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DAMPING VALVE DEVICE FOR A SHOCK ABSORBER OF A MOTOR VEHICLE

Abstract

A vibration damper for a motor vehicle comprises an outer tube and an inner tube arranged coaxially thereto, a working piston which is arranged axially movably inside the inner tube and divides the interior of the inner tube into a working chamber on the piston rod side and a working chamber remote from the piston rod, a first damping valve device with a first inlet connector for inlet of hydraulic fluid into the first damping valve device, and a second damping valve device with a second inlet connector for inlet of hydraulic fluid into the second damping valve device, wherein the first inlet connector extends radially inwardly through a first middle tube opening and an inner tube opening into the working chamber remote from the piston rod.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION
[0001] This application is a U.S. Non-Provisional that claims priority to German Patent Application No. DE 10 2024 103 965.5, filed Feb. 13, 2024, the entire content of which is incorporated herein by reference.
FIELD
[0002] The present disclosure relates to a damping valve device for a shock absorber for motor vehicles, wherein the damping valve device has a main valve and a pilot valve.
BACKGROUND
[0003] DE102021202418A1 discloses a vibration damper which has two external damping valves. Differing requirements for the installation space of the vibration damper in the vehicle require maximum flexibility and compactness of the arrangement of the damping valves relative to one another.
[0004] Thus a need exists to provide a vibration damper having two external damping valves which have a high degree of freedom in their arrangement relative to one another.

Description

BRIEF DESCRIPTION OF THE FIGURES
[0005] So that those skilled in the art to which the subject disclosure appertains will readily understand how to make and use the devices and methods of the subject disclosure without undue experimentation, preferred embodiments thereof will be described in detail herein below with reference to certain figures, wherein:
[0006] FIG. **1** shows a schematic illustration of a vibration damper according to a first exemplary embodiment, in a longitudinal sectional view.
[0007] FIG. **2** shows a schematic illustration of a detail view of a damping valve device according to an exemplary embodiment, in a longitudinal sectional illustration.
[0008] FIGS. **3** and **4** each show a schematic illustration of a detail view of a damping valve device according to further exemplary embodiments, in a plan view.
DETAILED DESCRIPTION
[0009] Although certain example methods and apparatus have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus, and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents. Moreover, those having ordinary skill in the art will understand that reciting “a” element or “an” element in the appended claims does not restrict those claims to articles, apparatuses, systems, methods, or the like having only one of that element, even where other elements in the same claim or different claims are preceded by “at least one” or similar language. Similarly, it should be understood that the steps of any method claims need not necessarily be performed in the order in which they are recited, unless so required by the context of the claims. In addition, all references to one skilled in the art shall be understood to refer to one having ordinary skill in the art.
[0010] According to a first aspect, a vibration damper for a motor vehicle comprises an outer tube and an inner tube arranged coaxially thereto, and a working piston which is arranged axially movably inside the inner tube and divides the interior of the inner tube into a working chamber on

the piston rod side and a working chamber remote from the piston rod. The vibration damper has a first damping valve device with a first inlet connector for inlet of hydraulic fluid into the first damping valve device, and a second damping valve device with a second inlet connector for inlet of hydraulic fluid into the second damping valve device. The first inlet connector extends radially inwardly through a first middle tube opening and an inner tube opening into the working chamber remote from the piston rod.

[0011] Such an arrangement offers a particularly space-saving valve mounting, wherein the damping valve devices can be oriented in different positions, in particular at different angles and axial positions.

[0012] The vibration damper is for example a single-tube vibration damper or a multi-tube vibration damper, for example a twin-tube vibration damper. The vibration damper comprises for example an outer tube which forms an outer face, in particular a housing, of the vibration damper. An inner tube, also known as a damper tube, is arranged inside the outer tube and coaxially thereto. A balance chamber, which is preferably filled at least partially with a hydraulic fluid, is formed between the outer tube and the inner tube. For example, the balance chamber is partially filled with a gas.

[0013] Preferably, a working piston connected to a piston rod is arranged inside the inner tube such that it is movable inside the inner tube, wherein the inner tube is preferably formed as a guide for the working piston. A valve device for example is arranged on the working piston. The working piston divides the interior of the inner tube in particular into a first working chamber on the piston rod side and a second working chamber remote from the piston rod.

