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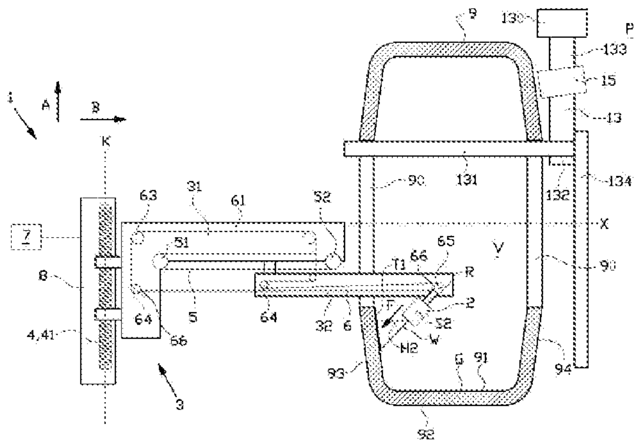
(54) **Method, inspection unit and computer program product for inspecting an inner surface of a tire, and tire processing assembly comprising the inspection unit**

(57) The invention relates to a method for inspecting an inner surface of a tire having a splice that extends along said inner surface in a splice direction transverse to the circumferential direction of the tire, wherein the method comprises scanning the splice with an imaging device while moving the field of view of said imaging device along the splice. The invention further relates to an inspection unit for inspecting an inner surface of a tire according to the method of the invention, wherein the inspection unit comprises a base, an imaging device and a drive assembly for driving a movement of said imaging device with respect to the base in an inspection plane and for driving a rotation of the imaging device about a rotation axis perpendicular to said inspection plane.



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Method, inspection unit and computer program product for inspecting an inner surface of a tire, and tire processing assembly comprising the inspection unit

BACKGROUND

The invention relates to a method, an inspection unit and a computer program product for inspecting an inner surface of tire, in particular for inspecting a splice of an inner liner of a green tire. The invention further relates to a processing assembly for processing a tire, wherein said processing assembly comprises the inspection unit according to the present invention.

US 11,198,339 B2 discloses an apparatus for detecting and checking defects on a tire at the end of a production process. The apparatus comprises a workstation having a workbench with a rotating table for supporting a tire; a profilometer; a high-resolution color linear camera for scanning outer surfaces of tire tread and tire shoulders; mechanical supports for the profilometer and color linear camera; a data processor for storing and processing data detected by the profilometer and the color linear camera, for providing a three-dimensional model of a tire, and for management of a database including parameters referring to surface characteristics of defect-free tires; and an interface for facilitating interaction between an operator and the apparatus. The profilometer and the color linear camera are configured to operate simultaneously and perform a full scan of all the profiles of inner and outer surfaces of a tire while the tire is in rotation at a controlled speed on the rotating table. The data processor is adapted to define and classify defects detected, by comparing parameters detected by the profilometer and the color linear camera to at least one corresponding parameter of a defect-free tire of a same type as a tire being tested.

EP1043578B1 discloses an inspection apparatus for tires in which a tire is supported on a positioning device and in which a measuring head is supported on a portal above said positioning device. A holder extending downwards from the portal for the measuring head can be travelled biaxially on the and along an axis perpendicular thereto. Furthermore, the holder can be rotated around its longitudinal axis or around an axis perpendicular to the contact surface of the positioning device for the tyre. The measuring head can be moved up and down along the holder. The vertical adjustability of the measuring head can also be performed by an adjustment of the holder itself, in particular by a longitudinal setting of the holder. The measuring head is furthermore swivellably attached around an axis to the holder.

EP1043578B1 further discloses an inspection apparatus in which three measuring heads are provided of which two inspect the inner side of the tyre casing and one its outer side. The measuring heads are attached to a holder which is supported on a portal. The holder is vertically adjustable and rotatable around its longitudinal axis. The measuring heads are each attached multi-axially adjustably to the holder. On the one hand, they can be travelled along radial axes, i.e. they are settable in their distance to the holder. In this way, the inspection apparatus can be set or adapted to different tyre diameters. Furthermore, all measuring heads are swivellably supported in each case around a swivel axis on the beam by means of which they are connected to the holder. The swivel axes of the measuring heads extend preferably tangentially to imaginary circles around the axis of rotation of the tyre. Furthermore, for the inspection of the inner side of the tyre, the measuring heads are vertically adjustable relative to the holder along the axes which extend parallel to the adjustment axis of the holder. The measuring heads can therefore be vertically adjusted together by means of the holder; furthermore, a vertical adjustment of the measuring heads can be effected relative to the holder.

The exhaustive adjustability of the measuring heads separately from one another or simultaneously with one another allows, on the one hand, an optimum adjustment of the single measuring heads to the tyre section to be inspected in each case. On the other hand, after an individual adjustment, the tyre can be travelled over with a rotation of the holder through its longitudinal axis.

SUMMARY OF THE INVENTION

A disadvantage of the known apparatuses for detecting and checking defects is that scanning of the entire tire is time consuming. Moreover, a lot of data needs to be collected in order to provide workable data in all three dimensions.

Additionally, scanning the entire tire requires placing the tire on a separate rotating table or positioning device. Placing the tire on the rotating table or positioning device may introduce inaccuracies in the placement of the tire relative to the profilometers and cameras. Moreover, the tire needs to be flipped on the rotating table in order to be able to scan all surfaces of the tire. Said flipping may introduce further inaccuracies which make it difficult to correlate the measurement from the two sides and may further delay the inspection process.

It is an object of the present invention to provide a method, an inspection unit, a tire processing assembly comprising said inspection unit, and a computer program product for inspecting an inner surface of tire, which can inspect a green tire more efficiently and/or more precisely.

According to a first aspect, the invention provides a method for inspecting an inner surface of a tire having a splice that extends along said inner surface in a splice direction transverse to the circumferential direction of the tire, wherein the method comprises scanning the splice with an imaging device while moving the field of view of said imaging device along the splice.

Defects or irregularities at the inner surface of the green tire are often located at or near the splice. Because the field of view of the imaging device is moved along the splice, i.e. following the direction of the splice, while scanning the inner surface of the tire, said splice can be scanned and/or inspected more precisely, more accurately, or more effectively. Moreover, the need to scan the entire circumference or perimeter of the inner surface of tire is eliminated. Accordingly, the inner surface of the tire can be scanned without rotating the tire about the central axis thereof. Hence, the tire does not need to be laid down for scanning. Additionally, the tire does not need to be flipped or turned over. Thus, the splice can be scanned or inspected more effectively and/or efficiently.

In an embodiment thereof, the method comprises scanning the splice with the imaging device while moving the field of view of said imaging device along a distinct number of inspection paths along the inner surface of the tire. Hence, the complex contour of the inner surface of the tire can be subdivided into a plurality of inspection paths. In other words, the method can allow the imaging device to inspect the inner surface of the tire by moving said imaging device along a sequence, series or superposition of inspection paths. Each inspection path can accurately represent a portion of the inner surface of the tire without the need to replicate the entire contour of the inner surface of the tire. Accordingly, said inspection paths can be defined in basic and/or elemental movements of the imaging device. Hence, moving the imaging device along the splice can be simplified. Accordingly, the imaging device can be moved along the splice more effectively. Preferably, said inspection paths at least partly overlap with the splice. Hence, the splice can be effectively inspected by moving the field of view along the distinct number of inspection paths.

In a further embodiment, moving the field of view of the imaging device along each one of the distinct number of inspection paths comprises:

a) moving the imaging device from an initial inspection position to a consecutive inspection position; and/or

b) rotating a viewing direction of the field of view of the imaging device from an initial inspection angle to a consecutive inspection angle about a rotation axis extending transverse to the splice direction. In other words, the field of view can be moved along a respective inspection path by either moving the imaging device or by rotating the viewing direction or by both moving the imaging device and rotating the viewing direction. Hence, a respective inspection path can be defined by an initial inspection position and a consecutive inspection position and/or by an initial inspection position and a consecutive inspection position only. Accordingly, said inspection positions and/or inspection angles can be adjusted to accurately or precisely follow the shape of a section or portion of the inner surface of the tire. Preferably, the inspection positions are predetermined based on a configuration and/or shape of the tire. In particular, each inspection position can be set at a predetermined distance from the inner surface of the tire, e.g. within the focus range of the imaging device. Hence, the imaging device can scan or inspect the splice more accurately or precisely along each inspection path.

In an embodiment thereof, the inspection paths of the distinct number of inspection paths are consecutive inspection paths. Preferably, the consecutive inspection position of a first inspection path is the initial inspection position of a consecutive inspection path, and the consecutive inspection angle of a first inspection path is the initial inspection angle of a consecutive inspection path. In other words, said inspection paths may be adjacent or adjoining inspection paths. Alternatively, said inspection paths may partially overlap. The inspection paths can be combined or superposed to perform a scan along the splice of the tire.

In a further, preferred embodiment, in step a), the imaging device is moved linearly from the initial inspection position to the consecutive inspection position.

In a further embodiment, steps a) and b) are performed simultaneously for moving the field of view of the imaging device along a respective one of the distinct number of inspection paths. Preferably, the viewing direction of the field of view is gradually rotated from the initial inspection angle to the consecutive inspection angle while the imaging device is moved from the initial inspection position to the consecutive inspection position. In other words, the rotation of the viewing direction can be linked to the movement of the imaging device for a respective inspection path. Hence, the scanning of the splice along a respective inspection path can be more even or uniform. Alternatively, the imaging apparatus may for example first be moved into an inspection position, after which the viewing direction is rotated while scanning the inner surface of the tire.

In a further embodiment, the initial inspection positions and consecutive inspection positions for each of the inspection paths of the distinct number of inspection paths are located in a common inspection plane. In other words, the method comprises moving the inspection unit within said inspection plane. Preferably, the rotation axis extends perpendicular to the inspection plane. In other words, the field of view of the inspection unit is directed in the inspection plane as well. Accordingly, the resulting inspections paths of the field of view can extend in the inspection plane as well.

In a further embodiment, the method comprises choosing the first inspection position and the one or more further inspection positions such that at least a part of the splice extends parallel to, substantially parallel to or in the inspection plane. Preferably, the imaging device has a field of view that is symmetric with respect to the inspection plane. Hence, the field of view can be centered at or near the splice. Accordingly, the splice can be scanned or inspected more accurately or precisely.

In a further embodiment, the method further comprises calibrating the inspection paths of the distinct number of inspection paths before scanning the splice, wherein the calibrating comprises the steps of:

- moving the field of view of the imaging device along a respective inspection path of the distinct number of inspection paths;
- determining, for said respective inspection path, a mutual distance between the imaging device and the inner surface of the tire; and
- adjusting the respective initial and consecutive inspection positions and/or the respective initial and consecutive inspection angles when said mutual distance is outside a predetermined range. A distance outside the predetermined reference range can for example indicate an error in the shape or configuration of the tire or an ill chosen inspection position and/or inspection angle. Accordingly, the configuration of the tire, the inspection positions and/or the inspection angles can be adjusted when said distance is not within the predetermined range. The predetermined range can for example comprise the focus distance or focus range of the imaging device. The calibration can improve the accuracy and/or precision of the inspection.

The calibration can be performed by adjusting individual inspection positions and/or inspection angles. Hence, it is not necessary to recalculate the entire trajectory of the imaging unit. Hence, calibration can be performed more effectively.

Preferably, the calibration is performed on a first tire op a series of tires with the same configuration. Hence, a single calibration of the inspection positions can be performed on said first tire to calibrate the inspection positions for all tires within the series of tires. Hence, the process efficiency can be improved.

In a further embodiment thereof, the calibrating further comprises the steps of:

- determining a mutual distance between the inspection plane and the splice;

- pivoting the inspection plane about a pivot axis when said mutual distance is outside a predetermined range. Hence, an angle of the inspection plane relative to the splice can be corrected. In other words, the inspection plane can be aligned or substantially aligned with the splice. Thus, the accuracy and/or precision of the inspection of the splice can be improved.

In a further embodiment, the distinct number of inspection paths is within a range from one to nineteen, preferably within a range from four to fourteen, more preferably in a range from seven to nine. Said number of inspection paths can be large enough to accurately scan the inner surface of the tire along the splice. Moreover, said number of inspection paths can be small enough to effectively and/or efficiently scan said inner surface of the tire.

In a further embodiment, the movement of the imaging device along the splice is computer controlled and/or automated. In other words, the imaging device can automatically be moved into the subsequent inspection positions and rotated into the subsequent inspection angles. Hence, the inner surface of the tire can be inspected more effectively and/or efficiently.

In a further embodiment, the method comprises supporting the tire in an upright orientation while inspecting the inner surface. In said upright orientation, the central axis of the tire extends in or substantially in the horizontal direction. The tire can for example be inspected while being transported in the upright orientation. Hence, process efficiency can be further improved.

According to a second aspect, the invention relates to an inspection unit for inspecting an inner surface of a tire according to the steps of the method of any one of the preceding claims, wherein the inspection unit comprises a base, an imaging device and a drive assembly for driving a movement of said imaging device with respect to the base in an inspection plane and for driving a rotation of the imaging device about a rotation axis perpendicular to said inspection plane, wherein the inspection unit further comprises a control unit that is operationally connected to the drive assembly for controlling the movement of the imaging device with respect to the base in the inspection plane and for controlling the rotation of the imaging device about the rotation axis, wherein the control unit is configured for controlling the drive assembly to subsequently position the imaging device at a distinct number of predetermined inspection positions in the inspection plane and associated inspection angles about the rotation axis.

The inspection unit is arranged for carrying out the method according to the first aspect of the invention. Hence, said inspection unit has the same advantages as discussed above. In particular, the inspection unit can move and rotate the field of view of the imaging device within the inspection plane. Hence, said inspection unit can be used to follow the splice on the inner surface of the tire when said tire is provided in a suitable orientation, e.g. when the inspection plane intersects with a radial plane of the tire. In particular, the inspection unit can move the field of view of the imaging device along a discrete number of consecutive inspection paths by subsequently positioning the imaging device in two or more inspection positions and/or by rotating the imaging device into two or more inspection angles. The control unit can comprise a database with predetermined inspection positions. Said inspection positions can for example be dependent on a configuration and/or dimension of the tire.

In an embodiment thereof, the control unit is arranged for controlling the drive assembly to gradually rotate the imaging device about the rotation axis from an initial inspection angle to a consecutive inspection angle while moving said imaging device from an initial inspection position to a consecutive inspection position.

In a further embodiment thereof, an initial inspection angle and a consecutive inspection angle are the same for an associated initial inspection position and a consecutive inspection position different from the initial inspection position. In other words, the control unit can be arranged to move the imaging device between two consecutive or subsequent inspection positions without rotating the imaging device.

In a further embodiment thereof, an initial inspection position and a consecutive inspection position are the same for an associated initial inspection angle and a consecutive inspection angle different from the initial inspection angle. In other words, the control unit can be arranged to rotate the imaging device between consecutive inspection angles without translating said imaging device.

In a further embodiment, the distinct number of predetermined inspection positions and associated inspection angles is within a range from two to twenty, preferably in a range from five to fifteen, more preferably in a range from eight to ten. Said number of inspection paths can be large enough to accurately scan the inner surface of the tire along the splice. Moreover, said number of inspection paths can be small enough to effectively and/or efficiently scan said inner surface of the tire.

In a further embodiment, the inspection unit is arranged to measure a distance between said imaging device and the inner surface of the tire.

In a further embodiment, the imaging device is movable with respect to the base along the inspection plane in a first direction and a second direction transverse or perpendicular to said first direction. In other words, the inspection plane is spanned by the first direction and the second direction. By moving the imaging device in the first direction and the second direction, said imaging device can be placed in any desired position in the inspection plane. Moreover, by moving the imaging device in the first and the second direction, the imaging device can be inserted through one of the openings of the tire and into the internal or enclosed volume of said tire.

In a further embodiment thereof, the drive assembly is pivotable with respect to the base about a pivot axis extending in the first direction for pivoting the inspection plane with respect to the base. In other words, the angular position of the inspection plane with respect to the base can be adjusted. Hence, the angular position of the inspection plane can be adjusted to an angle of a splice with respect to the circumferential direction of the tire. Accordingly, the imaging device can be displaced along said splice more precisely. Hence, the splice can be inspected more accurately.

In a preferred embodiment, the first direction is the vertical direction. Accordingly, the inspection plane is a vertical plane. Moving the imaging device in a vertical plane may facilitate inspecting tires in an upright orientation.

In a further embodiment, the drive assembly comprises a first member that is movable with respect to the base and a second member that is movable with respect to the first member, wherein the imaging device is rotatably mounted to the second member for rotation about the rotation axis. Preferably, the drive assembly further comprises a first linear drive for driving a movement of the first member with respect to the base in the first direction and a second linear drive for driving a movement of the second member with respect to the first member in the second direction. Hence, the imaging device can be moved in the first direction and the second direction and rotated about the rotation axis independently.

In a further embodiment, the drive assembly further comprises a rotation drive for driving the rotation of the imaging device about the rotation axis. In other words, the imaging device can be rotated about the rotation axis independent of the movement of the imaging device in the inspection plane.

In an embodiment thereof, the rotation drive is a belt drive comprising a plurality of pulleys and a belt that is guided along said plurality of pulleys, wherein the plurality of pulleys comprises an actuation pulley that is coupled in rotation to the imaging device. Preferably, the actuation pulley is rotatable about the rotation axis. Hence, the imaging device can be rotated by driving the belt along the pulleys. Preferably, said belt is an endless belt that is looped around the pulleys. Preferably, the belt is a toothed belt. A toothed belt can impart a rotation on the actuation pulley more accurately and/or precisely.

