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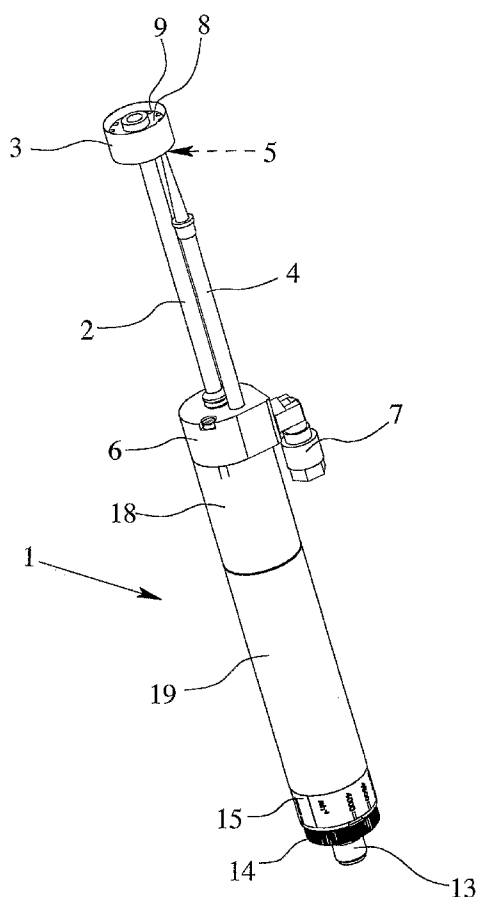
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(54) Title: ROTORSPRAY AND METHOD FOR OPERATING A ROTORSPRAY



(57) Abstract: This invention relates to an apparatus for applying a liquid material to a surrounding surface, preferably a surface defining a cavity or a bore, comprising a base member (1), an elongated support member (2) extending axially from one end of the base member (1), a rotor head (3) attached to the other end of the support member (2), and at least one liquid delivery conduit (4) positioned with its delivery outlet (5) close to and oriented towards the rotor head (3). The rotor head (3) is adapted to rotate at a high operating speed, and to throw a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) generally radially outwardly towards a surrounding surface. The rotor head (3) is driven by a drive means (11) and its operation and speed is controlled by a drive control (12). This apparatus is improved in that the drive control (12) is adapted to control the rotational speed of the rotor head (3) also to a low testing speed and to monitor the rotation of the rotor head (3) at the low testing speed and to generate a malfunction signal if the rotation of the rotor head (3) is unduly retarded.



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### **Rotorspray and method for operating a rotorspray**

The present invention relates to an apparatus for applying a liquid material to a surrounding surface with the features of the generic part of claim 1, claim 3, or  
5 claim 17. Such apparatus is commonly called a rotorspray. The present invention further relates to a method for operating such an apparatus, namely a rotorspray, with the features of the generic part of claim 21 or claim 23.

A rotorspray is an apparatus for applying a liquid material like oil, a resin or the  
10 like to a surrounding surface of a cavity, in particular a bore or a drilling. Large size rotorsprays are used for vertical application in manholes, wetwells or other vertical shafts or conduits (US-A-5 092 265), whereas rotorsprays of smaller size are widely used in manufacturing, e.g. in the automotive business for coating of the inner surface of cylinders in engine blocks or the like (DE-C-4 331 394). The  
15 liquid material to be applied to the surrounding surface has to have a sufficiently low relative viscosity in order to be efficiently applicable to the surface. As the surface normally is a drilling, bore or otherwise cylindrical cavity the elongated support member with the rotor head at its end is axially moved into the cavity with generally equal radial distance to all sides. To start the coating process the  
20 rotor head is accelerated to its high operating speed (US-A-5 092 269 mentions a speed of about 6000 rpm). Then the supply of liquid is started so that liquid is delivered from the delivery outlet to the rotor head from where, due to its high rotational speed, the liquid is thrown generally radially outward towards the surrounding surface. The result is an even, efficient coating of the surface with  
25 the respective liquid material.

Details of the application method of liquid material with a rotorspray may be obtained from above mentioned prior art sources, too.

30 The prior art mentioned above (DE-C-4 331 394) mentions the necessity to eliminate any risk that the rotor head rotating at the high operating speed unintentionally collides with an obstacle within the cavity. If this happens the rotor head will immediately be out-of-balance, operation of the apparatus has to be stopped. This is particularly problematic where such an apparatus is part of a  
35 semi-automatic manufacturing line. A breakdown of such an apparatus

immediately entails an interruption of the complete manufacturing process. This is a serious problem in the automotive manufacturing business.

5 In order to eliminate above mentioned problem the apparatus which forms the starting point of the present invention (DE-C-4 331 394) already has a collision detection system on the rotor head of this apparatus. The collision detection system comprises a free end of the elongated support member that projects beyond the rotor head itself and is displaceable axially against the force of a biasing spring. A mechanical switch generates a malfunction signal if the free  
10 end strikes an obstacle so that the apparatus can be stopped before the rotor head itself hits the obstacle.

Above mentioned collision detection system on such an apparatus is useful for obstacles that are blocking the axial feed of the rotor head. If, however, the  
15 apparatus is positioned within the cavity off-center or at an angle relative to the axial extension of the cavity this collision detection system is mostly useless.

Moreover, the prior art rotorspray (DE-C-4 331 394) provides only one specific operating speed. However, from actually sold items it is known to have a setting  
20 element for setting the operating speed to different values where the setting element has electromechanical microswitches within the housing of the base member to read the mechanical setting. This system is understood to be not as reliable as necessary in particular where above mentioned circumstances are given like in the automotive manufacturing industry.

25 The present invention now has as an object to improve the rotorspray in a way to reduce the risk of malfunction with the necessity to interrupt the operation of the apparatus. Similarly, the method for operating such a rotorspray shall be improved.

30 Above mentioned object is met in a first version by an apparatus with the features of claim 1. In a second version this object is met with an apparatus comprising the features of claim 3. In a third version this object is met with an apparatus comprising the features of claim 17. Finally above mentioned object is  
35 met with a method comprising the features of claim 21 or claim 23.

