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Actuation Device, Motor Vehicle

Abstract

An actuation device for a motor vehicle, in particular for specifying a braking and/or acceleration request is disclosed. The actuation device has a first housing portion and a second housing portion. The first housing portion is displaceably mounted on the second housing portion in the longitudinal extension of the second housing portion. The first housing portion has an actuating surface on a top surface facing away from the second housing portion, or a cover having an actuating surface is arranged on a top surface facing away from the second housing portion. The housing portions are each formed at least in sections in a cylindrical shape with a closed casing wall. The actuation device further has a first sliding element and a second sliding element arranged between the housing portions. The first sliding element and the second sliding element each abut axially against at least one of the housing portions. The actuation device further includes at least one spring element, in particular a coil spring, arranged as a return spring, pretensioned axially, in particular coaxially with the housing portions in order to urge the housing portions into an unactuated rest position.

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Background/Summary

[0001] This application claims priority under 35 U.S.C. § 119 to patent application no. DE 10 2024 201 375.7, filed on Feb. 15, 2024 in Germany, the disclosure of which is incorporated herein by reference in its entirety.

[0002] The disclosure relates to an actuation device for a motor vehicle, in particular for indicating a braking and/or acceleration request, having a first housing portion and having a second housing portion, wherein the first housing portion is displaceably mounted on the second housing portion in the longitudinal extension of the second housing portion, and wherein the first housing portion has an actuating surface on a top surface facing away from the second housing portion, or wherein a cover having an actuating surface is arranged on a top surface facing away from the second housing portion. In addition, the disclosure relates to a motor vehicle having one such actuation device.

BACKGROUND

[0003] From the prior art, it is known to detect an actuation of an actuation device for a motor vehicle which can be actuated by a driver using a sensor assigned to the actuation device. If the driver actuates the actuation device, a braking or acceleration request of the driver is in particular detected as a function thereof. For example, brake systems with electromechanical brake amplifiers are known that, together with a vehicle assistance system, in particular an electronic stability program (ESP), form a redundant brake-by-wire system, in which there is no mechanical connection from the actuation device to the brake system. A braking request is forwarded, for example, as a function of an actuation of the actuation device to an electromechanical actuator which is designed to carry out a pressure build-up in the braking system.

[0004] Analogously, actuation devices for drive units, in particular with internal combustion engines and/or electric motors, are known from motor vehicles which are part of a drive-by-wire system without a mechanical connection to the drive unit. For example, an acceleration request is detected as a function of an actuation of the actuation device and forwarded to the drive unit. Due to the lack of mechanical coupling of the actuation devices to the brake system and/or the drive unit, it is possible to design such actuation devices which are stroke-free or with at least a low stroke of a few millimeters. The use of different measurement methods is known for detecting the actuation.

[0005] For example, the applicant's application DE 10 2022 212 470.7, which has not yet been published, discloses an actuation device in accordance with the genus, which comprises a first and a second housing portion, wherein the first housing portion is displaceably mounted on the second housing portion in the height extension of the second housing portion, wherein the first housing portion has an actuating surface on a top surface facing away from the second housing portion or wherein a cover with the actuating surface is arranged on the top surface, wherein a sensor arrangement for detecting an actuation of the actuation device, in particular an actuating force exerted on the actuating surface, and wherein a partition is formed or arranged in the second housing portion, which forms a chamber with the second housing portion, in order to enclose at least one component of the sensor arrangement in a media-tight manner.

[0006] From the applicant's application DE 10 2022 212 450.2, which has also not yet been published, a matching sensor arrangement is known which has a force transmission element, in particular assignable or assigned to the actuating surface of the actuation device, for transmitting an actuating force exerted on the actuation device, in particular on the actuating surface, and a measuring head arranged in a circuit board, wherein the measuring head has a measuring membrane, and wherein the measuring membrane has a force sensor element at one end and is assigned to the force transmission element at the other end.

SUMMARY

[0007] The actuation device according to the disclosure is characterized in that the housing portions are each formed at least in sections in a cylindrical shape with a closed casing wall, that a first sliding element and a second sliding element are arranged between the housing portions, the first sliding element and the second sliding element each abut axially against at least one of the housing portions, and at least one spring element, in particular a coil spring, is arranged as a return spring, pretensioned axially, in particular coaxially with the housing portions, in order to urge the housing portions into an unactuated rest position. In this respect, the sliding elements perform an advantageous dual function. On the one hand, they ensure that the housing portions are displaceable relative to each other with little friction, and on the other hand, they securely lock the spring element in its position. In this respect, the actuation device according to the disclosure has, in contrast to the aforementioned actuation device of the applicant, in particular the two sliding elements with the spring element arranged therebetween. The shape of the housing portions also differs: in the prior art, they have a rather rectangular or trapezoidal cross-section, whereas the disclosure provides a cylindrical design, at least in sections, in particular with a circular cross-section. In particular, at least one of the housing portions has a different inner diameter and/or outer diameter in each of the areas associated with the sliding elements, so that a particularly advantageous stepped guide is realized overall by the sliding elements.

