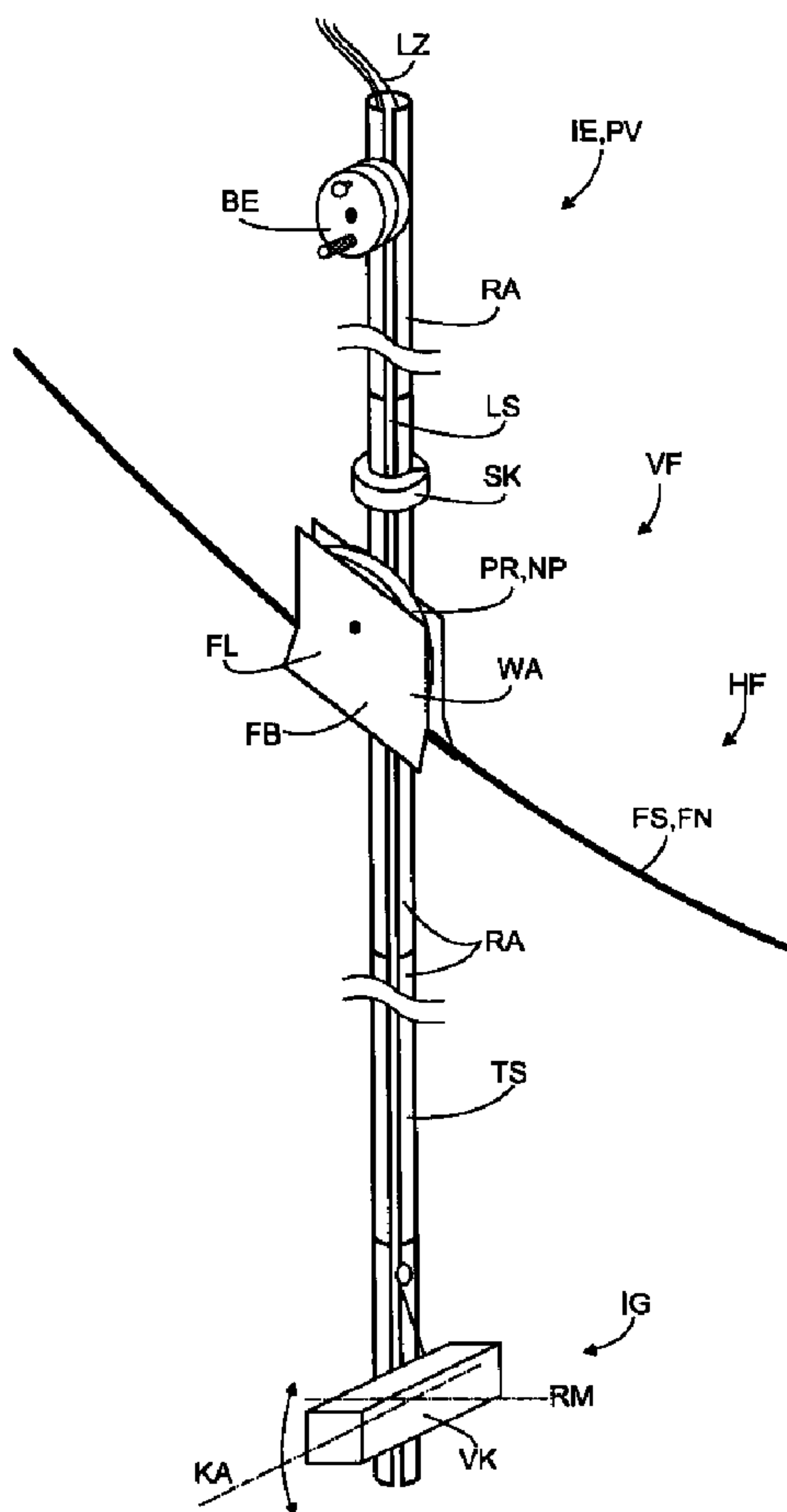




(86) Date de dépôt PCT/PCT Filing Date: 2006/04/15
 (87) Date publication PCT/PCT Publication Date: 2006/10/26
 (45) Date de délivrance/Issue Date: 2011/03/15
 (85) Entrée phase nationale/National Entry: 2007/10/22
 (86) N° demande PCT/PCT Application No.: DE 2006/000701
 (87) N° publication PCT/PCT Publication No.: 2006/111154
 (30) Priorité/Priority: 2005/04/22 (DE10 2005 020 070.2)

(51) Cl.Int./Int.Cl. *B63C 11/48* (2006.01),
B61B 7/00 (2006.01), *F16M 11/42* (2006.01),
A01K 61/00 (2006.01), *G01N 1/04* (2006.01)
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(54) Titre : APPAREIL POUR INSPECTER LES STRUCTURES SOUS-MARINES
 (54) Title: APPARATUS FOR INSPECTING UNDERWATER STRUCTURES



(57) Abrégé/Abstract:

Such inspection devices are used for observing and servicing aqua cultures, harbor systems or other surfaces submerged in water. They are provided with a smoothly adjustable vertical guidance with a telescoping rod and a smoothly adjustable horizontal

(57) Abrégé(suite)/Abstract(continued):

guidance with a guide track setting a path and a carriage moveable thereon on guide rolls for receiving the vertical guidance and appropriate inspection devices. Hitherto this required specially trained divers, hoisting the subject to be inspected out of the water or using inspection devices of very limited action space. The invention proposed a cost-efficient inspection apparatus (IE) usable without divers and operable in a substantially unlimited observation space. For the vertical guidance (VF) the telescoping rod (TS) may be extended without forming bulges, and for the horizontal guidance (HF) the guide track (FB) may be set in changeable continuous curve or composed of linear sections. Vertical and horizontal guidance (VF, HF) define the inspection plane in the three dimensions for the diverse inspection devices (IG).

Abstract

Inspection Apparatus for Underwater Structures with a Positioning Device.

5 Such inspection devices are used for observing and servicing aqua
cultures, harbor systems or other surfaces submerged in water. They are
provided with a smoothly adjustable vertical guidance with a telescoping rod
and a smoothly adjustable horizontal guidance with a guide track setting a
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continuous curve or composed of linear sections. Vertical and horizontal
guidance (VF, HF) define the inspection plane in the three dimensions for the
diverse inspection devices (IG).

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Apparatus for Inspecting Underwater Structures

Specification

5 The invention relates to an apparatus for inspecting underwater structures, equipped with a positioning device provided with a smoothly adjustable vertical guide including a telescopic rod and with a smoothly adjustable horizontal guide provided with a guide track for setting a path, and a carriage for receiving the vertical guide and conveyed thereon by way of
10 guide rolls, and with an underwater video camera functioning as at least one inspection device mountable on the rod.

Such inspection devices are needed, for instance, for servicing large-scale aquatic culture plants which are increasingly used throughout the world
15 for the production of algae and mussels. The organisms of the cultures grow on or within floating or submersed systems. Such systems usually are long line, long tube, annular systems, rafts or pole structures. Long lines and long tubes are horizontally suspended at the water surface or at a depth of from 1 to 10 meters below the water surface at a length of several hundred meters
20 and serve as support lines for culture suspension lines attached thereto. It is the culture suspension lines on which the algae and mussels are being cultivated. The cultivation of such organisms is carried out for periods extending from several months to several years. During this time, aside from routine operations (control of the cultures, removal of organisms, harvesting),
25 the condition and safety of technical structure are checked. Depending on their weight gain as results from the growth of the organisms, submerged structures in particular have to be furnished with additional floats. Furthermore, the culture organisms need be monitored in order to evaluate their exterior condition (wholesomeness, settlement) growth, predation
30 (aversion to feeding), food intake and competition. Such tasks may be performed by specially trained divers. Another possibility is to lift the complete structures by ship's derricks of special ships. Either operation can

only be performed when the sea is calm and are very expensive. Also, underwater cameras may be used as inspection equipment. Other fields of application of such inspection equipment are the observation and servicing of submerged technical devices, such as, harbor systems, etc.

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The Prior Art

A simple telescoping rod on which an underwater camera may be mounted is known from GB 2 400 451 A1. The length of the rod is adjusted
10 by extension sections before use. Feed lines are mounted at the exterior along the telescoping rod. Excess lines is coiled on a spool. The equipment is used from a pier or from a boat or pontoon for the observation, for instance, of harbor systems below the surface of the water. Its use on the open sea at wind and moving waves is made very difficult by the movement of the camera
15 in front of a subject. Because of its weight, use of the manually guided equipment is limited to shallow depths. A stationary inspection device for underwater applications is known from US 6,119,630, its original purpose being the constant observation of growth conditions of mussels under natural environmental conditions. After setting of the depth and selection of its
20 application site the device cannot be adjusted in either horizontal or vertical directions. A semi-automatic observation system with a remote-controlled unmanned boat and a cable-controlled video device is known from JP 10020382 A. The boat is guided over a site to be observed and the video system is lowered to a desired depth by a winch. Image and control signals
25 are fed over the cable. The observation system is complex and its application site is limited to the possible lengthly of the cable. It is not clear how the camera maintains its line of sight while it is suspended by the cable and is subjected to currents and swells. A similar system is disclosed by DE 103 10 550 A1. A streamlined underwater unit is guided through a body of water, at
30 a depth which may be adjusted by a cable, by a remote-controlled unmanned boat and records data by means of attached sensors. The observation system is complex and its site of application is limited by its possible line of

sight.