The apparatus with the features of claim 1 has a sophisticated collision detection system realized by the drive control of the apparatus. There is no mechanical modification of the rotor head like in the prior art collision detection system.  
5 Instead the drive control is adapted to control the rotational speed of the rotor head to a low testing speed. Running at the low testing speed the rotor head may be fed axially into the cavity in a test run. As the drive control is adapted to monitor the rotation of the rotor head at the low testing speed and is adapted to generate a malfunction signal if the rotation of the rotor head is unduly retarded,  
10 the surroundings of the rotor head within the cavity can be tested at low rotational speed before the actual coating at high operating speed begins. A light collision of the rotor head with an obstacle has no detrimental effect on the rotor head at the low testing speed.

15 In fact, the low testing speed must be selected appropriately so that the rotor head will not be damaged, in particular will not be out-of-balance. The speed of the axial advance of the rotor head within the cavity is of course important as well. Moreover it is important that the drive control reacts fast enough to stop the apparatus upon occurrence of a malfunction signal and/or to reverse the axial  
20 movement of the rotor head in the cavity.

The essential idea of the invention is that due to the low testing speed of the rotor head the impact of a collision on the rotor head and the apparatus in total is much less problematic than at the high operating speed.

25 The term "base member" defines any part of an apparatus according to the invention that is adapted to carry the elongated support member. The elongated support member is the part of the apparatus that is actually carrying the rotor head at its free end. It has to be elongated in order to allow the feeding of the  
30 rotor head axially into the cavity defining the surface.

The prior art discloses different ways to provide the rotor head with the ability to rotate at a high operating speed. One prior art document (US-A-5 092 265) provides that the rotor head rotates relative to the support member, whereas the  
35 support member itself is fixedly connected to the base member. This is achieved

by a pneumatic motor positioned at the free end of the support member with the rotor head mounted directly on the drive shaft of the pneumatic motor.

A different version is disclosed in another source (DE-C-4 331 394) where the rotor head is fixedly attached to the end of the support member and is rotating at high operating speed together with the support member relative to the base member. This can be realized with the rotatable support member within a stationary sleeve or without such a sleeve. Here the drive means is an electric drive motor, namely a DC-motor with a reducing gear means.

The rotor head in the first prior art document (US-A-5 092 265) has the form of a turbine impeller, whereas the second prior art source (DE-C-4 331 394) has a more cylindrical rotor head with radial openings on the one hand and a bottom with axial openings on the other hand. At the lower end of this cylindrical rotor head a rim is protruding inwardly. If the rotor head is operated vertically as disclosed in the prior art document the rim is able to collect residual liquid after the coating phase as been concluded and the rotor head is no longer rotating. However, in a horizontal orientation of the rotor head this rim is useless and residual liquid is dropping from the rotor head when this rotor head is retracted from the cavity.

As far as the liquid delivery is concerned the prior art discloses more than one liquid delivery conduit (US-A-5 092 265) or, for a small size version, particularly adapted to manufacturing processes in the automotive industry, just one liquid delivery conduit (DE-C-4 331 394). In the latter the delivery outlet is not only close to but in fact within a hollow chamber in the rotor head (Fig. 2 of DE-C-4 331 394). It depends on the specific liquid material to be applied as well as on the size of the rotor head whether one liquid delivery conduit is sufficient or a number of liquid delivery conduits and/or liquid delivery outlets are useful.

Finally, as far as the liquid material is concerned, of course its viscosity and its properties with regard to its adherence to the surface of the rotor head have to be taken into account when deciding on the material used for the rotor head or its surface as well as deciding about the useful operating speed and testing speed.

More details for the apparatus according to claim 1 can be obtained from the sub-claims, some of them are discussed below.

5 Of course, it is helpful that the malfunction signal is a signal stopping the rotation of the rotor head and/or a signal generating an alarm signal.

10 During testing of the apparatus according to the invention at the applicant's testing laboratory it was found that the use of a low testing speed brings about an additional advantage that can be achieved even if there is no monitoring of the rotation of the rotor head at the low testing speed. It was found that if the testing speed of the rotor head is appropriately chosen it can be so low that no liquid material on the rotor head is thrown off from the rotor head but can still be so high that residual liquid material on the rotor head will not drop off from the rotor head. So the rotor head can be retracted from the cavity without residual liquid dropping down onto the surface. This is particularly helpful where the rotor head is used with a horizontal orientation of the elongated support member or an orientation with a substantial horizontal component.

20 For the specific application purposes of the present invention for the automotive industry it is helpful to use an operating speed that is between 2000 rpm and 12000 rpm, preferably between about 4000 rpm and about 9000 rpm, and a testing speed that is between about 50 rpm and about 250 rpm, preferably around 100 rpm. As explained before, in particular the testing speed depends on viscosity and adherence properties of the liquid towards the surface of the rotor head.

25 If there is a sufficiently wide range of possible operating speeds it is preferable to provide for a setting element for setting the operating speed to different values. This setting element is part of the drive control.

30 Based on a generally elongated form of the base member it is practical to design the setting element as a mechanical setting ring rotatable relative to the base member. Easy adjustment is combined with reliable positioning if an index catch for each settable value of the operating speed is provided.

35

In a separate, independent version of the invention above mentioned problem is solved by a particularly convenient design of the drive control as far as setting the operating speed of the rotor head is concerned.

5 Claim 17 provides in this regard that the housing of the base member is provided with a sleeve which has an inner surface with optically reflecting and non-reflecting areas. The drive control itself is provided with optoelectronic switches that are positioned inside the sleeve in a way that by rotating the sleeve and the switches relative to each other the switches are selectively activated and  
10 deactivated to read the setting of the operating speed. So for reading the setting of the setting ring by the drive control no electromechanical microswitches are used but just a reliable optoelectronic system is applied.

