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(19) **United States**(12) **Patent Application Publication**
LUKAS et al.(10) **Pub. No.: US 2020/0093270 A1**(43) **Pub. Date: Mar. 26, 2020**(54) **GAS SPRING DEVICE FOR ADJUSTING THE
HEIGHT OF AN OFFICE CHAIR****Publication Classification**(71) Applicant: **LOGICDATA Electronic & Software
Entwicklungs GmbH, Deutschlandsberg
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A47C 3/30 (2006.01)
(52) **U.S. Cl.**
CPC **A47C 3/30** (2013.01)(72) Inventors: **Stefan LUKAS**, Preding (AT); **Thomas
NEGER-LOIBNER**, Graz (AT);
Richard HALATSCHEK,
Poelfing-Brunn (AT)(57) **ABSTRACT**

A gas spring device of an office chair has a gas spring for height adjustment by means of a movable component and at least one sensor element, which is configured to detect a load and to generate a sensor signal depending on the detected load. In addition, the gas spring device has an electronic circuit adapted to generate user data depending on the sensor signal. The user data represents one or more facts about the usage of the office chair. The at least one sensor element has at least one of the following: A force sensor for detecting a force acting on the gas spring in the direction of a longitudinal axis of the gas spring and generating a force signal therefrom and/or at least one deformation sensor for detecting a deformation of the gas spring device and to generate a deformation signal therefrom.

