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(54) **Title:** DAMPER, DAMPING ASSEMBLY, GAS GENERATOR, ASSEMBLY, AND DISASSEMBLY METHOD

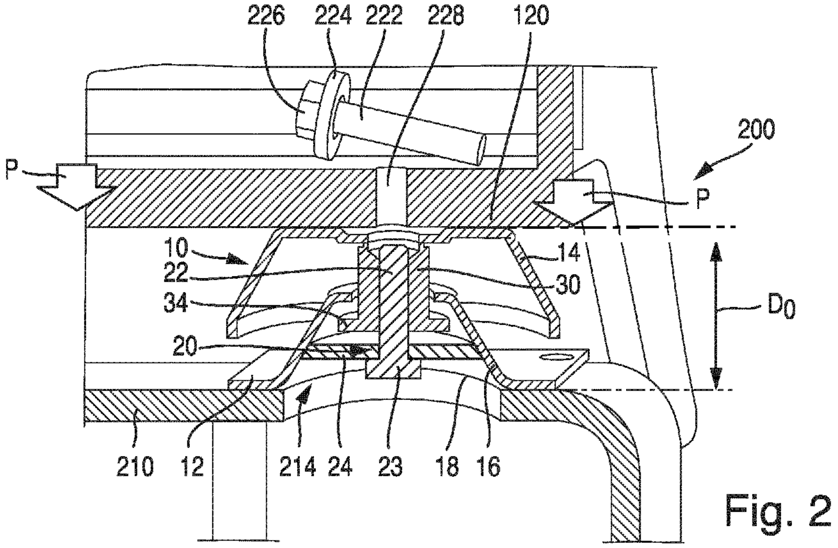

Fig. 2

(57) **Abstract:** The present invention pertains to a damper (10) for a damping assembly (100) of a gas generator unit (200) or gas engine unit, comprising a bottom part (12) configured to be assembled to a generator base plate (210) and a top part (14) configured to be assembled to a generator footplate (220), wherein the bottom part (12) comprises a protruding portion (16) protruding towards the top part (14) such that a bottom open cavity (18) is formed. The present invention further pertains to a damping assembly (100) of a gas generator unit (200), comprising at least one damper (10) and a generator base plate (210), wherein the generator base plate (210) comprises a service opening (212) configured to insert the clamping means (20) in a state when the damper (10) is assembled to the base plate (210). The invention further pertains to a gas generator unit (200) comprising a damping assembly (100) and a generator footplate (220). In an assembled state, each damper (10) is assembled to the generator footplate (210) via an assembling screw (222) threadably

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engaging the top part (14) of the damper (10). The invention further pertains to a disassembly method for removing the damper (10) from a gas generator unit (200) and to an assembly method for assembling a damper (10) to a gas generator unit (200).

Description

DAMPER, DAMPING ASSEMBLY, GAS GENERATOR, ASSEMBLY, AND DISASSEMBLY METHOD

Technical Field

The present invention pertains to a damper for a damping assembly of a gas engine or gas generator unit, comprising a bottom part configured to be assembled to a generator base plate and a top part configured to be assembled to a generator footplate, wherein the bottom part comprises a protruding portion protruding towards the top part such that a bottom open cavity is formed. The invention also pertains to damping assembly of a gas generator unit comprising at least one such damper, and to a gas generator unit, comprising such a damping assembly. The invention further pertains to a disassembly method for removing a damper from a gas generator unit and to an assembly method for assembling a damper to a gas generator unit.

Technological Background

Large gas engines or gas generator units are usually mounted to a base by mounting a footplate of the gas engine or gas generator to a base plate. To reduce noise generation and vibration-induced stresses, damper elements are arranged between the base plate and the footplate, damper elements.

In an assembled state, the gas engine or gas generator unit rests on the support elements and weight-induced loads compress the support elements in a predefined threshold.

Such damper elements may for example come in the form of compression-shear cup/engine mounts. Dampening of vibration and shock is achieved by providing an elastomer arranged between a bottom part and a top part of the damper. Further, such damper elements also provide an anchoring of the gas engine or gas generator unit by positively locking abutments provided on the inside of the damper element.

The support elements must be replaced regularly. For the replacement of a damper element, the entire gas engine unit or gas generator unit must usually be disassembled. This entails lifting the gas engine or gas generator until a gap between the support element and the engine is yielded, sufficient to allow removal of the relaxed damping element away from the yielded gap.

Such a damper element replacement operation can be costly, time-consuming and entails the risk of human error and damages to the components.

Other solutions suggest utilizing dedicated tools firmly connected to the damper element from the outside of the damper element. As an example, US 2021/0190256 A1 teaches securing a turnbuckle to a lower and upper assembling plate of the damper device. However, the assembly/disassembly of the damper element requires substantial installation efforts, and the damper elements must have a dedicated design and structure suitable for receiving the turnbuckle.

The damper, the damping assembly, the gas generator unit, the disassembly method, and the assembly method of the present disclosure solve one or more problems set forth above.

Summary of the Invention

Starting from the prior art, it is an objective of the present disclosure to provide a simple, cost-effective damper allowing replacement without the necessity of disassembling the gas engine or gas generator unit.

This objective is solved by means of a damper with the features of claim 1, a damping assembly of a gas generator or gas engine unit with the features of claim 11, a gas engine or gas generator unit with the features of claim 12, a disassembly method with the features of claim 13 and an assembly method with the features of claim 14. Preferred embodiments are set forth in the present specification, the Figures as well as the dependent claims.

Accordingly, a damper of a gas engine or gas generator unit is provided, comprising a bottom part configured to be assembled to a generator base plate and a top part configured to be assembled to a generator footplate. The bottom part comprises a protruding portion protruding towards the top part such that a bottom open cavity is formed. The clamping means are supported within the bottom open cavity and are configured to be engageable with the top part such that the bottom part and the top part can be set to a clamped distance.

Further, a damping assembly of a gas engine or gas generator unit is provided, comprising at least one damper and a generator base plate. The generator base plate comprises a service opening configured to insert the clamping means in a state when the damper is assembled to the base plate.

Additionally, a gas generator unit is provided, comprising a damping assembly and a generator footplate. In an assembled state, each damper is assembled to the generator footplate via an assembling screw threadably engaging the top part of the damper.

In addition, a disassembly method for removing a damper from a gas generator unit is provided, comprising the steps of disassembling the bottom part from the generator base plate, disengaging the assembling screw from the op part of the damper to disengage the top part from the generator footplate, inserting the clamping means into the bottom open cavity through the service opening of the generator base plate and setting the clamping distance between the bottom part and the top part such that the clamping distance is less than the distance of the generator base plate to the generator footplate.

Further, an assembly method for assembling a damper to a gas generator unit is provided, comprising the steps of inserting the clamping means into the bottom open cavity, setting the clamping distance between the bottom part and the top part such that the clamping distance is less than the distance of the generator base plate to the generator footplate, assembling the bottom part of the damper to the generator base plate, disengaging the clamping means from the damper via the service opening of the generator base plate, and engaging the assembling screw with the top part of the damper to assemble the top part of the generator footplate.

Brief Description of the Drawings

The present disclosure will be more readily appreciated by reference to the following detailed description when being considered in connection with the accompanying drawings in which:

Fig. 1 schematically illustrates a cross-section of a damper according to the state of the art in an assembled and compressed state;

Fig. 2 schematically illustrates a cross-section of a damper according to an embodiment in a disassembled and compressed state;

Fig. 3 schematically illustrates a cross-section of the damper of Fig. 2 in a disassembled and clamped state;

Fig. 4 schematically illustrates a gas generator unit in a state when the damper of Figs. 2 and 3 is removed;

Fig. 5 illustrates a gas generator unit in a perspective view;

Fig. 6 illustrates a disassembly method according to an embodiment; and

Fig, 7 illustrates an assembly method according to an embodiment.

