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(54) SUPPORT SPINDLE FOR WINDABLE MATERIAL COILS

(57) A support spindle (1) to engage a tubular winding core (2), comprises a central shaft (5) defining a rotation axis (6) and forming a connecting portion (7) and a supporting portion (9) extending from the connecting portion (8) along the rotation axis (6), a plurality of cam seats (11) formed in the supporting portion (9), a plurality of locking bodies (12) arranged radially outside the supporting portion (9) and in contact, by means of cam-follower members (13), with the cam seats (11), a supporting cage (14) connected to the central shaft (5) and which accommodates the locking bodies (12) so that the locking bodies (12) can slide radially to the rotation axis (6) with respect to the central shaft (5) and rotate about the rotation axis (6) with respect to the central shaft (5),
wherein a relative rotation between the locking bodies (12) and the central shaft (5) along an angular stroke (16) causes a radial displacement of the locking bodies (12) between a retracted position and an expanded position, wherein the cam-follower members (13) form a first convex cam surface (17) in contact with a second concave cam surface (18) of the corresponding cam seat (11).

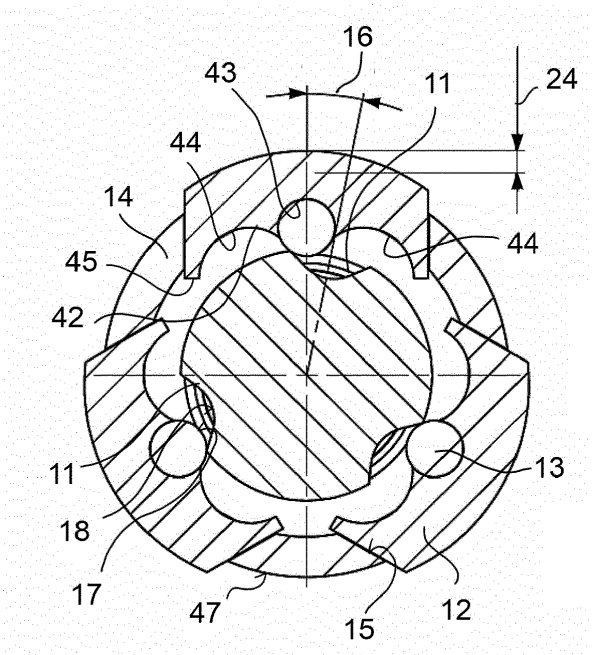

FIG. 5

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Description

[0001] The present invention relates to a support spindle for winding and unwinding coils or rolls of windable material on a winding core (or spool), in particular, but not limited to, coils or rolls of web-like or thread-like material, e.g., paper, fabric, corrugated cardboard, banknotes, polymer film, aluminum film, textile yarns and filaments, glass fibers, carbon fibers, electrical cables, etc.

[0002] In the manufacturing, processing, and handling processes of the web-like or thread-like material wound on a coil, it is necessary to wind and unwind the web-like material under controlled material speed and tension conditions.

[0003] It is known to wind the web-like material onto a winding core (or spool), typically a cylindrical tube made of cardboard, plastic, or metal, and engage the winding core from two opposite sides by means of two support spindles. The support spindles sustain the core and the entire coil of the material wound during the material winding or unwinding process and transmit a winding rotating moment or braking moment as well as possible desired translatory shifts to the coil. To this end, the support spindles are connected to actuation motors or braking systems which allow precise control of the winding/unwinding speed and tension of the material on the core.

[0004] Mechanical-pneumatic support spindles are known, which can be inserted into the winding core and configured to take a radially retracted configuration to (torsionally) disengage the winding core and allow the insertion and extraction of the spindle into/from the winding core, as well as a radially expanded configuration to (torsionally) engage the winding core, where the retraction and expansion of the support spindle can be carried out by means of a suitable pneumatic actuation system of the support spindle, irrespective of the interaction between the support spindle and the coil of wound material.

[0005] So-called "torsional" support spindles are also known, which can be inserted into the winding core and configured to take a radially retracted configuration to disengage the winding core and allow the insertion and extraction of the spindle into/from the winding core, as well as a radially expanded configuration to engage the winding core, where the retraction and expansion of the support spindle are driven by rotational movements of the winding core inserted onto the spindle, with respect to a central shaft of the spindle. This rotational movement of the winding core rotates an outer cage and outer sectors of the spindle with respect to the central shaft, and this relative rotation between the outer cage/outer sectors and the central shaft causes (e.g. by virtue of a wedge or cam effect) a displacement of the outer sectors radially outwards and in pressing engagement against an intrados of the winding core.

[0006] The torsional support spindles of the prior art have the disadvantage that the torsional engagement and disengagement with the winding core is not immediate and precisely coincident with the application of a coil winding moment or with the application of a core release moment although dependent on a real rotational movement and thus subject to undesired slipping phenomena between the spindle and the winding core and angular engagement/disengagement positions which are not controllable with certainty and not very precise.

[0007] Therefore, the need is felt for torsional support spindles with a limited or shorter angular actuation (engagement/disengagement) strokes, with a well controllable and more immediate engagement and disengagement effect, and which are less subject to undesired slipping during the steps of engaging and disengaging the winding core.

[0008] It is thus the object of the present invention provide a support spindle for winding and unwinding coils or rolls onto a tubular core, having features such as to avoid at least some of the drawbacks mentioned with reference to the prior art.

[0009] It is a particular object of the present invention to provide a support spindle, having features such as to limit or reduce the angular actuation (engagement/disengagement) strokes compared to the prior art.

[0010] It is a further particular object of the present invention to provide a support spindle, having features such as to make the engagement and disengagement with the winding core more controlled and immediate in response to a rotational feeding of the winding core with respect to the support spindle, and to reduce undesirable slipping during the steps of engaging and disengaging the winding core.

[0011] These and other objects are achieved by a support spindle for winding and unwinding coils of windable material on a core according to claim 1.

[0012] The dependent claims relate to preferred and advantageous embodiments of the invention.

[0013] In order to better understand the invention and appreciate the advantages thereof, some non-limiting exemplary embodiments thereof will be described below with reference to the accompanying drawings, in which:

- figure 1 is an exploded perspective view of a support spindle, according to an embodiment of the invention;
- figure 2 is a sectional view on a radial plane of the support spindle in figure 1,
- figures 3 and 4 are cross-sectional and side views of a support spindle according to an embodiment, in a retracted configuration,
- figures 5 and 6 are cross-sectional and side views of the spindle in figures 3 and 4, in a radially expanded configuration,
- figure 7 is a front view of a central shaft of a support spindle according to an embodiment,
- figure 8 is a front view of a central shaft of a support spindle according to a further embodiment,
- figure 9 is a perspective view of a two-diameter support spindle according to a further embodiment,
- figures 10, 11 are sectional views of a central shaft

of the two-diameter support spindle in figure 9,

- figures 12 and 13 show two opposite support spindles disengaged from (fig. 12) and engaged with the winding core of a coil of windable material, in which the coil is full and can be under unwinding,
- figure 14 is a sectional view taken along the section plane XIV-XIV in figure 13,
- figures 15, 16, 17, 18 are sectional views of parts of support spindles according to the embodiments, having different engagement diameters with the winding core and being in a fully radially expanded configuration,
- figure 19 is a side view of a support spindle according to an embodiment, having an ejection and positioning flange in a fully retracted position,
- figure 20 shows the support spindle in figure 19 with the ejection flange in a fully advanced position,
- figure 21 is a front view of the support spindle in figure 19,
- figure 22 is a perspective view of the support spindle in figure 19.

Detailed description of the invention

[0014] In the following description, the term "front" orientation relates to the orientation of sides, faces, surfaces, etc. in the insertion direction of the support spindle on a winding core, the term "rear" orientation relates to the orientation of sides, faces, surfaces, etc. in the retraction direction of the support spindle out of the winding core, unless otherwise specified. The terms "radial," "circumferential," and "axial" relate to the longitudinal axis of the support spindle, which corresponds to the rotation axis of the support spindle and the winding core engaged by the latter, unless otherwise specified.

[0015] With reference to the figures, a support spindle 1 to engage a tubular winding core 2 for winding and unwinding windable material 3 to form a coil 4, comprises:

A) a central shaft 5 defining a rotation axis 6 and forming:

- a connecting portion 7 on a rear side 8 of the support spindle 1,
- a supporting portion 9 extending from the connecting portion 8 along the rotation axis 6 towards a front side 10 of the support spindle 1,
- a plurality of cam seats 11 formed in the supporting portion 9,

B) a plurality of locking bodies 12 arranged radially outside the supporting portion 9 and in contact, by means of cam-follower members 13, with the cam seats 11,

C) a supporting cage 14 connected to the central shaft 5 and forming a plurality of guide seats 15 which accommodate and position the locking bodies 12 so that the locking bodies 12 can slide radially to the rotation axis 6 with respect to the central shaft 5 and rotate about the rotation axis 6 with respect to the central shaft 5,

where the cam seats 11 and the cam-follower members 13 are shaped so that a relative rotation between the locking bodies 12 and the central shaft 5 about the rotation axis 6 causes a radial displacement of the locking bodies 12 between a radially inner, retracted (end-of-stroke) position (Figure 3), and a radially outer, expanded (end-of-stroke) position (Figure 5), for disengaging and engaging the support spindle 1 with the winding core 2.