[0008] According to a preferred embodiment of the disclosure, it is provided that one of the sliding elements, in particular the first sliding element, is displaceable along the longitudinal extension of the second housing portion together with the first housing portion relative to the second housing portion, and/or that one of the sliding elements, in particular the second sliding element, is arranged in a stationary position on the second housing portion and the first housing portion is displaceable along the longitudinal extension of the second housing portion relative to the sliding element. In this respect, each sliding element is preferably arranged in a stationary position on exactly one of the housing portions, or moves with exactly one of the housing portions. Such a design and arrangement of the sliding elements is advantageous in ensuring that the housing portions are displaceable relative to one another with little friction. If, for example, the first sliding element is displaceable together with the first housing portion relative to the second housing portion, then the sliding element accordingly supports the first housing portion as the outer housing shell, which can move relative to the second housing portion as the inner housing shell. In particular, the sliding elements have different inner diameters and/or outer diameters. Preferably, at least one of the sliding elements is cylindrical or pot-shaped so that it is securely fixed in position relative to one of the housing portions.

[0009] It is particularly preferred that at least one of the sliding elements, in particular the first and the second sliding element, respectively, abuts against an inner side of the first housing portion by way of a first surface and/or abuts against an outer side of the second housing portion by way of a second surface, in particular the surface facing away from the first surface. This has the advantage that the sliding element is arranged in a planar manner between the two housing portions and the sliding effect is maximized, and it is ensured that the housing portions do not rub directly against one another, but that the respective sliding element is always arranged therebetween. In this case, a corresponding sliding effect is produced in particular between the first surface and the inner side of the first housing portion or between the second surface and the outer side of the second housing

portion.
[0010] According to a preferred embodiment of the disclosure, it is envisaged that the first housing portion has a first inner diameter in a first region associated with the first sliding element and has a second inner diameter in a second region associated with the second sliding element, which second inner diameter is greater than the first inner diameter. The different inner diameters result in a particularly advantageous stepped guidance of the housing portions on one another.
[0011] It is particularly preferred that the second housing portion has a first outer diameter in a first region associated with the first sliding element and has a second outer diameter in a second region associated with the second sliding element, which second outer diameter is greater than the first outer diameter. The different outer diameters result in a particularly advantageous stepped guidance of the housing portions on one another. In particular, the sliding elements and/or housing portions have an at least substantially constant material thickness, so that a ratio of the different outer diameters corresponds at least substantially to a ratio of the different inner diameters mentioned above.
[0012] According to a preferred embodiment of the disclosure, it is provided that the sliding elements are each at least essentially cylindrical in shape and have an outer diameter corresponding to the respective inner diameter of the first housing portion and/or an inner diameter corresponding to the respective outer diameter of the second housing portion. This advantageously ensures that the respective sliding element and the respective housing portion are securely held against each other or slide off each other with little friction.
[0013] It is particularly preferred that the spring element is configured as a coil spring and has an inner diameter corresponding to the first outer diameter. This has the advantage that the spring element is designed to fit the geometry of the housing portion and is arranged to surround or enclose the latter in some areas. The spring element is then pushed onto the housing portion to that extent and is held in an interlocking manner in the radial extent of the housing portion. In the axial extent, the spring element is then held by the sliding elements accordingly.
[0014] According to a preferred embodiment of the disclosure, it is provided that one of the sliding elements, in particular the first sliding element, has a circumferential radial protrusion, and in that the spring element abuts, at least in certain regions, against a surface of the protrusion facing the other of the sliding elements, in particular the second sliding element, by way of a first end, and/or that one of the sliding elements, in particular the second sliding element, has an end side having an opening with a diameter corresponding to the first outer diameter for the first region of the second housing portion and the spring element abuts, at least in certain regions, against a surface of the end side facing the other of the sliding elements, in particular the first sliding element, by way of a second end facing away particularly from the first end. The fact that the spring element abuts against the protrusion and/or the end side is advantageous in ensuring that the spring element is securely fixed between the sliding elements. The spring element is then advantageously secured in an interlocking manner in the radial and axial extent of the housing portion, in particular in connection with the aforementioned sliding on of the second housing portion.
[0015] It is particularly preferred that at least one first pin arranged in an opening of the first housing portion and protruding in the direction of the second housing portion, is arranged on the first housing portion, in particular on a circumferential radial protrusion, as an anti-rotation device, which first pin is introduced into an opening, corresponding to its outer contour, of the second housing portion, in particular an opening arranged in a circumferential radial protrusion. The advantage of such an anti-rotation device is that the housing portions are securely fixed and aligned relative to each other, and that the only degree of freedom of movement is the displacement in the axial extension of the housing portions.
[0016] According to a preferred embodiment of the disclosure, it is provided that the first pin is arranged in an opening in the second housing portion, and in that, on the first pin, on its end region facing away from the first housing portion an axial stop, in particular a press sleeve surrounding the

pin circumferentially, is arranged on the first pin for limiting a stroke of the housing portions relative to each other and/or for adjusting a pretensioning of the spring element. This creates a geometrically particularly advantageous and simple option for stroke limitation and preload adjustment by appropriately positioning the axial stop.

[0017] It is particularly preferred that at least one second pin, in particular a second pin arranged in an opening in the second housing portion and protruding in the direction of the first housing portion, is arranged on the second housing portion, in particular on a circumferential radial protrusion, for adjusting a stroke of the housing portions relative to each other. The advantage of using a corresponding pin is that the stroke can be easily adjusted as a function of the length and/or insertion depth of the pin.