Detailed Description of Preferred Embodiments

In the following, the invention will be explained in more detail with reference to the accompanying figures. In the Figures, like elements are denoted by identical reference numerals and repeated description thereof may be omitted to avoid redundancies.

The damper according to the following specification may be in a “relaxed”, “compressed” or “clamped” state. The “relaxed” state refers to a state in which no load is inflicted to the damper. The “compressed” state relates to a state of the damper in which weight-induced loads are inflicted to the damper, usually by the generator gas unit. The “clamped” state refers to a state in which a clamping load is inflicted to the damper via the clamping means. The higher the compression, the smaller the distance between a top part and bottom part of the damper. Compared to the “compressed” state, the “clamped” state usually corresponds to a higher degree of compression, and therefore to a smaller distance. The expressions “relaxed”, “compressed” and “clamped” have the same meaning when used independently from the state.

The damper according to the present disclosure may be in an “assembled” state or in a “disassembled” and/or “removed” state. The “assembled” state refers to a damper which is fully assembled within a gas generator unit for nominal operation. The “disassembled” state refers to a state in which the damper may still be arranged in place, but without its top and bottom parts being assembled to the adjacent components of the gas generator unit. The “removed” state refers to a state in which the damper is disassembled and fully removed from the gas generator unit. The expressions “assembled”, “disassembled” and “removed” have the same meaning when used independently from the state.

In the following specification, the term “generator” is used as placeholder for gas engines and further heavy-duty gas generation components subject to vibration, for gas engines, gas generators, preferably of the reciprocating internal combustion type, for heat exchanger components, recuperators, condensers, and the like.

The present disclosure is generally directed towards a damper that allows temporarily clamping the damper by clamping means which are supported within a bottom open cavity provided in the bottom part of the damper.

Assembled on a generator base plate, the bottom open cavity is formed between the generator base plate and the bottom part. However, the person skilled in the art will appreciate that the teaching of the present disclosure also includes an upside-down configuration of the disclosed damper.

In Figure 1, a cross-section of a damper according to the state of the art is shown in an assembled and compressed state. The damper 10 is assembled between a generator base plate 210 and a generator footplate 220. The damper 10 comprises a bottom part 12 which is configured to be assembled to the generator base plate 210. The shown bottom part 12 may have a square base and may require four base plate to bottom part assembling screws 212 for assembling the bottom part 12 to the base plate 210. The screws 212 may be hexagonal bolts. The damper 10 may also comprise a top part 14 which is configured to be assembled to the generator footplate 220 via an assembling screw 222. The bottom part 12 may comprise a protruding portion 16 protruding towards the top part 14 such that a bottom open cavity 18 is formed.

In the context of the present disclosure, the term protrusion may be understood such that the protrusion protrudes from a plane defined by the bottom part 12. Likewise, the term bottom open cavity 18 may be understood as a cavity provided by the displacement of the cavity between the plane defined by the bottom part 12 and the protruding portion 16.

The bottom part 12 comprises a protruding portion 16. The protruding portion 16 may be in the form of a convex shaped portion of the bottom part 12 protruding towards the top part 14 and thereby forming the bottom open cavity 16.

The top part 14 may comprise a threaded bushing 30 assembled to the top part 14 at a distal end 32 and comprises a flange portion 34 on its proximal end 36. The flange portion 34 may serve as an anchor for the top part 14 in case the footplate 220 is forced away from the base plate 210 beyond a predetermined extent. The protruding portion 16 may comprise an opening 28, in which the threaded bushing 30 may be movably arranged in the opening 28 such that the threaded bushing 30 is partly inside of the bottom open cavity 18.

The threaded bushing 30 may be configured to be engageable by an assembling screw 222 from its distal end 32 to assemble the top part 14 to the generator footplate 220. More specifically, the assembling screw 222 can be brought in threaded engagement with the threaded bushing 30 by inserting the assembling screw 222 via an assembling screw insert hole 228 of the generator footplate 220 into the distal end 32 of the threaded bushing 30. Between an assembling screw head 226 and the generator footplate 220 an assembling screw washer 224 may be placed to provide an abutment for the assembling screw 222.

Between the bottom part 12 and the top part 14 an elastomer 38 may be provided. In addition to the elastomer 38, an elastomer inlay 40 may be provided in an opening 28 of the protruding portion 16. Thereby, the threaded bushing 30 and the flange portion 34 can be protected from direct contact with the top part 14.

Figure 2 may be based on the disclosure of Figure 1. Figure 2 schematically illustrates a damper 10 according to an embodiment in a cross-sectional view of a perspective illustration. The damper 12 shown in Figure 2 is in a disassembled and compressed state. In Figure 2, the elastomer 38 and the elastomer inlay 40 are omitted for illustration purposes only. The damper 10 is in a disassembled state, because the assembling screw 222 and the base plate to bottom part assembling screw 212 are removed. However, the damper 10 is still arranged between the generator footplate 220 and the generator base plate 210, meaning that the load P of the generator unit 200 rests on the damper 10, which leads to a compression of the damper 10.

The damper 10 according to the embodiment shown in Figure 2 comprises clamping means 20 supported within the bottom open cavity 18. The clamping means 20 may be configured to be brought into threaded engagement with the top part 14 such that the bottom part 12 and the top part 14 can be set to a clamped distance D_C. In the illustration provided in Figure 2, the clamping means 20 are present but not yet engaged such that the bottom part 12 and the top part 14 are set to a clamped distance.

In the shown state, the clamping means 20 may be in a loosely engaged state, meaning that no clamping force F_C is applied to the damper 10. Accordingly, the distance between the bottom part 12 and the top part 14 is the default distance D_0, which depends on the material properties of the elastomer (not shown in Figure 2) and the load P acting on the damper 10.

The bottom open cavity 18 may be tapered, preferably conically tapered, towards the top part 14. In an alternative embodiment not shown in Figure 2, the bottom open cavity 18 may also have a stepped design. The clamping means 20 may comprise a clamping screw 22 which is configured to be brought into a threaded engagement with the top part 14. Further, the clamping means 20 may comprise a clamping washer 24 configured to provide an abutment for the clamping screw 22. The clamping washer may comprise tapered edges 26. The tapered edges 26 may preferably be shaped such that they provide a contact surface, contacting the inside of the protruding portion 16.

As shown in Figure 2, instead of the assembling screw 222, the clamping screw 22 is inserted into the same threaded washer 30 yet inserted from the other end of the threaded washer 30. Instead of the assembly screw 222 inserted to threadably engage the threaded bushing 30 via its distal end 32, the clamping screw is inserted to threadably engage the threaded bushing 30 from its proximal end 36.

The top part 14 may comprise a threaded bushing 30 assembled to the top part 14 at a distal end 32 and comprises a flange portion 34 on its proximal end 36. Further, the protruding portion 16 may comprise an opening 28, wherein the threaded bushing 20 may be movably arranged in the opening 28 such that the threaded bushing 30 is inside of the bottom open cavity 18.

The clamping means 20 may be configured such that a screw head 23 is fully incorporated within the bottom open cavity 18 when the clamping screw 22 engages the threaded bushing 30 such that the clamping washer 24 is in contact with the inside of the bottom open cavity 18.

Preferably, the clamping means 20 are configured such that the clamping screw 22 does not reach beyond the bottom part 12 and the top part 14, both in a loosely engaged state and in a state when the damper 10 is clamped.

The threaded bushing 30 may be configured to be engageable by the clamping means 20 from its proximal end 32 and, in a state when the clamping means 20 are not engaged with the threaded bushing 30, wherein the threaded bushing 30 is configured to be engageable by an assembling screw 222 from its distal end 32.

