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(71) Applicant: **Bromas-Log S.r.l.**
59100 Prato (PO) (IT)

(72) Inventor: **Brogi, Marco**
50013 Campi Bisenzio (FI) (IT)

(74) Representative: **Fanfani, Stefano**
Fanfani S.R.L.
Via Giovanni Bovio 19
50136 Firenze (IT)

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(54) **RADIAL BRAIDING MACHINE WITH PROGRAMMABLE AND VARIABLE BRAIDING PATTERNS**

(57) A radial braiding machine with braiding patterns that can be programmed and varied during processing, for the production of biaxial, triaxial, or multiaxial braids

or tubulars, with yarn or tape feeding in deroulé without deviators, particularly suitable for braiding semi-rigid tapes.

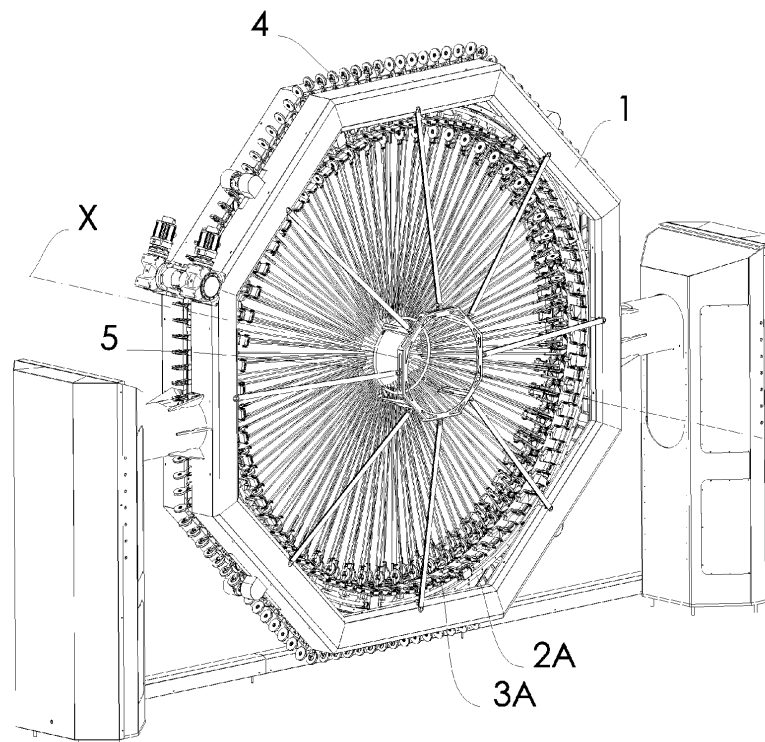


FIG. 1

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Description

Technical field

[0001] The present invention belongs to the technical field of machinery for the textile and rope-making industry.

[0002] More precisely, the present invention relates to a machine for braiding, better known as a "braiding machine," suitable for processing elongated elements such as yarns or tapes for the purpose of making braided fabric ropes or tubulars and for forming a braided fabric sleeve covering on products and manufactured goods of various shapes.

Present status of the art

[0003] Machines for braiding yarns consisting of thread-like or tape-like elements of different kinds, designed and built to form flat braids, tubulars, ropes and cords such as nautical ropes or mountaineering ropes, strings and laces such as the laces of some footwear, etc., have long been known.

[0004] The feed material, thread-like or tape-like, that is used to form said braids can be made from natural or synthetic fibers or from glass or plastic or metal yarns or even from composite materials, such as carbon fiber. The material is wound into bobbins formed on spools that are rotationally coupled to respective bobbin carrier. During processing, the material wound onto the bobbins is progressively unwound from the spools and is guided to the braiding point by means of appropriate guiding devices.

[0005] It has also long been known to use such braiding machines for the application of braided coverings to the outer surface of ropes or cables and the like. The coating generally consists of materials suitable for giving the product characteristics of high shear strength, rubbing resistance and tensile strength, or electrical and/or thermal insulation.

[0006] In more recent times, such braiding machines have found a new application in the manufacturing industry, particularly for the production of braided fabric sleeves or coverings that are wrapped around the outer surface of mechanical or structural components or components for industrial use, such as propellers, blades and other parts of aircraft or motor vehicles, masts for nautical applications, cylinders containing high-pressure gases, etc. In these cases the covering is often made of matrix materials of semi-rigid composites, which are used to improve the mechanical properties of the component in terms of strength or flexibility.

[0007] Also known are radial braiding machines, particularly suitable for the formation of tubular braids, in which the bobbin carriers are arranged circumferentially on a support frame, in the center of which is a thread-guiding ring, toward which the yarns fed from the bobbins converge, suitable for guiding the formation of the braid. The frame is generally in the form of a fixed ring or wheel

lying in a vertical plane, to one side face of the frame are rotationally coupled rotating bases suitable for supporting and rototranslating the bobbin carriers. Each rotating base includes one or more seatings or recesses each suitable for accommodating the stem of a bobbin carrier. Each bobbin carrier also includes a foot, slidable within multiple tracks defined in the frame and conformed to intersect with each other, so that the rotational motion of the bases forces the bobbin carriers to translate because their foot slides within the respective tracks; during their rototranslational motion the bobbin carriers move from one rotating base to the other.

[0008] Triaxial radial braiding machines comprising both movable and fixed bobbin carriers are also known.

The movable bobbin carriers are supported by two groups of rotating bases arranged concentrically on the frame, which exchange the bobbin carriers with each other by making them roto-translate; the third group of bobbin carriers is fixed relative to the frame and is used for the insertion of axial yarn. This type of braiding machine makes it possible to make biaxial, triaxial or even multi-axial braids.

[0009] An example of a triaxial braiding machine of the aforementioned type is illustrated in U.S. Patent Application US2014157974A1 where two concentric groups of rotating bases, one inner and one outer, and fixed yarn guides for the introduction of axial wires are described. The bobbin carriers engage interchangeably with a rotating base of each group by alternately passing from a base belonging to the inner group to a base belonging to the outer group and vice versa; the rotary motion of the bases forces the bobbin carriers to translate along tracks defined in the frame, simultaneously interchanging and crossing with other carriers, so as to realize the braiding of yarns.

[0010] However, in this machine configuration, as the yarns unwind from their respective bobbins they undergo continuous loosening and tensioning due to the continuous passage of the same bobbins from the outer group of rotating bases to the inner group of rotating bases and vice versa.

[0011] Another example of a triaxial braiding machine is illustrated in South Korean patent KR101155633B1, which describes a braiding machine comprising a single order of rotating bases arranged circumferentially on the support frame. The material that forms the axial braiding yarn is fed from fixed bobbins through a plurality of yarn guides, each of which passes coaxially through the shaft of a respective rotating base.

[0012] In the machine described above, as well as in most triaxial braiding machines currently known at the state of the art, the spools around which is wound the bobbin formed with the material to be braided are arranged according to axes parallel to the weaving axis. This configuration implies that the yarn must be wound in coils around the spool in order to unwind properly and without obstruction, and this excludes the possibility of employing flat tape material, especially if it consists of

semi-rigid material.

[0013] Another issue with currently known radial braiding machines is related to the insufficient amount of yarn that spools can carry, due to the fact that their diameter must be small enough to accommodate a sufficiently large number of bobbins on the same frame, while at the same time leaving sufficient maneuvering space for their rotation and mutual crossing. In addition, a small size of spools is preferred to allow their manual replacement by operators. All of this results in frequent interruptions in the work process for replacing used-up spools.

