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- (71) **Applicant:** AUDI AG [DE/DE]; 85045, Ingolstadt (DE).
- (72) **Inventor:** KAUSCH, Carsten; Building B6, 751 D-Park, Jiuxianqiao Road No. 4, Chaoyang District, Beijing 100015 (CN).
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(54) **Title:** VIBRATION ABSORBER FOR A COMPONENT, IN PARTICULAR OF A VEHICLE

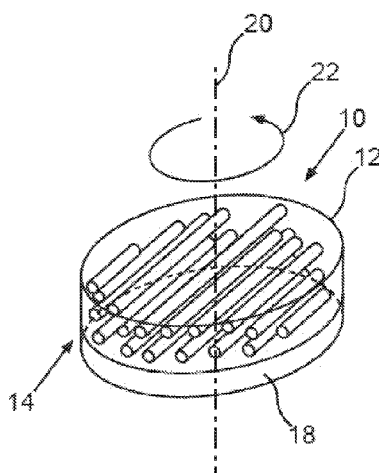


Fig. 1

(57) **Abstract:** The invention relates to a vibration absorber (10) capable of absorbing vibrations of a component, in particular of a vehicle, the vibration absorber (10) comprising: – at least one member (12) having a mass; – at least one duct (14) extending in the member (12), the duct (14) having an elongate extension and being filled with a liquid; and – a plurality of separate elements (16) each having a mass, the elements (16) being arranged in the duct (14) and surrounded by the liquid; wherein the vibration absorber (10) comprises a base element (18) via which the vibration absorber (10) is mountable on the component, the member (12) being pivotably connected to the base element (18) about at least one pivot axis (20).



Vibration Absorber for a Component, in particular of a Vehicle

Field of the Invention

The invention relates to a vibration absorber according to the preamble of patent claim 1.

5 Background Art

Such a vibration absorber can be found in DE 10 2011 079 869 A1. The vibration absorber is capable of absorbing vibrations of a component, in particular of a vehicle. The vibration absorber comprises at least one member having a mass. Moreover, the vibration absorber comprises at least one duct extending in the
10 member. The duct has an elongate extension. Furthermore, the duct is filled with a liquid of the vibration absorber.

Additionally, the vibration absorber comprises a plurality of separate elements. In other words, the elements are separate from each other. Each of said elements has a mass. The elements are arranged in the duct. Moreover, the elements are
15 surrounded by the fluid contained in the duct.

GB 2470180 A shows an impact or blast energy absorbing device consisting of a sealed, flexible, high tensile strength package filled with a plurality of approximately uniform sized compressible capsules, on average, at least two smaller stiff capsules, which do not compress significantly under impact, residing
20 in each of the void spaces between the compressible capsules, with an effectively incompressible matrix fluid filling the residual volume inside the package. The device has localized shearing gradients being created inside the matrix fluid when the larger capsules are compressed during an impact, with any adjacent stiff capsules travelling at different velocities in the matrix fluid tending to bunch up,
25 forcing the matrix fluid to travel round them, locally increasing the shearing gradients experienced by the matrix fluid and thereby increasing the viscous

damping caused by the shearing of the fluid, compared with the viscous damping that would have been generated if the stiff capsules had not been present.

In WO 2007/084318 A2 a pulse draping device can be found. The pulse draping device comprises an array of composite chains of alternating ensembles of soft beads and rigid beads in a supporting matrix.

Additionally, US 5 947 457 shows an active vibration absorber adapted for controlling vibration of a member, the active vibration absorber comprising a housing, means for attaching said housing to the member whose vibration is to be controlled, a first flexible element having an axial dynamic stiffness, a resonatable primary tuning mass flexibly suspended relative to said housing by said flexible element, wherein, when in operation, said primary tuning mass is constrained substantially solely by said first flexible element, a first fluid chamber having a defined volume stiffness, a fluid contained in said first fluid chamber, a moveable piston in fluid contact and interacting with said fluid in said first fluid chamber, and means for actively driving said moveable piston causing dynamic pressure variations in said first fluid chamber, said pressure variations causing said primary tuning mass and to resonate thereby producing active control forces.

In JPH05181547 A, a device using an electro-viscous fluid can be found.