Figure 3 schematically illustrates a cross-section of the damper 10 shown in Figure 2 in a disassembled and clamped state. The clamped state is achieved by applying the clamping force F_C to the damper 10 via the clamping means 20. The same principles and explanations provided in the context of Figure 2 may apply to Figure 3.

The clamping means 20 are supported within the bottom open cavity 18 and are brought into threaded engagement the top part 14 such that the bottom part 12 and the top part 14 are set to a clamped distance D_C. This may be achieved as shown in the exemplary embodiment by providing the open cavity 18 in a tapered design, conically tapered towards the top part 14. The clamping screw 22 may threadably engage with the threaded bushing 30 of the top part 14. The clamping screw 22 may also be abutted by its clamping screw head 23 by the clamping washer 24.

The clamping washer 24 itself may be abutted by its tapered edges 26 on the inner surface of the protruding portion 16. Therefore, driving the clamping screw 22 in a clockwise by a clamping screw rotation S_R may provide a clamping force F_C due to the threaded engagement of clamping screw 22 with the threaded bushing 30. Because the elastomer 38 is flexible, a sufficient clamping force F_C will drive the top portion 14 closer to the bottom portion 12, thereby reducing the distance of the bottom portion 12 to the top portion 14. To this end, the clamping screw 22 may be turned until a predefined clamping distance C_D is achieved, sufficient to provide a gap between the bottom part 12 and/or the top part 14 to the gap defined by the generator base plate 210 and the generator footplate 220.

As can be seen in Figure 3, the clamping means 20 are defined such that in a state when the clamping distance C_D is reached, the clamping means are arranged fully within the damper 10. Thereby, the clamped damper 10 can be removed away from the gap between the generator base plate 210 and the generator footplate 220 of the gas generator unit 200. To this end, the clamping washer 24 is provided such that the clamping screw head 23 does not extend beyond the bottom part 12. Further, the clamping washer 24 may be provided such that the threaded bushing 30 can move towards the clamping washer 24 at least in an amount equal to the length $D_0 - D_C$.

Figure 4 schematically illustrates the illustrates the gas generator unit 200 in a state when the damper of Figures 2 and 3 is removed from the gap defined between the generator base plate 210 and the generator footplate 220. In this illustration, the service opening 214 can be seen which allows accessing the asse damper 10 (not shown in Figure 4) for inserting clamping means 20 as well as tools for actuating the clamping means 20.

Figure 5 schematically illustrates a gas generator unit 200 in a perspective view. The gas generator unit 200 comprises a damping assembly 100 which may consist of one or more dampers 10. The gas generator unit 200 further comprises a generator footplate 220, wherein in an assembled state, each damper 10 may be assembled to the generator footplate 220 via an assembling screw 222 threadably engaging the top part 14 of the damper 10. The gas generator unit may further comprise a base plate 210 on which the damper 10 is assembled to by its bottom part 12 via generator base plate to bottom part assembling screws 212. Applying the teaching provided above in the context of the damper 10, each damper 10 according to the present disclosure may be removed or inserted by actuating its clamping means 20.

Figure 5 shows a flow diagram of a disassembly method according to an embodiment of the present disclosure. The disassembly method is suitable for removing a damper 10 from a gas generator unit 200 and comprises the steps of disassembling S10 the bottom part 12 from the generator base plate 210, disengaging S12 the assembling screw 222 from the top part 14 of the damper 10 to disengage the top part 14 from the generator footplate 220, inserting S14 the clamping means 20 into the bottom open cavity 18 through the service opening 212 of the generator base plate 210 and setting S16 the clamping distance D_C between the bottom part 12 and the top part 14 such that the clamping distance D_C is less than the default distance D_0 of the generator base plate 210 to the generator footplate 220.

Figure 6 shows a flow diagram of an assembly method according to an embodiment of the present disclosure. The assembly method is suitable for assembling a damper 10 to a gas generator unit 200 and comprises the steps of inserting S100 the clamping means 20 into the bottom open cavity 18, setting S110 the clamping distance D_C between the bottom part 12 and the top part 14 such that the clamping distance D_C is less than the default distance D_0 of the generator base plate 210 to the generator footplate 220, assembling S120 the bottom part 12 of the damper 10 to the generator base plate 210, disengaging S130 the clamping means 20 from the damper 10 via the service opening 212 of the generator base plate 210 and engaging S140 the assembling screw 222 with the top part 14 of the damper 10 to assemble the top part 14 to the generator footplate 210.

According to a further development, the step of setting S110 the clamping distance DC between the bottom part 12 and the top part 14 such that the clamping distance DC may be preceded by a step of compressing S105 (not shown in Figure 7) the damper 10, preferably in a vise.

It will be obvious for a person skilled in the art that these embodiments and items only depict examples of a plurality of possibilities. Hence, the embodiments shown here should not be understood to form a limitation of these features and configurations. Any possible combination and configuration of the described features can be chosen according to the scope of the invention.

This is in particular the case with respect to the following optional features which may be combined with some or all embodiments, items and all features mentioned before in any technically feasible combination. As an example, a damper may have more than one protruding portion protruding towards the top part such that a bottom open cavity is formed. Further, a damper may comprise more than one clamping means supported within the bottom open cavity. Relevant for the teaching of the present disclosure is the provision of an internal abutment for clamping means which allow clamping the damper without the clamping means protruding beyond the bottom part and the top part.

A damper for a damping assembly of a gas generator unit may be provided, comprising a bottom part configured to be assembled to a generator base plate and a top part configured to be assembled to a generator footplate, wherein the bottom part comprises a protruding portion protruding towards the top part such that a bottom open cavity is formed. The clamping means are supported within the bottom open cavity and are configured to be engageable with the top part such that the bottom part and the top part can be set to a clamped distance.

The clamped distance is a distance at which a damper may be removed from the gap encompassed by the generator base plate and the generator footplate without suffering structural damage. Usually, the clamped distance is slightly smaller than a default distance of the generator footplate to the generator base plate.

In the context of the present disclosure, the term protrusion may be understood such that the protrusion protrudes from a plane defined by the bottom part. Likewise, the term bottom open cavity may be understood as a cavity provided between the plane defined by the bottom part and the protruding portion. In other words, the protruding portion may be a convex portion of the bottom part and the bottom open cavity may be the volume displaced by the convex portion.

By providing clamping means supported within the bottom open cavity, the clamping means can clamp the damper without protruding beyond the bottom plate and the top plate. Thereby, the damper can be removed conveniently to the side when in a clamped state.

Supporting the clamping means may be achieved by a positive locking structure such as a step or abutment. Alternatively, or additionally, supporting the clamping means may be achieved by friction locking the clamping means within the bottom open cavity.

Providing the clamping means within the bottom open cavity also has the advantage that the clamping means may be inserted from underneath the damper, which can be more convenient and safter compared to an insertion from the side of the damper.

Providing clamping means configured to be engageable with the top part such that the bottom part and the top part can be set to a clamped distance has the advantage that the damper is merely actuated within its usual range of motion.

In a further development, the bottom open cavity may be tapered, preferably conically tapered, towards the top part. Thereby, a stepless abutment may be provided for the clamping means. In the context of the present disclosure, a tapered, preferably conically tapered, bottom open cavity may be synonymous with a tapered protruding portion. This has the advantage that different clamping means may be supported by the protruding portion within the bottom open cavity.

Providing the bottom open cavity conically tapered towards the top part has the advantage that a circular abutment may be provided for the clamping means. Thereby, the assembly of the clamping means is less complex which leads to a reduced risk of failure.

In a further development, the clamping means may comprise a clamping screw configured to threadably engage with the top part. By providing a clamping screw, the clamped distance can be set stepless using readily available tools. Further, by providing a clamping screw configured to threadably engage with the top part, simple and readily available tools for actuating the clamping means may be utilized.