15 Claims 18 to 20 are related to specific embodiments of this optoelectronic reading means.

As far as the method-claims are concerned they are added, because a prior art rotorspray may be operated by a drive control that was programmed accordingly to run not only in the high operating speed but at the low testing speed, too. The  
20 method-related sub-claims relate to specific further features in this regard.

Now, hereafter the present invention will be described in greater detail on the basis of the drawings which merely show one particularly preferable embodiment. While the invention is described with reference to the drawings  
25 further advantages and details of preferred embodiments of the invention are discussed as well.

In the drawings

30 Fig. 1 shows a perspective overall view of a rotorspray according to a preferred embodiment of the invention,

Fig. 2 shows an axial sectional view of the rotorspray according to Fig. 1,

Fig. 3 shows a perspective view, the housing partly cut away, of the second housing of the base member shown in Fig. 1,

Fig. 4 shows a schematic view of a printed circuit board with optoelectronic switches and corresponding sleeve with reflecting and non-reflecting patches.

Fig. 1 shows a perspective view of an apparatus for applying a liquid material to a surrounding surface that defines a cavity like are bore, a drilling, a cylindrical volume or the like. Such apparatus is normally called a rotorspray and so hereafter we will use the term rotorspray as well.

The liquid material applied by such an apparatus is usually a liquid like an oil or a resin. In the prior art an example is described for a two-component coating material with a liquid resin base and a liquid catalyst which are mixed simultaneously with their application by means of the rotor head. A further field of application is the coating of the inner surface of the cylinders of an engine block prior to assembly of the engine block with the plungers.

The rotorspray shown in Fig. 1 comprises a base member 1 and an elongated support member 2 that extends axially from one end of the base member 1. A rotor head 3 is attached to the free end of the support member 2.

At least one liquid delivery conduit 4, in this embodiment exactly one liquid delivery conduit 4, is positioned with its delivery outlet 5 close to and oriented towards the rotor head 3. On the base member 1 is provided an end portion 6 which is the portion of the base member 1 that actually carries the support member 2 and the delivery conduit 4. Within the end portion 6 the delivery conduit 4 is directed sideways to an attachment socket 7 where an external liquid supply line (not shown) may be attached.

In general the rotor head 3 of such a rotorspray is adapted to rotate at a high operating speed. This rotation may be relative to the support member 2 (as in the prior art from US-A-5 092 265. In the present embodiment however, the rotor head 3 rotates together with the support member 2 relative to the base member 1.

If the operating speed is sufficiently high liquid materials sprayed from the delivery outlet 5 onto the rotor head 3 is thrown generally radially outwards towards a surrounding surface. In order to allow this in the present embodiment the rotor head 3 is provided with a bottom 8 and a ring of small axial openings 9 in the bottom (see Fig. 1 and Fig. 2). As the inner surface 10 of the rotor head 3 is slightly inclined towards the end of the support member 2 rotation of the rotor head 3 leads to a flow of liquid towards the end of the rotor head 3 from where the liquid is evenly thrown radially towards the surrounding surface. This design of the rotor head 3 is similar to a prior art design (DE-C-4 331 394) and is particularly convenient for applying an oil coating to the inner surface of cylinders in an engine block.

To have an idea about the size of this preferred embodiment of a rotorspray the overall length including the support member 2 and the rotor head 3 is between 250 mm and 600 mm, with the base member 1 having a length of about 160 mm, with the diameter of the rotor head 3 about 40 mm, and with the diameter of the support member 2 about 6 mm. Of course, the size of the rotorspray depends largely on the field of application. The prior art relating to coating of manholes or the like needs much larger rotorsprays (US-A-5 092 265).

Fig. 1 and Fig. 2 disclose further that the rotor head 3 is adapted to be driven by a drive means 11 (Fig. 2). Its operation and speed is controlled by a drive control 12 (Fig. 2). As in the present and preferred embodiment the drive means 11 is an electric motor and the drive control 12 of course is an electronic control system, the base member 1 is equipped with an electric attachment means and interface 13.

Now, the drive control 12 is adapted to control the rotational speed of the rotor head 3 not only to the high operating speed for throwing the liquid towards the surrounding surface, but also to a low testing speed. The drive control 12 is further adapted to monitor the rotation of the rotor head 3 at the low testing speed and to generate a malfunction signal if the rotation of the rotor head 3 is unduly retarded. Braking or blocking of the rotor head 3 leads to generation of the malfunction signal at the low testing speed of the rotor head 3. This

malfunction signal may be a signal stopping the rotation of the rotor head 3 completely or a signal that just stops the advance movement of the rotor head 3 and/or it is just a signal initiating an alarm signal of any kind.

5 Rotorsprays are mostly visually controlled by an operator. So the alarm signal could be an optic or acoustic signal. As the testing speed is low compared to the operating speed the rotor head 3 will not be damaged and will not be out-of-balance if it collides with an obstacle within the cavity where the liquid material shall be applied. For detailed explanation reference is made to the introductory  
10 part of the present description.

Now, as also explained in detail in the introductory part of the description, it has been found out that the low testing speed of the rotor head 3 can be used to achieve a completely different advantage, too. Dropping of residual liquid from  
15 the rotor head 3 when the rotor head 3 stands still after coating of the surface has been terminated, can be prevented at least when the rotor head 3 on the support member 2 is positioned horizontally or at least with a substantial horizontal component by choosing the low testing speed of the rotor head 3 low enough that no liquid material on the rotor head 3 is thrown off from the rotor head 3 but still  
20 high enough that no residual liquid material is dropping of the rotor head 3. In this system the residual liquid on the rotor head 3 is continuously moved on the surface of the rotor head 3 and thus continues to adhere to the surface of the rotor head 3. Even in a vertical orientation of the rotor head 3 or the support member 2 this system works reasonably well, because there still is some relative movement  
25 between the residual liquid and the surface of the rotor head 3 which leads to adherence of the liquid on the surface.

For the fields of application which are preferred here it is advisable that the operating speed is between 2000 rpm and 12000 rpm, preferably between about  
30 4000 rpm and about 9000 rpm. In a preferred embodiment it is provided that the testing speed is between about 50 rpm and about 250 rpm, preferably around 100 rpm. It was explained before that the testing speed is largely dependent on the viscosity and adherence properties of the liquid material.

