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(11) **EP 4 050 161 A1**

(12) **EUROPEAN PATENT APPLICATION**

(54) **MATERIAL ADDITIVE MODULE AND A METHOD OF RENEWING MATERIAL IN WORN AREAS FOR GROUND MOVING PARTS**

(57)   A method of adding at least one wear protection region to a ground moving part comprising the steps of: providing a pre-use 3D image of the part; 3D scanning the geometry of the part after use to provide an after-use 3D image; comparing the after-use 3D image to the pre-use 3D image; calculating and identifying the positions and areas of one or more worn areas; selectively adding at least one wear protection region to or adjacent to the one or more worn areas on the part. Also, a module for selectively applying at least one wear protection region to a ground moving part for renewing wear resistance comprising: a 3D scanning device for producing an after-use 3D image and optionally also a pre-use 3D image; a computer system for comparing the pre-use 3D image and the after-use 3D image and processing the data to identify one or more worn areas; a wear protection additive
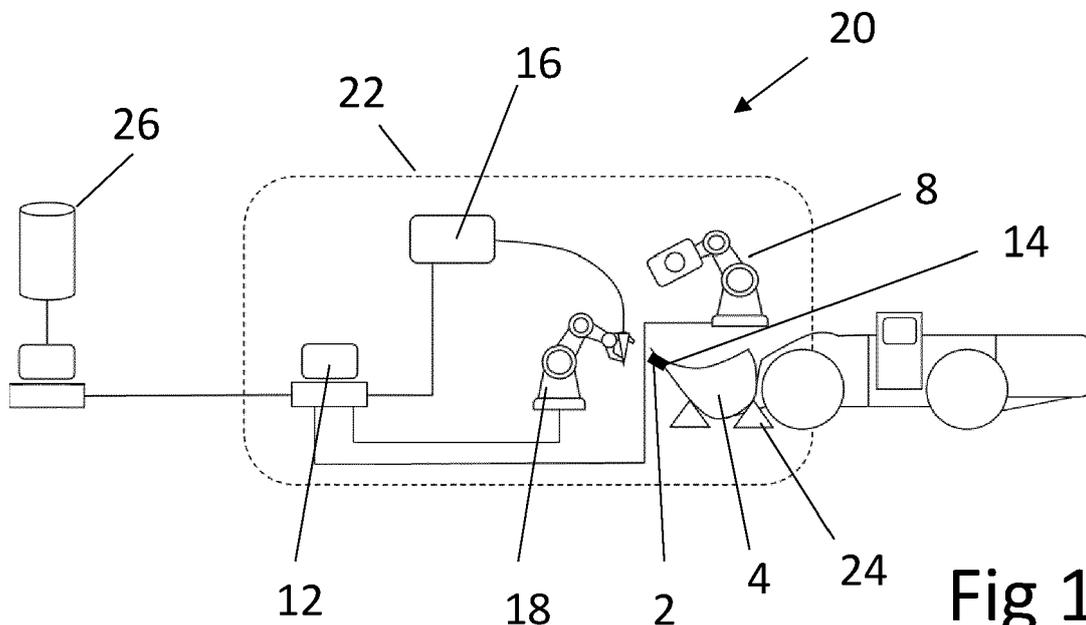
Fig 1

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Description

Field of invention

[0001] The present invention relates to a module and a method for the renewal of worn surfaces using a wear protection additive process, for example using laser cladding, although not exclusively, especially to a method of renewal of worn surfaces on ground moving parts, such as ground engaging tools, loader buckets or truck tubs.

Background art

[0002] Ground moving parts, such as buckets and ground engaging tools (GET), which are replaceable wear parts that are typically attached to the front lip or edge of the bucket, are subjected to high impact forces and operate in a highly abrasive environment and therefore wear out or become damaged during use. Therefore, these parts require regular replacement. However, replacing these parts is expensive, time consuming and usually required to be done in a workshop to ensure accuracy and quality of reconstruction. Downtime of equipment also adds to loss of productivity and increased operating costs to a business. Wear is particularly pronounced at a leading edge of the bucket, where ground engaging tools such as adaptors and teeth are used to penetrate matter being dug, wear is also found at bucket corners and heels.