[0014] Another negative aspect of many known models of radial braiding machines is that the unwinding of the yarn from the respective spool takes place in *defilé*, i.e., from the distal end of the spool in an axial direction with respect to it; however, this mode of unwinding causes excessive and undesirable twists in the yarn. An example of a braiding machine of the aforementioned type is described in EP0617154A1. To overcome this problem, deviation devices are often used that force the unwinding of the yarn, transforming it into *deroulé*, i.e., orthogonal to the axis of the spool, however, in this case the yarn is forced to make a bend of about 90°, undergoing potentially damaging tensions. This problem is amplified in case yarns with a circular cross-section are not used, but tapes are used, and if the tapes are then made of semi-rigid composite materials this problem becomes such that it prevents the formation of the braid without damaging the tape or at least without weakening it. Patent application US4619180A illustrates a bobbin carrier suitable for *deroulé* unwinding of bobbins of tape-like elements.

[0015] In all braiding machines of the known type, the movement of the bobbin carriers occurs according to a fixed pre-set pattern and cannot be dynamically varied without interrupting operation, which is a major limitation both from the point of view of production speed and from the point of view of the possible variations of braiding that can be achieved and the types of fabrics and materials that can be used. Patent application DE102014221996A1 illustrates a braiding machine in which the bobbins move on a ring-shaped support, either around the braiding center or by changing their axial position; however, the combinations of possible braiding achievable with such a machine are rather limited, moreover, the problem of the undesirable twisting suffered by the yarn fed from each bobbin to the weaving center is not eliminated.

Objects and summary of the invention

[0016] In this patent text, the term "bobbin" refers to windings of thread-like or tape-like elements, both generically referred to herein as "ribbons" or "tapes," which are laid on a cylindrical support referred to as a "spool." It should be noted that the term "tapes" is not used in a limiting sense, but includes elongated elements of any cross-section, whether circular, as with yarns, or rectan-

gular, as with proper tapes.

[0017] The scope of this invention is to identify a radial braiding machine with programmable and dynamically variable braiding, without the need to stop work, for the production of flat or tubular braids and also sleeves for covering products.

[0018] Another objective of the present invention is to provide a radial braiding machine that allows the manufacture of braided fabrics with traditional oblique braiding, as well as triaxial or multi-axial braiding, depending on the need, with homogeneous or variable braiding ratio.

[0019] Not the least of the objectives of the present invention is to provide a radial braiding machine with *deroulé* unwinding devoid of deviation devices, which can work by employing both thread-like and flat tape-like elements (so-called "tape") made of any material, particularly suitable for utilizing semi-rigid tapes such as carbon fiber tapes or the like.

[0020] In other words, the scope of the present invention is to provide an extremely versatile braiding machine suitable for making any configuration of braiding, with an easy loading system, capable of drastically reducing the time for set-up and replacement of spools whose bobbin has run out.

[0021] These and other objectives, which will become clear to the expert in the field from reading this text, are achieved by means of a braiding machine that can be configured to braid tapes according to different braiding patterns and that is also capable of dynamically varying the type of braiding produced, during processing.

[0022] The machine object of the present invention includes a frame to which are rotationally coupled two wheels of equal diameter, coaxial with the weaving axis, which can rotate independently of each other, clockwise or counterclockwise, relative to the frame. At least one guiding ring, where the tapes converge thanks to the pulling action exerted by a mechanical arm or by other known means, is arranged at the center of the frame, coaxial with the weaving axis. Connected to each wheel is an equal number of bobbin-carrier stations, angularly equally spaced with each other, each such station comprising a bobbin-carrier and means that induce the rotation of said bobbin-carrier, causing it to translate by an arc of 180° or a full circle of 360°. In the first case, the bobbin-carrier during rotation passes from a first mobile station on the first wheel to a second mobile station located on the second wheel and mirroring the first one, at the same time the bobbin-carrier located on the second mobile station passes on the first mobile station; the wheels rotate in opposite directions to each other, each wheel rotating by a predetermined arc of revolution clockwise and by a predetermined arc of revolution counterclockwise or vice versa. In the second case, the bobbin-carrier during the rotation passes from a first station on the first wheel to a second station on the second wheel, then returning again to the first station while the bobbin-carrier on the second station performs a corresponding rotation, passing to the first station

and then returning to the second station; in this case the two wheels rotate one arc of revolution, in the opposite direction to each other, each wheel always turning in the same direction.

[0023] Each bobbin-carrier rotationally supports a respective spool that rotates about an axis lying in a plane orthogonal to the weaving axis. Thus, advantageously, the unwinding of the tapes wound on the spools takes place in a deroulé manner. The bobbin-carriers are rotationally coupled to their respective supports according to a substantially radial axis and are free to rotate, so as to avoid unwanted twisting of the unwinding tape.

[0024] Additionally and advantageously, the inclination of the bobbin carriers can be adjusted so as to vary the angle of interweaving between the tapes, for this reason a preferred embodiment includes a ball joint, to orient the unwinding of the tape in the direction of the thread-guiding ring.

[0025] To produce a biaxial braided fabric, the two wheels rotate in opposite directions to each other, each making a predetermined arc of turn, generally corresponding to the angular distance between two successive bobbin-carrier stations. The biaxial braiding is produced by the crossing of the bobbins, which, with each progressive rotation (arc of revolution) of the wheels in the opposite direction, rotate passing from one wheel to the other.

[0026] In order to produce a triaxial or multiaxial fabric, an additional set of fixed bobbin-carrier stations is provided; these are integrally connected to the frame and their unwinding axes lie in a median plane equidistant from the two wheels and orthogonal to the weaving axis. The fixed bobbin-carrier stations are angularly equally spaced with each other, and their number is equal to the number of movable stations connected to each wheel or is equal to twice that number; the angular distance between consecutive fixed bobbin-carrier stations must be sufficient to allow the rototranslational movement of the bobbin-carrier supported by the mobile bobbin-carrier stations. The rototranslational movement of the bobbin-carriers supported by the mobile stations makes the tapes fed by said bobbin-carriers wound around the tapes fed by the fixed bobbin-carrier stations, thus producing triaxial, or even multiaxial, braiding. If biaxial fabric is to be produced, no bobbins are loaded on the fixed bobbin-carrier stations, or in any case the material wound on the bobbins loaded on the fixed stations is not fed to the braid.

[0027] The invention makes it possible to produce numerous different combinations of braiding, even by varying the braiding pattern during processing, making it possible to obtain biaxial or multiaxial braided fabrics presenting a heterogeneous braiding pattern, possibly even differentiated in the different sections of the fabric.

[0028] According to one aspect of the invention, the support frame is rotatable and vertically movable so that it can be alternately arranged between a first working position, in which the frame lies on a substantially vertical plane, and a second position for loading and replacing

spools, in which the frame is arranged on a horizontal plane and is conveniently translated downward, in order to facilitate set-up and spool replacement operations by operators.

Brief description of the drawings

[0029]

Fig. 1 shows an overall view of the frame (1) of the braiding machine to which are rotationally coupled the two wheels (2A, 2B) each supporting a respective set of mobile bobbin-carrier stations (3A, 3B). Also visible are the fixed bobbin-carrier stations (4) integrally attached to the frame (1), the latter being shown in the working position. Shown at the center of the frame is a thread-guiding ring (5) toward which the tapes of the bobbins of the mobile and fixed bobbin-carrier stations converge. Also shown is the weaving axis (X) orthogonal to the longitudinal median plane (YZ) of the frame (1).