In a further embodiment, the plurality of pulleys comprises a driven pulley for driving the belt, wherein the driven pulley is located at the first member or at the base. Hence, the rotation drive can affect a rotation of the imaging device about the rotation axis without the need to mount a motor or drive on to the second member. Thus, less weight is added to the second member and less force is required to displace said second member. Accordingly, the second member and the imaging device mounted thereto can be displaced more accurately, precisely and/or efficiently.

In a further, preferred embodiment, the imaging device has a field of view between twenty-five and forty-five degrees, preferably between thirty and forty degrees. Preferably, said field of view is determined in a direction perpendicular to the inspection plane. The field of view is directed in and/or centered about a viewing direction. Preferably, the field of view is centered with respect to the inspection plane, i.e. the viewing direction extends in the inspection plane.

In a further embodiment, the imaging device comprises a laser emitter for projecting a laser line on the inner surface of the tire and a camera for capturing an image of said laser line. A laser emitter and camera can be a suitable setup for imaging or scanning the profile of the inner surface of the tire, in particular the splice on said inner surface.

According to a third aspect, the invention provides a processing assembly for processing a tire, wherein the processing assembly comprises the inspection unit according to any one of the preceding claims.

The processing assembly comprises the inspection unit according to the preceding claims and, hence, inherently has the same advantages as described above.

In an embodiment thereof, the processing assembly further comprises a transport device for transporting the tire along a transport path, wherein the inspection unit is arranged along said transport path. Preferably, the inspection unit is arranged to inspect a tire on the transport device without removing said tire from the transport device. Hence, the tires can be inspected during transportation thereof. In other words, no separate inspection station for inspecting the tires is required. Accordingly all tires can be inspected during the production process. Hence, the tires inspection can be performed

In a further embodiment thereof, the transport device is arranged for transporting the tire in an upright orientation. The tires may for example be supported or suspended on the inner rim or on the outer surface, i.e. the thread surface, thereof. The upright orientation can allow the imaging device of the inspection unit to be inserted through an opening of said tire in a horizontal or substantially horizontal direction.

According to a fourth aspect, the invention provides a computer program product comprising instructions for making the inspection unit according to the second aspect of the present invention perform the method according to the first aspect of the present invention.

The various aspects and features described and shown in the specification can be applied, individually, wherever possible. These individual aspects, in particular the aspects and features described in the attached dependent claims, can be made subject of divisional patent applications.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be elucidated on the basis of an exemplary embodiment shown in the attached schematic drawings, in which:

figures 1A-1F show a plan view of an assembly for handling a tire according to the present invention comprising an inspection unit according to the present invention;

figures 2A-2G show a side view of the inspection unit of the present invention according to the line II-II in figure 1D during exemplary steps of inspecting the tire;

figure 3 shows a section view of the inspecting unit according to the line IV-IV in figure 2D;

figures 4A and 4B show a section view of the inspecting unit according to the line V-V in figure 3 during further exemplary steps of inspecting a tire;

figures 5A and 5B shows exemplary steps of a method of laying down a tire using a lay down device according to an embodiment of the present invention; and

figures 6A and 6B show exemplary steps of a method of laying down a tire using an alternative lay down device according to an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1A-1F show a plan view or top view of a processing assembly 10 for processing a tire 9, in particular a green or unvulcanized tire, according to an exemplary embodiment of the present invention.

As is best seen in figures 2A-2G, the tire 9 has a generally cylindrical or toroid shape extending circumferentially and/or concentrically about a tire axis X.

In particular, the tire 9 has a C-shaped, a U-shaped, or a substantially C-shaped or substantially U-shaped cross section that extends in a circumferential direction C about the tire axis X.

The tire 9 comprises a first lateral side 93 and a second lateral side 94 on opposite sides of the tire 9 in a lateral direction that extends parallel to the tire axis X. The tire 9 has two circular or substantially circular openings 90 in the respective lateral sides 93, 94. The openings 90 extend concentrically or circumferentially about the tire axis X.

The tire 9 further has an outer surface 92 facing radially outward with respect to the tire axis X. Said outer surface may for example be formed by a tread layer (not shown). The outer surface 92 extends circumferentially and/or concentrically about tire axis X. The tire 9 further comprises an inner surface 91 facing radially inward, i.e. said inner surface 91 faces towards the tire axis X. The inner surface 91 and the lateral sides 93, 94 define an internal volume V of the tire 9.

In this particular example, the inner surface is at least partly formed by an inner liner. The inner liner has been spliced along or at the inner surface 91 at a splice G. Said splice G extends on or along the inner surface 91 in a splice direction D transverse to the circumferential direction C of the tire 9. Depending on the configuration of the tire 9, the splice direction D may be perpendicular to circumferential direction C of the tire 9, i.e. parallel to the tire axis X. Alternatively, the splice direction D may extend at an acute angle or an obtuse angle with respect to the circumferential direction of the tire 9.

As is further shown in figures 1A-1F, the processing assembly 10 comprises a tire building drum 11 for assembling and/or shaping the tire 9, a lay down device 12 for receiving the tire 9 and for placing the tire 9 in a lay down orientation, and a transport device 13 for transporting the tire 9 from the tire building drum 11 to the lay down device 12. The tire processing assembly 10 further comprises a transfer ring 14 for removing the tire 9 from the tire building drum 11 and for transferring the tire 9 to the transport device 13.

The transport device 13 comprises a rail 130 that extends between the transfer ring 14 and the lay down device 12, and a carriage 133 that is movable along said rail 130. In this particular embodiment, the rail extends from the transfer ring 14 to the lay down device 12 in a transport direction T. Accordingly, the carriage 133 is movable along the rail 130 in said transport direction T for transporting the tire 9 from the transfer ring 12 to the lay down device 12.

As is best seen in figures 2A-2G, transport device 13 further comprises one or more support members 131, preferably one or more support rollers, for supporting the tire 9. The support members 131 protrude from the carriage 133 and are carried or supported by said carriage 133. In the embodiment as shown, the support members 131 are arranged to support the inner rims of the tire 9. In other words, the one or more support members 131 are arranged to be inserted through the openings 90 of the tire 9. Alternatively, support members may be arranged to support the circumferential outer surface 92 of the tire 9.

The transport device 13 is arranged for holding the tire 9 in an upright orientation, i.e. with the tire axis X extending horizontally or substantially horizontally. Preferably, the transport device 13 is arranged for transporting the tire 9 in an orientation in which the tire axis X extends transverse or perpendicular to the transport direction T. In particular, the support members 131 extend transverse or perpendicular to the transport direction T while transporting the tire 9 in the transport direction T.

Optionally, the transport device 13 is further provided with one or more load cells 132 for measuring a weight of the tire 9. Preferably, each of said one or more load cells 132 are arranged between the carrier 133 and a respective one of the support members 131. Hence, the weight of the tire 9 can be measured while said tire is transported by the transport device 13. Hence, no separate weighing station is required.

The transport device 13 may further comprise a sticker applicator 15 for applying a sticker to the tire 9. Alternatively, a marker applicator may be used for applying a marking or marker on the tire 9. Said sticker, marking or marker may for example comprise information about the configuration and/or the dimensions of the tire 9. Additionally or alternatively, the weight of the tire 9 measured by the load cells 132 may be marked on the tire 9. The sticker applicator 15 can apply a sticker to the tire 9 while said tire 9 is transported by the transport device 13. Hence, no separate sticker application station or marking station is required.

As can further be seen in figures 1D and 1E, the transport device 13 may be arranged for rotating or pivoting the tire 9 about a transfer axis Y into a transfer orientation for transferring the tire 9 to the lay down device 12. In particular, as is shown in figures 5A and 6A, the carrier 133 is rotatable with respect to rail 130 about the transfer axis Y. In the transfer orientation, the tire axis X extends parallel or substantially parallel to the transport direction Z.

As is shown in figures 5A and 5B the lay down unit 12 comprises a lay down support 121 and a plurality of lay down rollers 122. The lay down rollers 122 and the lay down support 121 form an L-shaped or substantially L-shaped frame for supporting the tire 9. Said frame is pivotable about a lay down axis M between a receiving orientation, as is shown in figure 5A and a lay down orientation as is shown in figure 5B. Said lay down axis M is located upstream of the lay down rollers 122 in the transport direction T. The lay down rollers 122 and the lay down support 121 each extend perpendicular to the lay down axis M. Preferably lay down rollers form a roller conveyor section. The lay down support 121 may comprise a roller conveyor as well.

As is shown in figure 5A, in the receiving orientation, the lay down rollers 122 extend generally vertical or upward. The lay down supports 121 extend in or substantially in the horizontal direction. The tire 9 has been transported up to the lay down unit 12 such that the outer surface 92 of the tire 9 is facing the lay down support 121 and the first side 93 of the tire is facing the lay down rollers 122. Preferably, tire 9 is supported with the outer surface 92 on the lay down supports 121. Optionally, the first side 93 of the tire 9 abuts the lay down rollers 122. When the tire 9 is supported on the lay down support 121, the support members 131 of the transport device 13 may be retracted from the tire 9. Subsequently, the lay down device 12 may be rotated from the receiving orientation to the lay down orientation.

As is shown in figure 5B, in the lay down orientation, the lay down rollers 122 extend in or substantially in a horizontal plane. The tire 9 has been pivoted about the lay down axis M and is now supported with the first side 93 thereof on the lay down rollers 122. Subsequently, the tire 9 may be transported further on the first side 93 thereof.

Figures 6A and 6B show an alternative lay down device 212. The alternative lay down device 212 differs from the previously discussed lay down device 12 in that the lay down axis M is located downstream of the lay down rollers 222 in the transport direction T. The lay down rollers 222 are arranged to accommodate the support members 131 of the transport device 13.

The tire processing assembly 10 further comprises an inspection unit 1 for inspecting the tire 9, in particular the inner surface 91 of the tire 9. More particularly, the inspection unit is arranged to inspect the splice G on the inner surface 91 of the tire 9. The inspection unit 1 is arranged along the transport device 13. In particular, the inspection unit 1 is arranged along or next to the transport device in a direction transverse to the transport direction Z. The inspection unit 1 is arranged to reach into the internal volume of the tire 9 via one of the openings 90 while the tire is supported by the transport device 13.

As is best shown in figures 2A-2F, the inspection unit 1 comprises an imaging device 2 for scanning or imaging the inner surface 91 of the tire 9. The imaging device 2 may for example comprise a profiler or a profilometer for detecting and/or imaging a height profile of the inner surface 91 of the tire 9. In this particular embodiment, the imaging device 2 comprises a laser emitter for projecting a laser line L on the inner surface 91 of the tire 9 and a camera for capturing an image of said laser line L on the inner surface 91.

Optionally, the transport device 13 further comprises a shielding unit 134 for shielding of the laser of the imaging device 2. In particular, the shielding unit is arranged for preventing that the laser of the imaging unit is emitted outside of the tire 9 through the opening 90 of said tire 9. The shielding unit 134 is supported on and/or suspended on the carrier 133. The shielding unit 134 is arranged to cover at least a part of the opening 90 of the tire along the tire axis X. The shielding unit 134 may for example comprises a plate or a sheet of laser shielding material.

The camera of the imaging device 2 has a field of view W that is directed along and/or centered about a viewing direction F. Said viewing direction F extends at a slight angle with respect to the emitted laser for capturing a profile of the inner surface 91 along the projected laser line L. In particular, the viewing direction F is directed at such an angle with respect to the emitted laser that the projected laser line L is within the field of view W of the imaging device 2.

As is shown in figures 3, 4A and 4B, the imaging device 2 is arranged to project the laser line L such that said laser line L extends transverse or perpendicular to the splice G. In this particular embodiment, the field of view W about the viewing direction F, i.e. in the direction of the projected laser line L, is between twenty-five and forty-five degrees. Preferably, said field of view W, in the direction of the projected laser line L, is between thirty and forty degrees.

The imaging device 2 may for example have a focus distance of forty millimeters and a focus range between five and seventy-five millimeters in the viewing direction F.

Preferably, the inspection unit 1 is arranged for measuring a distance between the imaging device 2 and the inner surface 91 of the tire 9. For example the imaging device 2 may comprise a triangulation camera for determining said distance.

The inspection unit 1 further comprises a base 8 and a drive assembly 3 for moving the imaging device 2 with respect to said base 8. In particular, the drive assembly 3 is arranged to drive a movement of the imaging device 2 with respect to the base 8 in an inspection plane P. As is shown in figures 2A-2F, the inspection plane P is spanned by a first direction A and a second direction B transverse or perpendicular to said first direction A. Preferably, as is shown in figures 2A-2F, the first direction A is a vertical or upright direction. In other words, the inspection plane P is a vertical or upright plane.

The drive assembly 3 comprise a first member 31 that is movable relative to the base 8 and a first drive 4 for driving the movement of said first member 31 relative to the base 8. In the embodiment as shown, the first member 31 is movable relative to the base 8 in the first direction A. Accordingly, the first drive 4 is a linear drive. In particular, the first drive 4 comprises a spindle 41 for moving the first member 31 back and forward in the first direction A.

The drive assembly 3 further comprises a second member 32 that is movable relative to the first member 31 and a second drive 5 for driving the movement of said second member 32 relative to the first member 31. In the embodiment as shown, the second member 32 is movable relative to the first member 31 in the second direction B. In this particular embodiment, the second drive 5 is a linear drive comprising a belt and pulley system having a first pulley 51 and a second pulley 52. Alternatively, the second drive 5 may for example comprise a spindle drive.

As can further be seen in figures 2A-2F, the drive assembly 3 is further arranged for driving a rotation of the imaging device 2 about a rotation axis R perpendicular to said inspection plane P. In particular, the drive assembly 3 is arranged to drive a rotation of the imaging device 2 about the rotation axis R with respect to the second member 32.

The drive assembly 3 comprises a rotation drive 6 for driving the rotation of the imaging device 2 about the rotation axis R. Said rotation drive 6 comprises a plurality of pulleys 63, 64, 65 and a belt 61 that is guided along said plurality of pulleys 63, 64, 65. Preferably, the belt 61 is a toothed belt.

The plurality of pulleys 63, 64, 65 comprises a third pulley or driven pulley 63 for driving the belt 61. Said driven pulley 63 may for example be driven by a servomotor (not shown). The driven pulley 63 is located on the first member 31 of the drive assembly 3. Alternatively , the driven pulley 63 may for example be located on the base 8. Accordingly, the associated servomotor can be located a position separate from the second member 32 of the drive assembly 3. Hence, said second member 32 may be moved in the second direction B more accurately, precisely and/or efficiently.

The plurality of pulleys 63, 64, 65 further comprises an actuation pulley 65 that is coupled in rotation to the imaging device 2. In other words, the rotation of the imaging device 2 is rotated about the rotation axis R by said actuation pulley 65. The actuation pulley 65 is mounted to the second member 32 of the drive assembly 3. In the embodiment as shown, the actuation pulley 65 is rotatable about the rotation axis R. Preferably, the imaging device 2 is co-rotatable or rotatable together with the actuation pulley 65.

The one or more pulleys 63, 64, 65 further comprise a plurality of fourth pulleys 64 for guiding the belt 61 between the actuation pulley 65 and the driven pulley 63. Said fourth pulleys 64 are passive pulleys, i.e. said pulleys are freely rotatable. The fourth pulleys 64 are distributed over the first member 31 and the second member 32 of the drive assembly 3. In particular, the fourth pulleys 64 are arranged to allow a telescopic extension of the belt 61 with a movement of the second member 32 relative to the first member 31.

As is further shown in figures 2A-2F, the rotation drive comprises two tension rollers 66. One of said tension rollers 66 is located at the actuation pulley 65. Said tension roller 66 guides the belt 61 along a larger part of the circumference of the actuation pulley 65. Hence, the belt may have a better grip on the actuation pulley 65. Accordingly, the actuation pulley 65 may be rotated about the rotation axis more precisely and/or accurately. The other one of the tension rollers 66 guides the belt along a larger part of the circumference of the fourth pulley 64 on the first member 31.

As is best shown in figures 4A and 4B, the drive assembly 3 is pivotable with respect to the base 8 about a pivot axis K. In other words, the inspection plane P is pivotable about the pivot axis K. As is shown in figures 2A-2G, said pivot axis K extends in the first direction A.

A method for inspecting the inner surface 91 of the tire 9 will now be described. The method comprises scanning or imaging the splice G with the imaging device 2. In particular, the method comprises using the imaging device 2 to scan or image the splice G while moving the field of view W and/or the laser line L of said imaging device 2 along the splice G. The imaging device 2 may for example use the laser emitter and the camera to detect a height profile of the splice G.

As is shown in figure 1D, a tire 9 is provided at the inspection unit 1 by the transport device 13. The method may comprises a step of orientating and/or positioning the tire 9 such that the splice G is in or substantially in a predetermined inspection position, e.g. a predetermined inspection position with respect to the inspection unit 1. This step may for example comprise tracking the location of the splice G in the circumferential direction C of the tire 9 on the tire building drum 11, the transfer ring 14 and/or the transport device 13. Alternatively, a marking indicative of the location of the splice G in the circumferential direction C of the tire 9 may be applied to the tire 9. In the embodiment as is shown in figure 2A, the splice G is located at or near the bottom of tire 9 in the predetermined orientation.

Figure 2A shows an initial state of the inspection unit 1. The tire 9 has been transported up to the inspection unit 1 by the transport device 13. Said tire 9 is suspended on the one or more support members 131 in a vertical or substantially vertical orientation. The inspection unit 1 is in an idle or contracted state. Preferably, in said idle or contracted state, the inspection unit 1 allows a tire to be transported up to and/or past the inspection station in the transport direction T.