[0003] One option to increase the wear resistance of the ground moving parts is to add a cladding of a harder material to areas that are most prone to wear, for example this could be done with a laser. Light weight buckets, which may be used for battery operated systems, are also especially prone to wearing fast due to the reduction in material, therefore the addition of a cladding layer on this type of bucket is particularly useful to increase the lifetime without adding excessive additional weight. This provides parts having both high interior toughness and a hard outer layer. However, cladding requires sending the parts to specialist facilities and so this is infrequently done and typically just applied once of the start of the lifetime of the part. If a hard-facing layer is applied over a large area the part will need to be pre-warmed beforehand in order to prevent cracking.

[0004] Therefore, the problem to be solved is how to increase the wear resistance and lifetime of the parts, in a way that is cost and time efficient and does not add unnecessary additional weight.

Summary of the Invention

[0005] It is an objective of the present invention to provide a method and module that can be used on site to continually renew the wear resistance of ground moving parts in a cost and time efficient way without adding unnecessary extra weight to the part.

[0006] The objectives are achieved by providing a method and module according to the claims of the present application.

[0007] According to a first aspect of the present invention there is provided a method of adding at least one wear protection region to a ground moving part comprising the steps of:

- providing a pre-use 3D image of the part;
- 3D scanning the geometry of the part after use to provide an after-use 3D image;
- comparing the after-use 3D image to the pre-use 3D image;
- calculating and identifying the positions and areas of one or more worn areas;
- selectively adding at least one wear protection region to or adjacent to the one or more worn areas on the part;

[0008] The pre-use 3D image may be provided from an original CAD drawing or equivalent or by scanning the part before use using a 3D scanner. The after-use 3D image is providing by 3D scanning the part after use using a 3D scanner. A computer system is used to compare the after-use 3D image to the pre-use 3D image. The computer system is also used to calculate and identify the positions of one or more worn areas. By selectively adding at least one wear protection region adjacent to the one or more worn areas on the part this means only localized regions have the wear protection added in only the volume required.

[0009] Advantageously, this provides a method to be able to continually renew wear protection on the ground moving part. It is especially beneficial to be able to apply the wear protection region(s) only where it is really needed and only in the volume required as this keeps costs down and the weight of the equipment down, for example this is important for battery operated equipment where a lightweight bucket is important to preserve energy.

[0010] Preferably, the part is a bucket or ground engaging tool (GET). Advantageously, GET parts and buckets, especially the side plates of the buckets are exposed to highly abrasive material and therefore suffer with high wear. Therefore, the ability to be able to provide a renewed cladding layer on a frequent basis will significantly increase the lifetime of the parts and overall reduce costs. If the lip of the bucket is clad, it may also remove the need to use GET parts altogether, which would provide even greater cost savings. This method could be used for any part that is made from steel or structural metal that are not dimensionally limited to a tight tolerance. For example, but not limited to, this method could be applied to protective side wings which are used to protect machine frame against tunnel side collision abrasive wear; for rubber repair or where there has been tyre damage.

[0011] In one embodiment, the wear protection region is in the form of an added material. Advantageously, material can be applied to in precise geometry, position and volume as required. The properties of the material cho-

sen can be selected to meet requirements.

[0012] In one embodiment, the added material used for the wear protection region is cemented carbide. Advantageously, cemented carbide provides a high hardness cladding with high wear resistance.

[0013] In one embodiment, the material applied is plastic or other elastomer material. Plastic or other elastomer materials are beneficially applied to areas such as the damper box on a ground moving tool in order to protect its rubber lining.

[0014] In one embodiment, the wear protection region is in the form of a weldable wear piece, such as a choky bar.

[0015] In one embodiment, the wear protection region is a heat-treated zone. The heat-treated zone will have enhanced wear resistance.

[0016] Preferably, there is additionally a cleaning step before applying the material. The cleaning step could be done to remove dirt from the part. This would typically be done in a separate module, for example using high pressure water before 3D scanning to get the after-use 3D image. Additionally, or alternatively, there could be a cleaning step before the material is applied to remove paint and rust, for example this could be done using the laser from the material application system.