In an even further development, the clamping means may comprise only one clamping screw configured to threadably engage with the top part. Thereby, the clamped distance can be set by driving only one screw until the desired clamped distance is reached.

In a further development, the clamping means may further comprise a clamping washer configured to provide an abutment for the clamping screw. Thereby, a bearing for the clamping screw may be provided such that the screw has only one degree of freedom, namely rotation about its longitudinal axis. By this, loads acting on the screw may be dissipated to the protruding portion via the clamping washer.

In a further development, the clamping washer may comprise tapered edges. Preferably, the edges of the clamping washer may be tapered at the same angle the open cavity and therefore the protruding portion are tapered. Thereby, the contact surface area between the clamping washer and the protruding portion may be increased. This has the advantage that loads acting on the screw may be dissipated to the protruding portion via the clamping washer more effectively, reducing the risk of clamping washer malfunction.

In a further development, the top part may comprise a threaded bushing assembled to the top part at a distal end and may comprise a flange portion on its proximal end. By proving a threaded bushing assembled to the top part, the top part can be engaged by a screw inserted from either side of the bushing, allowing to actuate the top part relative to the bottom part.

In the sense of the present disclosure, the terms proximal and distal are defined in relation to the bottom part. By providing a flange portion on its proximal end, an anchoring abutment may be provided, anchoring the threaded bushing against forces driving it away from the bottom part beyond an admissible extent.

In a further development, the protruding portion may comprise an opening and wherein the threaded bushing may be movably arranged in the opening, such that the threaded bushing is arranged at least partially within the bottom open cavity. Thereby, a bearing for the threaded bushing may be provided, allowing the threaded bushing to move into the opening when the damper is compressed or clamped.

In a further development, the threaded bushing may be configured to be engageable by the clamping means from its proximal end and, in a state when the clamping means are not engaged with the threaded bushing, wherein the threaded bushing is configured to be engageable by an assembling screw from its distal end. Thereby, only one threaded bushing is needed for both compression and clamping of the damper. This has the benefit that no additional threads need to be integrated into the damper for the purpose of clamping. In addition, the load inflicted to the damper due to clamping has very similar load fluxes compared to loads inflicted to the damper due to compression at nominal operation. In view thereof, the damper design may be kept largely unchanged.

In a further development, the damper may further comprise an elastomer provided between the bottom part and the top part to dampen relative movement therebetween. The elastomer may be a rubber-elastically deformable damping element extending between the top part and the bottom part. By providing an elastomer, excellent vibration dampening characteristics under vertical compression and shear loads may be achieved. Further, the elastomer may be vulcanized to the bottom part and/or the top part.

In a preferred embodiment, the top part may be provided as a cup-shaped design. This has the advantage that the elastomer may be protected from oils, industrial solvents, and chemicals.

In a further development, the clamping means may be configured to set a clamped distance which is equal or less than 90% of a default distance of the bottom part to the top part when no load is acting on the damper. Thereby, a sufficient gap between the clamped damper and the adjacent generator base plate and the generator can be achieved, sufficient for removing the clamped damper away from the generator unit.

A damping assembly of a gas generator unit may be provided, comprising at least one damper and a generator base plate according to the present disclosure, wherein the generator base plate comprises a service opening configured to insert the clamping means in a state when the damper is assembled to the generator base plate. Thereby, maintenance and replacement of the damping assembly may be simplified, reduced maintenance costs and reduced risk of human error.

More specifically, each damper according to the present disclosure may be replaced while the remaining dampers of the damping assembly may remain assembled. The replacement of a damper according to the present disclosure may be achieved by simply setting the damper to a clamped distance utilizing the clamping means and removing the damper sideways from the gas generator unit.

A gas generator unit may be provided, comprising a damping assembly and a generator footplate, wherein in an assembled state, each damper is assembled to the generator footplate via an assembling screw threadably engaging the top part of the damper. Thereby, maintenance and replacement of the dampers or the entire damping assembly of the gas generator unit may be simplified, allowing for shorter off-grid times, reduced maintenance costs and reduced risk of human error. The advantages identified for the damping assembly also apply to the gas generator unit.

A disassembly method for removing a damper from a gas generator unit may be provided, comprising the steps of disassembling the bottom part from the generator base plate, disengaging the assembling screw from the top part of the damper to disengage the top part from the generator footplate, inserting the clamping means into the bottom open cavity through the service opening of the generator base plate and setting the clamping distance between the bottom part and the top part such that the clamping distance is less than the distance of the generator base plate to the generator footplate.

The advantages identified above for the damper and the damping assembly also apply to the disassembly method. Inserting the clamping means into the bottom open cavity through the service opening of the generator base plate may be understood as inserting the clamping means from below the generator base plate. Thereby, during inserting and during disassembling, the clamping means are not exposed to oils, industrial solvents and chemicals which may be present on the outside of the damper. Further, the risk of injury or tool damage by pinching or clamping between the generator base plate and the generator footplate can be avoided altogether. In addition, inserting the clamping means into the bottom open cavity through the service opening of the generator base plate requires only one access direction to the damper for disassembly purposes. Even in the case of partial or full damper failure, for example a collapsed damper or a slipped damper, access to the damper from below the generator base plate is likely unobstructed.

The default distance of the generator base plate to the generator footplate may be understood as the actual current distance of the generator base plate to the generator footplate when the damper is disassembled, hence, not supporting the generator foot plate. Accordingly, by setting the clamping distance to a distance less than the default distance of the generator base plate to the generator footplate, the clamped damper may be removed away from the gas generator unit.

According to a further embodiment, the disassembly method may further comprise the step of removing the clamped damper away from the gas generator unit. Thereby, the clamed damper may be fully removed for inspection and/or replacement.

According to a further embodiment, the disassembly method may further comprise inserting a temporary support element into the gap left open by the clamped and/or removed damper. Thereby, the gas generator unit may still be held in its nominal position.

Further, an assembly method for assembling a damper to a gas generator unit may be provided, comprising the steps of inserting the clamping means into the bottom open cavity, setting the clamping distance between the bottom part and the top part such that the clamping distance is less than the distance of the generator base plate to the generator footplate, assembling the bottom part of the damper to the generator base plate, disengaging the clamping means from the damper via the service opening of the generator base plate, and engaging the assembling screw with the top part of the damper to assemble the top part to the generator footplate. The advantages identified above for the disassembly method also apply to the assembly method mutatis mutandis.

In a further development, the step of setting the clamping distance between the bottom part and the top part such that the clamping distance may be preceded by a step of compressing the damper in a vise. Thereby, the clamping of the damper may be achieved with less effort.

Industrial Applicability

With reference to the Figures, a damper for a damping assembly of a gas generator unit, a damping assembly of a gas generator unit, a gas generator unit, a disassembly method for removing a damper from a gas generator unit and an assembly method for assembling a damper to a gas generator unit are applicable in any suitable gas engine or gas generator installation.

In practice, a damper for a damping assembly of a gas generator unit, a damping assembly of a gas generator unit and/or any combination of these various assemblies and components may be manufactured, bought, or sold to retrofit a gas generator, a gas engine, or a gas engine already deployed in the field in an aftermarket context, or alternatively may be manufactured, bought, sold or otherwise obtained in an OEM (original equipment manufacturer) context.

As alluded to previously herein, the aforementioned embodiments may increase the improve the reliability and performance as will be elaborated further herein momentarily.

Referring to Figures 2 and 3, there is an embodiment shown disclosing a damper for a damping assembly of a gas generator unit, comprising a bottom part configured to be assembled to a generator footplate, wherein the bottom part comprises a protruding portion protruding towards the top part such that a bottom open cavity is formed. The clamping means are supported within the bottom open cavity and are configured to be engageable with the top part such that the bottom part and the top part can be set to a clamped distance. One skilled in the art will expect that various embodiments of the present disclosure will provide a damper that can be assembled and disassembled to and from a gas generator unit while the gas generator remains in place, hence at low maintenance efforts and a minimum of associated maintenance costs.