A camera stabilizer is known from US 2,945,428 A in which a camera operator carries a horizontal frame on his shoulders. It consists of two parallel straight guide rails which determine the horizontal path of movement of the camera. For horizontal movement the camera is mounted on a carriage which embraces each guide rail by at least one tubular enclosed guide sleeve. The camera may be vertically adjusted by a telescoping rod connected to the carriage below the camera and which is supported by the floor (see Fig. 5). Curvilinear movement of the camera is not readily possible with this known camera stabilizer. Furthermore, the stabilization (for camera operator and telescoping rod) always depends upon the floor.

Furthermore, an optical encoder, for instance an X-ray apparatus, having two apparatus components displaceable relatively to each other, is known from WO 2004/008077 A1. A position visualization unit is mounted on one of the apparatus components and an image acquisition unit is mounted on the other component of the apparatus. The position visualization unit is connected to a moving object and is optically registered in its movement by the image acquisition unit. The encoder includes a moveable carriage connected by four guide rolls to and below a horizontal guidance (see Figure 1). In this connection, the arrangement of the four rollers necessitates structural security. Moreover, a telescopic vertical guidance consisting of several moveable tetrahedral tubes which when extending show significant bulges between each other.

JP 61082146 A from which the instant invention is proceeding as the closest prior art, discloses a winch-actuated telescoping tube of defined extended length having an underwater video camera attached thereto. The observation depth is set by a hand crank on the winch. The telescoping tube may be manually moved on a cantilever in a horizontal direction by a carriage. The cantilever may also be manually rotated on two hinges about a support

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mast. Hence, the horizontal movement is smoothly continuous in two dimensions. In one dimension a strictly circular movement may be executed and a linear movement may be executed in the other dimension. The carriage can only be moved linearly along the cantilever. Because of these combined movements use of the camera is limited to a circle having the radius of the cantilever and, as regards depth, to the length of extension of the telescoping tube. Accordingly, it provides for a cylindrically limited observation space of defined radius and length,

10 Object

The object of some embodiments of the invention may be considered to provide an inspection apparatus for underwater structures equipped with a positioning device of the kind described above which provides for a substantially unlimited observation space, which can be economically manufactured and which can easily be handled without specially trained personnel. In accordance with the invention, the object is accomplished in the manner defined in the main claim. Advantageous improvements of the inspection apparatus in accordance with the invention have been described in the sub-claims and will be explained hereafter in the context of the invention.

The inspection unit in accordance with the invention consists of a horizontal and of a vertical guidance which set up a plane in which the inspection apparatus can be moved smoothly. The vertical guidance is provided with a tubular telescoping rod and always moves linearly. The horizontal guidance may have a guide track in the plane disposed normal to the vertical guidance, it may execute curvilinear movements, but, preferably, it may consist of linear sections and, most preferably, of a single linear section. The surface set up by the horizontal guidance and vertical guidance may thus be planar, or it may consist of any number of surface sections disposed angularly relative to each other, or it may be a surface bent in the third dimension, such as, for example, a cylinder of circular cross-section. For

setting the depth of the range of inspection, the telescoping rod may be lengthened or shortened, without forming any bulges, by adding or taking away tube sections. The telescoping rod is received in a guide mounted on a carriage which is held on, and may roll along, the guide track of the horizontal guidance by a guide roller. To this end the guide roller has a negative or concave profile which at least partially accommodates the profile of the guide track. Preferably, the inspection devices are arranged at the lower end of the telescoping rod. The setting of the operational depth selected for the inspection devices on the telescoping rod, the smooth guidance of the carriage with the telescoping rod and inspection devices over the horizontal guidance as well as manipulating the inspection devices as required, are preferably carried out manually.

The conduit harnesses required for supplying the inspection devices with energy and for operating them and, where necessary, for providing bidirectional signals for image and control data, as well as for mechanical action may for protection from mechanical damage be disposed in the interior of the telescoping rod. It is, therefore, preferably structured as a tube with a longitudinal slot making possible a very rapid change in length of the telescoping rod by adding or removing slotted tube sections without having to remove and, after such change in length, having to thread all the conduits anew. The conduit harnesses are unwound from and wound onto a supply, and a slotted tube section is either pushed over or removed from them. For a change in length, the tube section is provided with a detent mechanism which makes possible quickly to connect it in precise alignment with the its slot to an existing telescoping rod or to remove it from it in a simple manner. At a constant external diameter, the tube sections of the telescoping rod may at one end, for a length of about the diameter of the tube, have an enlarged internal diameter and, at the opposite end a commensurately reduced external diameter, so that one end of one tube section may be received with a little play in one end of another tube section without forming a bulge . The detent mechanism preferably consists of at least one resilient tongue with a

lug seated in the interior tube section of reduced outer diameter and engaging a bore in the interior section of enlarged diameter of another tube section when the longitudinal slots of the two tube sections are in alignment. By pressing the lug of the at least one tongue inwardly while at the same time pulling the two tube sections apart they can be disconnected in a simple manner and without any tools.

The path-setting guide track of the horizontal guidance may be a taut guide cable consisting of a single linear cable section or any number of cable sections abutting each other at small angles. The embodiment consisting of several cable sections may thus follow a quasi-continuous curve upon which the carriage may be moved. The carriage for a horizontal guidance consisting of a taut guide cable is formed by a guide section consisting of two closely adjacent planar guide plates between which guide rolls are rotatably mounted. The circumference of the guide rolls is notched inwardly and at the bottom of the circumferential notch they are shaped such that they may run along the taut guide cable at a snug fit but low friction. For guide cables of different diameters the notch may have matching stepped profile with width and height of the steps increasing from the axle of the guide roll towards the periphery thereof. The smaller steps not used at a selected diameter of the guide cable may be covered by a collar surrounding the bottom of the notch to be used to prevent jamming of the guide cable in the next smaller step. For safe moving along the guide cable the planar guide plates of the carriage may be provided with a downwardly extending guide section slightly flaring out from the lower edge of the guide roll thereby, on the one hand, to facilitate placement of the carriage on the guide cable and, on the other, to prevent jumping of the carriage off the guide cable under strong movements. The path-setting guide track of the horizontal guidance may also be a guide tube of any desired shape, preferably of circular shape, in a horizontal plane. In such an arrangement, the carriage is supported and guided by at least two pairs and one pair of cylindrical rollers mounted on a cover plate and respectively disposed vertically on each side of and horizontally on top of the guide tube and conforming at least in part to the diameter of the guide tube by

a concave profile. The profile, especially of the upper cylindrical rollers, is shaped such that it would fit on the largest diameter and serves essentially to distribute the load of the telescoping rod and inspection devices suspended from the carriage. As a negative profile it conforms at least in part to the profile of the guide tube. Since they need not absorb any load and since they only transmit lateral guide forces, the lateral cylindrical rollers need not be concavely profiled. In order to conform the carriage to different diameters of the guide tube, the lateral cylindrical rollers may be attached to the cover plate for selective movement by quick-release clamps. Non-profiled lateral rollers need not be vertically adjustable since their straight walls will engage a guide tube regardless of its diameter. Below the cover plate, the axles of the lateral guide rollers may be provided with a joint with a return spring so that they may adjust to different diameters and any irregularities in the surface of a tube.

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The telescoping rod may be connected to the carriage movable on the horizontal guidance by a guidance device. This may be a guidance aperture in the cover plate of the carriage into which, by opening, the telescoping rod may be quickly inserted laterally and, after closure, be secured against escape. Lateral insertion avoids threading the telescoping rod and associated inspection devices into the guidance aperture from above or below. The closed guidance aperture embraces the telescoping rod such that it may slide therein. A snap ring may be seated on the telescoping at any desired level to fix the maximum operating depth of the inspection devices and to secure the telescoping rod against slipping out in a downward direction. The telescoping rod may be manually moved up and down as well as rotated, the movement being limited in an upward direction by the inspection devices and downwardly by the snap ring. In the embodiment of the guidance tube where the carriage is provided with a cover plate and cylindrical guide rollers the guidance aperture may be a simple recess in the cover plate which can be opened and closed by a locking latch. In the case of a guidance cable where the carriage is constructed with two guide plates

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and guide rolls therebetween, the guidance aperture may be a split guide flange embracing the telescoping rod and the arms of which may be opened and closed by a screw. The split guide flange may be connected to the carriage by a simple pivot joint and a rigid spacer. The pivot joint serves to
5 compensate for small tilting movements of the telescoping rod relative to the carriage as may result from irregularities in the horizontal guidance of a carriage provided with more than one guide roller. Since because of its leverage and weight a telescoping rod connected to the carriage would not be able to follow such tilting movements, lack of a pivot joint would result in a
10 guide roll being lifted more or less off the horizontal guidance and lead to an imprecise lateral guidance. The rigid spaced prevents the telescoping rod from rubbing on the carriage and provides for a minimum spacing between the telescoping rod and associated inspection devices and the surface to be inspected to ensure, for instance, the minimum spacing of a video camera
15 required for an inspection. The telescoping rod is disposed in its guidance aperture laterally of the carriage resulting in a lever action between the fulcrum of the weight of the telescoping rod and the point of engagement or fulcrum of the carriage on the guidance cable or tube. In order to prevent an inclines disposition of the telescoping rod in the water, at least one float on an
20 adjustable cantilever rigidly connected to the carriage may be provided to compensate for the weight of the telescoping rod. The length of the cantilever and the buoyant force are set such that the weight of the telescoping rod is compensated for to the extent that the rod assumes a precise vertical disposition.