Now, the rotorspray of the present embodiment is provided with a further interesting feature. Fig. 1 and 2 as well as Fig. 3 and 4 show that the drive control 12 is provided with a setting element 14 for setting the operating speed to different values. Fig. 1 indicates with the denomination on a scale 15 next to the setting element 14 that the operating speed is settable at 500 rpm-increments between 4000 rpm and 9000 rpm. This is of course a specific embodiment only. In the present embodiment it is provided that the setting element 14 is a mechanical setting ring rotatable relative to the base member 1. In particular the setting element 14 is provided with an index catch 16 indicated in Fig. 2 for each settable value of the operating speed. So the operating speed is safely maintained and will normally not be changed unintentionally.

The prior art (US-A-5 092 265) proposes a pneumatic drive motor and optionally a reducing gear means for the drive means. In the present embodiment such a pneumatic drive could be applied, too. However, here it is provided that the drive means 11 comprises an electric drive motor, preferably a DC-motor, and optionally a reducing gear means.

The drive motor of the drive means 11 here is a 24 V DC-motor which is controlled by the drive control 12 by means of a pulse-width-modulation of the power supply. The monitoring of the rotation of the rotor head 3 at the low testing speed by the drive control 12 can be achieved by monitoring the current drawn by the electric drive motor. If the rotor head 3 collides with an obstacle and its rotation is retarded this is reflected by a rise in the current drawn by the drive motor. This is an indirect and very reliable method. However, a direct measurement of the rpm-reading at the low testing speed by optical or tachymetric means is also applicable, but more expensive.

In the present embodiment with the pulse-width-modulated DC-motor measuring and monitoring of the actual rotational speed is performed by measuring the electromotive force of the electric motor during p.w.m.-pause times. This is particularly reliable and inexpensive.

The drive control 12 can be equipped with a calibrating function. Following different lengths of the support member 2 and different sizes of the rotor heads 3

the load for the drive means 11 varies widely. So the power necessary to reach the high operating speed in a given time varies equally. Of course, also bearing friction has a similar effect. The drive control 12 can be operated in a learning mode where the drive control 12 adapts itself to the specific parameters of the actual rotorspray.

In the present embodiment the rotor head 3 is fixedly attached to the elongated support member 2. The support member 2 runs on bearings 17 in the base member 1 and is driven by the drive means 11.

In general it is possible to have one single elongated housing for the base member 1 which houses all components of the base member 1. In the present embodiment, however, a different construction of the base member 1 is used. Here the base member 1 comprises a first housing 18 which houses only the bearings 17 for the support member 2, and a second housing 19 which houses the drive means 11 and the drive control 12. The second housing 19 can be coupled to and decoupled from the first housing 18 simultaneously coupling or decoupling the drive means 11 to or from the support member 2. Fig. 1 and Fig. 2 show both housings 18, 19 whereas Fig. 3 is a perspective view, partly opened, of the second housing 19 with the drive means 11 and the drive control 12, the electric interface 13, setting element 14 and scale 15.

Fig. 1 as already explained above, shows the liquid delivery conduit 4 fixedly attached to the end portion 6 of the base member 1 and extending therefrom in parallel to the support member 2 towards and with the delivery outlet 5 into the rotor head 3.

An interesting further invention solving the same problem can be explained in detail based on Fig. 3 and Fig. 4 of the drawings.

The drive control 12 is positioned within the second housing 19 of the base member 1. The second housing 19 is provided with a mechanical setting ring 14 as a setting element rotatable relative to the housing 19 for setting the operating speed of the rotor head 3 to different values. Further, the housing 19 is provided with a sleeve 20. In the present embodiment this sleeve 20 is a stationary part of

the housing 19 and the scale 15 is printed onto the outside of the sleeve 20. In fact, the sleeve 20 forms the outer cylindrical wall of the second housing 19.

5 The inner surface of the sleeve 20 is provided with optically reflecting and non-reflecting areas. The drive control 12 is provided with optoelectronic switches 21. In Fig. 3 an optically reflecting area 22 is indicated by way of an example. Fig. 3 shows altogether four optoelectronic switches 21, Fig. 4 shows just those switches 21 with a section of the sleeve 20.

10 The drive control 12 has the switches 21 positioned within the sleeve 20 in a way that by rotating the sleeve 20 and the switches 21 relative to each other the switches 21 are selectively activated and deactivated. Fig. 4 indicates this by the arrows. Whereas the first, third and fourth (from left to right) switch 21 is deactivated, the second switch 21 is activated, because the light emitted by the  
15 LED of this switch is reflected by the area 22 and received by the photo diode or photo transistor of this switch 21. Of course, the optoelectronic switches 21 may have any appropriate design and may use any appropriate wavelength between far infrared and far ultraviolet. However, as a matter of convenience a normal LED-may be used as the sender of the switch, e. g. with red light emitted by this  
20 LED.

In the present embodiment it is further provided that the drive control 12 comprises a printed circuit board 23 or the like and the optoelectronic switches 21 are positioned on the board. The advantage of this construction is that all  
25 further electronic components 24 of the drive control 12 including a microprocessor, integrated circuits etc. can be positioned on the circuit board 23 as well and replacement of a defect circuit board 23 will be easier and more convenient.

30 In this present embodiment it is provided that the setting ring 14 is connected to the switches 21 so that the switches 21 are rotated relative to the sleeve 20, because the sleeve 20 is, as was said before, stationary with respect to the other parts of the base member 1. However, an inverse positioning could be provided, too.

