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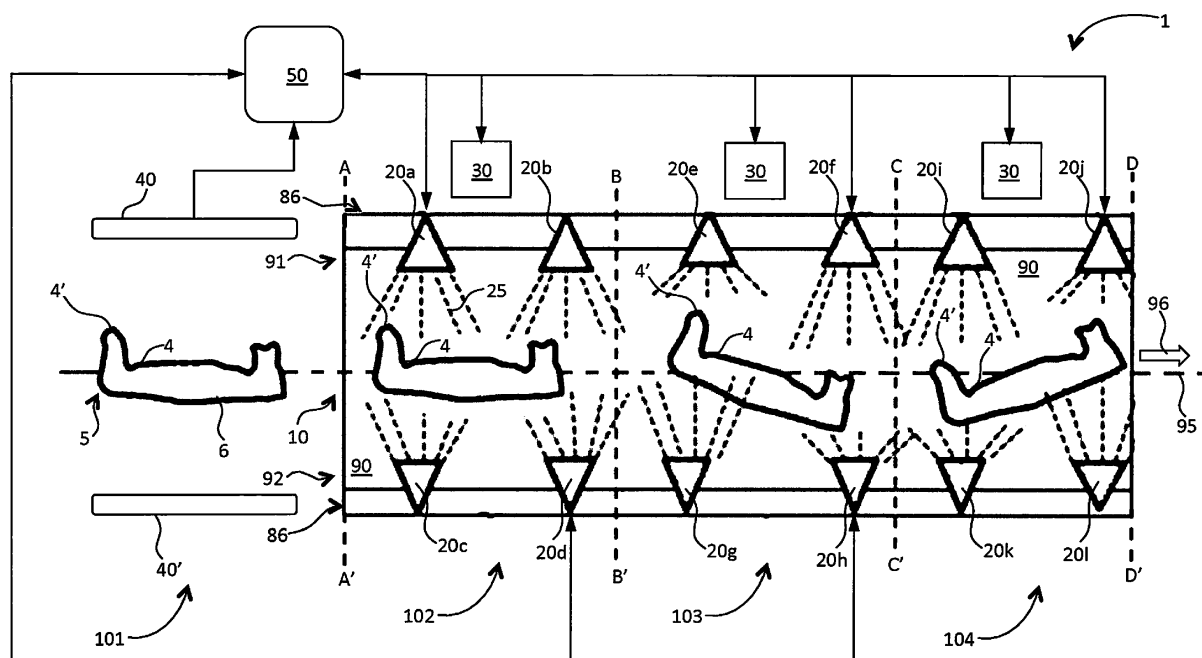
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(54) **SPRAY TREATMENT FOR CLEANING A SURFACE OF A 3D PART**

(57) The present invention refers to a spray treatment system (1) for cleaning a surface (6) of a 3D part (5). A conveyor mechanism (10) supports and moves the part (5) along a cleaning path (90) having a central axis (95). A plurality (22) of spray nozzles (20) positioned along sides (91,92) of the cleaning path spray a cleaning agent (3) in form of cleaning jets (25) towards the part (5). A 3D scanner (40,40') of the system (1) scans the part (5) to be cleaned and determines a shape and/or a size of

the part (5) and generates corresponding data that is received by a processor (50) which then consequently directs a part rotating mechanism (30) to orient the part (5) based on the shape and/or the size of the part (5) such that a surface portion (4,4') of the surface (6) of the part (5) is disposed at a predetermined distance from at least one spray nozzle (20) from the plurality (22) of spray nozzles (20).

FIG 5



Description

[0001] The present invention relates to a spray treatment system according to claim 1 of the present disclosure and to a spray treatment method according to claim 10 of the present disclosure.

Background of the Invention

[0002] In present times painting surfaces of articles, mostly made from metals and alloys, is an important manufacturing or post manufacturing fabrication step. For example successfully painting hot-dip galvanized steel, hereinafter also known as HDG steel, is important for increasing component life manufactured from HDG steel. Proper surface preparation, prior to the painting step, is crucial to ensure effective adhesion of the paint layer onto the HDG steel surface. The HDG steel surface is generally required to be free from dust, contaminants, grease etc before a successful layer of paint is applied.

[0003] HDG steel weathers naturally and byproducts develop on the surface throughout the weathering process and thus depending on time for which the HDG steel has been subjected to weathering, there are different elements present on the surface of HDG steel. There are generally three weathering states: newly galvanized, i.e. generally less than 48 hours after being galvanized, partially weathered, i.e. generally exposed to the atmosphere for more than 48 hours after being galvanized but usually for less than one year, or fully weathered, i.e. generally more than one year of being exposed to the atmosphere, have different cleaning and/or profiling requirements.

[0004] Newly galvanized HDG steel has none or few zinc compounds on the surface, thus cleaning may not be required generally. However, cleaning of the surface may still be required to free the surface of dirt, dust, oil or grease. For example grease may be present from rollers that may have been used in a manufacturing step to roll the HDG steel. Partially weathered galvanized surfaces of HDG steel have a build-up of zinc compounds and, possibly, organic contaminants such as dirt, dust, oil or grease. These compounds/contaminants become attached to the zinc coating by electrostatic forces or otherwise and may get released from the surface over time. The zinc compounds, mostly zinc oxide and zinc hydroxide, must be removed before painting. Partially weathered galvanized steel is the most common galvanized surface condition requiring painting, and also the most difficult to prepare and requiring thorough cleaning of the surface as part of surface preparation for subsequent painting. Fully weathered galvanized steel has zinc compounds covering the entire surface. The main compound in the fully weathered surface is zinc carbonate. Zinc carbonate is tightly adhered to the surface, is not water soluble, and does not wash off the surface when water hits the part. In fully weathered state, the zinc compounds need not be removed, as the paint performs better when

the compounds are left on the surface. Fully weathered galvanized coatings are the simplest surface condition to paint, as only mild cleaning may be necessary.

[0005] Therefore, cleaning is an integral step before most post processing steps, and especially before painting. Cleaning of simple shaped articles such as sheet or slab is easy to perform. Fig. 1 schematically presents a side view of a conventionally known spray treatment system 2 for cleaning a surface 6 of a part 5 i.e. a surface 6 of an article formed of HDG steel. The conventionally known spray treatment system 2, hereinafter also referred to as the system 2, generally has a cleaning chamber 7 enclosing a cleaning space 90 or cleaning path 90 or cleaning volume 90 in which the part 5 is cleaned. On both sides 91, 92 of the cleaning path 90 are a plurality 22 of spray nozzles 20 located. The part 5 is generally moved into the cleaning path 90 and suspended above a bottom surface 93 or floor 93 of the cleaning chamber 7 in front of the spray nozzles 20, hereinafter also referred to as the nozzles 20, by using a conveyor mechanism for example from a hook 12 of a pneumatic conveyer mechanism. The nozzles 20 are supplied with a cleaning agent 3, for example a mild acidic solution (e.g. a mixture of 25 parts water to one-part acid) or a mild alkaline solution (e.g. a mixture of ten parts water and one part alkaline cleaner) via supply lines 86 that carry the cleaning agent 3 from a reservoir or supply (not shown) to the nozzles 20 propelled by a pump 82. The cleaning agent 3 is ejected out of the nozzles 20 towards the surface 6 of the part 5 in form of sprays 25 or jets 25, hereinafter referred to as the cleaning jets 25 or simply as the jets 25, generally with a predetermined pressure for example a pressure of 1000 psi (pound per square inch) to 1450 psi or a pressure of 5000 psi or more. This conventionally known system 2, and the method of surface treatment associated with the system 2, is generally effective for simple shaped articles as the part 5.