[0014] The damping valve devices are for example arranged at least partially outside the outer tube of the vibration damper. Inside the balance chamber, preferably a middle tube is arranged coaxially to and between the inner tube and the outer tube. The damping valve devices are for example mounted on the middle tube. The middle tube is preferably mounted fluid-tightly on the inner tube, wherein an annular chamber is formed between the middle tube and the inner tube. The damping valve devices are preferably configured identically.

[0015] The middle tube is preferably attached to the inner tube by means of two middle tube mountings. The first middle tube mounting is for example arranged at the end of the middle tube remote from the piston rod, and the second middle tube mounting is arranged at the end of the middle tube on the piston rod side. The middle tube mounting preferably comprises two constrictions running circumferentially, radially on the inside, wherein in the region of the constrictions, the diameter of the middle tube is reduced such that the middle tube rests on the inner tube, preferably by means of a play fit. An in particular annular widening of the middle tube adjoins the constriction, wherein in the region of the widening, the diameter of the middle tube is widened to the previous diameter outside the constriction. Adjoining the widening on the outside in the axial direction is a further constriction for example, which in particular forms the end of the middle tube. The widening is preferably configured such that it forms a closed annular chamber between the middle tube and the inner tube. A sealing element, in particular a sealing ring, is for example arranged inside the annular chamber, resting on the inner tube and on the middle tube and forming a fluid-tight seal between them. The middle tube optionally extends over the entire length of the inner tube. In particular, the middle tube has a length which corresponds for example to 50% to 110%, in particular 90% to 100% of the length of the inner tube.

[0016] In particular, an annular chamber is formed between the middle tube and the inner tube. At least one passage opening is formed in the inner tube, fluidically connecting the first working chamber to the annular chamber. The passage opening preferably opens into the end of the annular chamber on the piston rod side. The middle tube is for example made from a metal.

[0017] The vibration damper preferably comprises at least two damping valve devices arranged at least partially outside the outer tube. The first damping valve device is preferably configured and arranged such that hydraulic fluid flows through it, in the compression stage, upon a movement of

the working piston in the compression direction. The second damping valve device is preferably configured and arranged such that hydraulic fluid flows through it, in the extension stage, upon a movement of the working piston in the extension direction.
[0018] Preferably, the first damping valve device is designated the compression stage valve and in particular is configured such that it damps the movement of the working piston in the compression direction. Preferably, the second damping valve device is designated the extension stage valve and in particular is configured such that it damps the movement of the working piston in the extension direction. The damping valve devices are for example magnetic control valves, pressure-limiting valves or multiway valves which preferably allow flow exclusively in one direction.
[0019] The middle tube in particular has a first middle tube opening which is configured and arranged for receiving the first damping valve device. The middle tube opening has in particular a circular cross section.
[0020] The inner tube preferably has an inner tube opening which is configured and arranged for receiving the first damping valve device, in particular the compression stage valve. The inner tube opening is in particular formed to be circular and preferably arranged coaxially to the first middle tube opening. The inner tube preferably has precisely one inner tube opening for receiving a damping valve device.
[0021] The outer tube preferably has a first and a second outer tube opening which are configured and arranged for receiving a respective damping valve device. The outer tube opening is in particular formed to be circular and preferably arranged coaxially to the respective middle tube opening. The outer tube preferably has precisely two outer tube openings for receiving a respective damping valve device.
[0022] The damping valve device preferably has a valve housing which forms the outer face of the damping valve device. The valve housing is arranged at least partially outside the outer tube and in particular is fixedly connected to the outer tube. The valve housing is preferably formed to be tubular. Coaxially to the valve housing, the damping valve device has an inlet connector which is preferably formed to be tubular and forms a fluid inlet into the respective damping valve device. The first inlet connector preferably forms a fluid inlet into the first damping valve device, wherein the second inlet connector preferably forms a fluid inlet into the second damping valve device. The first inlet connector of the first damping valve device preferably extends in the radial direction into the working chamber remote from the piston rod. For example, the first inlet connector extends through the first outer tube opening, the first middle tube opening and the inner tube opening, and opens into the working chamber remote from the piston rod. The second inlet connector extends in particular through the second outer tube opening and the second middle tube opening, and opens into the annular chamber between the middle tube and the inner tube.
[0023] The first damping valve device is preferably fluidically connected directly to the working chamber remote from the piston rod and to the balance chamber, wherein the second damping valve device is in particular fluidically connected directly to the annular chamber and to the balance chamber. The damping valve device comprises a preferably cylindrical damping valve housing.
[0024] The vibration damper preferably has a closure package which fluidically seals the interior of the outer tube on the piston rod side. Opposite the closure package, at the end remote from the piston rod, the interior of the outer tube is preferably fluidically sealed by means of a bottom piece.
[0025] Optionally, a bottom valve is arranged on the bottom piece, mounted at the end of the inner tube remote from the piston rod.
[0026] According to a first embodiment, the middle tube has the first middle tube opening and a second middle tube opening. The middle tube has in particular precisely two or more middle tube openings, which are configured and arranged for receiving a respective damping valve device. The middle tube openings in particular have a circular cross section. Preferably, the middle tube openings, in particular the middle points of the middle tube openings, are arranged in a common

