Title: AN APPARATUS FOR TREATING THE OUTER SURFACE OF A CYLINDRICAL ELEMENT

Abstract: An apparatus for treating the outer surface (3) of a cylindrical element (5), having a frame being movably and releasably connected to the cylindrical element and supporting a grinder (112). The apparatus comprising handles (111) and grinder control means (18a,b, 118a,b) arranged on a detachable support element (136). Roller bearings (21) of a material which is similar to the material of the outer surface.

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An apparatus for treating the outer surface of a cylindrical element

Field of the invention

The invention relates to devices for treating the outer surface of tubular elements.

More specifically, the invention concerns a grinding apparatus for a cylinder rod, or similar, as specified in the preamble to claim 1, and an associated method as specified in the preamble of claim 16.

Background of the invention

In the offshore petroleum industry it is well known to use tensioner systems on floating drilling rigs and other vessels, in order to maintain a pre-selected vertical tension in a marine riser extending from the rig and down to a subsea wellhead. When the vessel is heaving and rolling due to waves, currents and winds, the tensioner system will try to keep constant tension in the riser.

One type of tensioner system which is known in the art, is termed a "direct acting tensioner" (DAT) system. In a typical arrangement on a drilling vessel, a DAT system basically comprises a number of hydraulic-pneumatic cylinders suspended in a generally vertical orientation underneath the drill floor or via a designed frame in a circle-symmetrical configuration above the lower deck. The cylinder rods are connected to a so-called tensioner ring, which in turn may be connected to the riser or telescopic joint.

When a DAT system is in use, the cylinder rods are extended and retracted, and thus being exposed to the ambient air. This air may be saline, contain abrasive particles and/or have a high moisture level. Under certain operational conditions, the cylinder rods may become partly contaminated and areas of plaque may form on the cylinder rod surface. As a smooth surface is essential for the operation of the tensioner cylinders, such soiled spots are unacceptable, and must be removed. A commonly known method of removing plaque on cylinder rods, is to dismantle the cylinder and take it into a workshop for grinding away the damaged areas on the rod. In the case of a floating drilling rig, the removal of a tensioner cylinder, may involve shipment to a distant, land-based, facility.

As the tensioner cylinders are large and heavy, this implies considerable complications, cost and loss of time.

The present applicant has devised and embodied this invention to overcome the shortcomings of the prior art and to obtain further advantages.

Summary of the invention

The invention is set forth and characterized in the main claim, while the dependent claims describe other characteristics of the invention.
It is thus provided an apparatus for treating the outer surface of a cylindrical element, characterized by a frame being movably and releasably connected to the cylindrical element and supporting a treatment device, the apparatus further comprising frame movement control means and treatment device control means.

In one embodiment, the frame extends an axial distance along the cylindrical element and is enveloping the cylindrical element circumference in the region of said distance.

In one embodiment, the apparatus comprises frame supporting means, arranged for movable contact with the outer surface of the cylindrical elements, and configured such that the frame is maintained at a predetermined and controlled distance from the outer surface.

In one embodiment, the treatment device is supported by a movable element which is configured for moving the treatment device between a non-engaging position with respect to the outer surface, and an operating position in which the treatment device is operable to treat the outer surface.

In one embodiment, the frame comprises a first half and a second half which are connected via a hinge device at one of their respective sides and at the opposite sides comprise fastening means for securing the frame halves around the cylindrical element.

In one embodiment, the treatment device comprises a grinder having a motor and grinding disk configured and arranged for grinding and/or polishing selected regions of the cylindrical element.

The frame supporting means are preferably comprise roller bearings that are arranged at regular angular intervals around the outer surface perimeter.

The roller bearings are advantageously of a material which is similar to the material of the outer surface.

In one embodiment, the grinding face is arranged parallel with a tangent of the outer surface. In another embodiment, the grinding face is arranged non-parallel with the outer surface, i.e. at a first angle different from 0° with a tangent of the outer surface, and/or at a second angle different from 0° with respect to a plane which is parallel with a longitudinal axis of the cylindrical element.

In a preferred embodiment, the frame movement control means comprise handle bars, whereby the apparatus is supported and movable by a human operator in both axial and circumferential directions on the cylindrical element. The treatment device control means comprises a speed control means and control means for
moving the treatment device between the non-engaging position and the operating position.

In one embodiment, the treatment device, the frame movement control means and the treatment device control means are arranged on a support element which is releasably connectable to the frame.

In one embodiment, the frame comprises an attachment lug for attachment to suspension means. The frame preferably comprises a housing made of an engineering thermoplastic material, such as polyoxymethylene (POM).

