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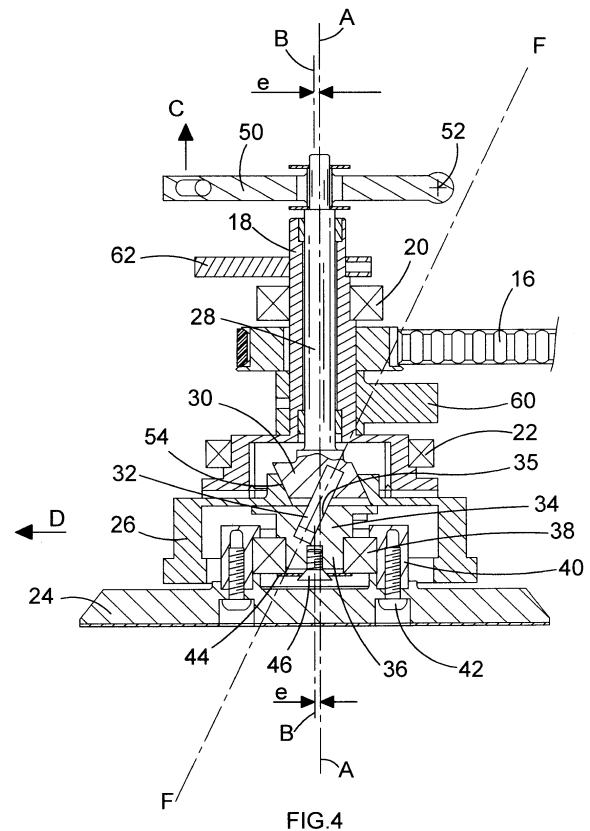
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(54) **Power tool**

(57) A power tool (2) comprises an eccentric platen (24) radially offset from a central drive axis A-A, the degree of eccentricity (e) of which can be varied by a control mechanism (50). A counterbalance mass (26) is arranged to move by an equal and opposite amount to any variance of the eccentricity of the platen in order to maintain static and dynamic balancing of the sander (2).



Description

[0001] The present invention relates to power tools and has particular, although not exclusive, relevance to powered sanders.

[0002] Different types of powered sanders, grinders and abraders are known and each has several possible uses.

[0003] For example, a powered sander may be used to remove paint from wood before re-painting. Alternatively it may be used in a more aggressive environment to remove rust from metalwork, again, before re-painting.

[0004] Although it is possible to use different types of sanding material with the power tool in order to have differing levels of sanding or abrading, it is also useful to enable the user of the tool to have sufficient control in order to be able to provide their own degree of aggressiveness of the sanding or grinding operation.

[0005] An example of a power tool which allows the user to set their own degree of sanding ability can be found, for example, in United States patent number US 5,947,804. In this disclosure, the user is able to rotate one sleeve mechanism relative to another in order to increase or decrease the eccentricity of the sanding platen. Because one sleeve is mounted eccentrically relative to the other, then rotation of one will affect the eccentricity of the platen which is mounted on the other sleeve.

[0006] The efficaciousness of this proposal is, however, limited, because a compromise has been reached between the static and dynamic balancing of the eccentricity of the platen. This is because varying the degree of eccentricity of the platen requires a concomitant, yet opposite variation, of the counterbalance mass. This is necessary in order to stop excessive vibration force on the sander during use as a result of imbalanced weights around the drive shaft. However in US 5,947,804 a variation of the eccentricity of the sanding platen does not result in an equal, yet opposite, variation in the eccentricity of the counterbalance masses. Therefore the entire proposal in this disclosure of allowing the user to vary the aggressiveness of sanding by altering the eccentricity of the sanding platen is always a compromise between flexibility and comfort as a result of no balance mass variation.

[0007] Furthermore, the operation to vary the platen eccentricity in US, 5,947,804 is quite cumbersome, requiring the user to stop using the tool and subsequently rotate one sleeve relative to the other. This is, therefore, a two-handed operation requiring the tool to be out of use at the time.

[0008] Accordingly a power tool having the ability to have a varying eccentricity of a tool part of thereof which can be achieved without stopping use of the tool and without the need for two-handed operation, is particularly attractive. Furthermore such a tool which achieves static and dynamic balancing automatically on varying the eccentricity of the tool part would have significant advantage over the known proposals. Undesirable vibration ef-

fects, for example, can be kept to a minimum, or even avoided altogether.

[0009] According to the present invention, therefore, there is provided a power tool comprising:

a housing for containing a motor therein;
the motor arranged to rotate a drive shaft about a rotational axis;
a tool part mounted with free rotation eccentrically with respect to the drive shaft and driven thereby;
a counter-balance mass mounted on and arranged to be rotated by the drive shaft, which counter-balance mass is mounted with an eccentric offset relative to the drive shaft;
control means for varying the eccentric offset of the tool part with respect to the rotational axis of the drive shaft, without rotation thereof, by radial movement of the tool part with respect to the rotational axis of the drive shaft;
such radial movement of the tool part by the control means also causing concomitant radial movement of the counter-balance mass, without rotation about the rotational axis of the drive shaft, such that the radial movement of the counter-balance mass is diametrically opposite to movement of the tool part.

