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Title: HANDHELD WORKING MACHINE

Abstract: An engine powered, portable, hand-held working machine (1) including a machine body (2) and an engine in the machine body (2), a tool arm (4a, 4b) secured at its first end section to the machine body (2) and the second end of the tool arm (4a, 4b) having a blade holder (3) being able to hold and rotate a rotational cutter blade (5), the tool arm (4a, 4b) including means to transfer power from the engine to the blade holder (3), an arched protective cover (8) defining a blade region having a maximum radius (Rmax) limiting the possible blade radius (Rl) of the attachable rotational cutter blade (5), both radiiuses (Rmax, Rl) starting from the rotational centre of the attachable rotational cutter blade (5), the hand-held working machine (1) further including a handle assembly (6,7) comprising a front handle (6) and a handle body (7), the machine body (2) with the tool arm (4a, 4b) being suspended in the handle assembly (6, 7) via a number of anti-vibrations elements (11, 12, 13), each anti-vibrations elements (11, 12, 13) having a first end section (Ha), a second end section (lib) and an intermediate flexible section(lib) wherein at least a portion of one of the anti-vibrations elements (11, 12, 13), the first anti-vibration element (11), is within the blade region (Rmax).
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HANDHELD WORKING MACHINE

Technical field
The present invention relates to an engine powered, portable, hand-held working machine including a machine body and an engine in the machine body, a tool arm connected at its first end to the machine body and the second end of the tool arm having a blade holder being able to hold and rotate a rotational cutter blade, the tool arm including means to transfer power from the engine to the blade holder, an arched protective cover defining a maximum radius limiting the possible blade radius of the attachable rotational cutter blade, both radiuses starting from the rotational centre of the attachable rotational cutter blade, the hand-held working machine further including a handle assembly comprising a handle and a handle body, the machine body and the cutting unit are suspended in the handle assembly via a number of anti-vibrations elements.

Background of invention
Vibrations are a severe problem in connection with engine powered, portable, hand-held working machines in general, and this is particularly true as far as cut-off machines, also referred to as power cutters, are concerned. Such machines include a rotational cutting blade, which in operation may cause vibrations adding to the vibrations generated by the engine. Similar problems exist also in connection with other engine powered working machines, such as chain saws.

It is known in the art to suspend the machine body, including the engine and the cutting or sawing equipment, in a handle system via anti-vibration elements. The handle system and the anti-vibration elements are designed to give as low vibration levels and comfortable usage as possible. However, the maximum amount of movement that is possible is limited for a number of technical reasons. Generally the vibration characteristics in the lateral direction, the vertical direction and the horizontal direction are different and hence it is desirable that the anti-vibrations elements can behave different in the respective directions. Using a combustion engine the movement of the crank shafts will transfer vibration in the vertical direction (of course assuming that the crank shafts are arranged to move vertically up and down). Also the rotational cutting blade causes vibrations as it rotates and when it...
cut a material. The vibrations in the lateral direction are far lower than the horizontal and vertical directions and therefore the suspension in the lateral direction may be limited and at least some rigidity in the lateral direction is needed in order for the rotational cutter blade to be controllable. The stiffness of the anti-vibration elements must be so large that their maximum suspension in the vertical and horizontal directions will hardly be overcome during work conditions.

**Brief disclosure of invention**

It is an object of the invention to provide an anti-vibration element and an arrangement of the anti-vibration element that eliminates or at least minimizes some of the disadvantages mentioned above, this is achieved by presenting an engine powered, portable, hand-held working machine including a machine body and an engine in the machine body, a tool arm secured at its first end section to the machine body and the second end of the tool arm having a blade holder being able to hold and rotate a rotational cutter blade, the tool arm including means to transfer power from the engine to the blade holder, an arched protective cover defining a blade region having a maximum radius limiting the possible blade radius of the attachable rotational cutter blade, both radiuses starting from the rotational centre of the attachable rotational cutter blade, the hand-held working machine further including a handle assembly comprising a front handle and a handle body, the machine body with the tool arm being suspended in the handle assembly via a number of anti-vibrations elements, each anti-vibrations elements having a first end section, a second end section and an intermediate flexible section wherein at least a portion of one of the anti-vibrations elements, the first anti-vibration element, is within a blade region defined by the maximum radius. By having an anti-vibration element within the blade region the position of the vibration dampening is moved forward closer to the where the rotational blade contacts the material subjected to cutting, i.e. the major vibration source during operation of the hand-held working machine. This drastically reduces the vibrations for the user of the hand-held working machine which of course is highly beneficial.

