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(54) **Pressure masking systems and methods for using same in treating techniques**

(57) Systems and methods of treating, e.g., stripping and coating, a target surface 11 of an article 10 including a passageway 12 are disclosed. The systems may fluidly connect a pressure masker 30 including pressurized masking fluid 35 to a first side of the passageway 12, passing the pressurized masking fluid 35 through the

passageway 12 from the first side to a second side including the target surface 11, and, submerging at least a portion of the target surface in a treatment bath, wherein the pressurized masking fluid 35 passing through the passageway 12 prevents the treatment bath from entering the passageway 12.

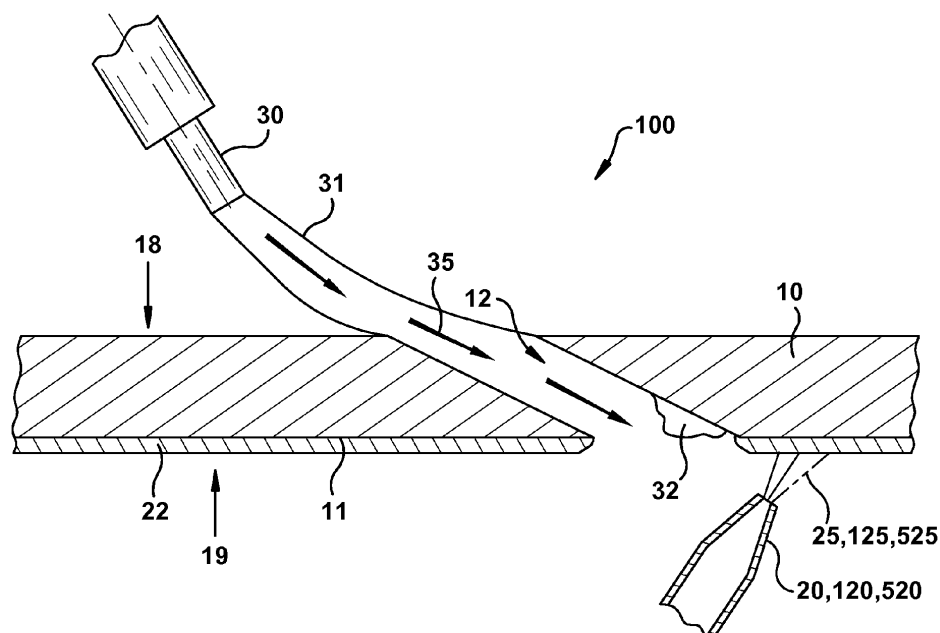


Fig. 2

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Description

[0001] The subject matter disclosed herein relates to masking systems and, more specifically, to pressure masking systems for treating articles with passageways.

[0002] In gas turbine engines, such as aircraft engines for example, air is drawn into the front of the engine, compressed by a shaft-mounted rotary-type compressor, and mixed with fuel. The mixture is burned, and the hot exhaust gases are passed through a turbine mounted on a shaft. The flow of gas turns the turbine, which turns the shaft and drives the compressor and fan. The hot exhaust gases flow from the back of the engine, driving it and the aircraft forward.

[0003] During operation of gas turbine engines, the temperatures of combustion gases may exceed approximately 1,649°C (3,000°F), considerably higher than the melting temperatures of the metal parts of the engine which are in contact with these gases. Operation of these engines at gas temperatures that are above the metal part melting temperatures is a well-established art, and depends in part on supplying a cooling air to the outer surfaces of the metal parts through various methods. The metal parts of these engines that are particularly subject to high temperatures, and thus require particular attention with respect to cooling, are the metal parts forming combustors and parts located aft of the combustor.

[0004] The metal temperatures can be maintained below melting levels by using passageways such as cooling holes incorporated into some engine components. Sometimes, thermal barrier coatings (TBCs) may also be applied to the component by a thermal spray process. However, the thermal spray process and other cleaning processes (e.g., grit blasting, shot peening, water jet washing) often result in overspray that partially or completely blocks the component's cooling holes.

[0005] As a result, present thermal spray and cleaning processes involve a multi-step, highly labor intensive process of applying a partial layer of TBC, allowing the component and the TBC to sufficiently cool to a temperature at which the component can easily be handled, removing the component from an application fixture on which the thermal spraying takes place, and removing any masking, which is then followed by separately removing the well-cooled, solidified coating from the cooling holes using a water jet or other cleaning methods. To prevent the cooling holes from becoming obstructed beyond a level from which they can be satisfactorily cleaned, only a fraction of the desired TBC thickness is applied prior to cleaning. As a result, the entire process must typically be repeated several times until the desired TBC thickness is reached. This complex process results in low productivity, high cycle time, and increases costs by a factor of five to ten times that of applying the same TBC to a similar non-holed part. Even when coatings are not applied, the pressure cleaning methods used to clean the target surfaces of articles can similarly overflow and obstruct the article's cooling holes.

[0006] Further, in treating components with an acid stripping or coating technique that involves submersing the component, masking is increasingly important as passageways and cooling holes may be fully submersed in an acid bath or coating. Previous techniques have utilized wax plugs in order to mask the component. However, these wax plugs can leak and must be removed after treating the component, which may leave portions of wax behind or allow debris to enter the passageways.

[0007] In one embodiment, a method of pressure cleaning a target surface of an article comprising one or more passageways is disclosed. The method includes fluidly connecting a pressure masker comprising pressurized masking fluid to a first side of at least one passageway, passing the pressurized masking fluid through the at least one passageway from the first side to a second side comprising the target surface, and, cleaning the target surface using a cleaning material, wherein the pressurized masking fluid passing through the at least one passageway prevents the cleaning material from permanently altering a cross sectional area of the at least one passageway.

[0008] In another embodiment, a pressurized masking system for cleaning a target surface of an article comprising passageways is disclosed. The pressurized masking system includes a pressure masker that fluidly connects to a first side of at least one passageway of the article and passes a pressurized masking fluid through the passageway from the first side to a second side, wherein the second side comprises the target surface. The pressurized masking system further includes a part cleaner that projects a cleaning material towards the target surface, wherein the pressurized masking fluid prevents the cleaning material from permanently altering a cross sectional area of the at least one passageway.

[0009] In another embodiment, a method of treating a target surface of an article including a passageway is disclosed. The method includes passing a pressurized masking fluid through the passageway from a first side to a second side including the target surface; and submerging at least a portion of the target surface in a treatment bath while passing the pressurized masking fluid through the passageway, wherein the pressurized masking fluid passing through the passageway substantially prevents the treatment bath from entering the passageway.

[0010] In another embodiment, a pressurized masking system for treating a target surface of an article including a passageway is disclosed. The pressurized masking system includes a pressure masker fluidly connected to a first side of the passageway of the article for passing a pressurized masking fluid through the passageway from the first side to a second side, wherein the second side includes the target surface. The pressurized masking system further includes a treatment bath comprising a treatment material to treat at least a portion of the target surface, wherein the pressurized masking fluid substantially prevents the treatment material from entering the

passageway.