[0010] By providing control means which simultaneously effects radial opposing movements of the tool part and the counter-weight, not only is the ability to vary the eccentricity of the tool part achieved, but also both the dynamic and static balancing of both the tool part and the counterweight about the central drive shaft is maintained.

[0011] Preferably radial movement of the counterbalance mass is of the same extent as any radial movement of the tool part. However, it is also possible for the amount of radial movement of the counterbalance mass to be different from that of the tool part.

[0012] Preferably the power tool includes a slidable member mounted around or within the drive shaft, which slidable member is axially movable with respect to the drive shaft, under influence of the control means, to effect radial movement of both the tool part and the counterbalance mass. By providing an axially movable slidable member operating under the influence of the control means, easy manual control of the degree of eccentricity of the tool part is achieved. Furthermore this can be achieved by the user with only one hand, and also while the tool is being used.

[0013] Additionally the slidable member may include a first portion having an outer surface angled with respect to the axis of the drive shaft and a second member having an outer surface angled with respect to the axis of the drive shaft.

[0014] Furthermore the outer surface of the first portion of the slidable member may be angled to cause movement of the tool part in a first radial direction and the outer surface of the second portion of the slidable member may

be angled to cause movement of the counterbalance mass in a second radial direction, wherein the first and second radial directions are diametrically opposite each other with respect to the drive shaft. By using such a mechanism, a single control element-the sliding member-is able to achieve movement both of the tool part and the counterbalance mass, yet in opposite directions. Furthermore the slidable member may govern the amount of movement of each of the tool part and the counterbalance mass so that, preferably, they each move by the same amount.

[0015] According to a preferred embodiment the first portion of the slidable member comprises a wedge member. Preferably the second portion of the slidable member comprises a pin.

Also further counterbalance masses may be disposed about the drive shaft

[0016] In a preferred embodiment of the pin may be formed within the wedge member.

[0017] Two embodiments of the present invention will now be described, by way of example only and with reference to the accompanying drawings, of which:

Figure 1 shows a cut-away view of a sander incorporating an eccentric-varying mechanism;
Figure 2 shows an exploded view of some of the components of Figure 1 laid out;
Figure 3 shows an isometric view of an alternative embodiment to that of Figure 1, having a different control mechanism;
Figure 4 illustrates schematically an axial section of the embodiment of Figure 3.

[0018] Although described in more detail below, it should be appreciated that the salient differences between the embodiment shown in figures 1 and 2 and that shown in figures 3 and 4 relates only to the control means used to adjust the eccentricity and counterbalance mass. All other components are the same and, hence, carry the same reference numerals.

[0019] Referring now to the drawings, a powered sander, shown generally as 2, has a housing 4 surrounding a motor 6. The motor 6 is activated by the user of the sander 2 operating a switch 8 coupled to a manually-actuable trigger 10. The switch is connected to an electrical supply via power cable 12, in known manner.

[0020] The motor 6 has an output spindle 14 formed with a toothed end for cooperation with a toothed belt 16 which is arranged to rotate a drive shaft 18 of the sander 2 about a rotational axis A-A (figure 4). Hence activation of the motor 6 causes rotation of its output spindle 14 which, in turn, drives the toothed belt 16 in order to rotate the drive shaft 18 about axis A-A.

[0021] The drive shaft 18 is supported by an upper bearing 20 and a lower bearing 22. The lower bearing 22 surrounds componentry arranged to both vary the eccen-

tricity of a tool part, here a sanding platen 24 coupled to the drive shaft 18 and also the eccentricity of counterbalance mass 26. This will be explained in detail below.

[0022] In the embodiment shown in the figures, the drive shaft 18 is formed as a sleeve and surrounds an internal axially movable slidable member, in this example slide 28. The slide 28 rotates with rotation of the drive shaft 18, and can be axially moved under influence of a control means, to be described further below.

[0023] The lower end of the slide 28 terminates in two portions: a first portion, in this example a wedge 30 which is axially separated from a second portion, in this example pin 32. It can be seen particularly from figures 2 and 4 that the wedge 30 is angled with respect to the drive axis A-A at a first inclination and the pin 32 is also angled relative to the drive axis A-A at the same angle, but in the opposite direction to that of the wedge 30.

[0024] The pin 32 is rigidly mounted into the base of wedge 30. No relative movement therebetween is possible.

[0025] The platen 24 is mounted to a terminal block 34 which is slidably coupled to and driven by the counterbalance mass 26. Shoulder 261 formed on the counterbalance mass 26 fits within a corresponding recess 221 formed in the lower bearing 22, thereby to permit a sliding movement between the mass 26 and bearing 22. Due to the angle of inclination of the pin 32 relative to the drive shaft 18 axis A-A, the terminal block 34 rotates about a separate axis, B-B, which, as can be seen best from figure 4, defines an eccentric offset, e, from that of the axis A-A.

