support that is used in conventional actuation with longitudinal drive belts, for example according to the aforementioned patent US 4,916,891. The special characteristic of the present invention concerns the replacement of one or both of the support bearings of the "twin disc" with the rotor of one or two individual actuation motors

that rest their outer casing on the fixed structure of the machine. The axles 5 of the rotors 10 of such one or two motors project at their ends and are in common with the "twin disc" support: the discs 6_{S,D}, 7_{S,D} are fixed on the projecting part of such axles. Both of the pairs of such discs - right and left - are motorised and transmit torque setting the shank 2 in rotation, and they are no longer idle like in the conventional "twin disc" support according to patent US 4,916,891. The support bearings of the rotor 10 of the motor act as a support also for the discs 6_{S,D}, 7_{S,D}. The shank 2 of the spinning rotor is dragged into rotation by friction by the outer coating of the motorised discs 6_{S,D}, 7_{S,D}, being pressed against them by the guide pulley 9.

[0024] In the motorisation set-up according to figures 2A,B,C two motors are indicated as examples, one for each axle 5, but different technical actuation solutions are also possible, the main ones of which are the following:

- figures 1A,B,C: a single motor on one of the pairs of discs 6_{S,D}, 7_{S,D}, for example the right one 6_D, 7_D with their motor 4_D, with the other pair of discs 6_S, 7_S dragged by a transmission. For example, it is possible to adopt a flat belt transmission 30 from the axle 5_D of the same motor of the first pair of discs to the axle 5_S of the pair of left discs 6_S, 7_S, so that both of the pairs of discs are motorised and able to transmit rotation torque to the shank of the rotor;
- unlike the previous embodiments in which the discs 6_{S,D}, 7_{S,D} are coplanar, in the embodiment according to figures 3A,B,C,
- which, purely as an example, shows the motorisation with two motors analogous to the set-up of figure 3 - the axles 5_S and 5_D of the twin-disc support are brought together, axially staggering the support discs 6_{S,D}, 7_{S,D} of the shank of the rotor, which interpenetrate and support the rotor at a higher level. Such an embodiment avoids the risk of the shank of the rotor jamming between the discs 6_{S,D}, 7_{S,D} and reduces the transverse bulk of the device. It is suitable for making higher transmission ratios.

[0025] In the case of motorisation with two motors, one for each pair of discs, which thus both cooperate in the generation and transmission of the rotation torque to the spinning rotor 1, the speed of the two motors is kept strictly equal between the two, both in steady running state and during transients.

[0026] According to the preferred embodiment of the invention, the preferred type of motorisation foresees the use of electric motors, even if the first actuation quoted above (figure 1) can also be actuated with different motors, for example compressed air turbines. Among electric motors synchronous motors are particularly recommended, preferably brushless or other types of frequency-controlled motor, with suitable high synchronisation with each other in the case of two motors, as illustrated

in figures 2 and 3.

[0027] For the actuation of the single spinning rotor motors with low power and rotation torque are needed and therefore their actuation can be controlled directly with a microprocessor or a control panel that can be single for each spinning unit or can even serve many spinning units simultaneously.

[0028] The two pairs of right and left discs $6_{S,D}$, $7_{S,D}$ preferably have the same diameter and are fitted on their parallel and horizontal axles $5_{S,D}$ of the motors or stators $4_{S,D}$, with an axle base slightly greater than their diameter in the embodiments according to the set-ups of figures 1 and 2, and on the other hand smaller than their diameter according to the set-up of figure 3.

[0029] In order to obtain adequate transmission between motors and spinning rotor, the size of the discs $6_{S,D}$, $7_{S,D}$ is preferably kept to between 60 and 100 mm in diameter, whereas the size of the shank 2 of the spinning rotor 1 is preferably kept to between 6 and 10 mm in diameter, with a transmission ratio between motor and spinning rotor 1 kept to between 6 and 15.