[0018] According to a preferred embodiment of the disclosure, it is provided that at least one of the pins is formed in one piece with the corresponding housing portion or is connected to the corresponding housing portion in an interlocking, force-fit and/or materially bonded manner, in particular glued, welded and/or pressed and/or screwed into a corresponding opening. This is an advantage in ensuring that the respective pin is designed or connected to the housing portion in a particularly secure and simple manner.

[0019] It is particularly preferred that a circumferential sealing element, in particular a bellows-like sealing element is arranged between the first and the second housing portion for sealing against a region outside the housing portions, in particular in each case in regions on a circumferential radial or axial protrusion of the respective housing portion. The advantage of the corresponding sealing element is that the corresponding region between the housing portions is protected from environmental influences.

[0020] According to a preferred embodiment of the disclosure, a sensor module for detecting an actuation of the actuation device, in particular an actuating force exerted on the actuating surface and/or an actuation path of the actuating surface, is arranged in the second housing portion. This type of sensor module provides a particularly advantageous and simple way of detecting the actuation. In particular, the sensor module is inserted into the second housing portion as a pre-assembly group.

[0021] The motor vehicle with the features set forth below is characterized by at least one actuation device according to the disclosure. The advantages specified hereinabove are achieved as a result. For example, a motor vehicle is provided that has two such actuation devices: one for indicating a braking request, i.e. as a brake pedal, and one for indicating an acceleration request, i.e. as an accelerator pedal. Alternatively, a motor vehicle is provided that has an actuation device of this kind for indicating a braking and acceleration request, i.e. as a combined accelerator pedal. This also results in the advantages specified hereinabove.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Further preferred features and combinations of features result from the previous description and from the claims. The disclosure is explained in more detail below with reference to the drawings. Shown are:

[0023] FIG. **1** an advantageous actuation device,

[0024] FIG. **2** the actuation device in a sectional view,

[0025] FIG. **3**A a first detailed view of the actuation device,

[0026] FIG. **3**B a second detailed view of the actuation device,

[0027] FIG. **4** a sensor module for the actuation device in a sectional view,

[0028] FIG. **5**A a first detail view of the sensor module,

[0029] FIG. **5**B a second detail view of the sensor module, and

[0030] FIG. **6** the actuation device with the sensor module in a further sectional view.

DETAILED DESCRIPTION

[0031] FIG. **1** shows an exemplary embodiment of an actuation device **1** for a motor vehicle not shown. The actuation device **1** is designed to indicate a braking request and/or an acceleration request. For this purpose, the actuation device **1** can be operated by a driver of the motor vehicle by foot, i.e. it is designed as a brake pedal, accelerator pedal and/or accelerator. This is an actuation device with a short stroke, for which only small displacements in the region of a few millimeters can usually be achieved.

[0032] The actuation device **1** comprises a first housing portion **2** and a second housing portion **3**. The first housing portion **2** is displaceably mounted on the second housing portion **3** in the longitudinal extension of the second housing portion **3**. In the present case, a cover **5** having an actuating surface **6** which can be actuated by the driver is arranged on a top surface **4** of the first housing portion **2** that faces away from the second housing portion **3**.

[0033] The cover **5** can be designed as a single piece or, as shown here, as several pieces, wherein the individual parts are interconnected in an interlocking manner, for example. According to a non-represented exemplary embodiment, the cover **5** with the actuating surface **6** is alternatively arranged directly on the top surface **4**.

[0034] The second housing portion **3** has a plurality of flanges **7**, in particular flanges which are formed integrally with the second housing portion **3** or are connected thereto, which flanges each have an opening **8** for a fastening mechanism **9**, which, in the present case, merely by way of example, is formed as a screw. The second housing portion **3** can be fastened by the fastening mechanism **9** in a footwell of an interior of the motor vehicle, so that the second housing portion **3** is arranged in a stationary position in relation to the motor vehicle.

[0035] A circumferential, in this case bellows-like, elastically deformable sealing element **10** for sealing against a region outside the housing portions **2**, **3** is arranged between the first housing portion **2** and the second housing portion **3**. According to an alternative, non-illustrated exemplary embodiment, the sealing element **10** is in full-surface contact with the first housing portion **2** and covers it completely.

[0036] FIG. **2** shows the actuation device **1** in a sectional view. In FIG. **2**, the components already described and their arrangement in relation to one another can be more clearly seen. The first housing portion **2** and the second housing portion **3** are each designed to be cylindrical, at least in sections, with a closed casing wall. The first housing portion **2** has a first thin-walled casing wall **11** and the second housing portion **3** has a second thin-walled casing wall **12**, which each have an at least substantially constant wall thickness, in particular at least approximately the same wall thickness.

[0037] In the present case, the first casing wall **11** merges into the surface **4**, so that the first housing portion **2** has a closed end side, whereas the second housing portion **3** is open at the end. The two housing portions **2**, **3** only have a constant cross section in certain areas or sections. For example, the housing portions **2**, **3** are formed as plastic portions or metal portions. The housing portions **2**, **3** are formed in particular as deep-drawn sheets, turned, drawn or extruded aluminum profiles, or as injection-molded plastic portions.