[0026] The lower end of the terminal block 34 has a shoulder 36 formed thereon. The shoulder 36 defines an annular recess for accommodating a bearing 38. Furthermore the terminal block 34 has an angled recess 35 corresponding to the projection of the pin 32 from the wedge 30. The pin 32 is able to move within the angled recess 35 of the terminal block 34 along axis F-F (see figure 4), as will be described below.

[0027] The bearing 38 is surrounded by a support ring 40 which has a series of internal threads for accepting screws 42. The screws 42 are used for mounting the platen 24 to the bearing 40 and, hence, the terminal block 34. In this manner, therefore, the platen 24 is able to freely rotate about the terminal block 34 and, hence, the eccentric axis B-B. Bearing 38 is retained on the terminal block 34 by a washer 44 and lock screw 46.

[0028] As mentioned above axial movement of the slide 28 is manually achievable by a control means, in the embodiment of figures 1 and 2 this is a rotatable knob 48, whereas in the embodiment of figures 3 and 4 this is a pivotal actuation rod 50. Although the knob 48 and the rod 50 operating different ways, they achieve the same effect. That is, to control axial movement of the slide 28 whilst allowing its rotation about axis A-A.

[0029] Referring now particularly to Figure 4 it can be seen that, if the rod 50 is moved upwards in the direction of arrow C to pivot about the pin 52, then the slide 28 will

also be moved upwards in the direction of arrow C. Because the slide 28 is constrained only for axial movement (that is parallel to the drive axis A-A) and also because the inclined pin 32 is axially offset from the drive axis A-A by the eccentric distance e, then the angled outer surfaces of the pin 32 (which co-operate with the corresponding angled recess 35 formed in the terminal block 34 for accepting the pin therein) will cause movement of the terminal block 34 to the left in the direction of Arrow D. This will, therefore, increase the distance between the two axes A-A and B-B and, hence, increase the eccentricity, e.

[0030] Conversely, movement of the rod 50 downwards in the opposite direction to arrow C will cause the pin 32 to move the terminal block 34 to the right, in the opposite direction to that of arrow D and, hence, decrease the distance between the two axes A-A and B-B, thus decreasing the eccentricity, e.

[0031] It will be apparent to those skilled in the art that downward movement of the pin 32 not only causes movement of the terminal block 34 to the right of the figure, but also the pin 32 starts to move further within the angled recess 35 of terminal block 34 by movement therewithin. Conversely, upward movement of the pin 32 as a result of movement of the rod 50 in the direction of arrow C not only causes movement to the left of figure 4 of the terminal block 34 in the direction of arrow D, but will also cause withdrawal of the pin 32 from the angled recess 35 formed within the terminal block 34.

[0032] Those skilled in the art will appreciate the need for both dynamic and static balancing of the platen 24 when the eccentric distance, e, is varied away from its balanced position, wherever that is chosen to be. Assuming that the sander has its platen balanced about its driven axis B-B, then any variation in separation between the parallel axes A-A and B-B, after this balancing, will create an imbalance both dynamically and statically about the central drive axis A-A. The differences between dynamic and static balancing will not be further discussed here, as they will be readily apparent to those skilled in the art.

[0033] In order to ensure a neutral effect both in terms of the dynamic and static balancing of the platen 24 under variation of the eccentric distance e, the wedge 30 is employed. It can be seen by reference to figure 4 that the outer surface of the wedge 30 is angled in the opposite direction to that of the pin 32 relative to the central drive axis A-A. In fact the outer surfaces of the wedge 30 lie in a direction having the same angle to the axis A-A as does the axis F-F of the pin 32 relative to the central drive axis A-A. In other words, the angular offset of the pin 32 relative to the central drive axis A-A is the same as that of the outer surfaces of the wedge 30.

[0034] The outer surfaces of the wedge 30 abut a correspondingly chamfered outer surface 54 of counterbalance mass 26. In this way, as movement of the rod 50 has been explained to cause movement of the terminal block 34 (because the wedge 30 and pin 32 are unable

to move axially independent of each other, but move as a single unit) then a concomitant yet radially opposite movement of the counterbalance mass 26 is achieved upon any movement of the platen 24. In other words, if the rod 50 is moved upwards in the direction of arrow C, then the terminal block 34 will move to the left in the direction of arrow D. This causes an increase of the eccentricity, e, and hence the eccentric offset of the platen 24 relative to the central drive shaft A-A.

[0035] A concomitant movement of the counterbalance mass 26 diametrically opposite that of the terminal block 34 and platen, therefore, occurs. Furthermore, the amount of movement of the counterbalance mass 26 in this diametrically opposite direction is exactly the same as the amount by which the terminal block 34 and platen 24 have moved. In this way, therefore, static and dynamic balancing are maintained.

[0036] Importantly it should be noted that there is no axial separation between the position of the terminal block 34 and that of the counterbalance mass 26. Thus any adverse effect, particularly in relation to dynamic balancing, is avoided.