[0006] Fig. 2 schematically represents a top view of the conventionally known system 2 being used for cleaning the part 5 having a more complicated shape than a simple sheet shape for example a frame of a television, or other household items such as a curved panel for a wardrobe, etc. Fig. 3 shows a section of the conventionally known system 2 and a section of the part 5 being used for cleaning of the surface 6 of the part 5. The surface 6 of the part 5 owing to the complicated 3D (three-dimensional) shape and/or size may have different portions or segments of the surface 6, hereinafter known as surface portions, that are oriented differently from a nozzle 20 ejected the cleaning jet 25 to clean the surface portions. For example as shown in Figs. 2 and 3 the surface 6 of the part 5 has a first surface portion 4 and a second surface portion 4' oriented at distances d and d' from the nozzle 20 as shown in Fig. 3. Since the distances d and d' are different from each other, the cleaning jets 25 ejected from the nozzle 20 of Fig. 3 will attack the surface portions 4 and 4' differently that means with variable pressure, which may result from difference in dis-

tances and difference in an angle at which the jets 25 interact with a given surface portion 4, 4'. Thus, the cleaning effect at surface portions 4 and 4' are variable and thus difficult to regulate or control.

[0007] Fig. 4 presents another embodiment of the part 5 having a shape of the part 5 different from a shape of the part 5 of Fig. 3. As shown in Fig. 4, the part 5 may have different subparts or portions such as a first section 5a and a second section 5b. The sections 5a, 5b are relatively oriented in the part 5 such that the first surface portion 4 is shadowed by the second surface portion 4' in the direction from the nozzle 20 of Fig. 4 towards the part 5. As a result the cleaning jet 25 ejected from the nozzle 20 of Fig. 4 would either not impact the first surface portion 4 or impact the first surface portion 4 substantially differently from the impact with the second surface portion 4'.

[0008] Referring to Fig. 2, even if the part 5 was moved in a direction 96 within the cleaning chamber 7 along a central axis 95 of the cleaning path 90 for example by moving it along a conveyor mechanism or belt, and even if the part 5 encountered cleaning jets 25 from serially arranged nozzles 20 along both sides 91, 92 of the cleaning path 90, still the disadvantage of cleaning some of the surface portions, such as the first surface portion 4 of Figs. 3 and 4, would still exist. The central axis 95 is a central line on the bottom surface 93 of the cleaning path 90. The central axis 95 is generally a straight-line segment, but nevertheless the central axis 95 may be curved depending on the cleaning path 90.

[0009] Hence, there exists a need for a spray treatment technique, preferably a spray treatment system and a spray treatment method, that would at least partially obviate the problems of uneven cleaning effect of conventionally known systems 2 on parts 5 having 3D shapes.

Object of the Invention

[0010] It is therefore an object of the present invention to provide a spray treatment, preferably a spray treatment system and a spray treatment method, that at least partially, and preferably completely, obviates occurrences of uneven cleaning effect on the different surface portions of a surface of a part.

Description of the Invention

[0011] The aforementioned object is achieved by a spray treatment system for cleaning a surface of a part according to claim 1 of the present invention, which presents a first aspect of the present technique. The part may be a hot-dip galvanized steel article, preferably having a 3D shape. The spray treatment system includes a conveyor mechanism, a plurality of spray nozzles, a part rotating mechanism, a 3D scanner, and a processor.

[0012] The conveyor mechanism supports the part, for example by hanging the part from a hook attached to a pneumatic conveyor. The conveyor mechanism also

moves the part along a cleaning path. The cleaning path has a central axis along which the part is moved for example by moving the hook, from which the part is suspended, from one position to another position along the central axis.

[0013] The spray nozzles spray a cleaning agent in form of cleaning jets towards the part. The spray nozzles are positioned along at least one side, and preferably along both sides in another embodiment, of the cleaning path. Furthermore, the spray treatment system of the present disclosure may have high pressure spray nozzles, i.e. that may be operated from 5000 psi to above for example from between 5000 psi and 10000 psi, and/or may have low pressure spray nozzles, i.e. that may be operated below 5000 psi for example from between 300 psi and 1000 psi. The part rotating mechanism rotates the part about an axis of the part such that the part is aligned in different orientations with respect to the central axis of the cleaning path. The part rotating mechanism may rotate the part as the part is moving from one position along the central axis to another position along the central axis and/or may rotate the part which the part is stationary along the central axis i.e. when the part is at a fixed or given location or position along the central axis.

[0014] The 3D scanner scans the part before the part is cleaned, and preferably before the cleaning of the part is initiated. The 3D scanner thus determines a shape and/or a size of the part and correspondingly generates data indicative of the shape and/or the size so determined by the part. The processor, for example a micro-processor or an FPGA, receives the data from the 3D scanner and directs the part rotating mechanism which in response to directions received from the processor rotates the part and thereby orients the part based on the shape and/or the size of the part such that a surface portion, i.e. a selected portion or segment of the surface, of the part is disposed at a predetermined distance from at least one spray nozzle, preferably a selected spray nozzle, of the plurality of spray nozzles.

[0015] As a result of the rotation, the relative distance between different surface portions, i.e. one or more selected portions of the surface, from the spray nozzles may be altered and thereby controlled, at least within a range. Furthermore, the angle at which a cleaning jet is incident on the surface portion from a given spray nozzle may also be altered. Additionally, any surface portion that may otherwise be overshadowed by another surface portion may be exposed to the cleaning jet at least in some orientations of the part.

[0016] The part rotating mechanism rotates the part about the axis of the part such that the part is aligned in different orientations with respect to the central axis of the cleaning path, while the part is at different positions along the cleaning path. Alternatively, or additionally, the part rotating mechanism rotates the part about the axis of the part such that the part is aligned in different orientations with respect to the central axis of the cleaning path at different time instances, while the part is at same

position along the cleaning path.

[0017] In an embodiment of the spray treatment system, the at least one spray nozzle, with respect to which the surface portion is disposed at the predetermined distance, is operable independent from the other spray nozzles of the plurality of spray nozzles. Thus operation of the at least one spray nozzle is achieved without requiring operation of the other spray nozzles. This provides more flexibility and control in choosing whether the surface portion is subjected to the cleaning jet or not.

[0018] In another embodiment of the spray treatment system, the processor controls the at least one spray nozzle to alter a pressure of the cleaning jet ejected out from the at least one spray nozzle compared to pressures of the cleaning jets ejected out from the other spray nozzles. Thus, in addition to the distance from the spray nozzle and/or angle of attack of the cleaning jet ejected from the spray nozzle, a pressure of the cleaning jet ejected out from the at least one spray nozzle is also regulated and controlled, and may be operated at a predetermined or desired pressure which thereafter may be altered to another predetermined or desired pressure.

