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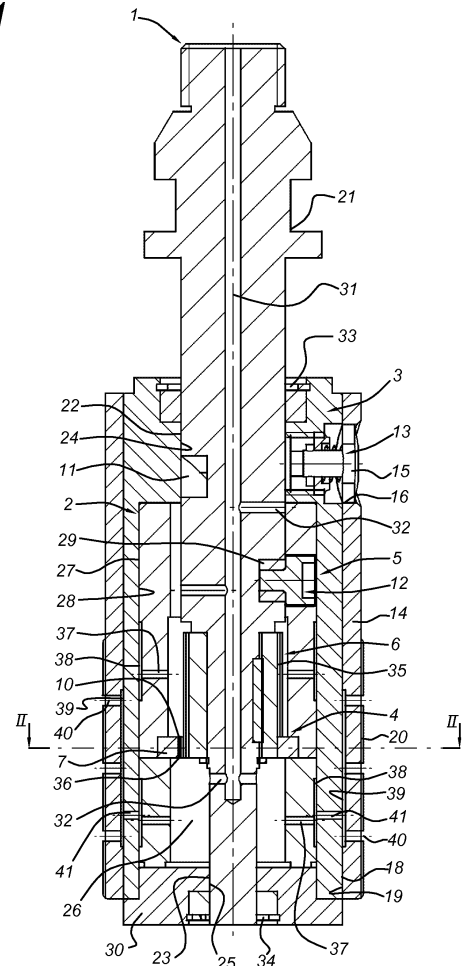
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(54) **Oscillating tool such as a grinding tool**

(57) A oscillating tool comprises a spindle and a sleeve which is supported on the spindle. The sleeve is rotatable with respect to the spindle according to a sleeve axis which is oriented in the same direction as a spindle axis. This sleeve is also translatable along the spindle in the direction of the sleeve axis. A housing has been provided which is supported on the sleeve; the sleeve and housing are rotatable with respect to each other according to the sleeve axis, wherein the spindle and the sleeve cooperate with each other through a rotational drive transmission having a transmission ratio different from unity as well as through an oscillating mechanism which provides a translational position of the spindle and the sleeve with respect to each other which depends on the rotational position of the spindle and the sleeve with respect to each other. The invention also comprises in combination, an oscillating tool as well as a work element, such as a grinding element, mounted onto the housing of the oscillating tool.

*Fig 1*



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## Description

**[0001]** The invention is related to the field of oscillating tools. Such tools can be used for many different purposes, such as for grinding, polishing etc. By means of the oscillating movements exerted by such tool, the surfaces of an object can be treated so as to obtain a specific texture or finishing. An example of an oscillating tool is disclosed in WO-A-01/41972. The handheld oscillating spindle sander which is shown in said document comprises first and second pulleys which have a different number of teeth. These pulleys are each driven in rotation by their respective belt, which belts are also guided around a drive pulley which is powered by an electric motor.

**[0002]** As a result of the different number of the of the first and second pulleys, these obtain different rotational speeds. The spindle is driven in rotation by one of the pulleys, whereas an oscillating track is driven by the other pulley. The spindle comprises a follower, which cooperates with said oscillating track. Due to the differences in rotational speed, the spindle is oscillated up and down in addition to being rotated. As a result of this oscillating movement, grinding or polishing operations can be carried out on locations which are otherwise difficult to reach, such as the inner corners in a frame etc.

**[0003]** Said prior art oscillating tool however has several disadvantages. First of all, the drive structure thereof is rather complicated, having regard to the large numbers of components including pulleys and belts. Furthermore, the spindle is driven in rotation, whereas often only an oscillating movement is required. Also, the oscillating tool is a dedicated, complete machine, including electric motor. Thus, the oscillating tool cannot be applied in a flexible way, for instance in combination with existing electric apparatuses.

**[0004]** The object of the invention is to provide an oscillating tool which has a relatively simple construction, and which can be applied in a much more flexible way, such as being adapted for fitting onto existing machinery, in particular handheld grinding apparatuses etc. This object is achieved by means of an oscillating tool comprising a spindle, a sleeve which is supported on the spindle, said sleeve being rotatable with respect to the spindle according to a sleeve axis which is oriented in the same direction as a spindle axis, said sleeve being also translatable along the spindle in the direction of the sleeve axis, a housing which is supported on the sleeve, said sleeve and housing being rotatable with respect to each other according to the sleeve axis, wherein the spindle and the sleeve cooperate with each other through a rotational drive transmission having a transmission ratio different from unity as well as through an oscillating mechanism which provides a translational position of the spindle and the sleeve with respect to each other which depends on the rotational position of the spindle and the sleeve with respect to each other.