[0037] It will be appreciated that the angular offset of the pin 32 relative to the central drive axis A-A may differ to the angular offset of the outer surfaces of wedge 30. This may achieve differential and opposite movement of the counterbalance mass 26 relative to movement of the platen 24, yet still maintain both static and dynamic balancing of the system in so far as the masses of each of the counterbalance mass 26 and platen 24 and their respective amount of movement are concerned. For example it could be that the counterbalance mass 26, having mass M_1 moves a distance D_1 and platen 24, having mass M_2 moves a distance D_2 , where $M_1 > M_2$ and $D_1 < D_2$. This could be readily applied in situations where space for movement of the masses was limited (in the housing of the power tool) and so by increasing the mass rather than the degree of movement, balancing can still be achieved.

[0038] The embodiment shown in figures 1 and 2 does not utilise a pivotal rod 50 but a rotatable knob 48. Rotation of the knob 48 causes a control block 56 to translate this rotational movement into a linear motion via thread-form 49 in order to move the slide 28 axially up or down, again to achieve movement of the wedge/pin combination as discussed above. Further discussion, therefore, of the differences between the rod 50 and knob 48 is not necessary.

[0039] The sleeve 18 carries two further counterbalance masses; second counterbalance mass 60 and third counterbalance mass 62. Further discussion of the second and third counterbalance masses will not be given here, as their purpose and effect is well-known to those skilled in the art. Suffice it to say that they are necessary in order to prevent moments manifesting themselves along the drive axis A-A which would otherwise cause imbalance during rotation of the platen 24 and combined with the platen 24 and counterbalance mass 26 constitute

a multiple-plane balancing system.

[0040] The counterbalance mass 26 is formed as a skirt substantially around bearing 38 and axially adjacent platen 24 in order to reduce moments about axis A-A between the two.

[0041] From the above it can be seen that movement of the platen 24 in order to adjust the eccentricity, e , in a first radial direction relative to the central drive axis A-A causes concomitant and equivalent radial movement of the counterbalance mass 26 in the diametrically opposite direction. There is no need for any relative rotation between the platen 24 and the counterbalance mass 26. Furthermore the entire process can be controlled with a simple one-hand actuated control member such as rod 50 or knob 48. Additionally because of the diametrically opposing movements of the platen 24 and counterbalance mass 26, both dynamic and static balancing are maintained throughout use of the sander 2. This provides an important advantage of the eccentricity, e , being adjustable during operation of the sander 2 without any need for release of the trigger 10 to disconnect the motor 6 from its power supply.

[0042] Although in the embodiments described above it is stated that the drive shaft 18 be formed as a sleeve around the slide 28, the converse could be possible. That is, the slide 28 to be formed as a sleeve around the drive shaft 18. Furthermore, although in the interests of efficient use of space it is highly desirable that the drive shaft 18 and slider 28 be formed concentrically.

[0043] In the above, it will be appreciated that the sander is initially balanced (both statically and dynamically) at the mid-point of the range of eccentric off-sets achievable by movement of the platen 24 (in other words centred on axis B-B). However, at no stage is the offset of the platen during this initial balancing equal to zero (or, in other words, centred on drive axis A-A). This is because the effect of the counterbalance masses 60 and 62 would render such a set-up imbalanced, as, at this initial balancing position, the platen 24 and counterbalance mass 26 are in balance and therefore contribute no effect to balancing. If the platen 24 were to be positioned concentrically with the drive axis A-A during this initial balancing, then the effect of masses 60 and 62 would cause the sander to be imbalanced.

[0044] At the midpoint of eccentric off-sets available to the platen 24 the counterbalance mass 26 is itself concentric with the drive axis A-A and, hence, plays no part in balance of the sander.

[0045] It will also be understood by those skilled in the art that the eccentric off-set of the platen 24 is maintained to ensure the free rotation thereof about the bearing 38 which permits a swirl-free finish on the workpiece to which the platen is applied during use of the sander. This is due to changes on the path traced by the abrasive particles attached to the rotating platen as the eccentricity changes.

Claims

1. A power tool comprising:

5 a housing for containing a motor therein;
the motor arranged to rotate a drive shaft about a rotational axis;
a tool part mounted with free rotation eccentrically with respect to the drive shaft and driven thereby;
10 a counter-balance mass mounted on and arranged to be rotated by the drive shaft, which counter-balance mass is mounted with an eccentric offset relative to the drive shaft;
15 control means for varying the eccentric offset of the tool part with respect to the rotational axis of the drive shaft, without rotation thereof, by radial movement of the tool part with respect to the rotational axis of the drive shaft;
20 such radial movement of the tool part by the control means also causing concomitant radial movement of the counter-balance mass, without rotation about the rotational axis of the drive shaft, such that the radial movement of the counter-balance mass is diametrically opposite to movement of the tool part.

2. A power tool according to claim 1 wherein the amount of radial movement of the counterbalance mass is the same as the amount of radial movement of the tool part.

3. A power tool according to Claim 1 wherein the amount of radial movement of the counterbalance mass is different from that of the tool part.

4. A power tool according to either one of the preceding claims wherein a slidable member mounted around or within the drive shaft, which slidable member is axially movable with respect to the drive shaft, under influence of the control means, to effect radial movement of both the tool part and the counterbalance mass.