[0019] In a further embodiment of the spray treatment system, the processor controls each of the plurality of spray nozzles to alter pressure of the cleaning jets ejected out from the spray nozzles. Thus, the processor may ensure that all the spray nozzles eject the cleaning jet at same pressure, and thus the present system may also be used for simple shaped articles as the part to be cleaned.

[0020] The aforementioned objective is also achieved by a spray treatment method for cleaning a surface of a part according to claim 10, which presents a second aspect of the present technique. In the spray treatment method, hereinafter also referred to as the method, first the part to be cleaned is scanned using a 3D scanner, and consequently a shape and/or a size of the part is determined. Based on the scanning, data is generated by the 3D scanner. The data is indicative of the shape and/or the size of the part to be cleaned. The part, for example a hot-dip galvanized steel article having a 3D shape, is then moved along a cleaning path. The cleaning path has a central axis, as described hereinabove for the first aspect of the present disclosure. The part is supported and moved along the cleaning path using a conveyor mechanism, as described hereinabove for the first aspect of the present disclosure.

[0021] Subsequently, the part is rotated, by using a rotating mechanism, about an axis of the part, as described hereinabove for the first aspect of the present disclosure. Consequently, the part is aligned based on the shape and/or the size of the part. The part may be aligned in one of the various different orientations that the part may assume with respect to the central axis of the cleaning path. The part is aligned such that a surface portion of the part is disposed at a predetermined distance from at least one spray nozzle from a plurality of spray nozzles. Finally, the at least one spray nozzle is

operated and thus a cleaning agent is sprayed in form of a cleaning jet onto the surface portion of the part. The alignment of the part and the effect of the alignment of the part are same as described hereinabove for the first aspect of the present disclosure.

[0022] In an embodiment of the method, the at least one spray nozzle, with respect to which the surface portion is disposed at the predetermined distance, is operated independent from the other spray nozzles of the plurality of spray nozzles. Thus, operation of the at least one spray nozzle is achieved without requiring operation of the other spray nozzles. This provides more flexibility and control in choosing whether the surface portion is subjected to the cleaning jet or not.

[0023] In another embodiment of the method, a pressure of the cleaning jet ejected out from the at least one spray nozzle is altered, preferably compared to pressures of the cleaning jets ejected out from the other spray nozzles. Thus, in addition to the distance from the spray nozzle and/or angle of attack of the cleaning jet ejected from the spray nozzle, a pressure of the cleaning jet ejected out from the at least one spray nozzle is also regulated and controlled, and may be operated at a predetermined or desired pressure which thereafter may be altered to another predetermined or desired pressure.

[0024] In a further embodiment of the method, the part is rotated by the part rotating mechanism about the axis of the part such that the part is aligned in different orientations with respect to the central axis of the cleaning path, while the part is at different positions along the cleaning path. In yet another embodiment of the method, the part is rotated by the part rotating mechanism about the axis of the part such that the part is aligned in different orientations with respect to the central axis of the cleaning path at different time instances, while the part is at same position along the cleaning path.

[0025] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which components of the invention are exemplarily illustrated. Components of the system and the method according to the invention, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described in all figures.

[0026] The invention is just exemplarily described with respect to the attached figures in the following.

Brief Description of the Drawings

[0027]

Fig. 1 schematically represents a side view of a conventionally known spray treatment system according to the prior art,

Fig. 2 schematically represents a top view of the conventionally known spray treatment system of Fig. 1,

Fig. 3 schematically represents a section of the conventionally known spray treatment system of Fig. 2 depicting a portion of a part to be cleaned and its relative orientation with respect to one of the spray nozzles,

Fig. 4 schematically represents the section of the conventionally known spray treatment system of Fig. 3 depicting a portion of a part, different from a part of Fig. 3, to be cleaned, and its relative orientation with respect to one of the spray nozzles,

Fig. 5 schematically represents a top view of an exemplary embodiment of a spray treatment system of the present invention, depicting different exemplary orientations of a part at different sections of the spray treatment system,

Fig. 6a schematically represents a top view of another exemplary embodiment of the spray treatment system of the present invention, depicting a part at an initial time instance t1,

Fig. 6b schematically represents a top view of the exemplary embodiment of the spray treatment system of Fig. 6a, depicting an exemplary orientation of the part at a time instance t2, subsequent to the initial time instance t1 of Fig. 6a, and when the part is at a given location in the spray treatment system,

Fig. 6c schematically represents a top view of the exemplary embodiment of the spray treatment system of Figs. 6a and 6b, depicting another exemplary orientation of the part at another time instance t3, subsequent to the time instance t2 of Fig. 6b, and when the part is at the same location in the spray treatment system as depicted in Fig. 6b,

Fig. 6d schematically represents a top view of the exemplary embodiment of the spray treatment system of Figs. 6a, 6b, and 6c depicting yet another exemplary orientation of the part at yet another time instance t4, subsequent to the time instance t3 of Fig. 6c, and when the part is at the same location in the spray treatment system as depicted in Figs. 6b and 6c,

Figs. 7a and 7b schematically represent a side view of the exemplary embodiment of the spray treatment system showing an exemplary scheme of rotation of the part as performed for Fig. 5 and for Figs. 6b to 6d,

Fig. 8 comparable to Fig. 3, schematically represents a section of the spray treatment system of Figs. 5 and 6a-d depicting an exemplary orientation of a portion of the part,

Fig. 9 comparable to Fig. 4, schematically represents

the section of the spray treatment system of Fig. 8 depicting a portion of a part, different from a part of Fig. 8, and

Fig. 10 is a flow chart depicting a spray treatment method; in accordance with the present technique.

Detailed Description of the Drawings

[0028] It may be noted that in the present disclosure, the terms 'first', 'second', etc are used herein only to facilitate discussion and carry no particular temporal or chronological significance unless otherwise indicated.

[0029] Fig. 5 depicts an exemplary embodiment of a spray treatment system 1 of the present invention. The spray treatment system 1, hereinafter also referred to as the system 1, functions to clean a surface 6 of a part 5. The part 5 may be a hot-dip galvanized steel article, preferably having a 3D shape. An example of the part 5 may be, but not limited to, a frame for a television formed from hot-dip galvanized (HDG) steel, a front, back and/or side panel for a washing machine or a dishwasher or a refrigerator having surface contouring and/or shapes other than simple sheet form, a T-shaped, L-shaped, Z-shaped article or joint, a segment of a body of an automobile, and so on and so forth. The part 5 may be an article that is intended to be painted, and is being cleaned by the system 1 of the present disclosure or by a spray treatment method 100 shown in Fig. 10 of the present disclosure, as surface preparation prior to the painting or coating of the surface 6 of the part 5. The part 5 may be formed of HDG steel that has been galvanized more than 48 hours back and less than a year prior to cleaning performed of the part 5 by the system 1 and/or method 100 of the present disclosure.

[0030] The system 1 includes a conveyor mechanism 10, a plurality of spray nozzles 20, a part rotating mechanism 30, a 3D scanner 40, 40', and a processor 50.