[0016] According to an advantageous embodiment, to each of said locking bodies 12 is associated exactly and only one of said cam follower members 13.

[0017] According to a further advantageous embodiment, each locking body 12 forms a radially internal surface 42 facing the support portion 9 and forming a partially cylindrical cavity 43 extending in a direction parallel to the rotation axis 6,

in which said cavity 43 rotatably accommodates one of said cam follower members 13 having an elongated cylindrical shape and being extended in a direction parallel to the axis of rotation 6,
wherein between respectively one locking body 12 and the support portion 9 there is interposed:

- only one of said cam follower members 13 having elongated cylindrical shape, or
- a group of said cam follower members 13 of elongated cylindrical shape, in which all said cam follower members 13 of the group are positioned and oriented concentric with each other and parallel to the rotation axis 6.

[0018] An angular stroke 16 of relative rotation of the locking bodies 12 with respect to the central shaft 5 about the rotation axis 6 (angular actuation stroke), corresponding to a total radial stroke 24 of the locking bodies 12 from the retracted (end-of-stroke) position and the expanded (end-of-stroke) position and vice versa, is preferably less than or equal to 30° or preferably less than or equal to 15°, and

possibly, the cam seats (11) and the cam-follower members (13) limit the relative rotation of the locking bodies (12) with respect to the central shaft (5) about the rotation axis (6) to a maximum relative rotation angle either less than or equal to 60° or less than or equal to 30°, i.e. twice the angular actuation stroke 16, and
possibly, the cam-follower members 13 form a first convex cam surface 17 in contact with a second concave cam surface 18 of the corresponding cam seat 11, and
possibly, on a sectional plane orthogonal to the rotation axis 6, the first convex cam surface 17 has a

circular arc shape and the second concave cam surface 18 has a symmetrical shape with respect to a symmetry plane 19 radial to the rotation axis 6, with an arc-shaped bottom section 20 and two opposite side sections 21, which may be substantially straight, mutually defining a cam angle 22 in the range from 100° to 145° or from 100° to 120°, preferably from 105° to 115°, even more preferably of 110°.

[0019] With further advantage, a radial depth 23 of the cam seat 11 is greater than the total radial stroke 24 of the locking bodies 12 between the retracted (end-of-stroke) position and the expanded (end-of-stroke) position, and
a circumferential width 25 of the cam seat 11 is greater than four times the radial depth 23 of the cam seat 10.

[0020] By virtue of the particular geometry of the cam seat 11, a significant radial displacement of the locking bodies 12 is achieved with a limited or shorter angular actuation (engagement/disengagement) stroke as compared to the prior art and with a more controlled and immediate engagement and disengagement effect. As a result, during the steps of engaging and disengaging the support spindle 1 with the winding core 2, the slipping of the winding core 2 with respect to the support spindle 1 and the uncertainties of the actual angular position of the coil 4 with respect to a planned angular position thereof are reduced. Furthermore, the geometry of the cam seat 11 and the cam-follower member 13 allow a mutual rolling and/or sliding with less friction, and thus an activation of the locking bodies with comparably small pulling forces on the windable material. Furthermore, the geometry of the cam seat 11 and the cam-follower member 13 achieve a reduction in wear compared to the prior art, resulting in an increase in the service life of the support spindle 1.

Detailed description of the central shaft 5.

[0021] In accordance with an embodiment (figure 1), the central shaft 5 can be made of a metal material, such as steel, for example. The connecting portion 7 may comprise a connecting flange in the shape of a circular disc or circular ring, extending in a plane orthogonal to the rotation axis 6, and forming a plurality of fixing holes 26 for connecting the support spindle 1 to a supporting and moving system 27 with an actuation motor 28 and/or with a brake 29 for performing controlled positioning and rotation of the support spindle 1 in order to engage/disengage the winding core 2 and to unwind and/or wind the coil 4 (figures 12,13,14).

[0022] The supporting portion 9 has an elongated shape with a preferably cylindrical outer surface in which the cam seats 11 are formed. The cam seats 11 can extend parallel to the rotation axis 6 along the entire supporting portion 9 and have a constant cross-section shape along the rotation axis 6.

[0023] The supporting portion 9 preferably comprises three cam seats 11 evenly distributed at an angular pitch of 120°.

[0024] The bottom section 20 may advantageously be shaped as an arc of a circle having a radius in the range from 17 mm to 23 mm, preferably from 19 mm to 21 mm, even more preferably of 20 mm.

[0025] The radial depth of the cam seat 11, measured along the symmetry plane 19 up to an outer circumference of the supporting portion 9, is advantageously in the range from 6 mm to 7 mm, preferably of about 6.5 mm.

[0026] The side sections 21 connect to opposite ends of the bottom section 20 with an orientation tangent to the arc of a circle of the bottom section 20.

[0027] A side edge 30 in an intersection region of the side sections 21 of the cam seats 11 with the outer circumference of the supporting portion 9 is advantageously beveled, e.g. with a bevel radius of 0.5 mm.

[0028] The outer surface of the supporting portion 9 between two cam seats 11, respectively, is preferably cylindrical and concentric with respect to the rotation axis 6. The connecting portion 7 and the support portion 9 can be advantageously formed in a single piece with continuity of material.

[0029] The shape features of the supporting portion 9 allow an accurate and cost-effective manufacturing thereof, a favorable balance for rotational movements, and low friction between the cam seats 11 and the cam-follower members 13, which will be described below.

[0030] Depending on the size and weight of the coils 4 to be wound and unwound, and thus of the supporting cores 2, the supporting portion 9 of the spindle 1 can be made with different axial lengths and diameters. Advantageously, the shape and size of the individual cam seats 11 may remain unchanged for a plurality of different diameters of the supporting portion 9.

[0031] In advantageous and preferred embodiments, with the geometric shape and size of the cam seats 11 described above, and with the arrangement of three cam seats 11 at an angular pitch of 120°:

- for a diameter 31 of the supporting portion 9 of 45 mm, the angular actuation stroke 16 is 15° (figure 15),
- for a diameter 31 of the supporting portion 9 of 62 mm, the angular actuation stroke 16 is 11.5° (figure 16),
- for a diameter 31 of the supporting portion 9 of 82 mm, the angular actuation stroke 16 is 10.7° (figure 17),
- for a diameter 31 of the supporting portion 9 of 102 mm, the angular actuation stroke 16 is 7.5° (figure 18).

[0032] In accordance with an embodiment (figures 1, 2), the central shaft 5 forms, on two opposite sides of the supporting portion 9, a first rear bearing seat 32 in the shape of a cylindrical step and a first front bearing seat 33 in the shape of a cylindrical step, which accommodate

a rear bearing 34 and a front bearing 35 for rotationally supporting the supporting cage 14 with respect to the central shaft 5 about the rotation axis 6.

Detailed description of the locking bodies 12 and cam-follower members 13

[0033] In accordance with an embodiment, the locking bodies 12 are preferably made of a metal material, such as steel, for example, and form a radially outer engagement surface 36, preferably shaped as part of a cylinder, intended for a pressing contact engagement against an intrados of the winding core 2. The engagement surface 36 preferably has a greater length in the direction of the rotation axis 6 than the width thereof in the circumferential direction with respect to the rotation axis 6. At two opposite longitudinal ends 37 of the locking body 12, the engagement surface 36 is beveled or inclined in a radially inward direction so as to reduce the risk of snagging with the intrados of the winding core 2 and the risk of damage to the locking body 12 or the winding core 2 during their mutual engagement and disengagement. Furthermore, the inclination of the engagement surfaces 36 at the opposite longitudinal ends 37 facilitates a radially inward displacement of the locking bodies 12 "freely hanging" in the supporting cage 14 during the insertion of the support spindle 1 into the winding core 2.

[0034] The locking body 12 also forms sliding surfaces 38,39 transverse to the engagement surface 36, in particular two longitudinal sliding surfaces 38 which are planar and parallel to each other and to the rotation axis 6, and/or two transverse sliding surfaces 39 which are planar and orthogonal to the rotation axis 6 (figure 1).

[0035] The sliding surfaces 38,39 are shaped in a complementary manner with corresponding guiding surfaces 40, 41 of the guide seats 15 of the supporting cage 14 to retain the locking bodies 12 in the guide seats 15 in a radially sliding manner with respect to the rotation axis 6.

[0036] Furthermore, the locking bodies 12 form a radially inner surface 42 facing the supporting portion 9 and which either forms or accommodates one or more cam-follower members 13 (figures 2,3,5). In accordance with an embodiment, the cam-follower members 13 are rolling bodies (preferably made of metal, e.g., steel) rotatably received in cavities 43 formed in the radially inner surfaces 42 and contact the cam seats 11 with rolling friction. Alternatively, the cam-follower members 13 can be directly formed from the locking bodies 12 and contact the cam seats 11 with sliding friction.