Summary of the Invention

Technical problem to be solved

It is an object of the present invention to provide a vibration absorber of the aforementioned kind, by means of which vibration absorber a vibration behavior of a component can be determined particularly efficiently so that the vibration behavior of the component can be adjusted in a time- and cost-efficient way.

This object is solved by a vibration absorber having the features of patent claim 1. Advantageous embodiments with expedient and non-trivial developments of the

invention are indicated in the other patent claims.

Technical solution

The invention relates to a vibration absorber capable of absorbing vibrations of a component, in particular of a vehicle. The vibration absorber comprises at least one member having a mass. The vibration absorber further comprises at least one duct extending in the member. The duct has an elongate extension. Moreover, the duct is filled with a liquid of the vibration absorber. Thus, the vibration absorber is configured as a fluid dynamic vibration absorber.

Additionally, the vibration absorber comprises a plurality of separate elements. In other words, the elements are separate from each other. Each of said elements has a mass. The elements are arranged in the duct. Moreover, the elements are surrounded by the liquid contained in the duct.

According to the present invention, the vibration absorber further comprises a base element via which the vibration absorber is mountable on the component. In other words, the vibration absorber can be attached to the component via the base element. For example, the base element has at least one fixing means by means of which the base element and, thus, the vibration absorber can be attached to the component. For example, said fixing means can be a through opening for a screw by means of which the vibration absorber can be attached to the component.

The member is pivotably connected to the base element about at least one pivot axis. This means the member and, thus, the duct extending in the member and the elements being arranged in the duct can be rotated in relation to the base element and, thus, the component. Thereby, a vibration behavior of said component can be determined by means of the vibration absorber according to the present invention particularly efficiently so that, for example, the vibration behavior of the component can be adjusted in a particularly cost- and time-efficient way and in a

need-based manner.

The vibration absorber according to the present invention is based on the realization that mechanical cell structures, in particular load-bearing panel elements having, for example, an at least substantially planar extension tend to
5 change their local eigenfrequencies and start to vibrate, swing or even buckle in a chaotic load case and in dependency on changeable surrounding conditions such as but not limited to temperature, pressure, and humidity.

Conventionally, the material of said mechanical cell structures (components) and/or their geometry is changed to shift the local eigenfrequencies in a range
10 which is unlikely to get excited in a load case. Thereby, the vibration behavior of the component can be adjusted. However, changing the material and/or the geometry in order to realize a desired vibration behavior of the component is a time-consuming and cost-intensive process.

By means of the vibration damper according to the present invention, however, the
15 eigenfrequencies and, thus, the vibration behavior of the component can be adjusted or affected in a particularly easy and time- and cost-efficient way by simply pivoting or rotating the member of the vibration damper in relation to the base element via which the vibration damper is mountable or mounted on the component. Thereby, the vibration behavior of the component can be affected and
20 adjusted in a need-based manner and in a time- and cost-efficient way without changing the geometry and/or the material of the component.

In other words, by pivoting the member in relation to the base element, the vibrational direction can be adjusted. Moreover, energy can be absorbed by the vibration absorber very efficiently through heating caused by mechanical friction
25 between the liquid and the elements.

In an advantageous embodiment of the invention, the elements are elastically

deformable. Thereby, energy can be absorbed by means of the vibration absorber particularly effectively and efficiently. For example, the elements deform elastically when they collide with each other. The deformation is reversible, in particular in a steady state of the vibration absorber or while the vibration absorber is approaching the steady state. Furthermore, the vibration absorber according to the present invention can be designed with particularly compact external dimensions.

For example, if the member is not connected to the base element in a rotationally fixed manner so that the member can rotate in relation to the base element about the pivot axis while the vibration absorber is mounted on the component and while the component vibrates, the member is still held on the base element and, thus, the component but free to rotate in relation to the base element and the component so that a maximum absorption with a maximum degree of efficiency will be reached automatically if the vibration absorber is arranged in the main vibration direction.

In a further particularly advantageous embodiment of the invention, the vibration absorber comprises at least one fixing element by means of which the member can be connected to the base element in a rotationally fixed manner in at least two different rotary positions. Thereby, an undesired rotational movement of the member in relation to the base element about the pivot axis can be avoided.