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§ 371 (c)(1),

(2) Date: **Aug. 17, 2018**(30) **Foreign Application Priority Data**

Feb. 18, 2016 (DE) 10 2016 102 891.6

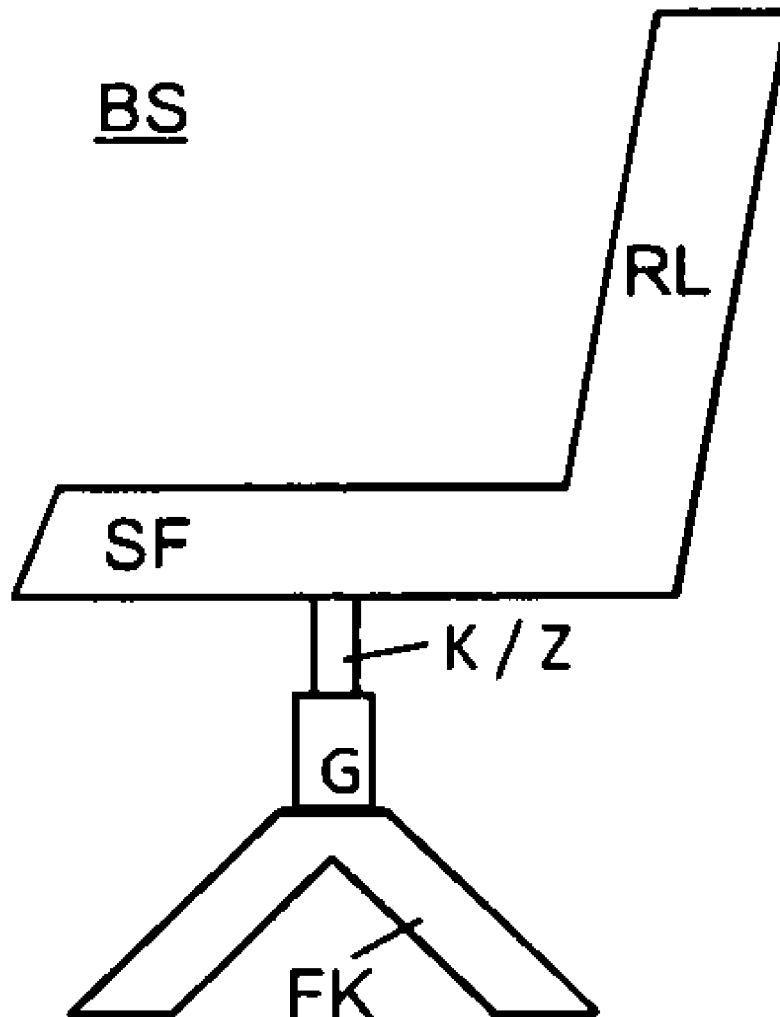


FIG. 1

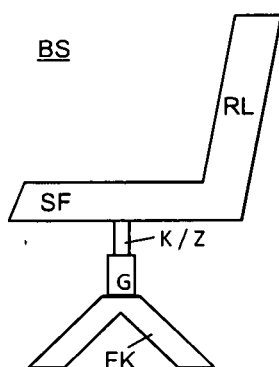


FIG. 2A

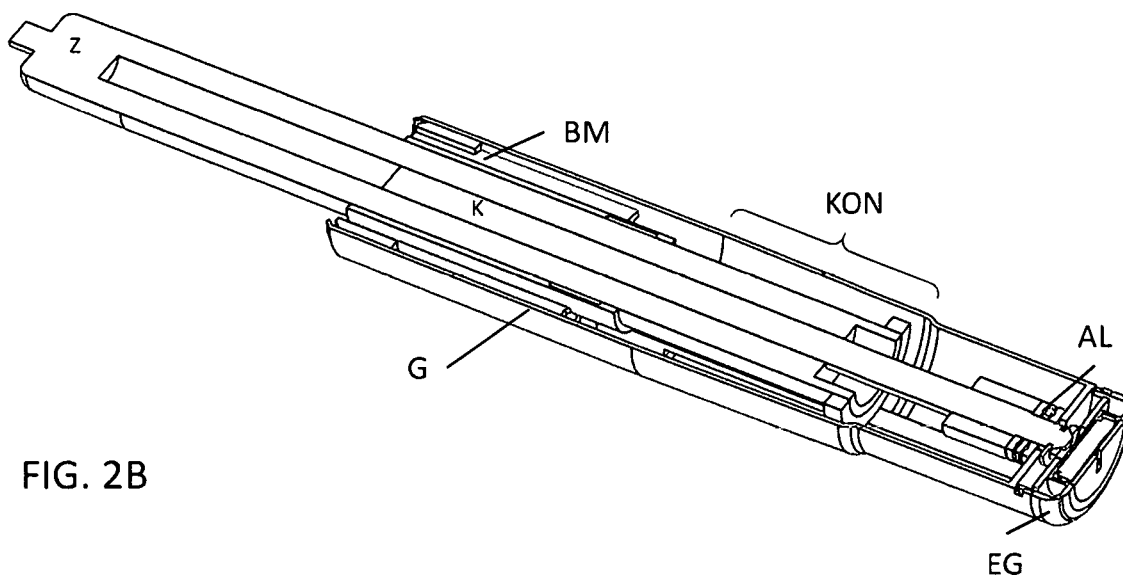


FIG. 2B

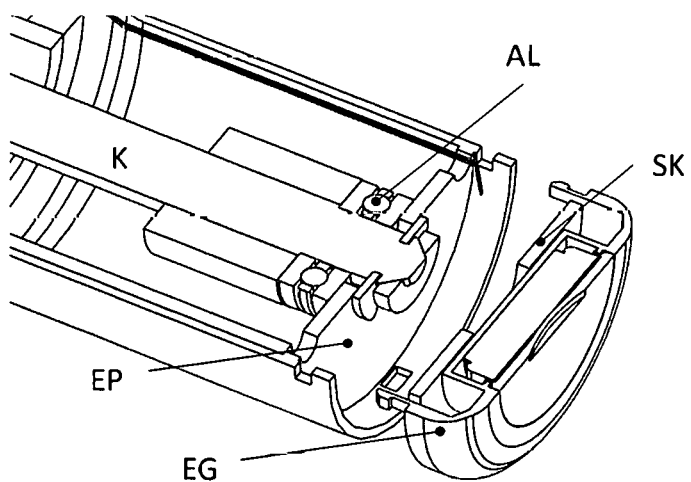


FIG. 3

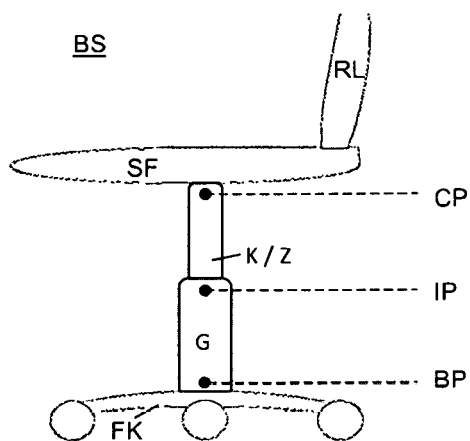


FIG. 4

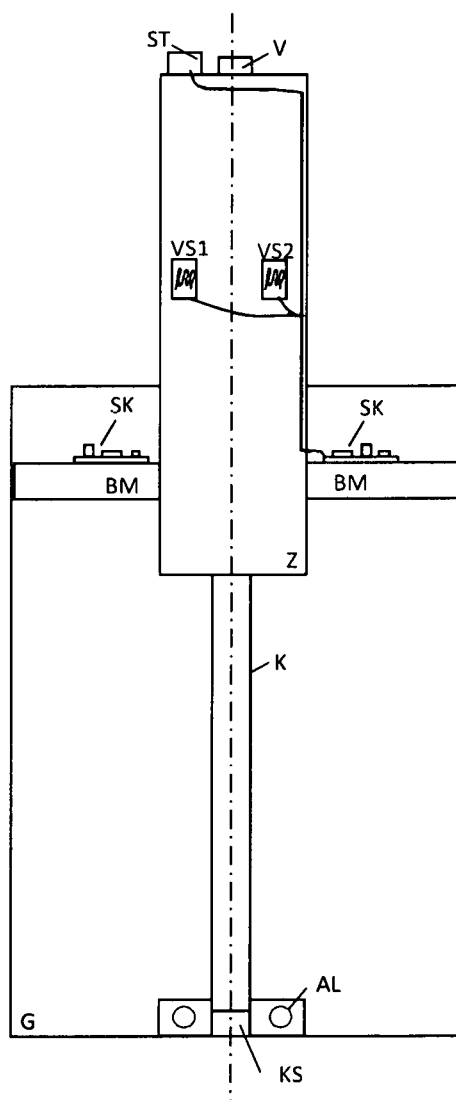


FIG. 5

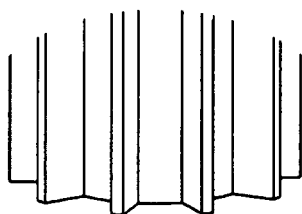


FIG. 6A

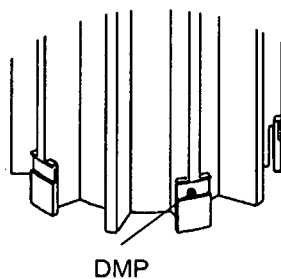


FIG. 6B

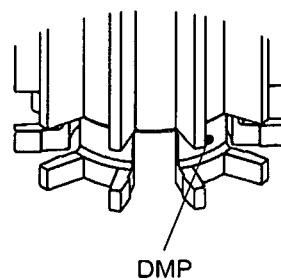


FIG. 6C

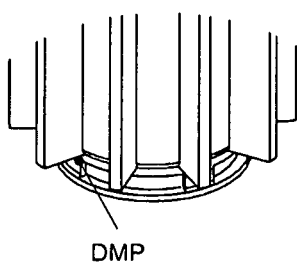


FIG. 6D

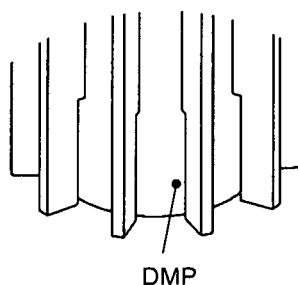


FIG. 6E

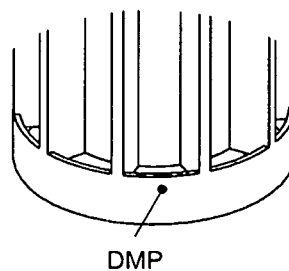


FIG. 6F

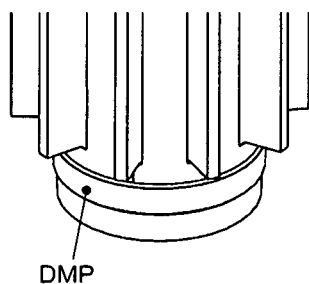


FIG. 6G

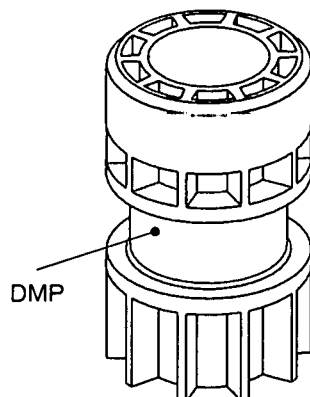


FIG. 6H

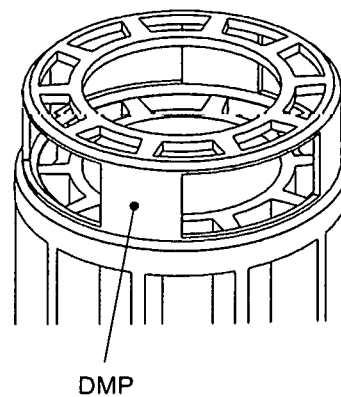


FIG. 7

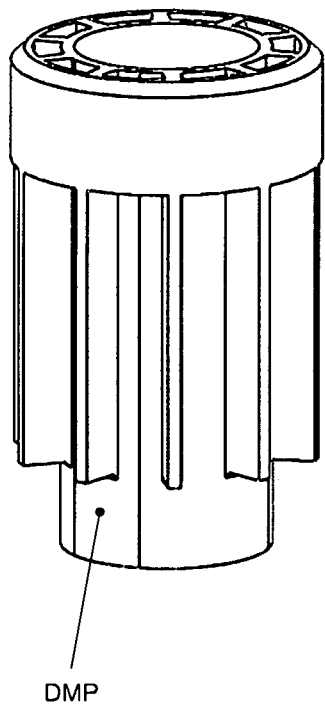


FIG. 8

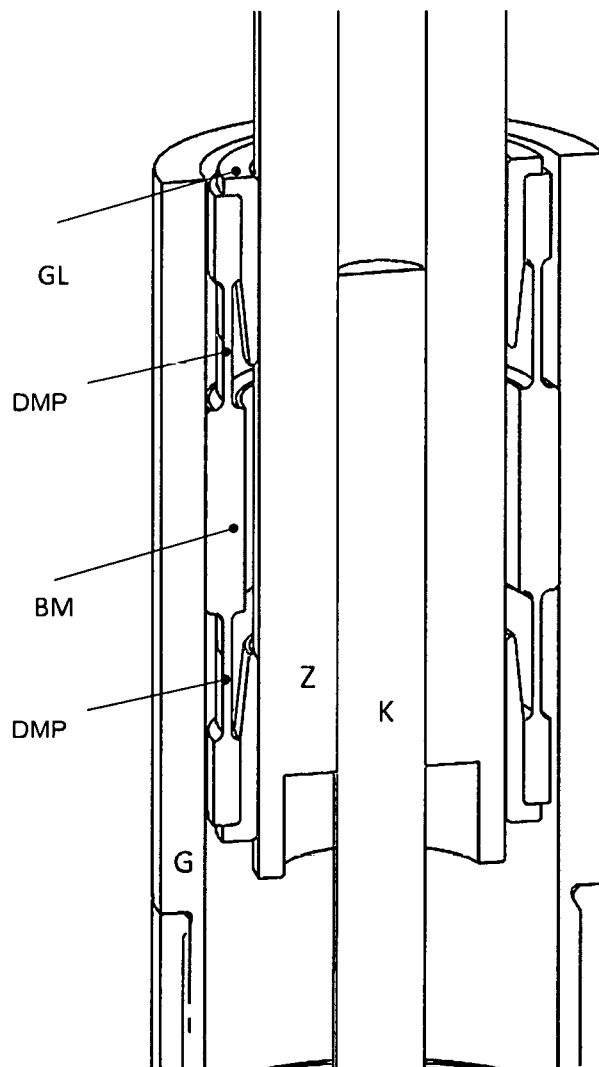


FIG. 9

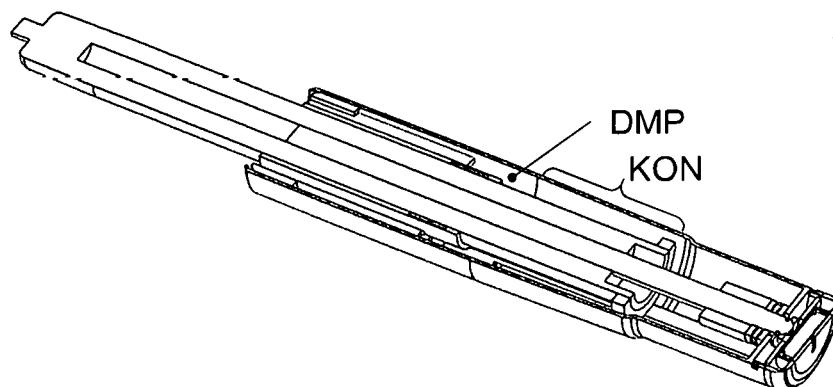


FIG. 10

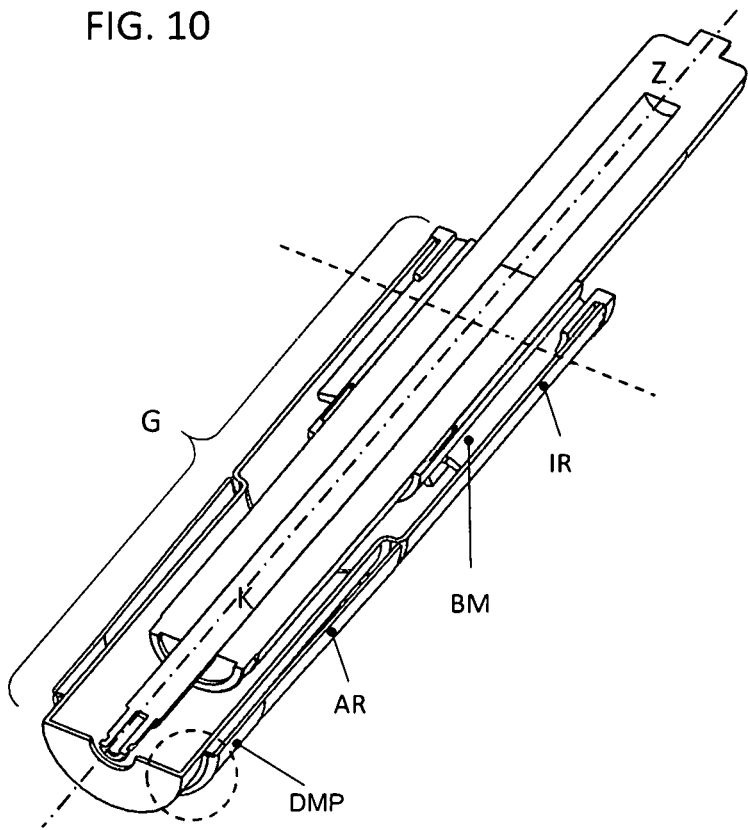


FIG. 11

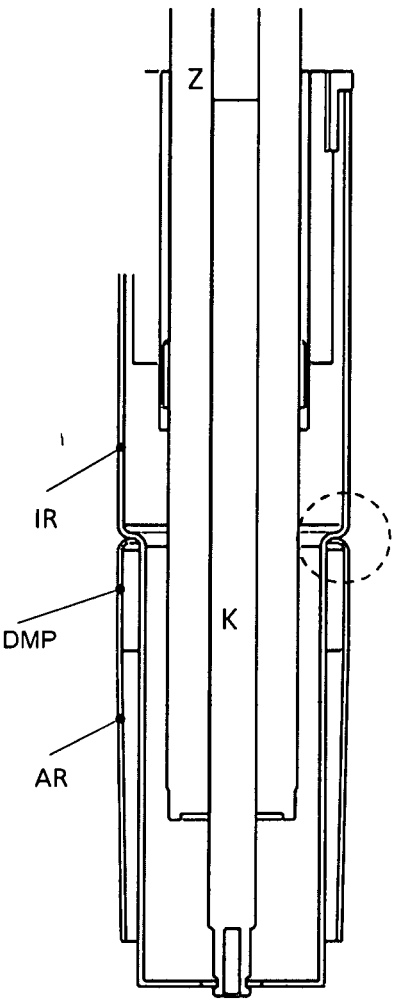


FIG. 12A