According to further aspects of the invention:

- the intermediate section of the first anti-vibration element is within the blade region.
- the first end section of the first anti-vibration element is within the blade region.
- the second end section of the first anti-vibration element is within the blade region.

- the blade region is limited by a second radius which second radius is less than 200 mm, the second radius starting from the rotational centre of the attachable rotational cutter blade, preferably the second radius is less than 150 mm and more preferably the second radius is less than 100 mm.

- the first end section of the first anti-vibration element is secured to the tool arm, preferably the lower side of the tool arm.

- the second end section of the first anti-vibration element is secured to a protruding part, protruding from the handle assembly into the blade region, preferably from the lower end of the handle assembly, thereby enabling the first anti-vibration element to be arranged within the blade region.

- the blade region is further limited to the area covered by the protective cover, thereby protecting the anti-vibration element from interference with the rotational cutter blade.

- the first anti-vibration element can be a flat plate spring, providing an economic and efficient anti-vibration element, where the plate spring may consist of a piece of 1-2 mm thick spring steel, and where the width extension of the plate spring may project in a direction coinciding with the direction of the rotational axle of the blade holder providing the advantage of stabilising the rotational cutter blade in its lateral direction and dampening the vibration in the plane of the rotational cutter blade, and where the plate spring may form an arch in the horizontal direction, and where the plate spring may protrude parallel to the tool arm in the horizontal direction.

- the first anti-vibration element can be a coil spring.

- the first anti-vibration element can be a resilient rubber spring.

- the engine can be a combustion engine.

- The engine can be one from the set of electric, pneumatic or hydraulic engine.
Brief description of the drawings

In the following the invention will be described in relation to the appended figures, wherein:

Figure 1 is a right-hand side view of a hand-held working machine having a most forward anti-vibration element according to the preferred embodiment of the present invention, and Figure 2 is perspective view from bottom side and the left-hand side of a hand-held working machine according to the preferred embodiment of the present invention, and Figure 3 shows a perspective view of the front handle and the handle body of the hand-held working machine and a number of anti-vibration elements, and Figure 4 shows an alternative embodiment of the most forwards anti-vibration element, and Figure 5 shows two further embodiments of the most forwards anti-vibration element.

Description of embodiments

With reference to figure 1 and figure 2, a combustion engine powered, portable, hand-held working machine is designated 1. Figure 1 shows the right hand side of the hand-held working machine 1. The hand-held working machine 1 includes a machine body 2 with an engine in the machine body 2. A tool arm 4a, 4b is secured at its first end section to the machine body 2. The second end of the tool arm 4a, 4b has a blade holder 3 (see figure 2). The blade holder 3 is able to hold and rotate a rotational cutter blade 5. The tool arm 4a, 4b including means to transfer power from the engine to the blade holder 3 and thereby to the rotational cutter blade 5, preferably by having a chain or a driving belt within the tool arm 4a, 4b linking the engine to the blade holder 3. The tool arm 4a, 4b of figure 1 has a fixed part 4a fixed to the machine body 2 and a moveable part 4b having the blade holder 3, the moveable part 4b can be moved in the horizontal direction in order to stretch the driving belt. The fixed party 4a having a tool arm mounting 4c at the lower end of the fixed part 4a close to where the moveable part 4b starts. An arched protective cover 8 partly covers the rotational cutter blade 5. The arched protective cover defines blade region having a maximum radius Rmax limiting the possible blade radius R1 of the rotational cutter blade 5.

The hand-held working machine 1 further includes a handle assembly 6, 7 comprising a front handle 6 and a handle body 7. The front handle 6 having a right portion 6a at the right hand side of the machine 1, a top portion 6b above the machine, a left portion 6c at the left...
side of the machine 1 and a bottom portion 6d at the lower front side of the handle body 7. The right end portion of the front handle 6 is secured to the handle body 7 at its right hand side and the bottom portion of the front handle 6 is secured to the lower front side of the handle body 7. The handle body comprises a back grip 7a having a throttle adjuster 10.