plane which is arranged perpendicularly to the central axis of the outer tube. The middle tube openings are preferably aligned with one another, in particular arranged coaxially to one another, and preferably have an identical diameter and an identical geometry.

[0027] According to a further embodiment, the second inlet connector extends through the second middle tube opening. The first middle tube opening is preferably configured and arranged for receiving the first damping valve device, and the second middle tube opening is preferably configured and arranged for receiving the second damping valve device. In particular, the second inlet connector does not extend through the inner tube.

[0028] According to a further embodiment, the second inlet connector opens into an annular chamber between the inner tube and the middle tube. The second inlet connector is preferably directly fluidically connected to the annular chamber and to the balance chamber. Preferably, the valve outlet is arranged in a region between the valve housing and the inlet connector. The valve outlet of the damping valve devices in particular fluidically directly adjoins the balance chamber.

[0029] According to a further embodiment, the damping valve devices are arranged in a common plane which extends perpendicularly to the central longitudinal axis of the vibration damper, in particular of the outer tube. The damping valve devices are for example mounted at the same axial height of the outer tube. For example, the damping valve devices are arranged coaxially to one another. In particular, each damping valve device is arranged in a respective plane which extends perpendicularly to the central longitudinal axis of the vibration damper, in particular of the outer tube. Preferably, the planes are arranged axially offset to one another.

[0030] According to a further embodiment, the damping valve devices are arranged in a common axial portion of the outer tube. The axial portion is for example the end region of the outer tube remote from the piston rod. Preferably, the axial portion extends from the bottom of the outer tube over around 10% to 25% of the length of the outer tube.

[0031] According to a further embodiment, the central axes of the damping valve devices, in the circumferential direction of the outer tube, form an angle of 20° to 180°, in particular 60° to 135°, preferably 90° to 120° to one another.

[0032] According to a further embodiment, the middle tube extends as far as the end of the inner tube remote from the piston rod. Preferably, the middle tube terminates flush with the inner tube at the end remote from the piston rod.

[0033] According to a further embodiment, the vibration damper has a bottom piece which forms the end remote from the piston rod of the working chamber remote from the piston rod, wherein the middle tube extends in the axial direction as far as the bottom piece. Preferably, the middle tube rests on the bottom piece. The bottom piece is preferably fluid-tightly connected to the inner tube and/or the outer tube. Preferably, the bottom piece is formed to be pot-shaped.

[0034] According to a further embodiment, the vibration damper has an adapter for the mounting of the first damping valve device, wherein the adapter has an adapter opening through which the first inlet connector extends. The adapter is preferably formed to be tubular and arranged coaxially to the outer tube. The adapter is in particular arranged completely inside the inner tube, and preferably rests with its radial outer face on the inner face of the inner tube. In particular, the adapter is fluid-tightly connected to the inner tube. The adapter has an adapter opening which is configured and arranged for receiving the first damping valve device, in particular the first inlet connector. The first inlet connector extends for example through the adapter opening and terminates preferably flush therewith. The adapter is preferably fluid-tightly connected to the first inlet connector. In particular, a sealing means, such as for example a sealing ring, is arranged between the adapter and the first inlet connector. The sealing means is arranged for example in a circumferential recess in the first inlet connector. The vibration damper preferably has precisely one adapter.

[0035] According to a further embodiment, the middle tube has a first flange region for the mounting of the first damping valve device and a second flange region for the mounting of the second damping valve device, wherein the first flange region is fluid-tightly connected to the first inlet connector and the second flange region is fluid-tightly connected to the second inlet connector.