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The inspection device is at least one underwater video camera. It may be positioned in a housing which can be pivoted from the surface of the water by at least $\pm 90^\circ$ about the spatial axis forming a right angle with the optical axis of the camera. In concert with the possibility of lateral rotation of the
30 entire telescoping rod, a view may be had over a complete relatively broad vertical section of the subject in front of which the camera is positioned at any given time. As a further inspection device, a suction device provided with a

suction hose for water samples and small organisms may be mounted on the telescoping rod at the same level as the underwater video camera. Samples of water and floating materials may be suctioned off the inspection site by a small pump, and stored. A further inspection device may be a removal device
5 for solid body samples provided with a receptacle basked for storing solid body samples from the inspection site. Advantageously, the bracket of the basket may be provided with sharp edges for scraping solid body samples, e.g. mussels, off the inspected ground and dropping them into the receptacle basket by appropriate movements of the telescoping rod. Another removal
10 device for solid body samples may be provided with a separator for solid body samples and may be structured as a mechanically actuated saw, pliers or knife. A further embodiment of an inspection device for the removal of solid body samples may, in addition to a receptacle sample, be provided with a mechanical gripper for picking up solid material samples from the inspected
15 ground and placing them into the receptacle basket. In addition, a measuring device, advantageously made up of two lasers disposed precisely parallel and at a predetermined distance from each other, connected to the camera on the telescoping rod may be provided as a further inspection device. During the observation of underwater structures the relation between the points of
20 impingement of the laser light and their known distance from each other provides an indication of the size of the observed structures, e.g. organisms.

Bowden wires may be used for manipulating the manually actuatable inspection devices to execute the necessary underwater movements from the
25 surface of the water. Bowden wires may be moved into desired positions by levers or rotary elements and may then be fixed in a stable position. When releasing the stable position the movable inspection devices may be returned to their initial positions by return springs. Rotary elements may be provided with a supply of cables for lengthening the telescoping rod by means of
30 slotted tube sections. When need, the supply may be simply be wound or unwound.

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In one broad aspect of the invention, there is provided an inspection apparatus for underwater structures with a positioning device provided with a smoothly adjustable vertical guidance with a telescoping rod and a smoothly adjustable horizontal guidance with a guide track setting a path and a carriage
5 moving thereon on guide roller for receiving the vertical guidance, and with an underwater video camera as at least one inspection device mounted on the telescoping rod, the telescoping rod being extendable, without forming bulges, by several tube sections, the guide track having a changeably set curved course and the guide rolls having a negative profile for accommodating the profile of the guide
10 track.

Embodiments

Embodiments of the inspection apparatus for underwater structures provided with a positioning device in accordance with the invention will hereafter be described in greater detail for a better understanding of the invention with reference to the schematic drawings, in which:

- Figure 1 shows an inspection apparatus including positioning device and inspection devices with a guidance cable;
- 10 Figure 2 depicts a carriage with a profiled roller and guidance device;
- Figure 3 shows an inspection apparatus including positioning device and inspection devices with a guidance tube;
- Figure 4 depicts a carriage with a cover plate including guidance device;
- Figure 5 depicts the structure of cylindrical guide rollers;
- 15 Figure 6 depicts tube sections with latching lugs of the telescoping rod;
- Figure 7 depicts a circular guidance tube;
- Figure 8 depicts guidance cable in sections;
- Figure 9 shows a telescoping rod with inspection devices; and
- Figure 10 shows an actuator unit for Bowden wires.

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Figure 1 depicts an inspection apparatus IE including a positioning device PV, inspection devices IG and horizontal guidance HF including guidance cable FS. A vertical guidance VF including a telescoping rod TS consisting of several tube sections RA is received on a carriage WA for up and down as well as rotational movements in a guidance device LE (not shown here). A snap ring SK limits the possible strike of the telescoping rod TS and determines the maximum submersion depth. The telescoping rod TS is provided with an uninterrupted longitudinal slot LS for receiving conduit harnesses LZ of for electric supply and mechanical adjustment of a video camera VK . The control device BE for mechanically adjusting the video camera VK may be arrested at fixed positions (not shown here). In this embodiment, the carriage WA is provided with a profiled guide roll PR which

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rolls along the guidance cable FS and which is provided with a negative profile NP for receiving the profile of the guidance cable FS and with a downwardly extending and flaring guidance section FB. The video camera VK can be pivoted at least about the horizontal spatial axis RM disposed at a right angle relative to the optical axis KA of the camera.

Figure 2 depicts a carriage WA with two profiled rolls PR and guidance device LE. The profiled guide rolls PR are seen to be provided with a profile section PB matching various cable diameters in steps. For clarity, in the depicted example the guidance cable FS extending in the plane of the drawing is shown in cross-section in the upper profile section PB. Any smaller non-used steps may be covered by a collar MA in order to prevent the guidance cable FS from jamming. The collar MA may be placed in full abutment with the next smaller step and may at its tapered ends be threadedly connected to form a ring. The profiled guide rollers PR are positioned between two planar plates FL forming the guide section FB and retained on rotary axles DA for free rotation. They are secured by nuts SM. Guide discs GS between the guide plates FL and the guide roller PR provide for low friction movement. The rotary axles DA are supported by a common spacer AH which at its central point ZP supports the guidance device LE for the telescoping rod TS in a rotary journal DL. In the present embodiment, the guidance device LE consists of a guide flange LF which may be opened by two hinges SR and which, when closed by a safety screw SS, retains the telescoping rod TS with sufficient play for the upward and downward as well as rotary movement thereof.

Figure 3 depicts an inspection apparatus IE including positioning device PV, inspection devices IG and horizontal guidance HF having a guidance track FN constituted by a guide tube FR. The vertical guidance VF including telescoping rod TS made of several tube sections RA is received for upward and downward as well a rotational movement in a guidance device LE on a carriage WA provided with a cover plate DP. In this embodiment, the

guidance device LE consists of a guidance aperture LO to receive the cross-section of the telescoping rod TS with sufficient play and of a latch SP structures as a rotatable open ring. A snap-ring SK limits the possible stroke of the telescoping rod TS and sets its maximum depth of immersion. The
5 telescoping rod TS is provided with an uninterrupted longitudinal slot LS for receiving von conduit harnesses LZ. An inspection device IG here shown is a device EF for removing samples of solid material and consists of a receptacle basket AN including a basket bracket KH with a blade-like edge KK as a separating device TF for solid material samples. In this embodiment, the
10 carriage WA provided with the cover plate DP is provided with two pairs of cylindrical guide rollers PR disposed vertically to the left and right of the guide tube FR and at least one pair of cylindrical guide rollers PR arranged horizontally above the guide tube FR, the guide rollers PR having a concave profile conforming at least in part to the diameter of the guide tube FR to roll
15 on the guide tube FR. The guide rollers PR may be adjusted to positions matching the given diameter of a guide tube, by quick-release clamps SN and elongated slots LL. In the case of the carriage WA provided with a cover plate DP the weight of the telescoping rod TS and the inspection devices IG mounted thereon is compensated by a float AK mounted on a cantilever AL at
20 a side of the carriage WA on the opposite side of the guide tube FR. The cantilever AL is also adjustably mounted on the cover plate DB by quick-release clamps SN and elongated slots LL.

Figure 4 is a top elevation of a carriage WA equipped with a cover
25 plate DP and a guidance device LF. The telescoping rod TS is received therein for upward and downward as well as rotary movements. The guidance device LE in this embodiment consists of a guide aperture LO for receiving the cross-section of the telescoping rod TS with play and a latch SP structured as a rod with a handle button SG and retained by two clamps SE.
30 The guide rollers PR arranged below the cover plate DP (not shown in this figure) may be fixed at positions matching a given diameter of the guide tube by quick-release clamps SN and elongated holes LL. The cantilever AL with

its float AK for balancing the weight is mounted on the side of the carriage WA opposite tube FR and guide track FN. The cantilever AL may be adjustably arrested at the cover plate DP by quick-release clamps SN and elongated holes LL.

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Figure 5 depicts the cylindrical guide rollers RP in a frame-like structure RB. As seen, the horizontally arranged guide rollers PR are provided with a profile AP which as a negative profile NP is at least in part conforming to the largest possible diameter of the guide tube FR and by means of which the entire carriage WA is centered on the guide tube FR. The vertically arranged guide rollers PR are not profiled, but their length is designed to accommodate the largest possible diameter of the guide tube FR. This avoids the necessity of making height-wise adjustments of the vertically arranged guide rollers PR when changing the diameter of the guide tube FR. The vertically disposed guide rollers PR are each rotatably mounted by axles AS in a parallelepiped bracket QH two of each being threadedly connected by a brace VS. The connected pairs of vertically disposed guide rollers PR thus formed are connected by the two profiled horizontally disposed guide rollers PR since the extended axles VA thereof are seated in lateral bores QB of associated parallelepiped brackets QH. The parallelepiped brackets QH are provided with central vertical bores by means the frame-like structure RB overall is fixed on the cover plate DP by the quick-release clamps SN and the elongated slots LL. For enhancing an adjustment to the diameter of the guide tube FR or for compensating for irregularities therein the axles AS may be provided with toggle links KG. To adjust the carriage WA to the diameter of the guide tube FR the quick-release clamps SN are loosened, the carriage is placed on the guide tube FR and the two pairs of vertically disposed guide rollers PR are pushed along the elongated slots LL against the guide tube FR. The horizontal guide rollers PR with their matching profiles AP can move by means of their axles VA seated in the transverse bores QB in the parallelepiped brackets QH until they assume a centered position on the guide tube FR. Thereafter, the quick-release clamps SN are tightened again.

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Figure 6 depicts two tube sections RA of the telescoping rod TS of which one at its upper end OE, at a constant external diameter d_A and for a partial section TB of the approximate length of the diameter of the telescoping rod TS has an enlarged internal diameter g_l , and the other one of which at its lower end UE for an equally long partial section TB and at a constant internal diameter d_l is provided with a reduced external diameter k_A , so that both ends OE, UE of the shown tube sections RA may be connected with little play and without forming a bulge. A latching device RE consists of at least one flexible tongue FZ provided with a lug RN disposed in the interior of the upper tube section RA at the lower end UE of reduced diameter k_A , the lugs RN, when the longitudinal slots LS of the connected tube sections RA are in precise alignment, protruding into superposed bores BN in the partial sections of the tube sections RA forming a connection site VB and thus firmly connecting them. By pressing on the lug RN of the at least one flexible tongue FZ and at the same time pulling the two tube sections RA apart the connection can be easily released without any tool. The latching device RE has been shown in dotted lines in its open position.