It is also provided a method of treating an outer surface of a cylindrical element by means of the apparatus according to the invention, characterized by:

a) attaching the frame around a portion of the cylindrical element, and

b) manually supporting and moving the frame with respect to the cylindrical element while selectively activating the treatment device and moving it into contact with an area on the outer surface.

In one embodiment, a support element which comprises a treatment device, frame movement control means and treatment device control means, is connected to the frame before step b but after step a.

The invented apparatus and method is particularly suited for removing impurities and/or plaque from selected areas on the surface of a rod of a hydraulic cylinder which is oriented substantially upright.

With the invention, DAT cylinder rods may be cleaned and treated in situ, i.e. while the DAT cylinder is suspended on the platform, in its operative configuration. With the invention, there is no need to dismantle the DAT cylinder and shipping it onshore for cylinder rod refurbishment. Consequently, the invention makes it possible to save time and costs, compared to the methods and means of the prior art.

**Brief description of the drawings**

These and other characteristics of the invention will be clear from the following description of a preferential form of embodiment, given as a non-restrictive example, with reference to the attached drawings wherein:

- Figure 1 is a perspective drawing of a DAT system on a floating drilling rig;

- Figures 2 and 3 are perspective drawings of a first embodiment of the apparatus according to the invention, in use on a cylinder rod;

- Figure 4 is a side view and partial cut-away drawing of the first embodiment of the apparatus according to the invention, mounted on a cylindrical element;
Figure 5 is a view of the apparatus illustrated in figure 4, as seen from an end, i.e. in the axial direction of the cylindrical element;

Figure 6 is similar to figure 5, but illustrates an alternative arrangement of the grinder unit;

Figures 7 and 8 are perspective drawings of a second embodiment of the apparatus according to the invention, mounted on a cylinder rod;

Figure 9 is a sectional drawing along section line A-A in figure 8;

Figure 10 is a sectional drawing along section line B-B in figure 8;

Figure 11 is a side view as seen into the plane C-C in figure 8;

Figure 12 is a perspective view of the housing of the second embodiment of the apparatus according to the invention, in an open state;

Figure 13 is an exploded perspective view of the detachable support element; and

Figure 14 is an exploded perspective view of the support element, connection plate and the tubular housing of the second embodiment of the apparatus according to the invention.

**Detailed description of preferential embodiments**

Figure 1 illustrates a DAT system 1, comprising a number of hydraulic-pneumatic cylinders 2 suspended in a circle-symmetrical configuration. Cylinder rods 5 are connected to a tensioner ring 6, which in turn is connected to a riser 8. In figure 1, the cylinder rods are shown in a partly extended state.

**Description of a first embodiment (cf. figures 2 - 6)**

Figures 2 and 3 show a cylinder rod 5 in an extended state, in which cleaning, grinding, polishing, and/or other refurbishment of the cylinder rod surface 3 may be performed. A surface treating apparatus 10, hereinafter also referred to as a rod grinder, is arranged around the rod 5 and is being held and operated by a human operator 4 standing in a working basket 7. A grinder unit 12 is mounted on top of the rod grinder. The operator may thus move the apparatus 10 up and down, and around the rod, treating the regions of the rod surface 3 which require grinding and/or cleaning.

Turning now to figures 4 and 5, the rod grinder 10 comprises a tubular housing made up of two halves 19a, 19b which are interconnected by a hinge 20 and hinge bolts 24. On the opposite side, locking bolts 23 secure the housing around the rod 5. The housing material is preferably a light-weight, high precision material, with high
stiffness, low friction and a high degree of dimensional stability, preferably an engineering thermoplastic such as polyoxymethylene (commonly referred to as POM and also known as acetal, polyacetal or polyformaldehyde).

Roller bearings 21 are arranged in receptacles 22 in the housing halves, at regular intervals around the rod periphery when the rod grinder is mounted around the rod. A configuration having two sets of bearings 21, one in each end of the housing, is preferred in order to ensure a constant distance and between the housing and the rod surface. The roller bearings should be of a material similar to that of the rod surface.

The hinge 20 may, if necessary, be furnished with a supplementary locking bolt (not shown) to be activated when the housing halves have been arranged around the rod 5, in order to remove any play in the hinge connection.

