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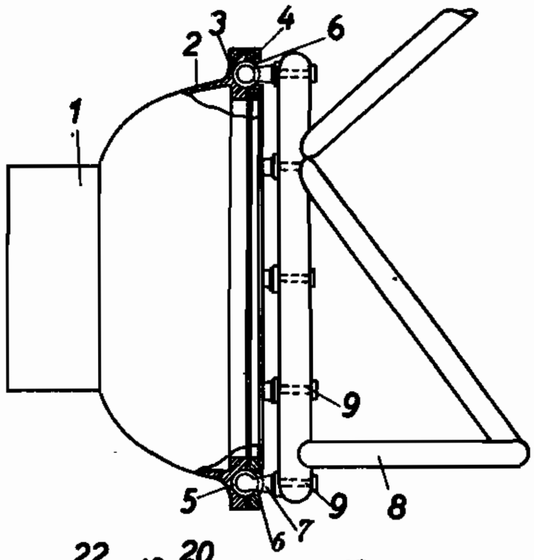

Fig.1

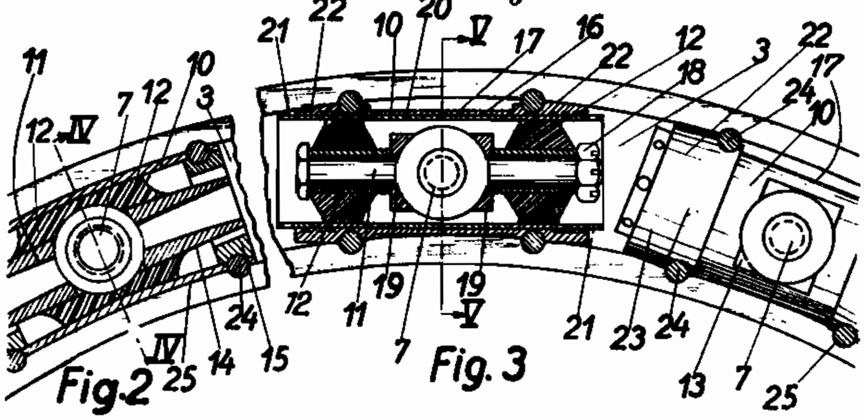

Fig.2 Fig. 3

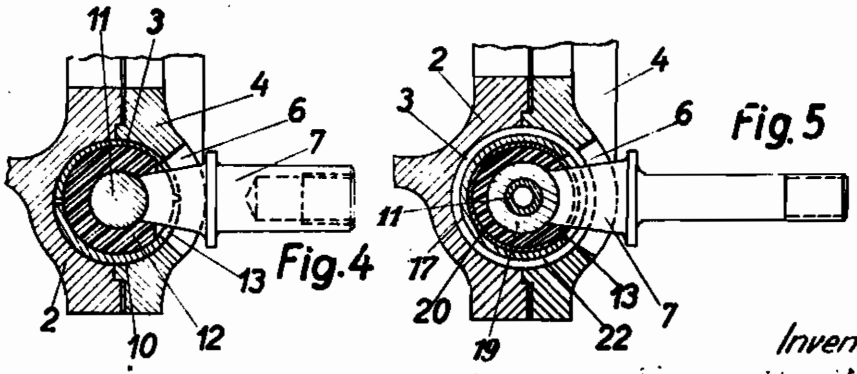

Fig.4 Fig.5

Inventors

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VIBRATION DAMPING SUSPENSION

Hans Joachim Seidel, Berlin-Wilmersdorf, and Adolf Weiler, Berlin-Spandau, Germany; vested in the Alien Property Custodian

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The invention relates to a suspension of power plants or of similar installations producing vibrations, particularly aircraft power plants by means of sleeve type springs, preferably with rubber as resilient material. The sleeve type rubber springs are embracing a carrier bolt in such a manner that a direct connection between bolt and rubber sleeve is not necessary.