[0030] In general, the guide pulley 9 is shorter than the "twin disc" support underneath and rests on the shank 2 of the rotor 1 being located in the gap between the pairs of discs $6_{S,D}$, $7_{S,D}$. It is mounted on a support pressed by a spring 24 that, if necessary, can be easily raised to free the shank of the rotor.

[0031] The individual indirect actuation device for open-end spinning units according to the invention has substantial advances with respect to individual direct actuation devices proposed by the prior art. One of the most obvious of these advances is the drastic reduction in the rotation speed required both for the motors and for the bearings in the indirect actuation solutions according to the present invention. It is clear that both of the pairs of discs are thus motorised with the same speed both in steady running state and during transients.

[0032] Still referring to the very high rotation speeds required for the spinning rotor, the use of the "twin disc" support arranged between motors and spinning rotors allows a decisive speed reduction ratio. For example, by making the two discs 6,7 with an outer diameter equal to ten times the diameter of the shank 2 of the spinning rotor, a transmission ratio of 1 to 10 is obtained: still to give the rotor a required speed of 150,000 revs/min, the necessary rotation speed of the motors and of the relative bearings falls to 15,000 revs/min. Such an order of magnitude of the steady rotation speeds in continuous use required for motors and bearings is much lower and more acceptable. Electric motors that work at 250 Hz and are frequency-controlled and mechanical bearings that work at 15,000 revs/min are somewhat less demanding and more reliable than those that are required for the direct motorisation of the spinning rotor. Such motors and bearings are supplied, by the relative manufacturers, and are on general sale.

[0033] Amongst the other advantages that are achieved with respect to conventional open-end spinners

are:

- the lower energy consumption, with savings of around 25% in the actuation of the rotor;
- drastic reduction in noise due to the elimination of the biggest noise source of the open-end spinner;
- simplification of the spinning unit - reducing its need for maintenance and spare parts - due to the elimination of the braking and clutch devices to disengage it from common actuation;
- higher joining quality, due to the possibility of precisely controlling the speed of reattachment and the subsequent acceleration ramp;
- constancy of the speed of the spinning units along the front of the machine, with constancy of the twists given to the yarn, avoiding the typical slipping of belt transmissions;
- substantial reduction in the need to clean and maintain the spinning units.

[0034] Compared to technical solutions that use a "twin disc" support according to patent US 4,916,891 or else WO 2003/038166, the technical solution according to the present invention makes it possible to transmit drive torque to the shank of the spinning rotor O-E with both the pairs of support discs, to a markedly greater extent (more than double for the same geometry of the system and load of the guide pulley) than what is permitted by a single rotary actuation member, and avoiding such rotary members acting as a brake for the rotation of the spinning rotor.

Claims

1. Device for individually actuating the rotation of the open-end spinning rotor (1) with which the rotary motion is transmitted indirectly to its shank (2), wherein said shank is supported with a so-called "twin disc" device consisting of two pairs of front discs ($6_{S,D}$) and rear discs ($7_{S,D}$), the discs being fitted onto axles (5_S , 5_D) parallel to the axle of the shank (2), said shank (2) being held resting against the cylindrical surface of the two pairs of discs ($6_{S,D}$, $7_{S,D}$) by a guide pulley (9), consisting of a third pair of discs (20), fitted onto an axle (21) parallel to the two axles (5_S , 5_D) of the discs ($6_{S,D}$, $7_{S,D}$) and pressed against them, **characterised in that** one or both of the bearings of the parallel axles (5_S , 5_D) of the "twin disc" support consist of the rotor ($10_{S,D}$) of one or two individual actuation motors having stators ($4_{S,D}$) that rest their outer casing on the fixed structure (8), giving the motion for actuating rotation of both shafts (5_S , 5_D) and both pairs of right and left discs ($6_{S,D}$, $7_{S,D}$), which in turn transmit it by friction to the shank (2) of the rotor (1).
2. Device for individually actuating the rotation of the

open-end spinning rotor (1) according to claim 1,
characterised in that the actuation is carried out
 with a single motor having the stator (4_D or 4_S) on
 one of the two pairs of discs (6_D , 7_D or 6_S , 7_S), the
 other pair of discs being dragged by a transmission 5
 (30) connected to the same motor, so that both of
 the pairs of discs are motorised with the same speed
 both in steady running state and during transients
 and able to transmit the torque for actuating rotation
 to the shank of the rotor. 10