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**Claims:**

1. Apparatus for applying a liquid material to a surrounding surface, preferably a surface defining a cavity or a bore, comprising
- 5 a base member (1),  
an elongated support member (2) extending axially from one end of the base member (1),  
a rotor head (3) attached to the other end of the support member (2),  
at least one liquid delivery conduit (4) positioned with its delivery outlet (5)
- 10 close to and oriented towards the rotor head (3),  
wherein the rotor head (3) is adapted to rotate at a high operating speed relative to the support member (2), or together with the support member (2) relative to the base member (1), and to throw a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) generally radially outwardly towards a
- 15 surrounding surface,  
wherein the rotor head (3) is adapted to be driven by a drive means (11) and its operation and speed to be controlled by a drive control (12),  
**characterized in that**  
the drive control (12) is adapted to control the rotational speed of the rotor head
- 20 (3) not only to the high operating speed for throwing the liquid towards the surrounding surface, but also to a low testing speed, and  
the drive control (12) is further adapted to monitor the rotation of the rotor head (3) at the low testing speed and to generate a malfunction signal if the rotation of the rotor head (3) is unduly retarded.
- 25
2. Apparatus according to claim 1, characterized in that  
the malfunction signal is a signal stopping the rotation of the rotor head (3) and/or a signal generating an alarm signal.
- 30
3. Apparatus for applying a liquid material to a surrounding surface, preferably a surface defining a cavity or a bore, comprising  
a base member (1),  
an elongated support member (2) extending axially from one end of the base member (1),
- 35 a rotor head (3) attached to the other end of the support member (2),

at least one liquid delivery conduit (4) positioned with its delivery outlet (5) close to and oriented towards the rotor head (3),

wherein the rotor head (3) is adapted to rotate at a high operating speed relative to the support member (2), or together with the support member (2) relative to the base member (1), and to throw a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) generally radially outwardly towards a surrounding surface,

wherein the rotor head (3) is adapted to be driven by a drive means (11) and its operation and speed to be controlled by a drive control (12),

optionally according to any one of the preceding claims,

**characterized in that**

the drive control (12) is adapted to control the rotational speed of the rotor head (3) not only to the high operating speed for throwing the liquid towards the surrounding surface, but also to a low testing speed,

the testing speed of the rotor head (3) is so low that no liquid material on the rotor head (3) is thrown off from the rotor head,

the testing speed of the rotor head (3) is sufficiently high so that no residual liquid material on the rotor head (3) is dropping down from the rotor head (3) provided that no liquid material is sprayed from the delivery outlet (5) onto the rotor head (3) any more.

4. Apparatus according to any one of the preceding claims, characterized in that

the operating speed is between 2000 rpm and 12000 rpm, preferably between about 4000 rpm and about 9000 rpm.

5. Apparatus according to any one of the preceding claims, characterized in that

the testing speed is between about 50 rpm and about 250 rpm, preferably around 100 rpm.

6. Apparatus according to any one of the preceding claims, characterized in that

the drive control (12) is provided with a setting element (14) for setting the operating speed to different values.

7. Apparatus according to claim 6, characterized in that the operating speed is settable at 500 rpm-increments.

5 8. Apparatus according to claim 6 or claim 7, characterized in that the setting element (14) is a mechanical setting ring rotatable relative to the base member (1).

9. Apparatus according to any one of the claims 6 to 8, characterized in that  
10 the setting element (14) is provided with an index catch (16) for each settable value of the operating speed.

10. Apparatus according to any one of the preceding claims, characterized in that  
15 the drive means (11) comprises a pneumatic drive motor and optionally a reducing gear means.

11. Apparatus according to any one of the claims 1 to 9, characterized in that  
20 the drive means (11) comprises an electric drive motor, preferably a DC-motor, and optionally a reducing gear means.

12. Apparatus according to any one of the preceding claims, characterized in that  
the drive control (12) is adapted to control the drive means (11) to a specific  
25 rotational speed by pulse-width-modulation of the power supply of an electric motor, preferably a DC-motor,  
wherein, preferably, measuring and monitoring of the actual rotational speed is performed by measuring the electromotive force of the electric motor during p.w.m.-pause times.

30 13. Apparatus according to any one of the preceding claims, characterized in that  
the rotor head (3) is fixedly attached to the elongated support member (2) and the elongated support member (2) runs on bearings (17) in the base member (1) and  
35 is driven by the drive means (11).

14. Apparatus according to any one of the preceding claims, characterized in that

the base member (1) comprises an elongated housing which houses the drive means (11) and the drive control (12).

5

15. Apparatus according to any one of the claims 1 to 13, characterized in that the base member (1) comprises a first housing (18) which houses only the bearings (17) for the support member (2), and a second housing (19) which houses the drive means (11) and the drive control (12),

10 wherein the second housing (19) can be coupled to and decoupled from the first housing (18) simultaneously coupling or decoupling the drive means to or from the support member (2).

16. Apparatus according to any one of the preceding claims, characterized in that

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the liquid delivery conduit (4) is fixedly attached to the base member (1) and extends therefrom in parallel to the support member (2).

17. Apparatus for applying a liquid material to a surrounding surface, preferably a surface defining a cavity or a bore, comprising

20

a base member (1),

an elongated support member (2) extending axially from one end of the base member (1),

a rotor head (3) attached to the other end of the support member (2),

25

at least one liquid delivery conduit (4) positioned with its delivery outlet (5) close to and oriented towards the rotor head (3),

wherein the rotor head (3) is adapted to rotate at a high operating speed relative to the support member (1), or together with the support member (1) relative to the base member (1), and to throw a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) generally radially outwardly towards a surrounding surface,

30

wherein the rotor head (3) is adapted to be driven by a drive means (11) and its operation and speed to be controlled by a drive control (12),

optionally according to any one of the preceding claims,

35

**characterized in that**

the drive control (12) is positioned within a housing of the base member (1),  
the housing (19) is provided with a mechanical setting ring (14) rotatable relative  
to the rest of the housing (19) for setting the operating speed of the rotor head (3)  
5 to different values,  
the housing (19) is further provided with a sleeve (20), the inner surface of the  
sleeve (20) being provided with optically reflecting and non-reflecting areas,  
the drive control (12) is provided with optoelectronic switches (21) positioned  
inside within the sleeve (20) in a way that by rotating the sleeve (20) and the  
10 switches (21) relative to each other the switches (21) are selectively activated  
and deactivated to read the setting of the operating speed.