The same advantages apply to the Figures 4-7, in particular to the gas generator unit comprising a damper assembly having several dampers according to the present disclosure.

The present description is for illustrative purposes only and should not be construed to narrow the breadth of the present disclosure in any way. Thus, those skilled in the art will appreciate that various modifications might be made to the presently disclosed embodiments without departing from the full and fair scope and spirit of the present disclosure. Other aspects, features and advantages will be apparent upon an examination of the attached drawings and appended claims. As used herein, the articles “a” and “an” are intended to include one or more items and may be used interchangeably with “one or more.” Where only one item is intended, the term “one” or similar language is used. Also, as used herein, the terms “has,” “have,” “having,” “include”, “includes”, “including”, or the like are intended to be open-ended terms. Further, the phrase “based on” is intended to mean “based, at least in part, on” unless explicitly stated otherwise. Further, coordinate axes are intended to be exemplary only without delimiting the scope of the disclosure.

All references to the disclosure or examples thereof are intended to reference the example being discussed at that point and are not intended to imply any limitation as to the scope of the disclosure more generally. All language of distinction and disparagement with respect to certain features is intended to indicate a lack of preference for those features, but not to exclude such from the scope of the disclosure entirely unless otherwise indicated.

Recitation of values or dimensions herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein.

Furthermore, variations or modifications to certain aspects or features of various embodiments may be made to create further embodiments and features and aspects of various embodiments may be added to or substituted for other features or aspects of other embodiments to provide still further embodiments.

Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

Claims

1. A damper (10) for a damping assembly (100) of a gas generator unit (200) or gas engine unit, comprising a bottom part (12) configured to be assembled to a generator base plate (210) and a top part (14) configured to be assembled to a generator footplate (220), wherein the bottom part (12) comprises a protruding portion (16) protruding towards the top part (14) such that a bottom open cavity (18) is formed,

characterized by

clamping means (20) supported within the bottom open cavity (18) and configured to be engageable with the top part (14) such that the bottom part (12) and the top part (14) can be set to a clamped distance (D_C).

2. The damper (10) according to claim 1, wherein the bottom open cavity (18) is tapered, preferably conically tapered, towards the top part (14).

3. The damper (10) according to any of the previous claims, wherein the clamping means (20) comprise a clamping screw (22) configured to threadably engage with the top part (14).

4. The damper (10) according to claim 3, wherein the clamping means (20) further comprise a clamping washer (24) configured to provide an abutment for the clamping screw (22).

5. The damper (10) according to claim 4, wherein the clamping washer (24) comprises tapered edges (26).

6. The damper (10) according to any of the previous claims, wherein the top part (14) comprises a threaded bushing (30) assembled to the top part (14) at a distal end (32) and comprises a flange portion (34) on its proximal end (36).

7. The damper (10) according to claim 6, wherein the protruding portion (16) comprises an opening (28) and wherein the threaded bushing (30) is movably arranged in the opening (28) such that the threaded bushing (30) is arranged at least partially within the bottom open cavity (18).

8. The damper (10) according to claim 7, wherein the threaded bushing (30) is configured to be engageable by the clamping means (20) from its proximal end (32) and, in a state when the clamping means (20) are not engaged with the threaded bushing (30), wherein the threaded bushing (30) is configured to be engageable by an assembling screw (222) from its distal end (32).

9. The damper (10) according to any of the previous claims, further comprising an elastomer (38) provided between the bottom part (12) and the top part (14) to dampen relative movement therebetween.

10. The damper (10) according to claim 9, wherein the clamping means (20) are configured to set a clamped distance (D_C) which is equal or less than 90% of a default distance (D_0) of the bottom part (12) to the top part (14) when no load (P) is acting on the damper (10).

11. A damping assembly (100) of a gas generator unit (200) or gas engine unit, comprising at least one damper (10) according to any of the previous claims and a generator base plate (210), wherein the generator base plate

(210) comprises a service opening (212) configured to insert the clamping means (20) in a state when the damper (10) is assembled to the generator base plate (210).

12. A gas generator unit (200), comprising a damping assembly (100) according to claim 11 and a generator footplate (220), wherein in an assembled state, each damper (10) is assembled to the generator footplate (220) via an assembling screw (222) threadably engaging the top part (14) of the damper (10).

13. A disassembly method for removing a damper (10) from a gas generator unit (200) or gas engine unit, comprising the steps of:

- disassembling (S10) the bottom part (12) from the generator base plate (210);

- disengaging (S12) the assembling screw (222) from the top part (14) of the damper (10) to disengage the top part (14) from the generator footplate (220);

- inserting (S14) the clamping means (20) into the bottom open cavity (18) through the service opening (214) of the generator base plate (210); and

- setting (S16) the clamping distance (D_C) between the bottom part (12) and the top part (14) such that the clamping distance (D_C) is less than the default distance (D_0) of the generator base plate (210) to the generator footplate (220).

14. An assembly method for assembling a damper (10) to a gas generator unit (200) or gas engine unit, comprising the steps of:

- inserting (S100) the clamping means (20) into the bottom open cavity (18);

- setting (S110) the clamping distance (D_C) between the bottom part (12) and the top part (14) such that the clamping distance (D_C) is less than the default distance (D_0) of the generator base plate (210) to the generator footplate (220);

- assembling (S120) the bottom part (12) of the damper (10) to the generator base plate (210);

- disengaging (S130) the clamping means (20) from the damper (10) via the service opening (212) of the generator base plate (210); and

- engaging (S140) the assembling screw (222) with the top part (14) of the damper (10) to assemble the top part (14) to the generator footplate (210).

15. The assembly method of claim 14, wherein the step of setting (S110) the clamping distance (D_C) between the bottom part (12) and the top part (14) such that the clamping distance (D_C) is preceded by a step of compressing (S105) the damper (10) in a vise.

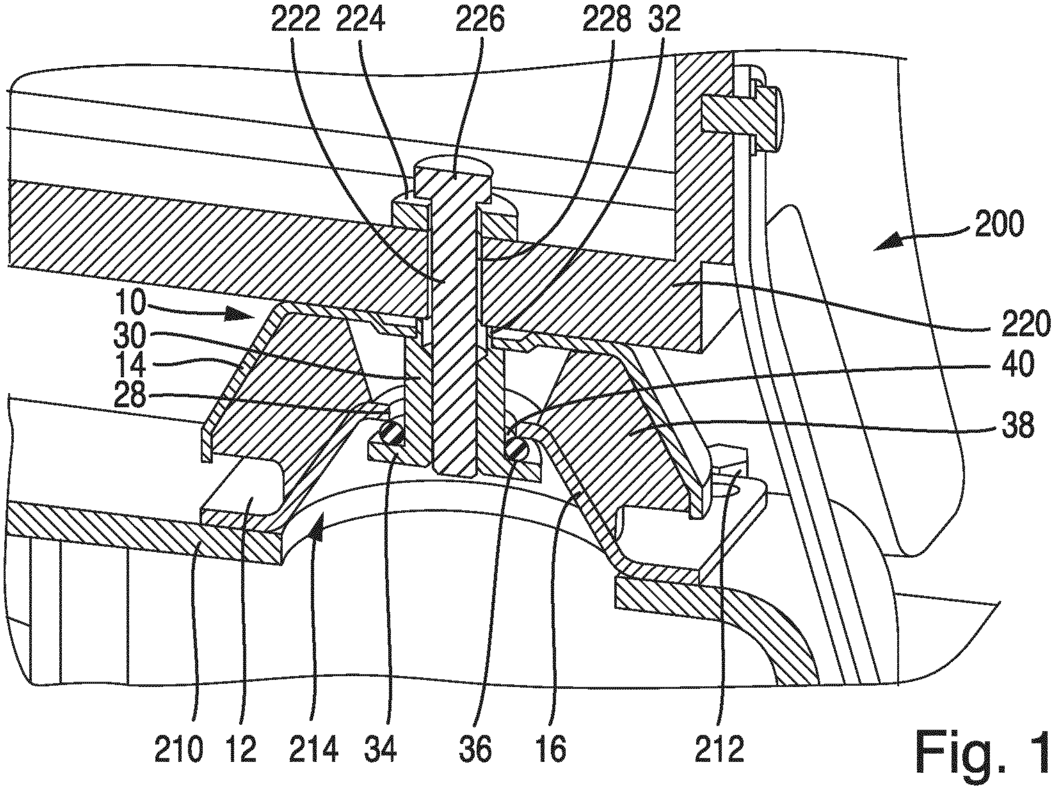
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Fig. 1