[0031] The conveyor mechanism 10, for example a mechanical or pneumatic conveyor system supports the part 5, for example by hanging the part 5 from the hook 12, as shown in Fig. 1, attached to the pneumatic conveyor. The conveyor mechanism 10 moves the part 5 along a cleaning path 90. The cleaning path 90 has a central axis 95 along which the part 5 is moved for example by moving the hook 12 from which the part 5 is suspended, from one position to another position along the central axis 95. Fig. 5 depicts the part 5 at different such positions. The central axis 95 may be understood as an imaginary central line on the bottom surface 93 of the cleaning path 90, or an imaginary line along which the net motion of the part 5 is executed by the conveyor mechanism 10. The central axis 95 is generally a straight line segment, but nevertheless the central axis 95 may be curved depending on the cleaning path 90. It may be noted that Fig. 5 depicts only one part 5 that is shown to be present at different positions 101, 102, 103, 104 moving from an initial position to a subsequent position i.e. say

from position 101 to position 102, then from position 102 to position 103, thereafter from position 103 to position 104 within the system 1.

[0032] Fig. 5 depicts twelve spray nozzles 20 forming the plurality 22 of spray nozzles 20. However, the number of spray nozzles 20, i.e. twelve spray nozzles 20 and their relative arrangement, depicted in Fig. 5 is for exemplary purposes only and is not depicted as way of a limitation to the present invention. The spray nozzles 20a, 20b, 20c, 20d, 20e, 20f, 20g, 20h, 20i, 20j, 20k, 20l spray a cleaning agent 3 in form of cleaning jets 25 towards the part 5. The cleaning jets 25 reach one or more regions of the surface 6 of the part 5 and perform the action of cleaning that region of the surface 6. This has been explained with respect to Fig. 1. Features and explanation provided hereinabove with respect to Fig. 1 is included herein for explanation of the system 1 and the method 100 of the present technique. The spray nozzles 20 are positioned along at least one side 91, 92, and preferably along both sides 91, 92 in the embodiment of Fig. 5, of the cleaning path 90. The spray nozzles 20 are supplied with the cleaning agent 3 via supply lines 86. The cleaning agent 3 may be induced to flow within the supply lines 86 and out of the spray nozzles 20, in form of the cleaning jets 25, due to action of a pump (not shown in Fig 5).

[0033] The system 1 may have high pressure spray nozzles 20, and/or may have low pressure spray nozzles 20. The spray nozzles 20 may form different sections or segments of the system 1, for example the system 1 of Fig. 5 has four segments - namely scanning segment that is upstream of AA' as shown in Fig. 5 with respect to an arrow marked with reference numeral 96, a segment AA'-BB', a segment BB'-CC', and a segment CC'-DD'. The arrow 96 presents a direction in which the part 5 moves along the central axis 95.

[0034] The part rotating mechanism 30 rotates the part 5 about an axis 9 of the part 5 such that the part 5 is aligned in different orientations with respect to the central axis 95 of the cleaning path 90. Figs. 7a and 7b schematically depict the part rotating mechanism 30 and its action on the part 5. The part rotating mechanism 30, for example a rotary drive, a servomotor, and so on and so forth may be installed as part of the conveyor mechanism 10 and may rotate the part 5 as shown in Figs. 7a and 7b along the axis 9 of the part 5. A rotation of the part 5 along the axis 9 is represented in Fig. 7a by an arrow marked with reference numeral 8. As may be observed from a comparison of Figs 7a and 7b, the relative orientation of a first and a second section or segment 5a, 5b of the part 5 is changed as a result of the rotation 8 about the axis 9 performed by the part rotating mechanism 30, hereinafter also referred to as the mechanism 30. As a result of the change in relative orientation different surface portions 4,4' of the surface 6 of the part 5 may be oriented or disposed at different spatial locations with respect to one another and with respect to another reference such as one of the spray nozzles 20. The mechanism 30 may rotate the part 5 as the part 5 is moving

from one position 102,103,104 along the central axis 95 to another position 102,103,104 along the central axis 95, i.e. while the part 5 is still in motion along the central axis 95, and/or may rotate the part 5 when the part 5 is stationary along the central axis 95 i.e. when the part 5 has moved to a position 102,103,104 along the central axis 95 and thereafter is stationary at that location or position 102,103,104.

[0035] The 3D scanner 40,40' scans the part 5 before the part 5 is cleaned, and preferably before the cleaning of the part 5 is initiated, for example when the part 5 is at the position 101 as shown in example of Fig. 5, wherein the cleaning of the part 5 initiates only when the part 5 moves to the position 102 from the position 101. The 3D scanner 40,40', for example a 3D laser scanner, a photometric scanner, etc is generally a contact-less scanner i.e. the 3D scanner 40,40' scans the part 5 without direct physical contact to the part 5. The system 1 may include two 3D scanners 40,40' as shown in Fig. 5 or may have just one 3D scanner (not shown) and the part 5 is rotated 360 degrees to allow the one 3D scanner to scan surface 6 on all sides of the part 5.

[0036] The number of 3D scanners 40,40' and the technique of scheme by which the part 5 is scanned may differ in different embodiments of the system 1, for example in an embodiment, the system 1 includes more than two 3D scanners 40,40'. The 3D scanners 40, 40' determine a shape and/or a size of the part 5 and correspondingly generate data indicative of the shape and/or the size so determined of the part 5. The processor 50, for example a micro-processor or an FPGA, receives the data from the 3D scanner 40,40' and directs the part rotating mechanism 30 which in response to directions received from the processor 50 rotates the part 5 and thereby orients the part 5 based on the shape and/or the size of the part 5 such that a surface portion 4,4', i.e. a selected portion or segment of the surface 6, of the part 5 is disposed at a predetermined distance from at least one spray nozzle 20, preferably a selected spray nozzle 20, of the plurality 22 of spray nozzles 20. This aspect has been explained in further details with reference to Fig. 8, which may be understood in comparison with Fig. 3.

[0037] As shown in Fig. 8, the part 5 is rotated as compared to a non-rotated orientation of part 5 depicted in Fig. 3. The part 5 is rotated as explained in reference to Figs. 7a and 7b hereinabove. Say, during the cleaning of the part 5, it is desired that the surface portions 4 and 4' are oriented similarly, i.e. at a same distance from a mouth 21 of the spray nozzle 20 shown in Fig. 8. To achieve this, the processor 50 using the 3D scan data indicative of the shape and the size of the part 5 calculates how much the part 5 has to be rotated with respect to the central axis 95 to be oriented in such a way that the surface portions 4 and 4' are oriented similarly, i.e. at same distance from the mouth 21 of the spray nozzle 20. The processor 50 is also provided with the relative orientations of the spray nozzle 20, the central axis 95 and the spatial orientation of the part 5 with respect to the central

axis 95 when the part 5 is in non-rotated or default orientation. Thus, as shown in Fig. 3, which may present an example of non-rotated or default orientation of the part 5, the distance of the first surface portion 4 from the mouth 21 of the spray nozzle 20 is d which is greater than d' , i.e. the distance of the second surface portion 4' from the mouth 21 of the spray nozzle 20. However, as a result of the rotation 8 (shown in Fig. 7a) of the part 5 by the rotary mechanism 30 after being instructed so by the processor 50 results in such an orientation of the part 5 with respect to the central axis 95 that the distance d of the first surface portion 4 from the mouth 21 of the spray nozzle 20 is same as the distance d' of the second surface portion 4' from the mouth 21 of the spray nozzle 20.