3. Device for individually actuating the rotation of the
 open-end spinning rotor (1) according to claim 1,
characterised in that the actuation is carried out
 with two motors having the stator ($4_{S,D}$), one for each 15
 pair of discs, which both cooperate in the transmis-
 sion of the rotation torque to the spinning rotor (1)
 with the speed of the two motors being the same as
 one another, both in steady running state and during
 transients. 20

4. Device for individually actuating the rotation of the
 open-end spinning rotor (1) according to claim 1,
characterised in that the actuation is carried out
 with frequency-controlled synchronous electric mo- 25
 tors.

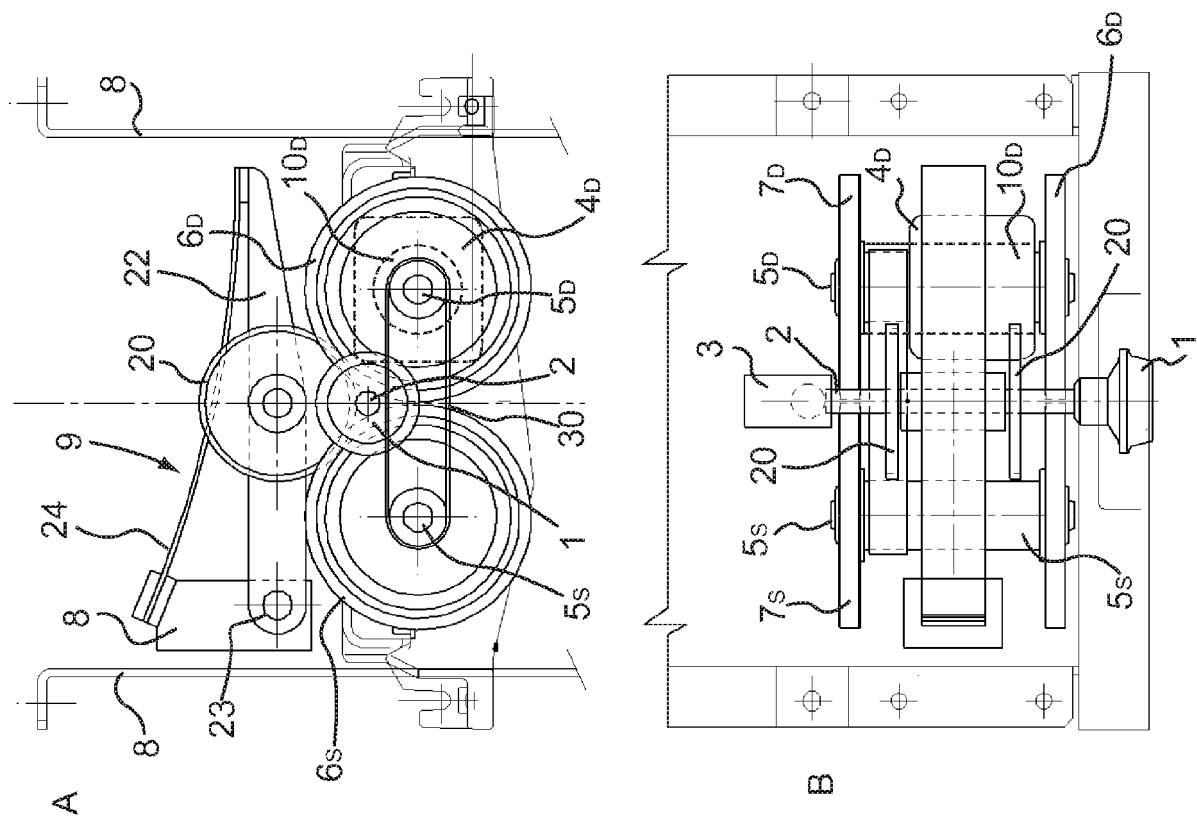
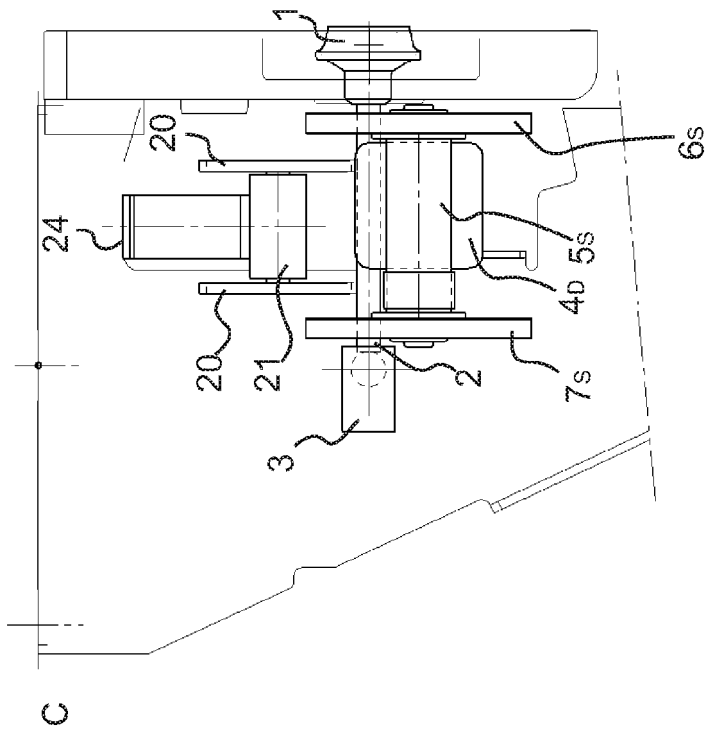
5. Device for individually actuating the rotation of the
 open-end spinning rotor (1) according to claim 5,
characterised in that the actuation is carried out 30
 with brushless motors.