Figure 7 depicts the guide tube FR as a guide track FN configured as a circle KR. The carriage WA runs around and in doing so, carries the telescoping rod TS along. The structure makes it possible to inspect cylindrical underwater structures.

Figure 8 depicts a guide cable FS as a guide track FN consisting of cable sections SA connected at small angles. The carriage WA runs along the guide cable FS and carried the telescoping rod TS with it. This structure makes possible an inspection of underwater structures of a quasi curved configuration.

Figure 9 depicts a telescoping rod TS with inspection devices IS which in this case are a suction device for water samples AW with a sheathing tube HR and suction hose SL, a mechanical gripper MG actuable by way of a

Bowden wire BZ (not shown) and return spring RF functioning as a removal device EF for solid body samples as well as a receptacle basket AN and a measuring device VV consisting of two lasers LR placed at a freely selectable spacing from each other in precise parallel alignment and mounted directly on the video camera VK. Another possible separation device TF for solid body samples such as a mechanically actuated saw, pair of pliers or knife has not been shown. The inspection devices IG are arranged such that all activities are within the field of view of the optics of the video camera and that the operator can fully control any required activities.

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Figure 10 shows a control unit for a Bowden wire of an inspection device. A detent disc RS with detent recesses RL is mounted on the telescoping rod TS. A wire spool DS is arranged coaxially therewith by means of a center screw ZS. The wire spool DS which may be rotated by a hand crank HK is provided with a circumferential recess in which there is provided a supply DV of wire for the Bowden wire. A safety pin ST is connecting the wire spool DS with the detent disc RS. When the length of the telescoping rod TS is changed it is necessary to wind or unwind wire. The safety pin ST is pulled out of its detent recess RL against the bias of a tension spring ZF, rotated by 90° and thus arrested in a release position. The wire spool DS can thus be rotated by the hand crank HK until the wire has either slackened and a tube section has been removed or has assumed the new length necessary for the Bowden wire and for adding a tube section to the telescoping rod TS. Thereafter, the safety pin is inserted again into the nearest detent recess RL.. To operate a given inspection device the safety pin ST is released again and the hand crank HK is rotated until the inspection device is in its proper position. When the hand crank HK is rotated in the reverse direction, the inspection device is returned up to its initial position by the hand crank HK. In order to maintain the inspection device in a defined position the wire spool DS may be arrested by the safety pin ST in any present detent position.

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List of Reference Characters

	AH	Spacer
5	AL	Cantilever
	AK	Float
	AN	Receptacle Basket
	AP	Matching Profile
	AS	Axle
10	AW	Suction device for Water Samples
	BE	Control Unit
	BN	superposed Bores
	BZ	Bowden wire
	DA	Rotational axle
15	dA	constant external Diameter
	DL	Rotary Journal
	dl	constant internal Diameter
	DP	Cover Plate
	DS	Wire Spool
20	EF	Removal Device for Solid Material Samples
	FB	Guide Range
	FL	Guide Tongue
	FN	Guide Track
	FS	Guide Cable
25	FR	Guide Tube
	FZ	flexible Tongue
	gl	enlarged internal Diameter
	GS	Slip Disk
	HF	horizontal Guidance
30	HK	Hand Crank
	HR	Sheathing
	IE	Inspection Device

	IG	Inspection Apparatus
	KA	Camera Axis
	kA	reduced outer Diameter
5	KG	Toggle Joint
	KH	Basket Bracket
	KK	Blade-like Edge
	KR	Circle
	LE	Guidance Device
10	LF	Guide Flange
	LL	elongated Hole
	LO	Guidance Aperture
	LR	Laser
	LS	elongated Slot
15	LZ	Conduit Harness
	MA	Collar
	MG	Gripper
	NP	negative Profile
	OE	upper End
20	PB	Profile Section
	PR	Guide Roller
	PV	Positioning Device
	QB	transverse Bore
	QH	parallelepiped Bracket
25	RA	Tube Section
	RB	frame-like Structure
	RE	Detent Device
	RF	Return Spring
	RM	spatial Axis
30	RL	Detent Hole
	RN	Lug
	RS	Detent Disc

	SA	Cable Section
	SE	Clamp
	SG	Rod with Handle Button
	SK	Snap Ring
5	SL	Suction Hose
	SM	Safety Nut
	SN	Quick-Release Clamp
	SP	Latch
	SR	Hinge
10	SS	Safety Screw
	ST	Safety Pin
	TB	Partial Section
	TF	Removal Device for Solid Bode Samples
	TS	Telescoping Rod
15	US	lower End
	VA	extended Axle
	VB	Connection Section
	VF	vertical Guidance
	VK	Video Camera
20	VS	Brace
	VV	Measuring Device
	WA	Carriage
	wa	selectable Spacing
	ZB	Central Bore
25	ZF	Tension Spring
	ZP	Central Point
	ZS	Central Screw

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CLAIMS:

1. An inspection apparatus for underwater structures with a positioning device provided with a smoothly adjustable vertical guidance with a telescoping rod and a smoothly adjustable horizontal guidance with a guide track setting a path and a carriage moving thereon on guide roller for receiving the vertical guidance, and with an underwater video camera as at least one inspection device mounted on the telescoping rod, the telescoping rod being extendable, without forming bulges, by several tube sections, the guide track having a changeably set curved course and the guide rolls having a negative profile for accommodating the profile of the guide track.
2. The inspection apparatus of claim 1,
wherein the telescoping rod is provided with an uninterrupted longitudinal slot to pass through conduit harnesses for supplying and operating the at least one inspection device.
3. The inspection apparatus of claim 1 or 2,
wherein the tube sections for extending the telescoping rod engage each other and are connected by resilient lugs.
4. The inspection apparatus of any one of claims 1 to 3,
wherein the guide track setting the path of the carriage is a taut guide cable extending in a horizontal plane.
5. The inspection apparatus of claim 4,
wherein the guide rolls have a profile matching different diameters of the guide cable in steps, the width and height of the steps increase from the axle of the guide roll toward the periphery thereof and the smaller steps not used with a selected diameter of the guide cable may be covered up.

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6. The inspection apparatus of any one of claims 1 to 5,

wherein on either side of the guide rolls is provided with guide plates forming a downwardly extending and outwardly flaring guide section.

7. The inspection apparatus of any one of claims 1 to 3,

5 wherein the guide track setting the path is a guide tube structured in a horizontal plane.

8. The inspection device of claim 7,

10 wherein the carriage is provided with a cover plate with at least two pairs of cylindrical guide rollers vertically arranged thereon to the left and right of the guide tube and at least one pair of cylindrical guide rollers disposed horizontally above the guide tube and having a concave profile at least partially matching the diameter of the guide tube.

9. The inspection apparatus of claim 8,

15 wherein the cylindrical guide rollers for matching the carriage with different diameters of the guide tube may be moved and arrested in elongated holes in the cover plate by quick-release clamps.

10. The inspection apparatus of claim 8 or 9,

20 wherein their axles below the cover plate the cylindrical guide rollers are provided with a toggle joint for matching the carriage with guide tubes of different diameters.

11. The inspection apparatus of any one of claims 4 to 6,

25 wherein the carriage is connected with the telescoping rod by a guide device, the guide device being provided with a guide flange embracing the telescoping rod and arranged on a rotary bearing and a spacer and with a snap ring which may be arrested on the telescoping rod at any height thereof above the guide flange.

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12. The inspection apparatus of any one of claims 7 to 10,

wherein the carriage is connected with the telescoping rod by a guide device, the guide device being provided with a guide aperture disposed in the Cover plate and embracing the telescoping rod and closeable by a latch and
5 with a snap ring which may be arrested on the telescoping rod at any height thereof above the guide aperture.

13. The inspection apparatus of any one of claims 1 to 12,

wherein the weight of the telescoping rod and of the at least one inspection device mounted thereon laterally affecting the carriage is compensated
10 by a float arranged on an extendable cantilever at the side of the carriage opposite the guide track.

14. The inspection apparatus of any one of claims 1 to 13,

wherein underwater video camera present as the at least one inspection device is pivotable at least about the horizontal spatial axis forming a
15 right angle with the optical axis of the camera.

15. The inspection apparatus of any one of claims 1 to 14,

wherein a suction device for water samples provided with a suction hose is mounted on the telescoping rod as a further inspection device.

16. The inspection apparatus of any one of claims 1 to 15,

20 wherein a removal device for solid body samples is mounted on the telescoping rod as a further inspection device.

17. The inspection apparatus of claim 16,

wherein the removal device for solid body samples is structured as a receptacle basket with a basket bracket.

25 18. The inspection apparatus of claim 17,

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wherein the basket bracket is provided with edges structured like blades.

19. The inspection apparatus of any one of claims 17 or 18,

5 wherein a separation device for solid body samples is mounted on the telescoping rod above the receptacle basket.

20. The inspection apparatus of claim 16,

wherein the removal device for solid body samples is structured as a mechanical gripper.

21. The inspection apparatus of any one of claims 1 to 20,

10 wherein a measuring device comprising two lasers disposed at a selectable spacing from each other and aligned precisely parallel is mounted on the telescoping rod as a further inspection device.

22. The inspection apparatus of any one of claims 1 to 21,

15 wherein the inspection devices are provided with Bowden wires and return springs which may be arrested in indent positions by control devices.