As is shown in figure 2B, the imaging device 2 has been moved through the opening 90 of the tire 9 into a first inspection position S1 within the internal volume V of the tire 9. Said first inspection position S1 is located in the inspection plane P. The imaging device 2 has been rotated about the rotation axis R into a first inspection angle H1. In particular, field of view W of the imaging device 2 has been rotated about the rotation axis R into said first inspection angle H1. In the embodiment as shown, the first inspection angle H1 is defined as the relative angle between the field of view W and the horizontal axis. Alternatively, the first inspection angle H1 may for example be related to the vertical axis, a reference plane on the second member 32 or the central axis X of the tire 9. Preferably, at said first inspection angle H1, the field of view W extends perpendicular or substantially perpendicular to the inner surface 91 of the tire 9.

As is shown in figure 2C, the imaging device 2 has scanned a first inspection path T1 along the inner surface 91 of the tire 9. In particular, the field of view W of the imaging device 2 has been moved along said first inspection path T1 while scanning the inner surface 91 of the tire 9.

The imaging device 2 has been moved from the first inspection position S1 into a second inspection position S2. In the case of the first inspection path T1, the first inspection position S1 is the initial inspection position and the second inspection position S2 is the consecutive inspection position. The second inspection position S2 is located in the inspection plane P. In particular, the imaging device 2 has been displaced from the first inspection position S1 in both the first direction A and the second direction B. Preferably, the imaging device 2 has been moved linearly, i.e. in a straight line, from the first inspection position S1 to the second inspection position S2.

As is further shown in figure 2C, the field of view W of the imaging device 2 has been rotated about the rotation axis R from the first inspection angle H1 to a second inspection angle H2. Preferably, the field of view W of the imaging device 2 is rotated from the first inspection angle H1 to the second inspection angle H2 while the imaging device is moved from the first inspection position S1 to the second inspection position S2. More preferably, the field of view W is rotated gradually from the first inspection angle H1 to the second inspection angle H2 while moving the imaging device 2 from the first inspection position S1. In other words, the rotation of the field of view W is proportional to the movement of the imaging device 2.

9.

As is shown in figure 2D, the imaging device 2 has been moved from the second inspection position S2 into a third inspection position S3 and has been rotated about the rotation axis R from the second inspection angle H2 to a third inspection angle H3 to scan a second inspection path T2 along the inner surface of the tire 9. The scanning of the second inspection path T2 is performed in a similar manner to the scanning of the first inspection path T1. In the case of the second inspection path T2, the second inspection position S2 is the initial inspection position and the third inspection position S3 is the consecutive inspection position. Accordingly, the second inspection angle H2 is the initial inspection angle and the third inspection angle H3 is the consecutive inspection angle. In the third inspection position S3 the imaging device 2 is located at least partly between the first side 93 and the second side 94 of the tire 9. In other words, the imaging device 2 is located below the opening in the tire 90 in the first direction A.

As is further shown in figures 2E-2G, the imaging device 2 is subsequently moved into a fourth inspection position S4, a fifth inspection position S5 and a sixth inspection position S6 and rotated into an associated fourth inspection angle H4, fifth inspection angle H5 and sixth inspection angle H6 to move the field of view W along a third inspection path T3, a fourth inspection path T4 and a fifth inspection path T5, respectively. The respective inspection paths T1-T5 may partially overlap. Preferably, the respective inspection paths T1-T5 form a continuous or contiguous inspection path.

Any discrete number N of predetermined inspection positions S1-Sn and associated inspection angles H1-Hn may be chosen for inspecting the inner surface 91 of the tire 9. Preferably, the number N of predetermined inspection positions S1-Sn is between three and twenty. More preferably, the number N of predetermined inspection positions S1-Sn is between five and fifteen inspection positions S1-Sn, for example eight inspection positions S1-Sn. Preferably, the number M of inspection paths T1-Tm is equal to the number N of predetermined inspection points S1-Sn minus one.

As is further shown in figures 4A and 4B, the splice

G on the inner surface 91 of the tire 9 extends at an oblique angle with respect to the tire axis X. In other words, the splice G extends at an acute or obtuse angle with respect to the circumferential direction C of the tire 9.

As is shown in figure 4A, the inspection plane P extends parallel or in line with the tire axis X. Hence, the inspection plane P extends at an acute or obtuse angle with respect to the splice G. In other words, the field of view W of the imaging device 2 is not centered at the splice along the entire inspection path T.

As is shown in figure 4B, the method may further comprise a step of adapting an angular position of the inspection plane P with respect to the tire 9. In particular, the method may comprise adapting the angular position of the inspection plane P with respect to the tire 9 by rotating the drive assembly 3 about the pivot axis K. Preferably, the drive assembly 3 is rotated about the picot axis K into an angular position in which the inspection plane P extends parallel or substantially parallel to at least a part of the splice G. More preferably, the drive assembly 3 is rotated about the pivot axis K into an angular position in which at least a part of the splice G extends in or substantially in the inspection plane P.

Alternatively, as is for example shown in figure 4A, an angular position of the inspection plane P relative to the splice G may be set at a sufficiently small mutual angle that allows the splice G to be within the field of view W of the imaging device 2 when moving and/or rotating said imaging device 2 within the inspection plane P.

As is further shown in figures 2A-2F and 3A-3F, the inspection unit 1 further comprises a control unit 7 that is operationally connected to the drive assembly 3 for controlling the movement of imaging device 2. In particular, the control unit 7 is configured for making the inspection unit 1 perform the method as described above. Preferably, the control unit 7 is further operationally connected to the imaging device 2. Preferably, the control unit 7 comprises a memory for storing the one or more inspection positions S1-Sn and the one or more inspection angles H1-Hn. The control unit 7 may be connected to an interface and/or an input device (not shown) which may be used by an operator to enter the one or more inspection positions S1-Sn and the one or more inspection angles H1-Hn in the memory of the control unit 7. The control unit 7 may be configured to store a fixed number N or a variable number N of inspection positions S1-Sn and inspection angles H1-Hn in the memory thereof. Alternatively, said one or more inspection positions S1-Sn and said one or more inspection angles H1-Hn may be preprogrammed in the memory of the control unit 7.

Preferably, the control unit 7 has access to a data base in which predetermined dimensional data are stored that are related to the shape and/or dimensions of the tire 9. The control unit 7 may be configured to compare the inspection positions S1-Sn and inspection angles H1-Hn in the memory thereof with a configuration of a tire 9 that has been stored in the data base. Preferably, the control unit 7 is configured to calculate, for each inspection path T1-Tm, an expected distance between the imaging device 2 and the inner surface 91 based on the dimensional data and the stored inspection positions S1-Sn and inspection angles H1-Hn. Accordingly, the control unit 7 may for example be configured to provide a feedback to an operator regarding the suitability of the inspection positions S1-Sn and the inspection angles H1-Hn that are stored in the memory for the use in the method of inspecting the inner surface 91 of the tire 9.

Preferably, the method according to the present invention further comprises a step of calibrating the inspection unit 1 prior to inspecting a batch of tires 9 having the same configuration, e.g. having the same dimensions.

The method comprises, for each inspection position S1-Sn, measuring a distance between the imaging device 2 and the inner surface 91 of the tire 9 and checking whether said distance is within a predetermined interval. The distance between the imaging device 2 and the inner surface 91 of the tire 9 may be determined separately for each inspection point S1-Sn. Alternatively or additionally, the distance between the imaging device 2 and the inner surface 91 of the tire may be determined along at least a part of each inspection path T1-Tn. Preferably, the distance between the imaging device 2 and the inner surface 91 of the tire is determined for the entire length of each inspection path T1-Tn. The predetermined interval for the distance between the imaging device 2 and the inner surface 91 of the tire 9 may for example be between five millimeters and seventy-five millimeters for each inspection position S1-Sn. Preferably said distance is between twenty and sixty millimeters for each inspection position S1-Sn.

The method further comprises correcting the inspection position S1-Sn and/or the associated inspection angle H1-Hn when the respective distance between the imaging device 2 and the inner surface 91 of the tire 9 is not within the predetermined interval.

Preferably, the above calibration steps are performed once before inspecting a plurality or a batch of tires 9 with the same configuration and/or dimensions. The calibration steps may be preprogrammed in the control unit 7.

It is to be understood that the above description is included to illustrate the operation of the preferred embodiments and is not meant to limit the scope of the invention. From the above discussion, many variations will be apparent to one skilled in the art that would yet be encompassed by the scope of the present invention.

<u>List of reference numerals</u>

1	inspection unit
2	imaging device
3	drive assembly

31	first member
32	second member
4	first linear drive
41	spindle drive
5	second linear drive
51	first pulley
52	second pulley
6	rotation drive
61	belt
63	third pulley or driven pulley
64	fourth pulley
65	fifth pulley or actuation pulley
66	tension roller
7	control unit
8	base
9	tire
90	opening
91	inner surface
92	outer surface
93	first side
94	second side
10	tire processing assembly
11	tire building drum
12	lay down device
121	lay down support
122	lay down roller
13	transport device
130	guide rail
131	support member
132	load cell
133	carriage
134	shielding element
14	transfer ring
15	sticker applicator
210	alternative tire processing assembly
212	alternative lay down device
221	lay down support

222	lay down roller
A	first direction
B	second direction
C	circumferential direction
D	splice direction
E	lay down axis
F	viewing direction
G	splice
H1-Hn	inspection angles
K	pivot axis
L	laser line
M	number of inspection paths
N	number of inspection positions
P	inspection plane
R	rotation axis
S1-Sn	inspection positions
T1-Tm	inspection paths
V	inner volume
W	field of view
X	tire axis
Y	transfer axis
Z	transport direction

C O N C L U S I E S

1. Werkwijze voor het inspecteren van een binnenoppervlak (91) van een band (9) met een lasnaad (G) die zich uitstrekt langs het binnenoppervlak (91) in een lasnaadrichting (D) dwars op de omtreksrichting (C) van de band (9), waarbij de werkwijze het scannen van de lasnaad (G) met een beeldvormingsinrichting (2) gedurende het bewegen van het gezichtsveld (W) van de beeldvormingsinrichting (2) langs de lasnaad (G) omvat.

2. Werkwijze volgens conclusie 1, waarbij de werkwijze het scannen van de lasnaad (G) met de beeldvormingsinrichting (2) gedurende het bewegen van het gezichtsveld (W) tot de beeldvormingsinrichting (2) langs een onderscheidbaar aantal (M) van inspectiebanen (T1-Tm) langs het binnenoppervlak (91) van de band (9) omvat.

3. Werkwijze volgens conclusie 2, waarbij het bewegen van het gezichtsveld (W) van de beeldvormingsinrichting (2) langs elke van het onderscheidbare aantal (M) van inspectiebanen (T1-Tm) omvat:

a) het bewegen van de beeldvormingsinrichting (2) vanaf een initiële inspectiepositie (S1-Sn) naar een opeenvolgende inspectiepositie (S1-Sn); en/of

b) het roteren van een kijkrichting (F) van het gezichtsveld (W) van de beeldvormingsinrichting (2) vanaf een initiële inspectiehoek (H1-Hn) naar een opeenvolgende inspectiehoek (H1-Hn) om een rotatie-as (R) die zich dwars op de lasnaadrichting (D) uitstrekt.

4. Werkwijze volgens conclusie 3, waarbij de inspectiebanen (T1-Tm) van het onderscheidbare aantal (M) van inspectiebanen (T1-Tm) opeenvolgende inspectiebanen zijn.

5. Werkwijze volgens conclusie 4, waarbij de opeenvolgende inspectiepositie (S2) van een eerste inspectiebaan (T1) de initiële inspectiepositie (S2) van een opeenvolgend inspectiebaan (T2) is, en/of waarbij de

opeenvolgende inspectiehoek (H2) van een eerste inspectiebaan (T1) de initiële inspectiehoek (H2) van een opeenvolgende inspectiebaan (T2) is.

6. Werkwijze volgens conclusie 3, 4 of 5, waarbij, in stap a), de beeldvormingsinrichting (2) lineair wordt bewogen vanaf de initiële inspectiepositie (S1-Sn) naar de opeenvolgende inspectiepositie (S2-Sn).

7. Werkwijze volgens één van de conclusies 3-6, waarbij stap a) en b) gelijktijdig worden uitgevoerd voor het bewegen van het gezichtsveld (W) van de beeldvormingsinrichting (2) langs een respectievelijke van het onderscheidbare aantal (M) van inspectiebanen (T1-Tm).

8. Werkwijze volgens conclusie 7, waarbij de kijkrichting (F) van het gezichtsveld (W) geleidelijk wordt geroteerd vanaf de initiële inspectiehoek (H1-Hn) naar de opeenvolgende inspectiehoek (H1-Hn) terwijl de beeldvormingsinrichting (2) wordt bewogen van de initiële inspectiepositie (S1-Sn) naar de opeenvolgende inspectiepositie (S1-Sn).

9. Werkwijze volgens één van de conclusies 3-8, waarbij de initiële inspectiepositie (S1-Sn) en opeenvolgende inspectieposities (S1-Sn) voor elk van de inspectiebanen (T1-Tm) van het onderscheidbare aantal (M) van de inspectiebanen (T1-Tm) zijn gelegen in een gezamenlijk inspectievlak (P).

10. Werkwijze volgens conclusie 9, waarbij de rotatie-as (R) zich loodrecht op het inspectievlak (P) uitstrekt.

11. Werkwijze volgens conclusie 9 of 10, waarbij de werkwijze het kiezen van de eerste inspectiepositie (S1) en de één of meer verdere inspectieposities (S2-Sn) omvat zodanig dat tenminste een deel van de lasnaad (G) zich parallel of in hoofdzaak parallel aan het inspectievlak (P) uitstrekt.

12. Werkwijze volgens conclusie 9, 10 of 11, waarbij de werkwijze het kiezen van de eerste inspectiepositie (S1) en de één of meerdere verdere

inspectieposities (S2-Sn) omvat zodanig dat tenminste een deel van de lasnaad (G) zich in het inspectievlak (P) uitstrekt.

13. Werkwijze volgens één van de conclusies 3-12, waarbij de werkwijze verder het kalibreren van de inspectiebanen (T1-Tm) van het onderscheidbare aantal (M) van inspectiebanen (T1-Tm) omvat voorafgaand aan het scannen van de lasnaad (G), waarbij het kalibreren de stappen omvat van:

- het bewegen van het gezichtsveld (W) van de beeldvormingsinrichting (2) langs een respectievelijke inspectiebaan (T1-Tm) van het onderscheidbare aantal (M) van de inspectiebanen (T1-Tm);
- het, voor de respectievelijke inspectiebaan (T1-Tm), bepalen van de onderlinge afstand tussen de beeldverwerkingsinrichting (2) en het binnenoppervlak (91) van de band (9); en
- het aanpassen van de respectieve initiële en opeenvolgende inspectieposities (S1-Sn) en/of de respectieve initiële en opeenvolgende inspectiehoeken (H1-Hn) wanneer de onderlinge afstand buiten een vooraf bepaald bereik ligt.

14. Werkwijze volgens conclusie 13, waarbij het kalibreren verder de stappen omvat van:

- het bepalen van de onderliggende afstand tussen het inspectievlak (P) en de lasnaad (G);
- het draaien van het inspectievlak (P) om een draai-as (K) wanneer de onderlinge afstand buiten een vooraf bepaald bereik ligt.

15. Werkwijze volgens één van de conclusies 2-14, waarbij het onderscheidbare aantal (M) van inspectiebanen (T1-Tm) binnen een bereik van één tot negentien ligt, bij voorkeur binnen een bereik van vier tot veertien, meer bij voorkeur binnen een bereik van zeven tot negen.

16. Werkwijze volgens één van de voorgaande conclusies, waarbij de beweging van de beeldvormingsinrichting (2) langs de lasnaad (G)

computergestuurd en/of geautomatiseerd is.

17. Werkwijze volgens één van de voorgaande conclusies, waarbij de werkwijze het ondersteunen van de band (9) in een rechtopstaande oriëntatie omvat gedurende het inspecteren van het binnenoppervlak (91).

18. Inspectie-eenheid (1) voor het inspecteren van een binnenoppervlak (91) van een band (9) volgens de stappen van de werkwijze volgens één van de voorgaande conclusies, waarbij de inspectie-eenheid (1) een basis (8), een beeldverwerkingsinrichting (2) en een aandrijfsamenstel (3) voor het aandrijven van een beweging van de beeldverwerkingsinrichting (2) ten opzichte van de basis (8) in een inspectievlak (P) en voor het aandrijven van een rotatie van de beeldverwerkingsinrichting (2) om een rotatie-as (R) loodrecht op het inspectievlak (P) omvat, waarbij de inspectie-eenheid (1) verder een stuureenheid (7) omvat die operationeel is verbonden met een aandrijfsamenstel (3) voor het sturen van de beweging van de beeldverwerkingsinrichting (2) ten opzicht van de basis (8) in het inspectievlak (P) en voor het sturen van de rotatie van het beeldverwerkingsinrichting (2) om de rotatie-as (R), waarbij de stuureenheid (7) is ingericht voor het sturen van het aandrijfsamenstel (3) voor het opeenvolgend positioneren van de beeldverwerkingsinrichting (2) bij een onderscheidbaar aantal (N) van vooraf bepaalde inspectieposities (S1-Sn) in het inspectievlak (P) en bijbehorende inspectiehoeken (H1-Hn) om de rotatie-as (R).

19. Inspectie-eenheid (1) volgens conclusie 18, waarbij de stuureenheid (7) is ingericht voor het sturen van het aandrijfsamenstel (3) voor het geleidelijk roteren van de beeldverwerkingsinrichting (2) om de rotatie-as (R) vanaf een initiële inspectiehoek (H1-Hn) naar een opeenvolgende inspectiehoek (H1-Hn) gedurende het bewegen van de beeldverwerkingsinrichting (2) vanaf een initiële inspectiepositie (S1-Sn) naar een opeenvolgende inspectiepositie (S1-Sn).

