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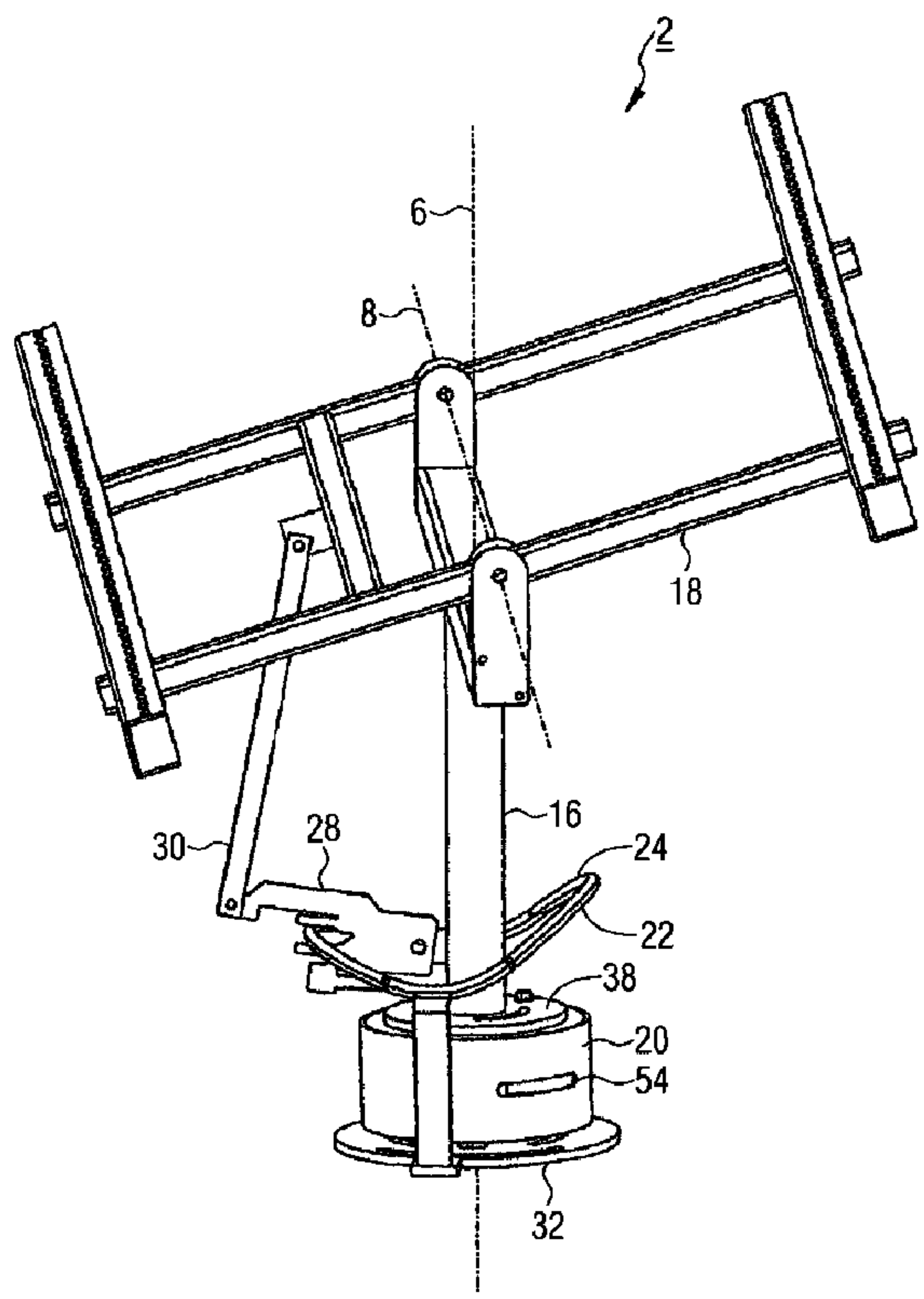
(54) Titre : DISPOSITIF D'ASSERVISSEMENT POUR UNE INSTALLATION PHOTOVOLTAIQUE ET PROCEDE DE MONTAGE D'UN TEL DISPOSITIF D'ASSERVISSEMENT
(54) Title: TRACKING DEVICE FOR A PHOTOVOLTAIC SYSTEM, AND METHOD FOR INSTALLING SUCH A TRACKING DEVICE

FIG. 2



(57) Abrégé/Abstract:
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(57) Abrégé(suite)/Abstract(continued):
mechanism is used for rotationally moving an elevation element (22) about a vertical axis (6) relative to an anchoring element (14). The second adjusting mechanism is used for also rotationally moving two sections (36A, 36B) of a mast (16) about a vertical axis (6).

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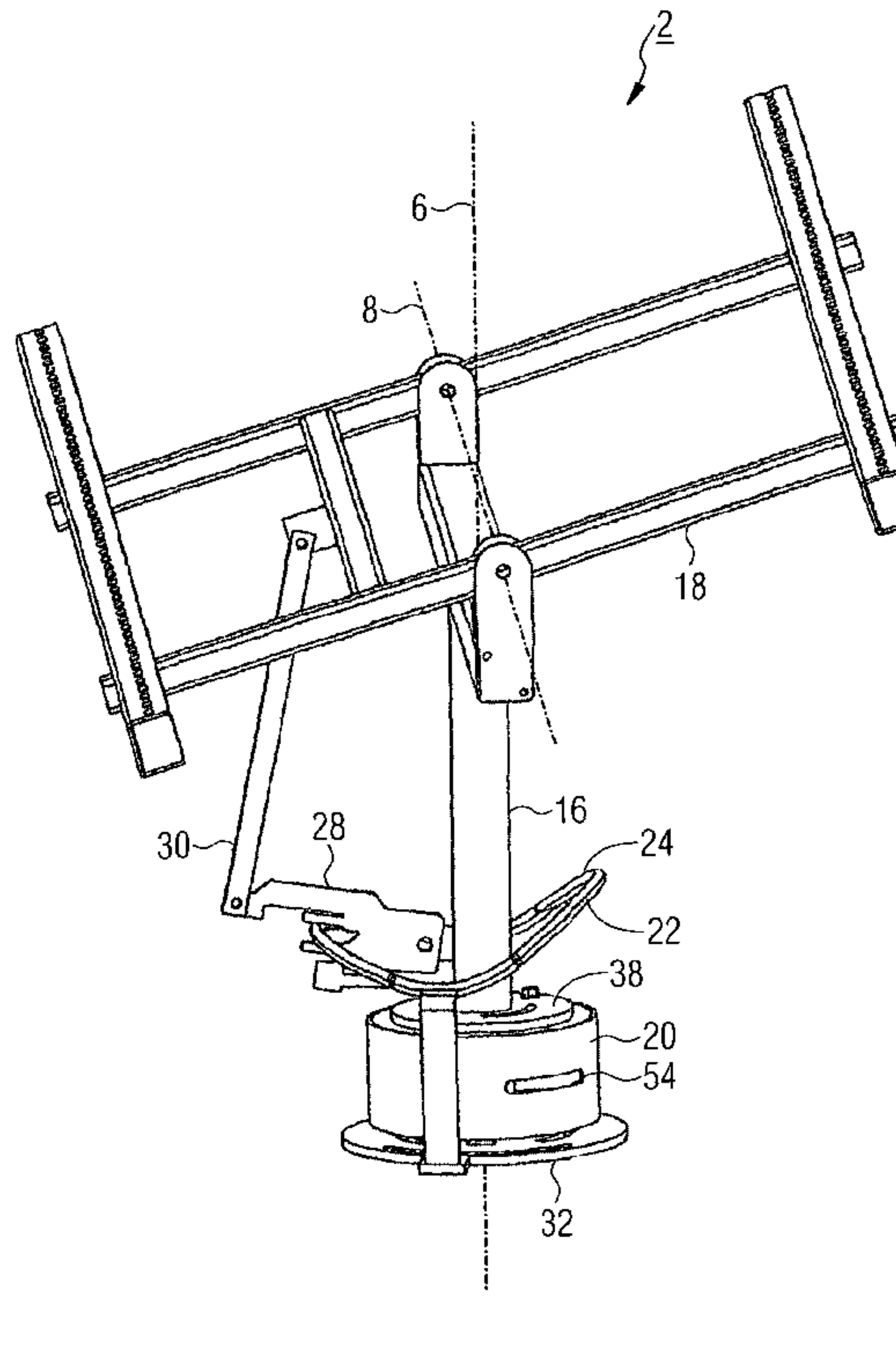
[Fortsetzung auf der nächsten Seite]

(54) Title: TRACKING DEVICE FOR A PHOTOVOLTAIC SYSTEM, AND METHOD FOR INSTALLING SUCH A TRACKING DEVICE

(54) Bezeichnung : NACHFÜHREINRICHTUNG FÜR EINE PHOTOVOLTAIKANLAGE SOWIE VERFAHREN ZUR EINRICHTUNG EINER SOLCHEN NACHFÜHREINRICHTUNG

FIG. 2



(57) Abstract: In order to make it easy to install a tracking device for a photovoltaic system, in which a horizontal tracking device is positively coupled to a vertical tracking device by mechanical means, preferably two adjusting mechanisms are provided. One adjusting mechanism is used for rotationally moving an elevation element (22) about a vertical axis (6) relative to an anchoring element (14). The second adjusting mechanism is used for also rotationally moving two sections (36A, 36B) of a mast (16) about a vertical axis (6).