[0017] In one embodiment, the wear information is collated and used to determine the combination of type(s) and position(s) of wear protection region(s) added to the part. Advantageously, this will enable improvements to be made ground moving part for example by adding an increased volume of material beyond the profile of the part from the pre-use image to form a more effective wear resistance layer at the locations on the part that are most exposed to wear in a way that is bespoke to the type of ground being moved and the type of operation being performed. This could also be used to forecast future potential wears based in other similar situations and provide a preventive solution rather than a passive solution.

[0018] A second aspect of the present invention is a module for selectively applying at least one wear protection region to a ground moving part for renewing wear resistance comprising:

- a 3D scanning device for producing an after-use 3D image and optionally also a pre-use 3D image;
- a computer system for comparing the pre-use 3D image and the after-use 3D image and processing the data to identify one or more worn areas;
- a wear protection additive system for selectively applying at least one wear protection region to or adjacent to only the one or more worn areas in the required volume.

[0019] The computer system will also inform the operator about where the wear has occurred and what cladding has been added. This data, which shows the wear areas during the life of the equipment, can help the design centre to optimize the design going forward.

[0020] Optionally, the module may additionally comprise a support system for holding the ground moving part in position and aligning the part with the 3D scanning device and / or material application system. The support system may be static or moveable.

[0021] Preferably, the module further comprises an automated movement system for positioning the material application system at the one or more worn areas. Advantageously, this improves the speed and accuracy of the material application. The automated movement system could, for example, be a robotic arm or gantry or any other suitable system. A further advantage of the automated movement system is that material can be added to alternately between different small areas in short bursts so that heating up and cracking of the part is avoided.

[0022] Alternatively, the material application system is moved manually to and between the one or more worn areas on the part that have been identified by the computer system. Advantageously, this is a cheaper alternative which in some cases may be more reliable. Alternatively, the material application system may be semi-automatic or adjustable between automatic and manual.

[0023] Preferably, the 3D scanning device used to produce the after-use 3D image and optionally also the pre-use 3D image is a 3D scanner, machine vision, LIDAR or structured light. Advantageously, these methods are able to provide automated inspection with high precision in a time efficient manner. The 3D scanning of the geometry could be done automatically or manually.

[0024] In one embodiment, the material application system is a laser. Advantageously, using a laser means that the base material of the tool is not heated and therefore its properties are not affected. Further, using a laser means that pre-warming of the part is not necessary. Typically, a fiber laser is used, but any other suitable laser could be used, such as C02, YAG or Diode.

[0025] In one embodiment, the wear protection additive system is a heating device and optionally also a water quenching device. This system can be used to form heat treated zones. Preferably, the module further comprises a transportable container for housing the 3D scanning device, the computer system, the wear protection additive system, optionally also the automated movement system. For example, this could be sea marine container. Advantageously, this enables the module to be easily transported by ship or road to the desired location so that the operation can be performed on site, which makes the process more cost efficient and time efficient.

[0026] In one embodiment, the computer system is connected to a database for collating wear information and calculating the combination of type(s) and position(s) of wear protection region(s) to be added to the part. For example, the optimal combination and position of wear protection region(s) added can be calculated taking into account the balance of cost, weight and wear protection required. Artificial intelligent could be used to aid this process. Advantageously, this will enable improvements

to be made to the ground moving part for example by adding an increased volume of material beyond the profile of the part from the pre-use image to form a more effective wear resistance layer at the locations on the part that are most exposed to wear in a way that is bespoke to the type of ground being moved and the type of operation being performed. This could also be used to forecast future potential wears based in other similar situations and provide a preventive solution rather than passive solution.

Brief description of drawings

[0027]   A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a schematic drawing of the module.

Figure 2 is a flow diagram of the method.