20. Inspectie-eenheid (1) volgens conclusie 19,

waarbij de initiële inspectiehoek (H1-Hn) in de opeenvolgende inspectiehoek (H1-Hn) hetzelfde zijn voor een bijbehorende initiële inspectiepositie (S1-Sn) en een opeenvolgende inspectiepositie (S1-Sn) die verschilt van de initiële inspectiepositie (S1-Sn).

21. Inspectie-eenheid (1) volgens conclusie 19, waarbij een initiële inspectiepositie (S1-Sn) en een opeenvolgende inspectiepositie (S1-Sn) hetzelfde zijn voor een bijbehorende initiële inspectiehoek (H1-Hn) en een opeenvolgende inspectiehoek (H1-Hn) die verschilt van de initiële inspectiehoek (H1-Hn).

22. Inspectie-eenheid (1) volgens één van de conclusies 18-21, waarbij het onderscheidbare aantal (N) van vooraf bepaalde inspectieposities (S1-Sn) en bijbehorende inspectiehoeken (H1-Hn) in een bereik ligt van twee tot twintig, bij voorkeur in een bereik van vijf tot vijftien, meer bij voorkeur in een bereik van acht tot tien.

23. Inspectie-eenheid (1) volgens één van de conclusies 18-22, waarbij de inspectie-eenheid (1) is ingericht voor het meten van een afstand tussen de beeldverwerkingsinrichting (2) en het binnenoppervlak (91) van de band (9).

24. Inspectie-eenheid (1) volgens één van de conclusies 18-23, waarbij de beeldverwerkingsinrichting (2) beweegbaar is ten opzicht van de basis (8) langs het inspectievlak (P) in een eerste richting (A) en een tweede richting (B) dwars of loodrecht op de eerste richting (A).

25. Inspectie-eenheid (1) volgens conclusie 24, waarbij het aandrijfsamenstel (3) draaibaar is ten opzichte van de basis (8) om een draai-as (K) die zich uitstrekt in de eerste richting (A) voor het draaien van het inspectievlak (P) ten opzichte van de basis (8).

26. Inspectie-eenheid (1) volgens conclusie 24 of 25, waarbij de eerste richting (A) de verticale richting is.

27. Inspectie-eenheid (1) volgens conclusie 24,

25 of 26, waarbij het aandrijfsamenstel (3) een eerste deel (31) dat beweegbaar is ten opzichte van de basis (8) en een tweede deel (32) dat beweegbaar is ten opzichte van het eerste deel (31) omvat, waarbij de beeldverwerkingsinrichting (2) roteerbaar is gemonteerd ten opzichte van het tweede deel (32) voor rotatie om de rotatie-as (R).

28. Inspectie-eenheid (1) volgens conclusie 27, waarbij het aandrijfsamenstel (3) verder een eerste lineaire aandrijving (4) voor het aandrijven van een beweging van het eerste deel (31) ten opzichte van de basis (8) in de eerste richting (A) en de tweede lineaire aandrijving (5) voor het aandrijven van een beweging van het tweede deel (32) ten opzichte van het eerste deel (31) in de tweede richting (B) omvat.

29. Inspectie-eenheid (1) volgens conclusies 27 of 28, waarbij het aandrijfsamenstel (3) verder een rotatie-aandrijving (6) omvat voor het aandrijven van de rotatie van de beeldverwerkingsinrichting (2) om de rotatie-as (R).

30. Inspectie-eenheid (1) volgens conclusie 29, waarbij de rotatie-aandrijving (6) een riemaandrijving is die een meervoud van schijven (63, 64, 65) en een riem (61) die langs het meervoud van schijven (63, 64, 65) wordt geleid omvat, waarbij het meervoud van schijven (63, 64, 65) een aandrijfschijf (65) omvat die in rotatie is gekoppeld aan de beeldverwerkingsinrichting (2).

31. Inspectie-eenheid (1) volgens conclusie 30, waarbij de aandrijfschijf (65) roteerbaar is om de rotatie-as (R).

32. Inspectie-eenheid (1) volgens conclusie 30 of 31, waarbij het meervoud van schijven (63, 64, 65) een aangedreven schijf (63) omvat voor het aandrijven van de riem (61), waarbij de aangedreven schijf (63) is gelegen bij het eerste deel (31) of bij de basis (8).

33. Inspectie-eenheid (1) volgens conclusies 30, 31 of 32, waarbij de riem (61) een tandriem is.

34. Inspectie-eenheid (1) volgens één van de conclusies 18-33, waarbij de beeldverwerkingsinrichting (2) een gezichtsveld (W) heeft, dat is gericht in de kijkrichting (F), waarbij het gezichtsveld (W), in een richting loodrecht op het inspectievlak (P), tussen de vijfentwintig en vijfenveertig graden ligt, bij voorkeur tussen de dertig en veertig graden.

35. Inspectie-eenheid (1) volgens één van de conclusies 18-34, waarbij de beeldverwerkingsinrichting (2) een laserzender omvat voor het projecteren van een laserlijn (L) op het binnenoppervlak (91) van de band (9) en een camera voor het vangen van de afbeelding van de laserlijn (L).

36. Verwerkingssamenstel (10) voor het verwerken van een band (9), waarin het verwerkingssamenstel (10) de inspectie-eenheid (1) volgens één van de conclusies 18-35 omvat.

37. Verwerkingssamenstel (10) volgens conclusies 36, waarbij het verwerkingssamenstel (10) verder een transportinrichting (13) omvat voor het transporten van de band (9) langs een transportbaan, waarbij de inspectie-eenheid (1) is ingericht langs de transportbaan.

38. Verwerkingssamenstel (10) volgens conclusie 37, waarbij de inspectie-eenheid (1) is geconfigureerd voor het inspecteren van een band (9) op de transportinrichting (13) zonder het verwijderen van de band (9) vanaf de transportinrichting (13).

39. Verwerkingssamenstel (10) volgens conclusie 37 of 38, waarbij de transportinrichting (13) is ingericht voor het transporteren van een band (9) in een rechtopstaande oriëntatie.

40. Computerprogrammaproduct dat instructies omvat om te veroorzaken dat de inspectie-eenheid (1) volgens één van de conclusies 18-35 de werkwijze volgens één van de conclusies 1-17 uitvoert.