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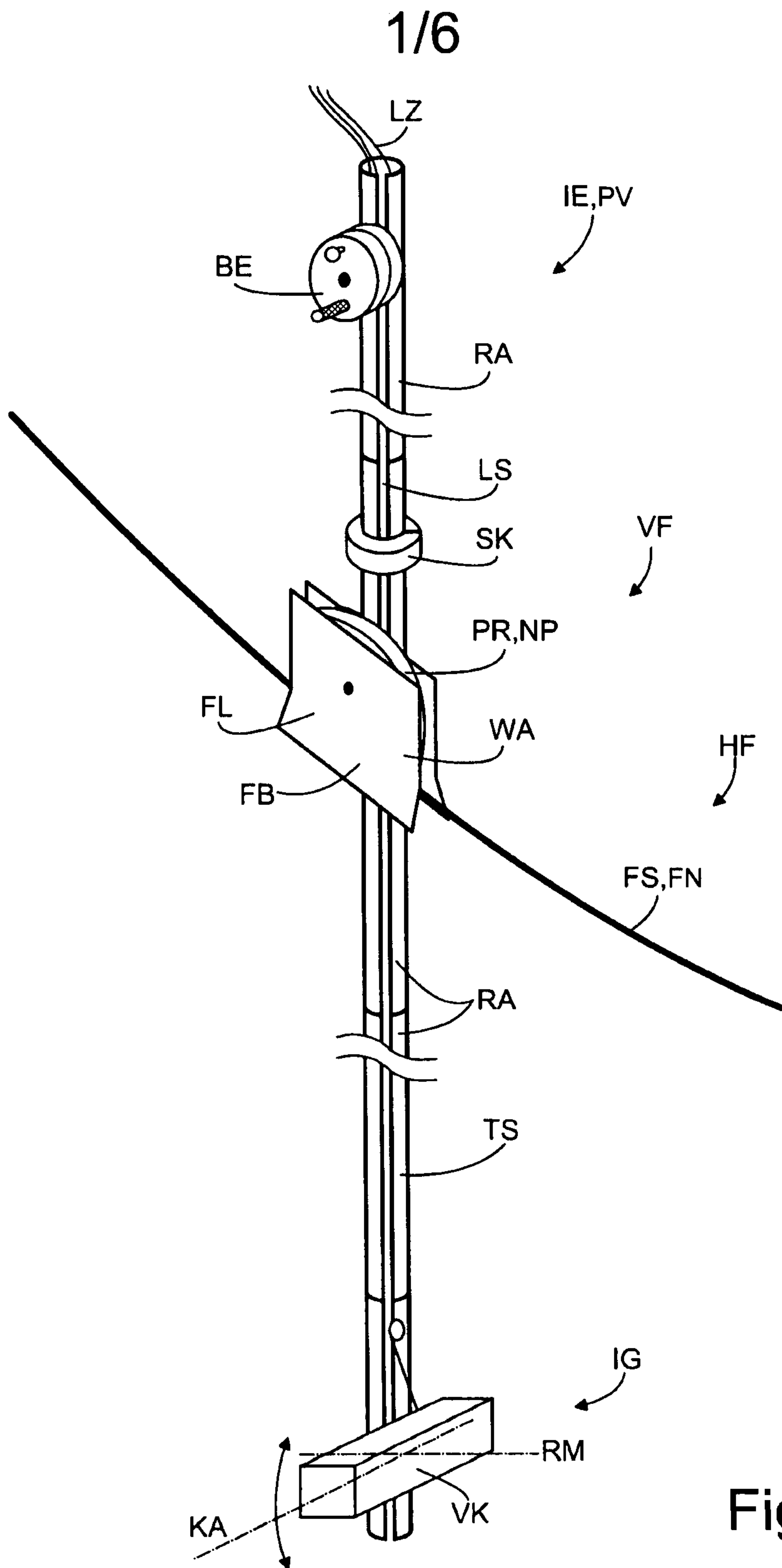


Fig.1

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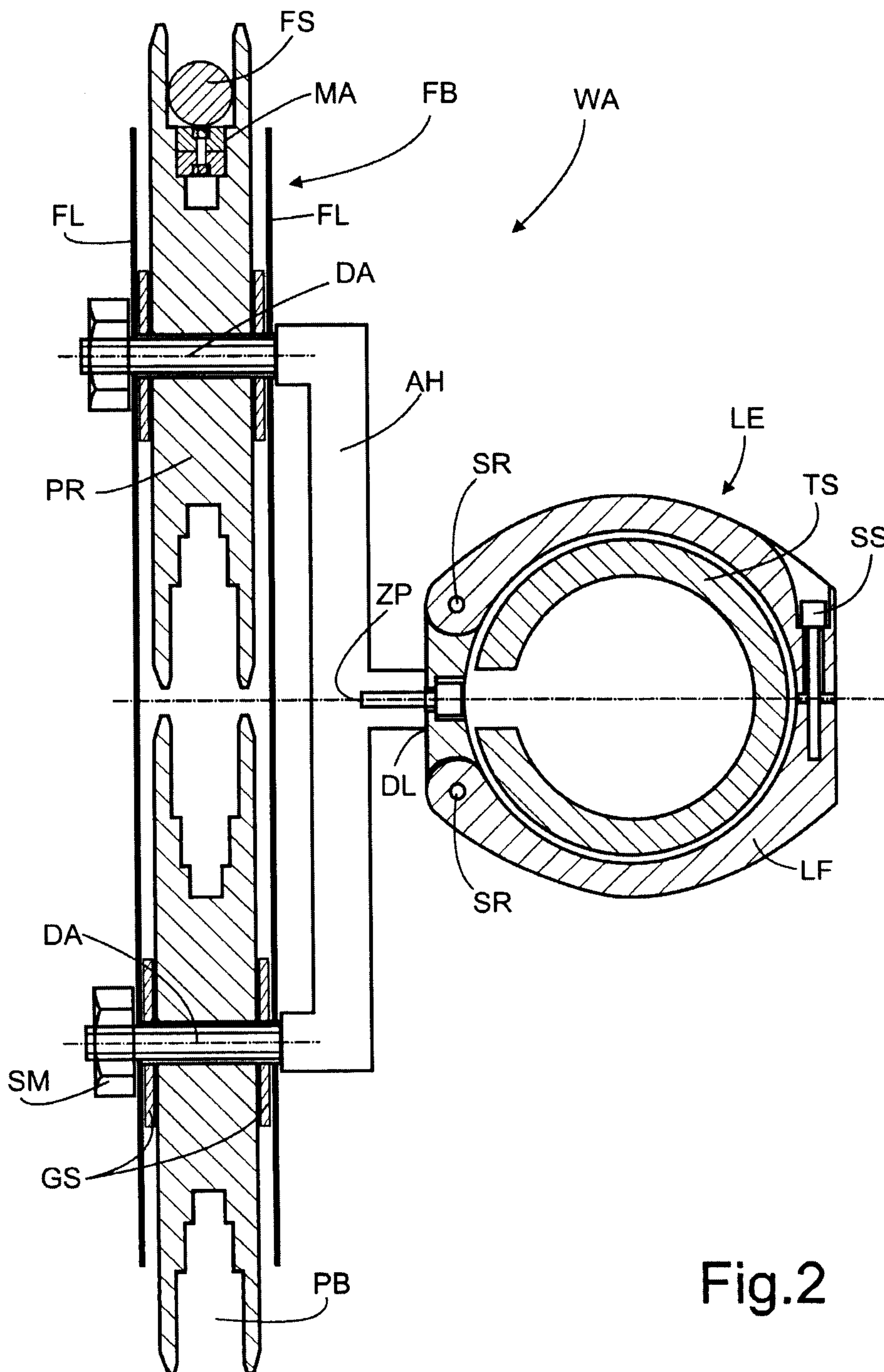