5. A power tool according to claim 4 wherein the slidable member may include a first portion having an outer surface angled with respect to the axis of the drive shaft and a second member having an outer surface angled with respect to the axis of the drive shaft.

6. A power tool according to claim 5 wherein the outer surface of the first portion of the slidable member may be angled to cause movement of the tool part in a first radial direction and the outer surface of the second portion of the slidable member may be angled to cause movement of the counterbalance mass in a second radial direction, wherein the first and

second radial directions are diametrically opposite each other with respect to the drive shaft.

7. A power tool according to either claim 5 or claim 6 wherein the first portion of the slidable member comprises a wedge member. 5
8. A power tool according to anyone of claims 5-7 wherein the second portion of the slidable member comprises a pin. 10
9. A power tool according to claim 8 wherein the pin is formed within the wedge member.
10. A power tool according to claim 9 when appendant to claim 3 wherein the angle of the pin relative to the drive shaft governs the difference. 15
11. A power tool according to any one of the preceding claims were in the counterbalance mass is formed as a circular skirt. 20
12. A power tool according to claim 11 wherein the circular skirt surrounds the tool part. 25
13. A power tool according to any one of the preceding claims wherein the tool comprises a sander.
14. A power tool according to any one of the preceding claims including further counterbalance masses disposed about the drive shaft. 30

Amended claims in accordance with Rule 137(2) EPC. 35

1. A power tool (2) comprising:

a housing (4) for containing a motor (6) therein; the motor arranged to rotate a drive shaft (18) about a rotational axis (A-A);
a tool part (24) mounted with free rotation eccentrically with respect to the drive shaft and driven thereby;
a counter-balance mass (26) mounted on and arranged to be rotated by the drive shaft, which counter-balance mass is mounted with an eccentric offset (e) relative to the drive shaft;
the power tool **characterised by** control means (48,50) for varying the eccentric offset of the tool part with respect to the rotational axis of the drive shaft, without rotation thereabout, by radial movement of the tool part with respect to the rotational axis of the drive shaft;
such radial movement of the tool part by the control means also causing concomitant radial movement of the counter-balance mass (26), without rotation about the rotational axis of the 40
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drive shaft (18), such that the radial movement of the counter-balance mass is diametrically opposite to movement of the tool part (24).

2. A power tool according to claim 1 wherein the amount of radial movement of the counterbalance mass (26) is the same as the amount of radial movement of the tool part (24).
3. A power tool according to Claim 1 wherein the amount of radial movement of the counterbalance mass (26) is different from that of the tool part (24).
4. A power tool according to either one of the preceding claims wherein a slidable member (28) mounted around or within the drive shaft, which slidable member is axially movable with respect to the drive shaft (18), under influence of the control means (48,50), to effect radial movement of both the tool part and the counterbalance mass.
5. A power tool according to claim 4 wherein the slidable member (28) may include a first portion (30) having an outer surface angled with respect to the axis of the drive shaft and a second member (32) having an outer surface angled with respect to the axis of the drive shaft.
6. A power tool according to claim 5 wherein the outer surface of the first portion (30) of the slidable member (28) may be angled to cause movement of the tool part in a first radial direction (D) and the outer surface of the second portion (32) of the slidable member may be angled to cause movement of the counterbalance mass in a second radial direction, wherein the first and second radial directions are diametrically opposite each other with respect to the drive shaft (28).
7. A power tool according to either claim 5 or claim 6 wherein the first portion of the slidable member comprises a wedge member (30).
8. A power tool according to anyone of claims 5-7 wherein the second portion of the slidable member comprises a pin (32).
9. A power tool according to claim 8 wherein the pin is formed within the wedge member.
10. A power tool according to claim 9 when appendant to claim 3 wherein the angle of the pin relative to the drive shaft governs the difference.
11. A power tool according to any one of the preceding claims were in the counterbalance mass is formed as a circular skirt (26).

12. A power tool according to claim 11 wherein the circular skirt surrounds the tool part.

13. A power tool according to any one of the preceding claims wherein the tool comprises a sander. 5

14. A power tool according to any one of the preceding claims including further counterbalance masses disposed about the drive shaft. 10