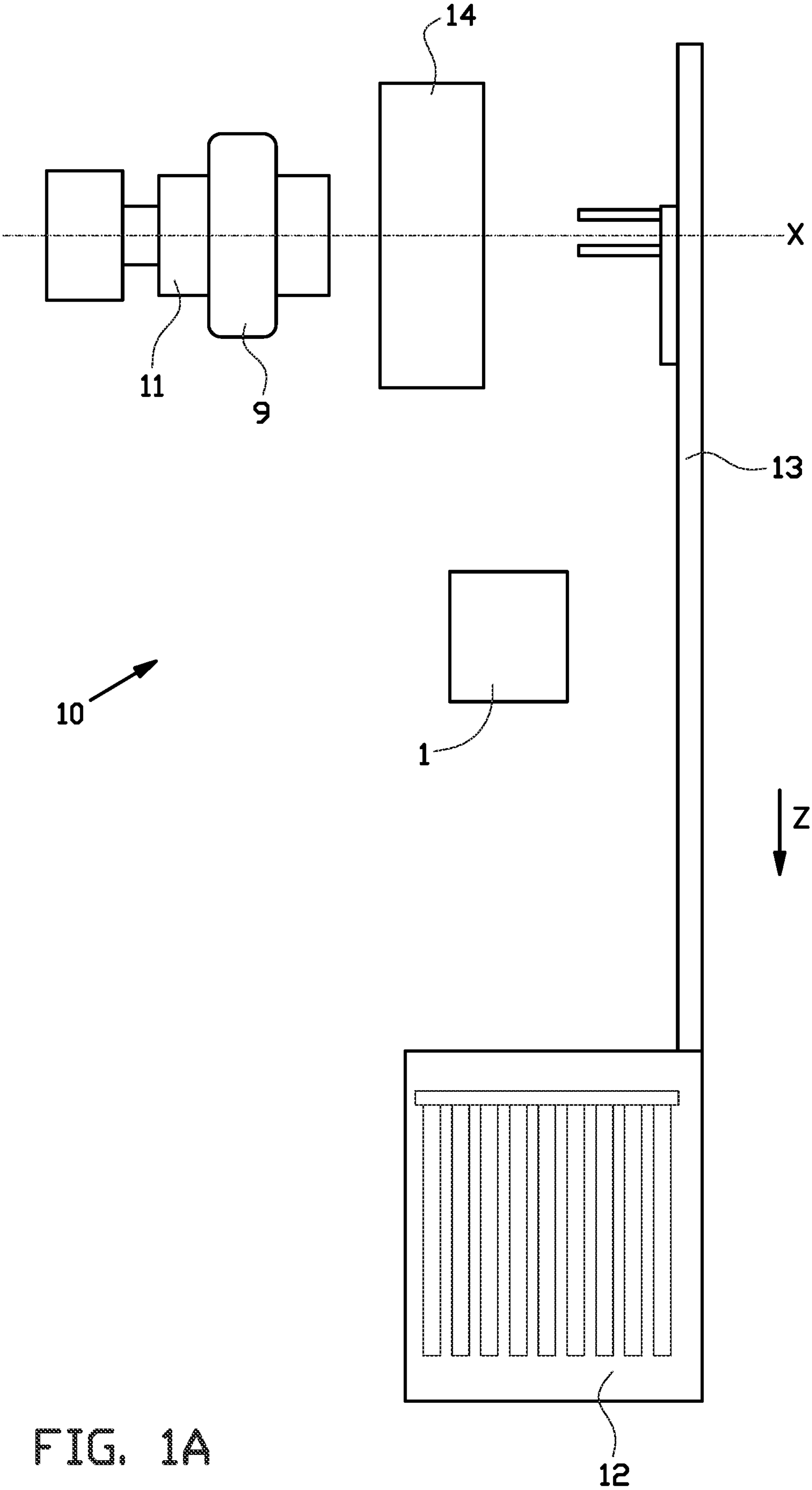

FIG. 1A

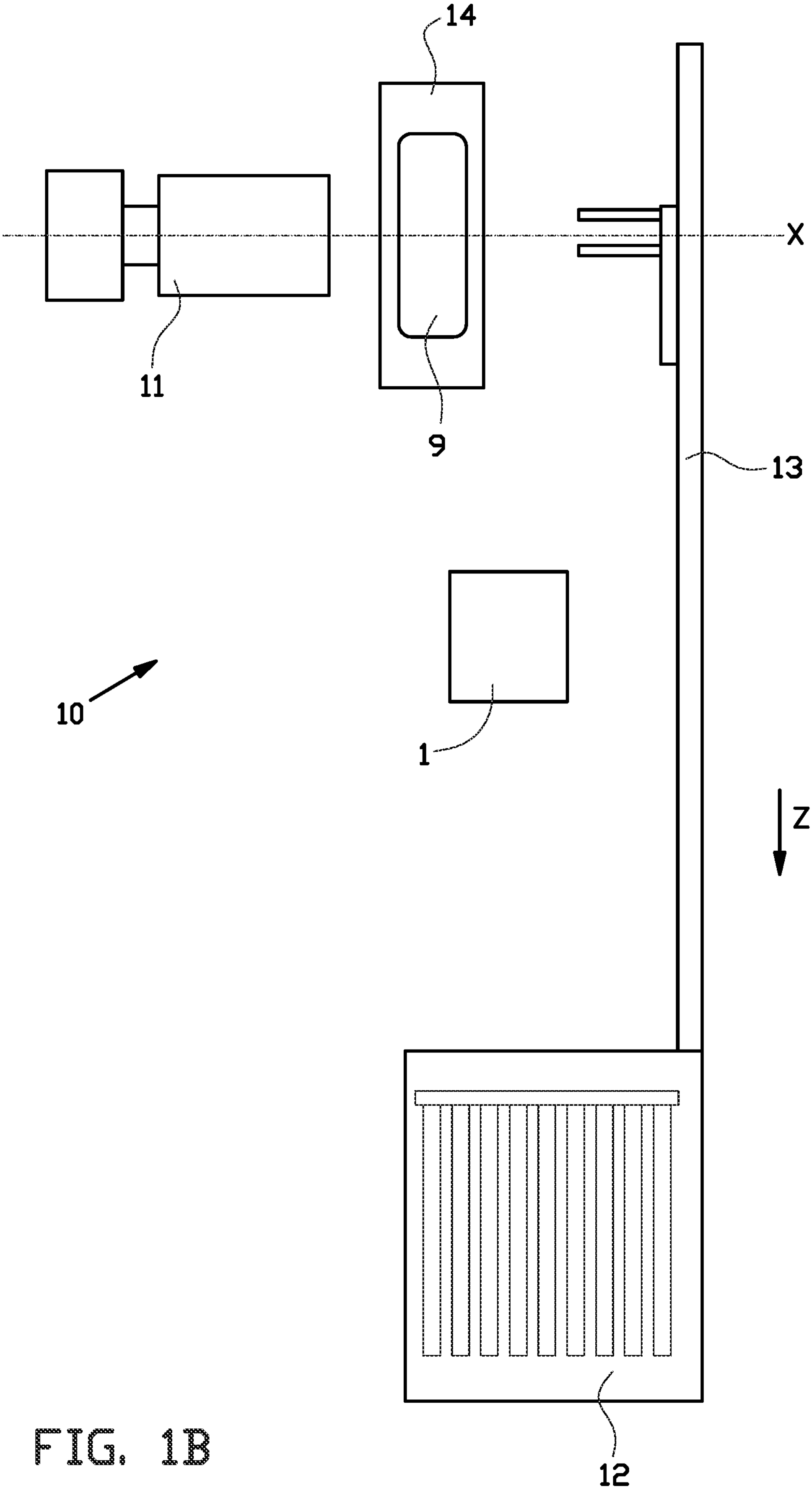

FIG. 1B

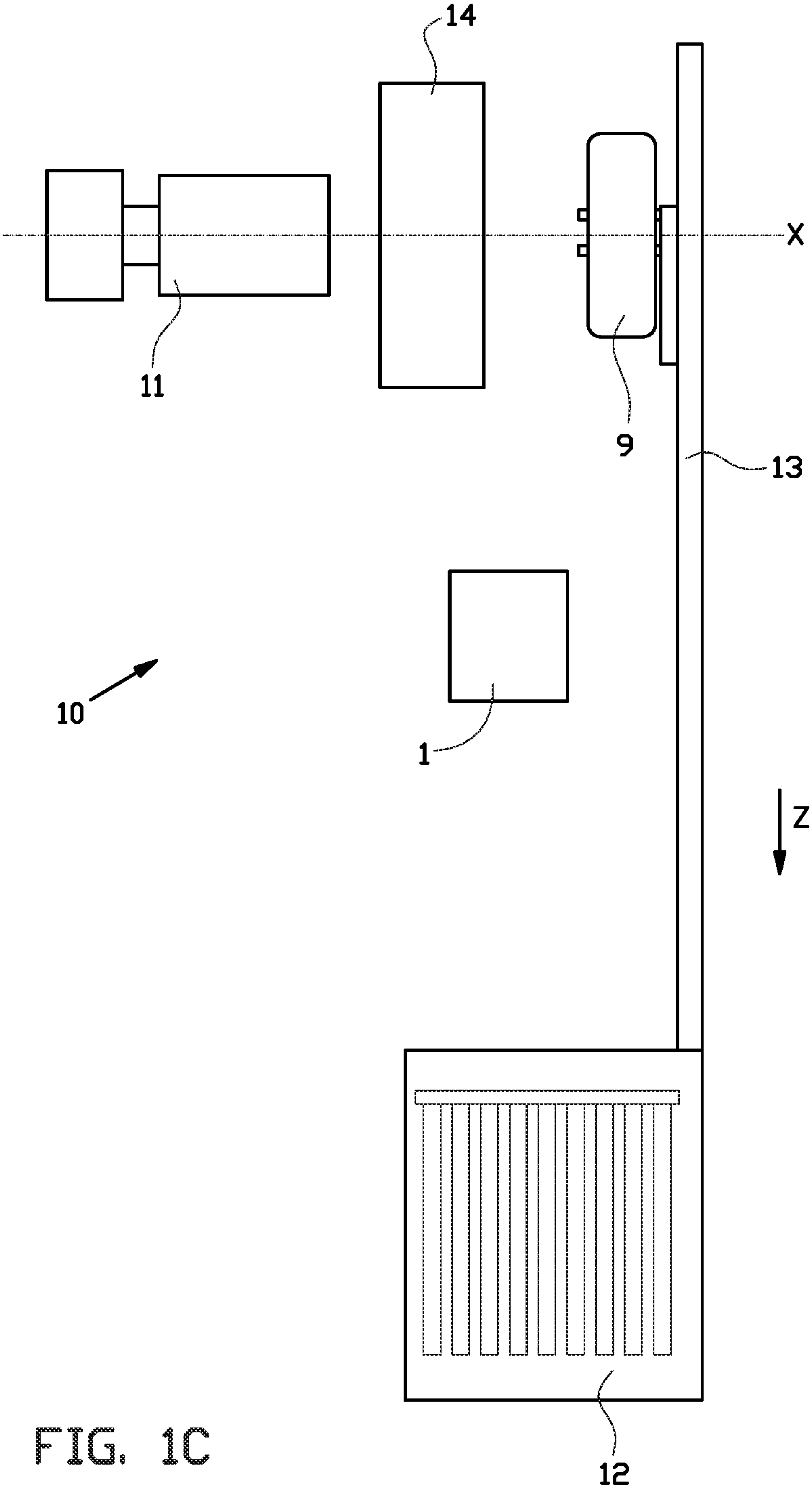

FIG. 1C

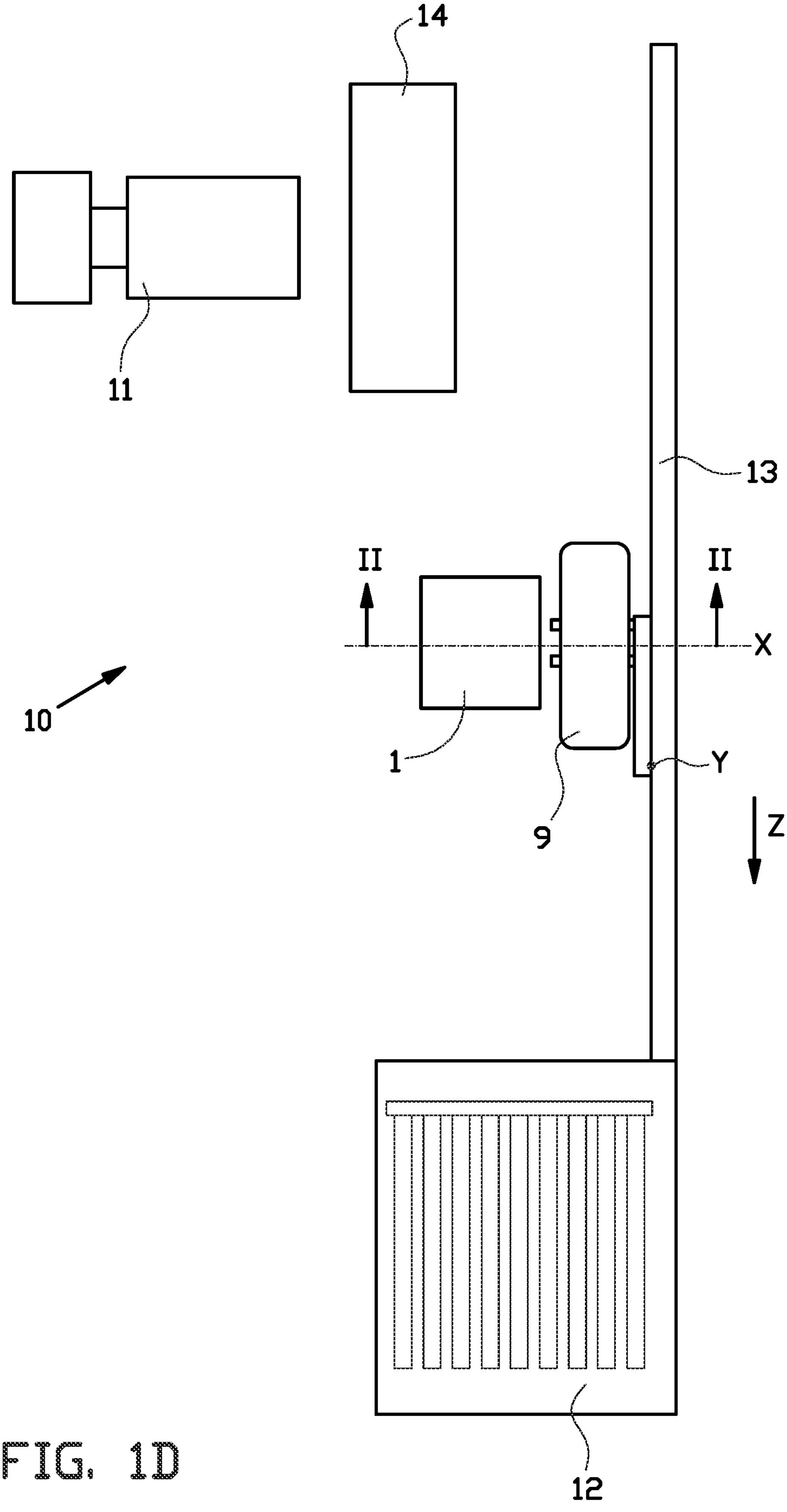

FIG. 1D

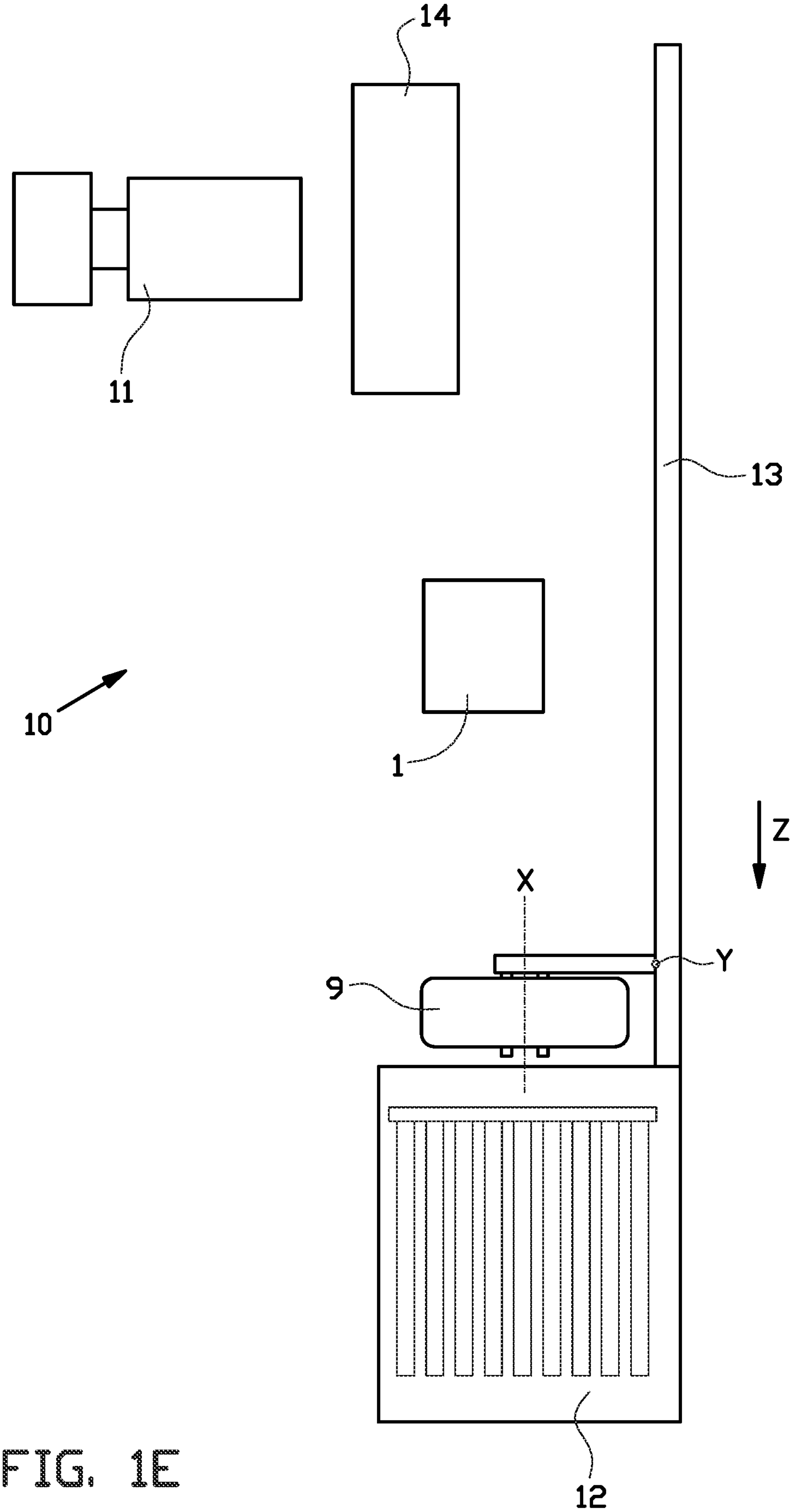

FIG. 1E

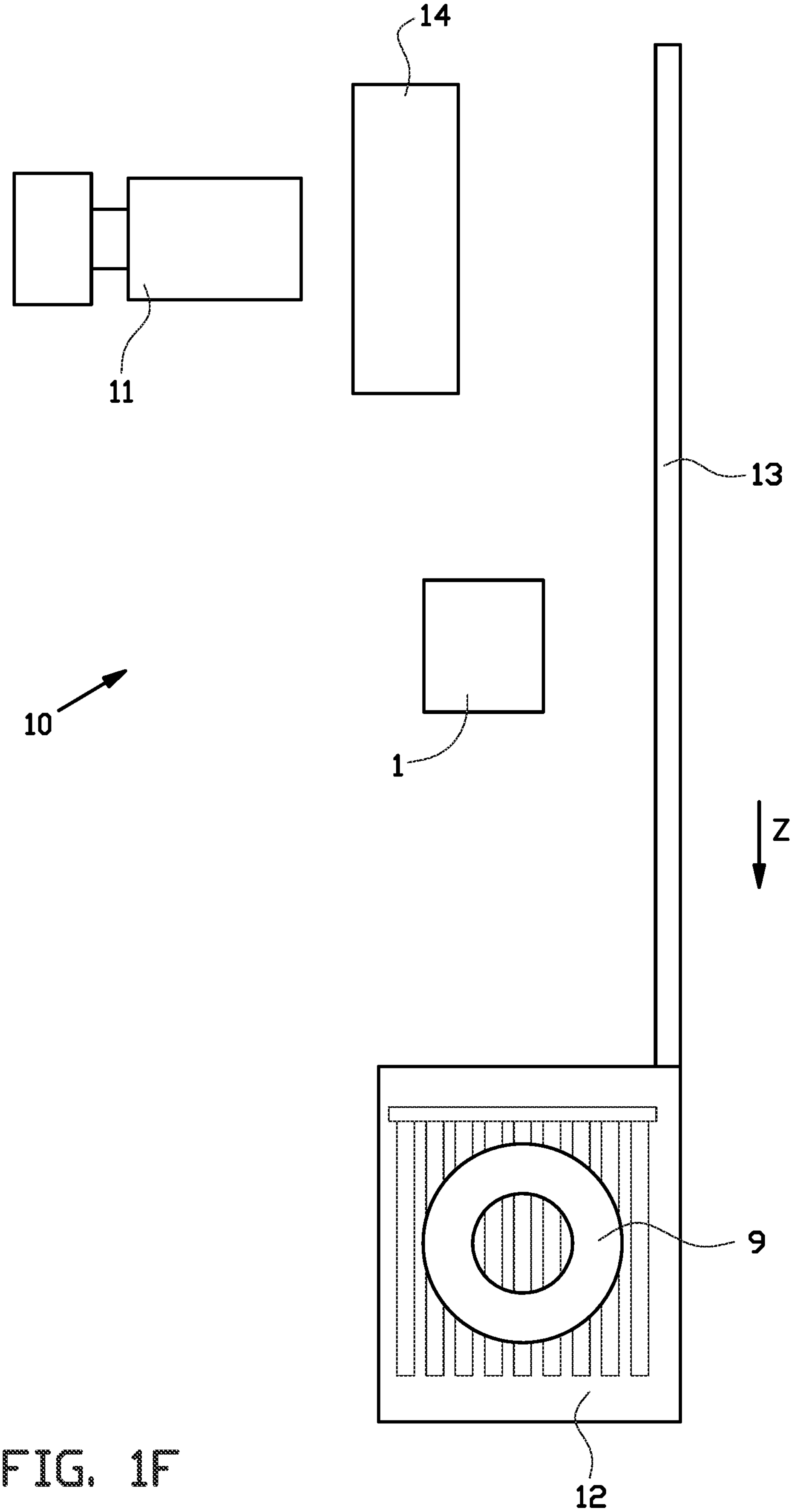

FIG. 1F

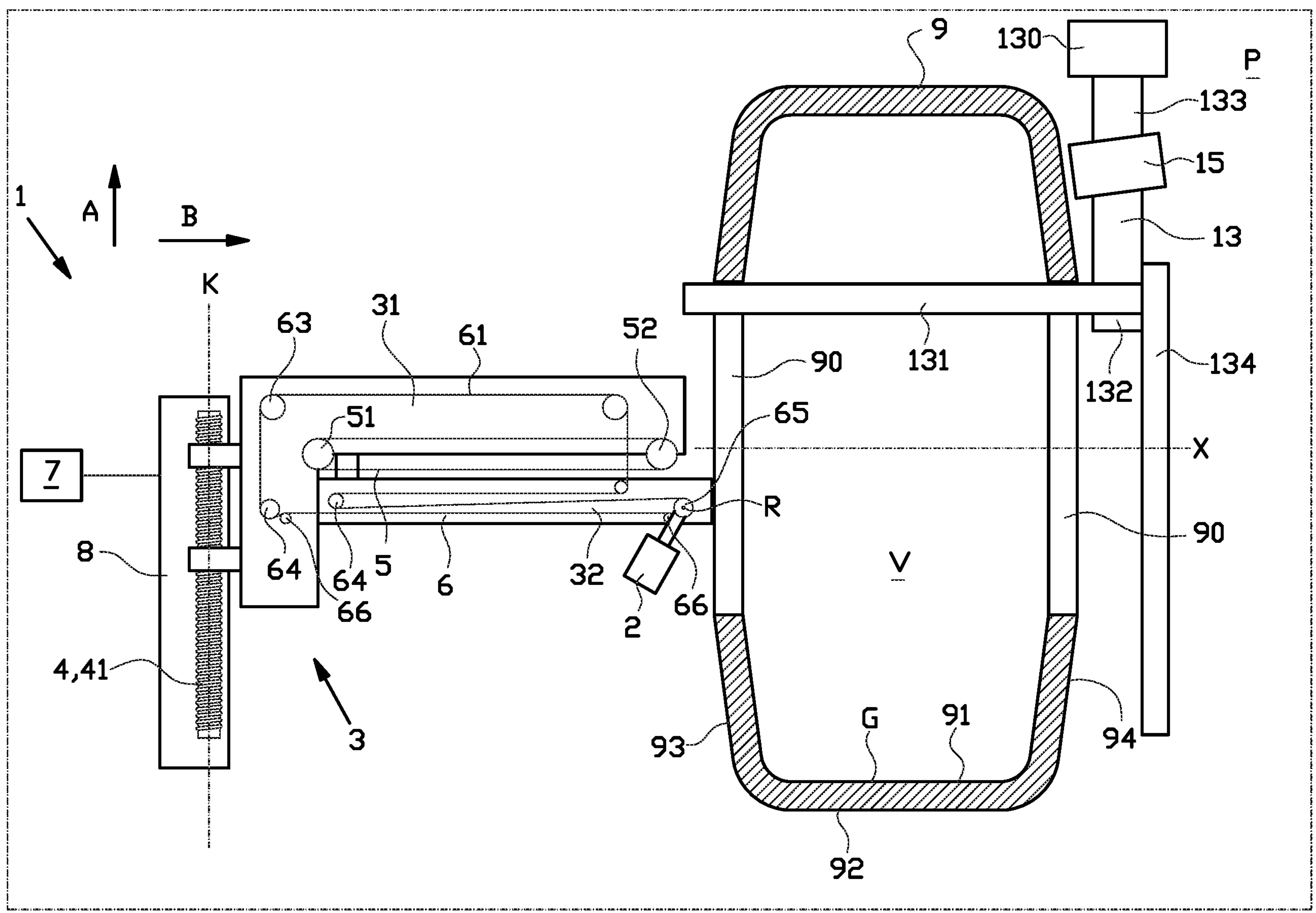
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FIG. 2A

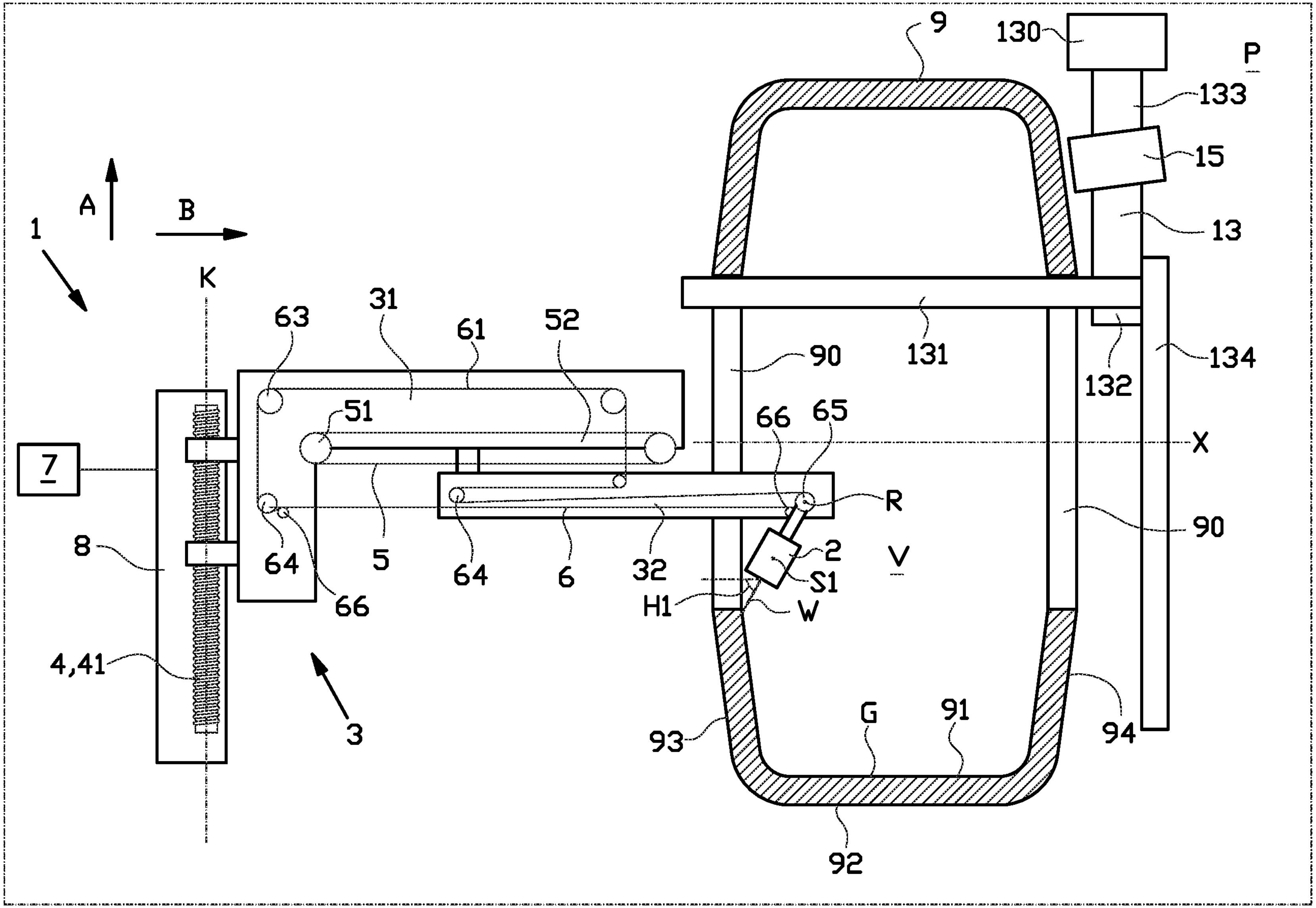
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FIG. 2B