[0036] Preferably, the middle tube has precisely two or more flange regions which each form one of the middle tube openings. Each flange region preferably forms a respective receiver for one of the damping valve devices. The flange regions are preferably formed identically. The flange region preferably circumferentially surrounds the middle tube opening.

[0037] In particular, the flange region has a radially outwardly pointing collar which delimits the preferably circular middle tube opening. The collar is preferably formed to be tubular and extends in particular coaxially to the respective damping valve device. A radial constriction radially adjoins the collar on the inside, forming a narrowing of the diameter of the middle tube. The narrowing of the diameter causes a reduction in the width of the annular chamber between the inner tube and the middle tube, and preferably forms a flow restrictor.

[0038] The first flange region is preferably fluid-tightly connected to the first inlet connector. For example, a sealing element, such as for example a sealing ring, is mounted between the first inlet connector and the first flange region. The sealing element is preferably arranged in a circumferential recess in the first inlet connector. The second flange region is in particular fluid-tightly connected to the second inlet connector. A further sealing element, such as for example a sealing ring, is mounted between the second inlet connector and the second flange region. The sealing element is preferably arranged in a circumferential recess in the second inlet connector.

[0039] FIG. **1** shows a vibration damper **10**, wherein the vibration damper **10** is a multi-tube vibration damper, for example a twin-tube vibration damper. The vibration damper **10** has an outer tube **12** which forms an outer face, in particular a housing, of the vibration damper **10**. An inner tube **14**, which may also be designated a damper tube, is arranged inside the outer tube **12** and coaxially thereto. A balance chamber **16**, which is preferably at least partially filled with a hydraulic fluid, is formed between the outer tube **12** and the inner tube **14**, in particular between the outer tube **12** and the middle tube **26**. For example, the balance chamber **16** is partially filled with a gas.

[0040] A working piston **18**, connected to a piston rod **20**, is arranged inside the inner tube **14** so as to be movable inside the inner tube **14**, wherein the inner tube **14** is preferably configured as a guide for the working piston **18**. The working piston **18** has for example a valve device (not shown). The working piston **18** divides the interior of the inner tube **14** into a first working chamber **22** which is arranged on the piston rod side, and a second working chamber **24** which is arranged on the side remote from the piston rod. Inside the balance chamber **16**, a middle tube **26** is arranged coaxially to and between the inner tube **14** and the outer tube **12**.

[0041] The interior of the outer tube **12** is fluidically sealed on the piston rod side by means of a closure package **34**. Opposite the closure package **34**, at the end remote from the piston rod, the interior of the outer tube **12** is fluidically sealed by means of a bottom piece **38**. Optionally, a bottom valve is arranged on the bottom piece **38**, mounted in particular on the end of the inner tube **14** remote from the piston rod. The bottom valve is for example a check valve which allows flow in both directions or in only one direction. The second working chamber **24** is preferably fluidically connected to the balance chamber **16** via the bottom valve. The end of the inner tube **14** and outer tube **12** on the piston rod side is preferably attached to the closure package **34**. A body connection **36**, for example, by means of which the vibration damper **10** can be attached to the vehicle body, in particular the vehicle axle, adjoins the bottom piece.

[0042] The middle tube **26** is preferably fluid-tightly mounted on the inner tube **14**. For example, the middle tube **26** is mounted on the inner tube **14** by means of two middle tube mountings **42**, **44**. The middle tube **26** preferably extends over the entire length of the inner tube **14**; in particular, the middle tube **26** has a length which corresponds to around 90% to 100% of the length of the inner tube **14**. The first middle tube mounting **44** is arranged at the end of the middle tube **26** remote from the piston rod, and the second middle tube mounting **42** is arranged at the end of the middle tube **26** on the piston rod side. The middle tube mounting **42**, **44** preferably comprises two constrictions running circumferentially, radially on the inside, wherein in the region of the constrictions, the diameter of the middle tube **26** is reduced such that the middle tube **26** rests, preferably fluid-tightly, on the inner tube **14**. Adjoining the constriction is an in particular annular widening of the middle tube **26**, wherein in the region of the widening, the diameter of the middle tube **26** is increased to the previous diameter outside the constriction. A further constriction adjoins the widening on the outside in the axial direction, forming for example the end of the middle tube **26**. With the exception of the middle tube mounting **42**, **44**, the middle tube **26** preferably has a constant diameter and cross section. The widening is preferably formed such that it forms a closed annular chamber between the middle tube **26** and the inner tube **14**. A sealing element **46**, in particular a sealing ring, is for example arranged inside the annular chamber, resting on the inner tube **14** and the middle tube **26** and forming a fluid-tight seal between them. Preferably, the middle tube mounting **42**, **44** has a respective annular chamber with a sealing element **46**. The middle tube **26** preferably extends as far as the end of the inner tube **14** remote from the piston rod and for example terminates flush therewith. For example, the middle tube **26** extends axially as far as the bottom piece **38** and preferably rests thereon.