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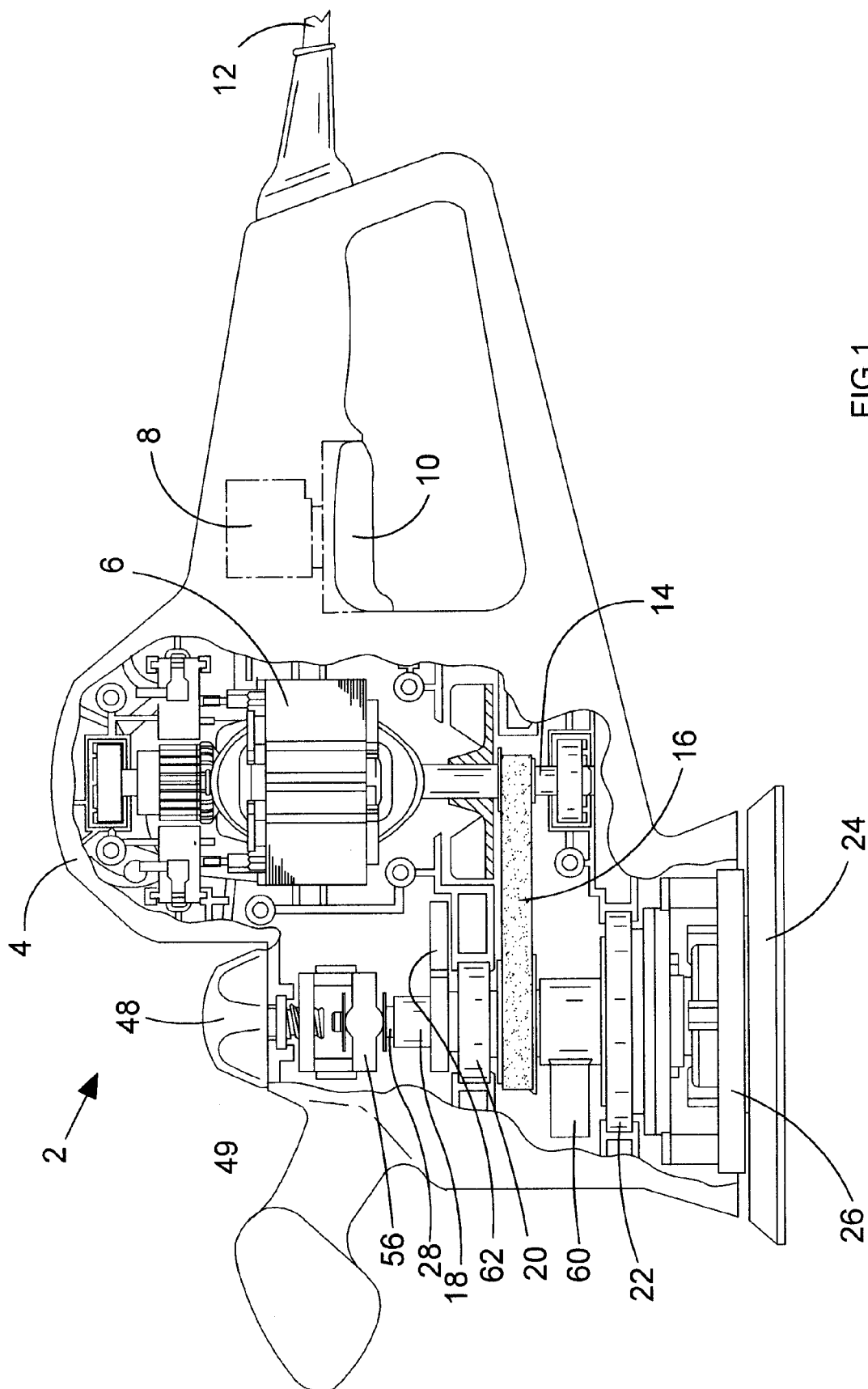