The machine body 2 with the tool arm 4a, 4b is suspended in the handle assembly 6, 7 via a first anti-vibrations element 11, a second anti-vibrations element 12, a third anti-vibrations element 13 and a forth anti-vibration element 14. Each anti-vibration element 11, 12, 13 and 14 has a first end section, a second end section and an intermediate flexible section.

A protruding part 9 protrudes from the lower front side of the handle body 7, at the right hand side of the hand-held working machine 1, to within a blade region limited by the maximum radius Rmax. The protruding part 9 has a first end 9a and a second end 9b. The first end 9a of the protruding part 9 is secured to the handle body 7 and the second end is within the blade region. The protruding part 9 is aligned to the tool arm 4a, 4b in the lateral direction. The circular holes in the protruding part 9, seen in the figures, are for reducing the weight of the protruding part 9 while maintaining its strength.

The first anti-vibration element 11, designed and arranged according to the invention, is secured between the second end 9b of the protruding part 9 and the lower side of the tool arm 4a, 4b at the tool arm mounting 4c, the tool arm mounting 4c preferably as close as possible to the second end of the tool arm 4a, 4b and the tool arm mounting 4c preferably at the fixed part 4a of the tool arm 4a, 4b. The first anti-vibration element 11 has a first end section 11a, a second end section 11b and an intermediate flexible section lie, where the first end section 11a is secured to the tool arm 4a, 4b and the second end section 11b is secured to the protruding part 9. The first anti-vibration element 11 is preferably an arched flat spring plate, where the arch points forward in the horizontal direction, i.e. the intermediate section lie of the spring plate 11 is further forward than its end sections 11a, 11b. The width extension of the flat spring plate 11 projects in the lateral direction. The flat spring plate 11 is preferably made of spring steel. The length of the spring plate 11 is preferably in the range of 50-200 mm, the width is preferably in the range of 5-30 mm, and the thickness is preferably in the range of 0.5 - 3 mm, and most preferably 1-2 mm. The spring characteristics of the spring plate can be controlled in the vertical direction, the
horizontal direction and the lateral direction; by changing the dimensions of the spring plate 11, e.g. changing the thickness, the width, the length of the spring plate 11; by changing the material of the flat spring; and by changing how it is arranged e.g. if it is arched, how it is aligned etc. Of course the spring plate 11 could be made to have varying thickness over its length or width and varying width over its length in order to further control the spring characteristics.

The second anti-vibration element 12 is secured between right portion of the front handle 6 and the upper right side of the machine body 2 (the second anti-vibration element 12 is hidden by the front handle 6 in figure 1 but can be seen in figure 3). The third anti-vibration element 13 (see figure 2 and figure 3) is secured between the lower left side of the handle body 7 and the lower left side of the machine body 2. The forth anti-vibration element 14 (see figure 3) is secured between the upper part of the handle body 7 and the back part of the machine body 2.

Figure 3 shows a perspective view of a handle assembly, the front handle 6 and the handle body 7, and the anti-vibration elements 11, 12, 13, 14 and 15. The handle assembly 6, 7 is the same as used in the hand-held working machine 1 of figure 1 and 2, according to the invention, but for the additional anti-vibration element 15. The additional anti-vibration element 15 shows a typical most-forward-placed anti-vibration element according to the prior art. According to the preferred embodiment of the invention the additional anti-vibration element 15 in figure 3, is removed and replaced by the first anti-vibration element 11. I.e. in the preferred embodiment the most-forward-placed anti-vibration element is moved further forward closer to the rotational centre of the rotational cutter blade 5 a. The arrangement of the remaining three anti-vibration elements, the second anti-vibration element 12, the third anti-vibration element 13 and the forth anti-vibration element 14, shown in figure 3, are not the focus of the present invention could accordingly be varied in size, shape and numbers without changing the scope of the invention.

In figure 4 the fixed part 4a of the tool arm 4a, 4 has been prolonged at its lower end to further extend in the horizontal direction towards the rotational centre of the rotational cutter blade 5. Hereby the tool arm mounting 4c at the tool arm 4a, 4b can be moved further forward compared to the mounting 4c in figure 1. The fist anti-vibration element 11' shown in figure 4 is also a flat spring plate, but not forming an arch as the fist anti-
vibration element 11 of figure 1-3, having its first end section 11a' at the tool arm mounting 4c most forward followed by the intermediate section 11e and finally the second end section 11f' secured to the protruding part 9 being most backwardly arranged.