[0043] An annular chamber **28** is formed between the middle tube **26** and the inner tube **14**. At least one passage opening **30**, which fluidically connects the first working chamber **22** to the annular chamber **28**, is formed in the inner tube **14**. The passage opening **30** is formed in the first working chamber **22**, in particular at the end of the inner tube **14** on the piston rod side. Preferably, the passage opening **30** is arranged directly below the second middle tube mounting **42**. The passage opening **30** preferably opens into the end of the annular chamber **28** on the piston rod side. The middle tube **26** is preferably made of a metal.

[0044] The vibration damper **10** preferably comprises two damping valve devices **54***a*,*b*, wherein hydraulic fluid flows through a respective damping valve device **54***a*, in the compression stage, upon a movement of the working piston **18** in the compression direction D, and through the respective other damping valve device **54***b*, in the extension stage, upon a movement of the working piston **18** in the extension direction Z. Preferably, the first damping valve device **54***a* is designated the compression stage valve, and in particular is configured such that it damps the movement of the working piston **18** in the compression direction D. In particular, the compression stage valve **54***a* is configured and arranged such that hydraulic fluid flows through it exclusively upon a movement of the working piston **18** in the compression direction D. Preferably, the second damping valve device **54***b* is designated the extension stage valve, and in particular is configured such that it damps the movement of the working piston **18** in the extension direction Z. In particular, the extension stage valve **54***b* is configured and arranged such that hydraulic fluid flows through it exclusively upon a movement of the working piston **18** in the extension direction Z.

[0045] The damping valve devices **54***a*,*b* are for example formed substantially identically. The damping valve devices **54***a*,*b* are for example magnetic control valves, pressure-limiting valve or multiway valves which allow flow exclusively in one direction. The damping valve devices **54***a*,*b* are for example mounted at the same axial height of the outer tube **12**. It is also conceivable that the damping valve devices **54***a*,*b* are mounted at different axial heights. Preferably, the damping valve devices **54***a*,*b* are arranged in a common plane which extends perpendicularly to the central longitudinal axis of the vibration damper **10**, in particular of the outer tube **12**. In particular, the damping valve devices **54***a*,*b* are arranged in a common axial portion of the outer tube **12**, wherein the axial portion is the end region of the outer tube **12** remote from the piston rod. Preferably, the axial portion extends from the bottom of the outer tube **12** over around 10% to 25% of the length of the outer tube **12**. Optionally, the damping valve devices **54***a*,*b* are arranged coaxially to one another.

[0046] The middle tube **26** has in particular two middle tube openings **56***a*,*b* which are configured and arranged for receiving a respective damping valve device **54***a*,*b*. The first middle tube opening

56*a* is preferably configured and arranged for receiving the first damping valve device **54***a*, and the second middle tube opening **56***b* is preferably configured and arranged for receiving the second damping valve device **54***b*. The middle tube openings **56***a,b* in particular have a circular cross section.

[0047] Preferably, the middle tube **26** has precisely two or more flange regions **32***a,b* which form the middle tube openings **56***a,b*. Each flange region **32***a* preferably forms a respective receiver for one of the damping valve devices **54***a,b*. The middle tube **26** for example has a first flange region **32***a* for mounting the first damping valve device **54***a*, in particular the compression stage valve, and a second flange region **32***b* for mounting the second damping valve device **54***b*, in particular the extension stage valve. The flange regions **32***a,b* are preferably formed identically. The flange region **32***a,b* preferably forms the middle tube opening **56***a,b* and preferably circumferentially surrounds the middle tube opening **56***a,b*.

[0048] In particular, the flange region **32***a,b* has a radially outwardly pointing collar which delimits the preferably circular middle tube opening **56***a,b*. The collar is for example formed to be tubular and preferably extends coaxially to the respective damping valve device **54***a,b*. Adjoining the collar radially on the inside is a radial constriction **48**, which forms a narrowing of the diameter of the middle tube **26**. The narrowing of the diameter causes a reduction in the width of the annular chamber **28** between the inner tube **14** and the middle tube **26**, and preferably forms a flow restrictor.