[0037] Advantageously, the cam-follower members 12 are elongated cylindrical bodies inserted in the longitudinal direction (along the rotation axis 6) into the corresponding cavities 43 which are partially cylindrical in shape and extending in a direction parallel to the rotation axis 6. The planned positioning of the cam-follower members 12 in the cavities 43 can be ensured by a positioning dowel 50 screwed into a positioning hole of the locking body 12 (figure 2).

[0038] According to an embodiment, the radially inner surface 42 of the locking bodies 12 forms two side cavities 44, arranged on two opposite sides with respect to the cam-follower member 13 to obviate the risk of space violations between the locking body 12 and the supporting portion 9, particularly when the locking body 12 is in the retracted position (figure 3) radially closer to the central shaft 5. The side cavities 44 are delimited, on one side, by the cam-follower member 13, and on the other side, by one of two side guide walls 45 extending on each longitudinal side of the locking body 12, projecting towards the interior of the support spindle 1 and forming the longitudinal sliding surfaces 38 (figure 3).

[0039] This configuration reconciles the needs of having to avoid space encroachments within the support spindle 1 during the relative actuation rotations, lightening the support spindle 1, and providing a sufficiently long radial guide for the locking bodies 12.

[0040] The total radial stroke 24 of the locking bodies 12 is for example in the range from 3 mm to 8 mm, preferably from 4 mm to 6 mm, preferably of about 5 mm.

[0041] In the retracted position, the locking bodies 12 preferably protrude with respect to an outer surface 47 of the supporting cage 14, e.g. with an initial radial protrusion value 46 in the range from 5% to 15% of the total radial stroke 24, preferably with an initial radial protrusion value 46 of 10% of the total radial stroke 24, e.g. by 0.5 mm (figures 3, 5).

[0042] Each locking body 12 further forms one or more, preferably two stop protrusions 48 which abut against the corresponding end-of-stroke surfaces 49 of the supporting cage 14 when the locking body 12 reaches the expanded position. Thereby, a complete release and loss of the locking bodies 12 out of the guide seats 15 is prevented, e.g. when the support spindle 1 is not inserted into a winding core 2 (figure 2).

Detailed description of the supporting cage 14.

[0043] According to an embodiment, the supporting cage 14 can be made of metal, such as steel, for example, and comprise a tubular wall 51, concentrically inserted on the supporting portion 9 of the central shaft 5, and having an outer surface 47, preferably cylindrical, and a (radially) inner surface 52 facing the supporting portion 9 of the central shaft 5.

[0044] The inner surface 52 forms, on two opposite sides with respect to the guide seats 15, a second rear bearing seat 53 in the shape of a cylindrical step and a second front bearing seat 54 in the shape of a cylindrical step which accommodate (outer rings of) the rear 34 and front 35 bearings for rotatably supporting the bearing cage 14 with respect to the central shaft 5 about the rotation axis 6.

[0045] The guiding seats 15 are formed by through openings in the tubular wall 51, delimited by the longitudinal guiding surfaces 40 and transverse guiding surfaces 41 for the guided sliding support of the locking bodies

12 (figures 1, 2,3,4).

[0046] The possibility of relative rotation of the locking bodies 12 with respect to the supporting portion 9 of the central shaft 5 is ensured by the rotatable support of the supporting cage 14 with respect to the central shaft 5. The relative rotation angle is defined and limited by the radial end stop (stop protrusions 48, figure 2) of the locking bodies 12 in the expanded position and by two opposite rotational end stops made by each cam seat 11 together with the corresponding cam-follower member 13 (figure 5).

[0047] According to an embodiment, on the front side 10 of the support spindle 1, the supporting cage 14 is beveled, rounded, or tapered, so as to facilitate the insertion of the support spindle 1 into the winding core 2.

[0048] Advantageously, the supporting cage 14 is axially locked on the central shaft 5 by an end cap 55 fixed to the front side 10 by means of a screw screwed into a threaded hole formed in the front surface of the central shaft 5. The end cap 55 is advantageously beveled, rounded, or tapered in accordance with the corresponding bevel or taper of the supporting cage 14.

[0049] The rear bearing 34 is a tapered roller bearing, adapted to support the supporting cage 14 axially and radially, while the front bearing 35 is preferably a radial bearing, such as a ball bearing. The supporting cage 14 may form one or more ejection through-holes 56, in communication with the second rear bearing seat 53, for a tool (such as a pin) to access for ejecting the outer ring of the tapered bearing from the second rear bearing seat 53 (figure 2). Furthermore, an annular dust protection disc 59 can be arranged within the supporting cage 14 between the rear bearing 34 and the cam-follower members 13.

[0050] In accordance with a further embodiment (figures 9,10,11), the support spindle 1 may form a plurality of, preferably two, supporting portions 9, 9' of different diameters, which are concentric and positioned axially next to each other, as well as a plurality of corresponding supporting cages 14,14' of different diameters, which are concentric and positioned axially next to each other, with the smaller diameter cage positioned more on the front side 10 of the support spindle 1, for versatile use of the support spindle 1 in combination with winding cores 2 having different diameters.

[0051] In accordance with yet another embodiment (figures 19,20,21,22), the support spindle 1 may comprise a positioning and ejection flange 57 axially sliding with respect to the central shaft 5 and guided, for example, by a plurality of guiding grooves 58 parallel to the rotation axis 6, formed in the outer surface of the supporting cage 14 (figures 19, 20).

[0052] In accordance with a further embodiment, the supporting cage 14, 14' may form one or more radial friction protrusions 60 (figure 22) adapted to engage the core 2 constantly in direct contact and with a friction such as to ensure minimum torque transmission from the core 2 to the supporting cage 14, 14' even when the locking bodies 12 are not (yet or no longer) activated. This obviates a problem of loss of control over the core during the almost complete unwinding or at the beginning of the winding operation when, due to the small winding diameter, the core rotation speed is very high with the transport speed of the wound/unwound material being equal.

[0053] The positioning and ejection flange 57 can provide an axial support reference for the core 2 during the steps of winding and unwinding the coil 4, as well as can act as an ejection pusher for easier disengagement of the support spindle 1 from the core 2.

[0054] The invention has numerous advantages that arise from its individual characteristics and from the synergy of their combination, including:

- the reduction or minimization of the drive rotation between the neutral position and the fully engaged position,
- the possibility of an automatic return to the neutral position,
- optimized contact between the support mandrel and the winding core thanks to the association of a single cam follower to each locking body,
- the prevention of pressure concentrations or excessive uneven pressures on the winding core,
- protection against overloads and ease of rotation in any operating situation, at least also due to the presence of an axial bearing,
- high mechanical resistance to support very heavy rolls and high wear resistance, due to the possibility of maximizing the diameter of the support portion and of using specifically hardened materials, for example for the support cage, as well as thanks to manufacturing the connection portion and the support portion in a single metal piece,
- a reduced number of individual components that facilitate maintenance, repair and cleaning, at least in part with the components in an assembled configuration,
- flexible adaptability of geometric parameters within an overall length set by the project, and therefore adaptable to different dimensions of winding cores,
- easy and quick access to and replacement of the support cage and / or of the locking bodies, thanks to the closing cap screwed to the front.

Reference numerals in the figures

[0055]

1	support spindle
2	winding core
3	windable material
4	coil
5	central shaft
6	rotation axis
7	connecting portion
8	rear side

9,9'	supporting portion
10	front side
11	cam seat
12	locking bodies
13	cam-follower members
14, 14'	supporting cage
15	guide seats
16	angular actuation stroke
17	first cam surface
18	second cam surface
19	symmetry plane
20	bottom section
21	side section
22	cam angle
23	radial depth of cam seat
24	total radial stroke
25	circumferential width of cam seat
26	fixing holes
27	supporting and moving system
28	actuation motor
29	brake
30	side edge of cam seat
31	supporting portion diameter
32	first rear bearing seat
33	first front bearing seat
34	rear bearing
35	front bearing
36	engagement surface
37	opposite longitudinal ends of the locking body
38	longitudinal sliding surface
39	transverse sliding surface
40	longitudinal guiding surface
41	transverse guiding surface
42	radially inner surface of locking body
43	cavity for rolling element
44	side cavities
45	side guide wall
46	initial radial protrusion value
47	outer surface of supporting cage
48	stop protrusion
49	end-of-stroke surface
50	positioning dowel
51	tubular wall of supporting cage
52	inner surface of supporting cage
53	second rear bearing seat
54	second front bearing seat
55	closing cap
56	ejection holes
57	positioning and ejection flange
58	guiding grooves
59	dust protection disc
60	friction protrusions

Claims

1. A support spindle (1) to engage a tubular winding core (2) for winding and unwinding windable material (3) to form a coil (4), comprising:

A) a central shaft (5) defining a rotation axis (6) and forming:

- a connecting portion (7) on a rear side (8) of the support spindle (1),
- a supporting portion (9) extending from the connecting portion (8) along the rotation axis (6) towards a front side (10) of the support spindle (1),
- a plurality of cam seats (11) formed in the supporting portion (9),

B) a plurality of locking bodies (12) arranged radially outside the supporting portion (9) and in contact, by means of cam follower members (13), with the cam seats (11),

C) a supporting cage (14) connected to the central shaft (5) and forming a plurality of guide seats (15) which accommodate and position the locking bodies (12) so that the locking bodies (12) can slide radially to the rotation axis (6) with respect to the central shaft (5) and rotate about the rotation axis (6) with respect to the central shaft (5),

wherein the cam seats (11) and cam follower members (13) are shaped so that a relative rotation between the locking bodies (12) and the central shaft (5) about the rotation axis (6), along an angular stroke (16), causes a radial displacement of the locking bodies (12) between a radially inner retracted position, and a radially outer expanded position, for disengaging and engaging the support spindle (1) with the winding core (2),
wherein the cam follower members (13) form a first convex cam surface (17) in contact with a second concave cam surface (18) of the corresponding cam seat (11).