Fig. 2 shows a mobile bobbin-carrier station (3A, 3B) comprising a base (31) in which is defined a recess in which is housed a half-crown (32) rotatable about the radial axis (R1) and whose teeth are reversibly engaged in the links of a chain representing the means of transmission (33) of rotational motion to said half-crown. Also visible is the bobbin-carrier (35) whose proximal portion (352) is coupled to the half-crown (32) by means of the support (34) that lets said bobbin-carrier be free to rotate about a substantially radial axis (R2). To the distal portion (351) of the bobbin-carrier is rotationally coupled a spool (36) rotatable about an axis (R3) by means of magnetic means (38) for support and braking. Also visible are the engaging means (37) slidably coupled to the base with a front face (371) suitable for pressing on one of the opposing faces of the proximal portion (352) of the bobbin-carrier. Finally, the thread-guiding eyelet (40) suitable for slidably receiving the tape fed from the bobbin is visible.

Fig. 3 shows an exploded view of a mobile bobbin-carrier station (3A, 3B). Shown here are the radial axis (R1) around which the half crown (32) rotates and the substantially radial axis (R2) around which the bobbin-carrier (35) rotates during its rototranslational motion. The distal portion (351) and the proximal portion (352) of the bobbin-carrier (35) are reciprocally connected by means of connecting means (39) comprising a joint (391) and two adjusting screws (392) by acting on which it is possible to adjust the inclination of said distal portion (351) of the bobbin-carrier (35) with respect to the proximal portion (352).

Figs. from 4 to 7 show in sequence several positions reciprocally assumed by two bobbin-carriers (35) supported by two mobile bobbin-carrier stations (3A, 3B) each located on a respective wheel and mirroring

each other, during their rototranslational motion; a fixed bobbin-carrier station (4) is also visible.

Fig. 8 shows an exploded side view of a bobbin-carrier (35) with corresponding spool (36). Illustrated here are the supporting and braking magnetic means (38) comprising a ferromagnetic disk (383) coaxially coupled to an idler wheel (385) the latter being integrally connected to the first end of a pin (386) passing through the distal portion (351) of said bobbin-carrier (35) and having a second threaded end to which is coupled a support (382) to which magnets (381) are integrally connected and whose position along the axis (R3) can be modified by acting on the adjusting means (384).

Fig. 9 shows a partial view of two wheels (2A, 2B) with their respective mobile bobbin-carrier stations (3A, 3B) and fixed bobbin-carrier stations (4).

Detailed description of an embodiment of the invention

[0030] According to a preferred embodiment, the radial braiding machine with programmable and variable braiding patterns that is the subject of the present invention includes:

- a frame (1) having horizontal side support arms, each of which is rotationally coupled with a corresponding vertical support, the longitudinal midplane (YZ) of said frame being orthogonal to the weaving axis (X);
- a thread-guiding ring (5) coaxial to the weaving axis (X) and located in correspondence with the center of the frame (1), said ring being suitable for guiding the formation of a tubular braid along the direction identified by the weaving axis (X);
- two wheels (2A, 2B) of equal diameter, rotationally coupled to the frame (1) by means that allow the rotation of each wheel independently of the other, both clockwise and counterclockwise, the wheels being both coaxial to the weaving axis (X) and equidistant with respect to said median plane (YZ) parallel to and intermediate between the planes on which the two wheels lie;
- two groups of mobile bobbin-carrier stations (3A, 3B) respectively integrally connected to the periphery of each of said wheels (2A, 2B), each group of stations being composed of the same number of bobbin-carrier stations angularly equally spaced with each other, so that the configuration of the bobbin-carrier stations of the first wheel is mirror-image to the configuration of the stations of the second wheel with respect to said median plane (YZ).

[0031] Each mobile bobbin-carrier station (3A, 3B) in turn comprises:

- a base (31) integrally connected to one of the wheels,

in which is defined a recess conformed like a circular half-annulus in which is housed a corresponding half-crown (32), which has teeth on the outer circumferential edge and is free to rotate resting on the bottom of the recess; the rotation of the half-crown takes place around a radial axis (R1) orthogonal to the weaving axis (X) and lying on said median plane (YZ);

- means (33) to transmit rotational motion to said half-crown (32), which in the embodiment described here consist of a chain in the links of which reversibly engage the teeth of said half-crown (32);
- a support (34) integral with said half-crown (32) and comprising means of idler rotational coupling of the proximal portion of a bobbin-carrier (35) according to a substantially radial axis (R2) orthogonal to said weaving axis (X);
- a bobbin-carrier (35), the distal portion (351) of which rotationally supports a spool (36) that rotates about an axis of rotation (R3) lying in a plane parallel to said median plane (YZ), the proximal portion (352) of said bobbin-carrier (35) presenting at least two diametrically opposed parts which in the embodiment described herein consist of two opposing surfaces parallel to each other and lying on planes parallel to the plane on which the axis (R3) of rotation of the spool (36) lies;;
- engaging means (37) slidably coupled to said base (31) and suitable for cooperating with the proximal portion of said bobbin-carrier (35) by forcing it to rototranslate during the rotation of the corresponding half-crown (32) so that the axis of rotation (R3) of the spool always lies in planes orthogonal to the weaving axis (X); in the embodiment described herein, such engaging means (37) comprise a sliding presser with a front face (371) that presses on one of the aforementioned opposing faces of the proximal portion of said bobbin-carrier (35), so as to prevent rotation of the latter about the axis (R2), keeping them always parallel to the longitudinal median plane (YZ). In this way, the bobbin-carrier roto-translate about the axis (R1) while keeping the axis (R3) of spool rotation always in a plane orthogonal to the weaving axis (X), it follows that the tape can unwind from the bobbin without twisting as a result of the rotation of the half-crown around the axis (R1).

[0032] The braiding machine object of the invention further includes means for controlling the angular positioning of said wheels (2A, 2B) and said half wheels (32). Such control means include at least one central control unit, as well as motors and actuator means. The control unit is programmable to achieve countless different types of intersections and allows the dynamic variation, during processing, of the movement of the wheels and of each of the mobile stations to achieve countless types of intersections.

[0033] The wheels (2A, 2B) rotate independently of

each other and are each controlled by a servomotor functionally connected to the central control unit, the latter manages the movement of both wheels, as well as their reciprocal positioning and rotational speed. When the wheels are reciprocally positioned so that two mobile stations are counterposed to each other the respective half-crowns can rotate by one or more straight angles about the same radial axis (R1) orthogonal to the weaving axis (X) and lying on said median plane (YZ), for each rotation passing from one station to the counterposed one.

[0034] Generally, the rotational motion of the wheels is of the intermittent type: each wheel (2A, 2B) makes a rotation of an arc of revolution equal to the angular distance between two successive bobbin-carrier stations or equal to a multiple of that distance, after each partial rotation of arc of revolution the wheels (2A, 2B) stop momentarily to allow for the possible rototranslation of the bobbin-carriers according to the planned braiding program, then each wheel makes a further rotation of arc of revolution. In this way, when the wheels stop to allow for the rototranslation of the bobbin-carriers, any mobile station placed on the first wheel is always facing with a corresponding mobile station on the second wheel, arranged mirroring the first. Depending on the desired braiding, each wheel (2A, 2B) is either rotated progressively always in the same direction or is rotated one arc of a revolution in one direction and then one arc of a revolution in the opposite direction; consequently, the bobbin-carriers (35) of the mobile stations (3A, 3B) are roto-translated by making a complete 360° revolution or a half revolution of 180°.