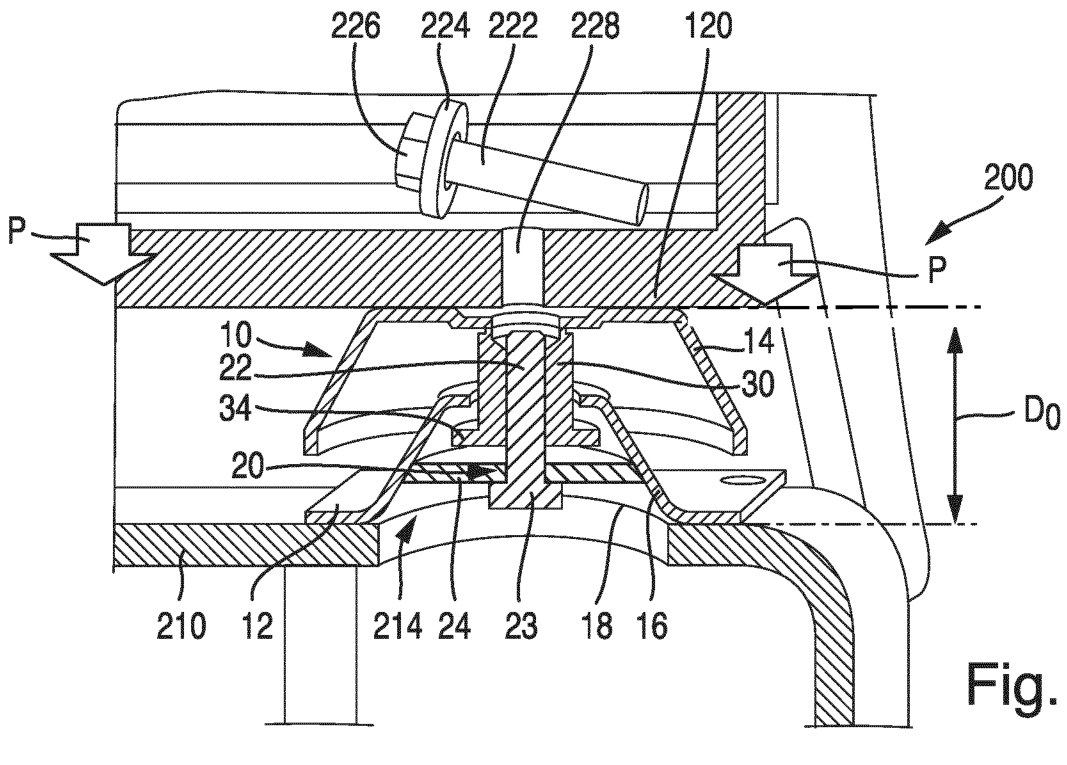
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Fig. 2

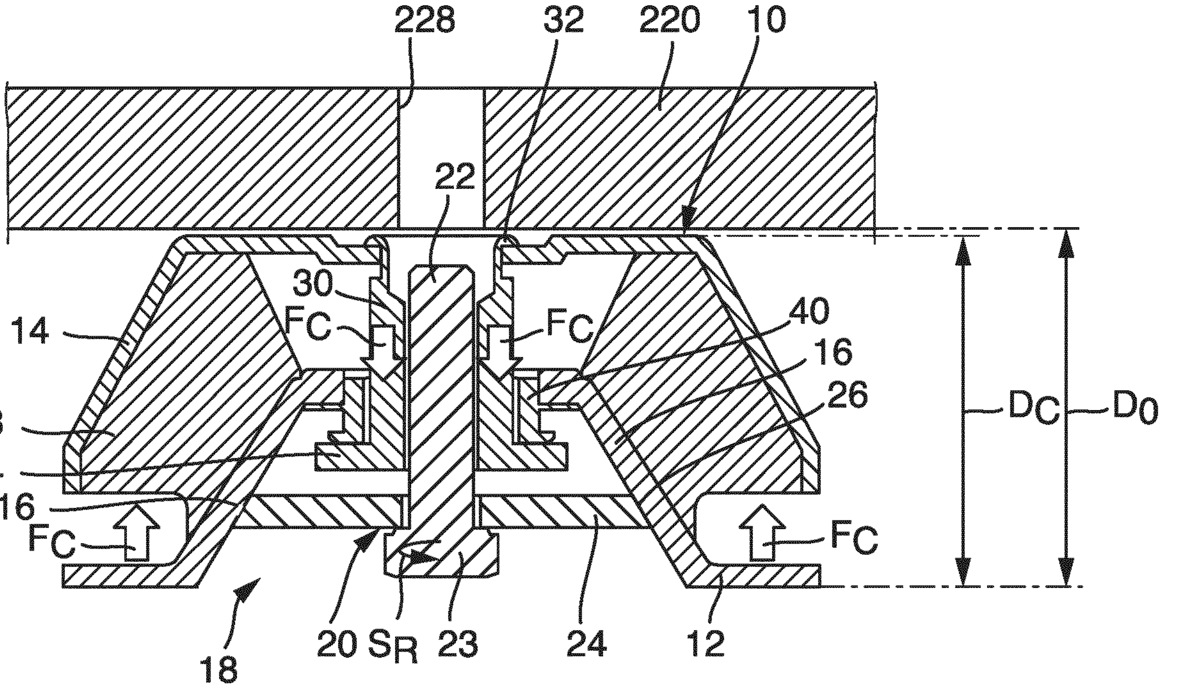
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Fig. 3

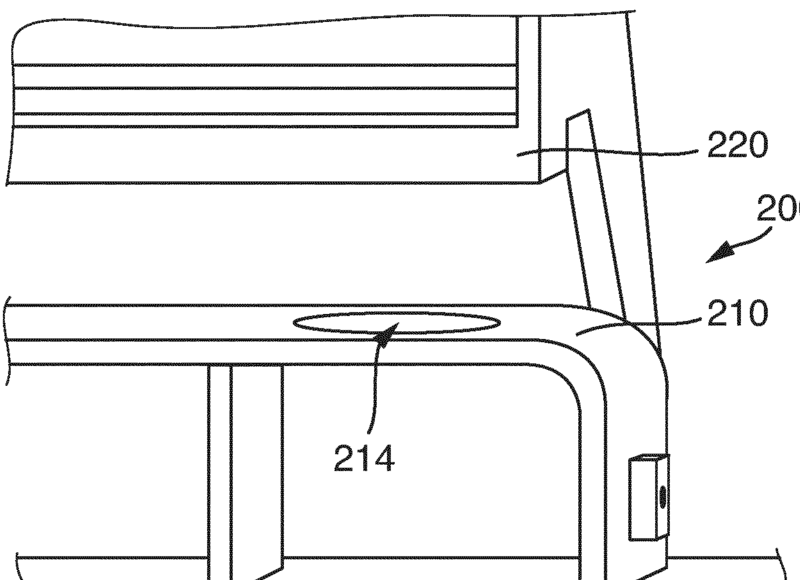
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Fig. 4