2. A support spindle (1) according to claim 1, wherein, on a sectional plane orthogonal to the rotation axis (6), the first convex cam surface (17) has a circular arc shape and the second concave cam surface (18) has a symmetrical shape with respect to a symmetry plane (19) radial to the rotation axis (6), with an arch-shaped bottom section (20) and two opposite side sections (21).

3. A support spindle (1) according to claim 1 or 2, wherein to each of said locking bodies (12) is associated exactly and only one of said cam follower members (13).

4. A support spindle (1) according to claim 1 or 2, wherein each said locking body (12) forms a radially internal surface (42) facing the support portion (9)

and forming a partially cylindrical cavity (43) extending in a direction parallel to the rotation axis (6),

in which said cavity (43) rotatably accommodates one of said cam follower members (13) having an elongated cylindrical shape and being extended in a direction parallel to the axis of rotation (6),
wherein between respectively one locking body (12) and the support portion (9) there is interposed:

- only one of said cam follower members (13) having elongated cylindrical shape, or
- a group of said cam follower members (13) of elongated cylindrical shape, in which all said cam follower members (13) of the group are positioned and oriented concentric with each other and parallel to the rotation axis (6).

5. A support spindle (1) according to any one of the preceding claims, wherein a radial depth (23) of the cam seat (11) is greater than the total radial stroke (24) of the locking bodies (12) and a circumferential width (25) of the cam seat (11) is greater than four times the radial depth (23) of the cam seat (10).

6. A support spindle (1) according to any one of the preceding claims, wherein:

- the connecting portion (7) comprises a circular disc-shaped connecting flange extending on a plane orthogonal to the rotation axis (6) and forming a plurality of fixing holes (26),
- the supporting portion (9) has an elongated shape with a cylindrical outer surface in which the cam seats (11) are formed,
- the cam seats (11) are extended parallel to the rotation axis (6) along the entire supporting portion (9) and have a constant cross-section shape along the rotation axis (6).
- the supporting portion (9) comprises three cam seats (11) evenly distributed at an angular pitch of 120°.

7. A support spindle (1) according to any one of the claims 1 to 4, wherein the bottom section (20) is shaped as an arc of a circle.

8. A support spindle (1) according to any one of the claims from 2 to 7, wherein the side sections (21) are joined at opposite ends of the bottom section (20) with an orientation tangent to the arc of a circle of the bottom section (20) and wherein a side edge (30) in an intersection region of the side sections (21) with an outer circumference of the supporting portion (9) is beveled.

9. A support spindle (1) according to any one of the preceding claims, wherein the locking bodies (12) form:

(A) a radially outer, cylinder part-shaped engagement surface (36) having a length in the direction of the rotation axis (6) greater than a width thereof in circumferential direction with respect to the rotation axis (6),
wherein at two opposite longitudinal ends (37) of the locking body (12) the engagement surface (36) is inclined in a radially inward direction,
B) sliding surfaces (38,39), transverse to the engagement surface (36), shaped in a complementary manner with corresponding guiding surfaces (40, 41) of the guiding seats (15) of the supporting cage (14),
C) a radially inner surface (42) facing the supporting portion (9) and accommodating one or more rolling cam-follower members (13),
D) one or more stop protrusions (48) which abut against corresponding end of stroke surfaces (49) of the supporting cage (14) when the locking body (12) reaches the expanded position.

10. A support spindle (1) according to claim 9, wherein the cam follower-members (12) are elongated cylindrical bodies inserted into the partially cylindrical-shaped cavities (43) in the direction parallel to the rotation axis (6).

11. A support spindle (1) according to claim 9 or 10, wherein the radially inner surface (42) of the locking bodies (12) forms two side cavities (44), arranged on two opposite sides with respect to the cam-follower member (13), wherein said side cavities (44) are delimited, on one side by the cam-follower member (13) and on the other side by one of two side guide walls (45) extended on each longitudinal side of the locking body (12), protruding towards the inside of the support spindle (1).

12. A support spindle (1) according to any one of the preceding claims, wherein in the retracted position the locking bodies (12) protrude with respect to an outer surface (47) of the supporting cage (14), with an initial radial protrusion (46) in the range from 5% to 15% of the total radial stroke (24), or 10% of the total radial stroke (24), or 0.5 mm.

13. A support spindle (1) according to any one of the preceding claims, wherein the supporting cage (14) comprises a tubular wall (51), inserted concentrically on the supporting portion (9) of the central shaft (5), and having a cylindrical outer surface (47) and an inner surface (52) facing the supporting portion (9),

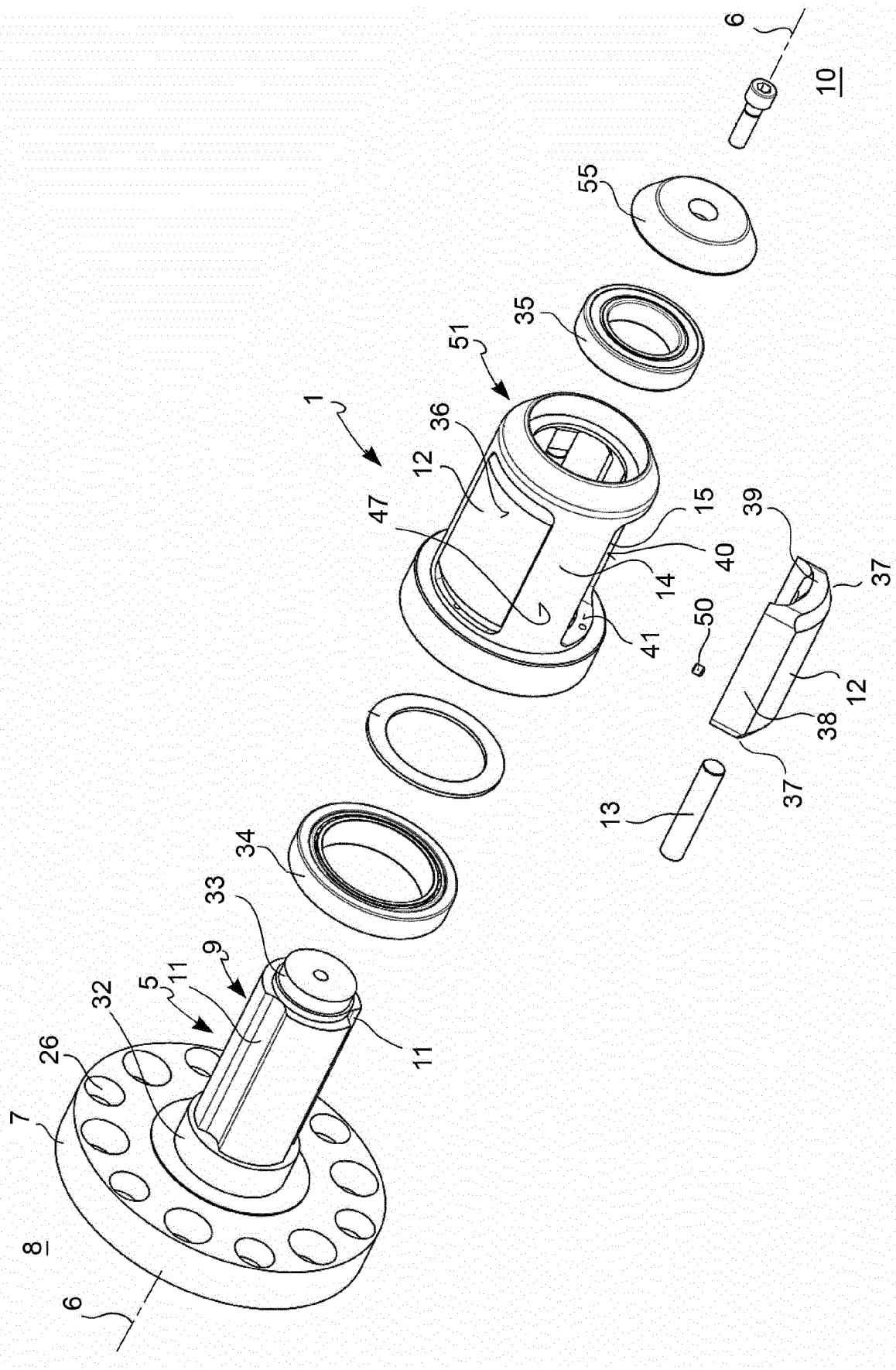
wherein the guiding seats (15) are formed by

through openings in the tubular wall (51), delimited by longitudinal guiding surfaces (40) and transverse guiding surfaces (41) for the guided sliding support of the locking bodies (12),
wherein on the front side (10) of the support spindle (1) the supporting cage (14) is beveled so that the support spindle (1) can be more easily inserted into the winding core (2),
wherein the supporting cage (14) is locked axially on the central shaft (5) by means of a closing plug (55) screwed to a front surface of the central shaft (5),
wherein the closing cap (55) is also beveled continuing the beveling of the supporting cage (14).