**[0005]** The oscillating tool according to the invention

is a self-contained unit, the spindle of which can be connected to any rotary machinery, such as to a handheld grinding device. In the first place, this has the advantage that the oscillating tool has a rather simple and therefore inexpensive layout, as any motor component is lacking. Instead, the oscillating tool according to the invention relies on standard electric apparatuses for its power. In the second place, having regard to its relatively simple construction, the oscillating tool has a relatively low cost price. Moreover, it is possible to design the oscillating tool in such a way that it provides an oscillating movement only, that is without a rotary movement.

**[0006]** Despite the fact that only the spindle of the oscillating tool according to the invention is connected to the drive spindle of e.g. a grinding apparatus, nevertheless a proper oscillating movement can be obtained. For that purpose, it is necessary to restrict the housing from rotating. This inhibition of the rotating movement of the housing can be obtained by grasping the housing, before starting the rotary movement of the grinding appliance, or by pressing the housing against an object to be treated.

**[0007]** The oscillating movement can be obtained due to the fact that the rotational speeds of the spindle and the sleeve are unequal. This rotational speed difference can be obtained by means of a gear transmission, such as a planetary gear transmission. Preferably however, an eccentric gear drive is applied. Such eccentric gear drive has the advantage that it has a simple layout and needs only two gears. Furthermore, the overall size of such eccentric gear drive can remain limited. According to a preferred embodiment, the eccentric gear drive comprises a drive gear mounted coaxially onto the spindle, and a driven gear mounted onto the sleeve, said driven gear being eccentric with respect to the drive gear and the drive gear and the driven gear engaging each other over a part of the tooth sets thereof, the remainder of these tooth sets being free from engagement with each other.

**[0008]** Having regard to the fact that the sleeve and the spindle can exhibit an oscillating movement with respect to each other, caution should be taken that the gears always properly mesh. This can be ensured by means of an embodiment wherein the axial dimension of at least one of the tooth sets is at least equal to the maximum oscillatory displacement. Thus, the gears may carry out translating movements with respect to each other, their teeth sliding along each other, without the meshing relationship being lost.

**[0009]** The eccentric position of the gears with respect to each other can be obtained in the embodiment according to which the driven gear is coaxial with respect to the sleeve, and the sleeve is eccentric with respect to the housing. In this connection, the housing has an eccentric inner cylindrical housing surface which is eccentric with respect to the spindle axis, the sleeve having an outer cylindrical sleeve surface which rotatably cooperates with the eccentric inner cylindrical housing surface.

**[0010]** Although the housing is properly supported, in

a rotatable fashion, with respect to the sleeve, is also desirable to support the housing rotatably with respect to the spindle. In this way, a compact and well enclosed embodiment is obtained, the gears being then well protected against soiling. Such layout can be obtained in case the housing has at least one inner cylindrical housing surface which cooperates with a corresponding cylindrical spindle surface. Preferably, the housing has at least one coaxial inner cylindrical housing surface which is coaxial with respect to the spindle axis, said coaxial inner cylindrical housing surface cooperating with a corresponding cylindrical spindle surface. More preferably, the housing has two coaxial inner cylindrical housing surfaces which enclose the eccentric inner cylindrical housing surface, said two coaxial inner cylindrical housing surfaces each cooperating with a corresponding cylindrical sleeve surface.

**[0011]** The oscillating mechanism of the oscillating tool according to the invention can be designed in several ways as well; in particular, the oscillating mechanism may comprise at least one circumferential track on one of the spindle and the sleeve, said track having a shape which deviates from a radial plane. Furthermore, the oscillating mechanism may comprise at least one follower on the other of the spindle and the sleeve, said follower engaging the track. The track can be applied in either the spindle or the sleeve, however preferably the spindle comprises an undulating continuous circumferential groove which is closed in itself, and the sleeve comprises an inwardly protruding pin which is slidably accommodated within the groove. The housing comprises mounting means for fixedly mounting a work element, such as a grinding body, onto the housing.