Figure 5 shows the front part of the hand held working machine 1 where two alternative anti-vibration elements are shown, a coil spring 11'' and a rubber spring 11". The coil spring 11'' and the rubber spring 11" both preferably having their respectively length extension in the lateral direction, i.e. being more rigid in the lateral direction.

Whereas the invention has been shown and described in connection with the preferred embodiment thereof it will be understood that many modifications, substitutions, and additions may be made which are within the intended broad scope of the following claims. From the foregoing, it can be seen that the present invention accomplishes at least one of the stated objectives.

Of course the machine body 2 with the tool arm 4a, 4b could be suspended by fewer anti-vibrations elements than by the above described four anti-vibration elements, in fact many hand-held working machines are commonly suspended by three anti-vibration elements but it would also be possible to use only two anti-vibration elements. It should be observed that the invention concerns how to design and arrange the most forward anti-vibration element, the first anti-vibration element 11, and not the possible arrangements of other anti-vibrations elements, e.g. anti-vibration elements 12, 13 and 14. Thus the main idea of the invention is to move the most forward anti-vibration element closer to rotational centre of the rotational cutter blade 5.

Even though the invention is presented with a plate spring as the first-anti vibration elements, other anti-vibration elements could of course be used, for example different kinds of springs, resilient rubber spring, coil springs and many other anti-vibration elements imaginable by the skilled person. The plate spring could also be made of another suitable metallic material or can be made of a plastic material, e.g. glass fibre or carbon fibre reinforced plastic.

Even though the hand-held working machine 1 is shown with a rotational cutter blade 5 having a radius R1 almost the same as the maximum radius Rmax, a rotational cutter blade
5 having a smaller radius R_l could of course be used. It is also obvious that the hand-held working machine 1 could be sold without the rotational cutter blade 5 since the rotational cutter blade 5 is commonly an interchangeable part due to wear out. Of course the arched protective cover 8 could have a polygonal shape still having a maximum radius R_max in the sense of the maximum possible size of a rotational cutter blade 5 inserted in the blade holder 3 and limited by the protective cover 8.

In the preferred embodiment of figure 1 the protruding part 9 protrudes from the lower front side of the handle body 7 at the right-hand side of the hand-held working machine 1. Of course the protruding part 9 could be arranged on the left hand side of the hand-held working machine 1, protruding from either the handle body 7 or the front handle 6, and the anti-vibration element 11 could be likewise be arranged between the second end 9b and the blade holder 3 or the protective cover 8. Furthermore the anti-vibration element 11 could be secured closer to the end of the tool arm 4a, 4b, preferably as close as possible to the rotational centre of the rotational blade 5. It is also obvious that the protruding part 9 could be secured at the front handle 6, protruding into the blade region, in the area above the tool arm 4a, 4b and thereby having an anti-vibration element 11 secured between the protruding part 9 and the upper part of the tool arm 4a, 4b.

Furthermore the tool arm 4a, 4b could consist of only a fixed part 4a, where the driving belt is stretched by other measures, enabling the first anti-vibration element 11 to be secured anywhere on the tool arm 4a, 4b.

Furthermore it would be possible to secure the first anti-vibration element 11 at the moveable part 4b of the tool arm 4a, 4b even though it would not be desirable.

Furthermore the hand-held machine 1 could also have another type of engine, such as electric, hydraulic or pneumatic.
CLAIMS

1. An engine powered, portable, hand-held working machine (1) including a machine body (2) and an engine in the machine body (2), a tool arm (4a, 4b) secured at its first end section to the machine body (2) and the second end of the tool arm (4a, 4b) having a blade holder (3) being able to hold and rotate a rotational cutter blade (5), the tool arm (4a, 4b) including means to transfer power from the engine to the blade holder (3), an arched protective cover (8) defining a blade region having a maximum radius (Rmax) limiting the possible blade radius (Rl) of the attachable rotational cutter blade (5), both radiuses (Rmax, Rl) starting from the rotational centre of the attachable rotational cutter blade (5), the hand-held working machine (1) further including a handle assembly (6,7) comprising a front handle (6) and a handle body (7), the machine body (2) with the tool arm (4a, 4b) being suspended in the handle assembly (6, 7) via a number of anti-vibrations elements (11, 12, 13), each anti-vibrations elements (11, 12, 13) having a first end section (llc), a second end section (lib) and an intermediate flexible section(llc) **characterised in that** at least a portion of one of the anti-vibrations elements (11, 12, 13), the first anti-vibration element (11), is within the blade region (Rmax).