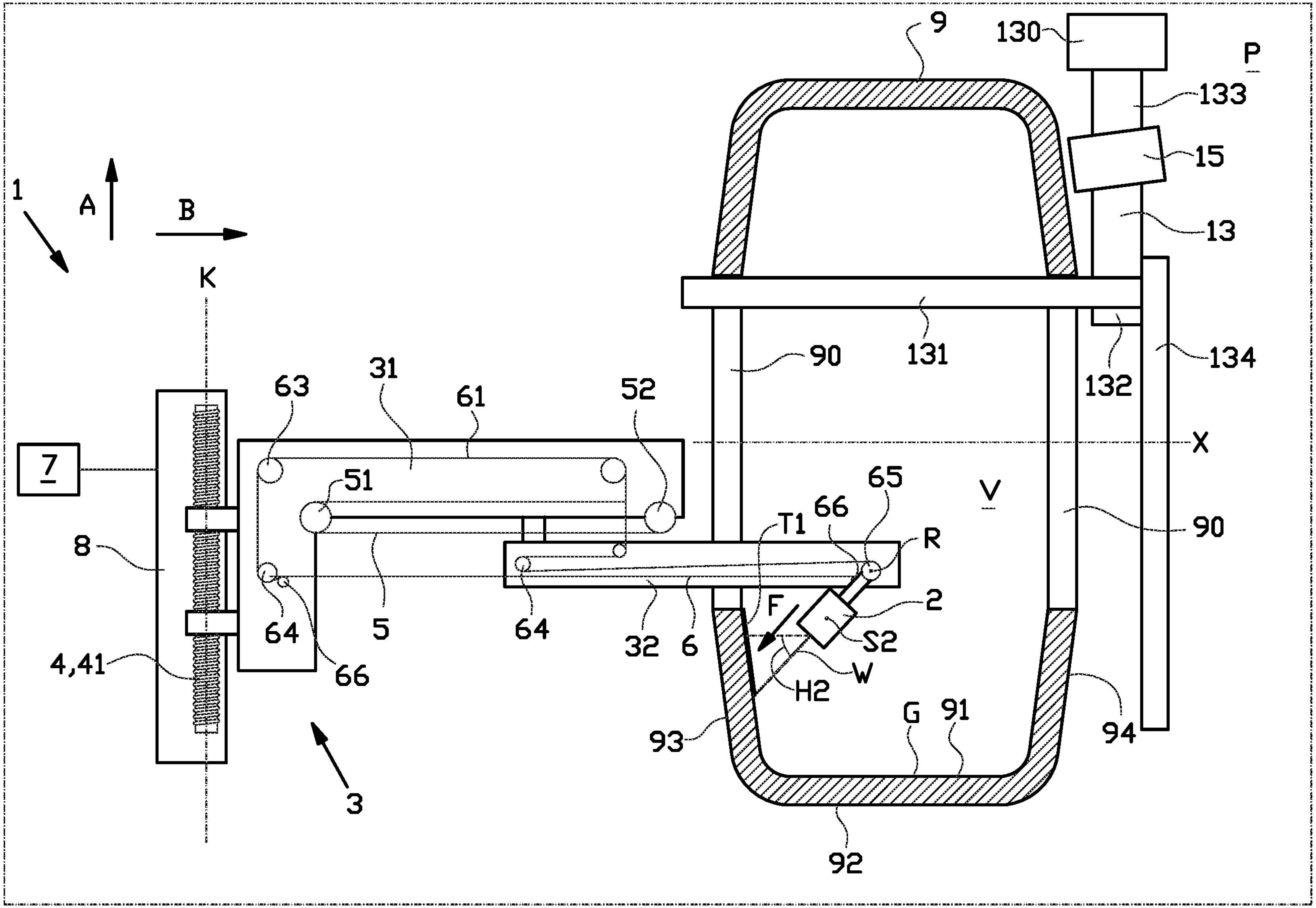
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FIG. 2C

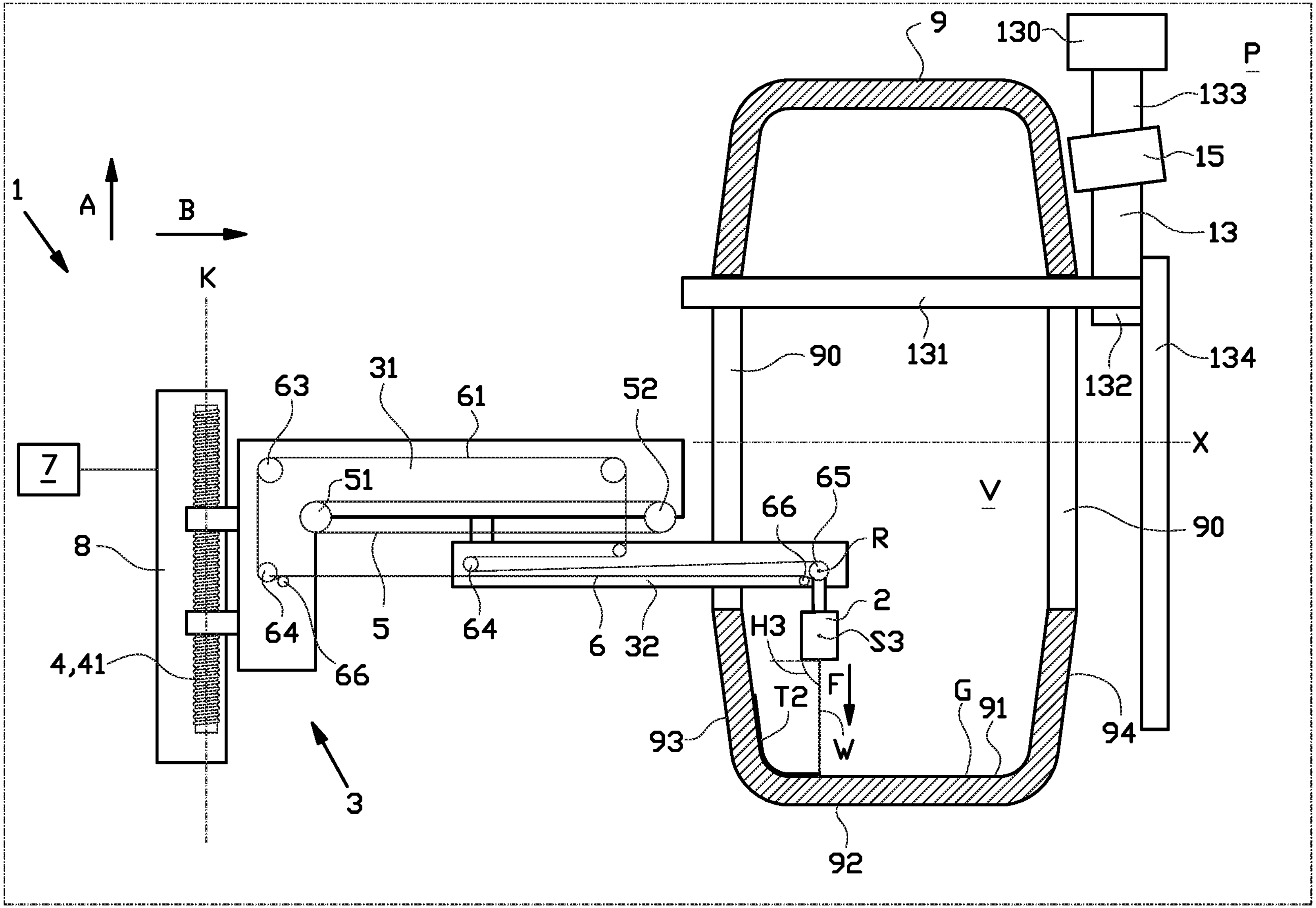
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FIG. 2D

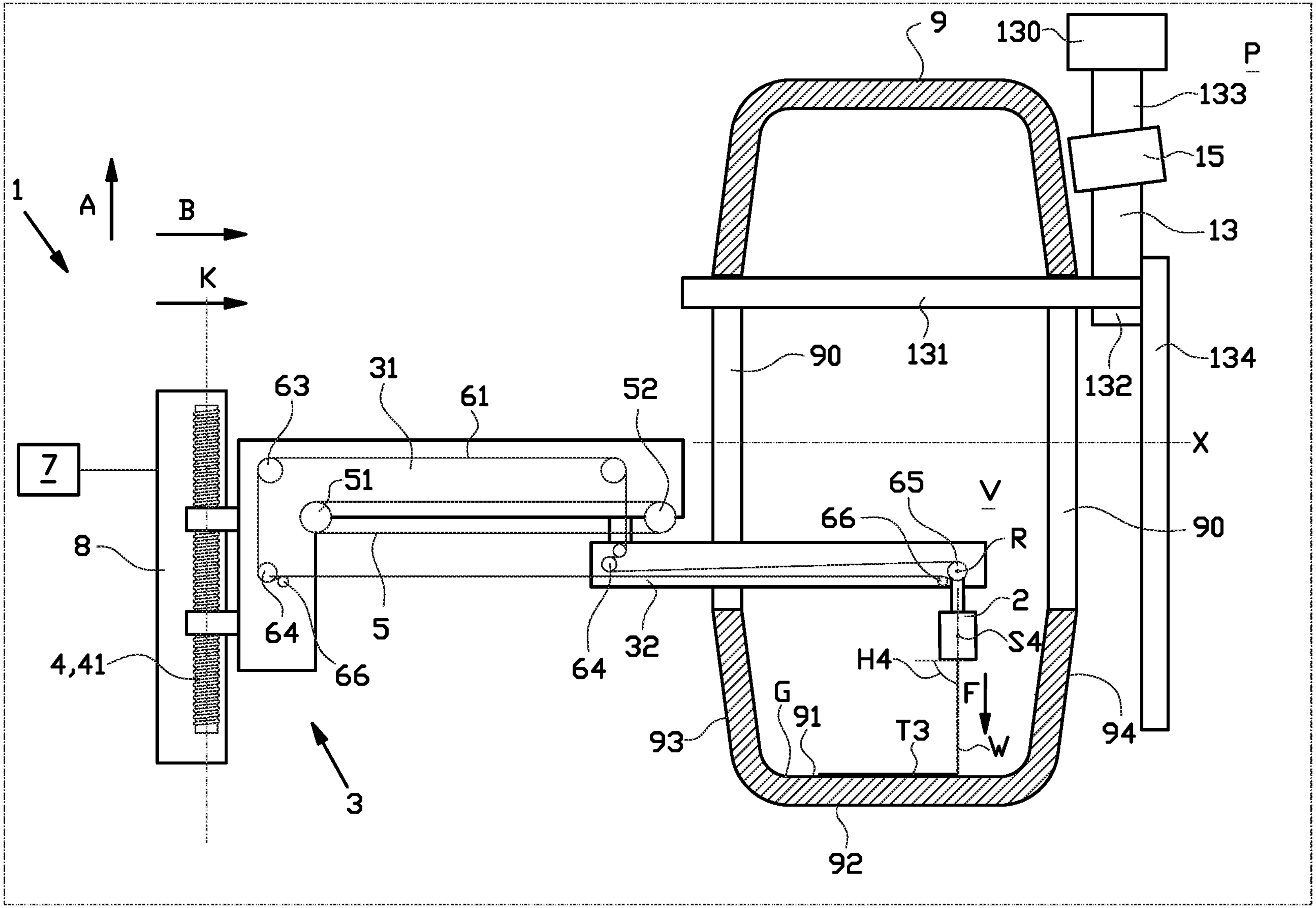

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FIG. 2E

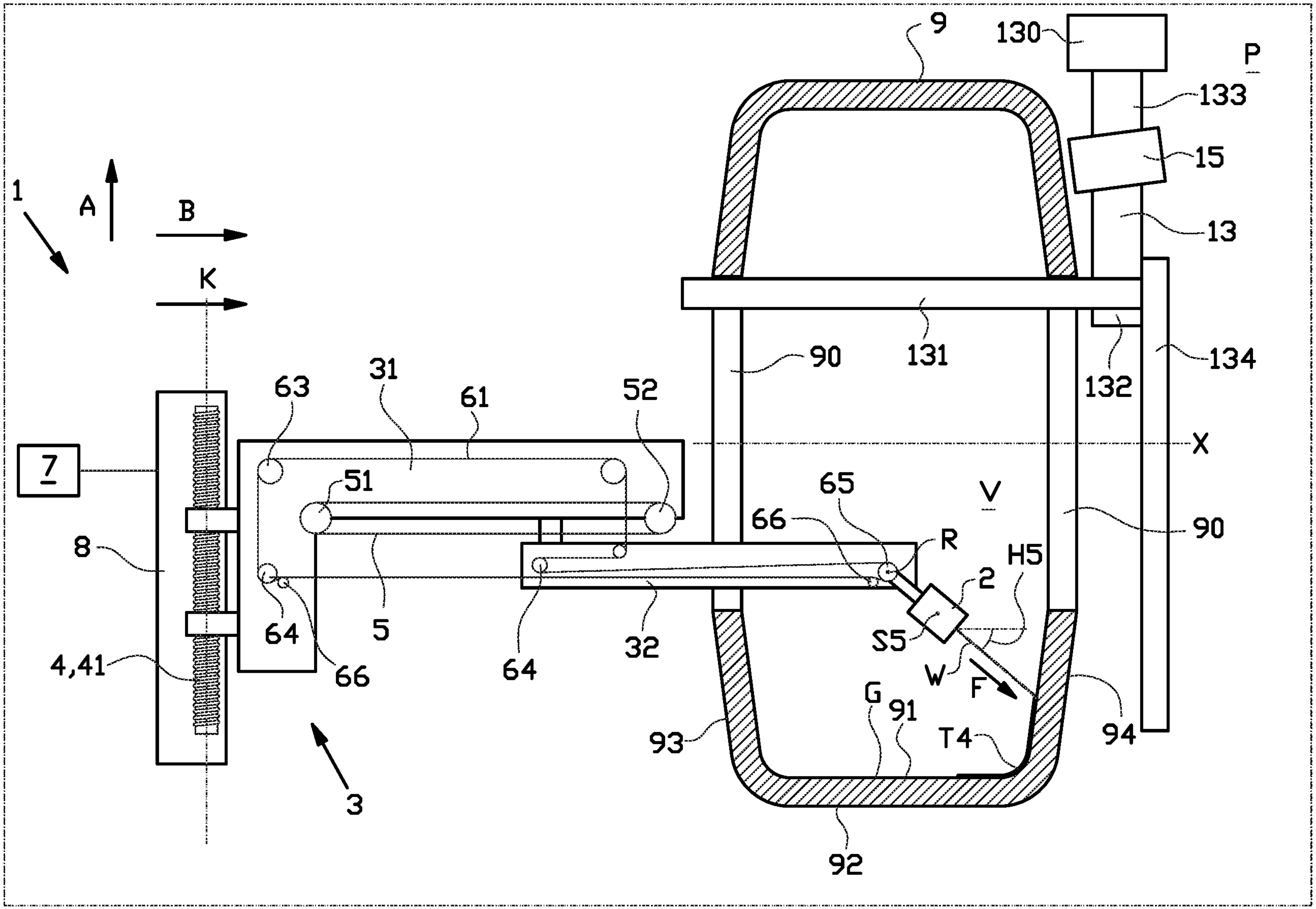
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FIG. 2F