**[0012]** The invention is furthermore related to an oscillating tool as described before, as well as a work element mounted onto the housing of the oscillating tool. The oscillating tool and the work element are to be connected firmly with respect to each other, so as to withstand the vibratory movements to which these components are subjected. At the same time however, it should be easy to apply and remove the work element with respect to the housing. This can be obtained by means of an embodiment wherein the work element and the housing are provided with a spring biased pin and an aperture, said pin being accommodated in the aperture under the influence of the spring bias.

**[0013]** The outer circumference of the work element can be carried out in many different ways. For instance, the work element may have a cylindrical outer surface, or an outer surface which has a square radial cross section. Other shapes are possible as well, and can be selected in relation to the surface to be treated.

**[0014]** For ease of replacing the work element, preferably the housing has a cylindrical outer support surface and the work element has a corresponding cylindrical inner support surface in such a way that the housing and the work element fit onto each other generally with a sliding fit. The work element may be a grinding or polishing

element and thus may have an outer grinding or polishing surface.

**[0015]** The invention is also related to a work element for use in the combination as described before, said work element having a cylindrical inner support surface and an outer work surface, as well as a fixation aperture which extends radially between the inner support surface and the outer work surface.

**[0016]** Finally, the invention is also related to a method for operating the combination as described before, comprising the steps of:

- driving the spindle in rotation,
- braking the rotational movement of the work element thereby generating a rotational speed difference between the spindle and the sleeve and generating an oscillatory movement of the housing and the work element. In particular, said method may comprise the steps of:
  - pressing the grinding or polishing surface of the work element against an object,
  - braking the rotational movement of the work element,
  - grinding or polishing the object through the oscillatory movements of the work element.

**[0017]** The invention will now be described further with reference to an embodiment shown in the drawings.

**[0018]** Figure 1 shows a longitudinal section according to II-II figure 2 of the oscillating tool according to the invention.

**[0019]** Figure 2 shows a cross-section according to I-I of figure 1.

**[0020]** Figure 3 shows a view in perspective of the oscillating tool according to figures 1 and 2.

**[0021]** Figure 4 shows a view in perspective of an alternative embodiment of the oscillating tool.

**[0022]** The oscillating tool shown in figures 1-3 comprises a spindle 1 which is provided with mounting surfaces 21 which there destined for mounting the spindle 1 onto a rotary apparatus, such as onto the rotary shaft of a handheld grinding machine (not shown). Furthermore, there is a housing 3 which surrounds part of the spindle 1. Said housing 3 has two coaxial inner cylindrical housing surfaces 24, 25. The spindle 1 has two cylindrical spindle surfaces 22, 23, onto which the respective coaxial inner cylindrical housing surfaces 24, 25 are rotatably supported. The inner cylindrical housing surface 25 has been applied on the cap 30, which closes one end of the housing 3.

**[0023]** The housing 3 has an internal housing space 26, through which the spindle 1 runs and in which the sleeve 2 has been accommodated. Said sleeve has an outer cylindrical sleeve surface 27, whereas the internal housing space 26 is delimited by the eccentric inner cylindrical housing surface 28. The surfaces 27, 28 are rotatably supported with respect to each other. As shown

in figures 1 and 2, the internal housing space 26 furthermore accommodates the drive gear 6 with radially outwardly pointing tooth set 35 which is mounted coaxially on the spindle 1, as well as the eccentric driven gear 7 with radially inwardly pointing tooth set 36 which is mounted onto the sleeve 2. In particular, the eccentric driven gear 7 is mounted on the inner surface of the sleeve 2. The eccentric driven gear 7 is eccentric with respect to the axis of the spindle 1 as well as to the axis of the housing 3, however said driven gear 7 is coaxial with respect to the sleeve 2. The drive gear 6 has a tooth set 35 with a smaller number of teeth than the tooth set 36 of the driven gear 7.