(57) Zusammenfassung: Um eine einfache Einrichtung einer Nachführeinrichtung für eine Photovoltaikanlage zu ermöglichen, bei der eine horizontale Nachführeinrichtung mit einer vertikalen Nachführeinrichtung mechanisch zwangsgekoppelt ist, sind vorzugsweise zwei Justiereinrichtungen vorgesehen. Die eine Justiereinrichtung dient hierbei zu einer Drehverstellung eines Elevationselements (22) um eine vertikale Achse (6) bezüglich eines Verankerungselements (14). Die zweite Justiereinrichtung dient zur Drehverstellung zweier Teilbereiche (36A, 36B) eines Tragmastes (16) ebenfalls um eine vertikale Achse (6) zueinander.

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Description

Tracking device for a photovoltaic system, and method for installing such a tracking device

The invention relates to a tracking device for a photovoltaic system having the features of the preamble of claim 1, and to a method for installing such a tracking device.

A tracking device of this kind can be gathered from EP 1 710 651 B1.

In photovoltaic systems, the achievable energy yield depends on the incidence angle of the Sun in relation to the photovoltaic module, and so, in order to increase the energy yield, it is expedient to use devices which make the photovoltaic modules of the system track the position of the Sun, which changes depending on the time of year or day. In this case, mention should first of all be made of vertical tracking, in which the photovoltaic module is made to track the Sun's path by rotation of the supporting structure that carries the module about an axis which is substantially vertical with respect to the surface of the Earth. In addition, in the case of biaxial tracking, horizontal tracking is possible in that the photovoltaic module is pivoted or inclined in a horizontal axis, so that ideally a right angle with respect to the Sun is ensured.

However, with such tracking devices, a separate drive is required both for tracking about the vertical axis and for tracking about the horizontal axis, in order to produce the necessary actuating movements. As a result, in electrical driving modes, a plurality of transmissions, motors and control units are required, with a possibly costly control device also being required in each case. Associated with this are considerable costs for photovoltaic systems which have such biaxial tracking. As a result, photovoltaic systems for tracking have hitherto been able to achieve only small market shares, since the additional energy yield of about 35% is largely canceled out by the additional costs to be incurred.

In order to solve this problem, according to EP 1 710 651 B1 a forced mechanical coupling is provided between the vertical and the horizontal tracking. In this case, there is provided an elevation element which is denoted as curved ring or curved disk and defines a curved track having different height levels. Via a coupling device, which is in the form of an articulated arm linkage, the different height levels are transmitted to the photovoltaic module during vertical tracking, i.e. a rotational movement about the vertical axis, in such a way that pivoting about the horizontal axis takes place. In this case, the coupling device comprises a coupling element which travels in operation along the curved or guide track of the elevation element.

The object underlying the invention is to further improve such a tracking device as can be gathered from EP 1 710 651 B1.

The object is achieved according to the invention by a tracking device having the features of claim 1 and by a method for installing such a tracking device having the features of claim 16. The tracking device is overall in the form of a biaxial tracking device for both vertical and horizontal tracking. Horizontal tracking takes place in this case via forced mechanical coupling to the vertical tracking, without an additional drive or an additional actuation means for the horizontal tracking being necessary and in particular also provided.

The tracking device comprises, for in each case one photovoltaic module, a supporting framework, which has a vertical tracking device and a horizontal tracking device which is forcibly mechanically coupled to the latter. In this case, the vertical tracking device comprises a supporting structure, which is preferably in the form of a supporting mast and is mounted in a rotatable manner about a substantially vertical axis. In operation, vertical tracking is executed with the aid of an in particular electromotive drive, the actuating movement of which is transmitted to the supporting structure. The horizontal tracking device comprises in particular an elevation element, which defines a mechanical guide track having different height levels. In operation, the height levels defined by the guide track are transmitted to the photovoltaic module with the aid of a mechanical coupling device, in the event of a rotational movement of the supporting structure about the vertical axis, in order to create a pivoting movement about the horizontal axis. In this case, the coupling device comprises a coupling element, which is configured preferably as a fork element and in operation travels along the mechanical guide track. The mechanical coupling device is preferably connected in a rotationally fixed manner to the supporting structure, so that in the event of a rotational movement about the vertical axis, the mechanical coupling device travels along the guide track. The elevation element is preferably connected in a rotationally fixed manner to an anchoring element, via which the supporting framework is fastened at the bottom to the provided installation surface for the photovoltaic system. The anchoring element is for example a ground anchor, with a separate ground anchor being assigned to each supporting framework. Alternatively, the anchoring element can also be a supporting profile structure, which is provided for example in the case of (flat) roof installations.

A mechanical guide track having different height levels is generally understood to mean that, by way of the guide track, different vertical distances from the photovoltaic module are predefined, said vertical distances then leading to a different inclination of the photovoltaic module about the horizontal axis. In a preferred embodiment, the guide track is formed such that in plan view it extends in a circle around the supporting mast and has elevations and depressions in order to define the different height levels. In an angled state of the guide track the latter thus extends in an undulating, for example sinusoidal, form. In particular, the guide track is formed by the abovementioned curved ring. A curved ring is in this case understood to mean a rod which is formed into a ring and extends along a predefined curve.

On account of the special configuration of the elevation element, depending on the rotational or azimuth angle, a different height level of the guide track is therefore generally transmitted to the photovoltaic module and thus, depending on the azimuth angle, a defined horizontal inclination angle of the photovoltaic module is forcibly set.

It is particularly advantageous in the case of the tracking device that the supporting framework has at least one adjusting device, via which the rotational orientation of the elevation element with regard to the anchoring element and/or the rotational orientation of different part regions of the supporting mast with respect to one another can be adjusted. These adjusting devices serve to simplify assembly or else for easy readjustment during operation. The configuration of these adjusting devices is based on the finding that, on account of the forced mechanical coupling between the vertical and horizontal tracking devices, precise alignment of the supporting framework in a setpoint orientation is necessary. In particular in the case of a photovoltaic system having a multiplicity of supporting frameworks which are connected together and the vertical tracking of which takes place via a common drive motor, as is provided for example in the case of the tracking device according to EP 1 710 651 B1, there is the problem that, on account of tolerances and play in the drive train, the individual photovoltaic modules assume different azimuth angles, i.e. different rotational angles about the vertical axis.

The division of the supporting structure into two part regions, which can be rotationally adjusted with respect to one another, leads to the advantage that, after the system has been put into operation, when, on account of such play and tolerance effects, the vertical orientation between different supporting frameworks is not entirely synchronous, the vertical rotational position of individual supporting frameworks can be set easily without the supporting framework as a whole having to be rotated with regard to the anchoring element.

The same applies to the adjusting device for rotationally positioning the elevation element. The guide track which is defined by the latter and has the different height levels has to be aligned precisely with regard to the points of the compass so that the highest point of the guide track points precisely toward the south. In the case of the tracking device known from EP 1 710 651 B1, the elevation element is connected in each case firmly to the anchoring element, for example by welding, etc., thus resulting in highly precise orientation of the anchoring element. This is sometimes difficult, in particular in the case of a photovoltaic system having a multiplicity of individual supporting frameworks. On account of the adjusting device, it is thus easily possible subsequently to precisely position the elevation element in the setpoint position.

The adjusting device for rotationally adjusting the elevation element is preferably independent of the adjusting device for rotationally adjusting the two part regions of the supporting structure with respect to one another. Preferably, they are used in combination, resulting in a double adjusting option.

According to a preferred embodiment, the elevation element is to this end connected to a fastening foot, in particular in a rotationally fixed manner, for example by welding, etc., wherein the fastening foot can be fastened reversibly in different rotational positions with regard to the anchoring element. With regard to a simple configuration of the adjusting option, the fastening foot and/or the anchoring element has at least one slot guide, which is curved in particular along a circular path, for a fastening element such as a screw, for example. Furthermore, the fastening foot expediently has a fastening plate, which is for example circular, for resting in a planar manner on the anchoring element. This serves for easy assembly and high mechanical stability.

With regard to the second adjusting device for the rotational adjustment of the part regions of the supporting structure with respect to one another, it is provided that the part regions can be fixed reversibly together at their dividing point in different rotational positions with respect to one another. In particular, the two part regions of the supporting mast are connected together via flanges at the dividing point. Here, too, at least one of the flanges has a slot guide, which is preferably curved along a circular path, for a fastening element such as a screw. The flanges ensure easy assemblability and high mechanical stability. It is usually provided that the drive for vertical tracking acts on one of the two part regions, in particular the lower part region.

According to an expedient development, it is provided that a spring element is arranged between the coupling element, which is for example in the form of a fork element, and the supporting mast.