[0011] These and additional features provided by the embodiments discussed herein will be more fully understood in view of the following detailed description, in conjunction with the drawings.

[0012] The embodiments set forth in the drawings are illustrative and exemplary in nature and not intended to limit the inventions defined by the claims. The following detailed description of the illustrative embodiments can be understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

FIG. 1 is a schematic illustration of a pressure masking system according to one or more embodiments shown or described herein;

FIG. 2 is a top view of a pressure masking system according to one or more embodiments shown or described herein;

FIG. 3 is a top view of another pressure masking system according to one or more embodiments shown or described herein;

FIG. 4 is a flow diagram illustrating a method of pressure cleaning an article using a pressure masking system according to one or more embodiments shown or described herein;

FIG. 5 is a flow diagram illustrating a method of acid stripping an article using a pressure masking system according to one or more embodiments shown or described herein;

FIG. 6 is a flow diagram illustrating a method of coating an article using a pressure masking system according to one or more embodiments shown or described herein;

FIG. 7 is a schematic illustration of a pressure masking system utilizing an acid bath according to one or more embodiments shown or described herein; and

[0013] One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of

design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0014] When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0015] Pressurized masking systems disclosed herein generally comprise a pressure masker and a part cleaner to treat the target surface of an article including one or more passageways. In some embodiments, treating may include cleaning the target surface. While the part cleaner projects cleaning material towards the target surface, pressurized masking fluid is fluidly connected to the passageway via a pressure masker and passed there-through to prevent the permanent altering of a cross sectional area of the passageway by the cleaning material. Pressurized masking systems, and methods of pressure cleaning a target surface of an article will be discussed in more detail herein.

[0016] Referring now to FIGS. 1-3, a pressurized masking system 100 is illustrated comprising a part cleaner 20 for projecting cleaning material and a pressure masker 30 for fluidly connecting pressurized masking fluid in order to clean an article 10. The article 10 comprises one or more passageways 12 passing through the article 10 from a first side 18 to a second side 19. As discussed above, the article 10 can comprise a variety of different parts such as a combustor liner or other component of a gas turbine engine. In some embodiments, the article 10 can comprise a turbine component such as a hot gas path component or a combustion component. The passageways 12 can comprise any passage through the article 10 (passing from the first side 18 to the second side 19) that is intended to remain open (such that air can pass through) when the article 10 is in use. For example, in some embodiments the passageways 12 may comprise cooling holes.

[0017] As best illustrated in FIGS. 2-3, the second side 19 of the article 10 comprises a target surface 11 that is to be cleaned. The target surface 11 may be cleaned prior to first use, during routine or repair maintenance, or as otherwise necessary depending on the life of the article 10. As used herein, "cleaned" refers to stripping, washing and/or treating the target surface such as through grit blasting, shot peening, water jet washing or the like as will become appreciated herein. For example, in some embodiments the target surface 11 of the article 10 may comprise a coating 22 or other debris that is to be removed prior to applying a fresh coating.

[0018] In some embodiments, such as when the article 10 comprises a metal hot gas path component, the target surface 11 of the article 10 may have or will have a thermal barrier coating ("TBC") disposed thereon. The TBC can comprise one or more layers of metal and/or ceramic coating material applied to the target surface 11 of the

article 10 to impede the transfer of heat from hot combustion gases to the article 10, thus insulating the component from the hot combustion gas. The presence of the TBC on the surface permits the combustion gas to be hotter than would otherwise be possible with the particular material and fabrication process of the component. Any suitable composition of TBC may be applied. For example, in some embodiments the TBC can comprise a bond layer of MCrAlY, wherein M is preferably Ni, Co, or a combination thereof, followed by a layer of yttria stabilized zirconia (YSZ).

[0019] In some embodiments, the article 10 may be disposed on a support stand 15 (FIG. 1) prior to or during the pressure cleaning as will become appreciated herein. The support stand 15 may be stationary or mobile (e.g., rotatable) and position the article 10 relative to the part cleaner 20 and the pressure masker 30 when cleaning the target surface 11 of the article 10.

[0020] Still referring to FIGS. 1-3, the pressurized masking system 100 further comprises the part cleaner 20. The part cleaner 20 comprises any device that projects a cleaning material 25 (FIGS. 2-3) towards the target surface 11 of the article 10. For example, in some embodiments, the part cleaner 20 can comprise a grit blaster. In such embodiments, the cleaning material 25 can comprise pressurized air with aluminum oxide, walnut shells, dry ice, charcoal, or any other particulates dispersed therein. In other embodiments, the part cleaner 20 can comprise a shot peening device. In such embodiments, the cleaning material 25 can comprise pressurized air with metallic, glass or ceramic particles dispersed therein. In even other embodiments, the part cleaner 20 may comprise a pressure washer. In such embodiments, the cleaning material 25 may comprise water with or without an additional abrasive material.

[0021] The part cleaner 20 may be disposed at any position relative to the article 10 that allows for the cleaning of the target surface 11. For example, as illustrated in FIG. 1, in some embodiments the article 10 may be disposed on a support stand 15 adjacent the part cleaner 20. The support stand 15 may then be able to rotate or otherwise displace the article 10 with respect to the part cleaner 20 and/or the part cleaner 20 may be able to articulate with respect to the article 10. The part cleaner 20 may then be used to project the cleaning material 25 towards the target surface 11 of the article 10. However, as a result of cleaning material 25 being projected toward the target surface 11 of the article 10, some of the cleaning material 25 may enter one or more of the passageways 12 from the second side 19 of the article 10. As such, some of the cleaning material 25, and more particularly any particulates (e.g., sand, shot, abrasives, etc.), may potentially form obstructions 32 in the one or more passageways 12 if left unopposed.

[0022] The part cleaner 20 may be used for a variety of applications to clean the target surface 11 of the article 10. For example in some embodiments the part cleaner 20 may be used to remove dirt or other contaminants

prior to applying a new coat. In some embodiments, the part cleaner 20 may be used to remove a previously applied coating that has since been worn and/or damaged. For example, in some embodiments the part cleaner 20 may be used to remove part or all of a TBC on the target surface 11 before reapplying or rejuvenating the TBC. In some embodiments, the part cleaner 20 may be used to remove one or more metallic coatings, contamination layers (e.g., rust, dirt, oxidation, etc.), diffused layers or other unwanted layers. While specific embodiments have been presented herein, it should be appreciated that these are illustrative only and any other application of the part cleaner 20 as part of the pressurized masking system 100 may also be realized.

[0023] Referring still to FIGS. 1-3, the pressurized masking system 100 further comprises a pressure masker 30. The pressure masker 30 comprises a fluid connection 31 that fluidly connects a source of masking fluid 35 to at least one passageway 12 of the article 10. As used herein, "fluid connection" refers to a connection that allows the pressurized masking fluid 35 to pass from the pressure masker 30 to the passageway 12 with negligible loss to the outside environment. The fluid connection can comprise, for example, flexible tubes, hoses, pipes or any other conduit that directs the passage of the pressurized masking fluid 35 to the one or more passageways 12.