18. Apparatus according to claim 17, characterized in that  
the drive control (12) comprises a printed circuit board (23) or the like and the  
15 optoelectronic switches (21) are positioned on the board.

19. Apparatus according to claim 17 or 18, characterized in that  
the setting ring (14) is connected to the switches (21) so that the switches (21)  
are rotated relative to the sleeve (20).  
20

20. Apparatus according to claim 17 or 18, characterized in that  
the setting ring (14) is connected to the sleeve (20) so that the sleeve (20) is  
rotated relative to the switches (21)

21. Method for operating an apparatus for applying a liquid material to a  
surrounding surface,  
the apparatus comprising  
a base member (1),  
an elongated support member (2) extending axially from one end of the base  
30 member (1),  
at least one liquid delivery conduit (4) positioned with its delivery outlet (5)  
close to and oriented towards the rotor head (3),  
a drive means (11) for driving the rotor head (3) to rotate at a high operating  
speed relative to the support member (2) or together with the support member (2)  
35 relative to the base member (1), and

a drive control (12) for controlling the operation of the apparatus and speed of the rotor head (3),

wherein at the high operating speed a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) is thrown generally radially outward towards a surrounding surface,

**characterized in that**

the rotational speed of the rotor head (3) in a first mode of operation is controlled to the high operating speed for throwing the liquid towards the surrounding surface and in a second mode of operation is controlled to a low testing speed and

the rotation of the rotor head (3) at the low testing speed is monitored by the drive control (12) and a malfunction signal is generated by the drive control (12) if the rotation of the rotor head (3) at the low testing speed is unduly retarded.

22. Method according to claim 21, characterized in that the malfunction signal is generated as a signal stopping the rotation of the rotor head (3) and/or as a signal generating an alarm signal.

23. Method for operating an apparatus for applying a liquid material to a surrounding surface,

the apparatus comprising

a base member (1),

an elongated support member (2) extending axially from one end of the base member (1),

at least one liquid delivery conduit (4) positioned with its delivery outlet (5) close to and oriented towards the rotor head (3),

a drive means (11) for driving the rotor head (3) to rotate at a high operating speed relative to the support member (2) or together with the support member (2) relative to the base member (1), and

a drive control (12) for controlling the operation of the apparatus and speed of the rotor head (3),

wherein at the high operating speed a liquid material sprayed from the delivery outlet (5) onto the rotor head (3) is thrown generally radially outward towards a surrounding surface,

optionally according to claim 21 or 22,

**characterized in that**

the rotational speed of the rotor head (3) in a first mode of operation is controlled to the high operating speed for throwing the liquid towards the surrounding surface and in a second mode of operation is controlled to a low testing speed,  
5 the testing speed of the rotor head (3) is so low that no liquid material on the rotor head (3) is thrown off from the rotor head,  
the testing speed of the rotor head (3) is sufficiently high so that no residual liquid material on the rotor head (3) is dropping down from the rotor head (3) provided that no liquid material is sprayed from the delivery outlet (5) onto the  
10 rotor head (3) any more.

24. Method according to any one of the claims 21 to 23, characterized in that in the first mode the speed of the rotor head (3) is controlled to lie between 2000 rpm and 12000 rpm, preferably between about 4000 rpm and about 9000 rpm.

15

25. Method according to any one of the claims 21 to 24, characterized in that in the second mode of operation the speed of the rotor head (3) is controlled to lie between about 50 rpm and about 250 rpm, preferably around 100 rpm.

20 26. Method according to any one of the claims 21 to 25, characterized in that the drive control (12) is adapted to control the drive means (11) to a specific rotational speed by pulse-width-modulation of the power supply of an electric motor, preferably a DC-motor,  
wherein, preferably, measuring and monitoring of the actual rotational speed is  
25 performed by measuring the electromotive force of the electric motor during p.w.m.-pause times.