Detailed description of preferred embodiment of the invention

[0028]   Figure 1 shows a ground moving part 4, in this case a bucket on a loader, but it could be any other ground moving part, for example a ground engaging tool (GET), which has been positioned in a module 20. The module 20 is designed to enable the selective application of a wear protective region 2 to a ground moving part 4 for renewing its wear resistance. The part 4 would typically be driven into the module 20, however it could be positioned in place by any other suitable means. The part 4 is supported in the correct position using a support system 24. The support system 24 may be static or adjustable in position. The module 20 comprises a 3D scanning device 8 for scanning the part in order to produce a 3D model of the part 4. The 3D scanning device 8 could be 3D scanner, machine vision, LIDAR or structured light or any other device suitable for scanning the 3D geometry of the part 4. The 3D scanning device 8 is connected to a computer system 12 which is capable of processing the data from the 3D scanning device 8. Optionally, the computer system 12 may also be connected to a database 26 for storing data which can be used to learn more about how the part 4 is wearing. This data may then be useful for development of the design of the parts and / or for identifying areas where additional wear protection is required. The computer system 12 is also connected to a wear protection additive system 16 which is capable of adding material, weldable wear part or heated-treated zone to selective areas on the part 4. Typically, the wear protection additive system 16 is a laser, most commonly a fibre laser. Other types of lasers could also be used, such as CO_2, YAG or Diode. Alternatively, the wear protection additive system 16 could be plasma or gas flame cladding, MIG, MAG or rod welding or any other suitable system. Alternatively, the wear protection additive sys-

tem 16 could be a heating device and optionally also a water quenching device which would be used to provide a heat-treated zone. The positioning of the wear protection additive system 16 relative to the different areas on the surface of the part 4 may either be controlled manually or using an automated movement system 18, such as a robotic arm or a gantry. Preferably, the support system 24, the 3D scanning device 8, the computer system 12, the wear protection additive system 16, including the automated movement system 18 if being used, are all contained inside a transportable container 22, for example a marine container. The database 26 may be external to the transportable container 22. The module 20 enables the identification of one or more worn areas 14 on the part 4, so that a wear protective region 2 can be selectively applied to the one or more worn areas 14, without the need to apply the wear protection over the whole of the part 4. In other words, the wear protection region 4 is able added only the identified one or more worn areas 14.

[0029]   Figure 2 shows a flow diagram for the steps involved in the method of adding a wear protective region 2 to the ground moving part 4 selectively to the one or more worn areas 14.

[0030]   In a first step 30, a pre-use 3D image 6 of the part 4 is provided or if this is not available, then the 3D scanning device 8 will scan the part 4 before it has been used and worn in order to produce the pre-use 3D image 6.

[0031]   In a second step 32, the part 4 is scanned after use, once worn, using the 3D scanning device 8 in order to produce an after-use 3D image 10 of the part 4.

[0032]   For both the first step 30 and the second step 32, the part 4 may be positioned in place by driving the part 4 to the module 20 and positioning the part 4 on the support system 24 so that is can be reached by both the 3D scanning device 8 and the wear protection additive system 16. The part could be positioned in place by any other suitable means and could be supported in the appropriate position by any other suitable means. For both the first step 30 and the second step 32 the 3D scanning device 8 may either be manually or automatically moveable.

[0033]   In a third step 34, the computer system 12 compares the after-use 3D image 10 to the pre-use image 6 and calculates and then identifies the position and areas of the one or more worn areas 14 on the part 4. Not only are the positions of the one or more worn areas 14 identified, but also the amount of material lost and the extent to which the part 4 has been worn are recorded. If the computer system 12 is connected to a database 26, then this information will also be stored and analysed.

[0034]   In a fourth step 36, the wear protection additive system 16 selectively applies the wear protective region 2 to only the one or more worn areas 14 and only in the volume proportion to the material lost calculated by the computer system 12 from comparison of the after use image 10 and the pre-use image 6.

[0035] The wear protection additive system 16 is preferably operated using an automated movement system 18, such as a robotic arm or a gantry. The automated movement system 18 will be capable of moving the wear protection additive system 16 to the one or more worn areas 14 as identified by the computer system 12 in the desired manner. For example, in order to avoid the build up of heat in localized region, which could cause cracking, the automated movement system 18 may move the wear protection additive system 16 to alternating regions, applying just a small volume of the wear protective region 2 required to a first worn area 14, then moving to a second worn area 14, then back to the first worn area 14 etc, until the required volume of wear protective region 2 has been added. Alternatively, the wear protection additive system 16 could be moved to the identified worn area(s) 14 manually.