On account of the spring element, which may preferably be in the form of a compression spring, the pressing force between the fork element and the elevation element, which is formed for example as a curved ring, is reduced. The spring element thus counteracts the considerable inertial forces of the photovoltaic modules, which, in the absence of a spring element, would otherwise produce high frictional forces. In particular, the energy requirement for biaxial tracking can be considerably reduced further by the spring element provided according to the invention, and so a larger number of tracking devices can be driven with a single drive.

The spring element is preferably arranged such that it exerts a torque on the coupling element, said torque counteracting the torque produced by the photovoltaic module. In this way, the torque, which can be considerable under certain circumstances and is produced by the photovoltaic module, is at least partially compensated by means of the spring element, and so the forces acting on the curved ring can likewise be reduced. The low friction between the curved ring and the fork element leads to a lower requirement for drive energy.

In a preferred development, it is provided that the coupling element has at least one rotatably mounted sleeve, by way of which the coupling element is supported on the guide track of the elevation element. During the tracking of the photovoltaic module, the rotatably mounted sleeves roll on the curved ring, and so the tracking demands only a small energy requirement.

Expediently, the coupling element is in this case configured as a fork element having two fingers which grip the elevation element in the form of a curved ring between one another. The curved ring is thus guided between the rotatably mounted sleeves.

In a preferred development, a protective collar is attached to the supporting mast in the region of the spring element. On account of the to some extent considerable forces and the variation therein, there is the risk that the supporting mast will be damaged by the supporting of the spring element, so that for example a protective coating is worn away. This is prevented by way of the protective collar, which consists for example of a suitable abrasion-resistant plastic or else of a suitable metal.

The entire supporting framework consists preferably of metal, which has to be weather-resistant on account of the necessary outdoor installation. Usually, galvanized metal structures are used. The rotational movement of the individual parts with respect to one another may result in undesired wear phenomena but also running difficulties. The latter are in particular also caused by the surface roughnesses produced during the galvanizing process. In order to reduce these problems, in a preferred embodiment it is provided that a sliding element, in particular a sliding sleeve, is arranged between the supporting mast and the fastening foot, on which the supporting mast is rotatably arranged. The sliding element is in this case arranged preferably in a loose manner and consists of a preferably abrasion-resistant plastic or else of a suitable metal. Usually, the fastening foot has a vertically oriented upright or guiding tube, which guides the supporting mast. To this end, the latter is selectively fitted over the upright tube or is plugged into the upright tube. In the configuration as a sliding sleeve, a radial guide between the supporting mast and the guiding tube is at the same time defined via said sliding sleeve. The sliding sleeve can in this case extend along the entire length of the guiding tube. However, it is preferably provided that a plurality of sliding sleeves, in particular two sliding sleeves, are provided, specifically in particular at the two end sides of the guiding tube.

In order to keep the surface pressure force between the supporting mast and the fastening foot low, the supporting mast has a bottom flange, by way of which it is supported on at least a part of the sliding element. If the sliding element is in the form of a sleeve, this sleeve preferably likewise has a flange.

In a preferred development, there is provided a storm protection means, which secures the supporting mast against being detached from the anchoring element and in particular from the fastening foot. To this end, provision is preferably made of a retaining element, which forms a form fit, which acts in the axial direction, between the fastening foot and the supporting mast, but at the same time still enables the rotational movement. In particular, there is provided a retaining lug, which is fastened to the fastening foot and overlaps the bottom flange of the supporting mast in a form-fitting manner, preferably without coming into contact therewith.

In order to transmit the actuating movement of the common motor, which is provided preferably for a plurality of supporting frameworks, there is preferably arranged - as in the tracking device known from EP 1 710 651 B1 - a hollow-cylindrical or tubular driver element which is arranged concentrically with the supporting mast and is connected in a rotationally fixed manner thereto, for example by struts. Provided in order to transmit the actuating movement of the motor is an elastic drive means, what is known as a wraparound means, which wraps around the driver element. Such a drive means is for example a cable, a belt, a strap, a chain or the like. The drive means, preferably a cable, is usually wrapped a number of times around the driver element. In order now to ensure a connection that is as slip-free as possible between the drive means and the driver element, a friction brake is generally formed in particular by structuring the lateral surface of the driver element. To this end, a guide slot, in which the drive means is accommodated in the assembled state, is preferably introduced in the driver element. In operation, the cable is therefore in the tensioned state at the edges of the guide slot, which are opposed in the circumferential direction, as a result of which the friction is increased and slip is prevented.

According to a preferred development, the flange of the lower part region of the supporting mast forms an upper termination for the driver element, i.e. the dividing point is arranged at the upper end of the driver element. In the hollow-cylindrical configuration of the driver element, this flange forms preferably a cover, so that a closed-off structural unit is formed. The bearing region of the supporting mast on the foot plate is better protected as a result.

Preferably, the tracking device comprises a multiplicity of supporting frameworks, to which a common drive is assigned, wherein the actuating movements exercised by the drive are transmitted to the supporting mast via a drive means, such as the cable, for example. In this case, the supporting frameworks are usually oriented in a row alongside one another. For example, 10 to 30 supporting frameworks are assigned to a common drive. A photovoltaic system can consist of a number of such rows.

The object is furthermore achieved by a method having the features of claim 16. According to the latter, it is provided that, in order to install the tracking device, with the aid of the adjusting devices the elevation element and/or the upper part region of the supporting structure are moved into a defined setpoint position. In particular in the latter case, an actuating movement is transmitted at least once beforehand from the drive to the supporting structure in order to take account of tolerance and play degrees of freedom upon initial operation, such as tensioning the cable, etc., for example. Specifically, in the arrangement of a multiplicity of supporting frameworks, upon initial operation the previously assumed rotational position is usually adjusted so that the individual photovoltaic modules are oriented in different vertical rotational positions.

The dependent claims contain to some extent separate inventive concepts which can be implemented also independently of the specific configuration of the adjusting device. This relates firstly to the aspect of the configuration and arrangement of the spring element according to claims 5 to 8, the aspect of the sleeve according to claim 9, the aspect of the arrangement and configuration of the sliding element according to claims 10 and 11, and the aspect of the friction brake in particular having the guide slot according to claim 12. We reserve the right to file partial applications relating to each of these aspects independently of the configuration of the adjusting devices.

An exemplary embodiment of the invention is explained in more detail in the following text on the basis of the figures, in which, in each case in partially simplified illustrations:

figure 1 shows a simplified illustration of a tracking device having a plurality of photovoltaic modules mounted on in each case one supporting framework, according to the prior art,

figure 2 shows a perspective illustration of a supporting framework,

figure 3 shows a sectional illustration of a detail of the supporting framework in the region of a fastening foot,

figure 4 shows a perspective view obliquely from below of the part region illustrated in figure 3,

figure 5 shows a side view of a coupling element configured as a fork element having guiding sleeves pushed onto the fork ends and having a compression spring pushed onto an extending arm,

figure 6 shows a perspective illustration of the fork element according to figure 4 without guiding sleeves and spring element,

figure 7 shows an illustration of a detail of a tracking device having a supporting framework without adjusting devices, having a photovoltaic module fitted on the supporting framework, and

figure 8 shows the tracking device according to figure 7 from a different perspective.

In the figures, identically acting parts are provided with the same reference signs.

Figure 1 shows a photovoltaic system, known from the prior art according to EP 1 710 651 B1, having a biaxial tracking device. The photovoltaic system has a multiplicity of supporting frameworks 2, which each support a photovoltaic module 4. In the exemplary embodiment, two supporting frameworks 2 are illustrated by way of example. Each of the photovoltaic modules 4 is pivotable about a vertical axis 6 and about a horizontal pivot axis 8. Provided for joint adjustment and tracking is a common drive motor 10 which transmits an actuating movement to the respective supporting framework 2 via a drive means, which in the exemplary embodiment is in the form of a cable 12, in order to exercise a synchronous rotation of the individual supporting frameworks 2 about their respective axis 6 for vertical tracking. In the event of such vertical tracking, horizontal tracking about the pivot axis 8 is forcibly exercised at the same time via a forced mechanical coupling.

The supporting framework 2 is generally fastened to the ground via an anchoring element 14. In the exemplary embodiment, a separate anchoring element 14 is assigned to each supporting framework 2. Said anchoring element 14 comprises a ground plate having an anchoring post that is driven into the ground.

A supporting mast 16 is arranged in a rotatable manner on the anchoring element 14. The supporting mast 16 extends in the vertical direction and is oriented concentrically with the vertical rotational axis 6. At its upper end, the supporting mast 16 is connected to a supporting frame 18 (cf. in particular figure 2). The horizontal pivot axis 8 crosses the supporting mast 16 or an extension thereof. In order to transmit the actuating movement of the drive motor 10, a driver element 20, which is formed as a hollow cylinder and is connected to the supporting mast 16 for example via connecting struts, is fastened on the supporting mast 16. The cable 12 is guided around this driver element 20 and wraps around the latter preferably a number of times. In the exemplary embodiment illustrated, the supporting mast 16 together with the driver element 20 form elements of a supporting structure of the supporting framework 2 for vertical tracking, said supporting structure being mounted in a rotatable manner about the vertical axis 6, and thus form at the same time also the essential elements of a vertical tracking device.