The grinder unit 12 comprises a motor 14 and a grinding disk 16, connected to the motor via a chuck 15, in a manner which is well known in the art. The grinding face 16a, having a roughness which is appropriate for the applicable operation, is parallel with the tangent t of the cylinder rod. The grinder unit 12 is connected to a bracket 17 on the housing via a slidable element 26, whereby the grinding face 16a may be moved into contact with the rod surface 3, and thus grind the surface. The sliding movement, between an operating (grinding) position and a non-operating position, is illustrated by the double arrow in figures 4 and 5.

In order to ensure a controlled and accurate movement of the grinding face in relation to the rod surface, the slidable element 26 is furnished with a micrometer screw or similar device (indicated schematically with reference number 27), whereby minute and precise adjustments may be made.

Two handles 11 are provided on the housing, and one or both handles comprise a motor control button 18a (to control grinding disk rotational speed) and a button 18b with which the aforementioned sliding movement of the grinder unit may be controlled. The required control units are not shown, as these are considered to be known in the art.

Figure 6 illustrates an embodiment where the grinder unit is arranged at a small angle with respect to the rod surface tangent. Thus, the grinding face 16a exhibits a shallow angle a with respect to the tangent t, whereby the grinding face contact area on the rod surface may be better controlled.

Description of a second embodiment (cf. figures 7 - 14)

A second embodiment of the surface treating apparatus, or rod grinder, 110 is shown in figures 7 - 11 arranged around the rod 5. A clamp 133 having an articulated arm 139 is attached to the rod, and provides a support for the rod grinder
via a lifting lug 134, a wire loop 138 and a cable 137, interconnected by a balance block 132. The balance block is preferably adjusted to compensate for the weight of the rod grinder, relieving the human operator of the having to carry this weight. The balance block may also be attached to another structure, e.g. the DAT cylinder body.

A grinder unit 112 is mounted on a support element 136, which is releasably connected to the housing 119a,b, more specifically the first housing half 119a, via connection plates 130, 141. Figure 14 illustrates how the support element 136 is connectable to the housing 119a,b via a first connection plate 141 which is connected to the support element and a second connection plate 130 which is connected to the housing (via screws 142). Stud bolts 140 and guide pins 135 ensures rapid connection/disconnection and accurate positioning.

The support element 136 also carries the handles 111, such that an operator may move the grinder 110 up and down, and around the rod, treating the regions of the rod surface 3 which require grinding and/or cleaning.

This second embodiment of the rod grinder 110 also comprises a tubular housing made up of two halves 119a, 119b which are interconnected by hinges 120. On the opposite side, a lock 123 comprising an eccentric lock hook 123a and corresponding lug 123b serve to secure the housing around the rod 5. The housing material is preferably a light-weight, high precision material, with high stiffness, low friction and a high degree of dimensional stability, preferably an engineering thermoplastic such as polyoxymethylene (commonly referred to as POM and also known as acetal, polyacetal or polyformaldehyde).

Roller bearings 121a,b are arranged in receptacles in the housing halves at regular intervals around the housing periphery. A configuration having two sets of bearings 121a,b, one in each end of the housing (see figure 12), is preferred in order to ensure a constant distance and between the housing and the rod surface. A first pair of roller bearings 121a is spring loaded, in order to ensure provide good contact with the outer surface and accommodate for surface unevenness. The roller bearings should be of a material similar to that of the rod surface.

As with the first embodiment, the grinder unit 112 of the second embodiment comprises a motor 114 and a grinding disk 116, connected to the motor in a manner which is well known in the art. The grinding face 116a, having a roughness which is appropriate for the applicable operation, is in this second embodiment tilted at an angle β with respect to the rod axis z-z (see figure 11). Thus, the grinding face 16a exhibits a shallow angle β with respect to the outer surface 3, whereby the grinding face contact area on the rod surface may be better controlled. The grinder tilt is accomplished by a wedge-shaped mounting plate 131 between the grinder unit 112 and the slidable element 126 (see figure 11 and 13). Thus, the grinding face 116a
may be moved into and out of contact with the rod surface, and thus grind the surface at the desired spots.

In order to ensure a controlled and accurate movement of the grinding face in relation to the rod surface, the slidable element is furnished with a micrometer screw or similar device, whereby minute and precise adjustments may be made.

Two handles are provided on the first housing half, and the handles comprise a motor control button (to control grinding disk rotational speed) and a button with which the aforementioned sliding movement of the grinder unit may be controlled. The required control units are not shown, as these are considered to be known in the art.

The detachable support element, which carries the handles and the grinder unit and its motion control units, may be interchanged between various housings, using the standardized connection plates. Therefore, the same grinder unit may be used on housing having different diameters (i.e. for different size cylinder rods), and hence increasing the versatility of the rod cleaner.