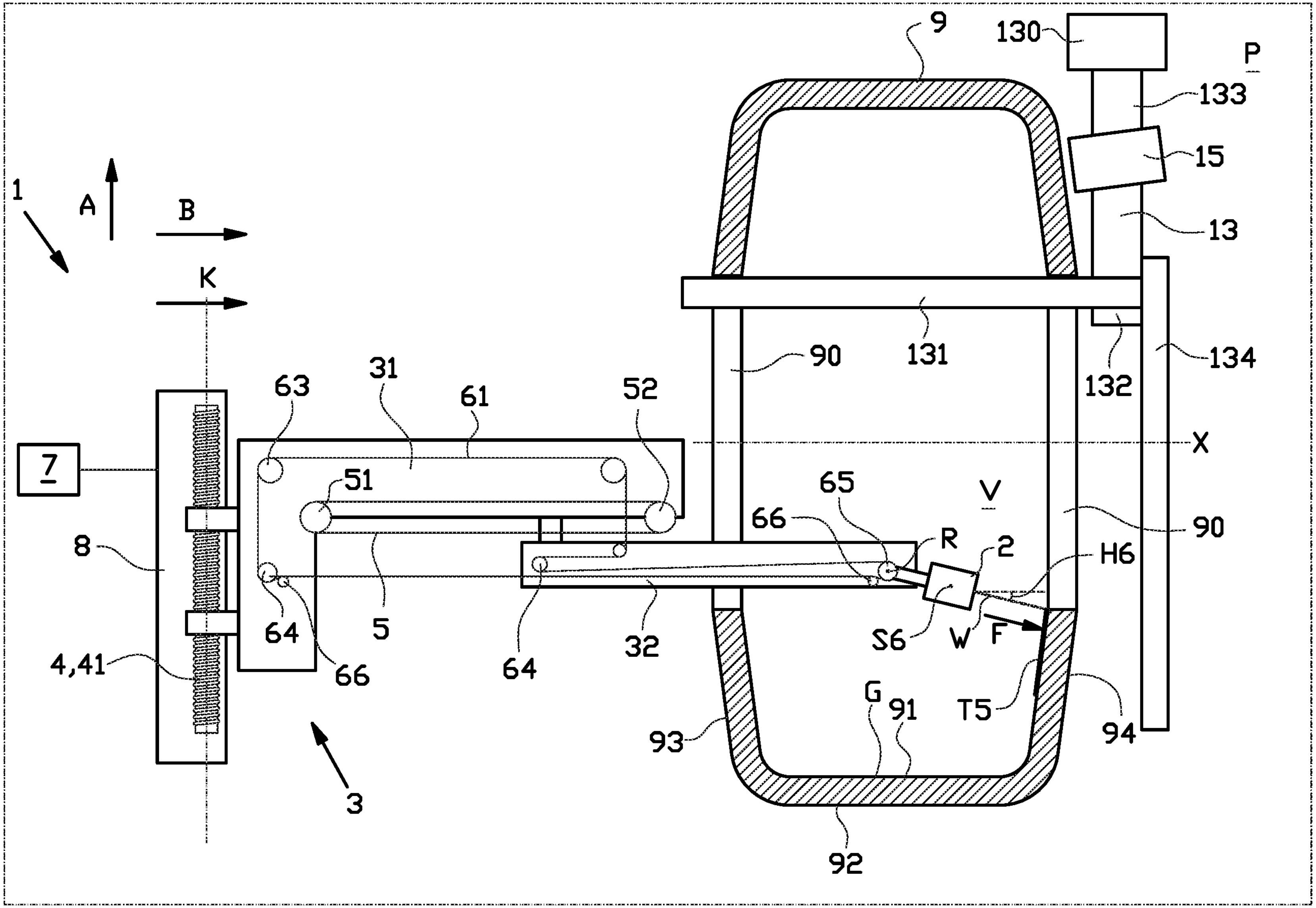
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FIG. 2G