[0035] The braiding machine subject of the invention further comprises a group of fixed bobbin-carrier stations (4) each supporting a spool and located outside the circumference of the two wheels (2A, 2B) solidly connected to said frame (1). The fixed bobbin-carrier stations (4) are angularly equally spaced with each other. The unwinding axes of said fixed stations (4) lie on the median plane (YZ) on which also lie the tape or thread-like elements unwound from the spools carried by said fixed stations (4). Each fixed bobbin-carrier station (4) includes a thread-guiding device suitable for smoothly accommodating the thread-like or tape-like element fed from the corresponding spool; said guiding device extends radially along an axis coincident with the radial axis (R1) of two mobile bobbin-carrier stations (3A, 3B). The total number of fixed bobbin-carrier stations (4) is either the same as the number of mobile stations (3A, 3B) connected on each wheel (2A, 2B) or is twice that number. In the latter case, when the mobile stations (3A, 3B) on their respective wheels (2A, 2B) face each other in a mirror-like manner, the fixed stations (4) are alternately located, every other one, in correspondence with portions of the wheels (2A, 2B) without mobile stations (3A, 3B), in other words, for every two successive fixed stations (4) only one is placed between two facing mobile stations (3A, 3B); the angular distance between two consecutive fixed stations (4) must be sufficient to allow the half-crowns

(32) to rotate without them interfering with the thread-guiding devices of the fixed stations (4) placed in correspondence with the portions of the wheels (2A, 2B) without mobile stations (3A, 3B).

[0036] The engaging means (37) of two counterposed mobile bobbin-carrier stations cooperate to prevent the rotation of the bobbin-carriers (35) supported by those stations around their respective substantially radial axis (R2) during their entire rototranslational motion. In the course of its own rototranslational motion, each bobbin-carrier (35) initially receives thrust only from the sliding presser of the mobile station supporting it, when the bobbin-carrier (35) reaches the median plane (YZ) it also comes into contact with the sliding presser of the counterposed mobile station, continuing in its rototranslational motion and passing over that second mobile station, the bobbin-carrier receives the thrust of only the presser of the latter station, until it again arrives in correspondence with the median plane (YZ) where it re-enters into contact with the sliding presser of the first mobile station and continuing still in rototranslation remains in contact only with the latter.

[0037] The braiding of the thread-like or tape-like elements of mobile stations can be achieved in several ways. The types of braiding that can be achieved are innumerable and are obtained by alternating one or more successive rotations of a wheel (2A, 2B) in one direction, clockwise or counterclockwise, and one or more rotations in the opposite direction: for example, the braiding machine that is the subject of the present invention makes it possible to achieve a "standard" triaxial crossing, i.e., with an axial tape interposed between two successive intersections of the two tapes fed by the mobile bobbin-carrier stations, or an alternating triaxial fabric in which the axial tape is interposed between every other successive intersections formed by the tapes fed by the mobile bobbin-carrier stations, or even a triaxial fabric with two axial tapes interposed between two successive intersections of the tapes fed by the mobile bobbin-carrier stations, or an alternating triaxial intersection with free unidirectional tapes in the center.

[0038] A first way to achieve the braiding of only those tapes fed by the mobile bobbin-carrier stations (3A, 3B) is to have the bobbin-carriers (35) of two of said mirror-facing stations each perform a 180° rototranslatory motion such that each of the two half-crowns (32) rotates by one straight angle around the radial axis (R1) passing from a first mobile station to the mobile station mirroring it. The wheels (2A, 2B) move in opposite directions to each other, each rotating one arc of revolution clockwise and subsequently one arc of revolution counterclockwise (or vice versa).

[0039] A second way to achieve the braiding of the tapes of the mobile stations is to have the bobbin-carriers (35) of two mirror-facing mobile stations (3A, 3B) each perform a 360° rototranslatory motion, and in this case each half-crown (32) rotates one full angle around the radial axis (R1) passing from the first mobile station to

the mirror-facing mobile station and then returning again to the first station; in this case the wheels (2A, 2B) move, in opposite directions to each other, each always in the same direction.

[0040] The central control unit individually and independently manages the operation of each mobile bobbin-carrier station (3A, 3B) in particular by controlling the means of transmission (33) and thus the direction and speed of rotation of the half-crowns (32) as well as their rotation by an arc of 180° or a full angle of 360°.

[0041] In a particularly complete embodiment, the invention further comprises a second thread-guiding ring also coaxial with the weaving axis (X) and located on the opposite side of the frame from the first thread-guiding ring (5). Such a second ring enables bidirectional processing, which is particularly useful when it is desired to cover the surface of an object several times with the braid.

[0042] According to the embodiment described herein and illustrated in the figures, each spool (36) is rotationally coupled to its respective bobbin-carrier (35) by means of magnetic means (38) which rotationally support said spool (36) on the corresponding bobbin-carrier (35) and also allow adjustment of the value of the unwinding tension of the spool. Such means (38) comprise one or more magnets (381) integral with a support (382) movable along said axis of rotation (R3) and a disk (383) of ferromagnetic material integral with said spool (36). By acting on appropriate means of adjustment (384) it is possible to vary the position of said movable support along said axis (R3) and consequently the distance between said magnets and said ferromagnetic disk, thus modifying the force of magnetic attraction exerted by the former on the latter and consequently the friction force opposing the rotation of the spool (36). In the attached figures, said spool (36) and said ferromagnetic disk (383) are coaxially supported by an idler wheel (385), the latter being integrally connected to the first end of a pin (386) passing through the distal portion (351) of said bobbin-carrier (35) and having a second threaded end, cooperating with said means for the adjustment (384) of the position of said support (382), in this case consisting of an adjustment wheel in which is defined a nut-screw that engages with the threaded end of said pin, said movable support (382) being coupled to said adjustment wheel so that the latter is free to rotate with respect to it. Advantageously, said magnets (381) are neodymium super magnets and said spool (36) is made of nonmagnetic material.

[0043] The distal portion (351) of said bobbin-carrier (35) is coupled to the corresponding proximal portion (352) by connecting means (39) that are reversibly lockable and allow adjustment of the inclination of said distal portion with respect to said substantially radial axis (R2). Such connecting means (39) include, in particular, a ball joint (391) and at least two locking screws (392), specularly counterposed, which block any rotation of the distal portion (351) of the bobbin-carrier (35) relative to the proximal portion (352). By alternately tightening or loos-

ening these locking screws (392), it is possible to adjust the inclination of the distal portion (351) of the bobbin-carrier (35) and consequently to modify the angle of incidence of the thread-like or tape-like element with respect to the thread-guiding ring (5), that is, the angle that the elements constituting the finished fabric form with respect to each other.

[0044] With reference to the embodiment described herein, the distal portion of each bobbin-carrier (35) includes a thread-guiding eyelet (40), preferably made of ceramic material, inside which the thread-like or tape-like element fed by the respective spool (36) runs.

[0045] The distal end of each of the horizontal side arms of the frame (1) is rotationally connected with a respective plate, the latter sliding within corresponding vertical guides defined in a respective vertical support. The vertical translation of the plate in the corresponding guides is actuated by hydraulic or pneumatic organs, such as by means of a jack. A respective gear wheel is coaxially integral to each frame arm (1) and cooperates with a fixed rack integral to the corresponding vertical support so that the vertical translation of the plates in the corresponding guides simultaneously causes the rotation of the frame support arms and consequently the rotation of the frame about its own transverse axis.

[0046] Very advantageously, this configuration makes it possible to position the frame (1) alternately in a working position, in which said longitudinal median plane (YZ) is substantially vertical and both support arms of the frame are located in correspondence with the upper end of the respective guide, and a position for loading and unloading spools, in which said frame (1) is arranged with its median plane (YZ) substantially horizontal and both side support arms are translated vertically toward the lowest point of the respective guides, so as to make it easier for the operators to work.