[0038] A first sliding element **13** and a second sliding element **14** are arranged between the first housing portion **2** and the second housing portion **3**, in this case between the first casing wall **11** and the second casing wall **12**. The first sliding element **13** and the second sliding element **14** each bear axially against at least one of the housing portions **2**, **3**. The sliding elements **13**, **14** are designed in particular as plastic plain bearings with a low coefficient of friction or as sintered metal bushes.

[0039] Between the sliding elements **13**, **14**, at least one spring element **15**, in the present case designed as a coil spring, is arranged as a return spring axially, in the present case coaxially with the housing portions **2**, **3**, pretensioned in order to urge the housing portions **2**, **3** into an unactuated

rest position. In the present case, the spring element **15** is designed as a single coil spring.
[0040] According to alternative, non-represented exemplary embodiments, it is also possible to use several spring elements connected in series, or to use one or several disk springs or similar spring elements. It is also conceivable to use one or more, preferably cylindrical, elastomers or any combination of different spring elements, in particular coil springs, disk springs and/or elastomers.
[0041] In this case, one of the sliding elements **13**, **14**, in this case the first sliding element **13**, is displaceable along the longitudinal extension of the second housing portion **3** together with the first housing portion **2** relative to the second housing portion **3**. One of the sliding elements **13**, **14**, in this case the second sliding element **14**, is arranged in a stationary position on the second housing portion **3**. The first housing portion **2** is correspondingly displaceable along the longitudinal extension of the second housing portion **3** relative to the second sliding element **14**.
[0042] The sliding elements **13**, **14** thus perform an advantageous dual function. On the one hand, they ensure that the housing portions **2**, **3** are displaceable relative to each other with little friction, and on the other hand, they securely fix the spring element **15** in its position.
[0043] The first housing portion **2** has an outer side **16**, on which the surface **4** is also located, and an inner side **17** facing away from the outer side **16**. Similarly, the second housing portion **3** has an outer side **18** facing the inner side **17** and an inner side **19** facing away from the outer side **18**.
[0044] The first sliding element **13** has a first, outer surface **20** and an inner surface **21** facing away from the first surface **20**. Similarly, the second sliding element **14** has a first, outer surface **22** and an inner surface **23** facing away from the first surface **22**.
[0045] The first sliding element **13** is in contact with the first surface **20** on the inner side **17** of the first housing portion **2** and with the second surface **21** on the outer side **18** of the second housing portion **3**. The second sliding element **14**, in turn, is in contact with the inner side **17** via the first surface **22** and with the outer side **18** via the second surface **23**.
[0046] In the present case, the first housing portion **2** has, along its longitudinal extension, not only cylindrical sections but also a conical section. This means that, in the present case, it has, along its longitudinal extension, at least one region in which its cross-sectional area or diameter is not constant but varies continuously.
[0047] In this case, it has a first constant inner diameter in a first region **24** assigned to the first sliding element **13** and a second constant inner diameter, which is greater than the first inner diameter, in a second region **25** assigned to the second sliding element **14**.
[0048] For example, the second inner diameter is at least exactly twice the size of the first inner diameter. The two regions **24**, **25** are therefore cylindrical in shape.
[0049] This applies analogously for the corresponding outer diameters, the first housing portion **2** has in this respect in the first region **24** a first constant outer diameter and in the second region **25** a second constant outer diameter which is greater than the first outer diameter.
[0050] The first region **24** is arranged in a longitudinal extension at a first end, in the region of the surface **4**, and the second region **25** is arranged at the second end, facing away from the first end, of the first housing portion **2**. The conical shape is created by the first region **24** and the second region **25** being connected by a third region **26**, in which the first inner diameter and outer diameter expand continuously to form the second inner diameter and outer diameter. The three regions **24**, **25**, **26** are thus part of the casing wall **11**, or at least form it in some regions.
[0051] According to an alternative, non-illustrative exemplary embodiment, the third region **26** has a constant inner diameter and/or outer diameter, in particular the same inner diameter and/or outer diameter as one the other two regions **24**, **25**, so that the first housing portion **2** is then not of overall conical design, but consists of at least two or three cylindrical sections.
[0052] In terms of its basic geometric shape, it would then correspond to the second housing portion **3**. In the present case, this has several such cylindrical sections that are arranged in a row, interconnected or formed integrally with one another.
[0053] Thus, the second housing portion **3** has, in a first region **27** associated with the first sliding

element **13**, a first constant inner diameter and a first constant outer diameter, and, in a second region **28** associated with the second sliding element **14**, a second constant inner diameter and a second constant outer diameter, wherein the second inner diameter and outer diameter are each larger than the first inner diameter and outer diameter. Here too, the regions **27**, **28** are similarly part of the casing wall **12** or at least form it in some regions.

[0054] The sliding elements **13**, **14** are designed to correspond geometrically to the guide elements in that they are each at least essentially cylindrical in shape or each have at least one correspondingly cylindrical section. At least in this portion, they have an outer diameter corresponding to the respective inner diameter of the first housing portion **2** and/or an inner diameter corresponding to the respective outer diameter of the second housing portion **3**.