[0024] In one embodiment, such as that illustrated in FIG. 2, the fluid connection 31 may comprise a tube that directly connects the output of the pressure masker 30 to the first side 18 of the passageway 12. In some embodiments, the fluid connection 31 may comprise a single tube between the pressure masker 30 and a single passageway 12 (such as that illustrated in FIG. 2). In other embodiments, the fluid connection may comprise a single tube leaving the pressure masker 30 that breaks off into segments that connect to a plurality of passageways 12 (such as that illustrated in FIG. 1). In even other embodiments, the fluid connection 31 may comprise a plurality of tubes leaving the pressure masker 30 that connects to a single or a plurality of passageways 12. For example, the fluid connection 31 may comprise a plurality of channels of similar or dissimilar pressurized masking fluids 35 that connect to two or more passageways. Moreover, the plurality of channels may comprise different pressures, temperatures, directions or mixtures of pressurized masking fluids 35. It should be appreciated that any other configuration that provides a fluid connection 31 between the pressure masker 30 and one or more passageways 12 may alternatively or additionally be realized.

[0025] For example, referring now to FIG. 3, in some embodiments the fluid connection 31 may comprise a multi-outlet manifold connection 40 comprising an internal passage 41 that can receive pressurized masking fluid 35 from the pressure masker 30 and fluidly distribute it to one or more passageways. The multi-outlet manifold connection 40 can thereby attach directly to the first side

18 of the article 10 and distribute the pressurized masking fluid 35 to a wide area about the article 10. Any passageways 12 within that area will thereby have pressurized masking fluid 35 fluidly pass there through.

[0026] The pressurized masking fluid 35 can comprise any medium that can pass through the passageway 12 with a positive energy and prevent the permanent altering of a cross sectional area of the at least one passageway by the cleaning material 25 (or particulates thereof). As used herein, "prevent the permanent altering of a cross sectional area" (and variants thereof) refers to removing and/or preventing substantially all of the cleaning material 25 that may enter the passageway 12 so that the cross sectional area of the passageway is not substantially reduced by a permanent obstruction 32 or increased due to erosion, deformation or the like. Examples of obstructions that would permanently alter the cross sectional area of the passageway 12 include, for example, large particulates lodged against a wall, a clumping of cleaning material 25 or the like. The pressurized masking fluid 35 may thereby comprise any material that can be forced through the one or more passageways 12 at a masking pressure to impact on and remove potential obstructions 32 from the cleaning material 25 that would alter the cross sectional area.

[0027] For example, in some embodiments, the pressurized masking fluid 35 may comprise a gas such as inert gas or nitrogen. Such embodiments may be realized when the part cleaner 20 comprises a grit blaster or shot peening device such that the gas can counter any sand, peen or other cleaning particulate from the part cleaner 20 that enters the passageway 12 and remove it therefrom. In some embodiments, the pressurized masking fluid 35 may comprise water with or without abrasives distributed therein. Such embodiments may be realized when the part cleaner 20 comprises a water jet or similar device. While specific embodiments of pressurized masking fluid and part cleaners have been presented herein, it should be appreciated that additional and alternative pressurized masking fluids and part cleaners may also be realized. Moreover, the pressurized masking fluid 35 may comprise a masking pressure that is greater than, equal to, or less than a cleaning pressure of the cleaning material so long as the pressurized masking fluid 35 has enough energy to remove obstructions 32 from the passageways 12. In other embodiments, the masking pressure may comprise a negative pressure (such as via a vacuum or suction element) on the second side 19 of the article 10 such that the negative pressure pulls the pressurized masking fluid 35 through the passageway 12. In some embodiments, the masking pressure may comprise a variable pressure that fluctuates during the masking process.

[0028] In operation, the pressure masker 30 thereby passes the pressurized masking fluid 35 through the at least one passageway 12 at a masking pressure from the first side 18 to the second side 19 (wherein the second side 19 comprises the target surface 11 of the article 10

that is to be cleaned). Likewise, the part cleaner 20 cleans the target surface 11 of the article 10 by projecting cleaning material 25 towards the target surface. As a result of flow pattern distributions, some of the cleaning material 25 may enter one or more passageways 12 and form one or more obstructions 32. For example, the obstructions 32 may comprise a grouping of particulates from the cleaning material that would decrease the cross sectional area of the passageway 12 and reduce the amount of air that could flow there through. However, to prevent the cleaning material 25 from permanently obstructing the at least one passageway 12 (and altering its cross sectional area), the pressurized masking fluid 35 will contact the obstruction 32 and push it back out of the passageway 12. In some embodiments, the pressurized masking fluid 35 may prevent any obstructions 32 from even entering the passageways 12 via the pressurized masking fluid 35 exiting the passageway 12 on the second side 19 of the article 10.

[0029] Referring now to FIGS. 1-4, a method 200 is illustrated for pressure cleaning a target surface 11 of an article 10 comprising one or more passageways 12. The method 200 first comprises fluidly connecting the pressure masker 30 to a first side 18 of at least one passageway 12 of the article 10 in step 210. As discussed above, the fluid connection 31 may comprise a variety of configurations and may connect any type of pressure masker 30 to any number of passageways 12. The pressure masker 30 then passes pressurized masking fluid 35 through the at least one passageway from the first side 18 to the second side 19 in step 220. Likewise, the part cleaner 20 cleans the target surface 11 on the second side 19 of the article 10 by projecting cleaning material 25 towards the target surface 11 in step 230.

[0030] It should be appreciated that passing pressurized masking fluid 35 through the at least one passageway 12 in step 220 and cleaning the target surface 11 in step 230 may start and end simultaneously in or with relative delay. For example, in some embodiments the pressurized masking fluid 35 may be passing through the passageway 12 in step 20 prior to the initiation of cleaning the target surface 11 in step 230. Such embodiments may prevent a buildup of obstructions 32 prior to activation of the pressure masker 30. In some embodiments, the pressurized masking fluid 35 may continue to pass through the passageway 12 in step 220 after the article 10 is cleaned in step 230. Such embodiments may help ensure any obstacles 32 remaining in the passageways 12 after cleaning is complete in step 230 are still removed by the pressurized masking fluid 35.

[0031] It should now be appreciated that pressurized masking systems may be used to clean the target surface of an article while preventing the permanent altering of a cross sectional area of one or more passageways. The use of a fluid connection between the pressure masker and the one or more passageways can prevent the need for physical masking barriers such as tape, wax or the like potentially providing a more efficient cleaning sys-

tem.