[0036] The wear protection additive system 16 is typically, but not limited to, a laser. In laser cladding, the laser beam is defocused on the part 4 with a selected spot size. The powder coating material 4 is carried by an insert gas through a powder nozzle into the melt pool. The laser optics and power nozzle are moved across the surface of the part 4 to deposit single tracks, complete layers or even high-volume build ups. Typically, a fiber laser is used, but any other suitable laser could be used, such as CO_2, YAG or Diode. Laser cladding can be applied quickly, and it is also possible for other maintenance works, which don't require moving of machine, to be done at same time, for example checking of systems. Therefore, this is a highly efficient operation. Alternatively, the wear protection additive system 16 could be plasma or gas flame cladding, MIG, MAG or rod welding or any other suitable system. Alternatively, the wear protection additive system 16 could be a heating device and optionally also a water quenching device.

[0037] The wear protection region 4 added will typically be a material. Typically, the material will have a higher hardness than the base material used in the part 4, so that a hardfaced layer is formed. The preferable material added is tungsten carbide. Alternatively, the material could comprise stillites, cobalt based materials, carbide powders or any other high wear resistance material, selected for the specific application and working environment. The material applied can be selected to meet customer needs and budget. Different cladding materials could be used in different areas on the same part 4 to meet specific performance requirements. The wear protective region 2 chosen will be based on a balance between wear resistance characteristic requirements, such as hardness, and cost. Alternatively, the material applied could be plastic or other elastomer material. Plastic or other elastomer materials are beneficially applied to areas such as on the damper box on a ground moving tool 4 in order to protect its rubber lining. Alternatively, the wear protection region 4 could be a weldable wear part, such as a choky bar or a heat-treated zone. The weldable wear part may be positioned by using a gripper to pick up the weldable wear part and then a robotic arm may be used to locate the weldable wear part in the desired location, on or next to the one or more worn areas, then a welding arm may then be used to weld the weldable wear part in position.