**[0024]** The spindle 1 has an external groove 11 which is closed in itself in circumferential direction, and which has an undulating shape. The sleeve 2 comprises an inwardly protruding pin or follower 12. The pin is provided with a bushing 29 which contacts the opposing walls of the groove 11. Onto the housing 3, a work element 14 has been applied. This work element 14 carries a work surface 20, for instance a grinding or polishing surface. The work element 14 has an aperture 16, and the housing 3 has a spring biased pin 15. Furthermore, the housing has a cylindrical outer support surface 18, and the work element 14 has a corresponding cylindrical inner support surface 19. By sliding the work element 14 with its cylindrical inner support surface 19 onto the cylindrical outer support surface 18 of the housing 3, the aperture 16 can be brought in register with the spring biased pin 15 so as to ascertain a fixed relationship between the work element 14 and the housing 3. The oscillating tool furthermore has seals 33, 34 by means of which the housing 3 sealed with respect to the spindle 1.

**[0025]** Next, the operation of the oscillating tool will be described. After the spindle 1 has been mounted onto the rotary shaft of e.g. a grinding appliance, the work element 14 is brought in contact with a surface to be treated (not shown). Thereby, the work element 14, and thus the housing 3 is prevented from a rotating also in case the spindle 1 is driven in rotation. The spindle rotation causes the drive gear 6 to rotate. In turn, the driven gear 7 is rotated at a lower rotational speed, having regard to the fact that said driven gear 7 has a tooth set 36 with a larger number of teeth and the tooth set 35 of the drive gear 7. As a result, the sleeve 3 will be rotated as a lower speed than the spindle 1, which makes that the follower is compelled to move along the track 11. Thereby, the sleeve 3 is made to move up and down in oscillating movement, together with the housing 3 as well as the work element 14 connected thereto. It is to be noted that both the housing 3 as well as the work element 14 do only exhibit this oscillating movement, but not a rotary movement. This is favourable for obtaining the desired treatment of the surface in question.

**[0026]** It is pointed out that, in case the work element 14 is not prevented from rotating, the oscillating tool will rotate as a unity together with the drive shaft of the grinding appliance. Under such conditions, no oscillating

movement of the work element 14 will be generated, having regard to the fact that the spindle 1 and the sleeve 2 will rotate at the same rotational speed as a result of internal friction. Thus, only after the work element 14 will be brake in some way, for instance by pressing it onto a surface, the oscillating movement will be obtained.

**[0027]** The spindle 1 has an axial channel 31, connected to radial channels 32 which open out at the circumference of the spindle and within the internal housing space 26. Additionally, the sleeve 2 has a radial channels 37, the outer end of which open out in the outer surface depressions 38 which have been applied into the outer cylindrical sleeve surface 27. Furthermore, the housing 3 has radial channels 41, which overlap the outer surface depressions 38 of the sleeve 2. The cylindrical inner support surface 19 of a work element 14 comprises inner surface depressions 39, which overlap the radial channels 41 of the housing 3. Said inner surface depressions 39 of the work element 14 open out into the radial channels 40. By means of these channels and depressions, water which is fed into the radial channel 31 of the spindle 1, is delivered onto the surface of the work element for promoting a grinding or polishing operation.

**[0028]** Although figures 1-3 show a work element 14 with a square shape, the invention is not limited to the use of such work element. As shown in figure 4, the work element also have an outer cylindrical shape or any other shape as desired.

30 List of reference numerals

**[0029]**

1. Spindle
2. Sleeve
3. Housing
4. Rotational drive transmission
5. Oscillating mechanism
6. Drive gear
7. Driven gear
8. Outwardly facing tooth set
9. Inwardly facing tooth set
10. Teeth
11. Track
12. Follower
13. Mounting means
14. Work element
15. Spring biased pin
16. Aperture
17. Outer surface work element
18. Cylindrical outer support surface of housing
19. Cylindrical inner support surface of work element
20. Work surface
21. Mounting surfaces
22. Cylindrical spindle surface
23. Cylindrical spindle surface
24. Coaxial inner cylindrical housing surface
25. Coaxial inner cylindrical housing surface

- 26. Internal housing space
- 27. Outer cylindrical sleeve surface
- 28. Eccentric inner cylindrical housing surface
- 29. Bushing
- 30. Cap
- 31. Axial channel in spindle
  
- 32. Radial channel in spindle
- 33. Seal
- 34. Seal
- 35. Tooth set drive gear
- 36. Tooth set driven gear
- 37. Radial channel in sleeve
- 38. Surface depression in sleeve
- 39. Surface depression in work element
- 40. Radial channel in work element