Fig.2

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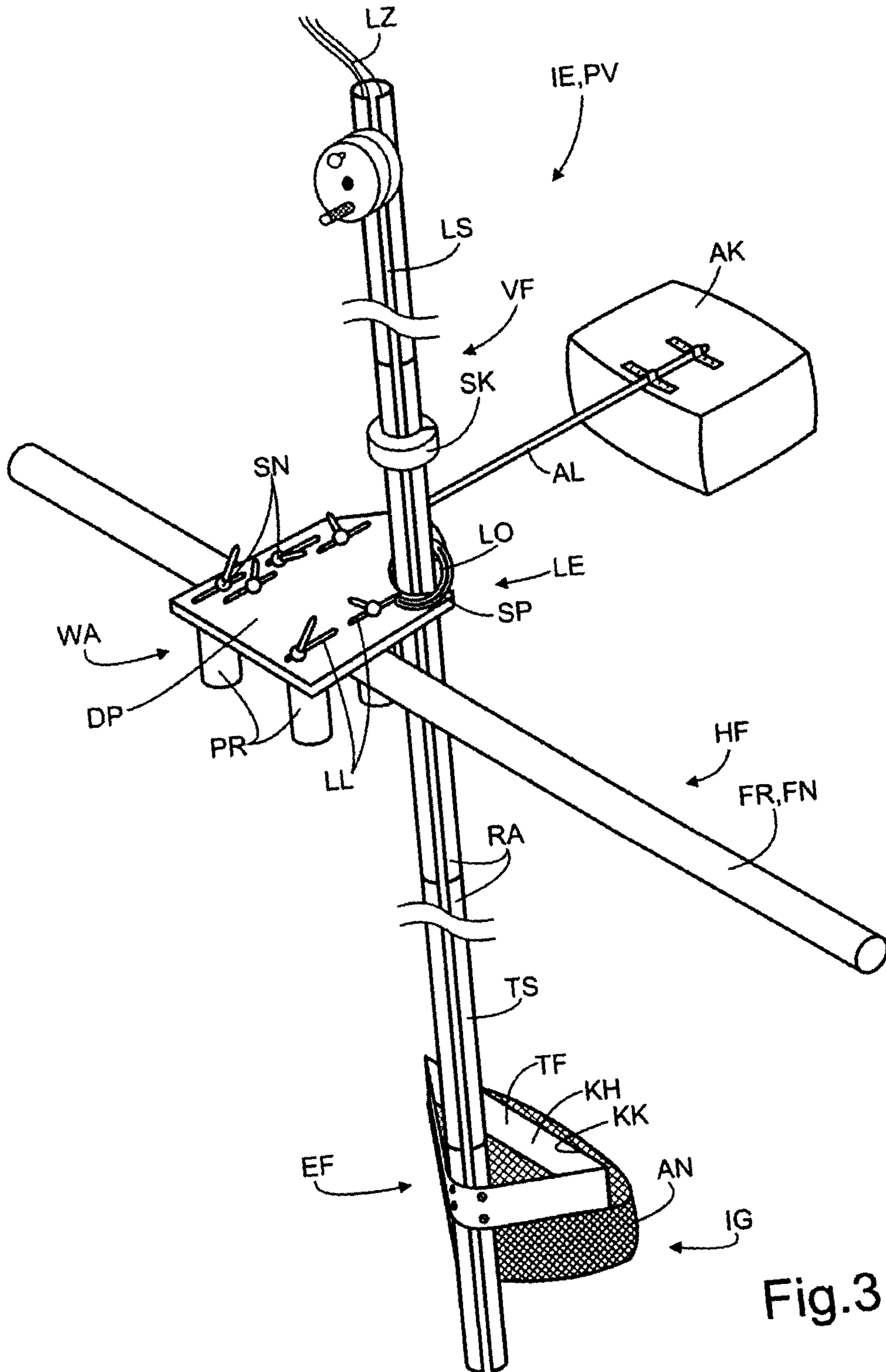


Fig.3

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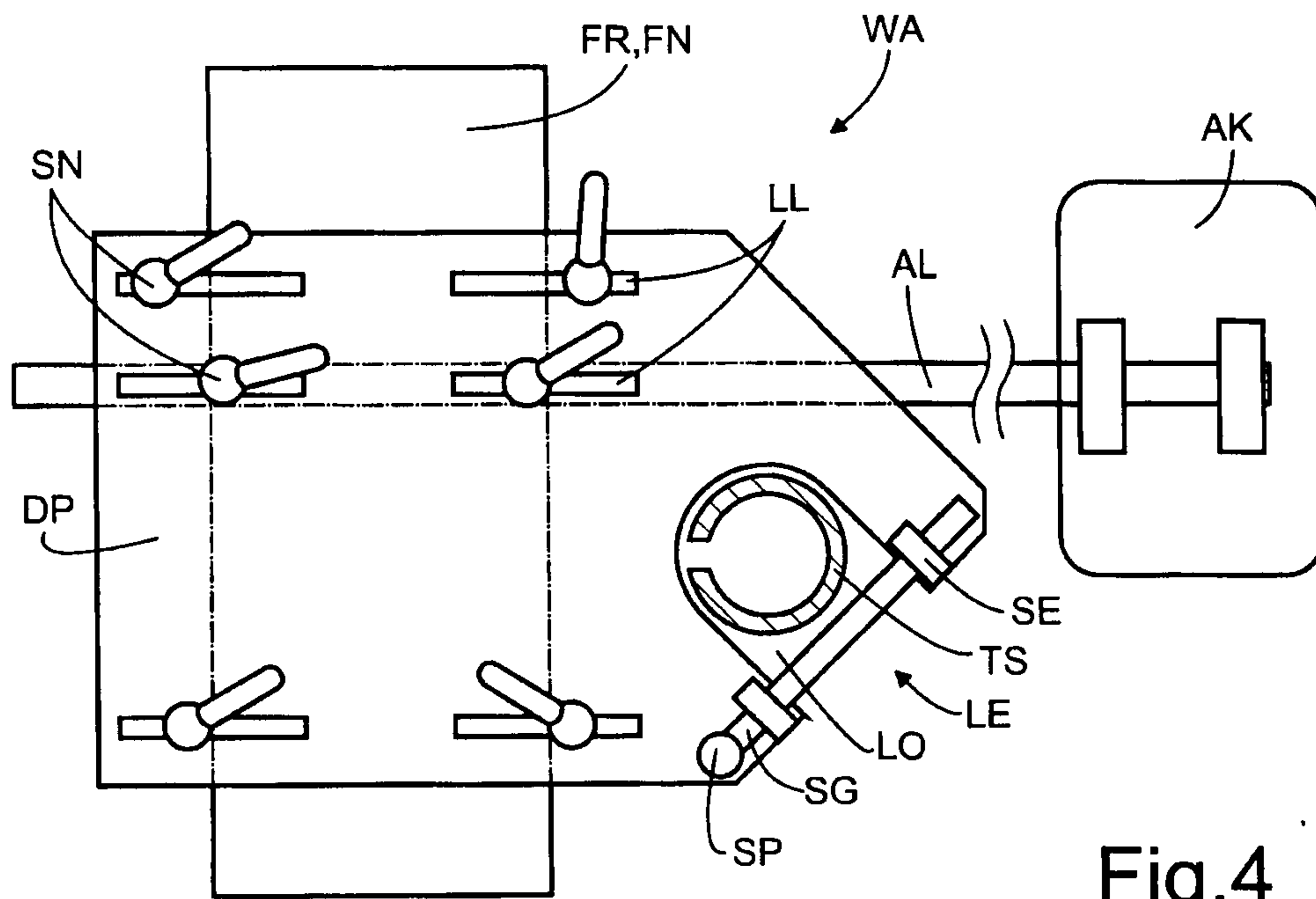