In both of the embodiments described above, the rod cleaner may be powered by external sources, via a cables (not shown), or may have built-in power sources in the form of battery packs, etc. (not shown). For example, the grinder motor may be a pneumatic motor, connected to a distal pressurized air supply via an air hose (not shown). The rod cleaner may also advantageously be equipped with a light source for illuminating the surface to be cleaned.
Claims

1. An apparatus (10; 110) for treating the outer surface (3) of a cylindrical element (5), characterized by a frame (19a,b; 119a,b) being movably and releasably connected to the cylindrical element (5) and supporting a treatment device (12; 112), the apparatus further comprising frame movement control means (11; 111) and treatment device control means (18a,b; 118a,b).

2. The apparatus of claim 1, wherein the frame (19a,b; 119a,b) extends an axial distance along the cylindrical element and is enveloping the cylindrical element circumference in the region of said distance.

3. The apparatus of any one of the preceding claims, further comprising frame supporting means (21; 121a,b), arranged for movable contact with the outer surface (3) of the cylindrical element and configured such that the frame is maintained at a predetermined and controlled distance from the outer surface (3).

4. The apparatus of any one of the preceding claims, wherein the treatment device (12; 112) is supported by a movable element (26; 126) which is configured for moving the treatment device (12; 112) between a non-engaging position with respect to the outer surface, and an operating position in which the treatment device is operable to treat the outer surface.

5. The apparatus of any one of the preceding claims, wherein the frame comprises a first half (19a; 119a) and a second half (19b; 119b) which are connected via a hinge device (20; 120) at one of their respective sides and at the opposite sides comprise fastening means (23; 123, 123a,b) for securing the frame halves around the cylindrical element.

6. The apparatus of any one of the preceding claims, wherein the treatment device (12; 112) comprises a grinder having a motor (14; 114) and grinding disk (16; 116) configured and arranged for grinding and/or polishing selected regions of the cylindrical element.

7. The apparatus of any one of claims 3 - 6, wherein the frame supporting means (21; 121a,b) comprise roller bearings that are arranged at regular angular intervals around the outer surface perimeter.

8. The apparatus of claim 7, wherein the roller bearings are of a material which is similar to the material of the outer surface (3).

9. The apparatus of any one of claims 6 - 8, wherein the grinding face (16a; 116a) is arranged parallel with a tangent (t) of the outer surface.

10. The apparatus of any one of claims 6 - 8, wherein the grinding face (16a; 116b) is arranged non-parallel with the outer surface, i.e. at a first angle (a)
different from 0° with respect to a tangent (t) of the outer surface, and/or at a
second angle (β) different from 0° with respect to a plane which is parallel with a
longitudinal axis (z) of the cylindrical element.

11. The apparatus of any one of the preceding claims, wherein the frame
movement control means (11; 111) comprise handle bars, whereby the apparatus is
supported and movable by a human operator (4) in both axial and circumferential
directions on the cylindrical element.

12. The apparatus of any one of claims 4 - 12, wherein the treatment device
control means (18a,b; 118a,b) comprises a speed control means (18a; 118a) and
control means (18b; 118b) for moving the treatment device (14; 114) between the
non-engaging position and the operating position.

13. The apparatus of any one of the preceding claims, wherein the treatment
device (112), the frame movement control means (111) and the treatment device
control means (118a,b) are arranged on a support element (136) which is releasably
connectable to the frame (119a,b).

14. The apparatus of any one of the preceding claims, wherein the frame
(119a,b) comprises an attachment lug (134) for attachment to suspension means
(132, 133, 137, 138).

15. The apparatus of any one of the preceding claims, wherein the frame (19a,b;
119a,b) comprises a housing made of an engineering thermoplastic material, such as
polyoxymethylene (POM).

16. A method of treating an outer surface (3) of a cylindrical element (5) by
means of the apparatus of any one of the preceding claims, characterized by:
a) attaching the frame (19a,b; 119a,b) around a portion of the cylindrical
element, and
b) manually supporting and moving the frame with respect to the cylindrical
element while selectively activating the treatment device (12; 112) and moving it
into contact with an area on the outer surface.

17. The method of claim 15, wherein a support element (136) which comprises a
treatment device (112), frame movement control means (111) and treatment device
control means (118a,b), is connected to the frame (119a,b) before step b but after
step a.

18. The use of the apparatus and method of any one of the preceding claims, in
removing impurities and/or plaque from selected areas on the surface (3) of a rod (5) of
a hydraulic cylinder (2) which is oriented substantially upright.
Fig. 1

Fig. 2

Fig. 3

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