### Claims

1. Oscillating tool comprising a spindle (1), a sleeve (2) which is supported on the spindle (1), said sleeve (2) being rotatable with respect to the spindle (1) according to a sleeve axis which is oriented in the same direction as a spindle axis, said sleeve (2) being also translatable along the spindle (1) in the direction of the sleeve axis, a housing (3) which is supported on the sleeve (2), said sleeve (2) and housing (3) being rotatable with respect to each other according to the sleeve axis, wherein the spindle (1) and the sleeve (2) cooperate with each other through a rotational drive transmission (4) having a transmission ratio different from unity as well as through an oscillating mechanism (5) which provides a translational position of the spindle (1) and the sleeve (2) with respect to each other which depends on the rotational position of the spindle (1) and the sleeve (2) with respect to each other.
2. Oscillating tool according to claim 1, wherein the rotational drive transmission (4) comprises an eccentric gear drive.
3. Oscillating tool according to claim 2, wherein the eccentric gear drive (4) comprises a drive gear (6) mounted coaxially onto the spindle (1), and a driven gear (7) mounted onto the sleeve (2), said driven gear (7) being eccentric with respect to the drive gear (6) and the drive gear (6) and the driven gear (7) engaging each other over a part of the tooth sets (35, 36) thereof, the remainder of these tooth sets being free from engagement with each other.
4. Oscillating tool according to claim 3, wherein the drive gear (6) has a radially outwardly facing tooth set (35) and the driven gear (7) has a radially inwardly facing tooth set (36).
5. Oscillating tool according to claim 4, wherein the axial dimension of at least one of the tooth sets (35, 36) is at least equal to the maximum oscillatory displacement.
6. Oscillation tool according to claim 4 or 5, wherein the tooth sets (35, 36) comprise axially oriented straight teeth.
7. Oscillating tool according to any of claim 3-6, wherein the driven gear (7) is coaxial with respect to the sleeve (2), and the sleeve (2) is eccentric with respect to the housing (3).
8. Oscillating tool according to claim 7, wherein the housing (3) has an eccentric inner cylindrical housing surface (28) which is eccentric with respect to the spindle axis, the sleeve (2) having an outer cylindrical sleeve surface (27) which rotatably cooperates with the eccentric inner cylindrical housing surface (28).
9. Oscillating tool according to any of the preceding claims, wherein the housing (3) has at least one coaxial inner cylindrical housing surface (24, 25) which cooperates with a corresponding cylindrical spindle surface (22, 23).
10. Oscillating tool according to claims 8 and 9, wherein the housing (3) has at least one coaxial inner cylindrical housing surface (24, 25) which is coaxial with respect to the spindle axis, said coaxial inner cylindrical housing surface (24, 25) cooperating with a corresponding cylindrical spindle surface (22, 23).
11. Oscillating tool according to claim 10, wherein the housing (3) has two coaxial inner cylindrical housing surfaces (24, 25) which enclose the eccentric inner cylindrical housing surface (28), said two coaxial inner cylindrical housing surfaces (24, 25) each cooperating with a corresponding cylindrical spindle surface (22, 23).
12. Oscillating tool according to claim 11, wherein the spindle (1) comprises an axial fluid channel (31) as well as radial channels (32) connected to the axial channel (31) and opening out on the surface of the spindle (1), the sleeve (2) comprises radial channels (37) opening out in an outer surface depression (38) of the sleeve (2), the housing (3) comprises radial channels (41) which overlap an outer surface depression (38) of the sleeve (2), the work element (14) comprises inner surface depressions (39) which overlap said radial channels (41) of the housing (3).
13. Oscillating tool according to any of the preceding claims, wherein the oscillating mechanism (5) comprises at least one circumferential track (11) on one