For forcibly coupled vertical tracking, a horizontal tracking device is provided. The latter comprises an elevation element, which is in the form of a curved ring 22 in the exemplary embodiment and is an annular element which is formed concentrically around the supporting mast 16 and defines a mechanical guide track 24 having different height levels. The curved ring 22 is connected firmly to the anchoring element 14 via fastening elements 26. Furthermore, the horizontal tracking device comprises a mechanical coupling device, which consists in the exemplary embodiment of an articulated arm linkage. The latter comprises substantially a coupling element 28, which is fastened pivotably thereto by way of its supporting-mast end. At its opposite end, it is connected likewise pivotably to a lever arm 30 which is in turn connected in a rotatable manner to the supporting frame 18 (cf. figure 2). The coupling point of the lever arm 30 on the supporting frame 18 is spaced apart from the horizontal pivot axis 8, and so a vertical actuating movement of the lever arm 30 results in horizontal pivoting.

The coupling element 28 is forcibly guided by the guide track 24 in the event of a rotational movement about the vertical axis 6 and therefore travels along the curved track having the different height levels that is predefined by the elevation element (curved ring 22). In the exemplary embodiment, the coupling element 28 is in the form of a fork element, the two fork ends of which engage around the curved ring 22.

During operation of the photovoltaic system, it is important for the individual photovoltaic modules 4 to be precisely aligned for as great efficiency as possible. It has been shown that upon starting up or during ongoing operation, the problem can occur that, for example on account of play and tolerance effects in the drive train, the individual supporting frameworks 2 and thus photovoltaic modules 4 assume different rotational positions with regard to their rotational position about the vertical axis 6. Furthermore, it has been shown that it is difficult to position the elevation element 22 precisely in the desired setpoint rotational position. The highest point of the elevation element 22 has to be oriented toward the south.

In order to solve these problems, a double adjusting device is provided, as is explained in more detail in the following text in conjunction with figures 2 to 4. The first adjusting device serves to adjust the elevation element 22 in the desired setpoint rotational position with regard to the vertical axis 6. This first adjusting device comprises substantially a fastening foot 32, which in the exemplary embodiment is in the form of a circular fastening plate and by way of which the entire supporting framework 2 is fastened to the anchoring element 14. The fastening foot 32 is in this case connected to the anchoring element 14 by means of releasable fastening, in particular screw fastening, such that, after the fastening has been released, the rotational position of the fastening foot 32 is variable. To this end, in the exemplary embodiment, the fastening foot 32 has two slot guides which extend in the form of a circular arc and through which the fastening screws can be plugged. On account of this configuration, it is therefore possible, after installation of the supporting frameworks 2 on the anchoring elements 14, still to change and precisely set the rotational position in particular of the elevation element 22 with respect to the respective anchoring element 14. Precise alignment of the anchoring elements 14 is therefore not necessary.

The second adjusting device serves to adjust the rotational position of the respective photovoltaic module 4 about the vertical axis 6 in the event of not precise synchronous alignment with the other photovoltaic modules 4. To this end, the supporting mast 16 is subdivided into an upper part region 36A and a lower part region 36B. These two part regions 36A, 36B are fastened together in a reversible and releasable manner at a dividing point, specifically such that their relative rotational position with respect to one another can be set. In this case, the dividing point is arranged generally below a coupling point at which the coupling device is fastened to the supporting mast. Furthermore, the dividing point is arranged above a coupling point at which the drive force exerted by the drive train is transmitted to the supporting mast 16.

To this end, in each case a fastening flange 38 is formed at the ends of the two part regions 36A, 36B. At least one of the fastening flanges 38 is formed with slot guides 34 in a similar manner to the fastening foot 32. The rotational position of the upper region of the supporting framework 2 can therefore be readjusted easily without this having an effect on the lower part region 36A, to which the drive force of the drive 10 is transmitted. Thus, via the dividing point, an uncoupling option is generally defined between the drive train and the upper part region.

In the exemplary embodiment, the flange 38 of the lower part region 36B forms at the same time an upper cover for the hollow-cylindrical driver element 20. Overall, as a result, a largely closed-off internal cavity is created, in which in particular the bearing point of the supporting mast 16 is accommodated in a protected manner. The fastening flange 38 is in particular somewhat spaced apart from the driver element 20, and so as little friction as possible occurs during vertical tracking. In contrast to the exemplary embodiment illustrated, the fastening flange 38 is arranged preferably above the driver element 20 and covering its edge sides.

As can be gathered in particular from the illustration according to figure 3, the supporting mast 16 is mounted in a rotatable manner on the fastening foot 32. To this end, the fastening foot 32 comprises a central supporting tube 40, over which the tubular supporting mast 16 is fitted. In order to avoid running difficulties, in the exemplary embodiment sliding elements of the bearing sleeve 42 type are provided. These are arranged in each case in the lower and upper region of the supporting tube 40. Preferably, the two bearing sleeves 42 have a kind of annular flange. The supporting mast 16 is supported by way of its lower end, at which it likewise forms an annular flange, on this annular flange of the bearing sleeve 42, and so relatively planar contact is formed. The bearing sleeves 42 consist for example of an abrasion-resistant plastic or of a suitable metal.

Furthermore, a storm protection means 43 is provided for the supporting mast 16 such that the supporting mast is secured in particular against lifting axially off the fastening foot 32 while at the same time being rotatable. To this end, in the exemplary embodiment, a form fit which acts in the axial direction is formed between the fastening foot 32 and the supporting mast 16, in particular its bottom flange. The storm protection means 43 is in this case formed in a simple manner by a curved lug, one end of which is fastened to the fastening foot 32 and the other end of which protrudes over the flange, in particular with a small axial spacing.

Figures 5 and 6 illustrate the configuration of the coupling element 28 as a fork element in more detail. The coupling element 28 comprises two fork ends 44. In a preferred configuration, a rotatably mounted sleeve 46 is plugged onto each of the fork ends 44, for example a plastic sleeve or a metal sleeve. In the installed state, these sleeves 46 roll on the guide track 24. In the configuration as a fork element, the curved ring 22 is guided between these sleeves 46. This results in guidance which is as low friction as possible, and so the drive force to be applied by the drive motor 10 can be kept low. In the region of the spring element 52, a shoe collar 53 is arranged on the supporting mast 16.

In order to be attached in an articulated manner to the supporting mast 16, the coupling element 28 furthermore has a fastening hole 48. Finally, the coupling element 28 furthermore has a fastening element formed as an extending arm 50, on which a spring element 52, in the exemplary embodiment a compression spring, is pushed. As can be gathered in particular from figures 7 and 8, the spring element 52 acts in the installed state between the coupling element 28 and the supporting mast

16, and is thus supported on the supporting mast 16. The spring element 52 exerts an opposing force directed counter to the inertial force of the photovoltaic module 4. The arrangement of the spring element 42, its size and its spring force/spring constant are therefore selected in a suitable manner to exert this opposing force. As a result, the pressing force transmitted to the elevation element 22 is reduced, and this leads to a smoother-running adjustment movement during a tracking movement and overall relieves the load on the motor 10. Since the force produced by the spring element 52 does not run through the rotary point, defined via the fastening hole 48, of the coupling element 28, the spring element 52 produces a torque which, in the view shown in figure 5, is directed in the counterclockwise direction.

Since the spring element 52 subjects the coupling element 28 to the torque, the torque produced by the photovoltaic module 4 is generally counteracted, and so the load on the curved ring 22 is less. Since the forces and moments acting on the curved ring 22 are reduced, the tracking of the photovoltaic module takes place with less outlay in terms of energy. Similarly, the forces acting on the cable 12 are reduced, and so the drive motor 10 can have smaller dimensions or a larger number of supporting frameworks can be connected.

According to figures 2 to 8, a guide slot 54 is furthermore introduced in the driver element 20 and acts as a friction brake for the cable 12. The guide slot 54 extends only over a part region of the lateral surface of the driver element 20. The cable 12 is guided round the lateral surface via the guide slot 54. On account of the tensioning of the cable upon starting up, said cable rests against the rim-side edges (as seen in the circumferential direction) of the guide slot 54, so that said edges form a friction brake that acts in both directions with only little structural outlay.

By way of the described configuration of the supporting framework, cost-effective installation and efficient operation of such a photovoltaic system is possible. By means of the in particular double adjusting device, simple, assembly-friendly and precise alignment of the supporting frameworks 12 in a setpoint rotational position is possible without problems. By way of the further measures, specifically the arrangement of the bearing sleeves 42, the arrangement of the spring element 52 and the arrangement of the sleeves 46, the necessary drive forces and actuating forces for the forced mechanical tracking with respect to the horizontal adjustment movement are kept low overall, and so permanently reliable operation is ensured.