Claims

1. A radial braiding machine with programmable braiding patterns, for the formation of multi-axial braids or tubes from bobbins of tape or thread-like elements wound onto spools, comprising:

- a support frame (1) whose longitudinal median plane (YZ) is orthogonal to the weaving axis (X);
- two wheels (2A, 2B) of equal diameter rotationally coupled, independently, to said frame (1) and both rotatable and coaxial with respect to the weaving axis (X);
- two groups of mobile bobbin-carrier stations (3A, 3B) respectively integrally connected to the periphery of each of said wheels, angularly equally spaced between them, the configuration of the stations of the first wheel being mirror image to the configuration of the stations of the second wheel with respect to a median plane

(YZ) orthogonal to the weaving axis and equidistant between the planes on which the two wheels lie;

- at least one guiding ring (5), coaxial with the weaving axis (X);

characterized in that each of the said mobile bobbin-carrier stations (3A, 3B) comprises:

- a base (31) comprising means of connection at the periphery of the wheel, in which is defined a recess conformed like a circular half-annulus in which is housed a corresponding half-crown (32), which has teeth on the outer circumferential edge and is free to rotate resting on the bottom of the recess; when two stations are counterposed, the respective half-crowns may rotate by one or more 180° angles around the same radial axis (R1) orthogonal to the weaving axis (X) and lying on said median plane (YZ), for each rotation passing from one station to the counterposed station;

- means (33) to transmit rotational motion to said half-crown (32);

- a support (34) comprising means for idle rotation coupling of the proximal portion (352) of a bobbin carrier (35) to said half-crown (32), according to a substantially radial axis (R2) orthogonal to said weaving axis (X);

- a bobbin carrier (35), the distal portion (351) of which rotationally supports a spool (36) rotating about a rotation axis (R3) lying in a plane parallel to said median plane (YZ), and whose proximal portion (352) is configured so as to cooperate with engaging means (37) slidably coupled to said base (31), in order to force said bobbin carrier to rototranslate during the rotation of said half crown, so that the axis of rotation (R3) of said spool always lies on planes orthogonal to said weaving axis (X);

- means for controlling the angular positioning of said wheels (2A, 2B) and said half crowns (32).

2. A braiding machine according to the preceding claim **characterized in that** it comprises a group of fixed bobbin-carrier stations (4) integrally connected to said frame (1) and angularly equally spaced, the unwinding axes of which lie on said median plane (YZ) on which also lie the tape or thread-like elements unwound from the bobbins carried by said bobbin-carrier.

3. Braiding machine according to one of the preceding claims **characterized in that** the proximal portion (352) of said bobbin carrier (35) has two parallel surfaces, diametrically opposed with respect to the substantially radial axis (R2), which are suitable to co-

operate with said engaging means (37).

4. Braiding machine according to the preceding claim 3 **characterized in that** said engaging means (37) comprise a sliding presser having a front face (371) which presses on one of said two parallel surfaces defined on the proximal portion of said bobbin carrier (35), preventing the rotation of said bobbin carrier (35) around the axis (R2) and maintaining the axis (R3) of rotation of said spool always on a plane orthogonal to the weaving axis (X).

5. Braiding machine according to one of the preceding claims **characterized in that** said distal portion (351) and said proximal portion (352) of said bobbin carrier (35) are reciprocally connected by means of a reversibly lockable ball joint (391).

6. Braiding machine according to one of the preceding claims **characterized in that** said distal portion of said bobbin carrier comprises means for adjusting the unwinding tension from the spool.

7. Braiding machine according to the preceding claim **characterized in that** said unwinding tension regulating means comprise magnetic friction regulating means.

8. Braiding machine according to one of the preceding claims **characterized in that** it comprises magnetic spool retaining means.

9. Braiding machine according to one of the preceding claims **characterized in that** it comprises means for rotating said frame (1) about a horizontal axis, in order to switch from a first working configuration to a second loading and unloading configuration.

10. Braiding machine according to the preceding claim **characterized in that** said means for rotating the frame also incorporate means for raising and lowering, so that in said second loading and unloading configuration the axis of rotation of said frame is at a lower height than the height of said first working configuration.