14. A support spindle (1) according to any one of the preceding claims, comprising two of said concentric supporting portions (9, 9') and having different diameters, as well as a plurality of said concentric supporting cages (14,14') having different diameters and positioned axially next to each other, with the smaller diameter supporting cage (14,14') positioned more on the front side (10) of the support spindle (1).

15. A support spindle (1) according to any one of the preceding claims, comprising a positioning and ejection flange (57) axially sliding with respect to the central shaft (5) and guided by a plurality of guiding grooves (58) parallel to the rotation axis (6), formed in an outer surface of the supporting cage (14).

16. A support spindle (1) according to any one of the preceding claims, wherein the supporting cage (14, 14') forms one or more radial friction protrusions (60) adapted to engage the core (2) constantly in direct contact and with a friction such as to ensure minimum torque transmission from the core (2) to the supporting cage (14, 14') even when the locking bodies (12) are not yet or no longer activated.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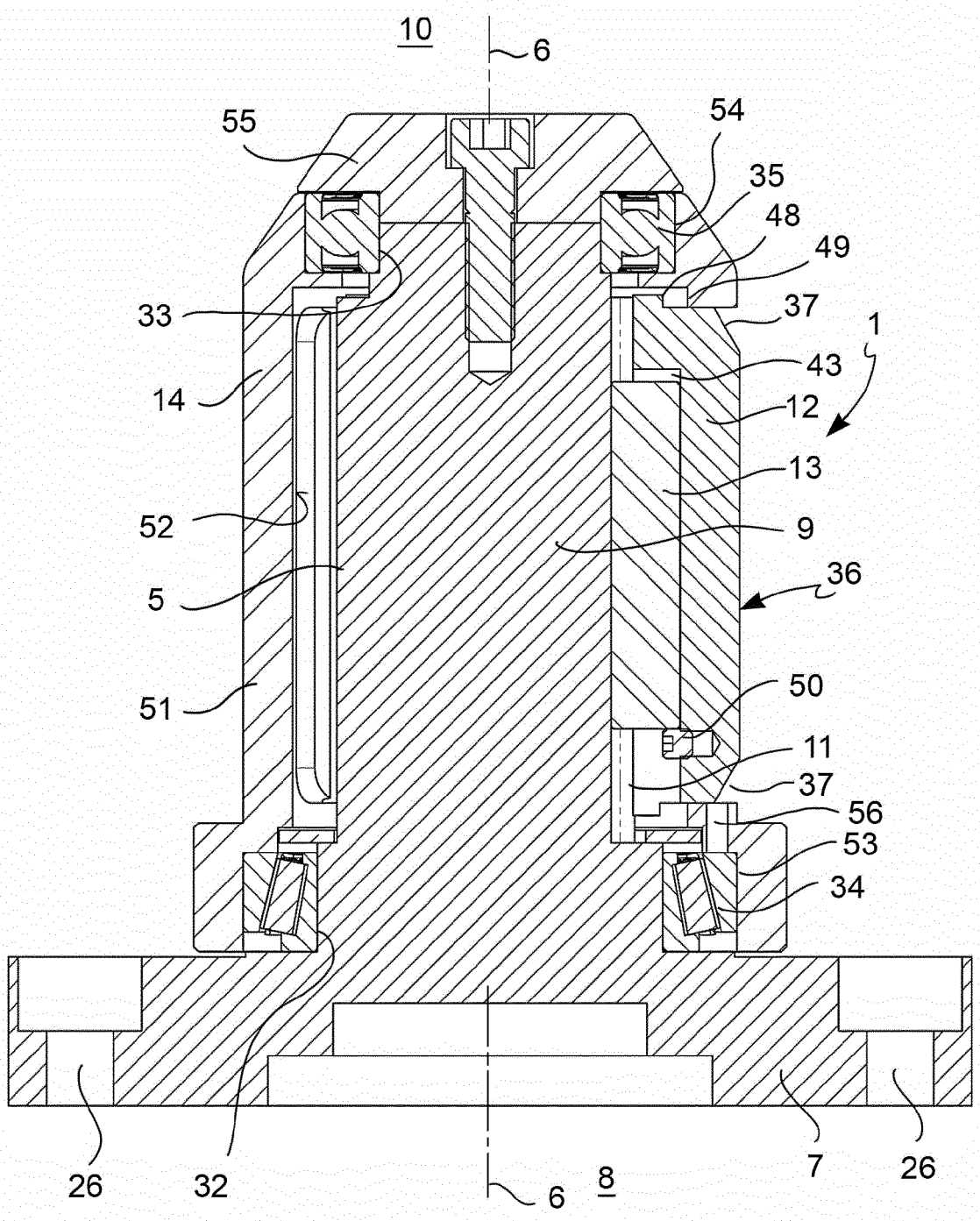
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FIG. 2