[0038] Cleaning of the part 4 may also be required. A cleaning step may be done before applying the wear protection zone 2. The cleaning step could be done to remove dirt and from the part 4. This would typically be done in a separate module (not shown), for example using high pressure water, before 3D scanning to get the after-use 3D image 10. Additionally, or alternatively, there could be a cleaning step before the material 4 is applied to remove paint and rust, for example this could be done using the laser in the wear protection additive system 16.
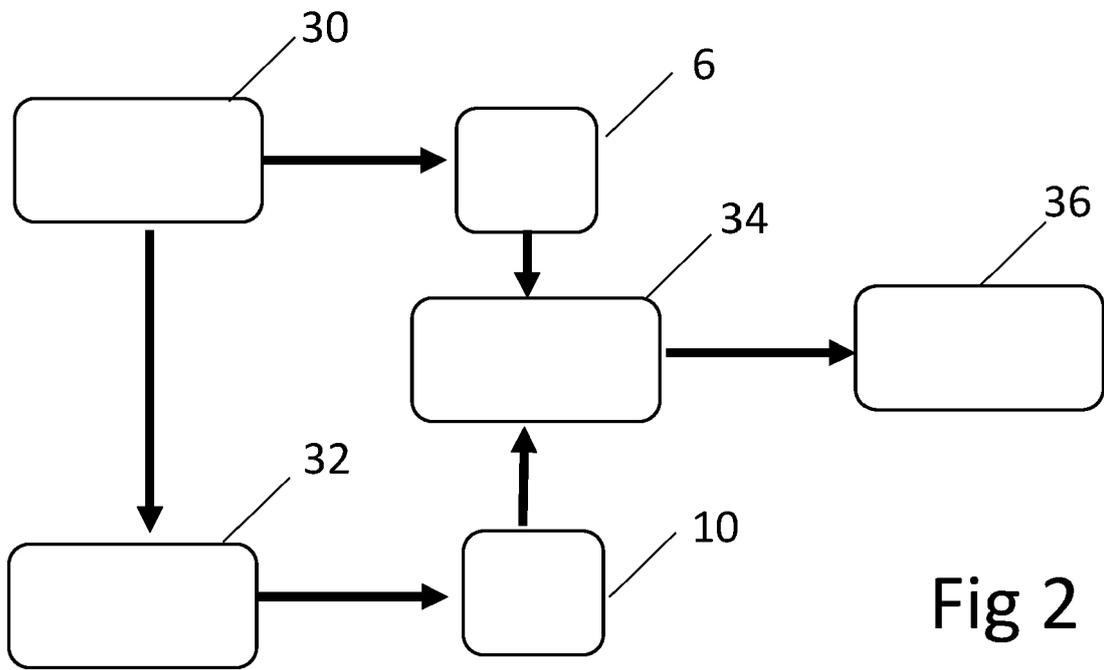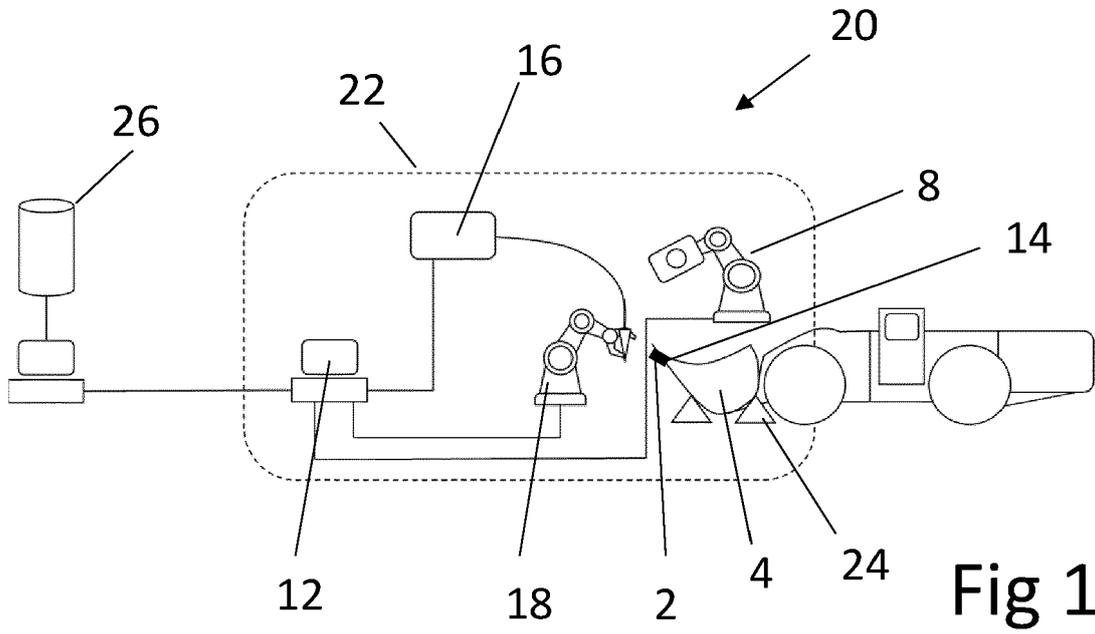
[0039] This process could be applied to parts 4 which are new and become worn or could be applied to parts 4 which were already word as long as a pre-use image 6 is available, for example from a CAD model drawing.

[0040] It is also possible for the computer system 12 to be connected to a database 26, which is able to collate all the wear information. This will enable the user to identify potential design improvements to the part 4 and / or to identify areas on the part 4 that would benefit from the addition of a higher volume of material 2, beyond the original profile of the part 4 before use, in order to provide increased wear protection in the areas that need it most. The computer system 12 and / or the database 26 may also have artificial intelligence capability. The database 26 could be located externally of the transportable container 22.

Claims

1. A method of adding at least one wear protection region (2) to a ground moving part (4) comprising the steps of:

    - providing a pre-use 3D image (6) of the part (4);
    - 3D scanning the geometry of the part (4) after use to provide an after-use 3D image (10);
    - comparing the after-use 3D image (10) to the pre-use 3D image (6);
    - calculating and identifying the positions and areas of one or more worn areas (14);
    - selectively adding at least one wear protection region (2) to or adjacent to the one or more worn areas (14) on the part (4);

2. The method according to claim 1, wherein the part (4) is a bucket or ground engaging tool (GET).

3. The method according to claim 1 or 2, wherein the wear protection region (2) is in the form of an added material.

4. The method according to any claim 3, wherein the added material used for the wear protection region (2) is cemented carbide.

5. The method according to claim 3, wherein the added material used for the wear protection region (2) is plastic or other elastomer material.