[0049] The inner tube **14** preferably has an inner tube opening **58** which is configured and arranged for receiving a damping valve device **54***a*, in particular the compression stage valve **54***a*. The inner tube opening **58** is in particular formed to be circular and preferably arranged coaxially to the first middle tube opening **56***a*. The inner tube **14** preferably has precisely one inner tube opening **58** for receiving a damping valve device **54***a*.

[0050] The outer tube **12** preferably has a first and a second outer tube opening **60***a,b*, which are configured and arranged for receiving a respective damping valve device **54***a,b*. The outer tube opening **60***a,b* is in particular formed to be circular and is preferably arranged coaxially to the respective middle tube opening **56***a,b*. The outer tube **12** has preferably precisely two outer tube openings **60***a,b* for receiving a respective damping valve device **54***a,b*.

[0051] The damping valve device **54***a,b* has for example a valve housing **50***a,b* which forms the outer face of the damping valve device **54***a,b*. The valve housing **50***a,b* is arranged outside the outer tube **12**. The valve housing **50***a,b* is preferably formed to be tubular and for example has a plurality of different diameters. Coaxially to the valve housing **50***a,b*, the damping valve device **54***a,b* has an inlet connector **52***a,b* which for example is formed to be tubular and forms a fluid inlet into the respective damping valve device **54***a,b*. The first inlet connector **52***a* preferably forms a fluid inlet into the first damping valve device **54***a*, and the second inlet connector **52***b* preferably forms a fluid inlet into the second damping valve device **54***b*. The first inlet connector **52***a* of the first damping valve device **54***a* preferably extends in the radial direction into the working chamber remote from the piston rod. For example, the first inlet connector **52***a* extends through the first outer tube opening **60***a*, the first middle tube opening **56***a* and the inner tube opening **58**, and opens into the working chamber **24** remote from the piston rod. The second inlet connector **52***b* extends in particular through the second outer tube opening **60***b* and the second middle tube opening **56***b*, and opens into the annular chamber **28**.

[0052] The first damping valve device **54***a* is preferably fluidically connected to the working chamber **24** remote from the piston rod and to the balance chamber **16**, wherein the second damping valve device **54***b* is fluidically connected to the annular chamber **28** and to the balance chamber **16**.

[0053] The first flange region **32***a* is preferably fluid-tightly connected to the first inlet connector **52***a*. For example, a sealing element **62**, such as for example a sealing ring, is mounted between the first inlet connector **52***a* and the first flange region **32***a*. The sealing element **62** is preferably arranged in a circumferential recess in the first inlet connector **52***a*. The second flange region **32***b* is in particular fluid-tightly connected to the second inlet connector **52***b*. A further sealing element **64**, such as for example a sealing ring, is mounted between the second inlet connector **52***b* and the second flange region **32***b*. The sealing element **64** is preferably arranged in a circumferential recess in the second inlet connector **52***b*.

[0054] The vibration damper **10** comprises for example an adapter **40** for the mounting of the first damping valve device **54***a*, in particular the compression stage valve. The adapter **40** is for example formed to be tubular and arranged coaxially to the outer tube **12**. The adapter **40** is arranged inside the inner tube **14** and preferably rests with its radially outer face on the inner face of the inner tube **14**. In particular, the adapter **40** is fluid-tightly connected to the inner tube **14**. The adapter **40** has an adapter opening **66** which is configured and arranged for receiving the first damping valve device **54***a*, in particular the first inlet connector **52***a*. The first inlet connector **52***a* extends for example through the adapter opening **66** and terminates preferably flush therewith. The adapter **40** is preferably fluid-tightly connected to the first inlet connector **52***a*. In particular, a sealing means **68**, for example a sealing ring, is arranged between the adapter **40** and the first inlet connector **52***a*. The sealing means **68** is arranged for example in a circumferential recess in the first inlet connector **52***a*.

[0055] The piston rod **20** has for example an optional extension stop which is loaded with a spring force via a spring element **42** upon a movement in the extension direction Z.