[0038] Similarly, the part 5 may be rotated by the mechanism 30 such that an angle at which the cleaning jet 25 emanating from a selected spray nozzle 20 is incident on the first surface portion 4 may be manipulated by rotating the part 5. Additionally, as shown in Fig. 9 in comparison to Fig. 4, the first surface portion 4 that was otherwise overshadowed by the second surface portion 4' in Fig. 4 is exposed, as shown in Fig. 9 to the spray nozzle 20, in particular to the cleaning jet 25 ejected from the spray nozzle 20, as a result of the rotation 8 (shown in Fig. 7a) of the part 5.

[0039] The part rotating mechanism 30 may rotate the part 5 such that the part 5 is aligned in different orientations with respect to the central axis 95 of the cleaning path 90, while the part 5 is at different positions 102, 103, 104 along the cleaning path 90, as depicted in Fig. 5. For example, the part 5 is presented to be oriented in the default position when in the position 102 in the segment AA'-BB', thereafter the part 5 moves from the position 102 to the position 103 in the segment BB'-CC' and is now oriented in a different orientation than the default orientation, and finally the part 5 moves from the position 103 to the position 104 in the segment CC'-DD' and is then rotated into yet another orientation different than the default orientation and different than the orientation of the part 5 when the part 5 was in the segment BB'-CC'. The cleaning jets 25 are sprayed on the surface 6 of the part 5 when the part 5 is in desired orientations, for example cleaning jets 25 are sprayed onto the part 5 when the part 5 was in the orientations shown in Fig. 5 at positions 102, 103, and 104. It may be noted that the mechanism 30 has been depicted in Fig. 5 at three locations, which represent the locations of the same mechanism 30 as the mechanism 30 travels along the central axis 95 along with the part 5.

[0040] Now referring to Figs 6a to 6d, another exemplary embodiment of the present technique is explained hereinafter. Fig 6a represents a time instance t_1 at which the part 5 is scanned by the 3D scanner. At time instance t_1 the part 5 is not subjected to any cleaning jets 25. Subsequently, the part 5 is moved by the mechanism 10 along the central axis 95 and consequently the part 5 attains a position between the spray nozzles 20a, 20b

and the spray nozzles 20c, 20d, and an orientation, say default orientation, depicted by Fig. 6b that represents the position and the orientation of the part 5 at a time instance t_2 , chronologically subsequent to time instance t_1 . The cleaning jets 25, for example all with same parameters such as at same pressure, are sprayed onto the surface 6 of the part 5. Thereafter, the part 5 while remaining at the same position as in time instance t_2 i.e. between the spray nozzles 20a, 20b and the spray nozzles 20c, 20d, is rotated by the mechanism 30 as explained for Figs. 7a and 7b and consequently the part 5 attains an orientation, say first orientation, depicted by Fig. 6c that represents the orientation of the part 5 at a time instance t_3 , chronologically subsequent to time instance t_2 . The cleaning jets 25, for example the cleaning jets 25 ejected from the spray nozzles 20b and 20c at higher pressure than the cleaning jets 25 ejected from the spray nozzles 20a and 20d, are sprayed onto the surface 6 of the part 5. Finally, for the example of Figs 6a to 6d, the part 5 while remaining at the same position as in time instances t_2 and t_3 i.e. between the spray nozzles 20a, 20b and the spray nozzles 20c, 20d, is rotated again by the mechanism 30 as explained for Figs. 7a and 7b and consequently the part 5 attains another orientation, say second orientation, depicted by Fig. 6d that represents the orientation of the part 5 at a time instance t_4 , chronologically subsequent to time instance t_3 . The cleaning jets 25, for example the cleaning jets 25 ejected from the spray nozzles 20a and 20d at higher pressure than the cleaning jets 25 ejected from the spray nozzles 20b and 20c, are sprayed onto the surface 6 of the part 5.

[0041] As shown in example of Figs. 6b, 6c and 6d the pressure from the spray nozzles 20 may be varied, and also as shown in Fig. 6a wherein no cleaning jet 25 is ejected from the spray nozzles 20 i.e. the pressure at which the cleaning jet 25 is ejected in Fig 6a may be zero. In an embodiment of the system 1, the at least one spray nozzle 20a, with respect to which the surface portion 4, 4' is disposed at the predetermined distance, is operable independent from the other spray nozzles 20b-20l of the plurality 22 of spray nozzles 20. The processor 50 controls the spray nozzle 20a to alter a pressure of the cleaning jet 25 ejected out from the spray nozzle 20a, for example compared to pressures of the cleaning jets 25 ejected out from the other spray nozzles 20b-20l. This has been depicted by different pressures at which the spray nozzle 20a is ejecting the cleaning jet 25 in Figs. 6b, 6c, 6d. Furthermore, the feature of the system 1 that the pressure at which the different cleaning jets 25 impact the surface 6 at different positions may be varied, is also depicted in Fig. 5 which depicts when the part 5 is in the position 102, the cleaning jets 25 from the spray nozzles 20a, 20b, 20c and 20d all are ejected at the same pressure, whereas when the part 5 is in the position 103, the cleaning jets 25 from the spray nozzles 20f and 20g are ejected at a higher pressure than the cleaning jets 25 ejected from the spray nozzles 20e and 20h, and furthermore when the part 5 is in the position 104, the cleaning

jets 25 from the spray nozzles 20i and 20l are ejected at a higher pressure than the cleaning jets 25 ejected from the spray nozzles 20j and 20k.

[0042] Thus, the processor 50 may control the spray nozzles 20 to eject the cleaning jets 25 at different pressures, at least between the cleaning jets 25 ejected from two of the spray nozzles 20.

[0043] However, the processor 50 may also controls each of the plurality 22 of spray nozzles 20 such that all the spray nozzles 20 eject the cleaning jet 25 at same pressure, as shown in Fig. 6b.

[0044] Hereinafter, the spray treatment method 100 of the present inventions as depicted in the flow chart of Fig. 10 is explained in combination with the system 1 explained hereinabove with reference to Figs. 5 to 9. In the spray treatment method 100, also referred to as the method 100, firstly in a step 110 the part 5 to be cleaned is scanned using the 3D scanner 40,40', and consequently the shape and/or the size of the part 5 is determined. Based on the scanning, data is generated by the 3D scanner 40,40'. The data is indicative of the shape and/or the size of the part 5 to be cleaned. The part 5, for example a hot-dip galvanized steel article having a 3D shape, is then moved along the cleaning path in a step 120. Subsequently, in a step 130 of the method 100, the part 5 is rotated, by using the mechanism 30, about the axis 9 of the part 5, as described hereinabove with reference to Figs. 5 to 9. As a consequence of step 130, the part 5 is aligned based on the shape and/or the size of the part 5. The part 5 may be aligned in a selected orientation from various different possible orientations that the part 5 may assume with respect to the central axis 95 of the cleaning path 90. The part 5 is aligned such that the surface portion 4,4' of the part is disposed at a predetermined distance from at least one spray nozzle 20, as described hereinabove with reference to Figs. 5 to 9. Finally, in a step 140 of the method 100, the at least one spray nozzle 20 is operated and thus a cleaning agent 3 is sprayed in form of the cleaning jet 25 onto the surface portion 4,4' of the part 4. The alignment of the part 5 and the effect of the alignment of the part 5 are same as described hereinabove with reference to Figs. 5 to 9.