FIG.1

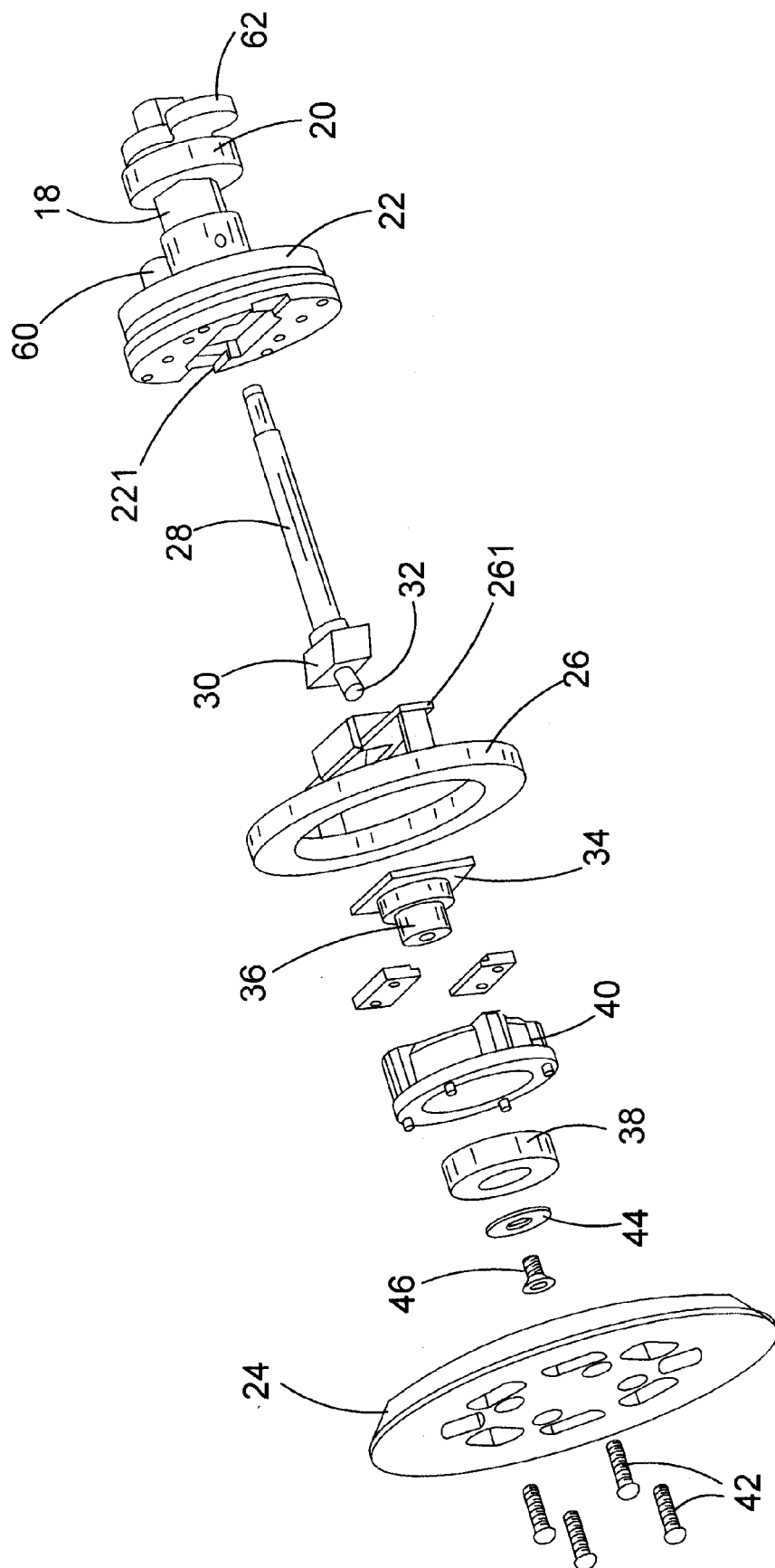


FIG.2

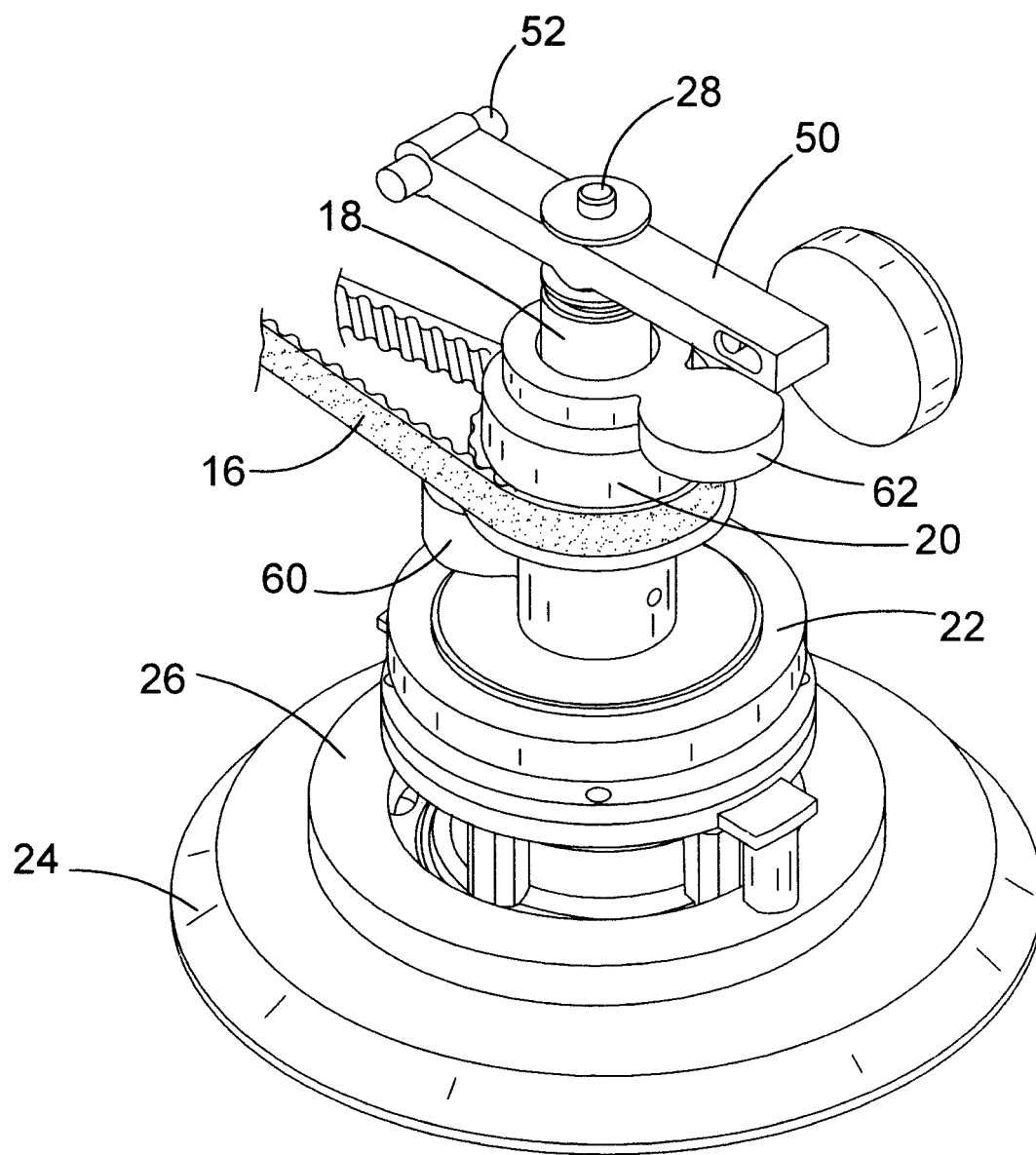
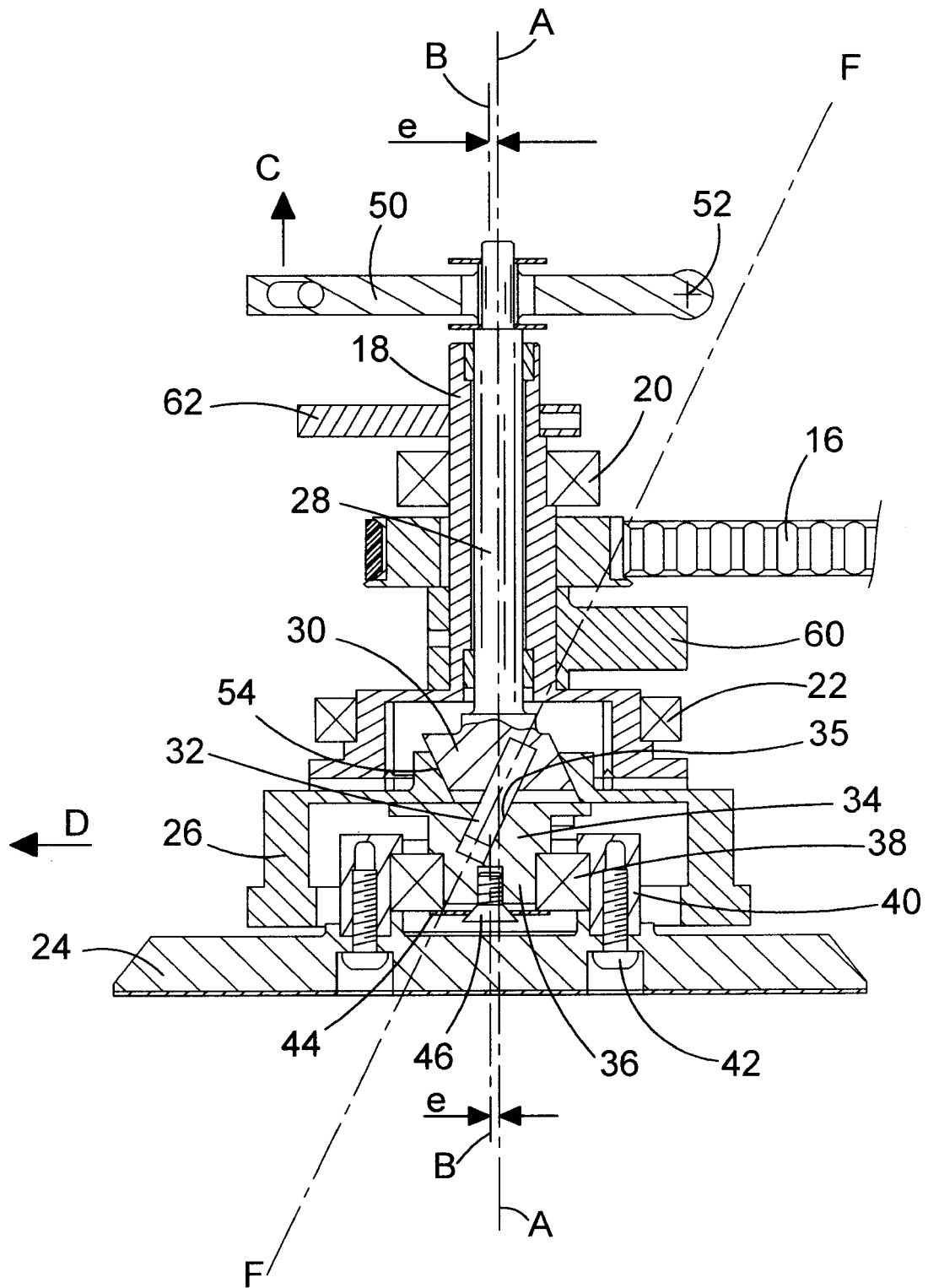


FIG.3





EUROPEAN SEARCH REPORT

Application Number
EP 08 15 7146

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 November 2008	Examiner Gelder, Klaus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 15 7146

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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05-11-2008

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REFERENCES CITED IN THE DESCRIPTION

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