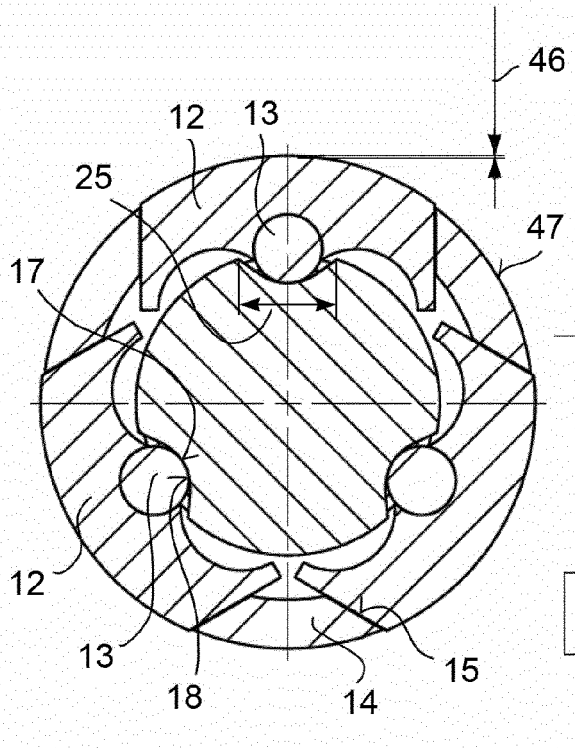

FIG. 3

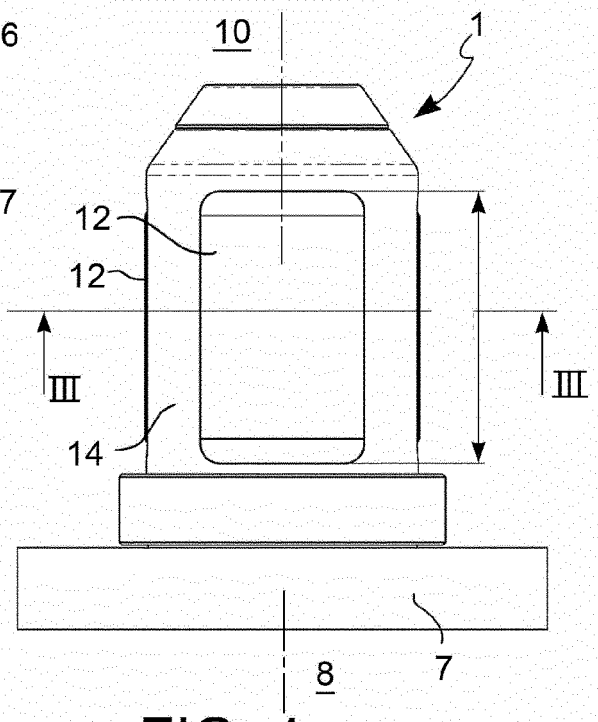

FIG. 4

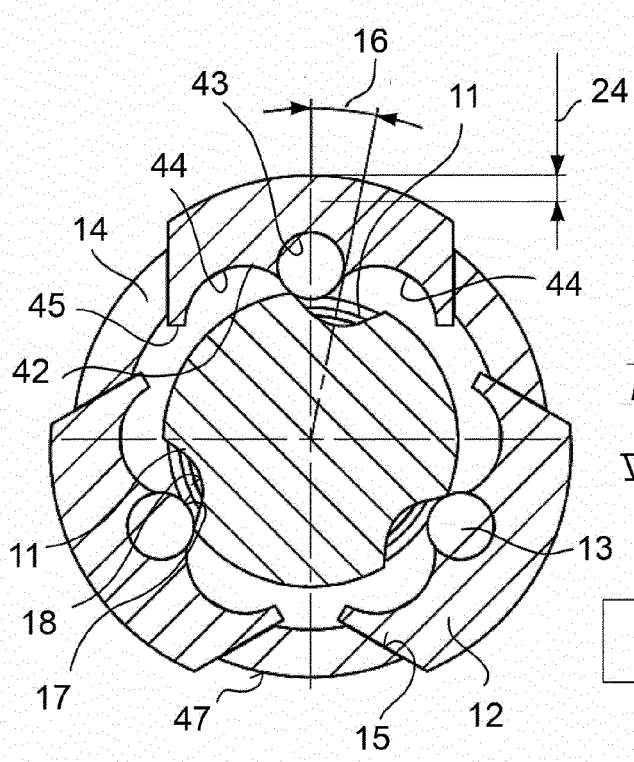

FIG. 5

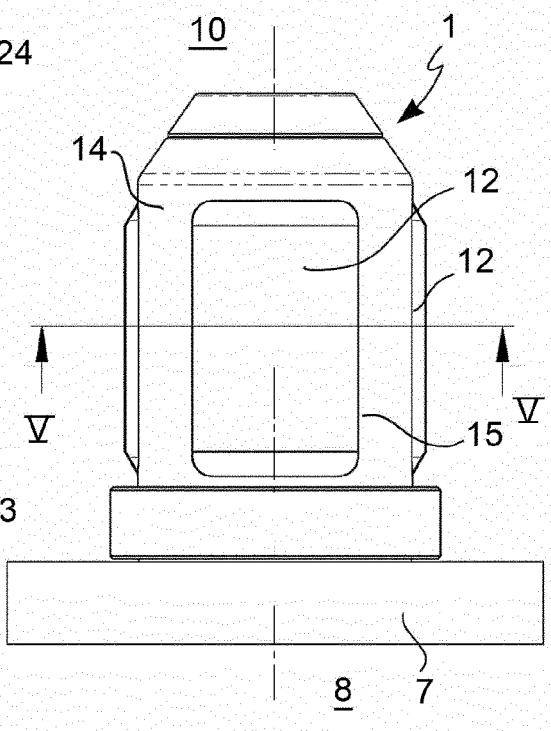

FIG. 6

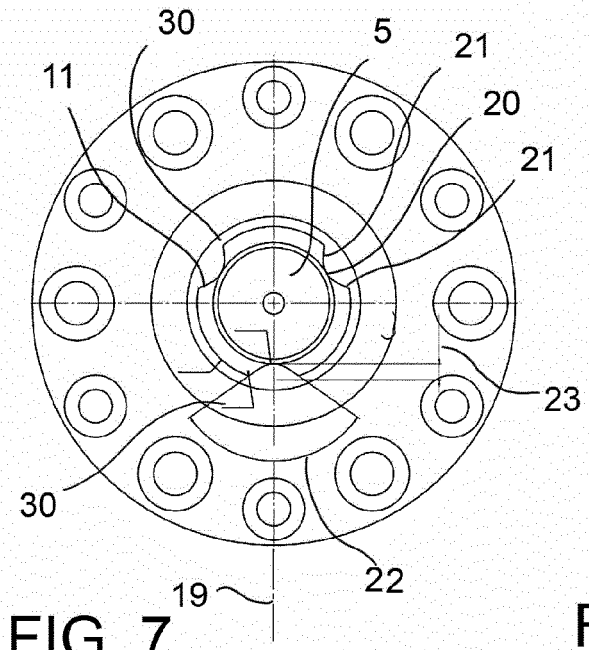

FIG. 7

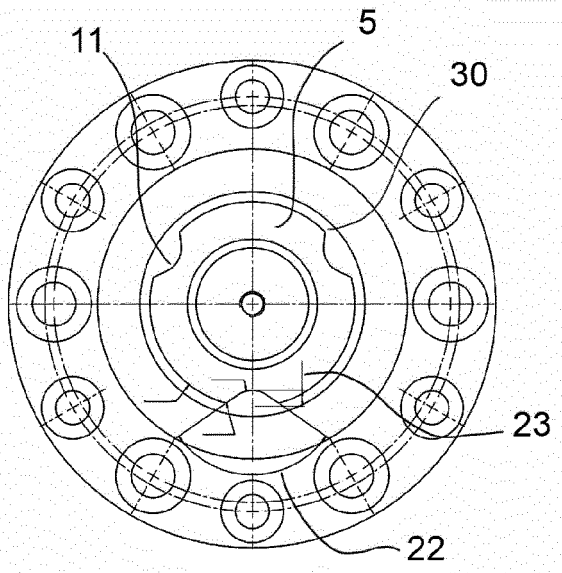

FIG. 8

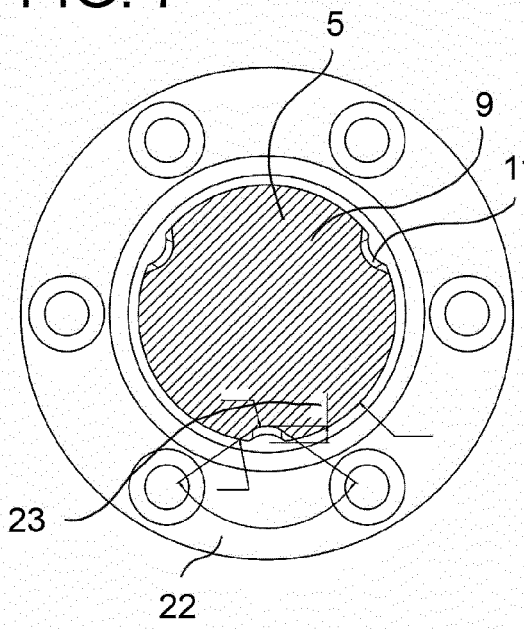

FIG. 10

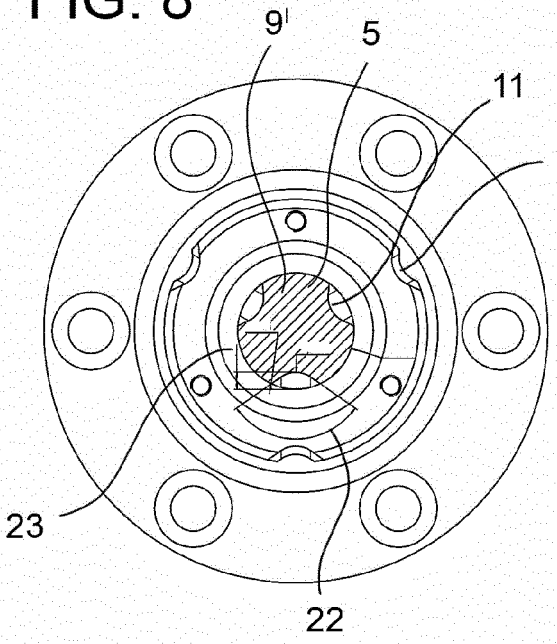

FIG. 11

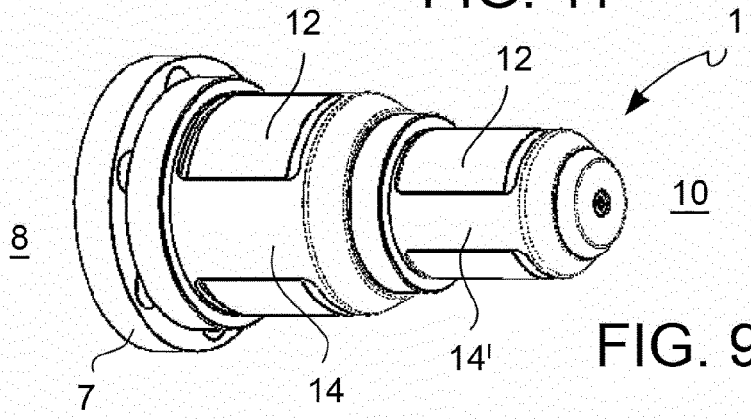