[0045] Thus, the present invention refers to a spray treatment system 1 for cleaning a surface 6 of a 3D part 5. A conveyor mechanism 10 supports and moves the part 5 along a cleaning path 90 having a central axis 95. A plurality 22 of spray nozzles 20 positioned along sides 91,92 of the cleaning path are spraying a cleaning agent 3 in form of cleaning jets 25 towards the part 5. A 3D scanner 40,40' of the system 1 scans the part 5 to be cleaned and determines a shape and/or a size of the part 5 and generates corresponding data that is received by a processor 50 which then consequently directs a part rotating mechanism 30 to orient the part 5 based on the shape and/or the size of the part 5 such that a surface portion 4,4' of the surface 6 of the part 5 is disposed at a predetermined distance from at least one spray nozzle 20 from the plurality 22 of spray nozzles 20.

List of reference signs

[0046]

5	1	spray treatment system
	2	conventionally known spray treatment system
	3	cleaning agent
	4	first surface portion of the part
10	4'	second surface portion of the part
	5	part
	5a	first section of the part
	5b	second section of the part
	6	surface of the part
15	7	cleaning chamber
	8	rotation about the axis
	9	axis of the part
	10	conveyor mechanism
	12	hook
20	20	spray nozzles
	20a-l	spray nozzles
	21	mouth of the spray nozzle
	22	plurality of spray nozzles
	25	cleaning jet
25	30	part rotating mechanism
	40,40'	3D scanner
	50	processor
	82	pump
	84	valves
30	86	supply lines
	90	cleaning path
	91	first side of the cleaning path
	92	second side of the cleaning path
	93	bottom surface of the cleaning path
35	95	central axis
	100	spray treatment method
	101	position of the part at the 3D scanner
	102-105	different positions along the cleaning path
	110	scanning the part
40	120	moving the part
	130	rotating the part
	140	operating the spray nozzle
	150	altering pressure of the cleaning jet
	d,d'	distances
45	t1	initial time instance
	t2	time instance after t1
	t3	time instance after t2
	t4	time instance after t3
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Claims

1. A spray treatment system (1) for cleaning a surface (6) of a part (5), the spray treatment system (1) comprising:
 - a conveyor mechanism (10) configured to support the part (5) and to move the part (5) along

- a cleaning path (90) having a central axis (95);
 - a plurality (22) of spray nozzles (20), each spray nozzle (20) configured to spray a cleaning agent (3) in form of a cleaning jet (25) towards the part (5), wherein the spray nozzles (20) are positioned along at least one side (91,92) of the cleaning path (90);
 - a part rotating mechanism (30) configured to rotate the part (5) about an axis (9) of the part (5) such that the part (5) is aligned in different orientations with respect to the central axis (95) of the cleaning path (90);
 - a 3D scanner (40,40') configured to scan the part (5) to be cleaned to determine a shape and/or a size of the part (5) and to generate data indicative of the shape and/or the size of the part (5) to be cleaned; and
 - a processor (50) configured to receive the data from the 3D scanner (40,40') and to direct the part rotating mechanism (30) to orient the part (5) based on the shape and/or the size of the part (5) such that a surface portion (4,4') of the surface (6) of the part (5) is disposed at a predetermined distance from at least one spray nozzle (20) from the plurality (22) of spray nozzles (20).
2. The spray treatment system (1) according to claim 1, wherein the at least one spray nozzle (20a) of the plurality (22) of spray nozzles (20) is configured to be operable independent from the other spray nozzles (20b-20l) of the plurality (22) of spray nozzles (20).
 3. The spray treatment system (1) according to claim 2, wherein the processor (50) is configured to control the at least one spray nozzle (20a) to alter a pressure of the cleaning jet (25) ejected out from the at least one spray nozzle (20a).
 4. The spray treatment system (1) according to any of claims 1 to 3, wherein the processor (50) is configured to control the plurality (22) of spray nozzles (20) to alter pressure of the cleaning jets (25) ejected out from the plurality (22) of spray nozzles (20).
 5. The spray treatment system (1) according to any of claims 1 to 4, wherein the spray nozzles (20) are positioned on both sides (91,92) of the cleaning path (90).
 6. The spray treatment system (1) according to any of claims 1 to 5, wherein the part rotating mechanism (30) is configured to rotate the part (5) about the axis (9) of the part (5) such that the part (5) is aligned in different orientations with respect to the central axis (95) of the cleaning path (90) at different positions (102,103,104) along the cleaning path (90).
 7. The spray treatment system (1) according to any of claims 1 to 5, wherein the part rotating mechanism (30) is configured to rotate the part (5) about the axis (9) of the part (5) such that the part (5) is aligned in different orientations with respect to the central axis (95) of the cleaning path (90) at different time instances (t2, t3, t4) at a given position along the cleaning path (90).
 8. The spray treatment system (1) according to any of claims 1 to 7, wherein the plurality (22) of spray nozzles (20) comprises at least one spray nozzle (20) operable at a higher pressure than the other spray nozzles (20).
 9. The spray treatment system (1) according to any of claims 1 to 8, wherein the plurality (22) of spray nozzles (20) comprises at least one spray nozzle (20) operable at a lower pressure than the other spray nozzles (20).
 10. A spray treatment method (100) for cleaning a surface (6) of a part (5), the spray treatment method (100) comprising:
 - scanning (110) the part (5) to be cleaned using a 3D scanner (40,40') to determine a shape and/or a size of the part (5) to be cleaned and to generate data indicative of the shape and/or the size of the part (5) to be cleaned;
 - moving (120) the part (5) along a cleaning path (90) having a central axis (95), wherein the part (5) is supported and moved along the cleaning path (90) using a conveyor mechanism (10);
 - rotating (130), by using a rotating mechanism (30), the part (5) about an axis (9) of the part (5) such that the part (5) is aligned based on the shape and/or the size of the part (5) in different orientations with respect to the central axis (95) of the cleaning path (90) such that a surface portion (4,4') of the surface (6) of the part (5) is disposed at a predetermined distance from at least one spray nozzle (20) from a plurality (22) of spray nozzles (20); and
 - operating (140) the at least one spray nozzle (20) to spray a cleaning agent (3) in form of a cleaning jet (25) towards the surface portion (4,4') of the surface (6) of the part (5).
 11. The spray treatment method (100) according to claim 10, wherein the at least one spray nozzle (20a) of the plurality (22) of spray nozzles (20) is operated independent from the other spray nozzles (20b-20l) of the plurality (22) of spray nozzles (20).
 12. The spray treatment method (100) according to claim 11, further comprising altering (150) a pressure of the cleaning jet (25) ejected out from the at least one

spray nozzle (20a).