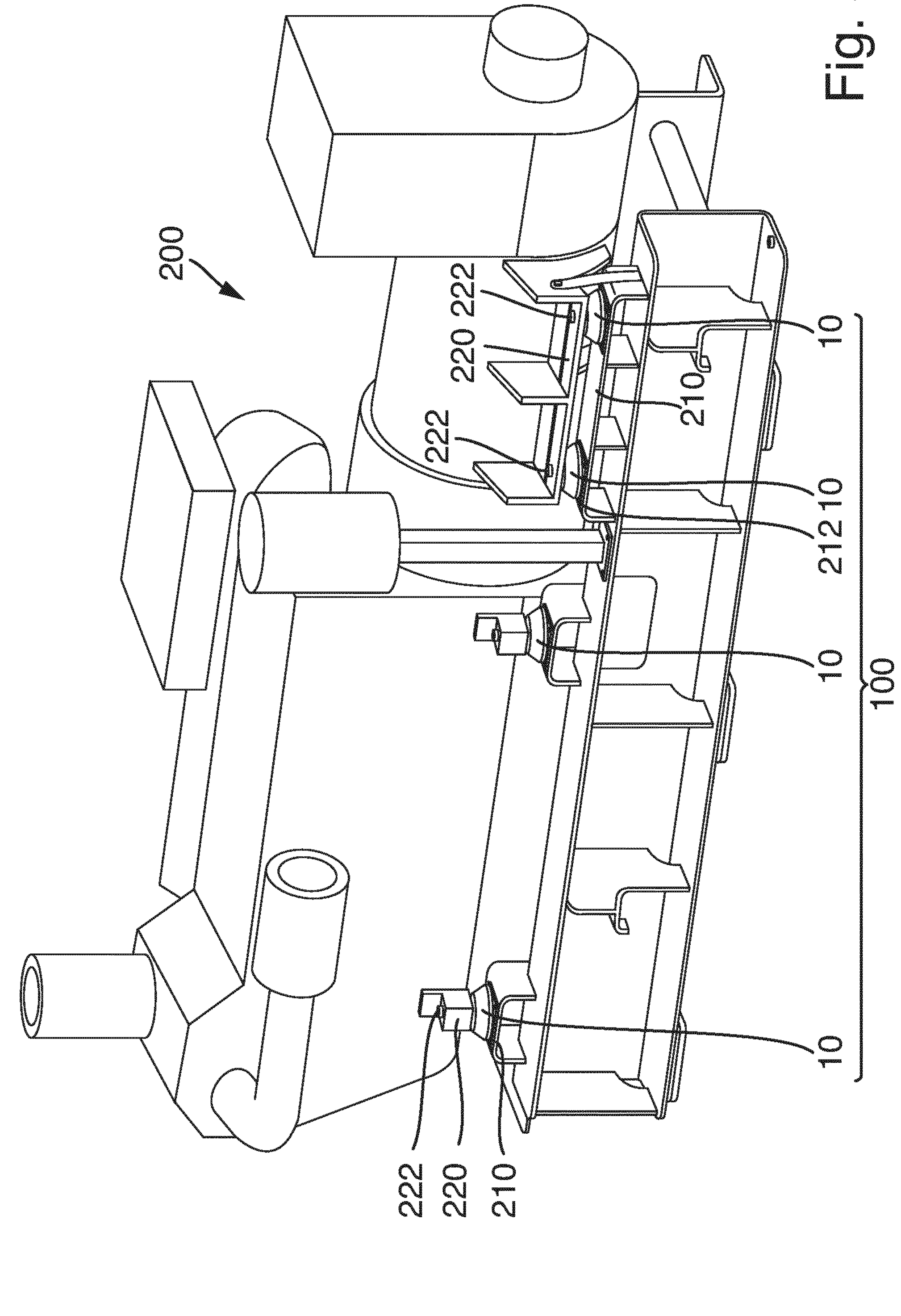

Fig. 5

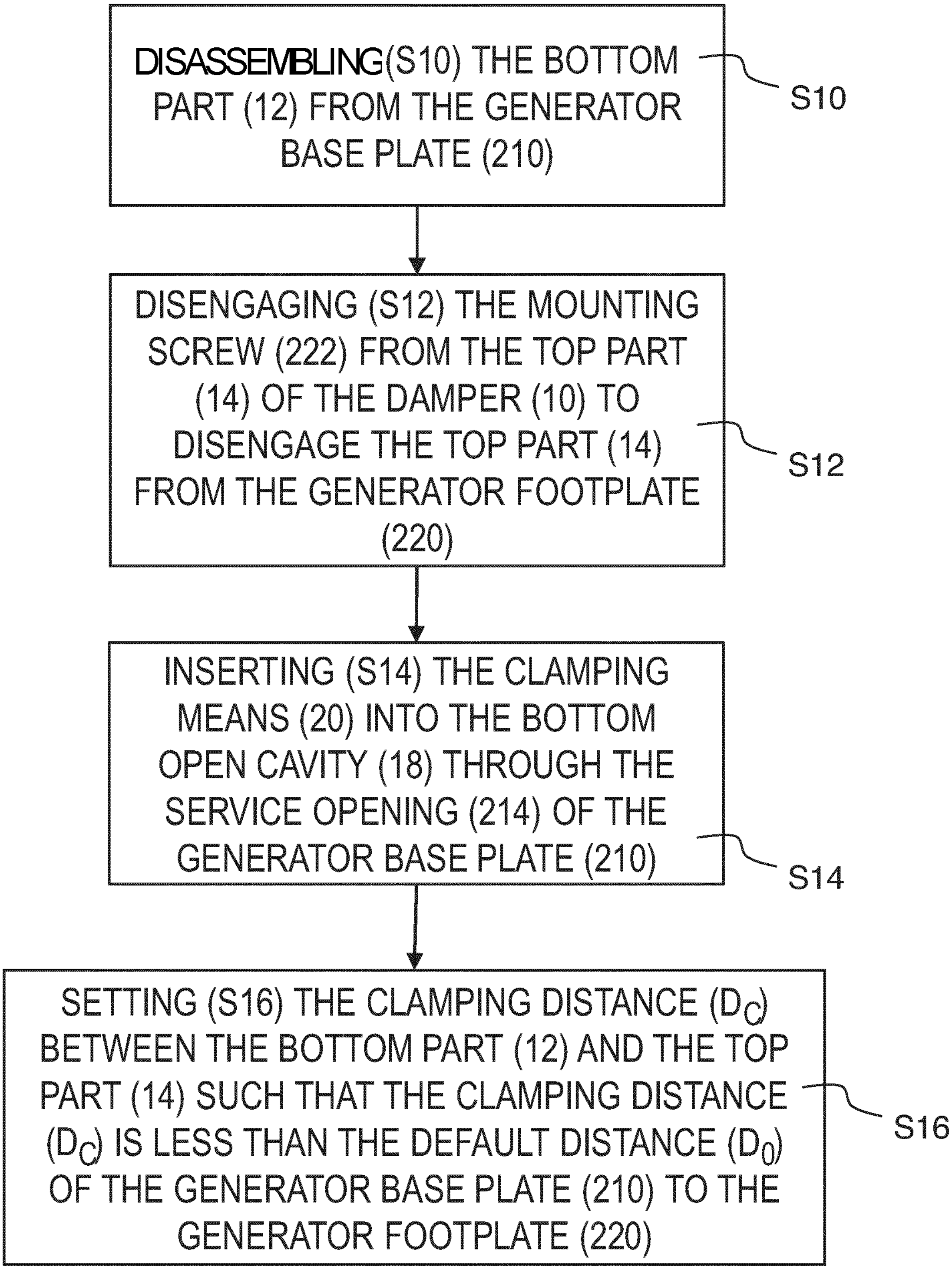
DISASSEMBLING (S10) THE BOTTOM PART (12) FROM THE GENERATOR BASE PLATE (210)
S10
DISENGAGING (S12) THE MOUNTING SCREW (222) FROM THE TOP PART (14) OF THE DAMPER (10) TO DISENGAGE THE TOP PART (14) FROM THE GENERATOR FOOTPLATE (220)
S12
INSERTING (S14) THE CLAMPING MEANS (20) INTO THE BOTTOM OPEN CAVITY (18) THROUGH THE SERVICE OPENING (214) OF THE GENERATOR BASE PLATE (210)
S14
SETTING (S16) THE CLAMPING DISTANCE (D_C) BETWEEN THE BOTTOM PART (12) AND THE TOP PART (14) SUCH THAT THE CLAMPING DISTANCE (D_C) IS LESS THAN THE DEFAULT DISTANCE (D_0) OF THE GENERATOR BASE PLATE (210) TO THE GENERATOR FOOTPLATE (220)
S16