- of the spindle (1) and the sleeve (2), said track (11) having a shape which deviates from a radial plane.
- 14.** Oscillating tool according to claim 13, wherein the oscillating mechanism (5) comprises at least one follower (12) on the other of the spindle (1) and the sleeve (2), said follower (12) engaging the track (11). 5
- 15.** Oscillating tool according to claim 13 of 14, wherein the spindle (1) comprises an undulating continuous circumferential groove (11) which is closed in itself, and the sleeve (2) comprises an inwardly protruding pin (12) which is slidably accommodated within the groove (11). 10
- 16.** Oscillating tool according to any of the preceding claims, wherein the housing (3) comprises mounting means (15) for fixedly mounting a work element (14), such as a grinding body, onto the housing (3). 15
- 17.** In combination, an oscillating tool according to claim 16, as well as a work element (14) mounted onto the housing (3) of the oscillating tool. 20
- 18.** Combination according to claim 17, wherein the work element (14) and the housing (3) are provided with a spring biased pin (15) and an aperture (16), said pin (15) being accommodated in the aperture (16) under the influence of the spring bias. 25
- 19.** Combination according to any of claims 16-18, wherein the work element (14) has a cylindrical outer surface (20). 30
- 20.** Combination according to any of claims 16-18, wherein the work element (14) has a square radial cross section. 35
- 21.** Combination according to any of claims 16-20, wherein the housing has (3) a cylindrical outer support surface (18) and the work element (14) has a corresponding cylindrical inner support surface (19) in such a way that the housing (3) and the work element (14) fit into each other generally with a sliding fit. 40
- 22.** Combination according to any of claims 16-21, wherein the work element (14) is a grinding or polishing element and has an outer grinding or polishing surface (20). 45
- 23.** Combination according to any of claim 16-21, comprising an oscillating tool according to claim 12, wherein the work element (14) comprises inner surface work element depressions (39) the radial channels (41) of the housing (3) overlapping and inner surface work element depression (39), as well as radial channels (40) which open out in an inner surface work element depression (39) as well as on the outer surface (20) of the work element (14). 50
- 24.** Work element (14) for use in the combination according to any of claims 15-23, having a cylindrical inner support surface (19) and an outer work surface (20), as well as an fixation aperture (16) which extends radially between the inner support surface (19) and the outer work surface (20). 55
- 25.** Work element (14) according to claim 24, wherein the outer work surface (20) is cylindrical.
- 26.** Work element (14) according to claim 24, wherein the outer work surface (20) defines a square cross section.
- 27.** Work element (14) according to any of claims 24-26, wherein the outer work surface (20) comprises grinding or polishing means.
- 28.** Work element (14) according to any of claims 24-27 for use in the combination according to claim 23, comprising inner surface work element depressions (39) as well as radial channels (40) which open out in an inner surface work element depression (39) as well as on the outer surface (20) of the work element (14).
- 29.** Method for operating the combination according to any of claims 17-23, comprising the steps of:
- driving the spindle (1) in rotation,
  - braking the rotational movement of the work element (14) thereby generating a rotational speed difference between the spindle (1) and the sleeve (2) and generating an oscillatory movement of the housing (3) and the work element (14).
- 30.** Method according to claim 29 for operating the combination of claim 22, comprising the steps of:
- pressing the grinding or polishing surface (20) of the work element (14) against an object,
  - braking the rotational movement of the work element (14),
  - grinding or polishing the object through the oscillatory movements of the work element (14).