13. The spray treatment method (100) according to any of claims 10 to 12, wherein the part (5) is rotated (130) such that the part (5) is aligned in different orientations with respect to the central axis (95) of the cleaning path (90) at different positions (102,103,104) along the cleaning path (90). 5
14. The spray treatment method (100) according to any of claims 10 to 12, wherein the part (5) is rotated (130) such that the part (5) is aligned in different orientations with respect to the central axis (95) of the cleaning path (90) at different time instances at a given position along the cleaning path (90). 10 15
15. The spray treatment method (100) according to any of claims 10 to 14, wherein the part (5) is a hot-dip galvanized steel article. 20

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FIG 1 (PRIOR ART)

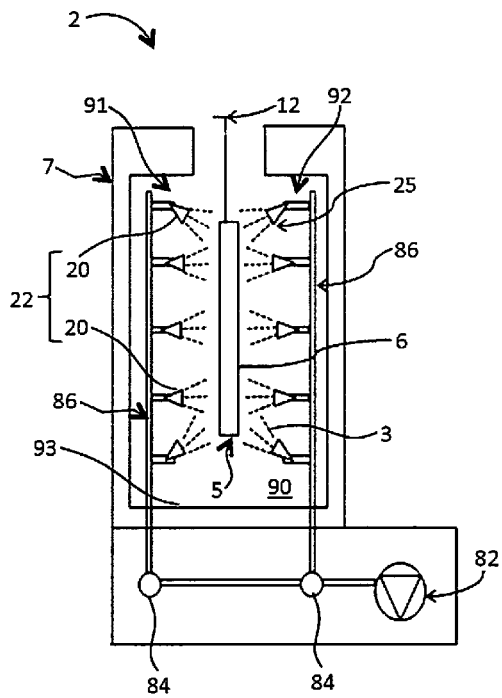


FIG 2 (PRIOR ART)

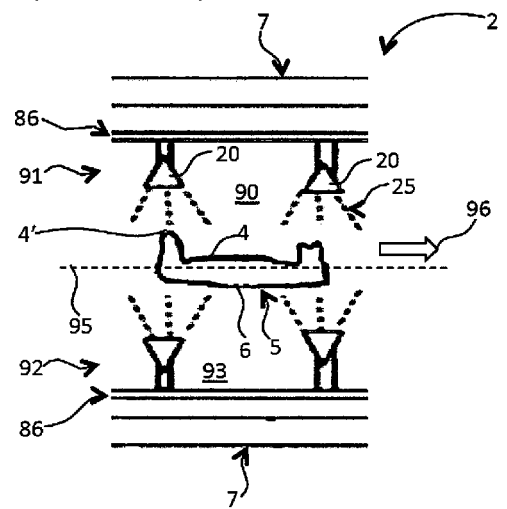


FIG 3 (PRIOR ART)

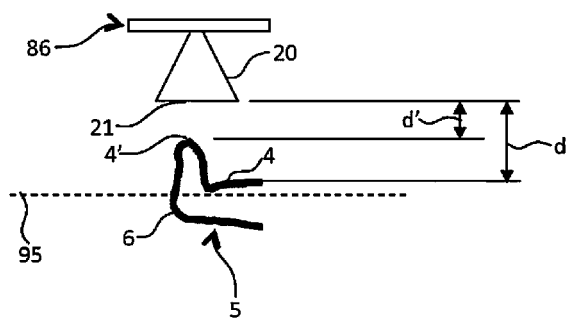


FIG 4 (PRIOR ART)