[0032] In a further embodiment, referring back to FIGS. 1-3 and 7, the pressurized masking system 100 may further comprise an acid stripping device 120 for treating target surface 11. In some embodiments, treating target surface 11 may comprise acid stripping target surface 11. Acid stripping device 120 comprises any device that applies an acid 125 towards target surface 11 of article 10, similar to part cleaner 20 of previous embodiments. This process is referred to as acid stripping, i.e., the removal of a coating or a material from target surface 11 of article 10 by applying an acid to target surface 11. For example, in some embodiments, a coating may have been added to target surface 11. In such embodiments, an acid 125 may be used to remove a portion of the coating or all of the coating on target surface 11. Further, pressurized masking system 100 may further comprise a coating device 520 for treating target surface 11. In some embodiments, treating target surface 11 may comprise applying a coating to, or coating, target surface 11. Coating device 520 could be used to apply a coating 525 to surface 11 of article 10. Any known coatings relevant to the art may be used, while any known coating techniques and the associated coating devices may be utilized.

[0033] As illustrated in FIG. 7, in one embodiment, article 10 may be fully or partially submersed in a treatment material within a treatment bath 145. At least a portion of target surface 11 of article 10 may be submersed in treatment bath 145. This can prevent the treatment material of treatment bath 145 from entering the passageway during the submersion. Treatment bath 145 can include a stripping bath. Stripping baths may include acid stripping baths, or stripping baths including solutions such as sodium hydroxide and potassium hydroxide. This can be useful for stripping ceramic coatings, such as coatings from Electron Beam Physical Vapor Deposition (EBPVD). For instance, treatment material may include acid 125 in an acid stripping bath 145 (FIG. 7), wherein article 11 may be partially or fully submersed in the treatment bath, while fluidly connected to pressure masker 30. In any event, pressure masker 30 prevents acid 125 from entering passageway(s) 12 of article 10 during acid stripping via an acid bath. In a further embodiment, pressure masker 30 can prevent any coating inside of passageway(s) 12 from being removed during the acid stripping. In yet another embodiment, treatment bath 145 may include, for instance, a coating bath with a treatment material including a coating 525. Such a coating bath can include a chemical bath or an electrolysis bath. In one example, a coating bath may comprise a bath of an aluminate coating. In using a coating bath, all or a portion of article 10 may be submerged in the coating. This coating could comprise the coating described above in reference to removing a coating via an acid stripping technique. Similar to the other embodiments, pressurized masking system 30 can prevent treatment material, including coating 525, from entering passageway(s) 12.

Treatment bath 145 may also include a cleaning bath. Cleaning baths can be used to clean target surface 11 after many processes. For instance, cleaning bath may include a treatment material comprising hot alkaline, pickling solution, or degreasing solutions.

[0034] Similar to the descriptions above, still referring still to FIGS. 1-3, pressurized masking system 100 used for treatment bath 145, including acid stripping, coating, or cleaning techniques, may further comprise a pressure masker 30. The pressure masker 30 may comprise a source of masking fluid 35 and any known pump to pass masking fluid 35. Pressure masker 30 may be used in conjunction with a fluid connection 31 that fluidly connects masking fluid 35 to passageway(s) 12 of article 10. As used herein, "fluid connection" refers to a connection that allows pressurized masking fluid 35 to pass from pressure masker 30 to passageway(s) 12 with negligible loss to the outside environment. Fluid connection 31 can comprise, for example, flexible tubes, hoses, pipes or any other conduit that directs the passage of the pressurized masking fluid 35 from pressure masker 30 to the passageway(s) 12.

[0035] In one embodiment, such as that illustrated in FIG. 2, fluid connection 31 may comprise a tube that directly connects the output of pressure masker 30 to first side 18 of passageway 12. In some embodiments, fluid connection 31 may comprise a single tube between pressure masker 30 and a single passageway 12 (such as that illustrated in FIG. 2). In other embodiments, fluid connection 31 may comprise a single tube (manifold) leaving pressure masker 30 that breaks off into segments that connect to a plurality of passageways 12 (such as that illustrated in FIG. 1). In even other embodiments, fluid connection 31 may comprise a plurality of tubes leaving pressure masker 30 that connects to a single or a plurality of passageways 12. For example, fluid connection 31 may comprise a plurality of fluid connections 31 of similar or dissimilar pressurized masking fluids 35 that connect to two or more passageways 12. Moreover, where a plurality of fluid connections 31 are used, they may employ different pressures, temperatures, directions or mixtures of pressurized masking fluids 35. It should be appreciated that any other configuration that provides a fluid connection 31 between the pressure masker 30 and one or more passageways 12 may alternatively or additionally be realized.

[0036] For example, referring now to FIG. 3, in some embodiments fluid connection 31 may comprise a multi-outlet manifold connection 40 comprising an internal passage 41 that can receive pressurized masking fluid 35 from pressure masker 30 and fluidly distribute it to one or more passageways. Multi-outlet manifold connection 40 can thereby attach directly to first side 18 of article 10 and distribute pressurized masking fluid 35 to a wide area about article 10. Any passageways 12 within that area will thereby have pressurized masking fluid 35 fluidly pass therethrough.

[0037] Pressurized masking fluid 35 can comprise any

medium that can pass through passageway(s) 12 with a positive energy and prevent the permanent altering of a cross sectional area of passageway(s) 12 by acid 125 or coating 525 (or particulates thereof) via treatment material of treatment bath 145. As used herein, "prevent the permanent altering of a cross sectional area" (and variants thereof) refers to removing and/or preventing substantially all of treatment material of treatment bath 145, acid 125, or coating 525 that may enter passageway(s) 12 so that the cross sectional area of the passageway 12 is not substantially reduced by a permanent obstruction 32 or increased due to erosion, deformation or the like. Examples of obstructions that would permanently alter the cross sectional area of passageway(s) 12 include, for example, large particulates lodged against a wall, a clumping of treatment material of treatment bath 145, acid 125, or coating 525 or the like. Pressurized masking fluid 35 may thereby comprise any material that can be forced through the passageway(s) 12 at a pressure to impact on and remove potential obstructions 32 from acid 125 or coating 525 that would alter the cross sectional area.

[0038] For example, in some embodiments, pressurized masking fluid 35 may comprise a gas such as inert gas or nitrogen. Such embodiments may be realized when acid stripping device 120 may cause the stripped material to enter any passageway(s) 12, such that the gas can counter any material removed by acid stripping device 120 that may enter passageway(s) 12 and remove it therefrom. Further embodiments may be realized when coating device 520 may cause coating 525 to enter any passageway(s) 12, such that the gas can counter any coating material applied by coating device 520 that may enter passageway(s) 12 and remove it therefrom. In some embodiments, pressurized masking fluid 35 may comprise water with or without abrasives distributed therein. While specific embodiments of pressurized masking fluid, part cleaners, acid stripping devices, and coating devices, and treatment material of treatment bath 145 have been presented herein, it should be appreciated that additional and alternative pressurized masking fluids and part cleaners, acid stripping devices, and coating devices may also be realized. Moreover, pressurized masking fluid 35 may comprise a masking pressure that is greater than, equal to, or less than a pressure of treatment material of treatment bath 145 or the applied acid 125 or coating 525 so long as pressurized masking fluid 35 has enough energy to remove obstructions 32 from passageway(s) 12. In other embodiments, the masking pressure may comprise a negative pressure (such as via a vacuum or suction element) on second side 19 of article 10 such that the negative pressure pulls pressurized masking fluid 35 through passageway(s) 12. In some embodiments, the masking pressure may comprise a variable pressure that fluctuates during the masking process.