FIG. 9

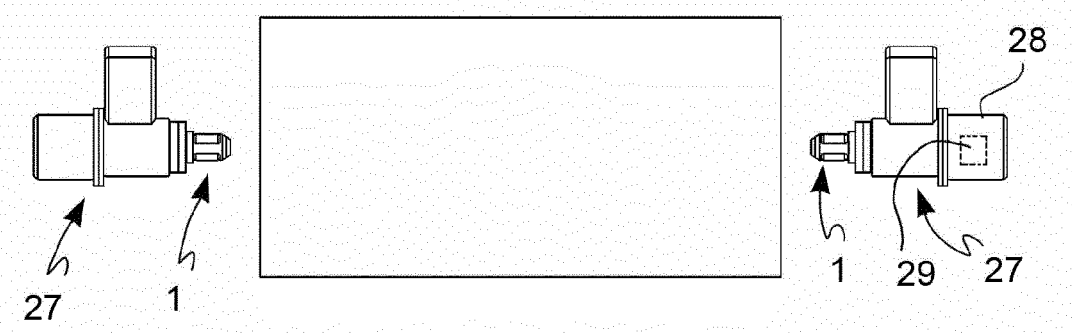

FIG. 12

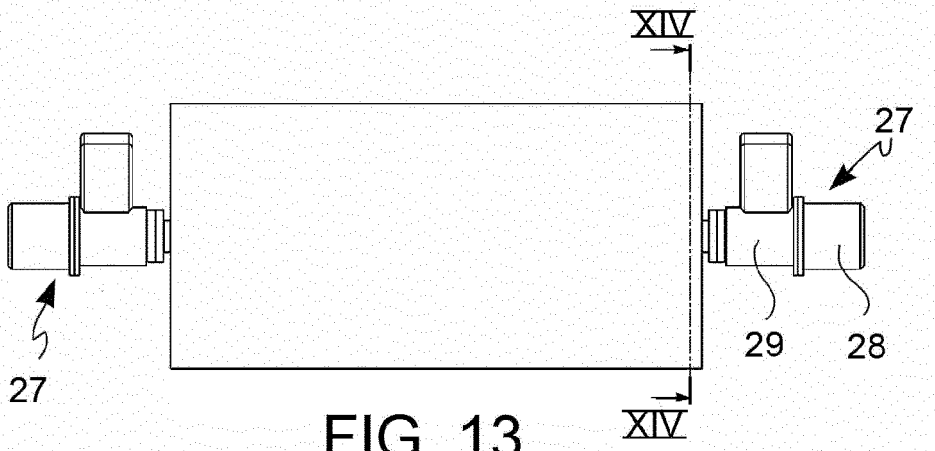

FIG. 13

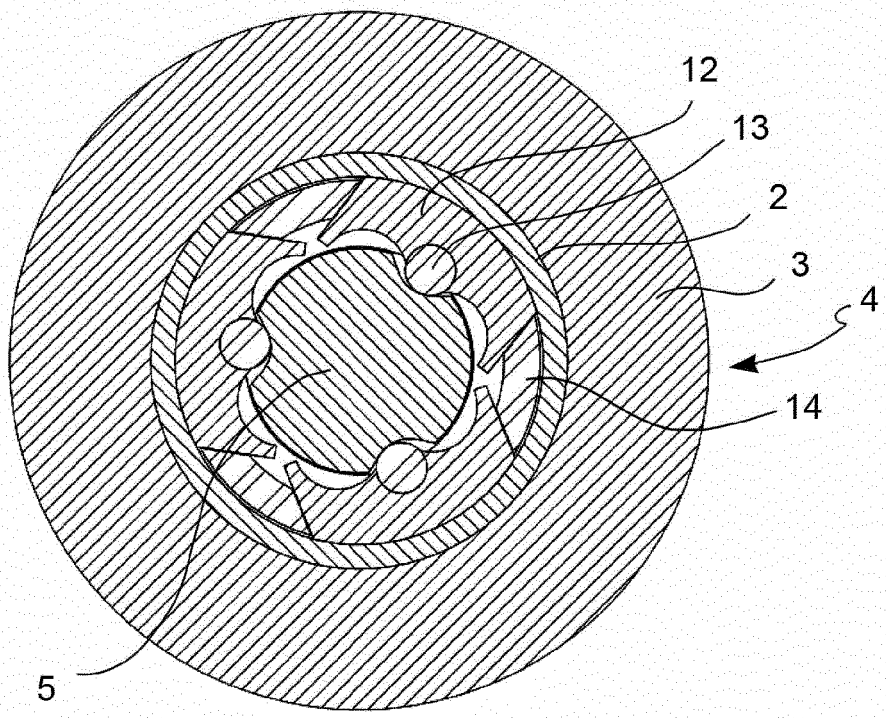

FIG. 14

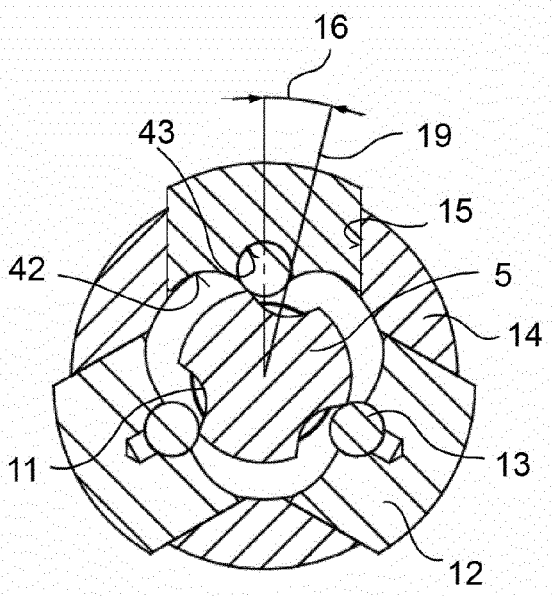

FIG. 15

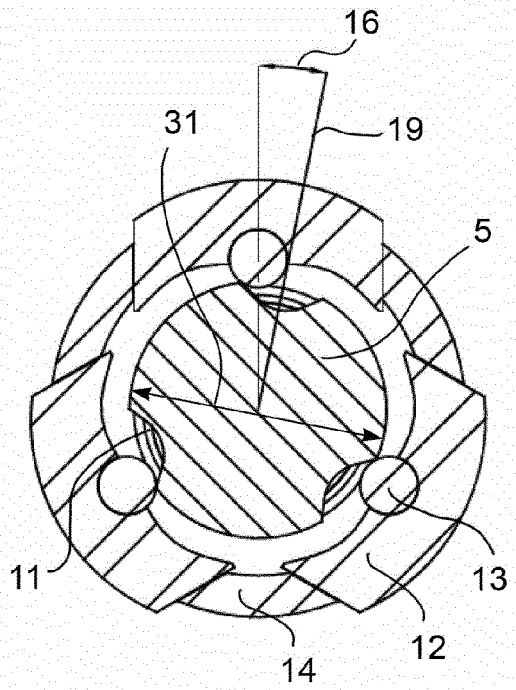

FIG. 16

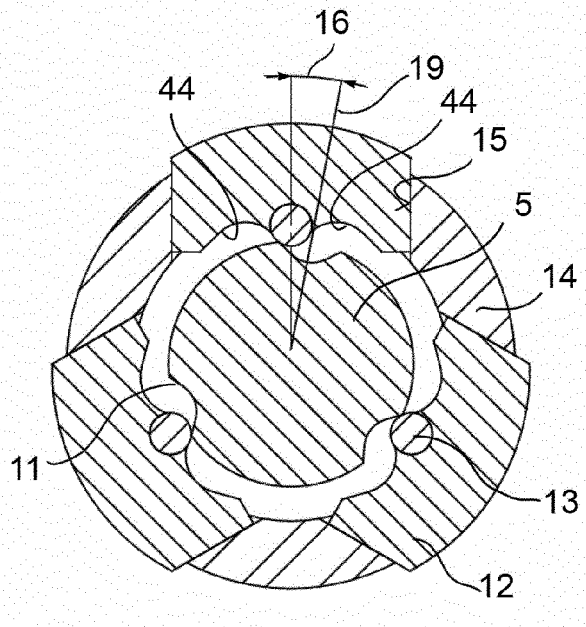

FIG. 17

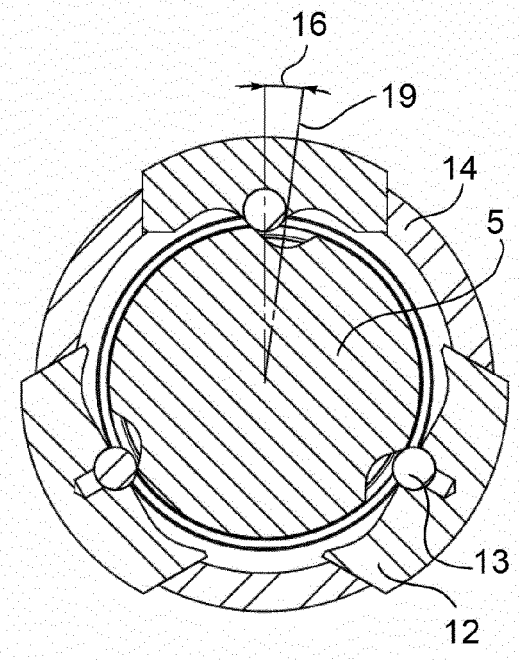

FIG. 18

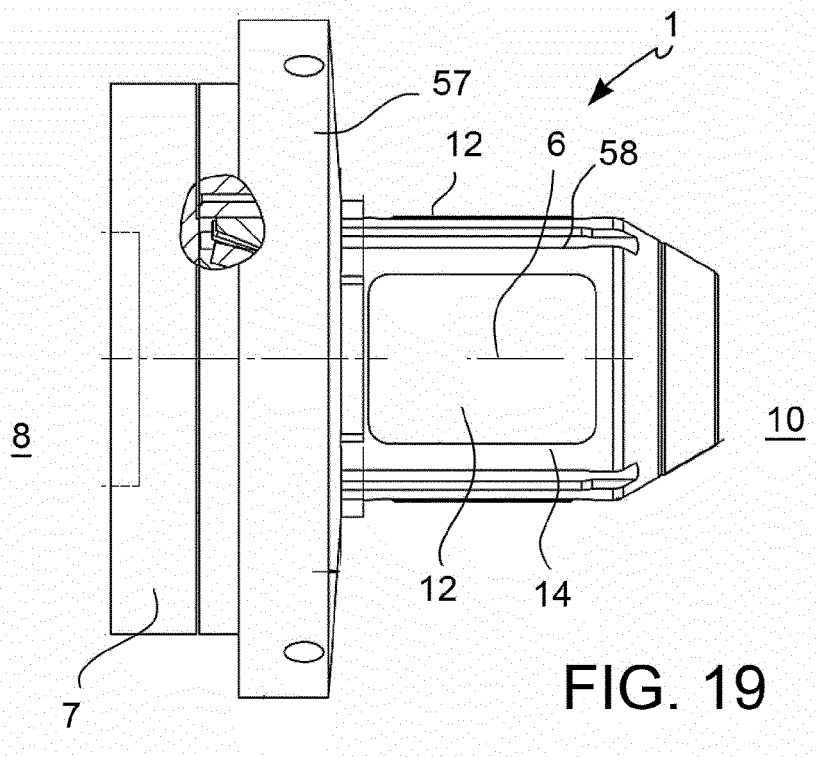

FIG. 19