Fig.4

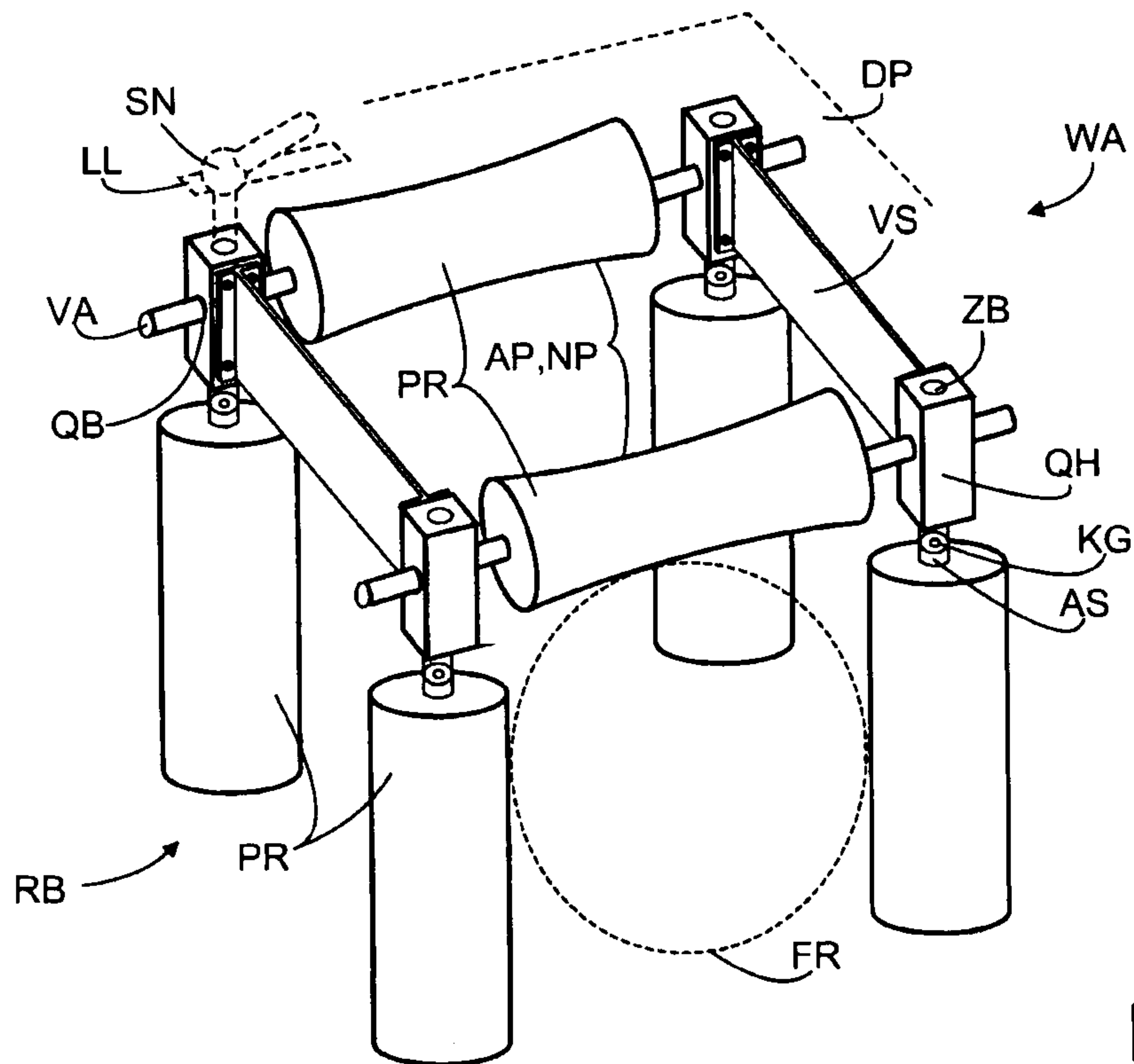


Fig.5

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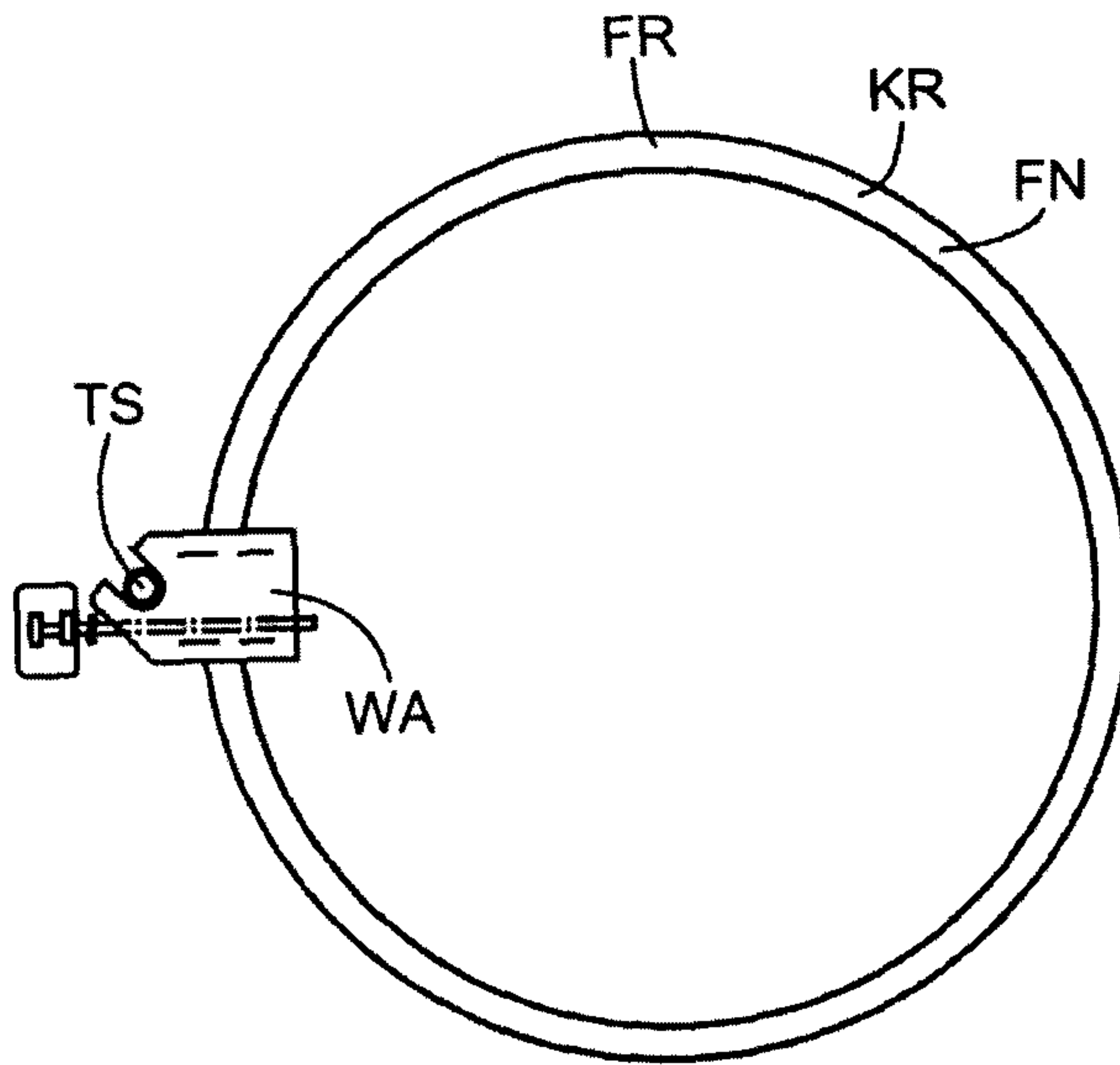