6. Device for individually actuating the rotation of the
 open-end spinning rotor (1) according to claim 1,
characterised in that the actuation is carried out 35
 with a transmission ratio between motor and rotor
 (1) of between 6 and 15.

7. Device for individually actuating the rotation of the
 open-end spinning rotor (1) according to claim 1, 40
characterised in that the axles ($5_S, 5_D$) of the twin-
 disc support are arranged a shorter distance apart
 than the diameter of the discs ($6_{S,D}, 7_{S,D}$) axially stag-
 gering said discs. 45

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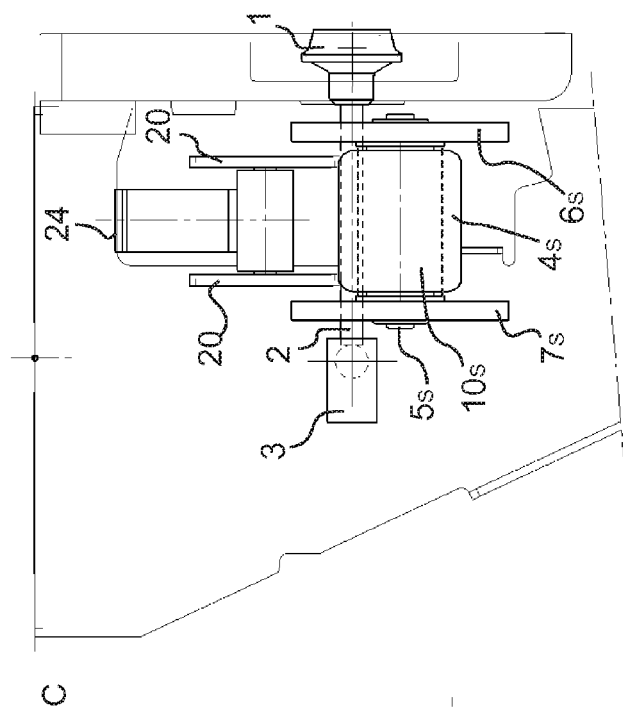
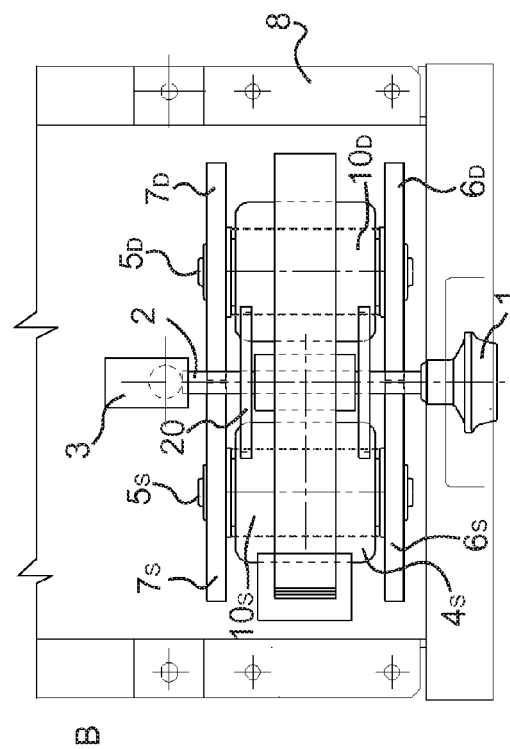
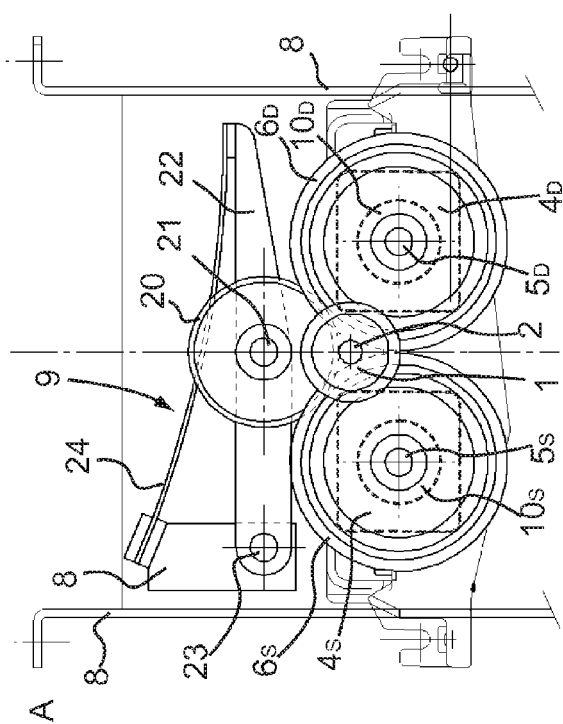