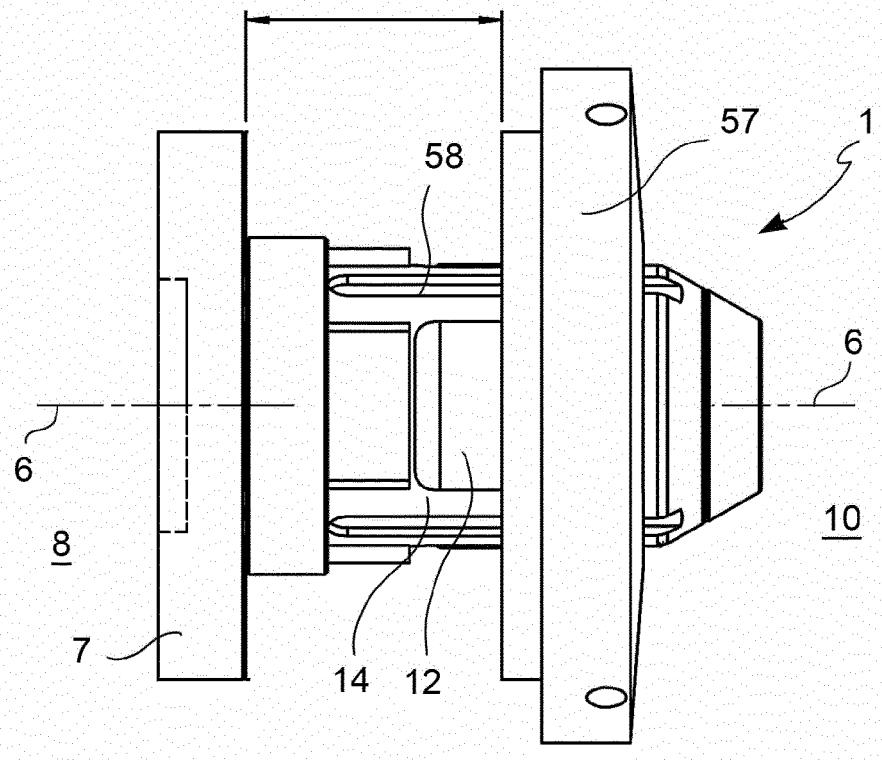

FIG. 20

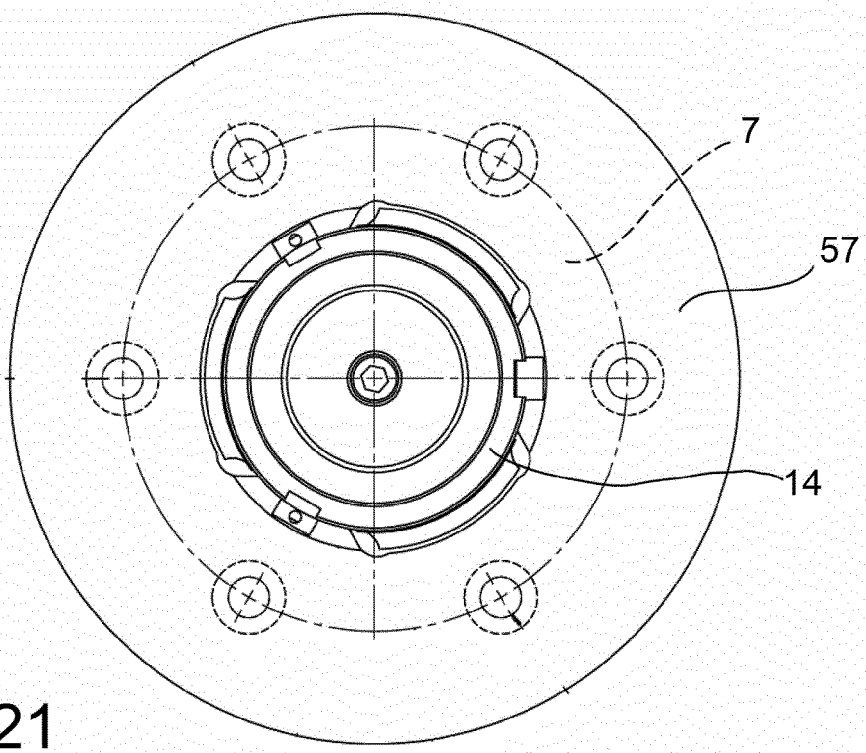

FIG. 21

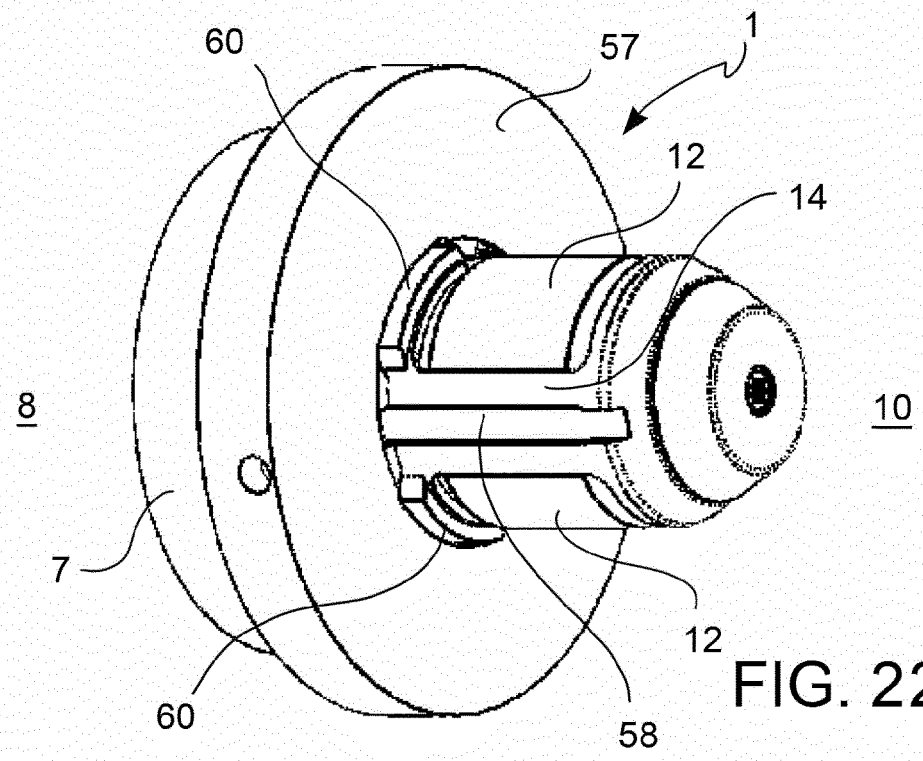

FIG. 22

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 8482

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 November 2021	Lemmen, René

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X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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