[0039] In operation, pressure masker 30 thereby passes pressurized masking fluid 35 through the passageway(s) 12 at a masking pressure from first side 18 to

second side 19 (wherein second side 19 comprises target surface 11 of article 10 that is to be cleaned). Likewise, acid stripping device 120 or coating device 520 applies acid 125 or coating 525 to target surface 11 of article 10 by applying acid 125 or coating 525 towards target surface 11. As a result of flow pattern distributions, some of the material removed in the acid stripping process or some of coating 525 may enter passageway(s) 12 and form one or more obstructions 32. For example, obstructions 32 may comprise a grouping of removed material or applied coating that would decrease the cross sectional area of passageway 12 and reduce the amount of air that could flow therethrough. However, to prevent acid 125 or coating 525 from permanently obstructing the passageway 12 (and altering its cross sectional area), pressurized masking fluid 35 will contact obstruction 32 and push it back out of passageway 12. In some embodiments, pressurized masking fluid 35 may prevent any obstructions 32 from even entering passageway(s) 12 via pressurized masking fluid 35 exiting passageway 12 on second side 19 of article 10.

[0040] Referring now to FIGS. 1-3 and 5, a method 300 is illustrated for treating target surface 11 of article 10 including passageway(s) 12. The method 300 may fluidly connect pressure masker 30 to a first side 18 of passageway 12 of article 10 in step 310. As discussed above, fluid connection 31 may comprise a variety of configurations and may connect any type of pressure masker 30 to any number of passageways 12. Pressure masker 30 passes pressurized masking fluid 35 through passageway 12 from first side 18 to second side 19 in step 320. At least a portion of target surface 11 may then be submerged in treatment bath 145, which may be used to strip target surface 11 on second side 19 of article 10 by submersion in, for instance, an acid bath in step 330.

[0041] It should be appreciated that passing pressurized masking fluid 35 through passageway 12 in step 320 and acid stripping target surface 11 in step 330 may start and end simultaneously in or with relative delay. For example, in some embodiments pressurized masking fluid 35 may be passing through passageway 12 in step 320 prior to the initiation of acid stripping target surface 11 in step 330. Such embodiments may prevent a buildup of obstructions 32 prior to activation of pressure masker 30. In some embodiments, pressurized masking fluid 35 may continue to pass through passageway 12 in step 320 after article 10 is acid stripped in step 330. Such embodiments may help ensure any obstacles 32 remaining in passageway 12 after acid stripping is complete in step 330 are still removed by pressurized masking fluid 35.

[0042] Referring now to FIGS. 1-3 and 6, a method 400 is illustrated for treating a target surface 11 of an article 10 comprising one or more passageways 12. The method 400 may include fluidly connecting pressure masker 30 to a first side 18 of passageway 12 of article 10 in step 410. As discussed above, fluid connection 31 may comprise a variety of configurations and may connect any

type of pressure masker 30 to any number of passageways 12. Pressure masker 30 passes pressurized masking fluid 35 through passageway 12 from first side 18 to second side 19 in step 420. At least a portion of target surface 11 may then be submerged in treatment bath 145, which may be used to coat target surface 11 on second side 19 of article 10 by submersion in, for instance, a chemical bath in step 430.

[0043] It should be appreciated that passing pressurized masking fluid 35 through passageway 12 in step 420 and coating target surface 11 in step 430 may start and end simultaneously in or with relative delay. For example, in some embodiments pressurized masking fluid 35 may be passing through passageway 12 in step 420 prior to the initiation of coating target surface 11 in step 430. Such embodiments may prevent a buildup of obstructions 32 prior to activation of pressure masker 30. In some embodiments, pressurized masking fluid 35 may continue to pass through passageway 12 in step 420 after article 10 is coated in step 430. Such embodiments may help ensure any obstacles 32 remaining in passageway(s) 12 after coating is complete in step 430 are still removed by pressurized masking fluid 35.

[0044] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

[0045] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A method of treating a target surface of an article including a passageway, the method comprising:

passing a pressurized masking fluid through the passageway from a first side to a second side including the target surface; and

submerging at least a portion of the target surface in a treatment bath while passing the pressurized masking fluid through the passageway, wherein the pressurized masking fluid passing through the passageway substantially prevents the treatment bath from entering the passageway.

2. The method of clause 1, further comprising:

fluidly connecting the pressure masker including pressurized masking fluid to the first side of the passageway.

3. The method of any preceding clause, wherein the fluid connection includes a multi-outlet manifold connection that connects to the first side and comprises an internal passage, wherein the internal passage receives the pressurized masking fluid and fluidly distributes it to the passageway.

4. The method of any preceding clause, wherein the pressurized masking fluid includes a gas.

5. The method of any preceding clause, wherein the passageway includes a cooling hole.

6. The method of any preceding clause, wherein the pressurized masking fluid includes a liquid.

7. The method of any preceding clause, wherein the treatment bath comprises a stripping bath that strips at least a portion of the target surface when a portion of the target surface is submerged.

8. The method of any preceding clause, wherein the stripping bath comprises an acid stripping bath.

9. The method of any preceding clause, wherein the treatment bath comprises a coating bath that coats at least a portion of the target surface when a portion of the target surface is submerged.

10. The method of any preceding clause, wherein the coating bath comprises one of a chemical bath or an electrolysis bath.

11. The method of any preceding clause, wherein the treatment bath comprises a cleaning bath that cleans at least a portion of the target surface when a portion of the target surface is submerged.

12. The method of any preceding clause, wherein the pressurized masking fluid continues to pass through the passageway after the at least a portion of the target surface is no longer submerged.

13. A pressurized masking system for treating a target surface of an article including a passageway, the pressurized masking system comprising:

a pressure masker fluidly connected to a first side of the passageway of the article for passing a pressurized masking fluid through the passageway from the first side to a second side, wherein the second side includes the target surface; and

a treatment bath comprising a treatment material to treat at least a portion of the target surface, wherein the pressurized masking fluid substantially prevents the treatment material from entering the passageway.

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14. The pressurized masking system of any preceding clause, wherein the pressure masker includes a multi-outlet manifold connection connecting to the first side of the article and an internal passage receiving the pressurized masking fluid for fluidly distributing the pressurized masking fluid to the passageway.

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15. The pressurized masking system of any preceding clause, wherein the pressurized masking fluid includes a gas.

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16. The pressurized masking system of any preceding clause, wherein the pressurized masking fluid includes a liquid.