Fig. 6

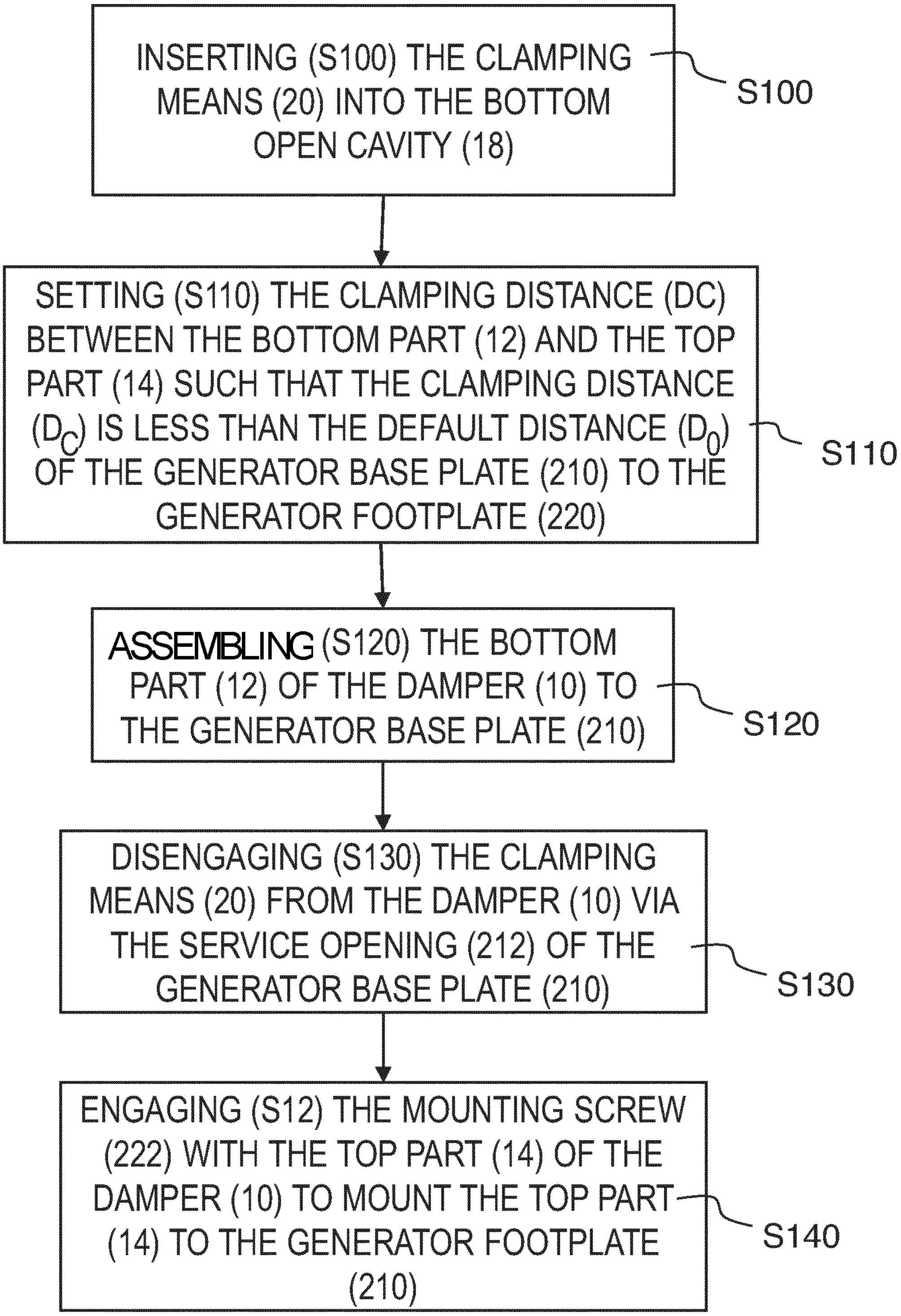
INSERTING (S100) THE CLAMPING MEANS (20) INTO THE BOTTOM OPEN CAVITY (18)
S100
SETTING (S110) THE CLAMPING DISTANCE (DC) BETWEEN THE BOTTOM PART (12) AND THE TOP PART (14) SUCH THAT THE CLAMPING DISTANCE (D_C) IS LESS THAN THE DEFAULT DISTANCE (D_0) OF THE GENERATOR BASE PLATE (210) TO THE GENERATOR FOOTPLATE (220)
S110
ASSEMBLING (S120) THE BOTTOM PART (12) OF THE DAMPER (10) TO THE GENERATOR BASE PLATE (210)
S120
DISENGAGING (S130) THE CLAMPING MEANS (20) FROM THE DAMPER (10) VIA THE SERVICE OPENING (212) OF THE GENERATOR BASE PLATE (210)
S130
ENGAGING (S12) THE MOUNTING SCREW (222) WITH THE TOP PART (14) OF THE DAMPER (10) TO MOUNT THE TOP PART (14) TO THE GENERATOR FOOTPLATE (210)
S140

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/025495

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16F1/38
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)

EPO-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	US 2014/306387 A1 (KREUZWEGER DAVID [AT]) 16 October 2014 (2014-10-16) figure 1 -----	1-3,5,6, 9-12
X	CN 201 472 404 U (CSR SIFANG LOCOMOTIVE & RS CO) 19 May 2010 (2010-05-19) figure 3 -----	1,3,4,7, 8
X	US 6 076 840 A (KINCAID JEFFREY L [US] ET AL) 20 June 2000 (2000-06-20) figure 10 -----	1
X	DE 43 41 404 A1 (BUNDESREP DEUTSCHLAND [DE]) 8 June 1995 (1995-06-08) figure -----	1
	-/--	

[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 February 2023	16/03/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Beaumont, Arnaud

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/025495

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2021/190256 A1 (THOMA ANDREAS [DE]) 24 June 2021 (2021-06-24) cited in the application figure 2 claim 21 -----	13-15

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2022/025495

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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			EP 2750953	A1	09-07-2014
			PL 2750953	T3	19-10-2020
			RU 2014107548	A	10-10-2015
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			WO 2013029924	A1	07-03-2013
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US 6076840	A	20-06-2000	NONE		
DE 4341404	A1	08-06-1995	NONE		
US 2021190256	A1	24-06-2021	CN 111315678	A	19-06-2020
			DE 102017126855	A1	16-05-2019
			EP 3710396	A1	23-09-2020
			KR 20200079538	A	03-07-2020
			US 2021190256	A1	24-06-2021
			WO 2019096839	A1	23-05-2019