Suspensions of this kind are already known per se. With these arrangements the sleeve type rubber springs are connected with the engine installation serving for mounting the power plant into the cell and provision is made on the casing of the power plant to receive the mounting bolts. This mode of suspension has the disadvantage, that it is mechanically unfavourable to connect the mounting bolts with the casing parts which are preferably made of light metal or corresponding alloys, for it appears that in such cases the points of application of the mounting bolts at the casing must be strengthened for a more favourable transmission of power in order to avoid a breakage of the bolt and/or a damage to the casing. Further, the different cell manufacturing works are designing the cells corresponding to the engine installations, each manufacturer preferring a particular embodiment of the rubber spring type suspension points. This means that many cases it is not feasible to mount the same power plant into different cells, as an exchange of the rubber spring is not always possible. This may lead to difficulties specially in war-time service since a storing of the different rubber springs becomes necessary.

These disadvantages are avoided, according to the invention, by the fact that the rubber springs form a part of the power plant. A particularly simple construction is realised by applying the sleeve type springs in a preferably circular groove provided in the engine crankcase or in an essential part of it.

This circular groove is fitted to be closed by a closing device like a cover. In this closing device apertures are provided through which the mounting bolt, being articularly or rigidly connected with the carrier bolt, is projecting. In this manner the sleeve type springs forming constituent parts of the crankcase and thus of the power plant can be designed from the first in such a way that no resonance vibrations of the power plant are occurring within the range of operating speed of rotation of engine and propeller.

Preferably the sleeve type springs are not equally spaced in the circular groove, but arranged, according to the elasticity of the engine installation resp. of the wing of the aircraft, with relation to the vertical and the transversal axis so that natural frequencies of both the said axis possibly coincide. In this manner the differences in the elasticity of the engine installation can almost be compensated in these directions of axis. This distribution of the sleeve type springs can be adapted subsequently to the actual engine installations or predetermined already from the first. Further owing to the insertion of the complete sleeve type spring into the crankcase the mechanical structure of the suspension becomes considerably more favourable, as now the forces are transmitted from the crankcase and distributed over the large surface of the sleeve so that any local overstressing of the crankcase is no longer occurring. Since at the same time the sleeve springs have become constituent parts of the engine, it is possible to exchange the same power plant among different cells.

The structural details of the sleeve type springs mounted in the approximately circular recess and fitted to be closed by a cover may be seen from the following description. The drawing shows the invention with its essential parts in two examples of construction, in which

Fig. 1 is a side view of the suspension partly in section;

Fig. 2 is a circular arrangement of a sleeve type spring in section;

Fig. 3 is a view of the circular arrangement of the sleeve type spring with the cover plate removed, partly in section.

Fig. 4 is a section on the line IV—IV of Fig. 2.

Fig. 5 is a section on the line V—V of Fig. 3.

At the crankcase 1 of the power plant (not represented) or at the bell shaped part 2 of the crankcase is provided an approximately circular groove, which is closed by an eventually sectional cover plate 4. Into the groove 3 are placed sleeve type springs 5 which can be distributed regularly on the circumference or arranged at certain intervals. The cover plate 4 has apertures 6 out of which the mounting bolts 7 projecting from the sleeve type springs are standing. These bolts 7 are bolted at 8 to the engine installation 9 for the suspension of the power plant.

The sleeve type spring comprises in a manner known per se and as shown in Fig. 2 a sleeve 10 and a carrier bolt 11 to which a resilient material, preferably rubber, is bonded. The mounting bolt 7 is specially put on the carrier bolt 11 or is forming one piece with it. The mounting bolt 7 is projecting through a recess 13 of the sleeve 10, as can be seen in Figs. 4 and 5.

In order to enable such sleeve type springs to be accommodated almost circularly in the groove 3 of the bell-shaped part 2 of the crankcase, the carrier bolt 11 is, as to be seen in Fig. 2, bent in conformity with the radius of this circle i. e. in this case the average radius and provided at its ends preferably with cylindrical extensions 14. The convex surface of the sleeve 10 is shaped to conform with the groove 3 and split for the introduction of the carrier bolt 11 which in the example of construction is made of one piece with the mounting bolt 7, the division plane running in the direction of the axis of the mounting bolt. In this manner it is possible to insert the mounting bolt 7 together with the carrier bolt 11 into the divided sleeve and to secure the rubber cover 12 by vulcanizing, so that all parts of the sleeve type spring form a self-contained unit. The interior bore of the sleeve 10 is preferably cylindrical at its ends, the axis of the bored sleeve 10 coinciding with the axis of the cylindrical extensions 14 of the carrier 11. These axes include an angle, the sides of which form tangents to the circle after the carrier bolt 11 being bent corresponding to the average radius of the groove 3.