List of reference signs

2	Supporting framework
4	Photovoltaic module
6	Vertical axis
8	Horizontal pivot axis
10	Drive motor
12	Cable
14	Anchoring element
16	Supporting mast
18	Supporting frame
20	Driver element
22	Curved ring
24	Guide track
26	Fastening element
28	Coupling element
30	Lever arm
32	Fastening foot
34	Slot guide
36A	Upper part region
36B	Lower part region
38	Fastening flange
40	Supporting tube
42	Bearing sleeve
43	Storm protection means
44	Fork end
46	Sleeve
48	Fastening hole
50	Extending arm
52	Spring element
53	Protective collar
54	Guide slot

Claims

1. A tracking device for a photovoltaic system having at least one photovoltaic module (4) for tracking the Sun, comprising a supporting framework (2) for in each case one photovoltaic module (4), which has
   - a vertical tracking device having a supporting structure (16), which supports the photovoltaic module (4) and is mounted in a rotatable manner about a substantially vertical axis (6), for vertical tracking by means of a drive (10), and
   - a horizontal tracking device for horizontal tracking of the photovoltaic module (4) by pivoting about a horizontal axis (8), said horizontal tracking device comprising
   - an elevation element (22) which defines a guide track (24) having different height levels, wherein the supporting structure (16) is rotatable about the vertical axis (6) in relation to the elevation element (22),
   - a mechanical coupling device (28, 30) which, in the event of a rotational movement of the supporting structure (16) about the vertical axis (6), travels with a coupling element (28) along the guide track (24) and transmits the height levels defined by the guide track (24) in order to create a pivoting movement about the horizontal axis (8),
   - a driver element (20) which is arranged concentrically with the supporting framework (16) and is connected in a rotationally fixed manner thereto, and is provided to transmit an actuating movement of a common drive (10) via a drive means (12), wherein the driver element (20) is wrapped around in operation by the drive means (12) and a plurality of supporting frameworks (2) are driven via the latter,

characterized

in that an adjusting device (36A, 36B, 38) is provided for the rotational adjustment of part regions (36A, 36B) of the supporting structure (16) about the vertical axis (16) with respect to one another.

2. The tracking device as claimed in claim 1,

characterized

by a further adjusting device (32, 34) for the rotational adjustment of the elevation element (22) about the vertical axis (6) with regard to an anchoring element (14).

3. The tracking device as claimed in claim 1 or 2,

characterized

in that the elevation element (22) is connected to a fastening foot (32) which can be fastened reversibly to the anchoring element (14) in different rotational positions.

4. The tracking device as claimed in claim 3,

characterized

in that the fastening foot (32) has a fastening plate for resting in a planar manner on the anchoring element.

5. The tracking device as claimed in one of the preceding claims,

characterized

in that the supporting structure (16) is divided into the two part regions (36A, 36B) at a dividing point and the two part regions (36A, 36B) can be fixed reversibly together at the dividing point, in particular via flanges (38), in different rotational positions with respect to one another.

6. The tracking device as claimed in one of the preceding claims,
characterized
in that a spring element (52) is arranged between the coupling element (28) and the supporting structure (16).

7. The tracking device as claimed in claim 6,
characterized
in that the spring element (52) exerts on the coupling element (28) a torque which counteracts a torque produced by the photovoltaic module (4) with regard to the horizontal axis (8).

8. The tracking device as claimed in claim 6 or 7,
characterized
in that the spring element (52) acts on the coupling element (28) in such a way that a pressing force between the coupling element (28) and the elevation element (22) is reduced.

9. The tracking device as claimed in one of claims 6 to 8,
characterized
in that a protective collar (53) is attached to the supporting structure (16) in the region of the spring element (52).

10. The tracking device as claimed in one of the preceding claims,
characterized
in that the coupling element (28) has at least one rotatably mounted sleeve (46), by way of which the coupling element (24) travels along the guide track (24).

11. The tracking device as claimed in one of the preceding claims,
characterized
in that the supporting structure comprises a supporting mast (16) which is arranged in a rotatable manner on a fastening foot (32), wherein at least one sliding element, in particular a sliding sleeve (42), is arranged between the supporting mast (16) and the fastening foot (32).

12. The tracking device as claimed in claim 11,
characterized
in that the supporting mast (16) has a bottom flange, by way of which it is supported in a planar manner on the sliding element.

13. The tracking device as claimed in one of the preceding claims,
characterized
in that the supporting structure (16) is connected in a rotationally fixed manner to a tubular driver element (20) for transmitting an actuating movement exercised by the drive, and the driver element (20) has a guide slot (54) in which an elastic drive means, such as a cable (12), which is connected to the drive (10), is accommodated in the assembled state.

14. The tracking device as claimed in one of the preceding claims and as claimed in claim 6,
characterized
in that the supporting structure (16) is connected in a rotationally fixed manner to a tubular driver element (20) for transmitting an actuating movement exercised by the drive (10), and one of

the flanges (38) forms a cover for the driver element (20).

15. The tracking device as claimed in one of the preceding claims,

characterized

in that a storm protection means (43) for securing the supporting structure (16) against lifting axially off the fastening foot (32) is provided, said storm protection means (43) being in particular in the form of a lug which is fastened to the fastening foot (32) and projects over a radially extending flange of the supporting structure (16).

16. The tracking device as claimed in one of the preceding claims, having a plurality of supporting frameworks (2), to which the common drive (10) is assigned, and in which the actuating movement exercised by the drive (10) is transmitted to the plurality of supporting structures (16) via the drive means (12).

17. A method for installing a tracking device as claimed in one of the preceding claims, in which a plurality of supporting frameworks (2) are fastened to at least one anchoring element (14), a common drive (10) is arranged and the individual supporting structures (16) are connected to the drive (10) via a drive means (12) and an actuating movement is transmitted from the drive (10) to the supporting structure (16),

characterized

in that, with the aid of the adjusting device (36A, 36B, 38), a first part region (36A) of the supporting structure (16) is moved into a setpoint rotational position with respect to a second part region (36B) of the supporting structure (16), at the individual supporting frameworks (2), as required.