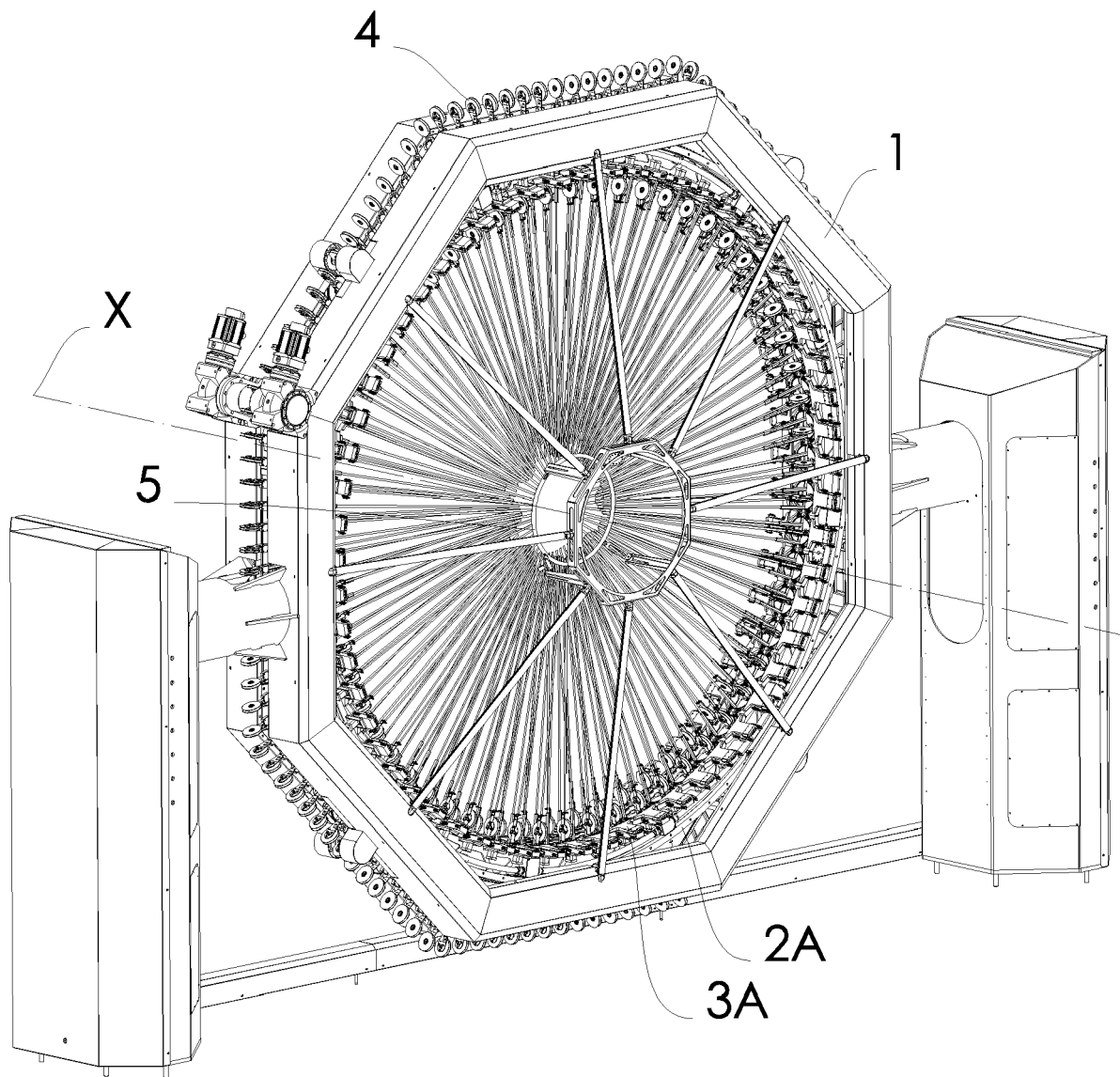


FIG. 1

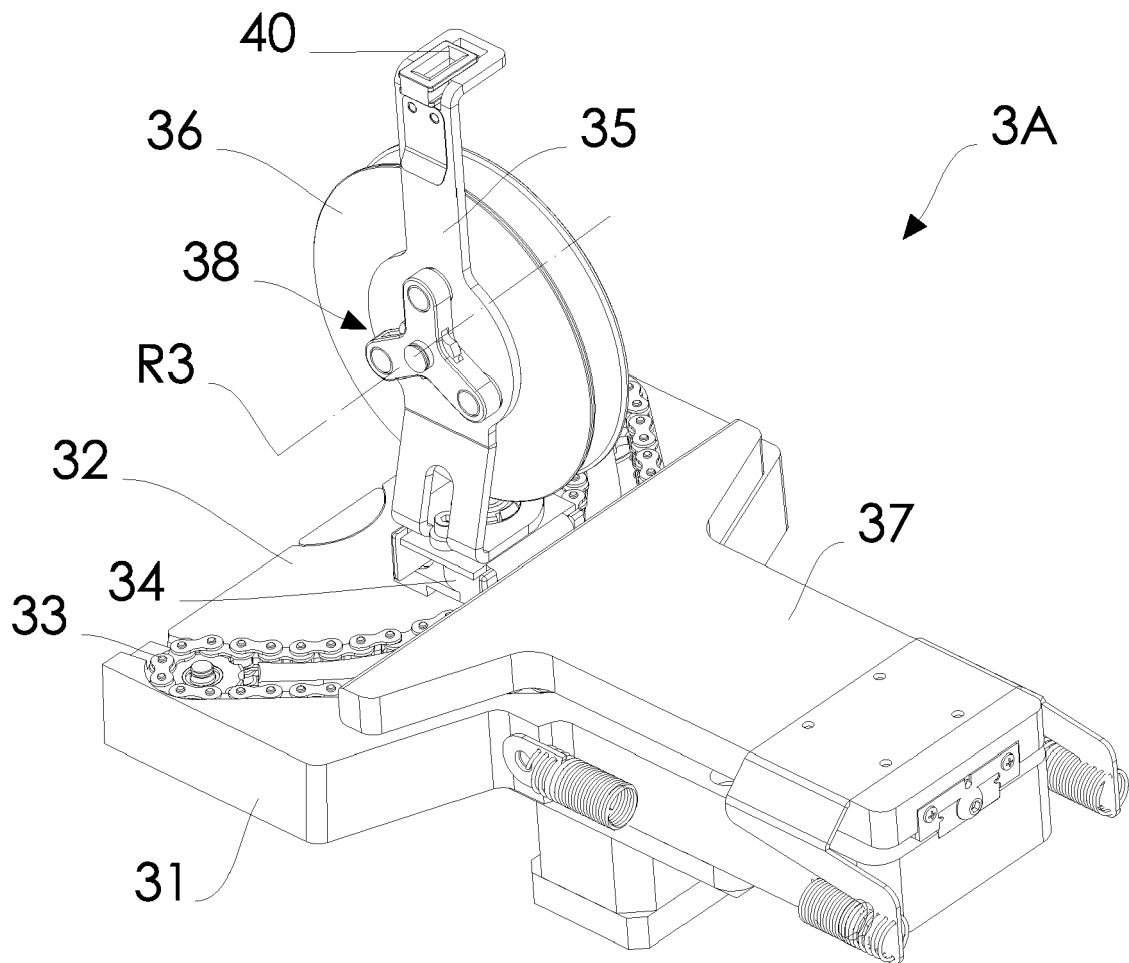


FIG. 2

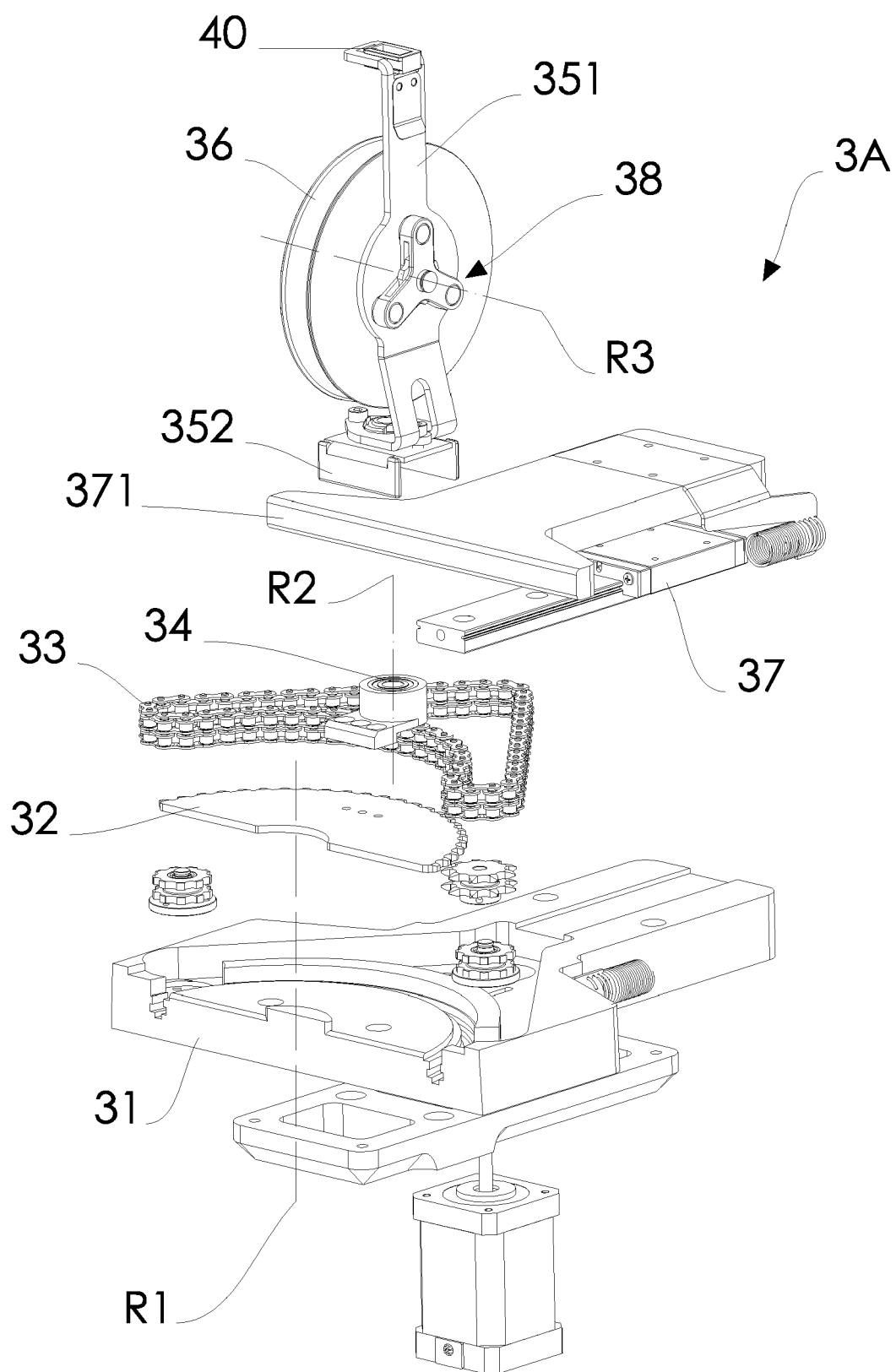


FIG. 3

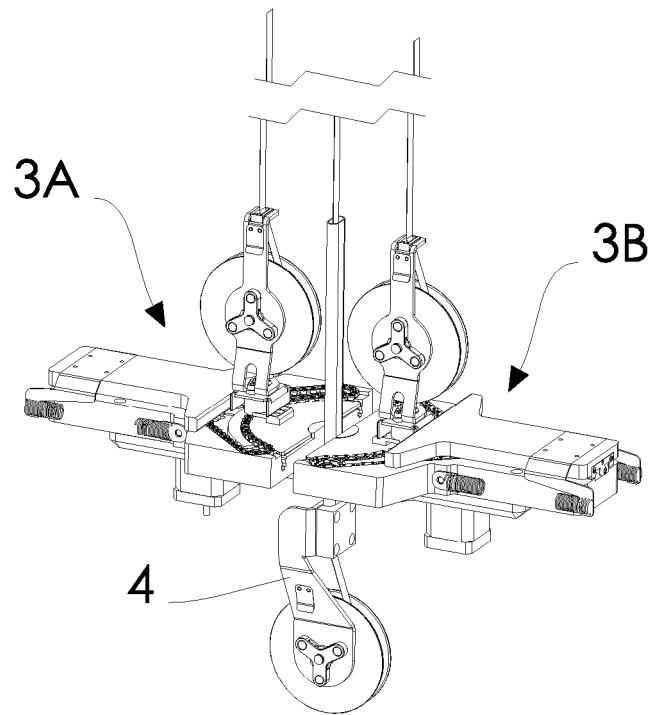


FIG. 4

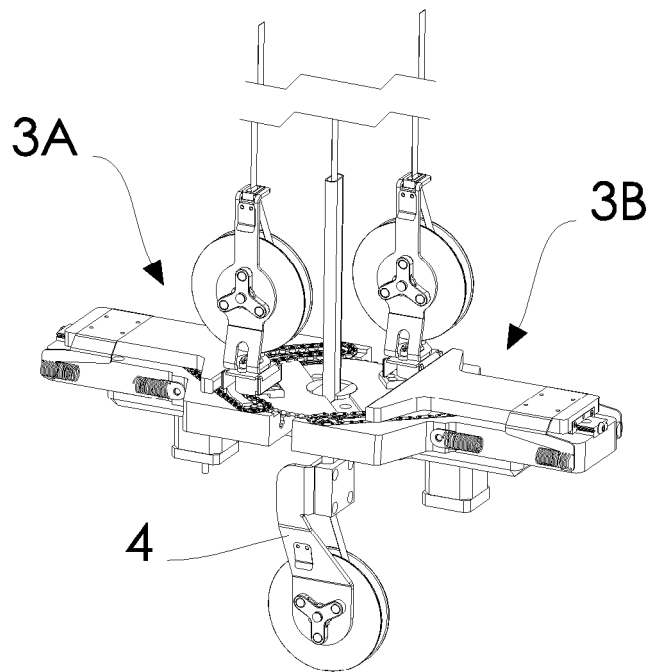


FIG. 5

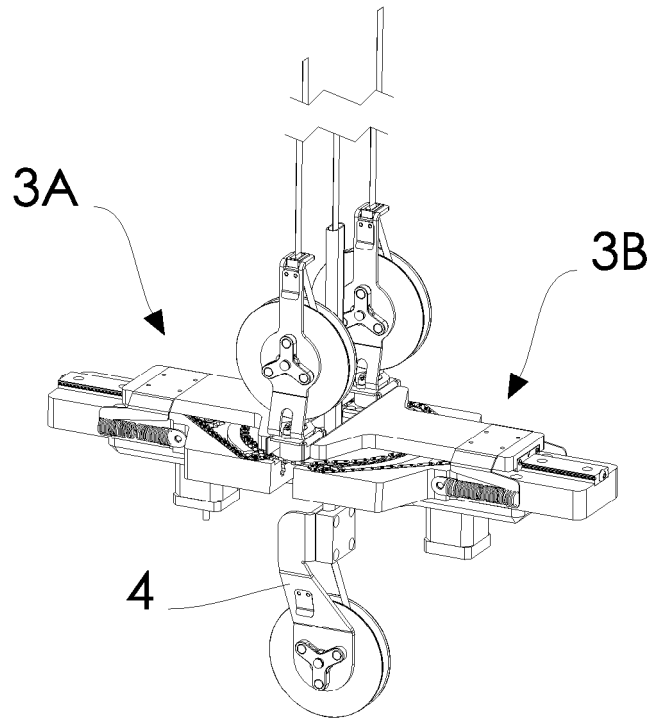


FIG. 6

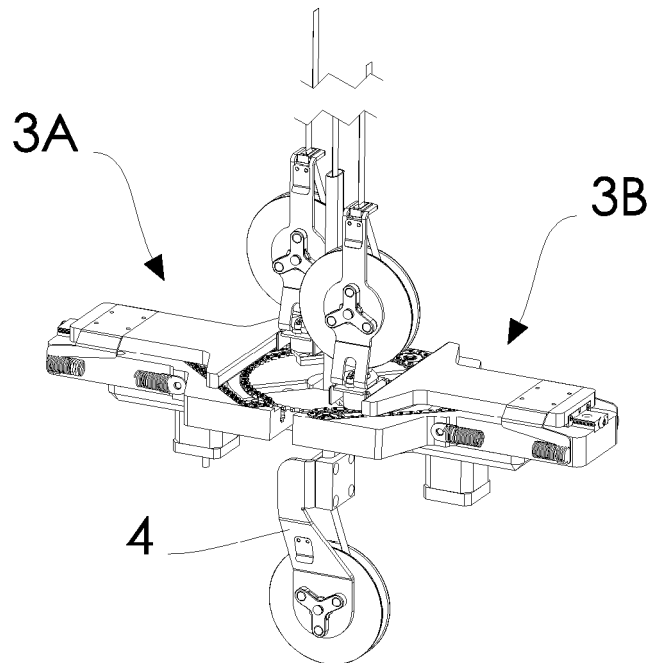


FIG. 7

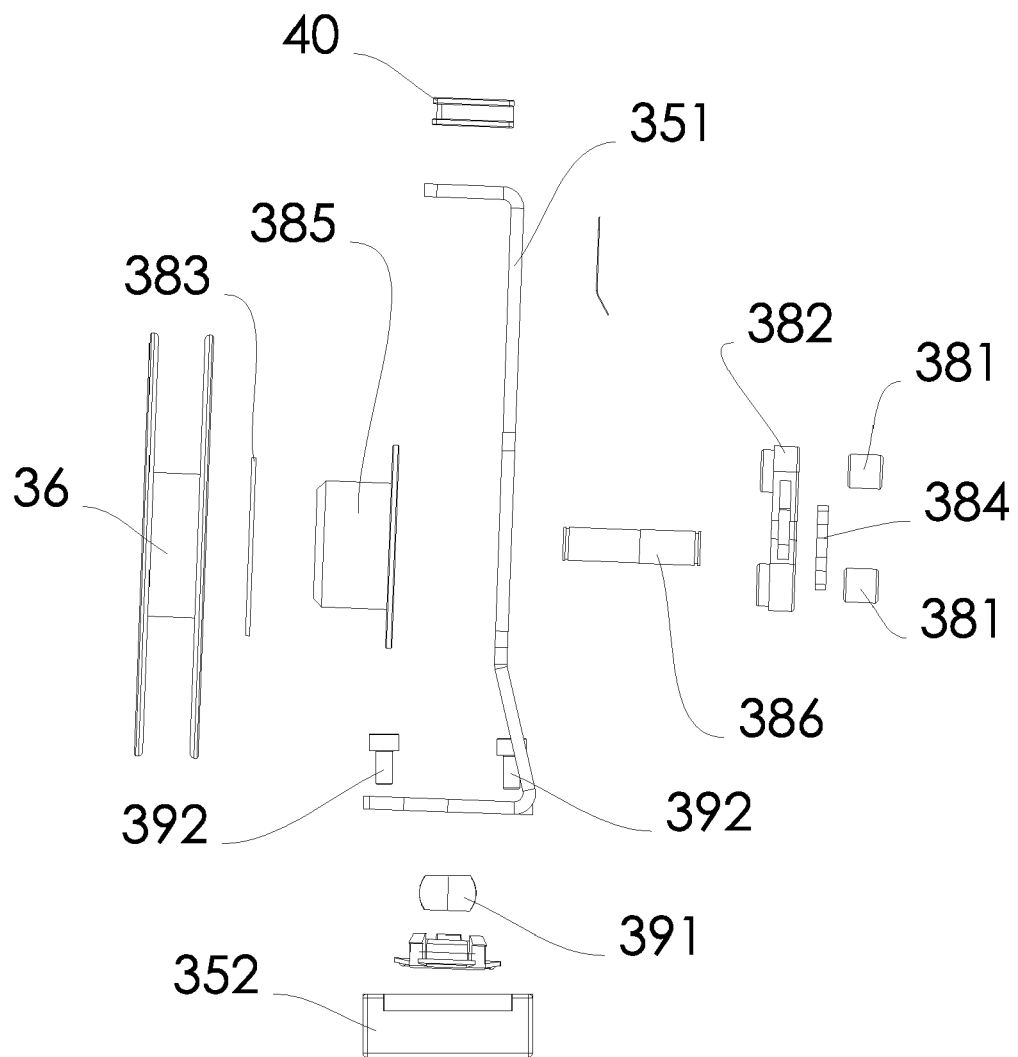


FIG. 8

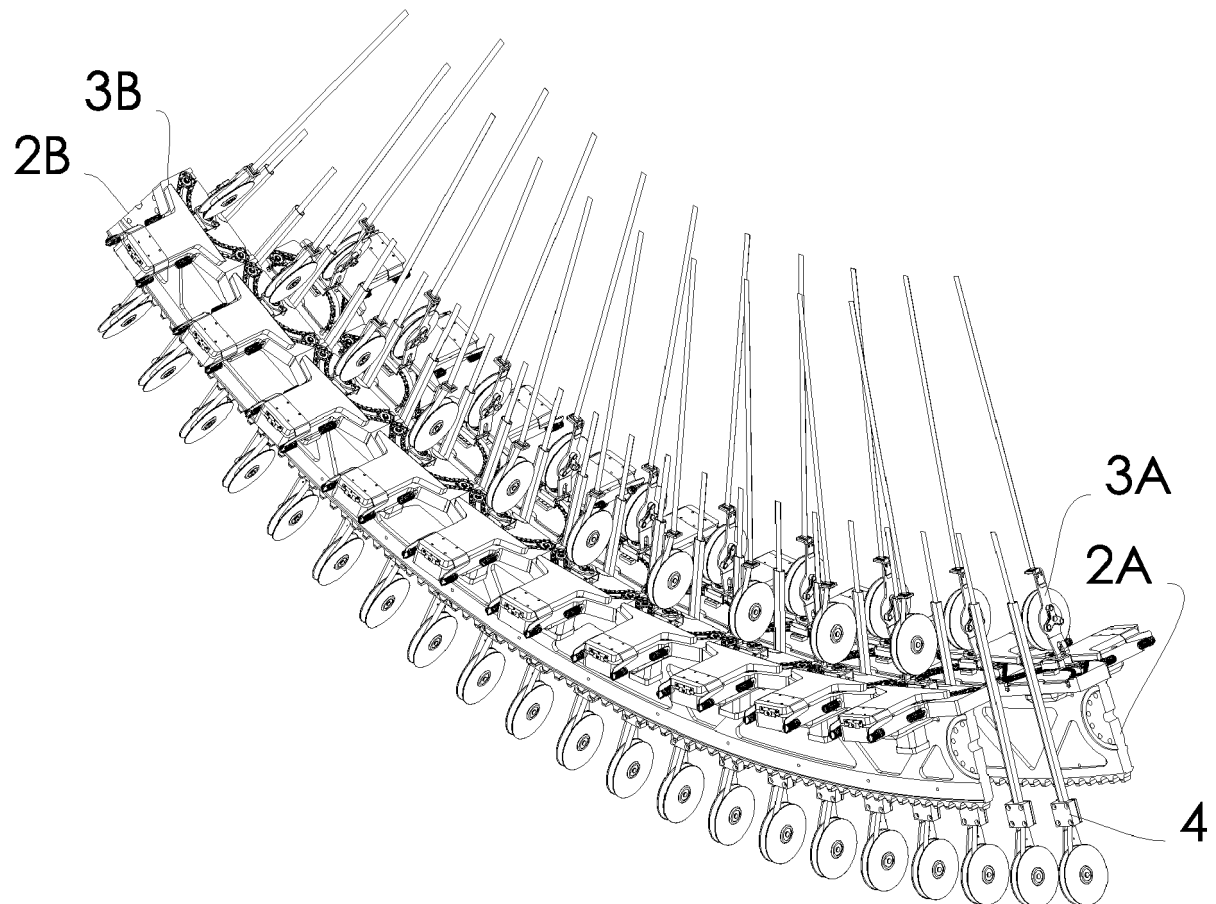


FIG. 9



EUROPEAN SEARCH REPORT

Application Number

EP 24 15 6362

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 10 2014 221996 A1 (UNIV STUTTGART [DE]) 4 May 2016 (2016-05-04) * paragraphs [0010] - [0011], [0013], [0021] - [0034]; claims 1, 2, 5, 7, 9, 10; figures 1-3 *	1,6	INV. D04C3/36 D04C3/38