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17. The pressurized masking system of any preceding clause, wherein the treatment bath includes a stripping bath that strips at least a portion of the target surface when a portion of the target surface is submerged in the treatment bath.

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18. The pressurized masking system of any preceding clause, wherein the stripping bath comprises an acid stripping bath.

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19. The pressurized masking system of any preceding clause, wherein the treatment bath comprises a coating bath that coats at least a portion of the target surface when a portion of the target surface is submerged.

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20. The pressurized masking system of any preceding clause, wherein the coating bath comprises one of a chemical bath or an electrolysis bath.

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21. The pressurized masking system of any preceding clause, wherein the treatment bath comprises a cleaning bath that cleans at least a portion of the target surface when a portion of the target surface is submerged.

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Claims

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1. A method (200; 300; 400;) of treating a target surface of an article including a passageway, the method comprising:

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passing (220; 320; 420) a pressurized masking fluid through the passageway from a first side to a second side including the target surface;

and

submerging (230; 330; 430) at least a portion of the target surface in a treatment bath while passing the pressurized masking fluid through the passageway, wherein the pressurized masking fluid passing through the passageway substantially prevents the treatment bath from entering the passageway.

2. The method of claim 1, further comprising:

fluidly connecting (210; 310; 410) the pressure masker including pressurized masking fluid to the first side of the passageway.

3. The method of claim 2, wherein the fluid connection includes a multi-outlet manifold connection that connects to the first side and comprises an internal passage, wherein the internal passage receives the pressurized masking fluid and fluidly distributes it to the passageway.

4. The method of claim 1, 2 or 3, wherein the pressurized masking fluid includes: a gas, and/or a liquid.

5. The method of any preceding claim, wherein the passageway includes a cooling hole.

6. The method of any preceding claim, wherein the treatment bath comprises a stripping bath that strips at least a portion of the target surface when a portion of the target surface is submerged, wherein, preferably, the stripping bath comprises an acid stripping bath.

7. The method of any preceding claim, wherein the treatment bath comprises a coating bath that coats at least a portion of the target surface when a portion of the target surface is submerged, wherein, preferably, the coating bath comprises one of a chemical bath or an electrolysis bath.

8. The method of any preceding claim, wherein the treatment bath comprises a cleaning bath that cleans at least a portion of the target surface when a portion of the target surface is submerged.

9. The method of any preceding claim, wherein the pressurized masking fluid continues to pass through the passageway after the at least a portion of the target surface is no longer submerged.

10. A pressurized masking system (100) for treating a target surface (11) of an article (10) including a passageway (12), the pressurized masking system (100) comprising:

a pressure masker (30) fluidly connected to a

first side of the passageway (12) of the article (10) for passing a pressurized masking fluid (35) through the passageway (12) from the first side to a second side, wherein the second side includes the target surface (11); and
a treatment bath (145) comprising a treatment material to treat at least a portion of the target surface (11), wherein the pressurized masking fluid (35) substantially prevents the treatment material from entering the passageway (12).

11. The pressurized masking system of claim 10, wherein the pressure masker (30) includes a multi-outlet manifold connection (40) connecting to the first side of the article (10) and an internal passage receiving the pressurized masking fluid for fluidly distributing the pressurized masking fluid (35) to the passageway (12).
12. The pressurized masking system of claim 13, wherein the pressurized masking fluid (35) includes: a gas, and/or a liquid.
13. The pressurized masking system of claim 10, 11 or 12, wherein the treatment bath (145) includes a stripping bath that strips at least a portion of the target surface when a portion of the target surface is submerged in the treatment bath, wherein, preferably, the stripping bath comprises an acid stripping bath.
14. The pressurized masking system of any one of claims 10 to 13, wherein the treatment bath (145) comprises a coating bath that coats at least a portion of the target surface when a portion of the target surface is submerged, wherein, preferably, the coating bath comprises one of a chemical bath or an electrolysis bath.
15. The pressurized masking system of any one of claims 10 to 14, wherein the treatment bath (145) comprises a cleaning bath that cleans at least a portion of the target surface when a portion of the target surface is submerged.