FIG. 1

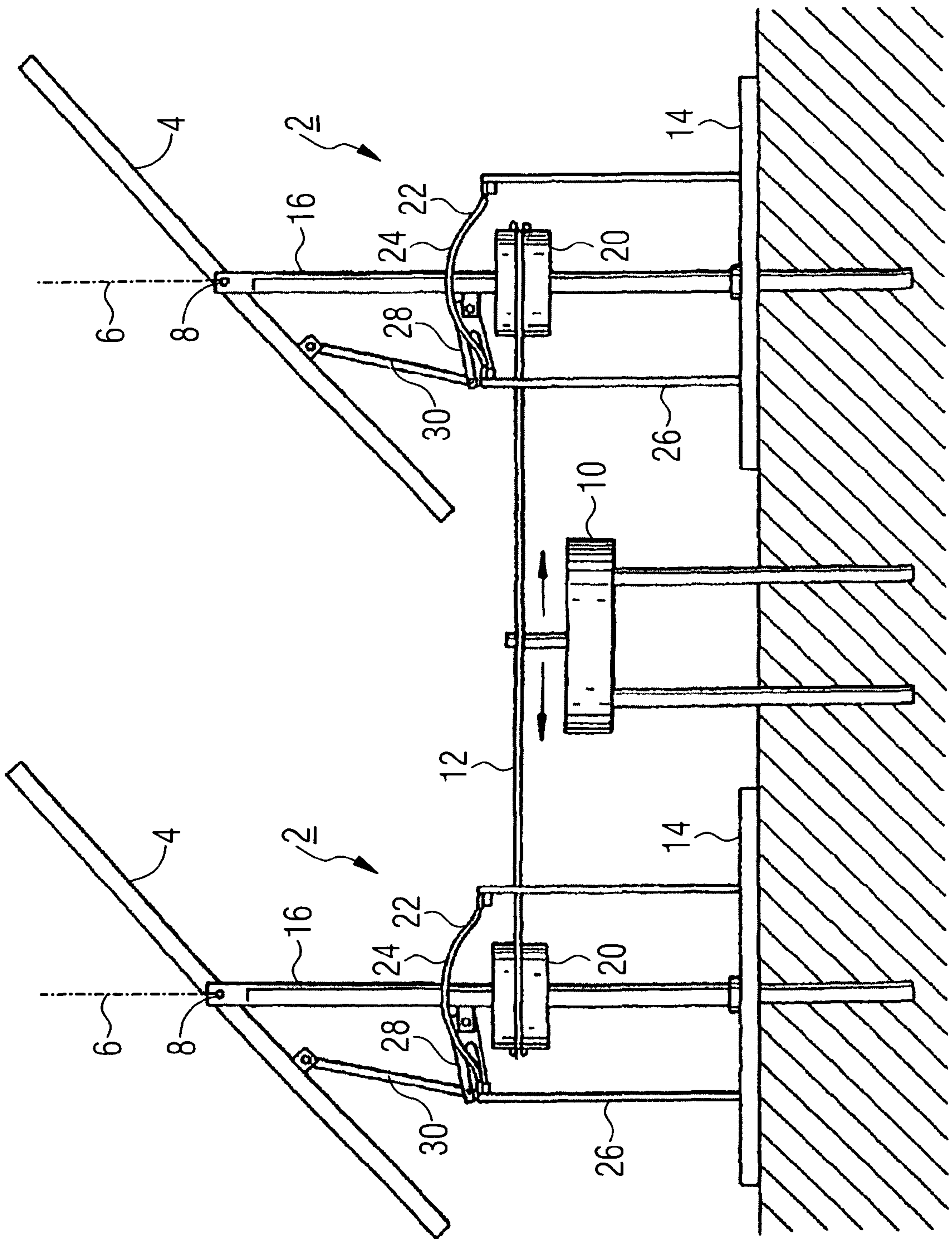

FIG. 2

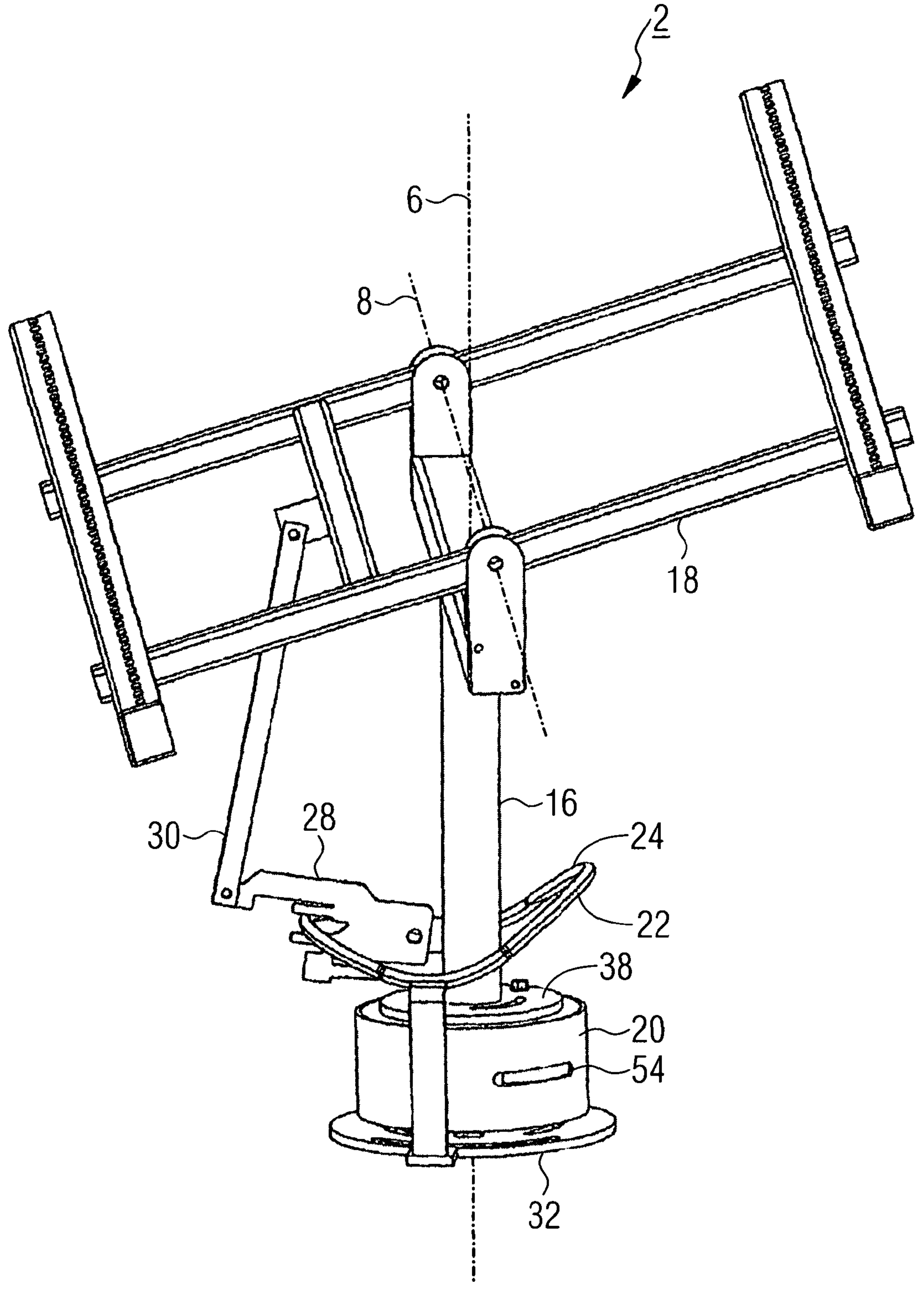

FIG. 3

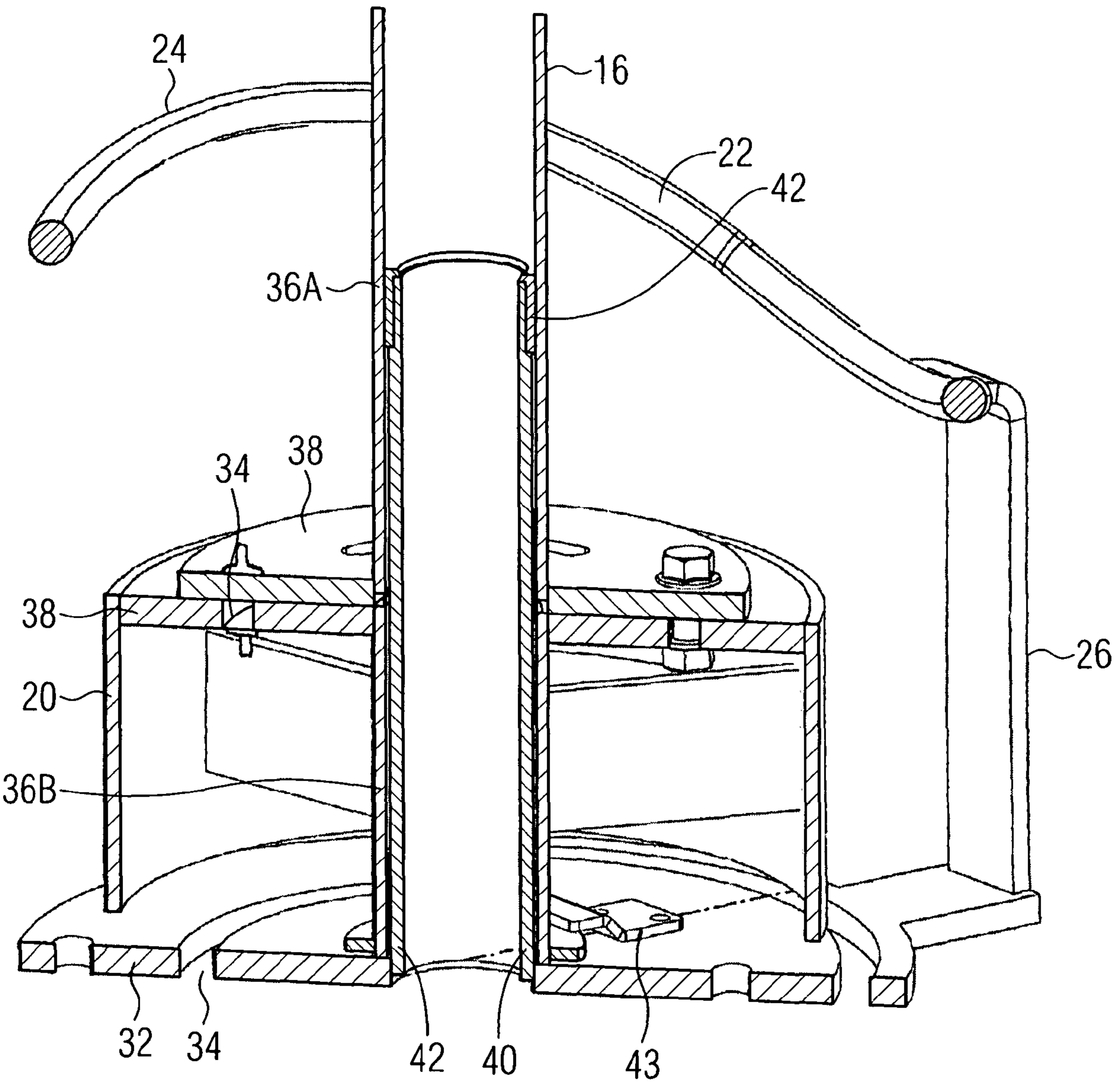