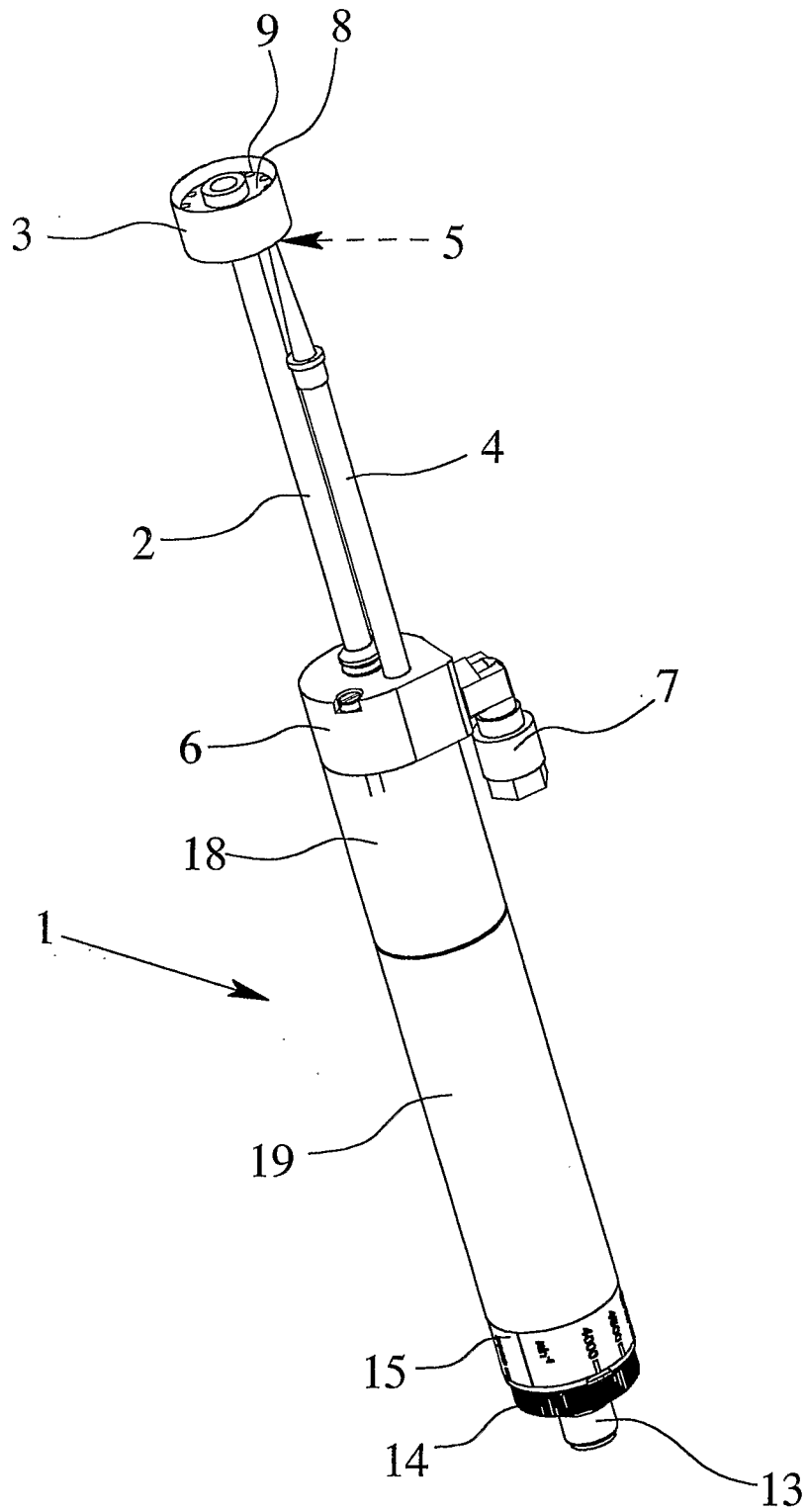


Fig. 1

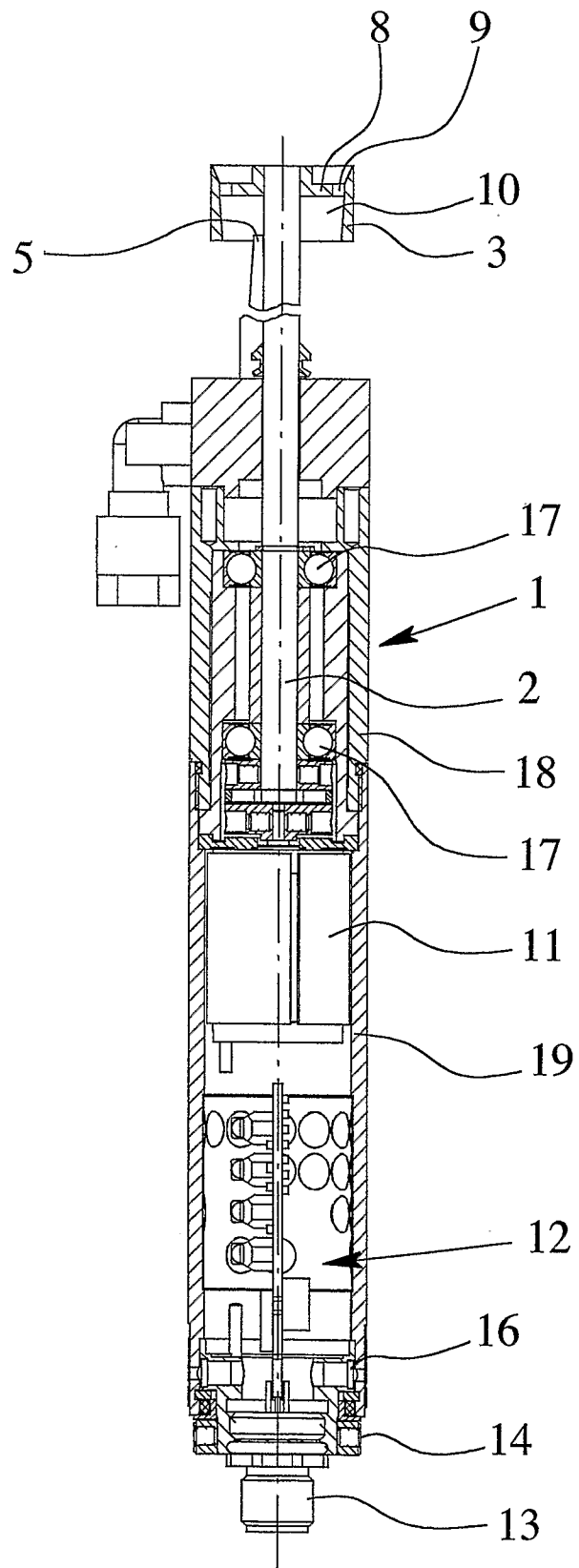


Fig. 2

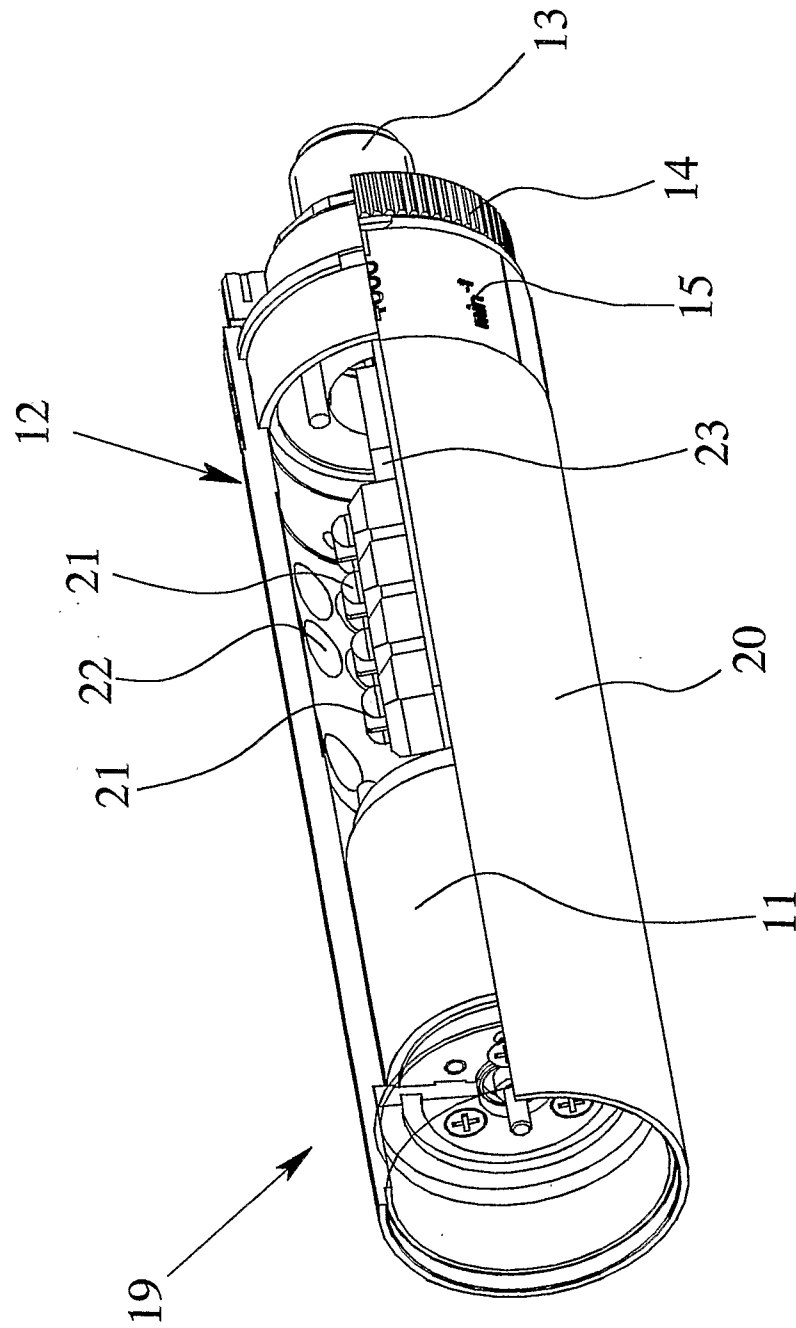


Fig. 3

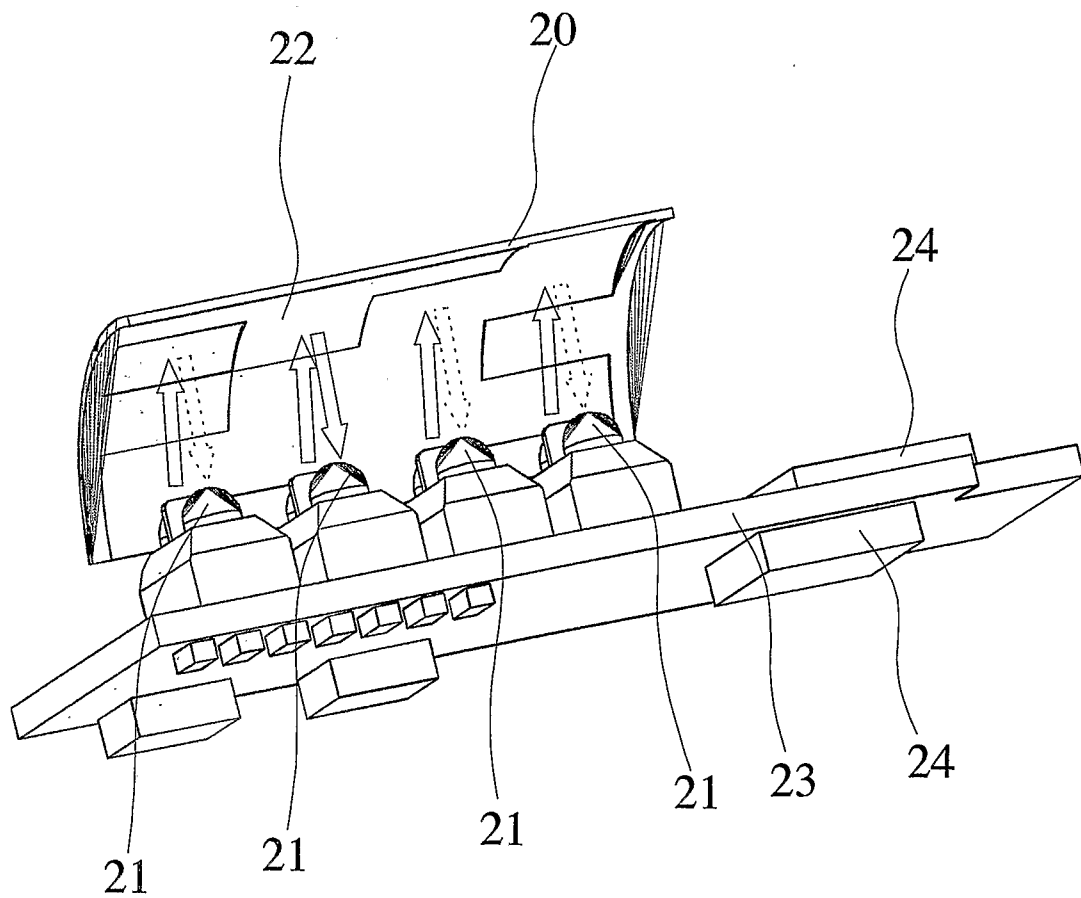


Fig. 4

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP2005/007488

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B05B13/06

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 7 B05B

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

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

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages                                                 | Relevant to claim No. |
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| A          | DE 43 31 394 A1 (DREI BOND GMBH, 85386<br>ECHING, DE) 16 March 1995 (1995-03-16)<br>cited in the application<br>the whole document | 1, 3, 17,<br>21, 23   |
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| -/--       |                                                                                                                                    |                       |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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

"&" document member of the same patent family

Date of the actual completion of the international search

12 October 2005

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP2005/007488

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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International Application No

PCT/EP2005/007488

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
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