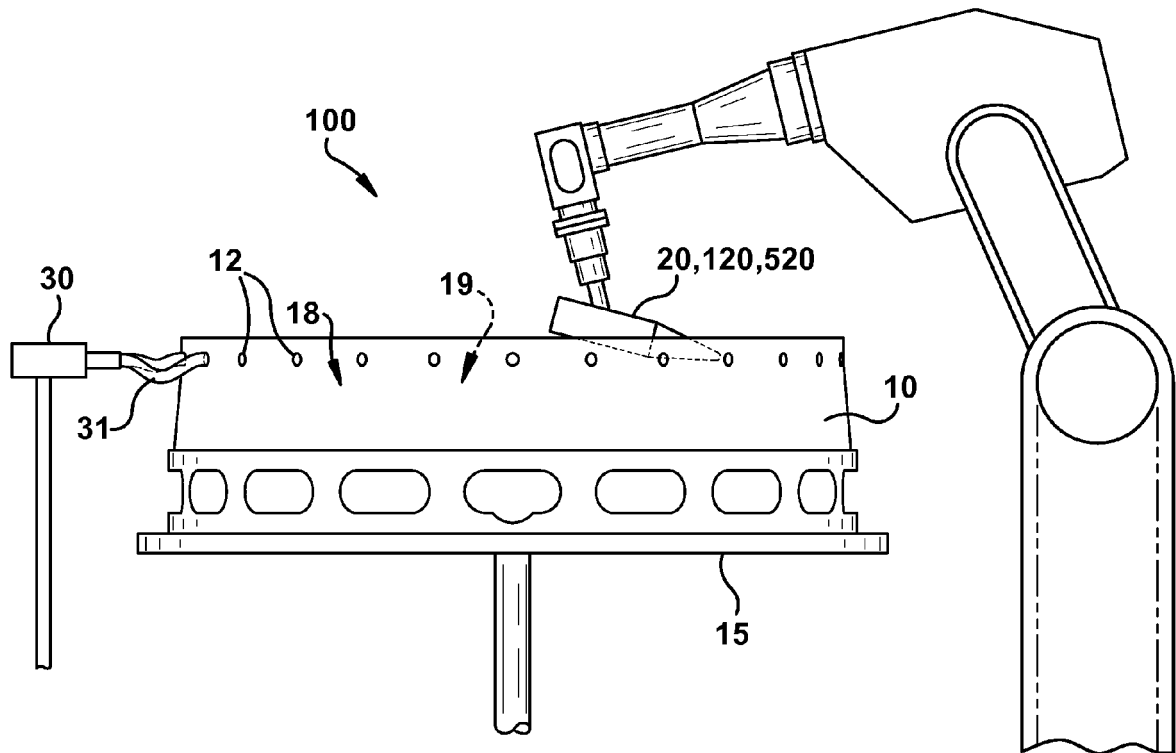


Fig. 1

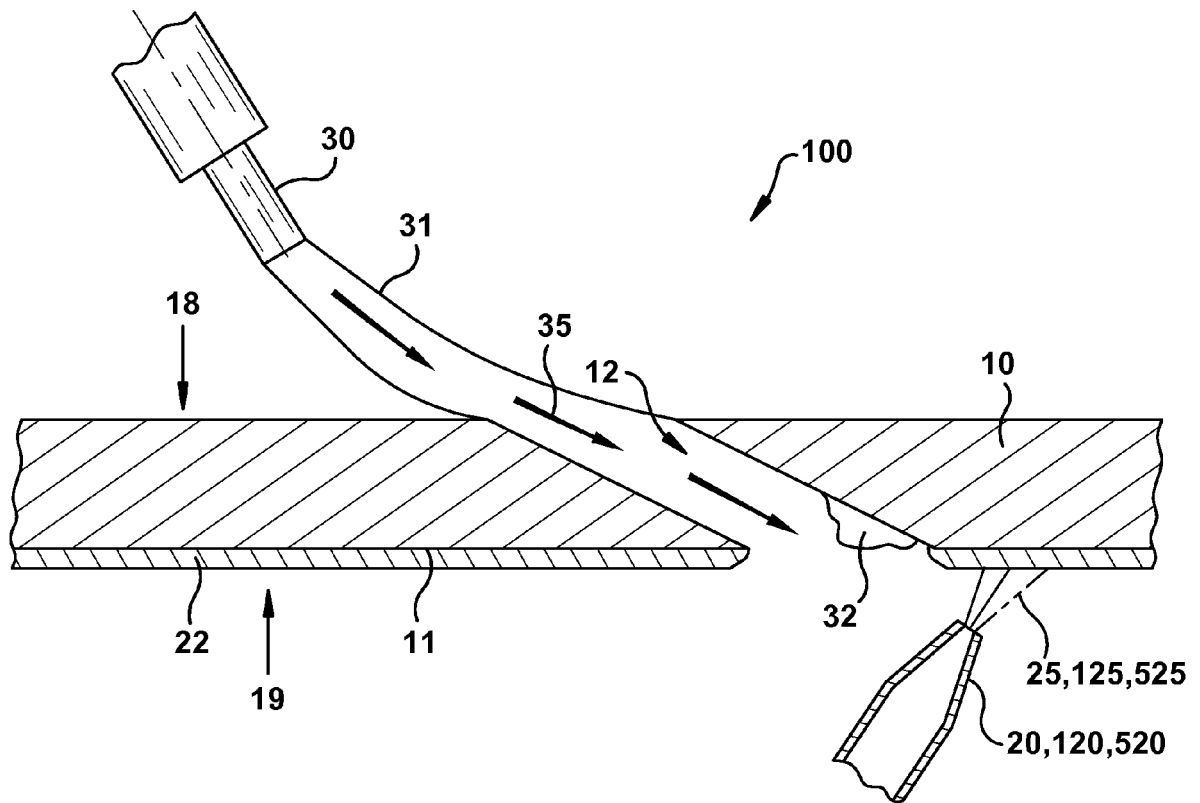


Fig. 2

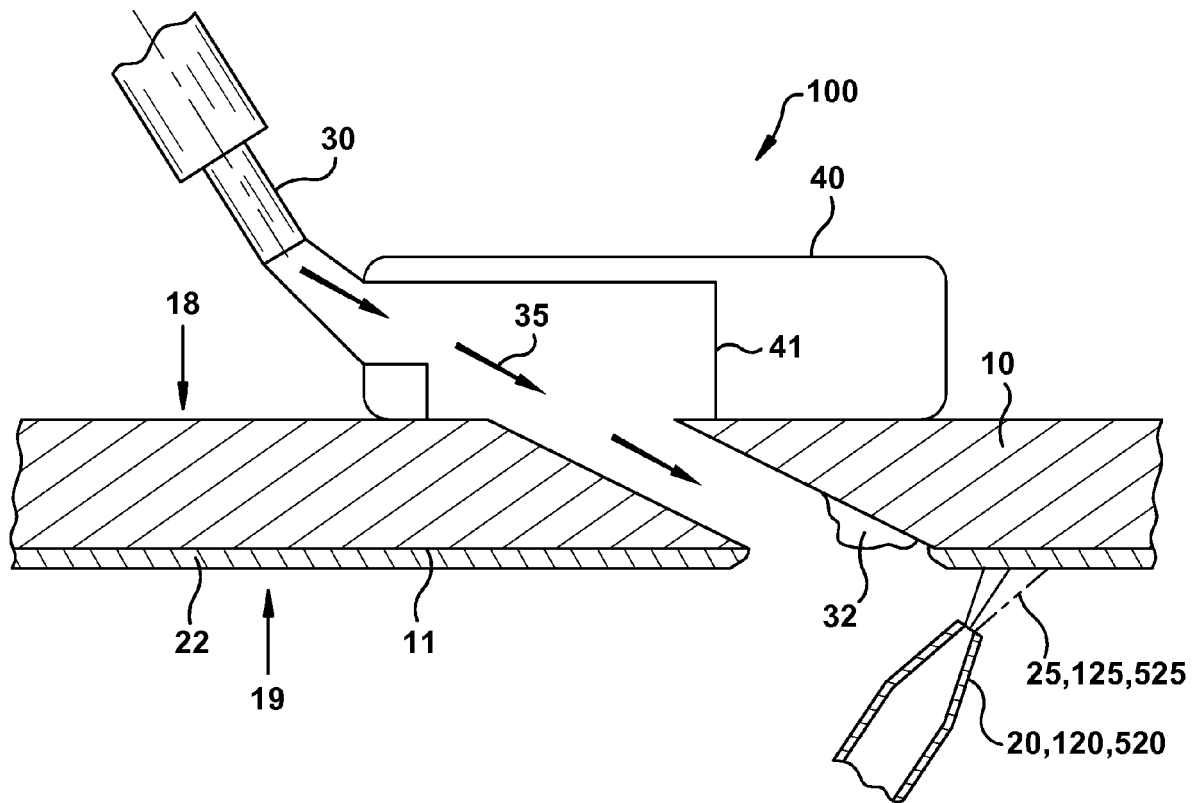


Fig. 3

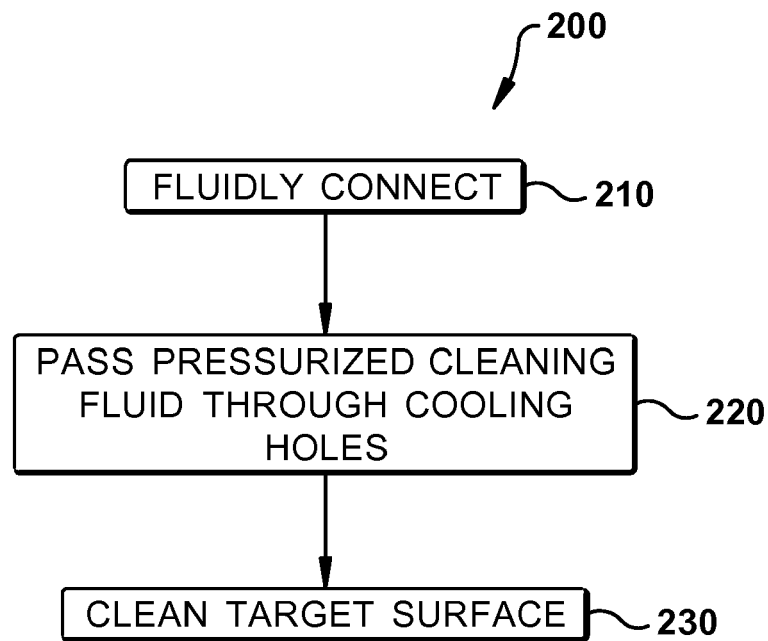