FIG. 4

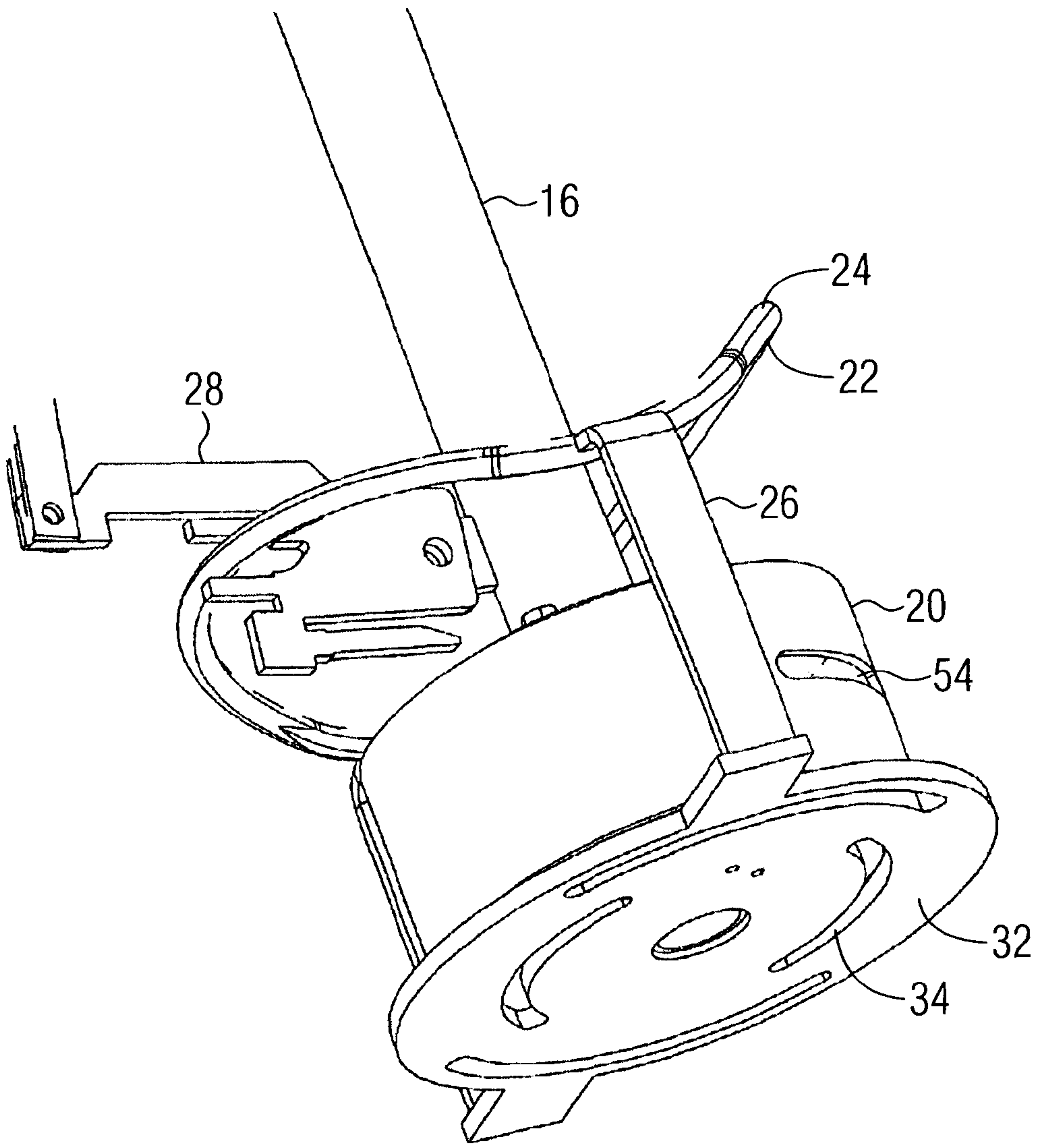

FIG. 5

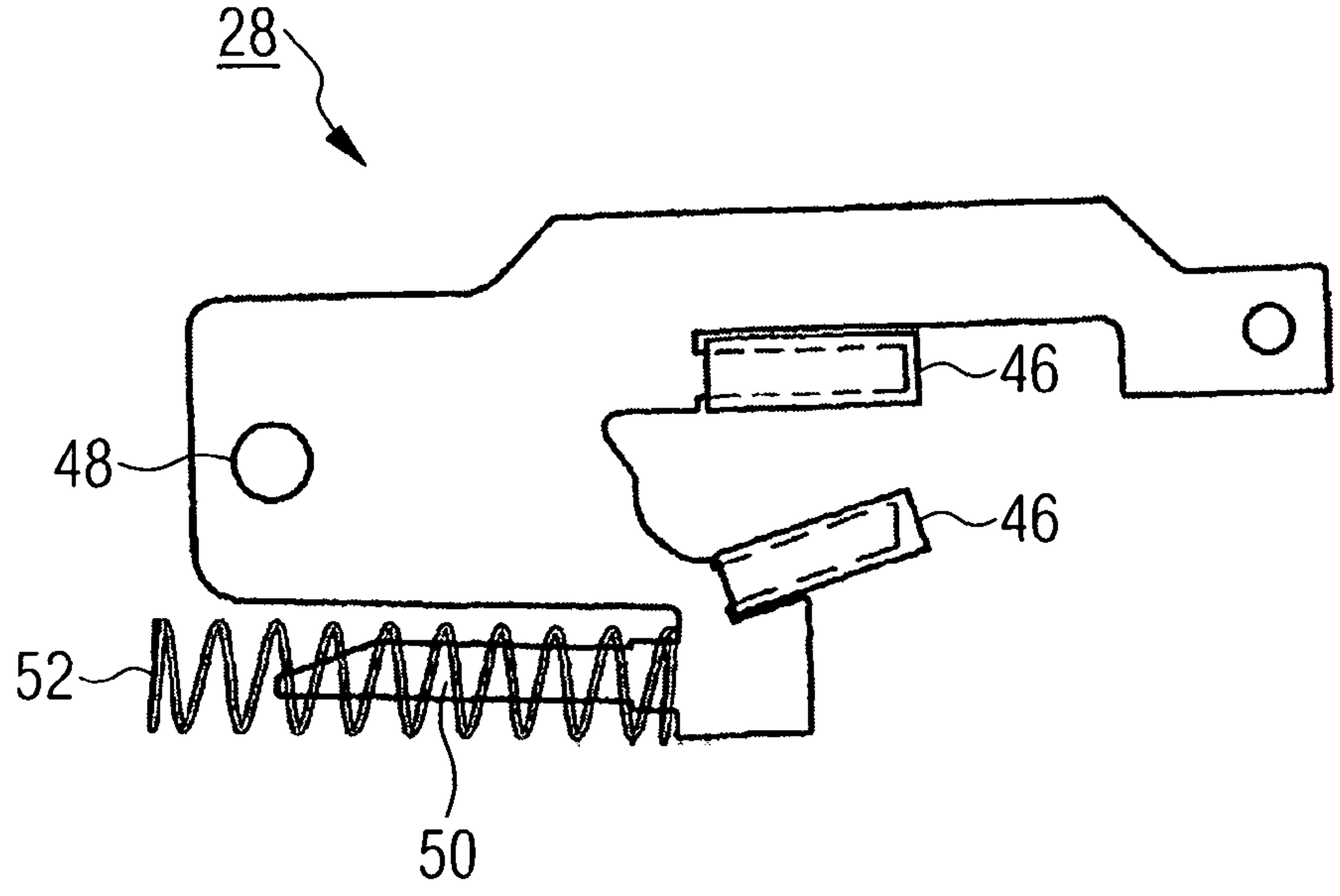

FIG. 6