Fig. 2



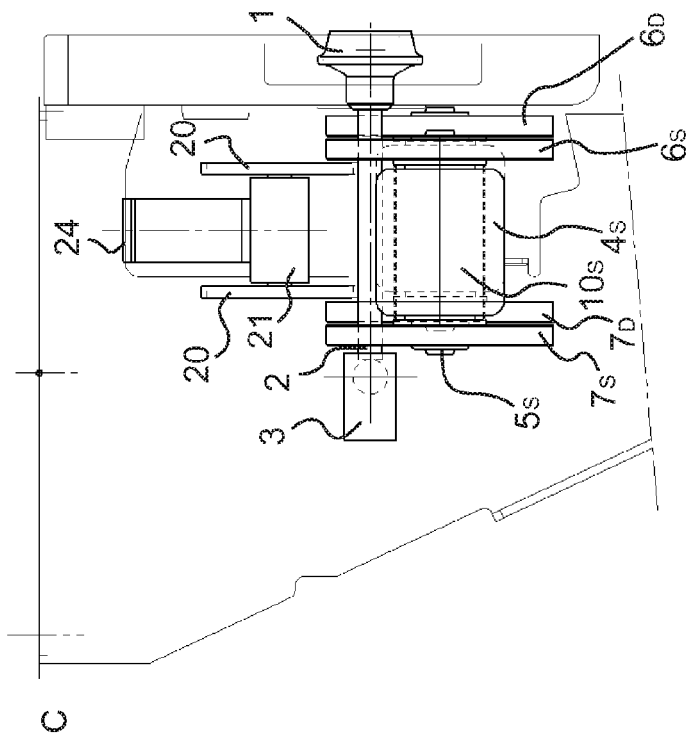
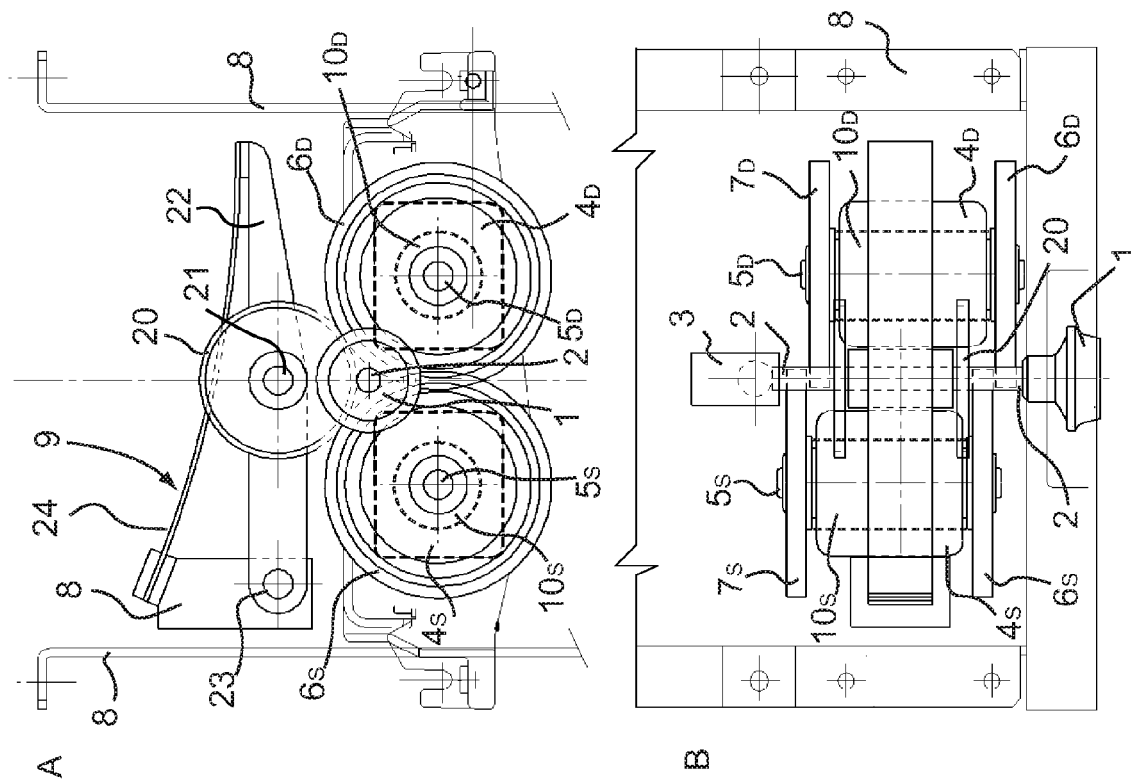


Fig. 3





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EP 10 15 3254

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 10 15 3254

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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