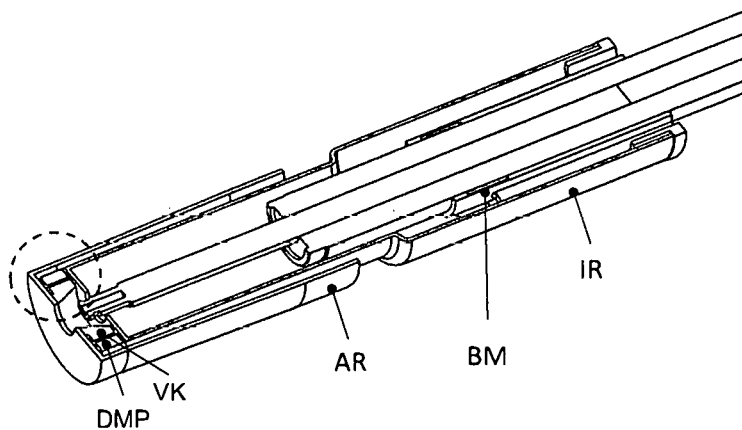


FIG. 12B

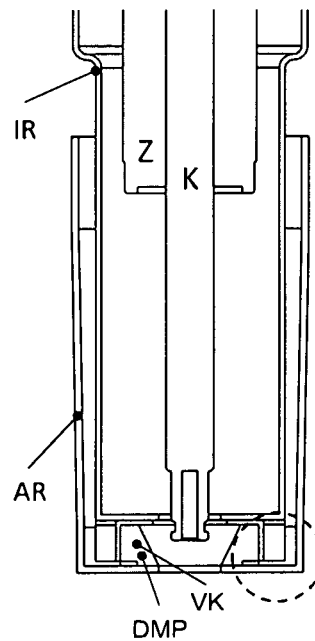


FIG. 13A

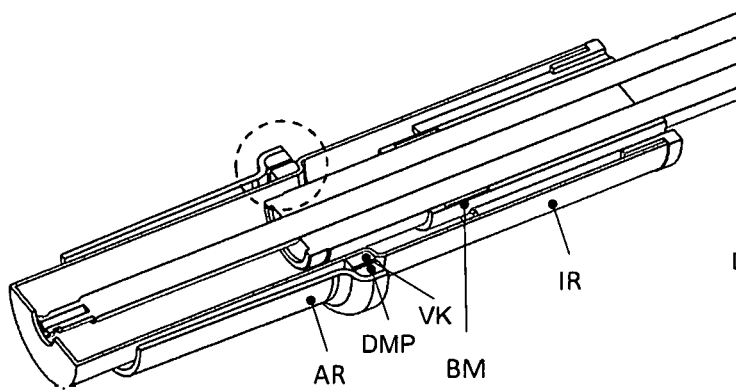


FIG. 13B

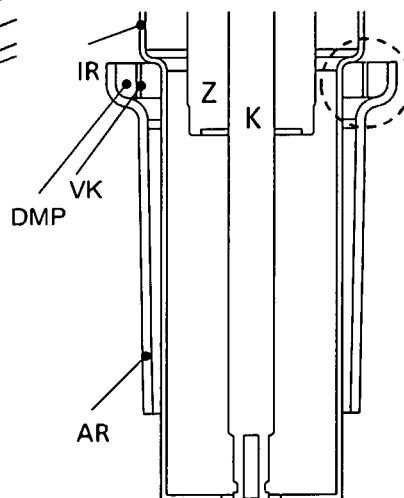


FIG. 14A

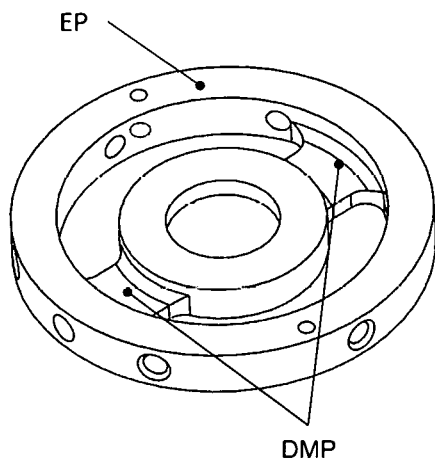


FIG. 14B

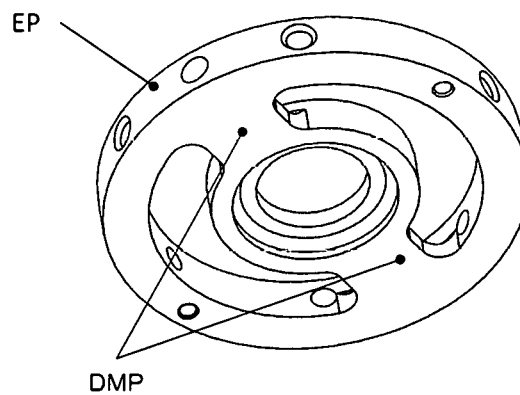


FIG. 14C

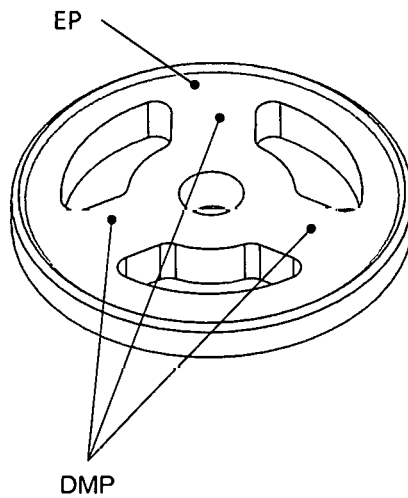


FIG. 15A

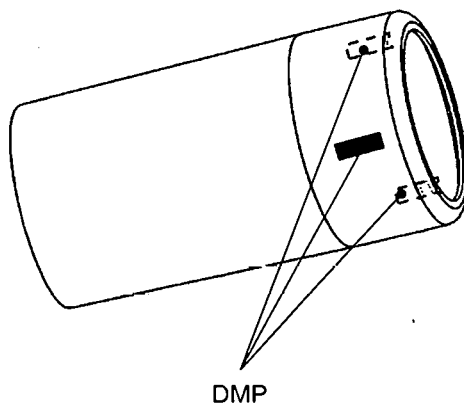


FIG. 15B

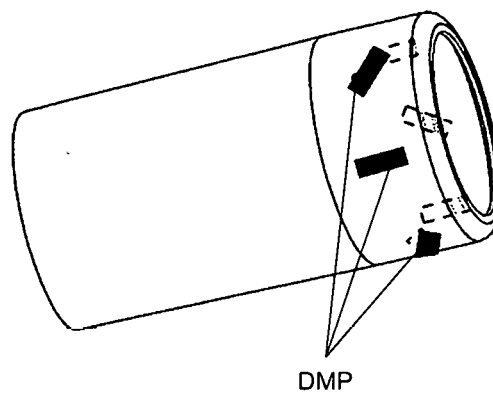


FIG. 15C

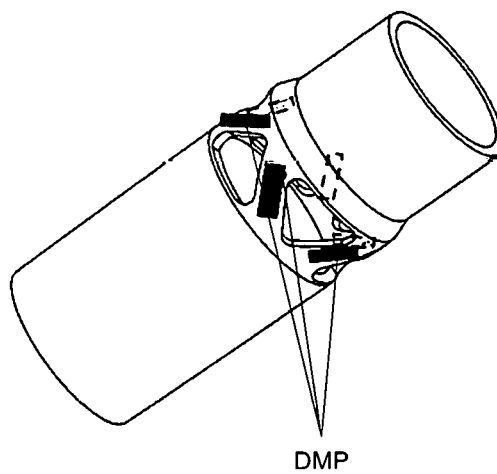


FIG. 16

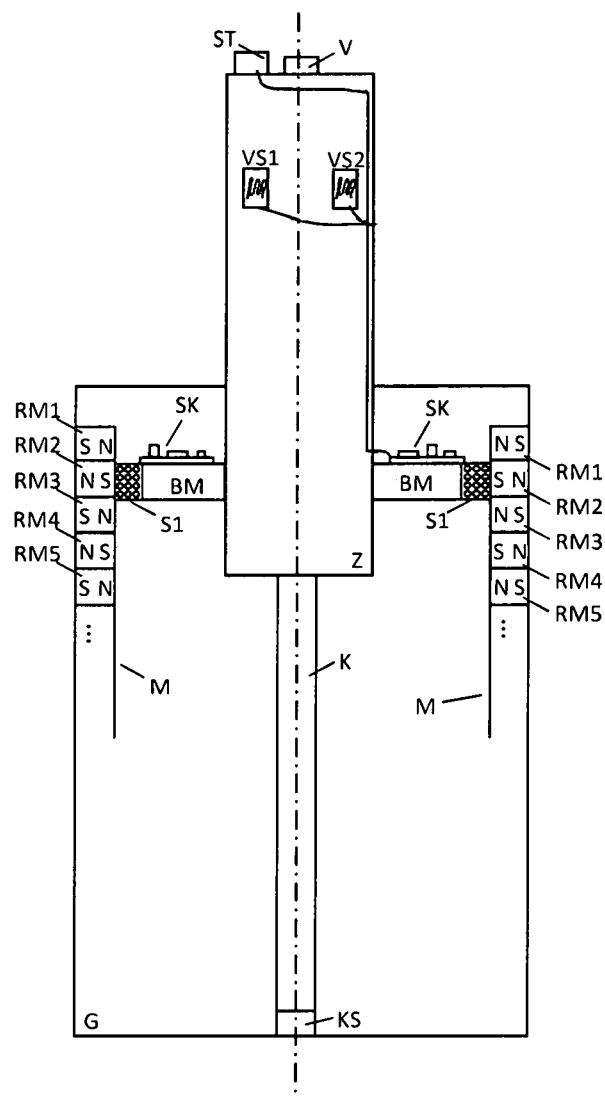


FIG. 17A

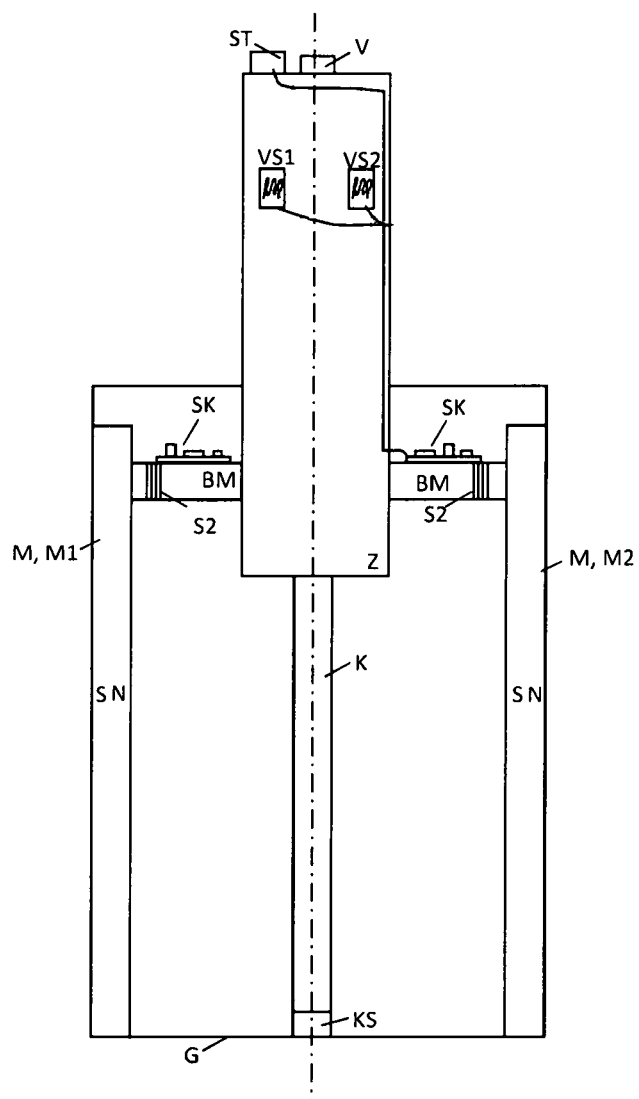


FIG. 17B

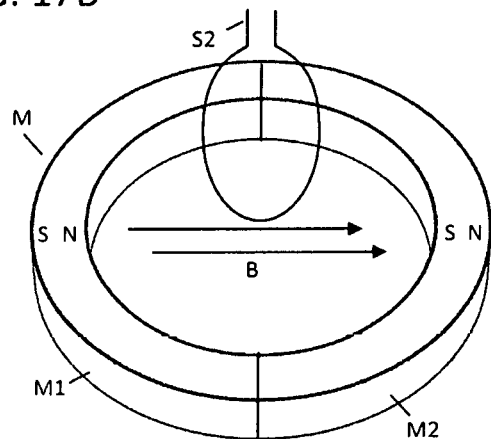


FIG. 17C

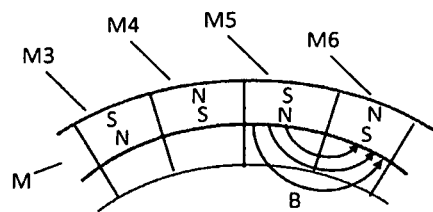
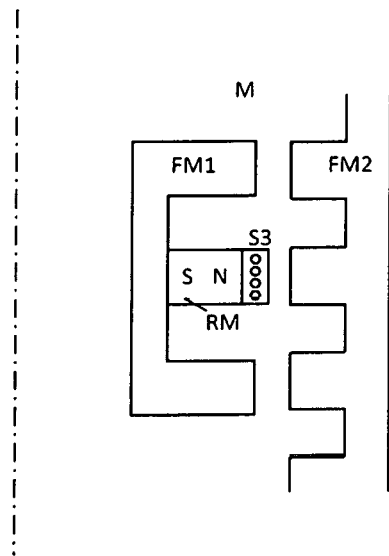


FIG. 18



GAS SPRING DEVICE FOR ADJUSTING THE HEIGHT OF AN OFFICE CHAIR

BACKGROUND OF THE INVENTION

[0001] The present disclosure concerns a gas spring device for adjusting the height of an office or work chair.

[0002] Office chairs offer various options for adjusting the seat height, the height of armrests, the inclination of the backrest, the inclination of the seat surface and so on, depending on the design. A gas spring, for example, can be used for height adjustment.