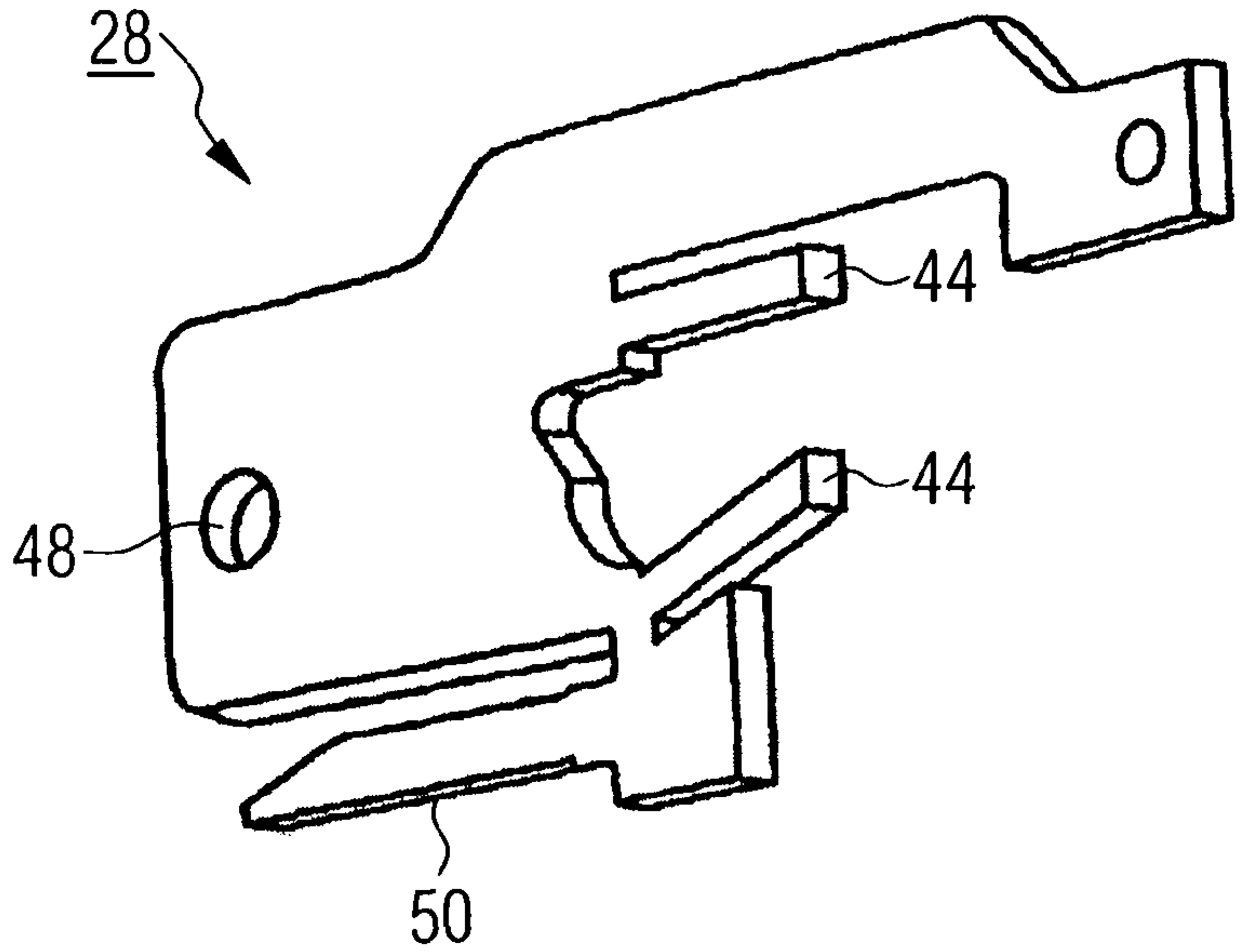

FIG. 7

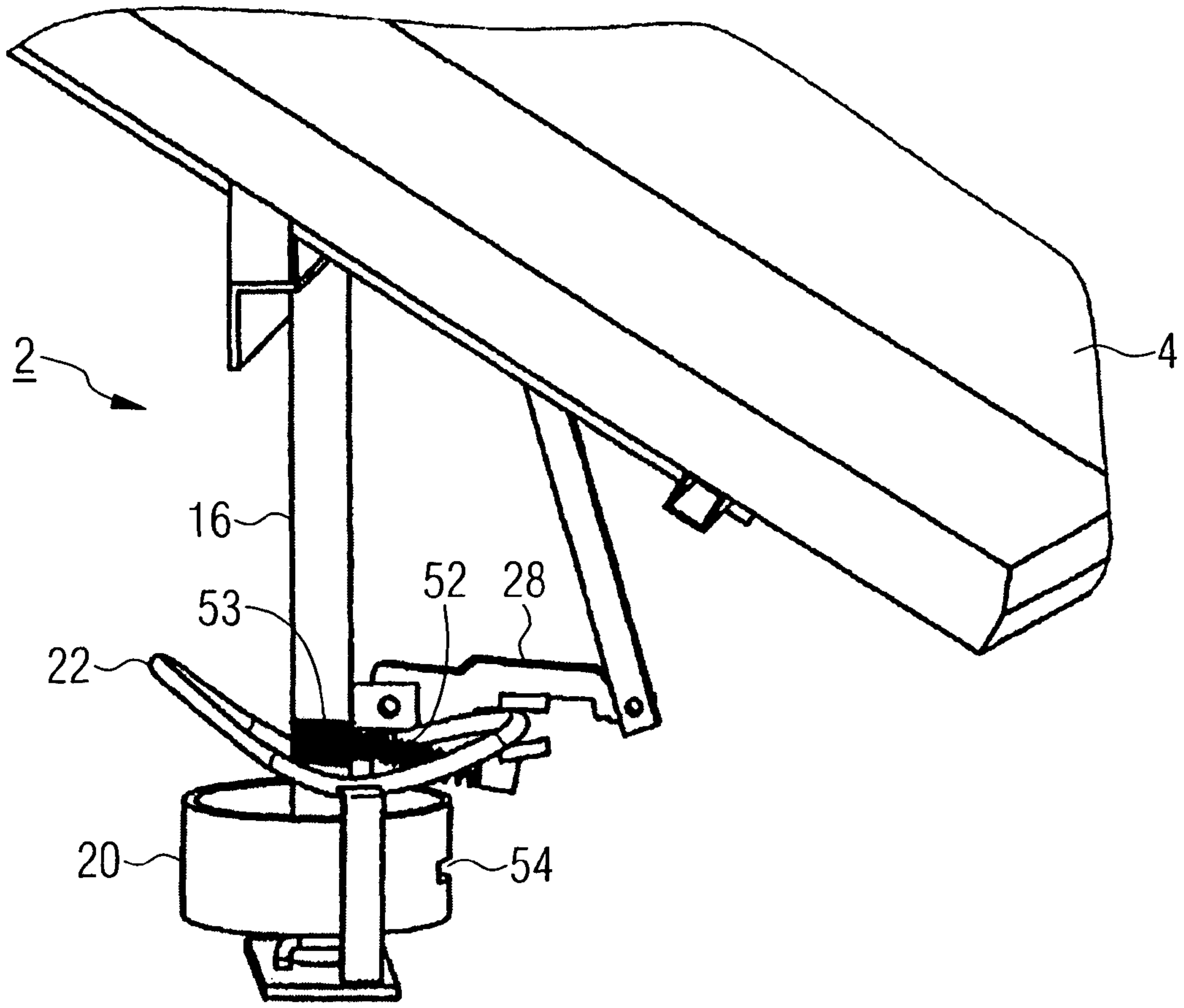

FIG. 8

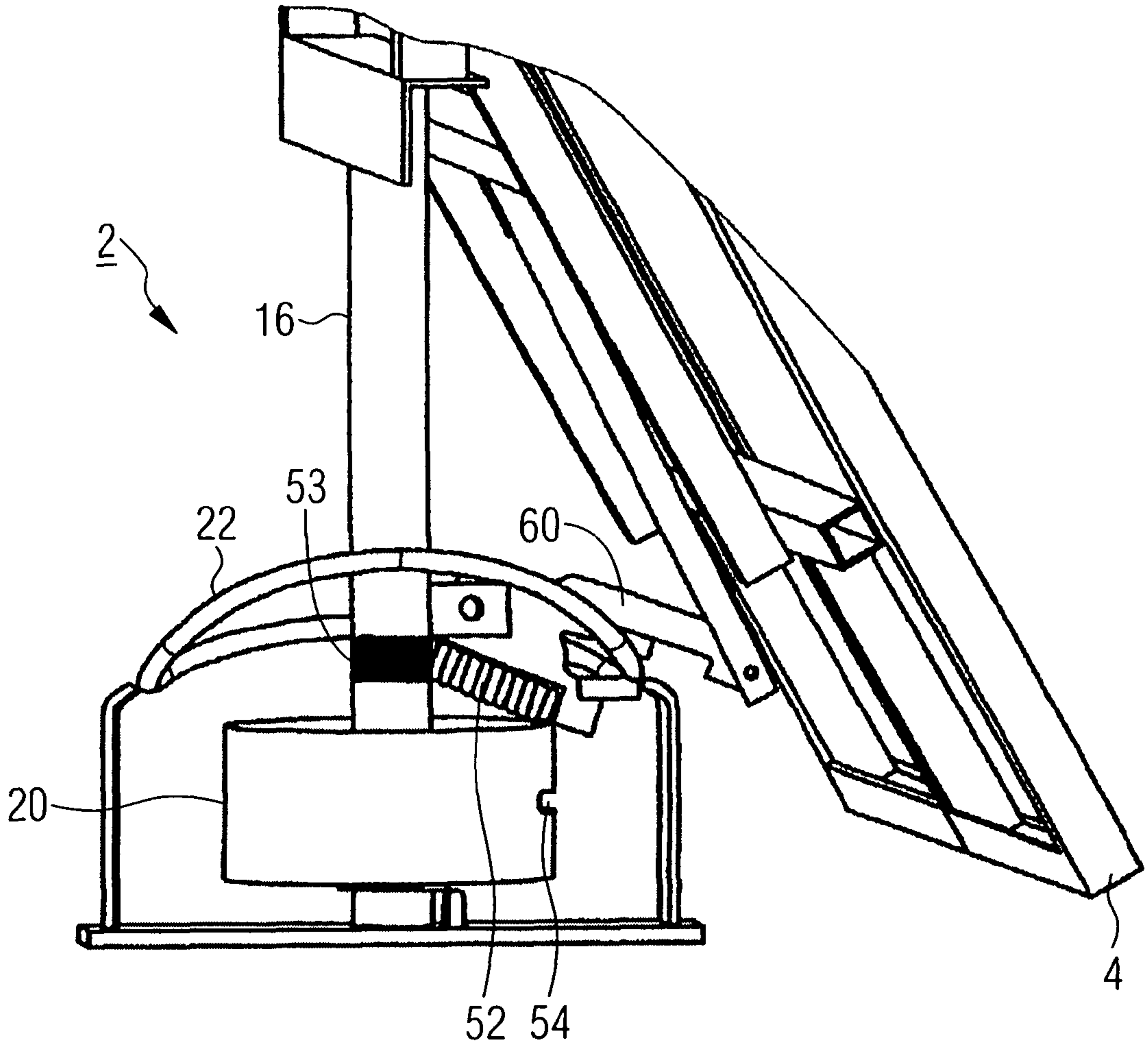

FIG. 2