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(54) **METHOD AND APPARATUS FOR TREATING A SURFACE**

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PROCÉDÉ ET APPAREIL DE TRAITEMENT D'UNE SURFACE

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## Description

**[0001]** This invention relates to methods and apparatus for treating surfaces. More particularly, but not exclusively, this invention relates to methods and apparatus for removing contaminants from surfaces.

**[0002]** The removal of contaminants from various surfaces usually involves the use of aggressive solvents or cleaners, or the use of mechanical methods such as sand blasting. Such methods can suffer from the disadvantage that physical or chemical damage may be caused to the substrate.

**[0003]** Patent specification No. US 4336073 discloses a glass cleaning process and apparatus.

**[0004]** According to one aspect of this invention, there is provided a method of treating a surface of an article with a surface treatment medium, said method comprising: providing a surface treatment apparatus comprising an absorbent member for holding the surface treatment medium, said absorbent member having a facing portion to contact the surface, a mounting member defining a recess to receive the absorbent member, wherein the mounting member has a sealing arrangement to provide a seal extending around the absorbent member; allowing the absorbent member to hold the surface treatment medium; effecting contact between the surface treatment medium and the surface for a sufficient period of time to effect the treatment of the surface; characterised in that the method further includes effecting engagement of the sealing arrangement either with the article or with a further component of the apparatus to form a seal against either said article or said further component to prevent leakage of the surface treatment medium from the apparatus.

**[0005]** According to another aspect of this invention, there is provided a surface treatment apparatus for treating a surface of an article with a surface treatment medium, the apparatus comprising: an absorbent member to hold the surface treatment medium, the absorbent member having a facing portion to contact the surface; a mounting member defining a recess to receive the absorbent member, wherein the mounting member comprises a main portion and a sealing arrangement extending around the absorbent member, the sealing arrangement comprising an edge arrangement; characterised in that the edge arrangement extends from the main portion to a region level with or beyond said facing portion to engage either the article or a further component of the apparatus to form a seal against either said article or said further component to prevent leakage of the surface treatment medium from the apparatus.

**[0006]** The mounting member may comprise a receiving member for receiving the absorbent member.

**[0007]** The recess may correspond with the shape of at least a region of the article. The recess can receive said region of the article to provide said intimate contact between the facing portion and said region of the article. The recess may surround, or partially surround, a non-planar region of the article, to provide the aforesaid intimate contact therewith.

**[0008]** At least a part of the mounting member may be inflatable to apply a pressure to press the absorbent member on the article. The mounting member may include a resistant member, which may be inflatable to apply the aforesaid pressure.

**[0009]** The absorbent member may comprise a pad, and may be formed of an absorbent material. The absorbent material may be capable of absorbing and retaining the surface treatment medium in intimate contact with the surface. The absorbent member may be flexible.

**[0010]** Suitable absorbent materials may comprise a foamed, natural or artificial polymer such as rubber or polyurethane; a woven or non-woven textile comprising natural or synthetic fibres such as wool, polyester, cellulose, glass, carbon or ceramic; an organic, inorganic or mineral-based powder such as starch, zeolite or talc or a hollow fibre material.The hollow fibre materials may comprise cellulosic fibre pads.

**[0011]** The mounting member may be chemically resistant to the surface treatment medium.

**[0012]** The sealing arrangement may comprise a main edge member and a seal member extending from the edge member, the seal member being configured to provide aforesaid seal. The seal member may comprise a suitable sealing material, such as a fluoroelastomer, thermoplastic elastomer, silicone rubber, nitrile rubber.

**[0013]** The surface may be the surface of an article. The seal member may be configured to engage either the article to be treated, or a further component of the apparatus.

**[0014]** The apparatus may include a base member upon which the mounting member may be mounted. The seal arrangement may form a seal by engaging the base member. The base member may be arrangeable above and/or below the mounting member.

**[0015]** The recess may surround, or partially surround, the non-planar region of the article, to provide the aforesaid intimate contact therewith.

**[0016]** The apparatus may comprise first and second opposed mounting members, each defining a respective recess. The apparatus may include first and second absorbent members, each being received on the formation of the respective first and second mounting members. The first and second mounting members may be arrangeable in face to face contact with each other. Each formation may be configured to mount thereon a region of the article when the first and second mounting members are in said face to face contact.

**[0017]** The apparatus may include securing means to hold the first and second mounting members in said face to face contact.

**[0018]** The first and second opposed mounting members may surround the article when the first and second mounting

members are secured to one another. The pressure control means may be operated to increase or decrease the pressure between the first and second mounting members.

**[0019]** The first and second mounting members may provide a casing to encase the article when the first and second mounting members are in face to face contact. The pressure control means may comprise a pump to pump air into or out of the casing to increase or decrease the pressure therein.