[0003] In order to improve the use of the office chair, for example with regard to aspects of workplace ergonomics, in particular to optimize the posture and/or sitting position of a user, it may be desirable for the user to record and evaluate the way in which the office chair is used.

SUMMARY OF THE INVENTION

[0004] The present disclosure provides an improved concept for a gas spring device for adjusting the height of an office chair, which allows the user to record and/or evaluate the way in which the office chair is used in a particularly efficient manner.

[0005] According to the improved concept, a gas spring device for height adjustment of an office chair comprises at least one sensor element for detecting a load as well as an electronic circuit in addition to the actual gas spring. By processing one or more sensor signals through the circuit, usage data of the office chair are generated. These can be evaluated by the circuit and/or external receivers to optimize the use of the office chair, for example.

[0006] According to the improved concept, a gas spring device for height adjustment of an office chair is specified. The gas spring device has a gas spring which is arranged and equipped to adjust the height of the office chair by means of a movable component of the gas spring. The gas spring device also has at least one sensor element arranged on the gas spring device, which is arranged to detect a load on the gas spring device and to generate at least one sensor signal depending on the detected load. In addition, the gas spring device has an electronic circuit arranged to generate usage data depending on the at least one sensor signal. The usage data represents one or more facts about the use of the office chair.

[0007] The gas spring device, in particular the gas spring, can be arranged, for example, between a seat surface and a base, also known as a spider or foot spider, of the office chair. For example, the gas spring contains a piston and a cylinder, whereby the piston in the cylinder can be moved along a longitudinal axis of the gas spring to adjust the seat height of the office chair. To fix the seat height, the penetration depth of the piston into the cylinder can be fixed, for example. In this state, for example, the gas spring is used as a spring for damping. The gas spring has a spring constant or effective spring constant, which is determined, for example, by the internal pressure of a gas inside the cylinder of the gas spring. This can, for example, cushion changes in the load on the seat surface of the office chair, especially when a user sits down on the seat surface.

[0008] The longitudinal axis of the gas spring corresponds to an axis along a direction of movement of the gas spring, in particular the movable component of the gas spring, for adjusting the height of the office chair.

[0009] In various embodiments, the gas spring device comprises a housing that can be attached to the base or the seat surface of the office chair, for example. The piston of the gas spring is fixed to the housing with respect to the housing, while the cylinder is movable along the longitudinal axis with respect to the housing and dips more or less deeply into the housing. In such designs, the cylinder is a movable component of the gas spring, while the piston is an immovable component of the gas spring. Alternatively, the cylinder can also be fixed to the housing with respect to the housing and the piston can be movable with respect to the housing and immerse more or less deeply into the housing. In such designs, the piston represents the movable component of the gas spring, while the cylinder represents the immovable component of the gas spring.

[0010] It is emphasized that the term “immovable” refers only to a direction of movement along the longitudinal axis of the gas spring. Thus, a rotational movement of the immovable component with respect to the housing is not excluded. The moving component, on the other hand, is movable along its longitudinal axis. In addition, the moving component can also be movable with respect to rotation.

[0011] For example, the housing can be connected to the base via a first cone and the movable component to the seat surface of the office chair via a second cone or vice versa. The housing can also be used to guide the moving component of the gas spring.

[0012] According to the various embodiments of the gas spring device, the circuit is arranged inside or on the housing. In some embodiments, the circuit is mounted on the inside of the housing or on the moving component.

[0013] The usage data generated by the circuit can be used to evaluate the user's usage behavior. This makes it possible to optimize the use of the office chair, particularly with regard to ergonomic aspects.

[0014] Applications for the improved concept can include not only the provision of data to optimize a user's posture and/or sitting position with regard to use in a desk chair, but also the following: User presence detection, user activity tracking, fail-use detection, use as an input device for computers, for example as a so-called “body joystick” or “body controller” for computer games, generation of statistical data for the further development of office chairs. Further application possibilities are of course not excluded.

[0015] In addition to force and position measurements, the results of which are aimed at improving workplace ergonomics, other data could also be recorded with the help of this invention by using the respective sensors, which also contribute to the health or well-being of the user. Examples include measurements of noise, brightness, oxygen, CO₂, humidity, temperature, acceleration or measurements with other environmental sensors.

[0016] In various implementations of the gas spring device, the at least one sensor element has a force sensor which is designed to detect a force acting on the gas spring in the direction of the longitudinal axis of the gas spring and to generate a force signal depending on the detected force. For example, the circuit is designed to generate weight data representing the body weight of a user of the office chair, depending on the force signal.

[0017] In various implementations, the force sensor contains one or more strain gauges and/or one or more piezo sensors, especially piezoelectric sensors.

[0018] In various implementations, the force sensor is arranged on the fixed component of the gas spring, for example the piston or the cylinder. For example, the force sensor may be located between the immovable component and the housing, between the immovable component and the base or between the immovable component and the seat surface.

[0019] In various implementations of the gas spring device, the at least one sensor element has at least one deformation sensor which is designed to detect a deformation of the gas spring device and/or the gas spring and to generate a deformation signal depending on the detected deformation. For example, the circuit is designed to generate center of gravity data representing a position of a center of gravity of a user of the office chair, depending on the deformation signal.

[0020] The user's center of gravity can be changed, for example, by shifting the user's weight on the seat surface or by changing the inclination of the seat surface, the inclination of the backrest of the office chair or another adjustment of a component of the office chair.

[0021] In various implementations, the deformation sensor is set up to detect a deformation, in particular a bend, of the gas spring, of the piston, of the cylinder and/or of the housing and to generate the deformation signal depending on this.

[0022] In various implementations, the at least one strain sensor contains one or more strain gauges which are arranged on the gas spring, in particular on the piston and/or the cylinder, or on an inside or outside of the housing.

[0023] In various designs, the at least one sensor element comprises both the at least one deformation sensor and the force sensor. The circuit is designed to generate the center of gravity data as a function of the deformation signal and the force signal.

[0024] By means of the weight data and/or the center of gravity data, the usage behavior can be recorded and evaluated.

[0025] In various embodiments, the at least one deformation sensor is arranged on the gas spring, in particular on the piston or the cylinder, and is designed to detect a deformation of the gas spring, in particular of the piston or the cylinder, and to generate the deformation signal depending on the detected deformation of the gas spring.

[0026] In various embodiments, the at least one deformation sensor is arranged on a housing, in particular on an inside or an outside of the housing, of the gas spring and is designed to detect a deformation of the housing of the gas spring and to generate the deformation signal depending on the detected deformation of the housing of the gas spring.

[0027] In various embodiments, the at least one sensor element comprises a deformation body which is arranged at least in part between the gas spring device and a seat surface of the office chair. The at least one deformation sensor is arranged on the deformation body and is designed to detect a deformation of the deformation body and to generate the deformation signal depending on the detected deformation of the deformation body. The deformation body acts, for example, as a guide element for the gas spring in a housing of the gas spring device.

[0028] A housing of the gas spring device can be formed by two tubular parts which are at least partially pushed into one another, the deformation sensor being arranged in the region of a connection between these two parts.

[0029] Alternatively, the deformation body can be arranged at least partially between the gas spring device and a base of the office chair.

[0030] The at least one strain sensor contains, for example, one or more strain gauges and/or one or more piezoelectric sensors which are arranged on the deformation body.

[0031] In various embodiments, the deformation body acts as a guide element for the cylinder in a housing of the gas spring device.

[0032] For example, the deformation body has at least one selected area of reduced stiffness, the at least one deformation sensor being attached to this selected area, or if there are several such areas, to these selected areas. In particular, the reduced stiffness relates to the other areas of the deformation body, which are stiffer in comparison. Due to the lower stiffness in the selected areas, deformation occurs there more noticeably and can be detected more reliably via the deformation sensor(s). From the deformation signal, the load, especially radial forces, i.e. forces perpendicular to the longitudinal axis of the gas spring and corresponding bending moments can be deduced.

[0033] The selected areas result, generally speaking, from a change in the uniform geometry of the deformation body. For example, the at least one selected area is formed by a weakening of the material, in particular a recess, a notch or another weak point. The change in geometry can also cause a force flow through the deformation body through the at least one selected area.

[0034] In various configurations, the deformation body can be made of plastic or metal. While plastic is characterized by simplified production, the use of a metal deformation body improves the measurements of the deformations due to the linear material properties. In the case of a metal deformation body or guide element, it may be advantageous to insert additional plastic sliding pieces between the guide element and gas spring, for example to improve the contact properties.

[0035] In various embodiments, a housing of the gas spring device is formed by two tubular parts which are at least partially pushed into each other. The deformation body is arranged in the area of a connection between these two parts. For example, the two parts are connected together in the area of an end plate of the gas spring device. Alternatively, the two parts are connected together in the end area of one of the two parts facing a center of the housing. The connection is therefore approximately in the area of the middle of the housing.

[0036] In various embodiments, the at least one deformation sensor is designed to detect a force acting on the deformation body in the direction of the longitudinal axis of the gas spring and to generate a further force signal depending on the force acting on the deformation body. The circuit is designed to generate first additional weight data representing the body weight of the user of the office chair, depending on the further force signal.

[0037] With advantage, both the body weight and the user's center of gravity can be determined with the help of the deformation body. Generally speaking, the deformation signal can represent exclusively or additionally a force which acts on the gas spring essentially in a direction perpendicular to the longitudinal axis of the gas spring.

[0038] In various designs, the at least one sensor medium is formed by a pressure sensor which detects an internal

pressure of the gas spring, the force signal being formed by the detected internal pressure.

[0039] In various embodiments of the gas spring device, the gas spring device features an energy harvesting device which is designed to harvest electrical energy from a movement of the gas spring, in particular a movable component of the gas spring, for example the piston or the cylinder. The circuit is connected to the energy harvesting device to supply power to the circuit. In such designs, the principle of “energy harvesting” is thus implemented in a gas spring device for adjusting the height of an office chair.

[0040] In various embodiments, the energy harvesting device includes an energy store for storing the energy obtained and the circuit is connected to the energy store or contains the energy store for supplying power to the circuit.

[0041] In various embodiments, the energy harvesting device includes at least one piezoelectric element which is arranged on the gas spring device, in particular on the gas spring or the housing, and is designed to harvest the electrical energy from the movement of the gas spring.

[0042] The at least one piezoelectric element of the energy harvesting device is arranged, for example, between the gas spring and the housing or between the housing and the office chair, in particular the base or the seat surface, or between the gas spring device and the office chair, in particular the base or the seat surface.

[0043] In configurations in which the force sensor contains one or more piezo sensors, for example, a piezo sensor of the force sensor can be used as a piezoelectric element of the energy harvesting device.

[0044] In various embodiments, the energy harvesting device is designed to harvest electrical energy from a movement of the gas spring along the longitudinal axis of the gas spring. Alternatively or additionally, the energy harvesting device is designed to harvest the electrical energy from a rotational movement of the gas spring. For example, a rotational movement of the gas spring designates a rotational movement with the longitudinal axis of the gas spring as an axis of rotation.

[0045] In various designs of the gas spring device, the energy harvesting device has at least one coil and at least one permanent magnet. The at least one coil or the at least one permanent magnet is attached to the movable component of the gas spring.

[0046] In different designs, the at least one coil and the at least one permanent magnet are arranged and aligned with respect to one another in such a way that a magnetic flux generated by the at least one permanent magnet varies through the at least one coil when the movable component moves, in particular varies in time.