In a further advantageous embodiment of the invention, the elements are made of solid material. This means the elements are not hollow. Thereby, energy can be absorbed by means of the vibration absorber particularly efficiently.

In a further advantageous embodiment of the invention, the pivot axis extends angularly or perpendicularly to the longitudinal extension of the duct. Hence, the vibration behavior of the component can be adjusted particularly advantageously by pivoting or rotating the member in relation to the base element about the pivot axis.

In order to realize a particularly advantageous absorbing effect of the vibration absorber, the vibration absorber comprises at least one second duct extending in the member, the second duct having an elongate extension. The second duct is filled with a second liquid. Moreover, the second duct is fluidically separate from the first duct. Moreover, the vibration absorber comprises a plurality of second separate elements each having a mass. The second elements are arranged in the second duct. Moreover, the second elements are surrounded by the second liquid.

In a further advantageous embodiment of the invention, at least one of the members, i.e. the first member and/or the second member can be pivoted in relation to the base element about at least two pivot axes, which extend angularly or perpendicularly in relation to each other.

In a further advantageous embodiment of the invention, the second duct extends parallel to the first duct. Thereby, vibrations of the component can be damped particularly effectively.

In a further embodiment of the invention, the vibration absorber comprises at least one second member having a mass. Moreover, the vibration absorber comprises at least one third duct extending in the second member. The third duct has an elongate extension. Moreover, the third duct is filled with a third liquid. The third duct is fluidically separate from the first duct. Furthermore, the vibration absorber can comprise a plurality of third separate elements each having a mass, the third element being arranged in the third duct. Additionally, the third elements are surrounded by the third liquid. Moreover, the second member is pivotably connected to the base element at least indirectly. Thereby, the vibration behavior of the component can be affected and adjusted in a particularly advantageous way.

The words “first”, “second”, and “third” are not necessarily to be regarded as numerals but as words used to distinguish between the members and/or ducts and/or liquids and/or elements being part of the respective embodiment.

In a further advantageous embodiment of the invention, at least one of the members, i.e. the first member and/or the second member can be pivoted in relation to the base element about at least two pivot axes which extend angularly or perpendicularly in relation to each other.

- 5 Advantageously, the at least two members of the vibration absorber can be rotated in relation to each other. In other words, the members are rotatable in relation to each other. Thereby, the damping effect and, thus, the vibration behavior of the component can be adjusted in a need-based manner and particularly effectively.

10 Preferably, the liquid has a higher viscosity than water. In other words, the respective liquid can be a viscous liquid by means of which vibrations can be damped and absorbed particularly well.

In a further advantageous embodiment of the invention, the elements are designed as spheres. Hence, a particularly good absorbing effect of the vibration absorber can be realized.

15 **Brief Description of the Drawings**

Further advantages, features, and details of the invention derive from the following description of preferred embodiments as well as from the drawing. The features and feature combinations previously mentioned in the description as well as the features and feature combinations mentioned in the following description of
20 the figures and/or shown in the figures alone can be employed not only in the respective indicated combination but also in any other combination or taken alone without leaving the scope of the invention.

Fig. 1 a schematic perspective view of a first embodiment of a vibration
absorber capable of absorbing vibrations of a component, in particular
25 of a vehicle, the vibration absorber comprising at least one member
having a mass, at least one duct extending in the member, the duct

having an elongate extension being filled with a liquid, and a plurality of separate elements each having a mass, the elements being arranged in the duct and surrounded by the liquid, wherein the vibration absorber further comprises a base element via which the vibration absorber is mountable on the component, the member being pivotably connected to the base element about at least one pivot axis;

Fig. 2 a schematic perspective view of a duct of the member according to Fig. 1;

Fig. 3 a schematic sectional view of the member according to Fig. 1;

Fig. 4 a schematic perspective view of a second embodiment of the vibration absorber;

Fig. 5 a schematic perspective view of a third embodiment of the vibration absorber;

Fig. 6 a schematic perspective view of the third embodiment of the vibration absorber; and

Fig. 7 a schematic perspective view of a fourth embodiment of the vibration absorber.

In the figures, the same elements or elements having the same function are indicated with the same reference sign.