The bore at the ends of the sleeve 10 and the extensions 14 serve for screwing in or for inserting special abutments in the shape of rings 15. The inner width of these rings is large enough that during normal operating conditions the carrier bolt 11 with its extensions 14 is nowhere abutting. With growing stresses, i. e. through static stresses due to the influence of external forces, e. g. propeller traction, torque or during levelling up the airplane, the extensions 14 of the carrier bolt 11 abut against the annular stops 15. In this way forces e. g. below 1,5 resp. 2,5 g are transmitted, without interfering with the rubber cover, directly to the suspension points, so that the rubber is dealt with sparingly. If such limiting stops would be lacking, there would be the danger of the rubber cover becoming destroyed or at least slackened from its assembly.

Instead of adapting the entire convex surface of the sleeve 10 to the shape of the recess 3, it is also possible, as shown by the example of construction in Fig. 3, to provide the sleeve with a rectilinear cylindrical bore and e. g. to turn down the middle part of the sleeve on its convex surface at 17, so that the sleeve is not abutting at the groove 3. Into the bore 16 of the sleeve the carrier bolt 11 together with the mounting bolt 7 is inserted and the spring elements 12 are put on to both ends of the carrier bolt 11 and fixed by screwing up the nut 18.

Between the mounting bolt 7 and the spring elements 12 an abutment 19 is still provided at each side. Both these abutments 19 can abut on the interior wall of the sleeve 10 and have the same object as the annular abutments 15 of the example of construction in Fig. 2. The arrangement of these abutments in the immediate vicinity of the mounting bolt 7 has the advantage, that the bending moments, in the case of the abutments on the carrier bolt 11 becoming effective, will remain small in amount.

The spring elements 12 are in this example of construction independent structural parts and are inserted into the inner bore 16 of the sleeve 10 after a particular distance ring 20 being provided in the bore 16. The spring elements 12 are held in the sleeve 10 preferably by annular screw members 21 screwed into the sleeve 10, and, according to the position of these two screw members 21, the spring elements can be so adjusted or displaced that the mounting bolt 7 occupies a predetermined position in the recess 6 of the cover plate 4. The subdivision of the resilient material in two independent spring elements has the advantage that the characteristics of resiliency can be kept lower with approximately the same spring volume and that further the ratio of the characteristics of resiliency in transversal direction to that in longitudinal direction becomes smaller. This is essential for the purpose of obtaining low natural frequencies.

In order to conform the rectilinear surface of the sleeve 10 to the curved outlines of the groove 3, the thickened ends of the sleeve 10 are turned to produce cylindrical extensions 22, of which the axes are inclined at an angle, the sides of which run in the direction of the tangents on the circle on which the sleeve in the groove is abutting. If the radius of curvature of the groove 3, as shown by the example of construction of Fig. 3, is small compared with the length of the sleeve 10, the part of the convex surface of the extensions 22 opposite the diminishing radius of the groove 3 would be no longer abutting in the groove. To avoid this, the ends of the sleeve 10 are turned once more circumferentially and cylindrically, according to the radius variation, preferably on the outer halves at 23, in which case the axis of the turned part may coincide with the axis of the inner bore 16 of the sleeve 10. Thus the bearing face of the extensions 22 is diminished, as shown in the right part of Fig. 3. Owing to this second turning, the extension 22 is brought with its entire convex surface into contact with the groove 3. When fastening the sleeve 10 with the help of the bolts 24, shown in section, which partly engage with in recesses 25 of the sleeve 10, the latter is absolutely secured against displacement both axially as well as radially.

If it was the question that the sleeve-type springs 10 are arranged in a groove of an approximately circular course, it is of course possible to arrange the sleeve type springs 10 also in a groove 3 which e. g. only partially has a circular course. The circular form, however, has the advantage, that the sleeve type springs can be arranged in the groove 3 at will. There is further the possibility of fastening the cover plate 4 by means of the mounting bolts 24 simultaneously securing the position of the sleeve type springs.

HANS JOACHIM SEIDEL.
ADOLF WEILER.