[0055] For example, the first sliding element **13** is arranged in the first region **24** in an interlocking, force-fitting and/or materially bonding manner, in particular it is pressed in, so that it does not displace relative to the first housing portion **2**, and/or the second sliding element **14** is arranged in an interlocking, force-fit and/or materially bonded manner on the second region **28**, in particular pressed on, so that it does not displace relative to the second housing portion **3**.

[0056] The spring element **15** is arranged in the present case so as to surround the first region **27**, is thereby radially fixed and accordingly has an inner diameter which corresponds to the first outer diameter of the second housing portion **3**, that is to say is at least as large as or larger than the first outer diameter.

[0057] In order to also secure the spring element **15** axially between the sliding elements **13**, **14**, the first sliding element **13** has a circumferential radial protrusion **29** at an end assigned to the spring element **15**. At least one axial protrusion **30**, in particular also circumferential, adjoins the protrusion **29**. The spring element **15** abuts, at least in certain regions, against a surface **31**, facing the second sliding element **14**, of the radial protrusion **29**, by way of a first end **32**, and is thus fixed axially. It is additionally fixed radially by the protrusion **29** between the protrusion **29** and the outer side **18** of the second housing portion **3**.

[0058] In order to axially secure the spring element **15** in another way, the second sliding element **14** has an end side **33** having an opening **34** with a diameter corresponding to the first outer diameter for the first region **27** of the second housing portion **3**. The second sliding element **14** is pushed onto the second housing portion **3** until an inner surface **35** of the end side **33** and an outer surface **36** of the outer side **18**, which is aligned in the radial extension of the second housing portion **3**, touch.

[0059] The spring element now abuts, at least in certain regions, against a surface **37** of the end side **33** facing the first sliding element **13** and facing away from the inner surface **35**, by way of a second end **38** facing away from the first end **32**, and is thus axially fixed. The second sliding element **14** additionally has axial protrusions **39** that protrude from the surface **37**, by way of which the second end **38** is additionally radially fixed between the respective protrusion **39** and the outer side **18** of the second housing portion, analogously to the protrusion **30** of the first sliding element **13**.

[0060] Furthermore, at least one first pin **40** is arranged on the first housing portion **2** as an anti-rotation device. This is shown in a first detailed view of FIG. **3**A, which shows a further sectional view in a sectional plane arranged approximately at right angles to the sectional plane of FIG. **2**.

[0061] The first housing portion **2** has a circumferential radial protrusion **41** adjoining the second region **25**. The first pin **40** is arranged on the protrusion **41** and projects in the direction of the second housing portion **3**. In particular, the first pin **40** is arranged in an opening of the protrusion **41**. The second housing portion **3** has a circumferential radial protrusion **42** that is adjacent to the second region **28**. A first opening **43** is provided in the protrusion **42**, which corresponds to an outer contour of the pin **40**, and into which the pin **40** is inserted.

[0062] At the first pin **40**, at its end region **44** facing away from the first housing portion **2**, there is an axial stop **45**, in the present case in the form of a press sleeve circumferentially surrounding the

pin, for limiting a stroke of the housing portions **2**, **3** relative to each other. The axial stop **45** is mounted when the first pin **40** is inserted through the opening **43**, and in this respect also advantageously ensures that the housing portions **2**, **3** are held captive to one another. The first pin **40** also defines a pretensioning of the spring element **15**, or rather the pretensioning is set as a function\ of its length.

[0063] With regard to the sealing element **10**, it can still be clearly seen in FIG. **3**A, in particular, that this rests against the respective outer sides of the housing portions **2**, **3** in order to seal the region in which the first pin **40** is located and thus to seal the interior of the housing portions **2**, **3** as a whole. Specifically, the sealing element **10** abuts against the second region **25** and against the protrusion **41** of the first housing portion **2**, as well as against a further axial circumferential protrusion **46**, adjoining the radial protrusion **42**, of the second housing portion **3**. The already described radially extending flanges **7** then adjoin the protrusion **46**. The sealing element **10** thus abuts in certain areas against a circumferential radial or axial protrusion **41**, **46** of the respective housing portion **2**, **3**.

[0064] At least one second pin **47** for adjusting a stroke of the housing portions **2**, **3** relative to each other is finally arranged on the second housing portion **3**. In the present case, at least two second pins **47** are provided. This is shown in a second detailed view of FIG. **3**B, which shows an enlarged section of FIG. **2** in the lower left region.

[0065] It can be seen that the second pin **47** is arranged in a second opening **48** of the already described circumferential radial protrusion **42**. It projects in the direction of the first housing portion **2**, specifically in the direction of the protrusion **41**. For example, the pin **47** is pressed into the opening **48**; in the present case, it also has a corrugation along the longitudinal extension.

[0066] Depending on how far the pin **47** is inserted into the opening **48** or how far it protrudes in the direction of the protrusion **41**, the maximum stroke results from when the end of the pin **47** strikes a surface **49** of the protrusion **41** facing it.

[0067] In this case, each of the pins **40**, **47** is connected to the corresponding housing portion **2**, **3** in an interlocking, force-fit and/or materially bonded manner, in particular by adhesive bonding, welding, and/or by being pressed and/or screwed into the corresponding opening **43**, **48**. Alternatively, at least one of the pins **40**, **47** is formed in one piece with the corresponding housing portion **2**, **3**.