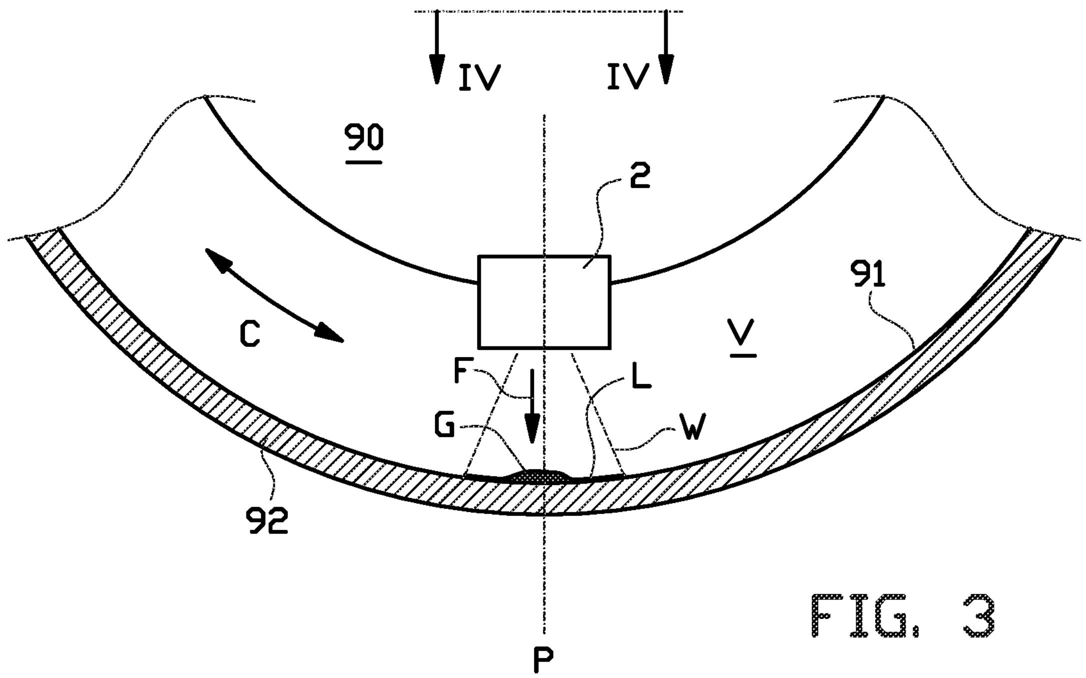

FIG. 3

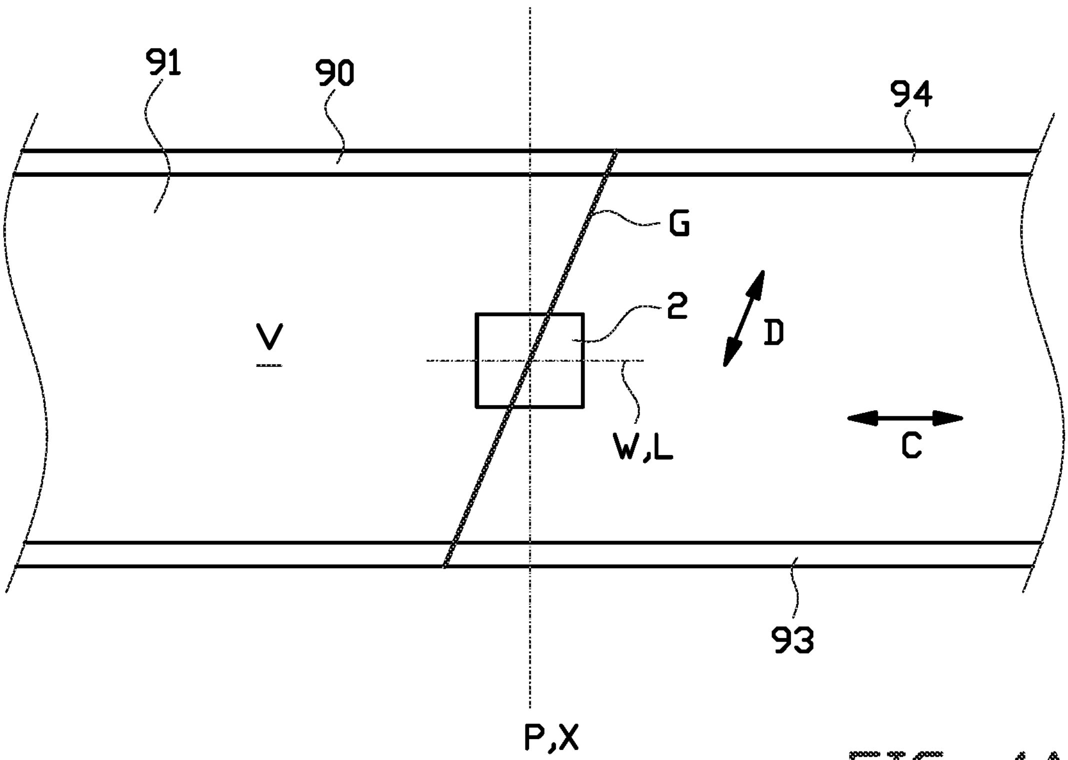

FIG. 4A

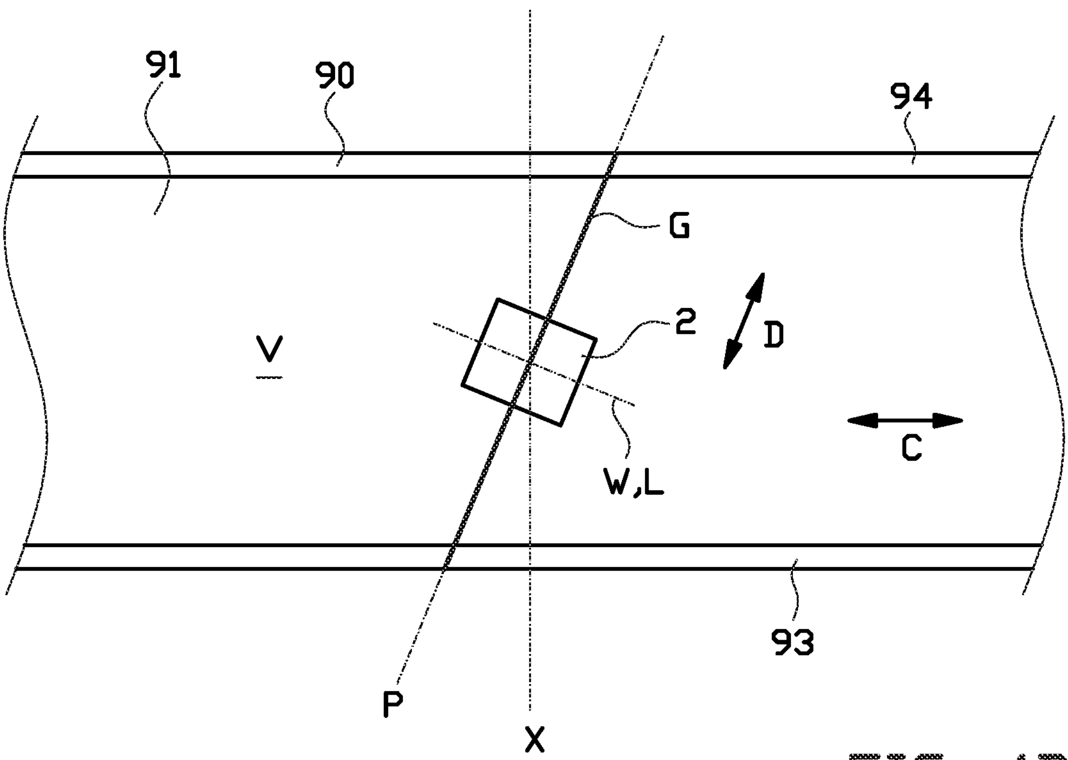

FIG. 4B

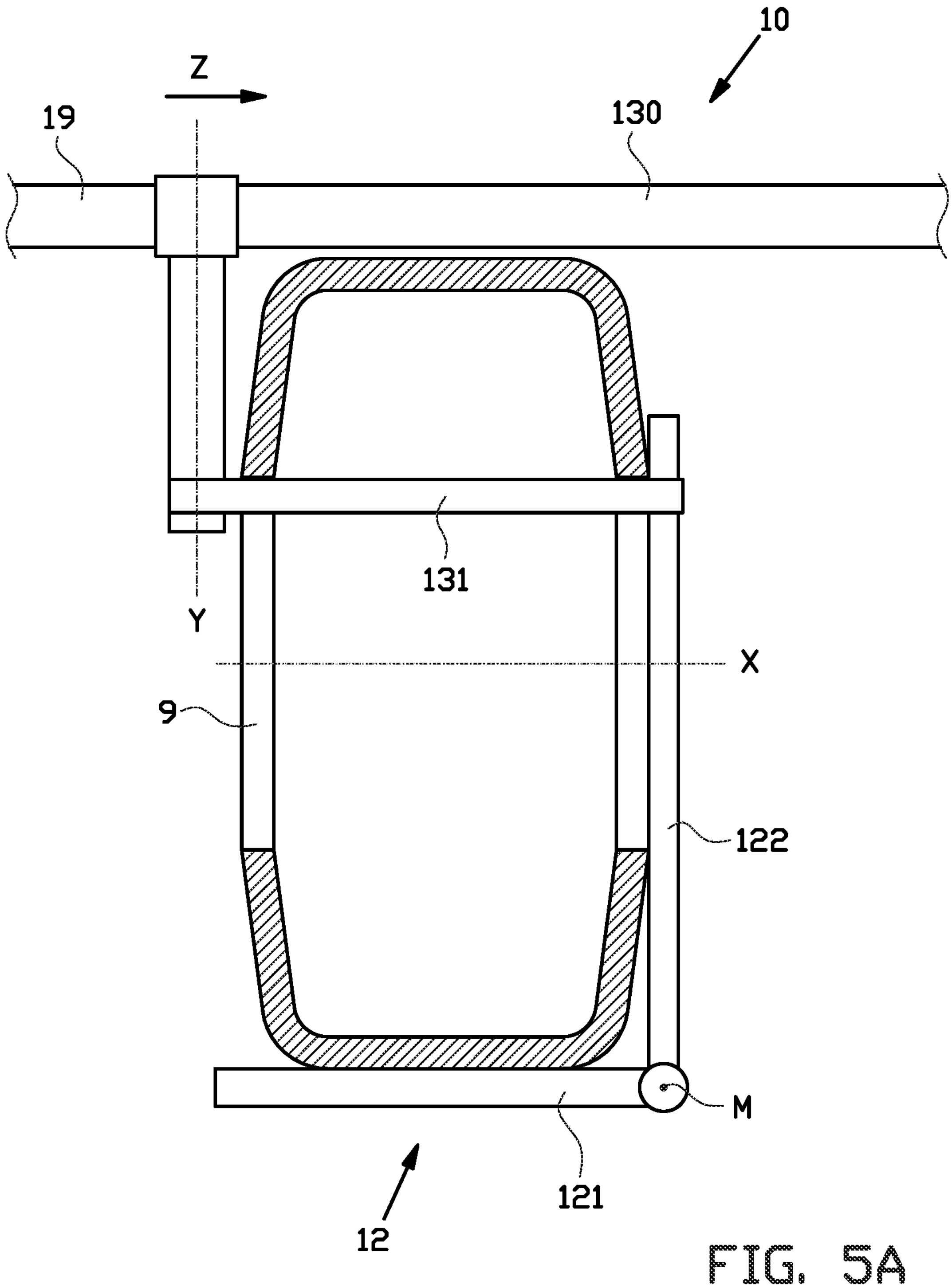

FIG. 5A

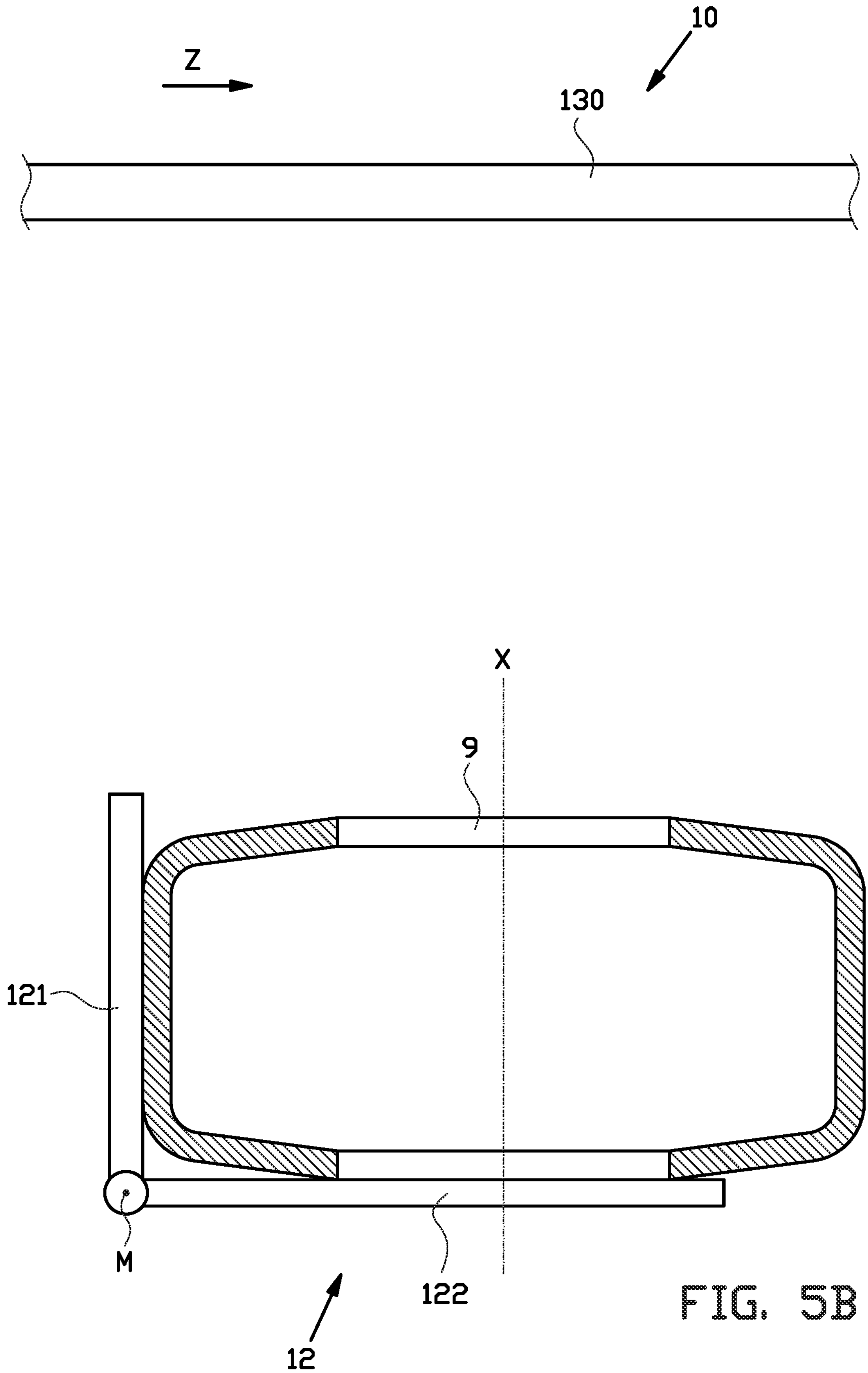

FIG. 5B

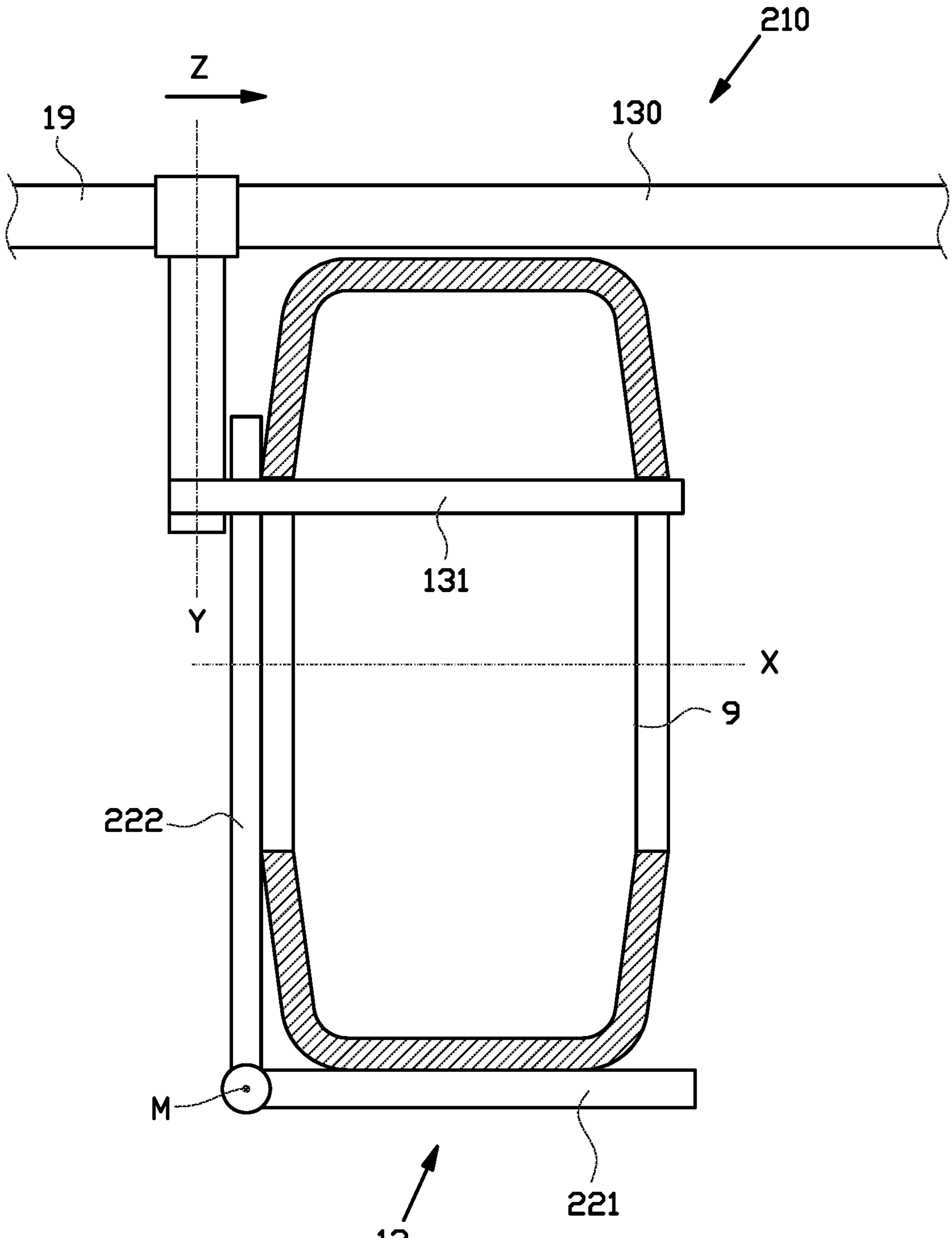

FIG. 6A

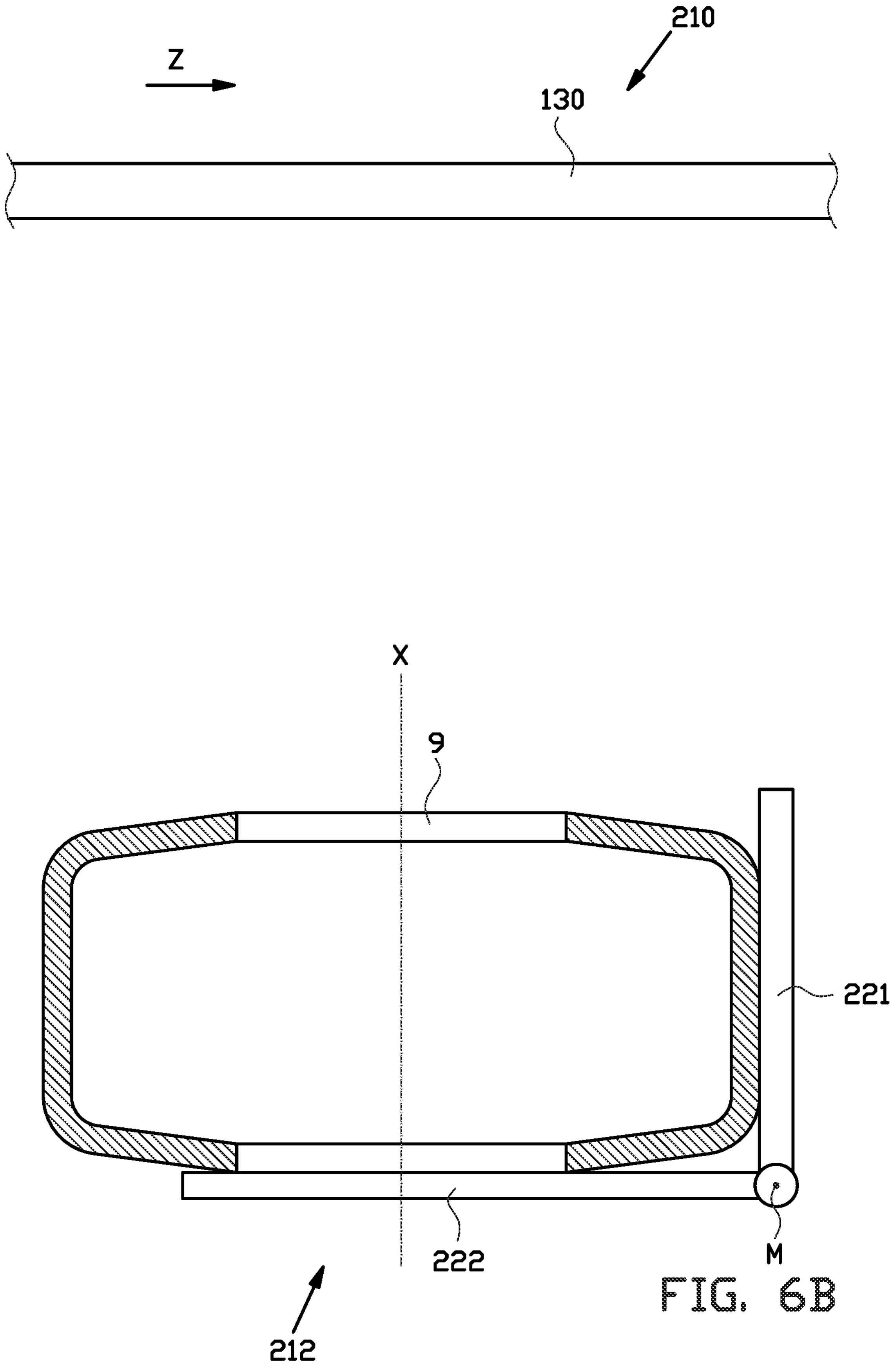

FIG. 6B

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	**KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE**
Nederlands aanvraag nr. **2034216**	Indieningsdatum **23-02-2023**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **VMI Holland B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **03-06-2023**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN83919**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

	Onderzochte minimumdocumentatie
Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2034216

A. CLASSIFICATIE VAN HET ONDERWERP
INV. B60C25/00 B60C25/05 B29D30/00 G01M17/02 G01B9/00
G01B11/00 G01N21/88 B29D30/06
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
B60C B29D G01M G01B G01N

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2019/123327 A1 (PIRELLI [IT]) 27 juni 2019 (2019-06-27)	1-29, 34-40
A	* conclusies; figuren *	30-33
X	FR 3 066 815 A1 (IFP ENERGIES NOW [FR]; NT2I [FR]) 30 november 2018 (2018-11-30)	1-29, 34-40
A	* conclusies; figuren *	30-33
X	DE 10 2013 102296 A1 (MÄHNER BERNWARD [DE]; DENGLER STEFAN [DE]) 26 juni 2014 (2014-06-26)	1-29, 34-40
A	* alinea [0012]; conclusies; figuren *	30-33
X	EP 1 808 686 A1 (STEINBICHLER OPTOTECHNIK GMBH [DE]) 18 juli 2007 (2007-07-18)	1-29, 34-40
A	* alinea [0036]; figuur 11 *	30-33

-/--

[x] Verdere documenten worden vermeld in het vervolg van vak C.

[x] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

8 september 2023

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

1

De bevoegde ambtenaar

Thanbichler, Peter

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2034216

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X A	DE 199 44 314 A1 (STEINBICHLER OPTOTECHNIK GMBH [DE]) 12 april 2001 (2001-04-12) * conclusies; figuren * -----	1-29, 34-40 30-33
X A	WO 2020/129100 A1 (PIRELLI [IT]) 25 juni 2020 (2020-06-25) * conclusies; figuren * -----	1-29, 34-40 30-33
X A	WO 2007/110414 A1 (MAEHNER BERNWARD [DE]) 4 oktober 2007 (2007-10-04) * conclusies; figuren * -----	1-29, 34-40 30-33
X A	WO 2015/004587 A1 (PIRELLI [IT]) 15 januari 2015 (2015-01-15) * alineas [0001] - [0003]; conclusies; figuren * -----	1-29, 34-40 30-33
X A	WO 2016/174543 A1 (PIRELLI [IT]) 3 november 2016 (2016-11-03) * conclusies; figuren * -----	1-29, 34-40 30-33

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ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2034216

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2019123327 A1	27-06-2019	BR 112020012235 A2	24-11-2020
		CN 111492221 A	04-08-2020
		EP 3729045 A1	28-10-2020
		US 2020400590 A1	24-12-2020
		WO 2019123327 A1	27-06-2019
FR 3066815 A1	30-11-2018	GEEN	
DE 102013102296 A1	26-06-2014	DE 102013102296 A1	26-06-2014
		WO 2014096452 A1	26-06-2014
EP 1808686 A1	18-07-2007	DE 102006001848 A1	26-07-2007
		EP 1808686 A1	18-07-2007
DE 19944314 A1	12-04-2001	GEEN	
WO 2020129100 A1	25-06-2020	CN 113167743 A	23-07-2021
		EP 3899506 A1	27-10-2021
		WO 2020129100 A1	25-06-2020
WO 2007110414 A1	04-10-2007	AT 539340 T	15-01-2012
		DE 102006014070 A1	11-10-2007
		EP 1999448 A1	10-12-2008
		JP 2009531687 A	03-09-2009
		US 2010013916 A1	21-01-2010
		WO 2007110414 A1	04-10-2007
WO 2015004587 A1	15-01-2015	BR 112015032611 A2	25-07-2017
		CN 105378447 A	02-03-2016
		EP 3019847 A1	18-05-2016
		JP 6154494 B2	28-06-2017
		JP 2016525208 A	22-08-2016
		KR 20160021815 A	26-02-2016
		MX 349104 B	11-07-2017
		PL 3019847 T3	29-09-2017
		RU 2016103472 A	15-08-2017
		US 2016377556 A1	29-12-2016
		WO 2015004587 A1	15-01-2015
WO 2016174543 A1	03-11-2016	BR 112017022664 A2	17-07-2018
		CN 107532971 A	02-01-2018
		EP 3289330 A1	07-03-2018
		JP 6715859 B2	01-07-2020
		JP 2018521299 A	02-08-2018
		KR 20170142172 A	27-12-2017
		MX 371335 B	23-01-2020
		RU 2017135286 A	05-04-2019
		US 2018143102 A1	24-05-2018
		WO 2016174543 A1	03-11-2016

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN83919	23.02.2023		NL2034216

International Patent Classification (IPC) INV. B60C25/00 B60C25/05 B29D30/00 G01M17/02 G01B9/00 G01B11/00 G01N21/88 B29D30/06
Applicant VMI Holland B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☐ Box No. II — Priority
- ☐ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI — Certain documents cited
- ☒ Box No. VII — Certain defects in the application
- ☐ Box No. VIII — Certain observations on the application

	Examiner Thanbichler, Peter

Application number

WRITTEN OPINION

NL2034216

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the application as filed.

   b. ☐ furnished subsequent to the filing date for the purposes of search,

   ☐ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the application as filed.

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the application, this opinion has been established to the extent that a meaningful opinion could be formed without a WIPO Standard ST.26 compliant sequence listing.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	1-40
	No:	Claims	
Inventive step	Yes:	Claims	30-33
	No:	Claims	1-29, 34-40
Industrial applicability	Yes:	Claims	1-40
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1	WO 2019/123327 A1 (PIRELLI [IT]) 27 juni 2019 (2019-06-27)
D2	FR 3 066 815 A1 (IFP ENERGIES NOW [FR]; NT2I [FR]) 30 november 2018 (2018-11-30)
D3	DE 10 2013 102296 A1 (MÄHNER BERNWARD [DE]; DENGLER STEFAN [DE]) 26 juni 2014 (2014-06-26)
D4	EP 1 808 686 A1 (STEINBICHLER OPTOTECHNIK GMBH [DE]) 18 juli 2007 (2007-07-18)
D5	DE 199 44 314 A1 (STEINBICHLER OPTOTECHNIK GMBH [DE]) 12 april 2001 (2001-04-12)
D6	WO 2020/129100 A1 (PIRELLI [IT]) 25 juni 2020 (2020-06-25)
D7	WO 2007/110414 A1 (MAEHNER BERNWARD [DE]) 4 oktober 2007 (2007-10-04)
D8	WO 2015/004587 A1 (PIRELLI [IT]) 15 januari 2015 (2015-01-15)
D9	WO 2016/174543 A1 (PIRELLI [IT]) 3 november 2016 (2016-11-03)

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not inventive.

Document D1 discloses (references in parentheses applying to this document):

A method of inspecting (claim 1: method for checking tyres) an inner surface (figs. 3-8) of a tire suitable for scanning a splice on said inner surface using an imaging device ("acquisition system 23 of three-dimensional (3D) high-definition images") during the movement of the imaging device. This method does not disclose the special case that the imaging device is moved along a possible splice portion on the inner surface of the tire.

However, such a movement is quite obvious for a man skilled in the art who wants to check special irregularities on the inner surface and he would adopt the movement of the imaging device with its field of view according to the needed requirements without applying any inventive skills.

This is also the case with regard to the disclosure of documents D2-D9, each of them disclosing a method of inspecting the inner surface of a tire.

Hence, the subject-matter of claim 1 is also not inventive with regard to theses documents in combination with the ordinary practise of a skilled person.

Hence, the subject-matter of claim 1 is not inventive with regard to D1 and the ordinary practise of a man skilled in the art.

The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 18, which therefore is also considered not inventive.

Document D1 discloses an inspection device (21, 22, 23, 24, 25; figs.) for inspecting the inner surface of a tire (figs.) with a base, an image processing device (23, 24, 25) and a drive assembly (robotic arm 21) for the movement of the image processing device relative to the base in an inspection plane and for rotating the image processing device about a rotation axis perpendicular to the inspection plane (figs. 9 and 10 with different angles between the robotic arm 21 and the image processing device 26), wherein the inspection unit further comprises a control unit (electronic unit 28; fig. 1) operatively connected to the drive unit (robotic arm) for controlling the movement of the of the image processing devices relative to the base and for controlling the rotation of the image processing device about the rotation axis, the control unit further controls the drive assembly to sequentially position the image processing apparatus at a distinct number of predetermined inspection positions in the inspection plane and associated inspection angles about the rotation axis (figs. 3-14).

Again the required scanning of a splice can be checked with such an inspection device and the required path movement can be easily adopted and programmed by a man skilled in the art which is within his usual work without applying any inventive skills.

Hence the subject-matter of claim 18 is also not inventive.

Independent claim 40 referring to a computer program product comprising instructions for causing the inspection unit to perform the method checking the inner surface of a tire is also obvious with regard to the programmable electronic unit 28 of D1 to operate the robotic arm and the image processing units within the inner cavity of the tire.

Hence, the subject-matter of claim 40 is also not inventive.

Dependent claims 2-17 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step, since these features of said claims also seem to be obvious for a man skilled in the art starting from the known prior art of checking the inner surface of a tire as mentioned in documents D1-D9. Also the orientation of the tire and an automated movement is discloses e.g in D4.

The same applies for the corresponding apparatus claims 19-29 concerning the movements of the image processing device.

Claims 30-33 refer to a special configuration of pulleys together with a toothed belt to perform the rotation of the image processing device around the axis which is neither known nor rendered obvious by the available prior art documents D1-D9.

The integration of an inspection device in a production line is known from D8 or D9 and claims 34-39 seem to be obvious for a man skilled in the art.

Re Item VII

The relevant background art disclosed in D1-D9 is not mentioned in the description, nor are these documents identified therein.

Independent claims are not in the two-part form, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble and the remaining features being included in the characterising part.