2. Machine according to claim 1 **characterised in that** the intermediate section (lie) of the first anti-vibration element (11) is within the blade region (Rmax).

3. Machine according to any of claim 1 and 2 **characterised in that** the first end section (Ha) of the first anti-vibration element (11) is within the blade region (Rmax).

4. Machine according to any of claim 1 to 3 **characterised in that** the second end section (lib) of the first anti-vibration element (11) is within the blade region (Rmax).

5. Machine according to any of claim 1 to 4 **characterised in that** the blade region (Rmax) is further limited by a second radius, the second radius starting from the rotational centre of the attachable rotational cutter blade (5) and which second
radius is less than 200 mm, preferably less than 150 mm, more preferably less than 100 mm.

6. Machine according to any of claim 1 to 5 characterised in that the first end section (Ha) of the first anti-vibration element (11) is secured to the tool arm (4a, 4b), preferably to the lower side of the tool arm (4a, 4b).

7. Machine according to any of claim 1 to 6 characterised in that the second end section (lib) of the first anti-vibration element (11) is secured to a protruding part (9), protruding from the handle assembly (6, 7), preferably from the lower end of the handle body (7), into the blade region.

8. Machine according to any of claim 1 to 7 characterised in that the blade region is further limited to the area protected by the protective cover (8).

9. Machine according to any claim above characterised in that the first anti-vibration element (11) is a flat plate spring.

10. Machine according to claim 9 characterised in that the plate spring (11, 11’) consists of a piece of 0.5 - 3 mm thick spring steel, and preferably of 1 - 2 mm thick spring steel.

11. Machine according to any of claim 9 to 10 characterised in that the width extension of the plate spring (11, 11’) projects in the lateral direction coinciding with the direction of the rotational axle of the blade holder (3).

12. Machine according to any of claim 9 to 11 characterised in that the plate spring (11) forms an arch in the horizontal direction.

13. Machine according to any of claim 9 to 12 characterised in that the plate spring (11, 11’) protrudes parallel to the tool arm (4a, 4b) in the horizontal direction.

14. Machine according to any of claim 9 to 12 characterised in that the first anti-vibration element (11) resilient rubber spring (H”).
15. Machine according to any of claim 9 to 12 characterised in that the first anti-vibration element (11) is a coil Spring (11').

16. Machine according to any claim above characterised in that the engine is a combustion engine.

17. Machine according to any of claim 1 to 13 characterised in that the engine is one of from the set of electric, pneumatic or hydraulic engine.
# INTERNATIONAL SEARCH REPORT

## International application No.
PCT/SE2005/001913

### A. CLASSIFICATION OF SUBJECT MATTER

**IPC:** see extra sheet
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):**

**IPC:** B25F, B23D, B24B, B26B, B27B

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

SE, DK, FI, NO classes as above

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

**EPO-INTERNAL, WPI DATA, PAJ**

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>X</td>
<td>US 20050224244 A1 (E. KRAENZLER ET AL), 13 October 2005 (13.10.2005), figure 1, paragraph (0031) - (0032)</td>
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<td>A</td>
<td>US 5046566 A (W. DORNER ET AL), 10 Sept 1991 (10.09.1991), column 3, line 20 - line 68, figures 1,2</td>
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<td>A</td>
<td>DE 4416044 A1 (FRAUNHOFER-GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.), 9 November 1995 (09.11.1995), whole document</td>
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**Date of the actual completion of the international search**
25 July 2006

**Date of mailing of the international search report**
15-07-1006

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International patent classification (IPC)

B23D 45/16 (2006.01)
B24B 23/02 (2006.01)
B25F 5/00 (2006.01)
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| DE      | 4416044 A1         | 09/11/1995 | NONE  |
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