[0068] In particular, at least one of the pins **40**, **47** is coated and/or the opening **43**, **48** associated with it is provided with a noise-damping element. Alternatively or additionally, an elastic buffer element, for example a plastic disc, is provided as a noise-damping measure, in particular on the axial stop.

[0069] The components of the actuation device **1** described so far are purely mechanical or a kind of mechanical module of the actuation device **1**. However, it can be seen in FIG. **2** that the interior of the second housing portion **3** forms a cavity. To fill this cavity, a sensor module **50** is provided, which is shown in FIG. **4** as an exemplary embodiment in detail in a sectional view.

[0070] The sensor module **50** can be arranged in a precisely fitting manner in the second housing portion **3** and is designed to detect an actuation of the actuation device **1**, in particular an actuating force exerted on the actuating surface **6** and/or an actuation path of the actuating surface **6**.

[0071] The sensor module **50** has a plate-shaped sensor element **51**, in particular made of metal or plastic. The sensor element **51** can be or is assigned to an actuating element of the actuation device **1**. The actuating element is in particular the actuating surface **6** or the first housing portion **2** connected thereto.

[0072] The sensor module **50** further comprises a sensor housing **52**. The sensor housing **52** has a first cylindrical housing portion **53** and an adjoining, i.e. connected, second cylindrical housing portion **54**, which is formed integrally therewith. The housing portions **53**, **54** have identical, at least largely constant wall thicknesses. The inner diameter and outer diameter of the first housing portion **53** are smaller than the inner diameter and outer diameter of the second housing portion **54**.

[0073] Furthermore, the sensor module **50** in the present case has at least one force sensor element **55** associated with the sensor element **51** for detecting a force exerted on the sensor element **51**, in particular by way of the actuating element, and at least one displacement sensor element **56** associated with the sensor element **51** for detecting a displacement of the sensor element **51**. The force sensor element **55** comprises in particular strain gauges and is in particular configured as described in the previously known prior art of the applicant mentioned at the beginning.
[0074] In order for the sensor module **50** to function as presented, it is sufficient if either the force sensor element **55** or the displacement sensor element **56** is present, wherein, if both are present, an advantageous redundancy arises due to the different measuring principles. In particular, at least two force sensor elements **55** and/or displacement sensor elements **56** are provided in each case in order to further improve the reliability of the measurement and the redundancy.
[0075] In this way, such redundancy in particular fulfills corresponding standards and/or laws in order to meet quality/safety requirements. For example, two different measuring principles are prescribed for brake pedals, and these are each redundant in order to be ASIL-D capable. For accelerator pedals, two redundant sensors with the same measuring principle are sufficient.
[0076] If one sensor fails or drifts, it must be ensured that the remaining sensors are still able to detect the “true” signal of the driver's intention. If a sensor fails, a warning message is issued to the driver, for example. An entire circuit can fail, in which case two sensors would be affected on the brake pedal and one sensor on the accelerator pedal. In this case, the respective redundant sensors take over the detection of the driver's intention, preferably combined with a warning message to the driver.
[0077] The sensor element **51** is mounted in the first housing portion **53** so as to be longitudinally displaceable. For this purpose, the first housing portion **53** has on its inner side **57** at least one groove **58** and/or one web **59** running along its longitudinal extension, in particular at least two the inner side **57**, for example, diametrically opposed grooves **58** and/or ridges **59**, in and/or on which the sensor element **51** is guided.
[0078] For this purpose, the sensor element **51** is assigned to a respective longitudinal side of the respective groove **58** or the web **59**, in particular inserted into the respective groove **58** or placed on the respective web **59**. For this purpose, the sensor element **51** preferably has, on the longitudinal side, a groove with an inner contour corresponding to the respective outer contour of the web **59**. The sensor element **51** is guided in or on the groove **58** or the web **59** in particular in a manner that is at least approximately free of play or subject to play.
[0079] The sensor module **50** further comprises at least one first spring element **60**, which is designed as a coil spring in this case. According to alternative, non-represented exemplary embodiments, it is also possible to use several spring elements connected in series, or to use one or several disk springs or similar spring elements. It is also conceivable to use one or more, preferably cylindrical, elastomers or any combination of different spring elements, in particular coil springs, disk springs and/or elastomers.
[0080] The sensor element **51** is operatively connected to the force sensor element **55** by way of the first spring element **60**. According to an alternative, non-represented exemplary embodiment, in which no force sensor element **55** is present, the sensor element **51** can be supported on the sensor housing **52** by way of the first spring element **60**. In the present case, the sensor element **51** also projects from the first housing portion **53** at least in an unactuated rest position of the spring element **60**, that is to say in the assembled state in the direction of the actuating element of the actuation device **1**.
[0081] The first spring element **60** is pushed, at least in certain regions, onto a protrusion **62** of the sensor element **51** by way of a first end **61** and, at least in certain regions, onto a protrusion **64** of a further sensor element **65**, which is operatively connected to the force sensor element **55**, by way of a second end **63** facing away from the first end **61**.
[0082] A sensor element **51** is assigned a transmitter element **66**, in this case a magnet element,

which is assigned a displacement sensor element **56**, in this case a Hall sensor. For example, a magnetic element in the form of a permanent magnet is provided, which is arranged on a longitudinal side of the sensor element **51** and is connected thereto, in particular in an in an interlocking, force-fit and/or materially bonded manner. The displacement sensor element **56** is then based on a magnetic measuring principle. Alternatively, other measuring principles, in particular optical ones, are provided for the displacement sensor element **56**.