Detailed Description of Embodiments

Fig. 1 shows a first embodiment of a vibration absorber 10 capable of absorbing vibrations of a component, in particular of a vehicle. For example, the component can be a component of a passenger vehicle. The component can be a mechanical cell structure having an at least substantially planar extension. For example, the component can be a cladding panel such as an outer cladding panel. Preferably, the component is inherently stable. Moreover, the component can be a load-bearing component of the vehicle.

The component can be a window pane configured to cover a window opening of the body of the vehicle at least partially. Such a mechanical cell structure having an at least substantially planar extension can tend to vibrate during operation of the vehicle. This can result in a humming noise. In order to avoid excessive humming noise caused by vibrations of the component, the vibration behavior of the component needs to be adjusted. The vibration behavior of the component can be affected and, thus, adjusted by means of the vibration absorber 10 in a particularly time- and cost-efficient way.

The vibration absorber 10 comprises a member 12 which is, for example, a body. Moreover, the vibration absorber 10 according to the first embodiment comprises a plurality of first ducts 14 extending in the member 12. Each of said first ducts 14 has an elongate extension. Moreover, the first ducts 14 are fluidically separate from each other. In each of the first ducts 14, a viscous liquid is contained. In other words, the first ducts 14 are filled with a viscous liquid.

As can be seen from Fig. 2, the vibration absorber 10 comprises first elements 16 in the form of spheres or balls. A plurality of first elements 16 is arranged in each first duct 14. The elements 16 arranged in the respective first ducts 14 are separate from each other so that they can move in relation to each other. Moreover, each of the first elements 16 has a mass. Moreover, the respective elements 16 arranged in the respective ducts 14 are surrounded by the viscous liquid.

As can be seen in Fig. 2, the respective first duct 14 has a length l and a diameter d_2 . The respective element 16 has a first diameter d_1 since the respective element 16 is designed as a sphere. The length l of the respective duct 14, the mass of the respective element 16, the viscosity of the respective liquid, the diameter d_1 , the diameter d_2 and the number of elements 16 can be adjusted in a need-based manner.

As can be seen from Fig. 1, the vibration absorber 10 further comprises a base

element 18. The base element 18 and the member 12 each have the form of a cylinder, wherein the base element 18 is arranged coaxially in relation to the member 12.

Moreover, the member 12 is pivotably connected to the base element 18 about a pivot axis 20. This means the member 12 can be rotated in relation to the base element 18 about the pivot axis 20. A rotational movement of the member 12 in relation to the base element 18 is illustrated in Fig. 1 by a directional arrow 22.

The vibration absorber 10 can be mounted on the component via the base element 18. This means the member 12 can be rotated in relation to the base element 18 and the component thereby adjusting the vibration behavior of the component. For example, the base element 18 is configured to mount the vibration absorber 10 on the component. By rotating the member 12 and, thus, the ducts 14 and the elements 16, local eigenfrequencies of the component can be shifted.

Preferably, as many ducts as possible extend in the member 12, said ducts being fluidically separate from each other. The respective elements 16 in the ducts 14 can move in a statically indeterminate manner within the respective liquid.

Energy can be absorbed from the vibrating or excited system (component) by fluid friction or liquid friction and collisions between the elements 16 in the liquid. Thereby, a damping effect or a steady state within the vibration absorber 10 can be reached, wherein the energy balance of the local cell structure can be freed from a local undesired vibration by means of the vibration absorber 10.

Fig. 3 illustrates the statically indetermination and a heat-transfer coefficient λ_1 of the member 12, a heat-transfer coefficient λ_2 of the liquid and a heat-transfer coefficient λ_3 of the respective elements 16.

Since the member 12 can be rotated in relation to the base element 18, the main mass inertia of the vibration absorber 10 can be adjusted in different directions.

For example, the member 12 can be rotated in multiple panes in relation to the base element 18. This means that, in a further embodiment, a plurality of pivot axes can be provided about which the member 12 can be rotated in relation to the base element 18. Alternatively or additionally, different mass-viscosity-combinations can be provided. This means that, for example, in one of the ducts 14, a first liquid can be contained. In another one of the ducts 14, a second liquid can be contained, the second liquid being different from the first liquid. For example, the second liquid has a different viscosity than the first liquid. Alternatively or additionally, the elements 16 can have different masses. For example, the elements 16 in at least one of the ducts 14 can have different masses. Alternatively or additionally, the elements 16 arranged in one of the ducts 14 can have different masses than the elements 16 in another one of the ducts 14.