Fig. 4

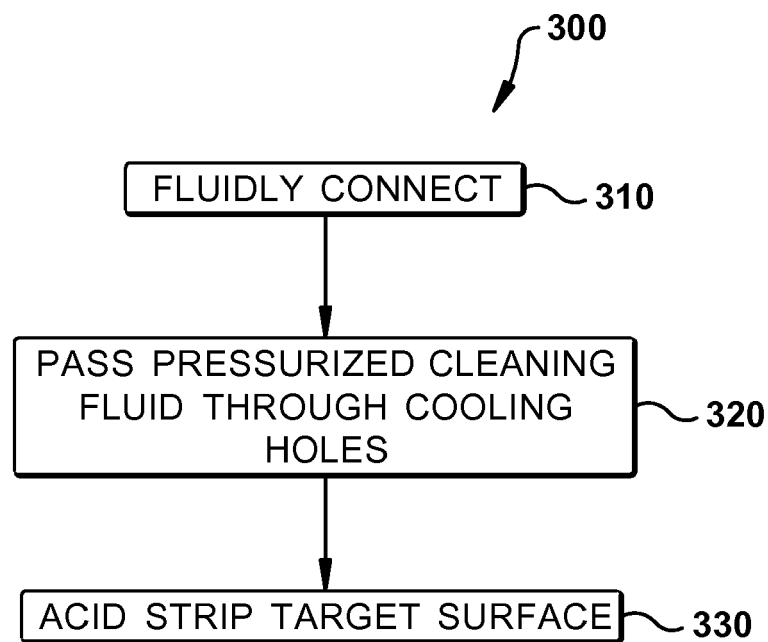


Fig. 5

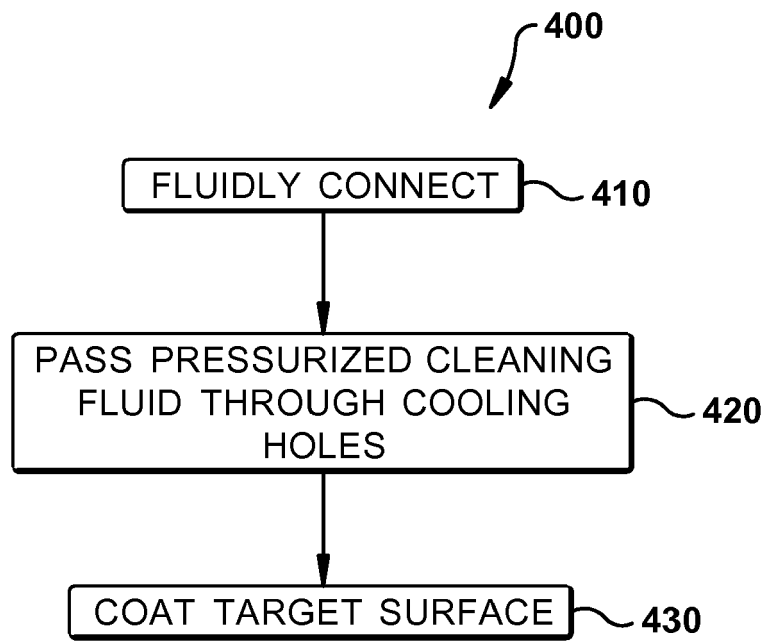


Fig. 6

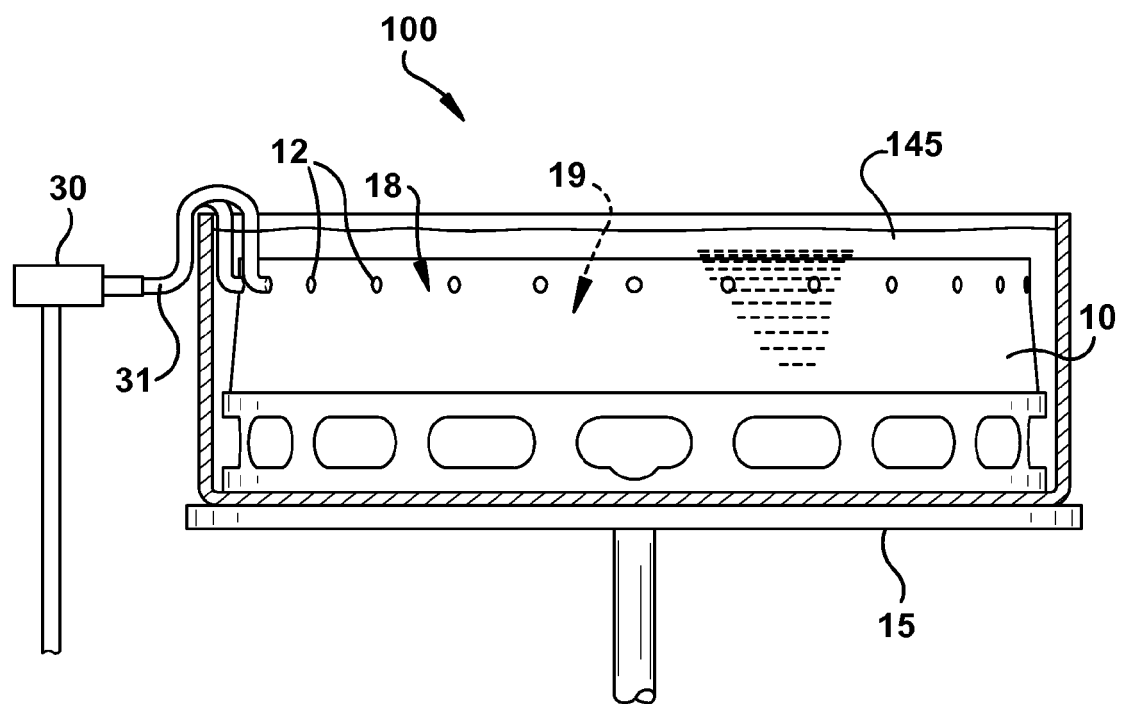


Fig. 7