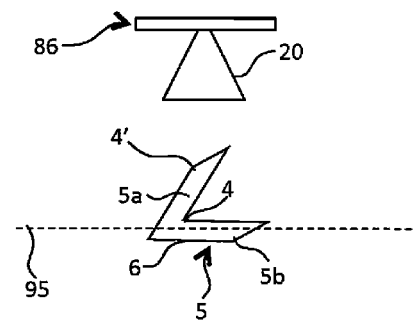


FIG 5

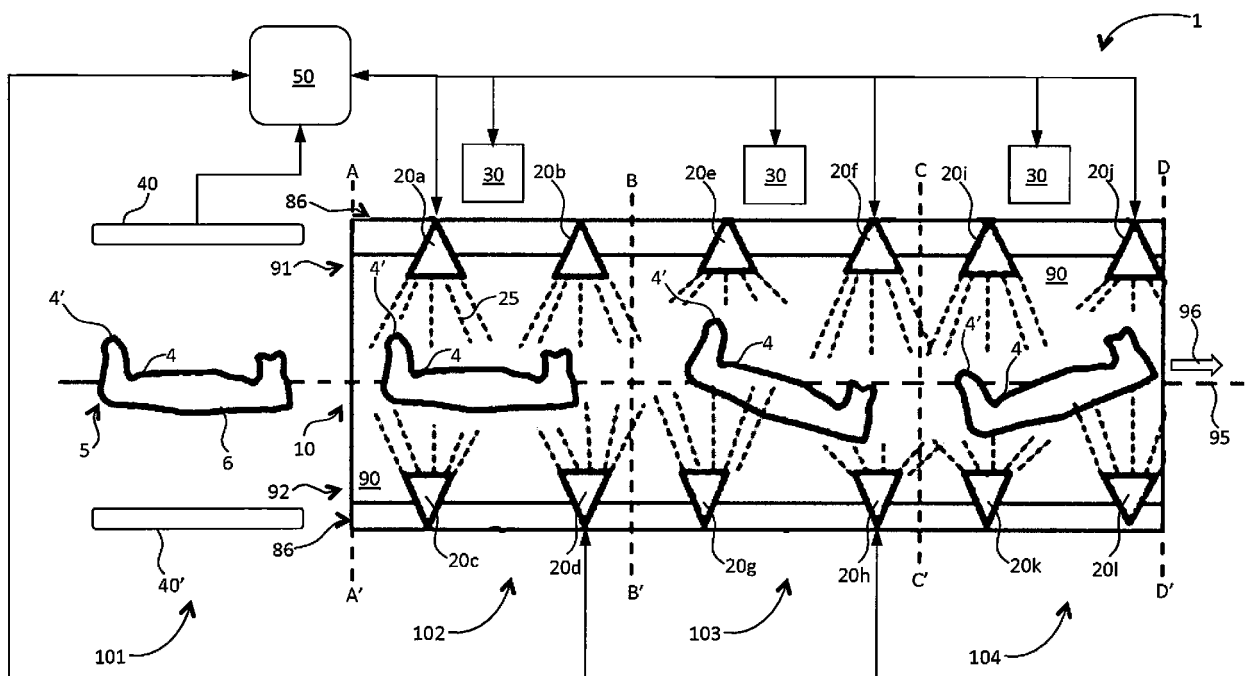


FIG 6a

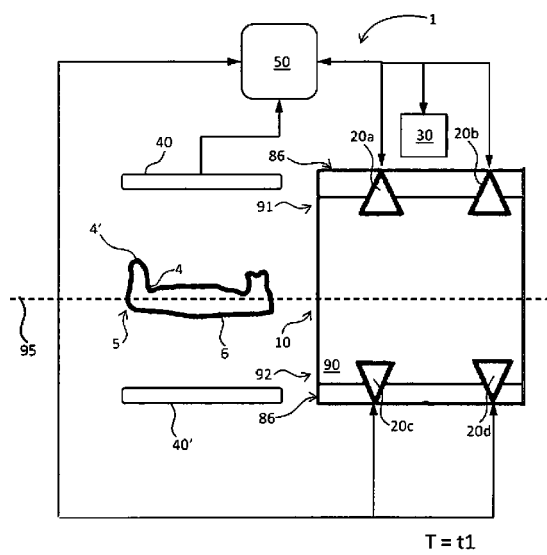


FIG 6b

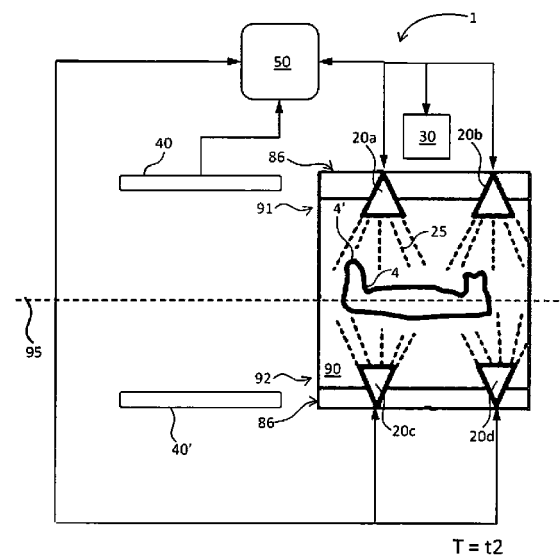


FIG 6c

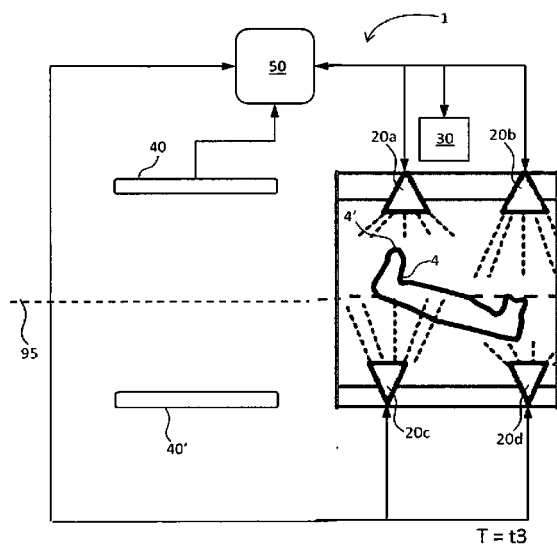


FIG 6d

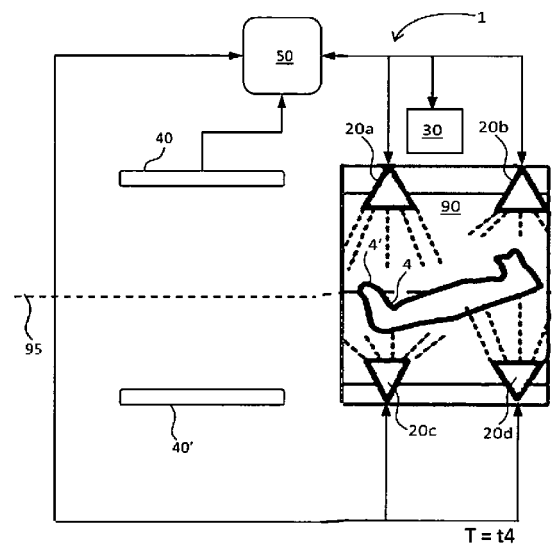


FIG 7a

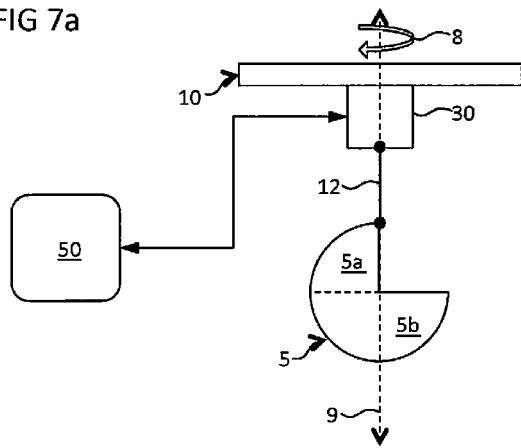


FIG 7b

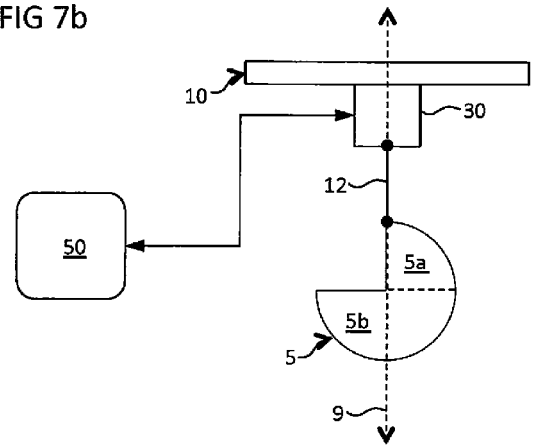


FIG 8

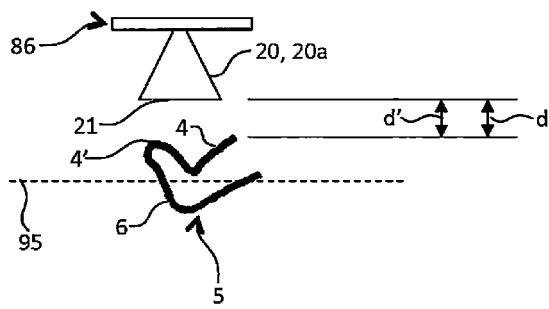


FIG 9

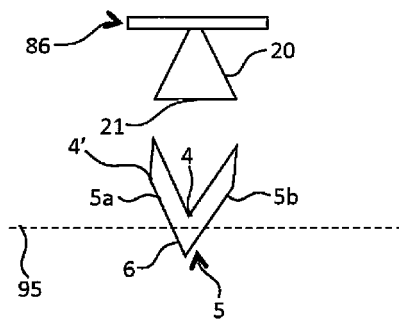
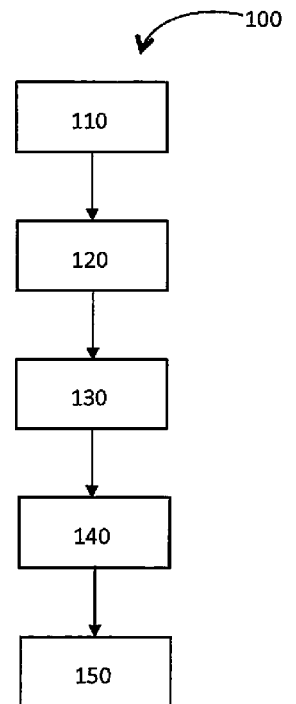


FIG 10





EUROPEAN SEARCH REPORT

Application Number
EP 17 18 2926

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 103 32 443 A1 (BASIC JOSEF [DE]; REICH KONRAD [DE]) 10 February 2005 (2005-02-10) * abstract *; figures * * paragraph [0010] - paragraph [0016] * * paragraph [0026] - paragraph [0050] * -----	1-15	INV. B08B3/02 B05B13/02 B05B12/02 B05B12/12
A	DATABASE WPI Week 201678 Thomson Scientific, London, GB; AN 2016-698292 XP002777399, -& KR 2016 0126358 A (KOREA IND BANK) 2 November 2016 (2016-11-02) * abstract; figures * * paragraphs [0026], [0031]; claims 1,2 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) B08B B05B B65G C23C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 18 January 2018	Examiner Plontz, Nicolas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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The members are as contained in the European Patent Office EDP file on
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18-01-2018

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KR 20160126358 A	02-11-2016	NONE	

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