Fig.7

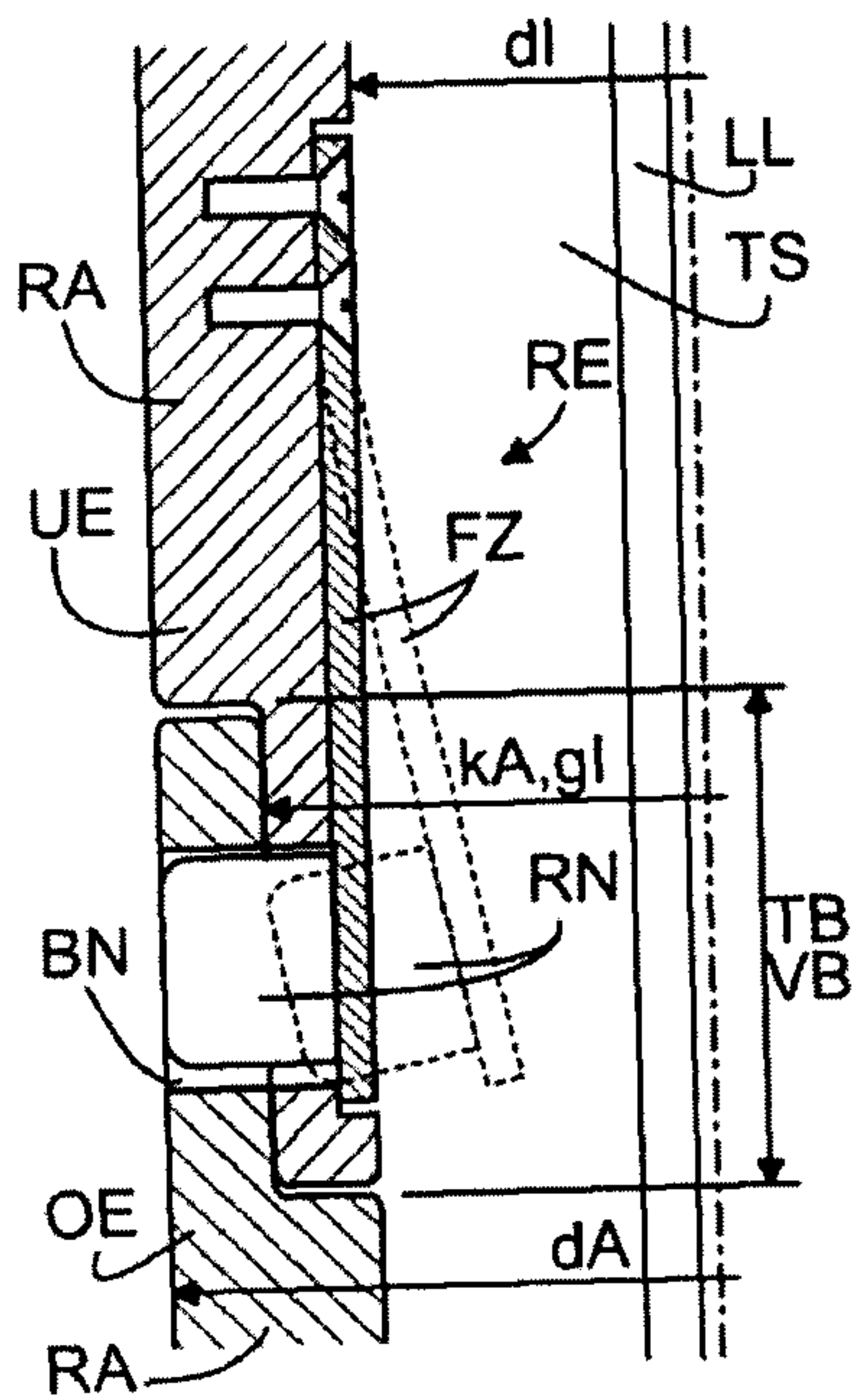


Fig.6

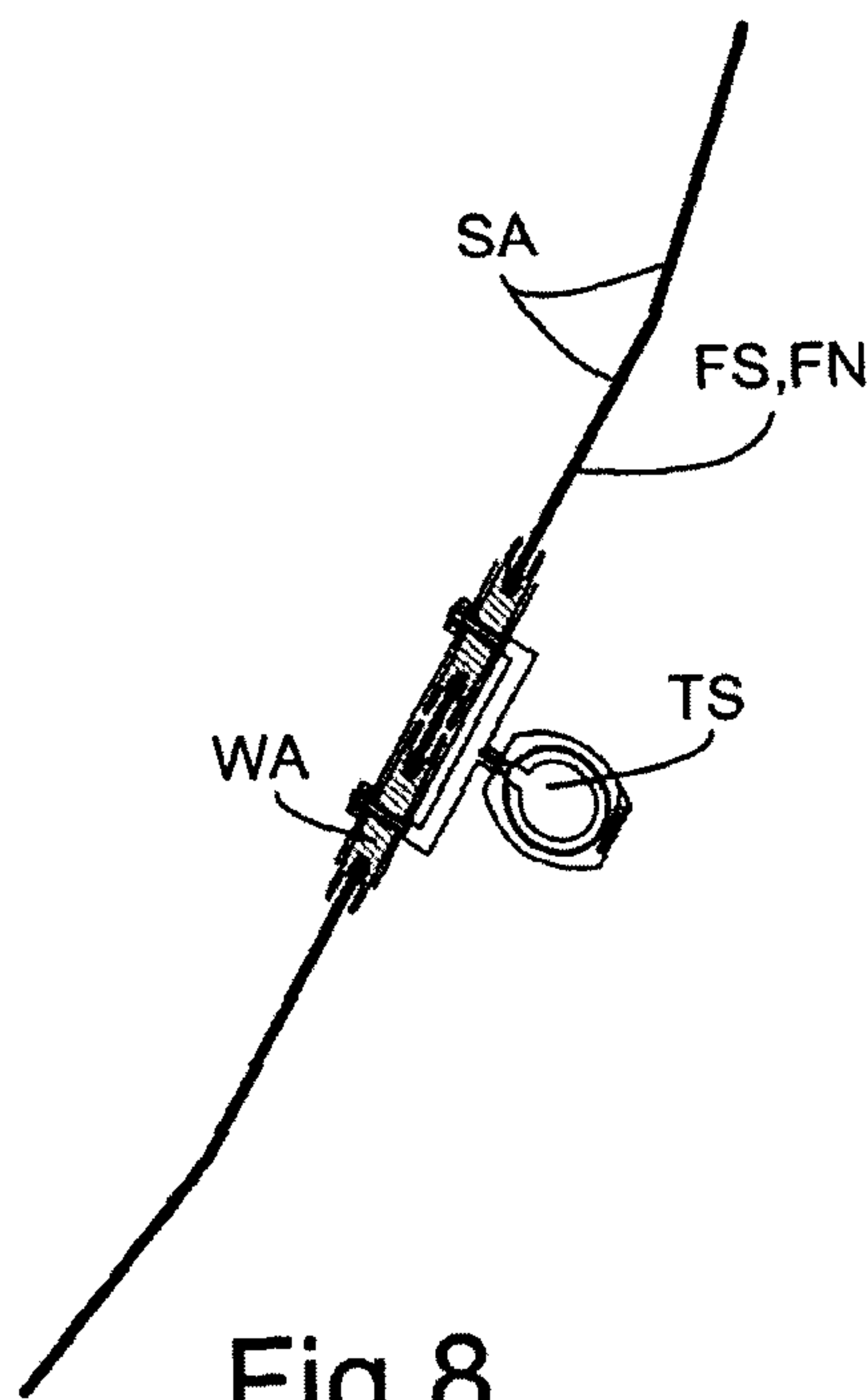


Fig.8

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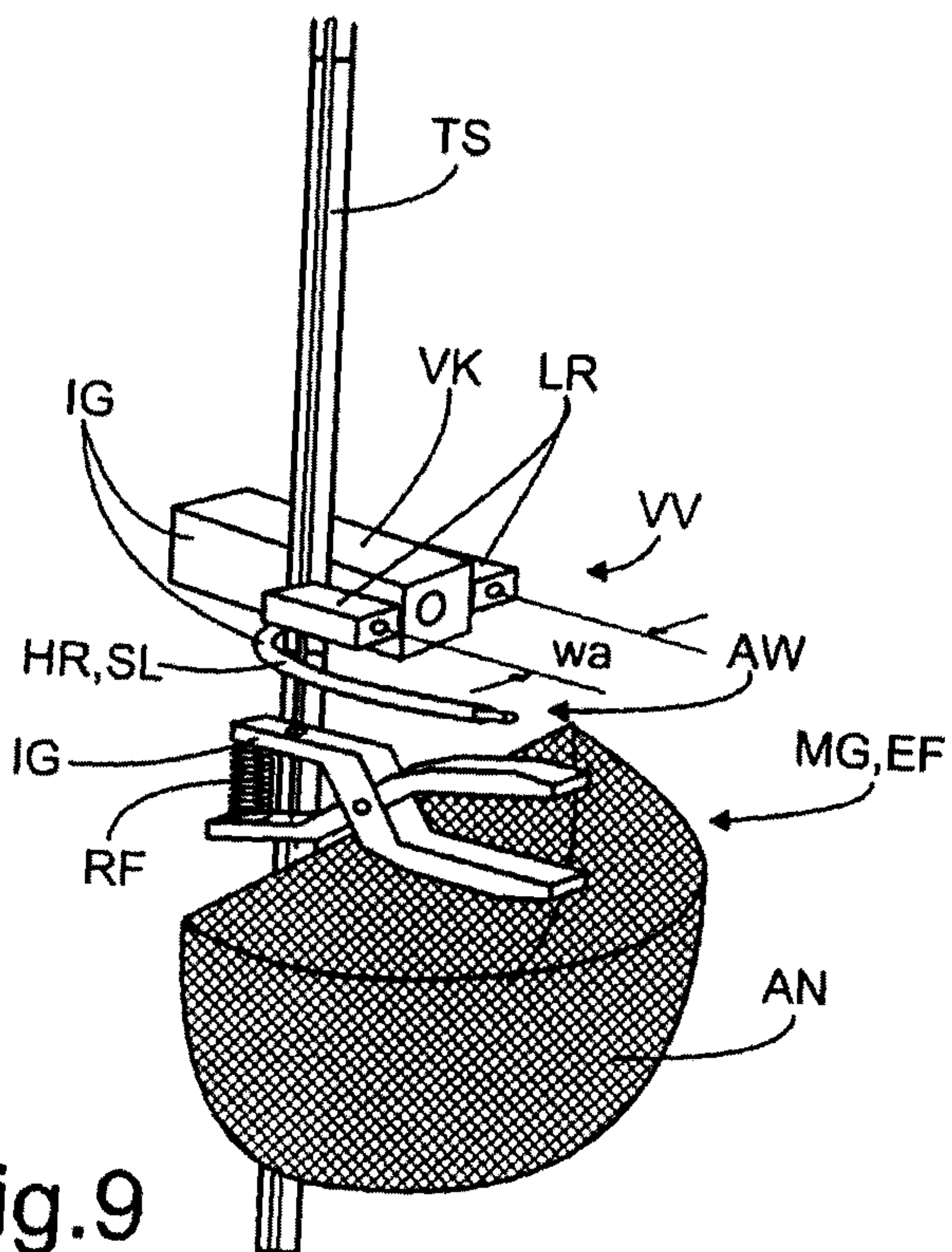


Fig.9

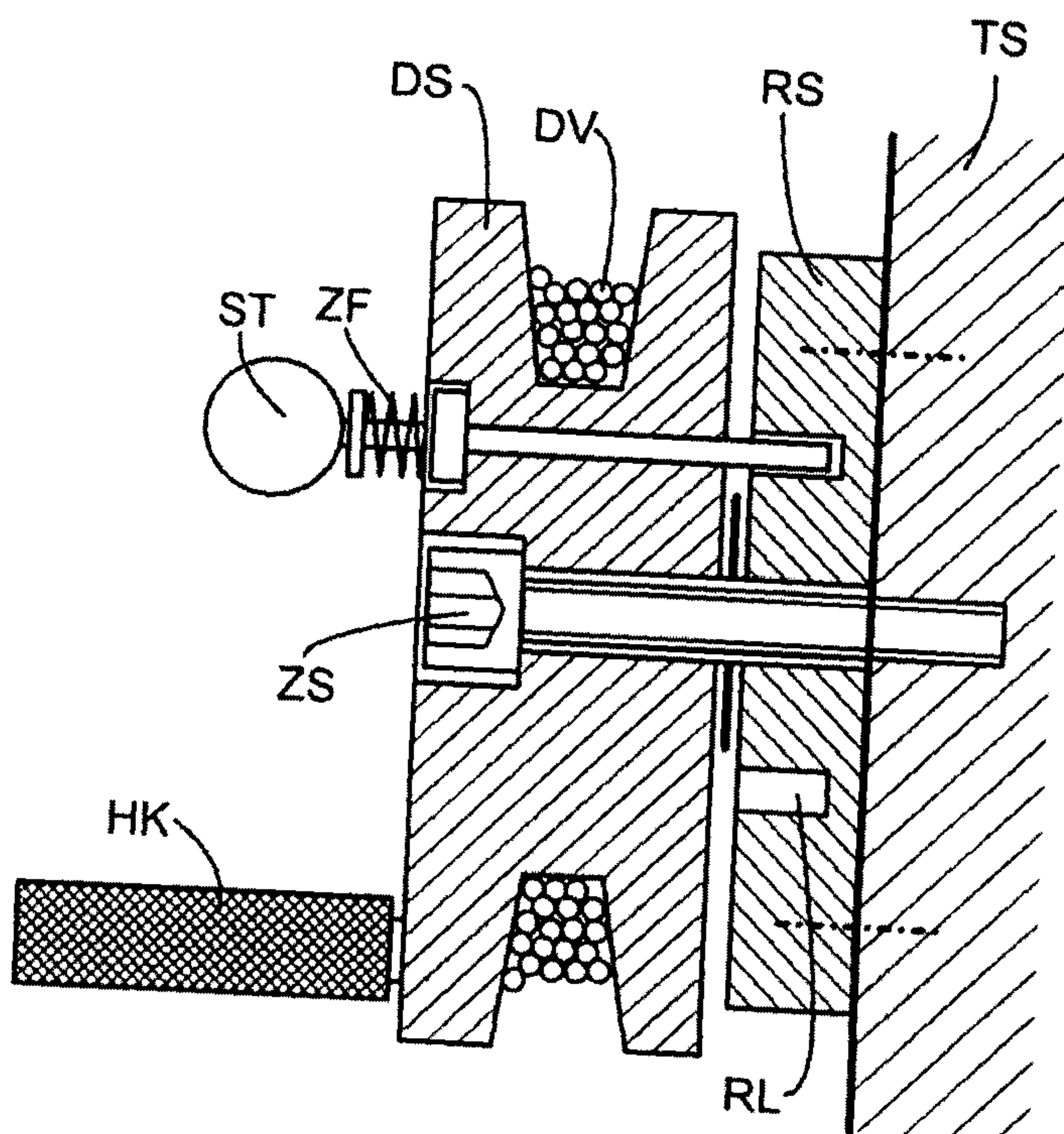


Fig.10