[0047] The movement of the movable component can be a movement along the longitudinal axis or a rotary movement. The movement along the longitudinal axis can be caused, for example, by a height adjustment. Alternatively or additionally, the movement along the longitudinal axis can be caused by a damping movement of the moving component, for example when a user sits down on the office chair. The rotational movement can be caused, for example, by a rotary movement of the office chair, especially the seat surface.

[0048] In such embodiments, the effect of electromagnetic induction is used to induce a voltage in the coil and, for

example, to charge the energy store of the energy harvesting device by means of a current generated by the induced voltage.

[0049] The at least one coil has one or more windings. In various embodiments, the coil is movably arranged relative to the at least one permanent magnet or the at least one permanent magnet is movably arranged relative to the coil. Depending on the orientation of the coil and the permanent magnet, a magnetic flux through the coil changes during the movement of the coil or of the at least one permanent magnet, whereby the voltage is induced electromagnetically.

[0050] In various embodiments, both the permanent magnet and the coil are movably arranged and the gas spring device also contains a magnetically conductive or ferromagnetic component, which is immovably arranged in the gas spring device. The magnetically conductive or ferromagnetic component has first areas located at a first distance from the longitudinal axis of the gas spring and second areas located at a second distance from the longitudinal axis of the gas spring. The second distance is larger than the first distance.

[0051] When the at least one permanent magnet and the coil move along the longitudinal axis of the gas spring, a distance between the at least one permanent magnet and the magnetically conductive or ferromagnetic component changes. Consequently, a magnetic flux density also changes along a movement of the coil and thus a magnetic flux through the coil during the movement of the coil. As a result, a voltage is induced by electromagnetic induction, which generates a current to charge the energy store.

[0052] In various embodiments, the at least one coil and the at least one permanent magnet are arranged on the movable component of the gas spring and the magnetically conductive or ferromagnetic component is immovably arranged in the housing of the gas spring device. Alternatively, the magnetically conductive or ferromagnetic component may be fixed to the movable component of the gas spring and the at least one coil and the at least one permanent magnet may be fixed in the gas spring device.

[0053] In various embodiments, a sign or polarity of the induced voltage changes during the movement of the moving component. In such designs, the circuit has a rectifier circuit which is designed to rectify the induced voltage or the current generated thereby to charge the energy store.

[0054] The change in the sign or polarity of the voltage is, for example, due to a change in the direction of the magnetic flux density with respect to a surface spanned by the at least one coil, in particular a winding plane of the at least one coil, or a winding axis of the at least one coil. Alternatively or additionally, the change in the sign or the polarity of the voltage can be caused by a change in the direction of movement of the moving component.

[0055] In various embodiments, the at least one permanent magnet has at least one radially magnetized annular first permanent magnet arranged around the movable component of the gas spring.

[0056] In various embodiments, a first coil of the at least one coil is firmly connected to the movable component, so that the first coil is moved along with it when the movable component moves in the direction of the longitudinal axis of the gas spring. The at least one first permanent magnet is fixed in the gas spring device.

[0057] In various embodiments, the windings of the first coil run around the movable component of the gas spring.

The movable component and the first coil are located in an inner area, in particular within an inner radius of the at least one first permanent magnet.

[0058] In various embodiments, the at least one first permanent magnet is permanently connected to the movable component, so that the at least one first permanent magnet is moved along with a movement of the movable component in the direction of the longitudinal axis of the gas spring and the first coil is arranged fixedly in the gas spring device.

[0059] The movable component is then located, for example, in the interior, whereas the first coil is located in an exterior area, especially outside an exterior radius, of at least one first permanent magnet.

[0060] In various embodiments, the winding axis of the first coil, a symmetry axis of the at least one first permanent magnet and the longitudinal axis of the gas spring coincide in particular.

[0061] In various embodiments, the at least one permanent magnet has two or more radially magnetized annular first permanent magnets. The two or more first permanent magnets are arranged relative to each other in such a way that their axes of symmetry coincide. For example, the two or more first permanent magnets are arranged one above the other, whereby there may be a distance or no distance between adjacent of the two or more first permanent magnets.

[0062] In various embodiments, the two or more first permanent magnets are alternately magnetized. Neighboring of the two or more first permanent magnets have opposite magnetic poles on their respective radial insides and opposite magnetic poles on their respective radial outsides.

[0063] By using two or more first permanent magnets, a range of motion of the movable component in which the voltage is induced is increased, for example. Furthermore, a greater inhomogeneity of the magnetic flux density generated by the at least one permanent magnet can be achieved, which in turn can lead to an increased induced voltage.

[0064] In various embodiments, the at least one permanent magnet has at least one second permanent magnet. The at least one second permanent magnet has a magnetization which lies at least partially in a plane perpendicular to the longitudinal axis of the gas spring.

[0065] In various embodiments, a second coil of the at least one coil is fixedly connected to the movable component of the gas spring, so that the second coil is moved along with a rotational movement of the movable component and the at least one second permanent magnet is fixedly arranged in the gas spring device.

[0066] The rotational movement of the second coil changes an angle of a direction of the magnetic flux density generated by the at least one second permanent magnet with respect to a winding plane or a winding axis of the second coil. This changes the magnetic flux through the second coil during a rotational movement of the movable component and the second coil. As a result, electromagnetic induction induces a voltage in the coil which can generate a current to charge the energy store.

[0067] In various embodiments, the at least one second permanent magnet is permanently connected to the movable component, so that the at least one second permanent magnet is moved along with the rotary movement of the movable component. The second coil is then fixed with the gas spring device.

[0068] In various embodiments, the winding axis of the first coil, especially during the rotational movement, lies in a plane on which the longitudinal axis of the gas spring is perpendicular.

[0069] In various embodiments, the at least one sensor element has at least one position sensor which is designed to detect a position of the moveable component and to generate a position signal depending on the detected position.

[0070] In various embodiments, the at least one position sensor contains an incremental measuring sensor, a direct measuring sensor, a magnetic sensor, a Hall sensor, a capacitive sensor and/or an optical sensor. The position can also be measured resistively, e.g. via a potentiometer in combination with a gear which converts a linear movement into a rotary movement, a linear potentiometer and/or coding, e.g. a Grey Code.

[0071] In various embodiments, the circuit is designed to generate height data representing a height setting of the gas spring or office chair, depending on the position signal.

[0072] By means of the height data and the height setting represented by it, the usage behavior can be further recorded and optimized.

[0073] In various embodiments, the circuit is designed to determine a force acting on the gas spring in the direction of the longitudinal axis of the gas spring based on a change in the position signal and a spring constant of the gas spring. The circuit is also set up to generate second weight data representing the body weight of a user of the office chair, depending on the determined force.

[0074] The change of the position signal is, for example, due to a change of the position of the movable component while a height adjustment is not possible or deactivated. The change in position of the movable component can result, for example, from a user sitting on the office chair. The force acting on the gas spring in the direction of the longitudinal axis of the gas spring can, for example, be determined as the product of the spring constant of the gas spring and a path corresponding to the change in position of the moving component.

[0075] In various embodiments, the at least one sensor element comprises at least one further position sensor which is arranged to detect a position of the movable component based on a spatial inhomogeneity of the magnetic flux density generated by the at least one permanent magnet and to generate a further position signal depending on the detected position. The circuit is designed to generate additional height data representing a height setting of the gas spring or office chair, depending on the further position signal.

[0076] For example, the at least one further position sensor can have at least one Hall sensor. The at least one Hall sensor is designed to detect the spatial inhomogeneity of the flux density of the at least one permanent magnet. For example, conclusions can be drawn about the position of the movable component and about the height setting of the gas spring or office chair.

[0077] With advantage, both the determination of further height data and thus the height setting of the gas spring or the office chair as well as the energy harvesting by means of the energy harvesting device with the same at least one permanent magnet can be achieved.

[0078] In various embodiments, the energy harvesting device comprises an electric generator and a transmission device, for example a gearbox. The transmission device is

connected on the driven side to the housing of the gas spring device and on the driving side to a drive shaft of the generator. The transmission device is arranged and designed to convert a rotary movement of the movable component into a rotary movement of the drive shaft.

[0079] A transmission ratio of the transmission device is such that a speed of the rotational movement of the drive shaft is greater than a speed of the rotational movement of the movable component.

[0080] The connection of the transmission device to the housing can, for example, be formed via a gear wheel of the transmission device and a toothing on an inner side of the housing.

[0081] The electrical energy generated by the electrical generator is used to power the circuit and/or charge the energy storage device.

[0082] In various embodiments, the gas spring device has a wake-up element designed to signal the start of use of the gas spring device or office chair, in particular, to switch on the circuit from a standby state. For example, the wake-up element is formed by a piezoelectric element which is mounted between an end plate and an axial bearing of the gas spring device and emits a corresponding voltage pulse when pressurized, which can be evaluated by the circuit. For example, if the circuit is not used for a longer period of time, it goes into standby mode.

[0083] In various embodiments, the circuit comprises a communication interface which is equipped for wireless transmission of the user data, in particular the weight data, the center of gravity data, the first further weight data, the second further weight data, the height data and/or the further height data, to at least one external receiver.

[0084] Wireless transmission of user data can take place via Bluetooth, WLAN, GSM-based technology, radio technology such as Zigbee, RF or RFID, or another transmission technology.

[0085] The at least one external receiver can contain office equipment such as a table, air conditioning, room lighting or table lighting. The office equipment can then be controlled, for example, depending on the usage data, in particular depending on the usage behavior.

[0086] The at least one external receiver can alternatively or additionally contain a computer or a server. The computer or server can be used to evaluate the usage data or the usage behavior.

[0087] The at least one external receiver can alternatively or additionally include a display unit, such as a screen, a display, a smartphone, a tablet computer. This allows the user of the office chair, for example, to document, check and/or adapt the usage behavior.

[0088] In various embodiments, the gas spring device, in particular the gas spring, for example the movable component of the gas spring, includes a plug connector, in particular a plug or a socket for a plug connection, which is designed to electrically connect the gas spring device, in particular the circuit, with other electronic components of the office chair.

[0089] Other electronic components may include, for example, other sensor elements, input devices, keys, display devices and/or signal transmitters.

[0090] By connecting the other electronic components to the circuit of the gas spring device, data generated by the other electronic components can be transmitted to the circuit. For example, the data generated by the other electronic

components can then be transmitted wirelessly to the at least one external receiver via the communication interface of the circuit.

[0091] According to the improved concept, an office chair with a gas spring device for height adjustment of the office chair is also described. The gas spring device is designed according to the improved concept of the gas spring device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0092] In the following, the invention is explained in detail on the basis of exemplary implementation forms with reference to the drawings. Components that are functionally identical or have an identical effect can have identical reference signs. Identical components or components with identical functions may be explained only in terms of the figure in which they appear first. The explanation is not necessarily repeated in the following figures.