[0083] The displacement sensor element **56** and the force sensor element **55** are arranged on a common printed circuit board **67** arranged in the sensor housing **52**. According to a further, non-represented exemplary embodiment, the displacement sensor element **56** and the force sensor element **55** are each arranged on a printed circuit board arranged in the sensor housing **52**.

[0084] The common printed circuit board **67** has a first portion **68** with the force sensor element **55** and a second portion **69** with the displacement sensor element **56**. The second portion **69** is angled at least approximately at right angles to the first portion **67**.

[0085] In their original form, the two portions **68**, **69** of the printed circuit board **67** lie in a common plane, and only before assembly in the sensor housing **52** is the second portion **69** bent correspondingly. In FIG. **4**, both states (flat and bent) and the mobility are indicated by a dashed double arrow.

[0086] According to an alternative, non-represented exemplary embodiment, a first printed circuit board with the force sensor element **55** is provided, which is arranged, in particular at least approximately at right angles, at an angle to a second printed circuit board with the displacement sensor element **56** and is electrically connected to the second printed circuit board.

[0087] The first portion **68** of the printed circuit board **67** (or, alternatively, the corresponding first printed circuit board) is arranged within the second housing portion **54** and the second portion **69** of the printed circuit board **67** (or, alternatively, the corresponding second printed circuit board) is arranged within the first housing portion **53**. The second portion **69** then extends parallel to the longitudinal extension of the sensor element **51**, and the first portion **68** extends perpendicular to the longitudinal extension of the sensor element **51**.

[0088] FIG. **5** shows a detailed view of the printed circuit board **67** in its original state, i.e. without the portions being angled with respect to each other. The two portions **68**, **69** are electrically interconnected by an electrical flexible connection **70**, which in the present case has several wires, so that in particular the force sensor element **55** and the displacement sensor element **56** arranged on it can be connected or are connected to an external power supply and/or a communication bus.

[0089] Furthermore, a further six spring elements are arranged on the circuit board **67**, in each case on the side of the circuit board **67** facing away from the sensor element **51** and the displacement sensor element **56** and the force sensor element **55**.

[0090] On the one hand, at least one second spring element **71** for supporting the printed circuit board **67** is arranged on the sensor housing **52**, in the second portion **69** in the present case (or, alternatively, on the corresponding second printed circuit board). The second spring element **71** ensures that the displacement sensor element **56** is at a defined distance from the transmitter element **66**. In the assembled state, it is supported on the inner side **57** in the first housing portion **53**.

[0091] On the other hand, a multiplicity of third spring elements **72** (of which, for reasons of clarity, only one is provided with a reference numeral) is arranged for making electrical contact with the printed circuit board, with a connector **73**, in the first portion **68** (or, alternatively, on the corresponding first printed circuit board). This is shown in FIG. **5**B in a second detailed view, where the connector **73**, which has a plurality of connection pins **74**, is shown. Each of the connection pins **74** is in contact with one of the third spring elements **73**.

[0092] The connector **73** is in turn inserted into a housing cover **75**, which can also be seen in FIG. **4**, and which is used to close the sensor housing **52** as soon as the printed circuit board **67** is inserted into the sensor housing **52**.

[0093] A housing wall **76** comprising several sections is also provided inside the sensor housing **52**. In the present case, the housing wall **76** is designed in one piece with the sensor housing **52**. A first portion **77** of the housing wall **76** extends at least substantially perpendicular to the longitudinal extension of the sensor element **51** and parallel to the longitudinal extension of the housing cover **75** and, in the mounted state, of the first portion **68** of the printed circuit board **67**.
[0094] The first portion **77** is adjoined by a second portion **78**, which is aligned at a right angle thereto and which, accordingly, extends at least essentially parallel to the longitudinal extension of the sensor element **51** or, in the mounted state, parallel to the second portion **69** of the printed circuit board **67**. A third portion **79**, which is oriented at right angles to the second portion **78**, runs at a corresponding distance parallel to the first portion **77**. The housing wall **76** thus forms, together with an outer wall of the sensor housing **52**, a receiving pocket for the second portion **69** of the printed circuit board **67**.
[0095] The first portion **77** extends exactly between the two housing portions **53**, **54**, or at the level of and parallel to an end side **80** of the second housing portion **54**, which has an opening **81** from which the first housing portion **53** projects. In this respect, the first portion **77** fills the opening **81** again in sections. The second portion **78** and the third portion **79** are arranged correspondingly within the first housing portion **53**.
[0096] The housing wall **76** has an opening **82** for the further sensor element **63** only in the first portion **77** and is otherwise formed without openings (if several force sensor elements **55** with corresponding sensor elements **63** are provided, then preferably a separate opening is also provided for each of these). In this respect, the printed circuit board **67** is completely separated from the sensor element **51**, preferably in a media-tight manner.
[0097] Finally, FIG. **6** shows the fully assembled actuation device **1** together with the sensor module **50**. For reasons of clarity, only the most important components are provided with reference numerals. The sensor module **50** is now inserted into the second housing portion **3** and closed with the housing cover **75**.
[0098] The sensor element **51** abuts against the inner side of the first housing portion **2** connected to the actuating surface **6** by way of the pretensioning of the spring element **60**, so that each actuation of the actuating surface **6** is transmitted by way of the sensor element **51** to the displacement sensor element **56** and the spring element **60** and then to the force sensor element **55** and the displacement sensor element **56**.