Combinations of such absorber systems can help draw conclusions about the origin of the vibrations of the component in a very time-efficient way without having to use a laser vibration measurement process which is time-consuming and cost-intensive. Moreover, the vibration absorber 10 can provide a solution to extinguish undesired vibrations of the cell structure.

Fig. 4 illustrates a scaling of a pane of inertia of the vibration absorber 10. Moreover, Fig. 4 shows a second embodiment of the vibration absorber 10, the second embodiment having a plurality of members 12. According to Fig. 4, the second embodiment of the vibration absorber 10 has three members 12 each having a plurality of ducts which extend within the respective member 12. Said scaling of the pane of inertia is illustrated by angles γ , β and α . For example, the members 12 are connected to one another in a rotationally fixed manner so that the members 12 can be rotated together about the pivot axis 20 in relation to the base element 18. In a further embodiment, at least one of the members 12 can be rotated in relation to the others members 12 and the base element 18 about the

pivot axis 20.

Fig. 5 shows a third embodiment of the vibration absorber 10. In the third embodiment, the base element 18 has a plurality of surfaces 24a-d, on which the members 12 are mounted. As can be seen from Fig. 5, the surfaces 24a and 24c are arranged opposite to each other, wherein the member 12 mounted on the surface 24a is arranged coaxially in relation to the member 12 arranged on the surface 24c. Thus, the member 12 arranged on the surface 24a and the member 12 arranged on the surface 24c can be rotated about a mutual first pivot axis 20 shown in Fig. 6. The member 12 mounted on the surface 24b can be rotated about a second pivot axis 26 which extends perpendicularly to the pivot axis 20. Moreover, the member 12 arranged on the surface 24d can be rotated about a third pivot axis 28 which extends perpendicularly to the pivot axis 20 and the pivot axis 26.

Fig. 7 shows a fourth embodiment of the vibration absorber 10. The vibration absorber 10 according to the fourth embodiment has at least five members 12 and 13. For example, the member 13 is arranged on a surface of the base element 18 according to Fig. 5, wherein said surface on which the member 13 is mounted is arranged opposite to the surface 24d. Thus, the member 12 arranged on the surface 24d is arranged coaxially in relation to the member 13 so that the member 13 can be rotated about the pivot axis 28 in relation to the base element 18 as well.

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What is claimed is:

1. A vibration absorber (10) capable of absorbing vibrations of a component, in particular of a vehicle, the vibration absorber (10) comprising:

- at least one member (12) having a mass;
- at least one duct (14) extending in the member (12), the duct (14) having
- an elongate extension and being filled with a liquid; and
- a plurality of separate elements (16) each having a mass, the elements (16) being arranged in the duct (14) and surrounded by the liquid;

characterised in that

the vibration absorber (10) comprises a base element (18) via which the vibration absorber (10) is mountable on the component, the member (12) being pivotably connected to the base element (18) about at least one pivot axis (20).

2. The vibration absorber (10) according to claim 1, characterised in that

the elements (16) are elastically deformable.

3. The vibration absorber (10) according to any one of claims 1 or 2, characterised in that

the vibration absorber (10) comprises at least one fixing element by means of which the member (12) can be connected to the base element (18) in a rotationally fixed manner in at least to different rotary positions.

4. The vibration absorber (10) according to any one of the preceding claims, characterised in that the elements (16) are made of solid material.

5. The vibration absorber (10) according to any one of the preceding claims, characterised in that

the pivot axis (20) extends angularly or perpendicularly to the longitudinal

extension of the duct (14).

6. The vibration absorber (10) according to any one of the preceding claims, characterised in that

the vibration absorber (10) comprises:

- 5 – at least one second duct (14) extending in the member (12), the second duct (12) having an elongate extension and being filled with a second liquid and being fluidically separate from the first duct (14); and
- a plurality of second separate elements (16) each having a mass, the second elements (16) being arranged in the second duct (14) and
- 10 surrounded by the second liquid.