Fig 2

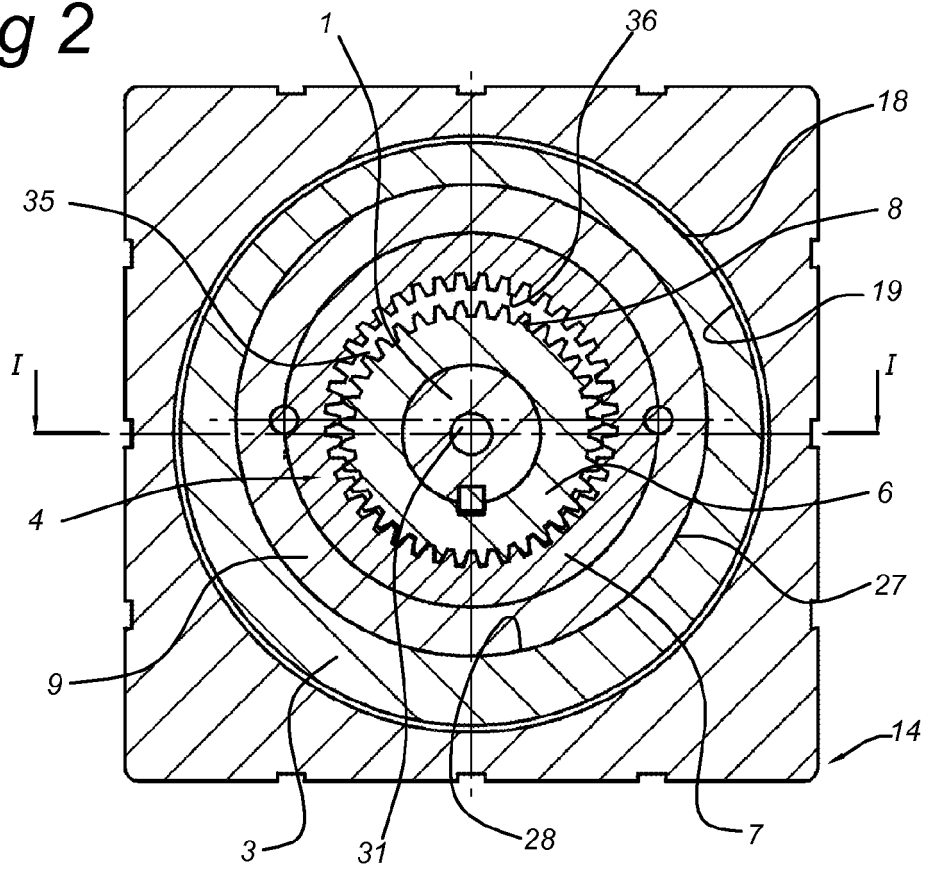
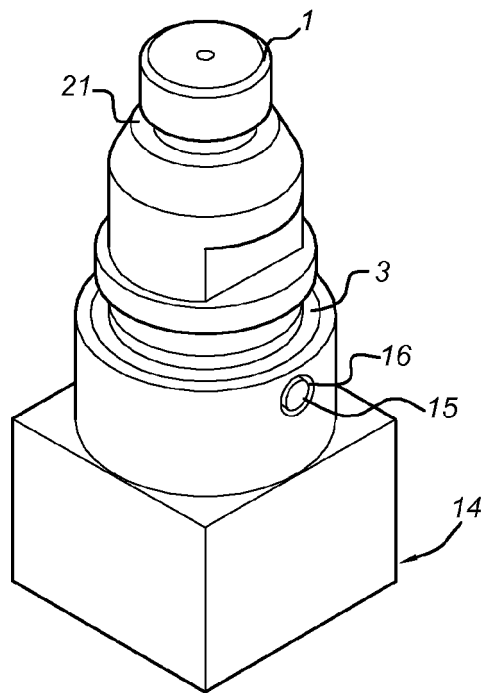
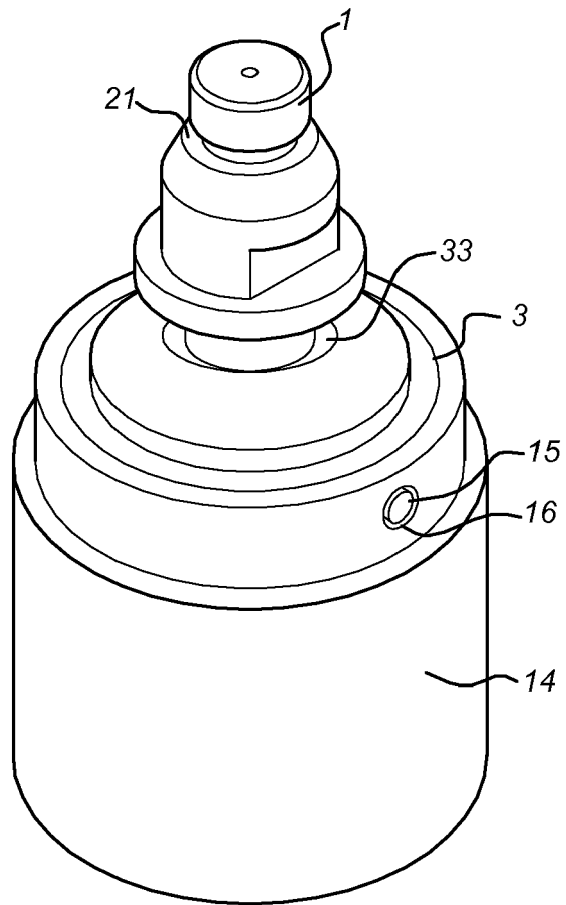


Fig 3



*Fig 4*





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