A	EP 0 617 154 A1 (MURATA MACHINERY LTD [JP]) 28 September 1994 (1994-09-28) * column 1, line 46 - column 10, line 57; claim 1; figures 1-13A, 24, 25 *	1,2,6,9, 10	ADD. D04C3/12 D04C3/16
A	US 4 619 180 A (MOYER JAMES D [US]) 28 October 1986 (1986-10-28) * column 2, line 3 - column 6, line 6; claims 7, 10; figures 1-3 *	6-8	
A	US 2 197 111 A (MULLER JOHN A) 16 April 1940 (1940-04-16) * page 4, column 1, lines 40-47; claim 1; figures 1-6 * * page 3, column 1, lines 54-65; figure 8 *	1,6	
			TECHNICAL FIELDS SEARCHED (IPC)
			D04C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 July 2024	Examiner Sterle, Dieter
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 24 15 6362

5 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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09-07-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102014221996 A1	04-05-2016	NONE	
EP 0617154 A1	28-09-1994	DE 69419795 T2 EP 0617154 A1 TW 353123 B US 5476027 A	27-04-2000 28-09-1994 21-02-1999 19-12-1995
US 4619180 A	28-10-1986	AT E49426 T1 CA 1277857 C EP 0211581 A2 JP S6285060 A US 4619180 A US 4736668 A	15-01-1990 18-12-1990 25-02-1987 18-04-1987 28-10-1986 12-04-1988
US 2197111 A	16-04-1940	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2014157974 A1 [0009]
- KR 101155633 B1 [0011]
- EP 0617154 A1 [0014]
- US 4619180 A [0014]
- DE 102014221996 A1 [0015]