Claims

1. An actuation device for a motor vehicle for specifying a braking and/or acceleration request, comprising: a first housing portion and a second housing portion, wherein the first housing portion is displaceably mounted on the second housing portion in the longitudinal extension of the second housing portion, and wherein the first housing portion has an actuating surface on a top surface facing away from the second housing portion, or wherein a cover having an actuating surface is arranged on a top surface facing away from the second housing portion, and wherein the first housing portion and the second housing portion are each formed at least in sections in a cylindrical shape with a closed casing wall; a first sliding element and a second sliding element arranged between the first housing portion and the second housing portion, wherein the first sliding element and the second sliding element each abut axially against at least one of the first housing portion and the second housing portion; and at least one spring element arranged between the first sliding element and the second sliding element as a return spring, which is pretensioned coaxially with the first housing portion and the second housing portion in order to urge the first housing portion and the second housing portion into an unactuated rest position.
2. The actuation device according to claim 1, wherein: the first sliding element is configured to be displaceable along the longitudinal extension of the second housing portion together with the first

housing portion relative to the second housing portion, and/or the second sliding element is arranged in a stationary position on the second housing portion and the first housing portion is displaceable along the longitudinal extension of the second housing portion relative to the second sliding element.

3. The actuation device according to claim 1, wherein the first sliding element abuts against an inner side of the first housing portion by way of a first surface and/or abuts against an outer side of the second housing portion by way of a second surface facing away from the first surface.

4. The actuation device according to claim 1, wherein the first housing portion has (i) a first inner diameter in a first region associated with the first sliding element, and (ii) a second inner diameter, which is greater than the first inner diameter, in a second region associated with the second sliding element.

5. The actuation device according to claim 1, wherein the second housing portion has (i) a first outer diameter in a first region associated with the first sliding element, and (ii) a second outer diameter, which is greater than the first outer diameter, in a second region associated with the second sliding element.

6. The actuation device according to claim 4, wherein the first sliding element and the second sliding element are each designed to be at least essentially cylindrical and have an outer diameter corresponding to the respective inner diameter of the first housing portion and/or an inner diameter corresponding to the respective outer diameter of the second housing portion.

7. The actuation device according to claim 5, wherein the spring element is designed as a coil spring and has an inner diameter corresponding to the first outer diameter.

8. The actuation device according to claim 1, wherein: the first sliding element has a circumferential radial protrusion, and the spring element abuts, at least in certain regions, against a surface of the protrusion facing the second sliding element by way of a first end, and/or the second sliding element has an end side having an opening with a diameter corresponding to the first outer diameter for the first region of the second housing portion, and the spring element abuts, at least in certain regions, against a surface of the end side facing the first sliding element by way of a second end facing away from the first end.

9. The actuation device according to claim 1, further comprising at least one first pin arranged in an opening of the first housing portion and protruding in the direction of the second housing portion, and arranged on a circumferential radial protrusion of the first housing portion as an anti-rotation device, and wherein the first pin is introduced into an opening arranged in a circumferential radial protrusion, corresponding to its outer contour, of the second housing portion.

10. The actuation device according to claim 9, wherein: the first pin is arranged in an opening in the second housing portion, and on the first pin, on its end region facing away from the first housing portion, a press sleeve surrounding the first pin circumferentially, is arranged for limiting a stroke of the first housing portion and the second housing portion relative to each other and/or for adjusting a pretensioning of the spring element.

11. The actuation device according to claim 1, further comprising at least one second pin arranged in an opening in the second housing portion and protruding in the direction of the first housing portion, and arranged on a circumferential radial protrusion of the second housing portion for adjusting a stroke of the first housing portion and the second housing portion relative to each other.

12. The actuation device according to claim 9, wherein at least one of the first pin and the second pin is formed in an interlocking, force-fit, and/or materially bonded manner in one piece with the corresponding housing portion or is connected to the corresponding housing.

13. The actuation device according to claim 1, further comprising a circumferential, bellows-like, sealing element arranged between the first housing portion and the second housing portion for sealing against a region outside the housing.

14. The actuation device according to claim 1, further comprising a sensor module configured to detect an actuating force exerted on the actuating surface and/or an actuation path of the actuating

surface, wherein the sensor module is arranged in the second housing portion.

15. A motor vehicle comprising at least one actuation device according to claim 1.

16. The actuation device according to claim 1, wherein the at least one spring element includes at least one coil spring.

17. The actuation device according to claim 9, wherein at least one of the first pin and the second pin is formed in an interlocking, force-fit, and/or materially bonded manner in one piece with the corresponding housing portion, or is glued, welded, and/or pressed and/or screwed into a corresponding opening.

18. The actuation device according to claim 1, further comprising a circumferential, bellows-like, sealing element arranged between the first housing portion and the second housing portion for sealing in each case against regions on a circumferential radial or axial protrusion of the respective housing portion.