[0093] In the drawings:

[0094] FIG. 1 shows an office chair with a gas spring device;

[0095] FIGS. 2A and 2B show a cross-section of an exemplary design of a gas spring device according to the improved concept;

[0096] FIG. 3 shows another representation of an office chair with a gas spring device;

[0097] FIG. 4 shows a cross-section of another exemplary design of a gas spring device according to the improved concept;

[0098] FIG. 5 is an example of a fastener;

[0099] FIGS. 6A to 6H show various implementations of fasteners as deformation bodies according to the improved concept;

[0100] FIG. 7 shows an example of a deformation body according to the improved concept for illustrating a measuring point;

[0101] FIG. 8 shows a cross-section through an example implementation of a gas spring device with deformation body and slider according to the improved concept;

[0102] FIG. 9 shows a cross-section of another example implementation of a gas spring device according to the improved concept for illustrating a measuring point;

[0103] FIG. 10 shows a cross-section of another example implementation of a gas spring device according to the improved concept with a two-part housing;

[0104] FIG. 11 shows a cross-section of another example implementation of a gas spring device according to the improved concept with a two-part housing;

[0105] FIGS. 12A and 12B show cross sections through another example implementation of a gas spring device according to the improved concept with a two-part housing and a deformation body;

[0106] FIGS. 13A and 13B show cross sections through another example implementation of a gas spring device according to the improved concept with a two-part housing and a deformation body;

[0107] FIGS. 14A, 14B and 14C show different implementations of end plates as deformation bodies according to the improved concept;

[0108] FIGS. 15A, 15B and 15C show different implementations for mounting deformation sensors according to the improved concept;

[0109] FIG. 16 shows a cross-section of another example implementation of a gas spring device according to the improved concept;

[0110] FIG. 17A shows a cross-section of another example implementation of a gas spring device according to the improved concept;

[0111] FIG. 17B is an example implementation of a permanent magnet arrangement for use in a gas spring device according to the improved concept;

[0112] FIG. 17C is another example implementation of a permanent magnet assembly for use in a gas spring device according to the improved concept; and

[0113] FIG. 18 is another example implementation of a permanent magnet arrangement for use in a gas spring device according to the improved concept.

DETAILED DESCRIPTION

[0114] FIG. 1 shows a work chair BS with a gas spring device, for example a gas spring device according to the improved concept. The work chair BS has a seat surface SF, a backrest RL connected to the seat surface SF and a base FK.

[0115] In addition, the work chair BS comprises a gas spring device, which includes a housing G and a gas spring with a piston K and a cylinder Z, for example. In the example in FIG. 1, the housing G of the gas spring device is connected to the base FK of the work chair BS via a cone (not shown). In addition, the piston K or the cylinder Z is connected to the seat surface SF of the work chair BS via a cone (not shown).

[0116] The gas spring, for example, is an adjustable gas spring that is designed to adjust the seat height of the work chair BS, especially the seat surface SF. Optionally, an inclination of the seat surface SF and/or the backrest RL.

[0117] FIG. 2A and FIG. 2B show an exemplary sectional view of a design of a gas spring device according to the improved concept. The gas spring device contains a housing G, which can be connected to the base FK of the work chair BS in the area of a cone KON. Furthermore, the gas spring device comprises a gas spring with a cylinder Z and a piston K. The piston K can also be called a piston rod. In the example shown, for example, the piston K is permanently connected to the housing G via an axial bearing AL. The cylinder Z is mounted or fastened in the housing G by means of a BM fastener. This BM fastener acts as a guide element for cylinder Z in housing G.

[0118] In FIG. 2B the area of the gas spring device around the end plate EP is shown enlarged in an exploded view. It becomes clearer that the thrust bearing AL is designed as a ball bearing. A circuit SK is arranged in an electronic housing EG. Circuit SK, for example, can contain a circuit board or printed circuit board on which electronic components and/or integrated circuits are arranged and, if necessary, interconnected.

[0119] FIG. 3 shows another representation of an office chair BS with the gas spring device, which is based on the representation of FIG. 1. Various positions are shown at which a force measurement can be carried out, for example. One of these points is, for example, the connection point CP between the chair and the gas spring device. It is also possible to measure the force at the connection point BP between the gas spring device and the base FK. Alternatively or additionally, a force measurement can also be carried out within the gas spring device, marked by the point IP.

[0120] FIG. 4 shows a cross-section of an exemplary design of a gas spring device according to the improved concept, especially for use in an office chair BS, as shown in FIG. 1 or FIG. 3.

[0121] The gas spring device comprises a housing G, which, for example, is connected via a first cone to the base FK of the work chair BS. In addition, the gas spring device comprises a gas spring with a cylinder Z and a piston K. In the example shown, for example, the piston K is fixedly connected to the housing G. The cylinder Z, for example, is connected to the seat surface SF of the work chair BS via a second cone. With fixed housing G and piston K, cylinder Z can move along a longitudinal axis of the gas spring, for example to adjust the height of the seat surface SF and/or to cushion the seat surface SF, for example when a user sits down on the work chair BS. The longitudinal axis of the gas spring is indicated by a semi-dotted line in FIG. 4. In addition to the movement along the longitudinal axis, the gas spring, in particular the cylinder and/or piston K, can be rotationally movable to allow the seat surface SF of the work chair BS to rotate.

[0122] The gas spring has, for example, an adjustment element V on cylinder Z. If the adjustment element V is actuated, for example by a lever (not shown) which can be actuated by the user of the office chair, a movement of the cylinder Z along the longitudinal axis of the gas spring is released for height adjustment of the seat surface SF. If the adjustment element V is not actuated, the cylinder is locked, so that a height adjustment of the seat surface SF is not possible. In this state, for example, the gas spring is only used for damping depending on a spring constant of the gas spring.

[0123] The gas spring device also has a fastener BM, which is firmly connected to the cylinder Z, for example. For example, the fastener BM can be ring-shaped and enclose the cylinder Z. Alternatively, the fastener BM can also have two or more elongated or rod-shaped individual components which are attached to the cylinder Z at different, in particular opposite positions. If the cylinder Z moves along the longitudinal axis or if the cylinder Z rotates around the longitudinal axis of the gas spring, the fastener BM also moves along the longitudinal axis or rotates around the longitudinal axis accordingly.

[0124] The gas spring device also has an electronic circuit SK. The circuit SK, for example, can be located on or attached to the fastener BM, in particular. Circuit SK, for example, can contain a circuit board or printed circuit board on which electronic components and/or integrated circuits are arranged and, if necessary, interconnected. For example, the board can be attached to the fastener BM.

[0125] The gas spring device also has a force sensor KS, which is attached, for example, to the gas spring, especially to the piston K or to the housing G. In the example shown, the force sensor KS is attached to piston K. The force sensor KS, for example, can include a strain gauge that is attached to the piston K, for example. Alternatively, the force sensor KS can include a piezoelectric sensor, which is arranged, for example, on the piston K or between the piston K and the housing G. The force sensor KS is electrically connected to the circuit SK (connection not shown).

[0126] When a force acts on the gas spring in the direction of the longitudinal axis of the gas spring, for example because a user sits on the work chair BS, the force sensor KS detects the force acting in the direction of the longitudinal

axis and generates a force signal depending on the force detected. The force sensor KS transmits the force signal to the circuit SK. For example, the SK circuit calculates weight data representing the body weight of the user of the work chair BS from the force signal.

[0127] The SK circuit also includes a communication interface, in particular an interface for wireless data transmission. The interface can be a Bluetooth interface, a WLAN interface, a GSM-based interface, a radio interface such as Zigbee, RF or RFID or another interface. For example, the circuit can transmit the weight data via the communication interface to an external receiver, such as another office equipment, a display device such as a smartphone or tablet computer, a computer or a server.

[0128] Optionally, the gas spring device has a deformation sensor, which in the example shown in FIG. 4 comprises a first deformation sensor element VS1 and a second deformation sensor element VS2. The deformation sensor elements VS1, VS2 are arranged on the cylinder Z, for example. The deformation sensor elements VS1, VS2 are strain gauges, for example. The deformation sensor elements VS1, VS2 are electrically connected to the circuit SK.

[0129] If the gas spring, in particular cylinder Z, is deformed, for example by a position of a center of gravity of the user of the work chair BS or a change in the position of the center of gravity, the deformation sensor elements VS1, VS2 detect a deformation of the gas spring, in particular of cylinder Z, for example by a different load on cylinder Z at the positions of the deformation sensor elements VS1, VS2. The deformation sensor, in particular the deformation sensor elements VS1, VS2, are designed to generate a deformation signal depending on the detected deformation and to transmit the deformation signal to the circuit SK. Depending on the deformation signal, especially depending on the deformation signal and the force signal, the circuit determines center of gravity data representing a position or a position of the center of gravity of the user of the office chair.

[0130] For example, the circuit SK is set up to transmit the center of gravity data to the external receiver via the communication interface.

[0131] In some embodiments, the circuit is set up to generate the center of gravity data depending on the deformation signal and the force signal.

[0132] FIG. 5 shows an example of a fastener which can be used, for example, as a guide element for the gas spring in a housing G of the gas spring device. Only a representative area of the element is shown, which is formed by a cylindrical base body with radially protruding ribs. The element is preferably made of plastic, but can also be designed as a metal body. In the version shown, the element has a substantially homogeneous cross-section, so that a constant stiffness results in axial direction.

[0133] The element can be used as a deformation body in the gas spring device, as deformations of the gas spring or the housing also lead to a deformation of the element. Such deformations can in turn be detected by one or more deformation sensors. Depending on the orientation of the deformation sensors, the resulting deformation signals allow conclusions to be drawn about the axially and/or radially acting forces on the gas spring arrangement.

[0134] Based on the principle shown in FIG. 5, FIGS. 6A to 6H show various designs of fasteners as deformation bodies according to the improved concept. Each of these

deformation bodies is characterized by at least one selected area with reduced stiffness, which are especially suitable as measuring positions DMP for deformation sensors. In particular, these areas have a reduced stiffness in relation to other, for example adjacent areas of the deformation body. Due to the lower stiffness in the selected areas, deformation occurs there more noticeably and can be detected more reliably via the deformation sensor(s).

[0135] By changing the geometry of a uniform body, it is possible, among other things, to cause a flow of force through the deformation body through the area or areas with reduced stiffness. This concentration of load allows deformations to be detected more noticeably and/or reliably.

[0136] For example, in FIG. 6A, some of the ribs are formed with flatter and thinner areas, resulting in an increased effect of deformation.

[0137] In the example in FIG. 6B, both the cylindrical body of the guide element or deformation body and the radial ribs are interrupted, so that a force flow essentially occurs via the remaining webs. These therefore represent a possible measuring position DMP.

[0138] In the example of FIG. 6C, the cylindrical area at the lower end is formed by a web construction, whereby the force flow over the remaining webs takes place as measuring positions DMP.

[0139] In the example in FIG. 6D, the ribs in the lower part of the element are provided with recesses so that there are no direct connections of the ribs to the cylindrical base body in this area. The resulting weakening results in one or more possible measuring positions DMP.

[0140] In the example of FIG. 6E, a cylindrical ring is provided at the lower end of the ribs, which, with the exception of the ribs, has no connection to the central cylindrical body. This in turn results in a lower stiffness in this range, which enables a measuring position DMP.

[0141] The example in FIG. 6F is similar to the design in FIG. 6C and differs in that a ring construction is provided at the lower end of the element instead of the web construction. This in turn results in a possible measuring position DMP.

[0142] In the example of FIG. 6G, there is an area of lower stiffness where there are neither ribs nor other stabilizing constructions, as shown in the upper half of the body. Thus a measurement can be made in this area.

[0143] In the example of FIG. 6H, similar to FIG. 6C, a web construction is formed in which a force flow essentially takes place via the webs, which are marked as measuring positions DMP.

[0144] The principle described in FIGS. 6A to 6H is also used in the design example of a deformation body in FIG. 7. Here a measurement is preferably carried out at the measuring positions DMP in the lower area of the cylindrical base body without ribs.

[0145] The deformation bodies shown in FIGS. 5-7 can be produced advantageously from plastic, although production from metal is not excluded.

[0146] FIG. 8 shows a cross-section of an example implementation of a further gas spring device with deformation body or fastening element BM with a sliding piece GL between the cylinder Z and the fastening element BM. The illustration shows that the deformation body BM has areas of lower stiffness, namely where the deformation body BM has corresponding recesses inside and outside along the cylindrical circumference. For example, the deformation body BM in the shown embodiment is made of metal,

whereby the form-fitting connection between gas spring or cylinder Z and deformation body BM is produced by the sliding piece at the top and bottom.