7. The vibration absorber (10) according to claim 6,

characterised in that

the second duct (14) extends parallel to the first duct (14).

8. The vibration absorber (10) according to any one of the preceding claims, characterised in that

the vibration absorber (10) comprises:

- at least one second member (13) having a mass;
- at least one third duct extending in the second member (13), the third duct having an elongate extension, being filled with a third liquid and
- 20 being fluidically separate from the first duct (14); and
- a plurality of third separate elements each having a mass, the third elements being arranged in the third duct and surrounded by the third liquid, wherein the second member is pivotably connected to the base element (18) about at least one pivot axis (28).

25 9. The vibration absorber (10) according to claim 8,

characterised in that

the members (12, 13) are rotatable in relation to each other.

10. The vibration absorber (10) according to any one of the preceding claims, characterised in that the liquid has a higher viscosity than water.

5 11. The vibration absorber (10) according to any one of the preceding claims, characterised in that the elements (16) are designed as spheres.

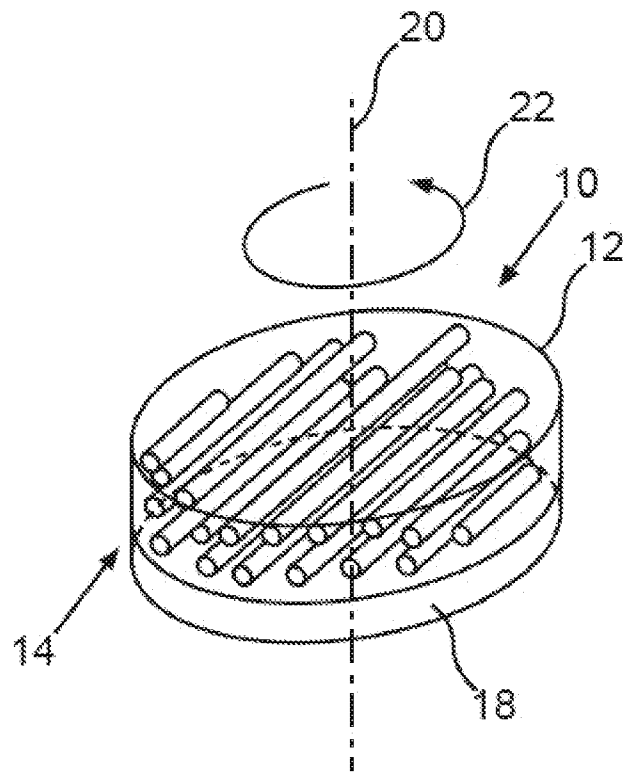


Fig.1

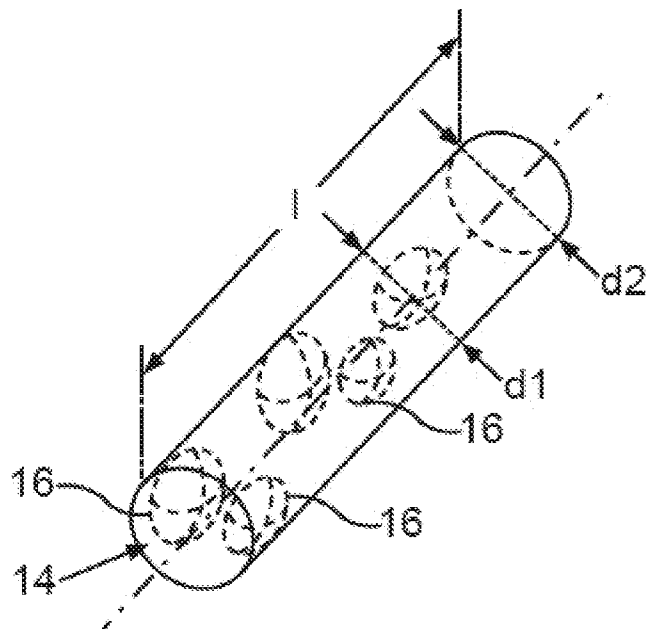


Fig.2

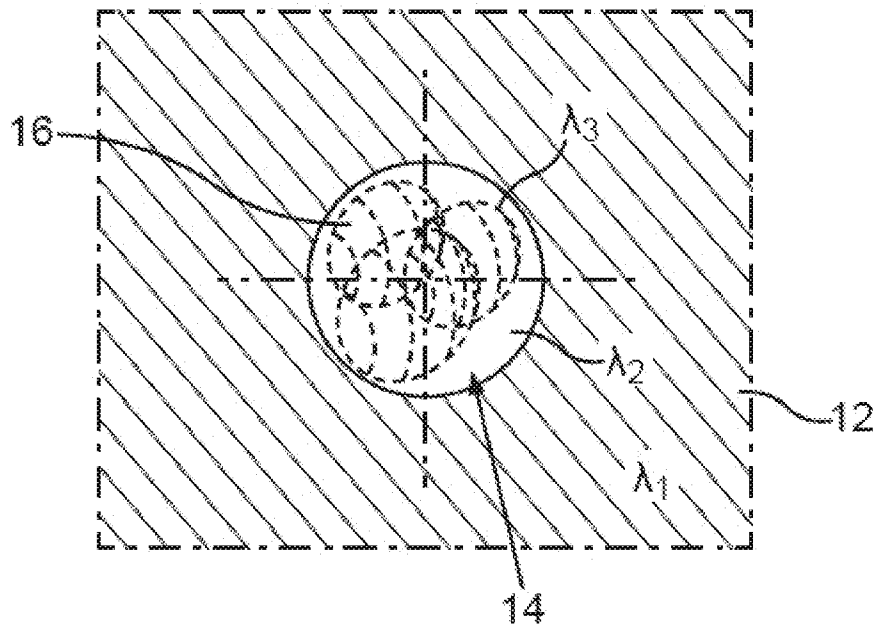


Fig.3

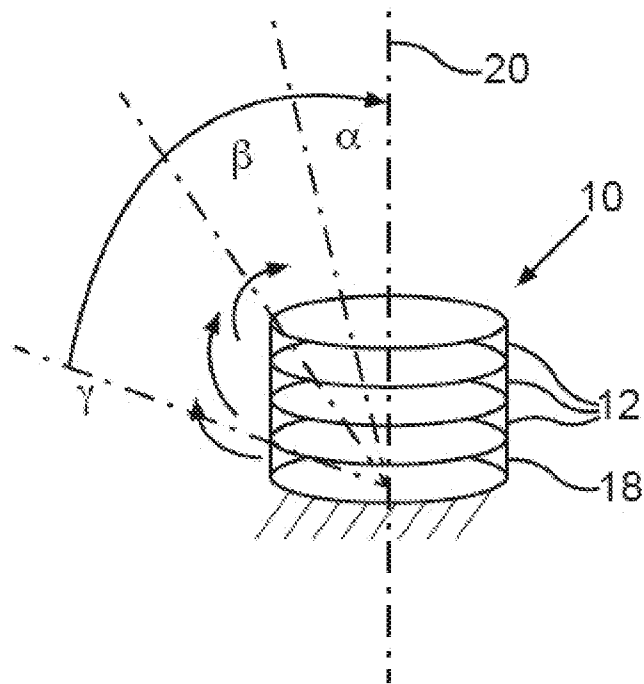


Fig.4

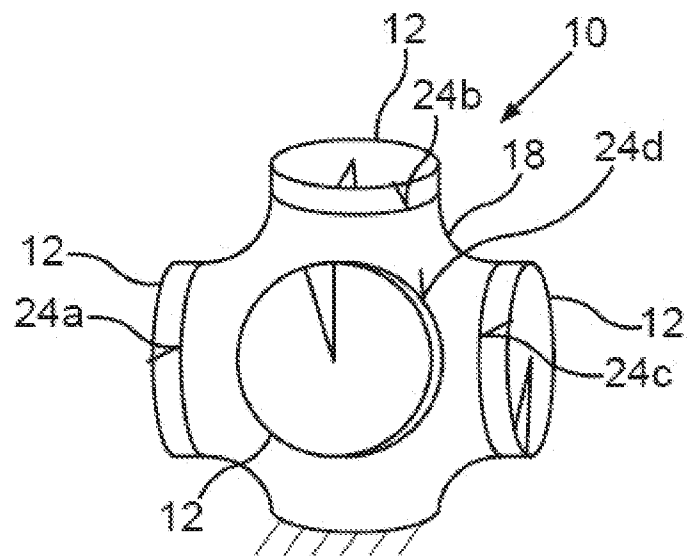


Fig.5

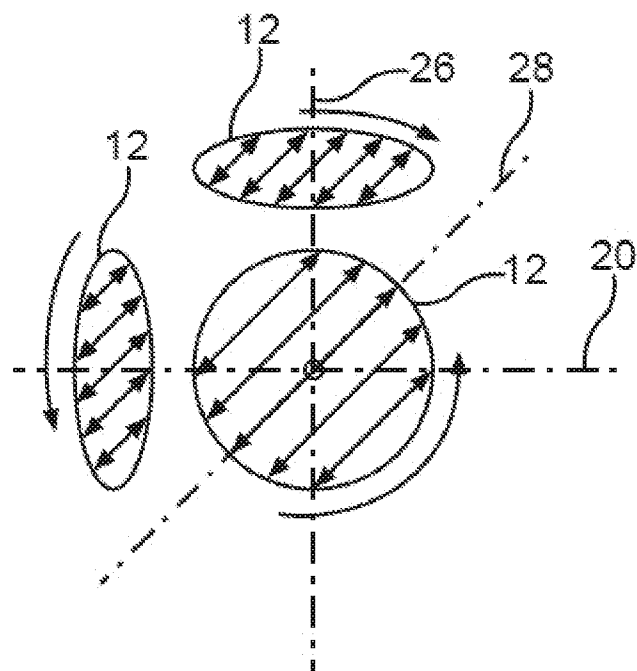


Fig.6

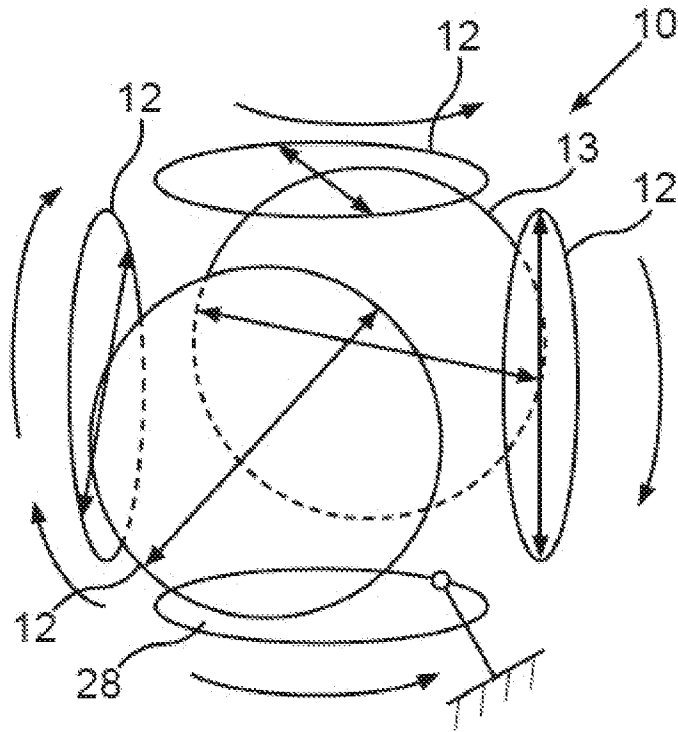


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/059327

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16F15/023 F16F7/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2011 079869 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 31 January 2013 (2013-01-31) cited in the application	1-4,8-11
Y	the whole document	5-7
Y	----- US 2012/024645 A1 (TSUGIHASHI KAZUKI [JP] ET AL) 2 February 2012 (2012-02-02) the whole document	5-7
A	----- EP 1 060 970 A1 (HITACHI LTD [JP]) 20 December 2000 (2000-12-20) paragraph [0065] - paragraph [0077]; figures 26-31 ----- -/--	1-11

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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24 November 2014

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 102 35 397 A1 (SCHEFENACKER VISION SYSTEMS [DE]) 19 February 2004 (2004-02-19) the whole document	1-11
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/059327

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