[0056] FIG. **3** and FIG. **4** show further possible arrangements of the damping valve devices **54***a,b* relative to one another. In the exemplary embodiment of FIG. **3**, the first and the second damping valve devices **54***a,b* are arranged for example in a common plane, wherein the central axes of the damping valve devices **54***a,b* extend perpendicularly to the central axis of the outer tube **12**. The central axes of the damping valve devices **54***a,b* form for example an angle of 135° to one another. In the exemplary embodiment of FIG. **4**, the damping valve devices **54***a,b* are arranged coaxially to one another and form for example an angle of 180° to one another. For example, the central axes of the damping valve devices **54***a,b* form an angle of 20° to 180°, in particular 60° to 135°, for example 90° to 120° to one another.

LIST OF REFERENCE SIGNS

[0057] **10** Vibration damper [0058] **12** Outer tube [0059] **14** Inner tube [0060] **16** Balance chamber [0061] **18** Working piston [0062] **20** Piston rod [0063] **22** First working chamber/working chamber on piston rod side [0064] **24** Second working chamber/working chamber remote from piston rod [0065] **26** Middle tube [0066] **28** Annular chamber [0067] **30** Passage opening [0068] **32***a* First flange region [0069] **32***b* Second flange region [0070] **34** Closure package [0071] **36** Body connection [0072] **38** Bottom piece [0073] **40** Adapter [0074] **42** Second middle tube mounting [0075] **44** First middle tube mounting [0076] **46** Sealing element [0077] **48** Constriction [0078] **50***a* Valve housing of first damping valve device [0079] **50***b* Valve housing of second damping valve device [0080] **52***a* First inlet connector [0081] **52***b* Second inlet connector [0082] **54***a* First damping valve device/compression stage valve [0083] **54***b* Second damping valve device/extension stage valve [0084] **56***a* First middle tube opening [0085] **56***b* Second middle tube opening [0086] **58** Inner tube opening [0087] **60***a* First outer tube opening [0088] **60***b* Second outer tube opening [0089] **62** Sealing element [0090] **64** Sealing element [0091] **66** Adapter opening [0092] **68** Sealing means

Claims

1. A vibration damper for a motor vehicle, comprising: an outer tube and an inner tube arranged coaxially thereto; a working piston which is arranged axially movably inside the inner tube and divides the interior of the inner tube into a working chamber on the piston rod side and a working chamber remote from the piston rod; a first damping valve device with a first inlet connector for inlet of hydraulic fluid into the first damping valve device; and a second damping valve device with a second inlet connector for inlet of hydraulic fluid into the second damping valve device; wherein the first inlet connector extends radially inwardly through a first middle tube opening and an inner tube opening into the working chamber remote from the piston rod.

2. The vibration damper according to claim 1, wherein the middle tube has the first middle tube opening and a second middle tube opening.

3. The vibration damper according to claim 2, wherein the second inlet connector extends through the second middle tube opening.

4. The vibration damper according to claim 1, wherein the second inlet connector opens into an annular chamber between the inner tube and the middle tube.

5. The vibration damper according to claim 1, wherein the damping valve devices are arranged in a common plane which extends perpendicularly to the central longitudinal axis of the outer tube.

6. The vibration damper according to claim 1, wherein the central axes of the damping valve devices, in the circumferential direction of the outer tube, form an angle of 20° to 180° to one another.

7. The vibration damper according to claim 1, wherein the central axes of the damping valve devices, in the circumferential direction of the outer tube, form an angle of 60° to 135° to one another.

8. The vibration damper according to claim 1, wherein the central axes of the damping valve devices, in the circumferential direction of the outer tube, form an angle of 90° to 120° to one another.

9. The vibration damper according to claim 1, wherein the middle tube extends as far as the end of the inner tube remote from the piston rod.

10. The vibration damper according to claim 1, wherein the vibration damper has a bottom piece which forms the end remote from the piston rod of the working chamber remote from the piston rod, and wherein the middle tube extends in the axial direction as far as the bottom piece.

11. The vibration damper according to claim 1, wherein the vibration damper has an adapter for the mounting of the first damping valve device, and wherein the adapter has an adapter opening through which the first inlet connector extends.

12. The vibration damper according to claim 1, wherein the middle tube has a first flange region for the mounting of the first damping valve device and a second flange region for the mounting of the second damping valve device, and wherein the first flange region is fluid-tightly connected to the first inlet connector and the second flange region is fluid-tightly connected to the second inlet connector.

13. The vibration damper according to claim 1, wherein the damping valve devices are mounted in the same axial region of the outer tube.