[0147] When using a metal component, the deformation measurements improve due to the linear material properties of the metal, as it has a linear elastic behavior.

[0148] In various configurations, a measuring position DMP can be provided on the inside or outside of a housing of the gas spring device, as shown in FIG. 9, for example. In particular, the measuring position DMP is located between a fastener or guide element and the cone KON. At this point in particular radial forces can be measured, i.e. forces perpendicular to the longitudinal axis of the gas spring.

[0149] The principle just described can be applied in a similar way to arrangements with a multi-part housing, as shown for example in FIG. 10 and FIG. 11. In particular, in these embodiments the housing G is formed by an inner tube IR, which is at least partially inserted into an outer tube AR and connected to it. In the configurations shown, the connection is made in the area of the dashed circles along the respective circumference, i.e. at the lower end in FIG. 10 and in the middle area of the housing in FIG. 11.

[0150] In the configurations shown, conventional designs can be modified both for the guide element or fastening element BM and for an end plate in the lower area of the gas spring arrangement. By extending the housing by a further tube, axial forces along the longitudinal axis as well as radial forces and bending moments can be measured at the same position directly on the tube. The possible measuring positions DMP are again marked in the drawing and are mainly located in the area of the connection between inner tube IR and outer tube AR. In the configurations shown, measurements of any frictional effects that may occur between the guide element and the gas spring are not affected or at least reduced.

[0151] FIGS. 12A and 12B and FIGS. 13A and 13B use a concept for case G similar to FIGS. 10 and 11. Correspondingly, the housing again is built by inner pipe IR and outer pipe AR, which are connected at points marked by a dotted circle along the circumference.

[0152] A special deformation body VK is provided in each case in the area of these fastenings, on which corresponding strain gauges or similar can be applied. This is indicated by the possible measuring positions DMP. For example, the strain gauges can be mounted in advance on the deformation body VK and then inserted into the housing.

[0153] FIGS. 14A, 14B and 14C show different designs of end plates EP as deformation bodies according to the improved concept. In the examples in FIGS. 14A and 14B, the end plates EP are formed with two webs from an outer ring to an inner ring on which axial forces can be absorbed by the gas spring. This finally leads to deformations at the webs, on which deformation sensors, especially strain gauges, can be applied at the corresponding measuring positions DMP. This allows at least the axial forces to be measured.

[0154] In FIG. 14C, the connection between the outer ring and inner ring is formed by three webs, at each of which a measuring position DMP can be provided. In addition to the detection of axial forces, this also enables the detection of a bending load on the gas spring, i.e. radial forces.

[0155] FIGS. 15A, 15B and 15C show different designs for mounting deformation sensors according to the improved

concept. In particular, by using several strain gauges at the measuring positions DMP, different force influences can be recorded in order to record forces in several directions, for example axial forces and radial forces. Bending moments can also be calculated from the measurements.

[0156] FIG. 16 shows another potential embodiment of the gas spring device, which is essentially based on the embodiment shown in FIG. 4.

[0157] The gas spring device in this embodiment optionally contains an energy harvesting device with an energy store (not shown), a coil S1 and a permanent magnet arrangement M. The energy store can be contained by the circuit SK or be arranged at another location of the gas spring device, for example in the housing G.

[0158] In the example in FIG. 16, coil S1 is arranged in a ring around the cylinder Z. So one or more windings of coil S1 run ring-shaped or essentially ring-shaped around cylinder Z. For example, the coil S1 is wound or arranged around the fastener BM. For example, a winding axis of coil S1 is parallel to or coincides with the longitudinal axis of the gas spring. Coil S1 is electrically connected to circuit SK.

[0159] The permanent magnet arrangement M in the gas spring device of FIG. 16, for example, is formed by an annular permanent magnet or a large number of annular permanent magnets RM1, RM2, RM3, RM4, RM5. It should be noted that the permanent magnet arrangement M comprises at least one annular permanent magnet. In particular, the number of ring-shaped permanent magnets is not necessarily equal to 5, as shown in FIG. 16. In addition, the permanent magnet arrangement M can also contain more than five annular permanent magnets, as indicated by the points in FIG. 16.

[0160] Each of the annular permanent magnets RM1, RM2, RM3, RM4, RM5 is radially magnetized. In particular, each of the annular permanent magnets RM1, RM2, RM3, RM4, RM5 has a north pole on an inner side, in particular a radial inner side, and a south pole on an outer side, in particular a radial outer side, or vice versa. The North and South poles are shown in FIG. 16 as N and S. The annular permanent magnets RM1, RM2, RM3, RM4, RM5 of the permanent magnet arrangement M, for example, are stacked one above the other along the longitudinal axis of the gas spring. Neighboring annular permanent magnets are magnetized in the opposite direction. For example, annular permanent magnets adjacent to an annular permanent magnet with a south pole on the inside and a north pole on the outside have a north pole on the inside and a south pole on the outside and vice versa.

[0161] Each of the annular permanent magnets RM1, RM2, RM3, RM4, RM5 has a symmetry axis which coincides with or substantially coincides with the longitudinal axis of the gas spring or runs parallel to the longitudinal axis of the gas spring. The annular permanent magnets RM1, RM2, RM3, RM4, RM5 are arranged around the cylinder Z, the fastening element BM and the coil S1. The annular permanent magnets RM1, RM2, RM3, RM4, RM5, for example, are mounted on an inner side of housing G.

[0162] The permanent magnet arrangement M generates an inhomogeneous magnetic flux density inside the annular permanent magnets RM1, RM2, RM3, RM4, RM5. The arrangement and orientation of the annular permanent magnets RM1, RM2, RM3, RM4, RM5 or their axis of symmetry and the arrangement or orientation of coil S1 generate a magnetic flux through coil S1. Due to the inhomogeneity of

the magnetic flux density, the magnetic flux through coil S1 changes during movement of cylinder Z and thus of coil S1 along the longitudinal axis of the gas spring.

[0163] The changing magnetic flux through coil S1 induces a voltage in coil S1 by electromagnetic induction and generates a current in the coil based on the induced voltage, for example. The circuit SK is designed to tap the induced voltage and/or the generated current and thus charge the energy store. If necessary, the circuit SK may also be equipped to rectify the induced voltage or the current generated to charge the energy store by means of a rectifier circuit.

[0164] A power supply of the circuit SK, the force sensor KS, the deformation sensor, the communication interface and/or other elements of the gas spring device is thus possible by means of the energy harvesting device and the energy store.

[0165] In alternative embodiments, the energy harvesting device can contain the force sensor KS instead of or in addition to the coil S1 and the permanent magnet arrangement M, especially if the force sensor KS comprises a piezoelectric sensor. The energy store can then be charged, for example, by an electrical voltage generated by the piezoelectric sensor or a resulting current.

[0166] It should be noted that alternative embodiments of the gas spring device do not include the energy harvesting device. In such designs, for example, the circuit can be supplied with electrical energy via one or more batteries.

[0167] Alternative embodiments of the gas spring device do not include the force sensor KS and/or the deformation sensor.

[0168] In alternative embodiments, the housing G is not connected to the base FK, but to the seat surface SF, for example, while the piston K or the cylinder Z is connected to the base FK.

[0169] In alternative embodiments, not the cylinder Z of the gas spring is movable, but the piston K, while the cylinder Z is fixedly connected to the housing G along the longitudinal axis of the gas spring.

[0170] In alternative embodiments, the circuit SK is not arranged on the fastener BM, but for example at a different position in or on the housing G. Circuit SK for example can also be arranged outside of housing G.

[0171] In alternative embodiments, the permanent magnet arrangement M is connected to the cylinder Z and is moved along the longitudinal axis when the cylinder Z moves. In such designs, the coil S1 is not connected to the cylinder Z and is not moved along the longitudinal axis when the cylinder Z moves.

[0172] Optionally, the gas spring device has a plug connector ST, especially a plug or a socket. The connector ST, for example, can be connected to another corresponding connector of the office chair BS, which is arranged, for example, on the seat surface SF or the base FK. In addition, the connector ST is electrically connected to the circuit SK.

[0173] Via the connector, for example, data can be exchanged between the circuit SK and other electronic components of the office chair BS. In particular, data can be transferred from the other electronic components of the office chair to the circuit SK. The data transmitted from the other electronic components to the circuit SK, for example, can be transmitted via the communication interface of the circuit SK to the other external receiver.

[0174] The other electronic components can, for example, be supplied with electrical energy via the energy harvesting device and the plug connector ST. In designs that include both the connector ST and the energy harvesting device, the energy harvesting device can be used to supply power to the other electronic components.

[0175] FIG. 17A shows another example embodiment of a gas spring device according to the improved concept. The gas spring device of FIG. 17A is based on the gas spring device of FIG. 4 or FIG. 16.

[0176] Differences between the gas spring device of FIG. 17A and the gas spring device of FIG. 4 or FIG. 16 concern, for example, only the energy harvesting device and possibly a shape of the fastener BM.

[0177] The energy harvesting device of the gas spring device of FIG. 17A contains a coil S2 whose windings run, for example, around a winding axis which lies in a plane which is perpendicular to the longitudinal axis of the gas spring. For this purpose, for example, the coil S2 can be arranged on the fastener BM. The fastener comprises, for example, at least one elongated component arranged on the cylinder Z.

[0178] In the gas spring device of FIG. 17A, the permanent magnet arrangement M contains a first and a second permanent magnet M1, M2. The first permanent magnet M1, for example, is mounted on a first side of housing G, especially on an inner side of housing G. For example, the second permanent magnet M2 is mounted on a second side of housing G, especially on an inner side of housing G. The second side is opposite the first side. The first permanent magnet M1 has a south pole on one side facing housing G and the second permanent magnet M2 has a north pole on one side facing housing G. The first permanent magnet M1 has a north pole. Accordingly, the first permanent magnet M1 has a north pole on one side facing away from the housing G, i.e. towards the gas spring, while the second permanent magnet M2 has a south pole on one side facing away from the housing, i.e. towards the gas spring.

[0179] The arrangement of coil S2 or its orientation and the arrangement and orientation of the first and second permanent magnets M1, M2 generate a magnetic flux density which, depending on the position, especially the rotational position, generates a more or less large magnetic flux through coil S2. If the cylinder Z or the gas spring rotates around the longitudinal axis of the gas spring, for example caused by a rotation of the office chair or the seat surface SF, the coil S2 also rotates in this way. Consequently, an angle that includes the coil S2, in particular a winding plane or the winding axis of the coil S2, with a direction of magnetic flux density changes during rotation. As a result, the magnetic flux through coil S2 varies during the rotational movement around the longitudinal axis, which in turn leads to an induction voltage in coil S2. The induced voltage induces a current which is picked up by the circuit SK, rectified if necessary and used to charge the energy store.

[0180] With a gas spring device as in FIG. 17A, electrical energy can be harvested from a rotational movement of the seat surface and thus the energy store can be charged. It is pointed out that in other embodiments the energy harvesting devices of the gas spring devices as described and shown in FIGS. 16 and 17A, 17B and 17C can be combined at any time. This means that energy can be won and stored in the

energy store both when the seat surface or gas spring rotates and when it moves along the longitudinal axis of the gas spring.

[0181] FIG. 17B shows an example implementation of a permanent magnet arrangement M for use in a gas spring device according to the improved concept, in particular a gas spring device as shown in FIG. 17A.

[0182] For example, the first magnet M1 is a semicircular magnet with radial magnetization, so that on the inside of the first magnet M1 there is a north pole and on the outside of the first magnet M2 there is a south pole. Correspondingly, the second permanent magnet M2 is also designed as a radially magnetized semicircular magnet. The second permanent magnet M2 has a south pole on one inside and a north pole on one outside. The first and second permanent magnets M1, M2 are arranged so that together they form a ring which is arranged around the coil S2 and the gas spring, as shown in FIG. 17A.