6. The method according to claim 1 or 2, wherein the wear protection region (2) is in the form of a weldable wear piece.

7. The method according to claim 1 or 2, wherein the wear protection region (2) is a heat-treated zone.

8. The method according to any of the previous claims, wherein there is additionally a cleaning step before applying the at least one wear protection region (2).

9. The method according to any of the previous claims wherein the wear information is collated and used to determine the combination of type(s) and position(s) of wear protection region(s) (2) added to the part (4).

10. A module (20) for selectively applying at least one wear protection region (2) to a ground moving part (4) for renewing wear resistance comprising:

- a 3D scanning device (8) for producing an after-use 3D image (10) and optionally also a pre-use 3D image (6);
- a computer system (12) for comparing the pre-use 3D image (6) and the after-use 3D image (10) and processing the data to identify one or more worn areas (14);
- a wear protection additive system (16) for selectively applying at least one wear protection region (2) to or adjacent to the one or more worn areas (14) in the required volume.

11. The module (20) according to claim 10, further comprising an automated movement system (18) for positioning the wear protection additive system (16) at the one or more worn areas (14).

12. The module (20) according to claim 10 or 11, wherein the 3D scanning device (8) used to produce the after-use 3D image (10) and optionally also the pre-use 3D image (6) is a 3D scanner, machine vision, LIDAR or structured light.

13. The module (20) according to any of claims 10-12, wherein the wear protection additive system (16) is a laser.

14. The module (20) according to any of claims 10-12, wherein the wear protection additive system (16) is a heating device.

15. The module (20) according to any of claims 10-14, further comprising a transportable container (22) for housing the 3D scanning device (8), the computer system (12) and the wear protection additive system (16).

16. The module (20) according to any of claims 10-15, wherein the computer system (12) is connected to a database (26) for collating wear information and calculating the combination of type(s) and position(s) of wear protection region(s) (2) to be added to the part (4).

26

22   16

20

8

14

12   18   2   4   24

Fig 1

30

6

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36

32

10

Fig 2

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EUROPEAN SEARCH REPORT

Application Number

EP 21 15 9682

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2020/237324 A1 (CQMS PTY LTD [AU]) 3 December 2020 (2020-12-03) * page 1, paragraph 4 * * page 18, paragraph 52 - page 20, paragraph 59 * * page 26, paragraph 75 * * page 31, paragraph 89 - page 32, paragraph 91 * * figures 1,4-6 *	1-3,6, 9-16 4,5,7,8	INV. E02F3/14 E02F9/28
Y	US 2013/035874 A1 (HALL DAVID R [US] ET AL) 7 February 2013 (2013-02-07) * page 2, paragraph 31 - paragraph 32 * * figure 3 *	4	
Y	US 9 856 629 B1 (CATERPILLAR INC [US]) 2 January 2018 (2018-01-02) * column 3, line 55 - line 65 * * column 7, line 64 - column 9, line 19 * * figure 11 *	5,7,8	
A	US 2017/356165 A1 (SERRURIER DOUG [US] ET AL) 14 December 2017 (2017-12-14) * page 6, paragraph 56 - paragraph 59 * * figure 10 *	1,10	TECHNICAL FIELDS SEARCHED (IPC) E02F A01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 September 2021	Gavriliu, Costin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 21 15 9682

02-09-2021

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 2020237324	A1	03-12-2020	NONE		
US 2013035874	A1	07-02-2013	US 2013035874	A1	07-02-2013
			US 2013035875	A1	07-02-2013
US 9856629	B1	02-01-2018	CA 3031342	A1	25-01-2018
			CL 2019000070	A1	14-06-2019
			CN 109477327	A	15-03-2019
			US 9856629	B1	02-01-2018
			WO 2018017207	A1	25-01-2018
			ZA 201900612	B	27-05-2020
US 2017356165	A1	14-12-2017	AU 2017277557	A1	17-01-2019
			BR 112018075552	A2	19-03-2019
			CA 3028269	A1	14-12-2017
			CL 2018003539	A1	22-03-2019
			CN 109312558	A	05-02-2019
			EP 3469151	A1	17-04-2019
			US 2017356165	A1	14-12-2017
			WO 2017213784	A1	14-12-2017
			ZA 201900062	B	27-05-2020

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82