[0183] Just for clarification, a single winding of coil S2 and an exemplary direction of the magnetic flux density B are shown.

[0184] In alternative embodiments, the permanent magnet arrangement M can also be designed as a single diametrically polarized magnet. With such magnets, one half ring half represents a north pole and another half ring half a south pole.

[0185] FIG. 17C shows another example of a permanent magnet arrangement M for use in a gas spring device according to the improved concept, in particular a gas spring device as shown in FIG. 17A.

[0186] The permanent magnet arrangement M is annular (FIG. 17C shows only a partial segment of the permanent magnet arrangement M) and runs around the coil S2 and the gas spring, especially the cylinder Z. The permanent magnet arrangement M consists of permanent magnets M3, M4, M5, M6 arranged side by side, which for example have the form of ring segments. Adjacent ring segments correspond to alternately magnetized magnets, especially alternately radially magnetized magnets. Each ring segment M3, M4, M5, M6 has either a north pole on one side and a south pole on the outside or vice versa. Ring segments adjacent to a ring segment which has a south pole on the inside and a north pole on the outside have a north pole on the inside and a south pole on the outside and vice versa.

[0187] The magnetic flux density B runs in an arc on the inside of the permanent magnet arrangement M from the north poles of the ring segments to the south poles of the adjacent ring segments. This generates an inhomogeneous magnetic field inside the permanent magnet arrangement M. Consequently, the magnetic flux through coil S2 changes during a rotational movement of coil S2 around the longitudinal axis of the gas spring, which in turn leads to an induced voltage in coil S2. For the sake of clarity, the magnetic flux density B is shown as an example only between two ring segments M5, M5.

[0188] FIG. 18 shows another example implementation of a permanent magnet arrangement M for use in a gas spring device according to the improved concept. The permanent magnet arrangement M of FIG. 18, for example, can be used in a gas spring device as in FIG. 16 instead of or in addition to the permanent magnet arrangement shown and described there.

[0189] The permanent magnet arrangement M of FIG. 18 contains an annular permanent magnet RM, which is

arranged around the gas spring, especially around the cylinder Z. The longitudinal axis of the gas spring is indicated in FIG. 18 by a semi-dot line. The permanent magnet arrangement M also has a first ferromagnetic element FM1, which has a U-shaped profile with an opening facing away from the gas spring or cylinder Z, respectively. The first ferromagnetic element FM1, for example, is rotationally symmetrical around the longitudinal axis of the gas spring and runs around the gas spring or around the cylinder Z. The annular permanent magnet RM is radially magnetized and has a south pole on a radial inner side and a north pole on a radial outer side or vice versa. The annular permanent magnet RM1 is connected to the first ferromagnetic element FM1, in particular magnetically conductive. For example, the annular permanent magnet RM1 is located inside the U-shaped profile of the first ferromagnetic element FM1.

[0190] The permanent magnet arrangement M also has a coil S3, which is arranged around the annular permanent magnet RM and is connected to it, for example. A winding axis of the coil S3 is parallel to the longitudinal axis of the gas spring and/or to the symmetry axis of the annular permanent magnet RM.

[0191] For example, the first ferromagnetic element FM1 is connected to the cylinder Z of the gas spring, so that when the cylinder Z moves along the longitudinal axis of the gas spring, the first ferromagnetic element FM1, the annular permanent magnet RM and the coil S3 also move along the longitudinal axis of the gas spring.

[0192] The permanent magnet arrangement M also has a second ferromagnetic element FM2, which is not moved along the longitudinal axis of the gas spring when the cylinder Z moves and is connected, for example, to the housing G of the gas spring device. The second ferromagnetic element FM2, for example, is arranged rotationally symmetrically around the gas spring, for example on an inner side of housing G. The second ferromagnetic element FM2 has a stepped profile. In particular, the second ferromagnetic element FM2 has first regions which have a first distance, in particular a first radial distance, from an axis of symmetry of the second ferromagnetic element FM2 and second regions which have a second distance, in particular a second radial distance, from the axis of symmetry of the second ferromagnetic element FM2. The second distance is greater than the first distance.

[0193] When the cylinder Z, the first ferromagnetic element FM1, the annular magnet RM and the coil S3 move along the longitudinal axis of the gas spring, the magnetic flux density at one position of the coil S3 varies through a changing flux density guidance due to the first and second ferromagnetic elements FM1, FM2, the U-shaped profile of the first ferromagnetic element FM1 and the stepped profile of the second ferromagnetic element FM2.

[0194] This causes a magnetic flux through the coil S3 to change during movement along the longitudinal axis, resulting in an electromagnetically induced voltage in the coil S3.

[0195] For example, the first and/or second ferromagnetic elements FM1, FM2 contain iron or another ferromagnetic material.

[0196] In alternative embodiments, the second ferromagnetic element FM2 is connected to the cylinder Z and is moved along the longitudinal axis. Then the first ferromagnetic element FM1, the annular permanent magnet RM and the coil S3 are not connected to the cylinder Z and are therefore not moved along the longitudinal axis.

[0197] The different aspects and components of the gas spring device or the office chair BS according to the improved concept described here can be combined depending on the specific application.

[0198] With an office chair BS according to the improved concept, it is possible to record user data such as the weight data, the center of gravity data, the other weight data, the height data and/or the other height data and to transmit them to an external receiver, for example to evaluate the user data, using the circuit SK. The evaluated user data can serve, for example, as a basis for instructions to the user of the office chair BS. In this way, the usage behavior of the user of the BS office chair can be improved.

[0199] By arranging the at least one sensor element, the circuit SK and, if necessary, the energy harvesting device in or on the gas spring device, a particularly efficient and flexible solution is achieved. In particular, the gas spring device is easy to replace, so that, for example, conventional office chairs can also be equipped with a gas spring device of an office chair BS according to the improved concept.

REFERENCE SIGNS

- [0200] BS office chair
- [0201] SF seat surface
- [0202] RL backrest
- [0203] FK base
- [0204] G housing
- [0205] Z cylinder
- [0206] K piston
- [0207] SK electronic circuit
- [0208] KS force sensor
- [0209] VS1, VS2 deformation sensor elements
- [0210] BM fastener
- [0211] V adjustment element
- [0212] ST connectors
- [0213] S1, S2, S3 coils
- [0214] M permanent magnet arrangement
- [0215] RM1, RM2, RM3, permanent magnets
- [0216] RM4, RM5, RM, M1, permanent magnets
- [0217] M2, M3, M4, M5, M6 permanent magnets
- [0218] S South pole
- [0219] N North pole
- [0220] B magnetic flux density
- [0221] FM1, FM2 ferromagnetic elements

1. A gas spring device for adjusting the height of an office chair, the gas spring device comprising

a gas spring, arranged and equipped for height adjustment of the office chair by means of a movable component of the gas spring,

at least one sensor element arranged on the gas spring device, configured to detect a load on the gas spring device and to generate at least one sensor signal depending on the detected load, and

an electronic circuit arranged to generate usage data depending on the at least one sensor signal, the usage data representing one or more facts about a usage of the office chair; wherein

the at least one sensor element comprises at least one of the following:

a force sensor, which is configured to detect a force acting on the gas spring in the direction of a longitudinal axis of the gas spring and to generate a force signal depending on the detected force;

at least one deformation sensor which is configured to detect a deformation of the gas spring device and to generate a deformation signal depending on the detected deformation.

2. The gas spring device according to claim 1, wherein the at least one sensor element comprises the force sensor, and the circuit is configured to generate weight data representing a body weight of a user of the office chair as a function of the force signal.

3. The gas spring device according to claim 1, wherein the at least one sensor element comprises the at least one deformation sensor, and

the circuit is adapted to generate center of gravity data representing a position of a center of gravity of a user of the office chair depending on the deformation signal.

4. The gas spring device according to claim 3, wherein the at least one sensor element comprises a deformation body which is arranged at least in part between the gas spring device and a seat surface of the office chair, and the at least one deformation sensor is arranged on the deformation body and is configured to detect a deformation of the deformation body and to generate the deformation signal as a function of the detected deformation of the deformation body.

5. The gas spring device according to claim 4, wherein the deformation body acts as a guide element for the cylinder in a housing of the gas spring device.

6. The gas spring device according to claim 4, wherein the deformation body has at least one selected area of reduced stiffness, in particular with respect to other areas of the deformation body, and wherein the at least one deformation sensor is arranged on the at least one selected area.

7. The gas spring device according to claim 6, wherein the at least one selected area is formed by a weakening of material, in particular by a recess, a notch or some other weak point.

8. The gas spring device according to claim 6, wherein a force flow through the deformation body passes through the at least one selected area.

9. The gas spring device according to claim 4, wherein the deformation body is formed from plastic or metal.

10. The gas spring device according to claim 4, wherein a housing of the gas spring device is formed by two tubular parts at least partially pushed into one another, and wherein the deformation body is arranged in a region of connection of the two parts.

11. The gas spring device according to claim 10, wherein the two parts are connected together in a region of an end plate of the gas spring device.

12. The gas spring device according to claim 10, wherein the two parts are connected in an end portion of an outer one of the two parts, said end portion facing a center of the housing.

13. The gas spring device according to claim 4, wherein the at least one deformation sensor is configured to detect a force acting on the deformation body in the direction of the longitudinal axis of the gas spring and to generate a further force signal depending on the force acting on the deformation body, and

the circuit is configured to generate first additional weight data representing a body weight of a user of the office chair depending on the further force signal.

14. The gas spring device according to claim **3**, wherein the at least one deformation sensor is arranged on the gas spring and is configured to detect a deformation of the gas spring and to generate the deformation signal dependent on the detected deformation of the gas spring.

15. The gas spring device according to claim **3**, wherein the at least one deformation sensor is arranged on a housing, in particular on an inside or an outside of the housing, of the gas spring and is configured to detect a deformation of the housing of the gas spring and to generate the deformation signal depending on the detected deformation of the housing of the gas spring.

16. The gas spring device according to claim **15**, wherein a housing of the gas spring device is formed by two tubular parts at least partially pushed into each other, and wherein the deformation sensor is arranged in a region of connection of the two parts.

17. The gas spring device according to claim **1**, wherein the deformation signal represents exclusively or additionally a force which acts on the gas spring substantially in the direction perpendicular to the longitudinal axis of the gas spring.

18. The gas spring device according to claim **1**, wherein the at least one sensor element is formed by a pressure sensor which detects an internal pressure of the gas spring, wherein the force signal is formed by the detected internal pressure.

19. The gas spring device according to claim **1**, wherein the at least one sensor element comprises at least one position sensor which is adapted to detect a position of the movable component and to generate a position signal dependent on the detected position; and the circuit is configured, to determine, based on a change in the position signal and on a spring constant of the gas spring, a force which acts on the gas spring in the direction of a longitudinal axis of the gas spring, and to generate second additional weight data representing the body weight of a user of the office chair, depending on the determined force.

20. The gas spring device according to claim **1**, wherein the circuit comprises a communication interface configured for wireless transmission of the usage data to at least one external receiver.

21. The gas spring device according to claim **20**, wherein the communication interface is adapted to transmit the usage data via Bluetooth, WLAN, Zigbee, RF, RFID or a GSM-based technology.

22. The gas spring device according to claim **20**, wherein the external receiver is formed as a smartphone or tablet computer.

23. The gas spring device according to claim **1**, further comprising a plug connector for a plug connection adapted to electrically connect the gas spring device to other electronic components of the office chair.

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