**[0020]** The absorbent member may be chemically resistant to the surface treatment medium, and may be thermally stable. The absorbent member may be configured to correspond with the shape of the region of the article to be treated. In one embodiment, the absorbent member may be generally planar. In another embodiment, the absorbent member may be curved. In another embodiment, the absorbent member may define a recess to correspond to the shape of the region of the article to be treated.

**[0021]** The absorbent member may have a facing portion to engage the surface of the article to be treated. In one embodiment, the facing portion may constitute part of the absorbent member. In this embodiment, the absorbent member may be formed of a material having a smoothness of 4 to 5 on the American Association of Textile Colorists and Chemists. (AATCC) scale, preferably, substantially 5 on the AATCC scale.

**[0022]** In another embodiment, the facing portion may comprise a facing layer on the absorbent member. The facing layer may be formed of a material having a surface smoothness of 4 to 5 on the AATCC scale, preferably, substantially, 5 on the AATCC scale.

**[0023]** The apparatus may further include a resistant element on the absorbent member. The resistant element may be provided between the absorbent member and the mounting member.

**[0024]** The resistant element may be provided to prevent leakage of the surface treatment medium from the absorbent member. The resistant element may retain the integrity of the absorbent member.

**[0025]** In one embodiment, the resistant element may have an edge portion to extend around the absorbent member. The edge portion of the resistant element may contribute to the sealing of the mounting member.

**[0026]** The resistant element may be formed of a material that is chemically resistant to the surface treatment medium, and may be inert to the surface treatment medium. The resistant element is desirably not adhesively bonded to the absorbent member.

**[0027]** The resistant element may be thermally stable, particularly at the temperatures used during the treatment of the article.

**[0028]** In one embodiment, the resistant element may comprise a film provided on the absorbent member. The film may be chemically inert. The film may be thermally stable, particularly at the temperatures used during the treatment of the article. The film may be formed of a metallic foil, or a polymeric material, such as a polyimide. Suitable films are sold under the trade mark KAPTON.

**[0029]** The mounting member may be chemically resistant to the surface treatment medium. It is desired that the mounting member is substantially chemically inert to the surface treatment medium.

**[0030]** The mounting member may constitute an insulating member, and may insulate the absorbent member thermally. The mounting member may insulate the absorbent member chemically. The mounting member may chemically protect the heating element.

**[0031]** The feature of the mounting member being thermally insulating provides an advantage in the embodiments described herein that it allows the surface treatment processes to be carried out above and below room temperature.

**[0032]** The mounting member is desirably thermally stable, particularly at the temperatures used during the treatment of the article.

**[0033]** The mounting member may include a main portion extending over the absorbent member. The edge arrangement may extend from the main portion. In one embodiment, the edge arrangement may depend from the main portion.

**[0034]** The apparatus may include a pressure control means to apply pressure to the absorbent member. The pressure control means may be arranged to apply a substantially uniform pressure across the absorbent member.

**[0035]** The pressure control means may comprise a weight on or in the mounting member. Alternatively, the pressure control means may comprise opposed pressure members which may be secured to one another in a pressure applying relationship by securing members.

**[0036]** The apparatus may include a temperature control means to control the temperature of the surface treatment medium. The temperature control means may be associated with the mounting member, and may comprise heating and/or cooling elements, which may be arranged within the mounting member.

**[0037]** The temperature control means may further include a conduit arrangement to provide a heated or cooled fluid to the heating and/or cooling elements.

**[0038]** Alternatively, the heating and/or cooling elements may be electrically operated to heat or cool the mounting member. An electrical controller may be provided to control the heating and/or cooling elements.

**[0039]** The surface treatment medium can be selected from one or more of the following group of surface treatment media: aqueous/non aqueous surfactant based solutions; aqueous solutions of inorganic/organic compounds; non-aqueous solutions of inorganic/organic compounds; polar aprotic solvents; hydrocarbon solvents; mono-basic esters;

di-basic esters; tri-basic esters; glycols; glycol ethers; cyclic carbonates; ketones; alcohols; ionic liquids; liquid organic or inorganic compounds; enzymatic solutions.

**[0040]** The step of applying the surface treatment medium to the absorbent member may comprise impregnating the absorbent member with the surface treatment medium.

**[0041]** The step of applying the absorbent member to the article may comprise applying a force to the absorbent member sufficient to effect intimate contact between the absorbent member and the substrate.

**[0042]** The step of contacting the surface treatment medium with the surface of the article may comprise effecting the aforesaid contact for a period of time of substantially 5 minutes to substantially 24 hours. The aforesaid contact between the surface treatment medium and the surface of the article is desirably effected for a period of time of substantially 15 minutes to substantially 8 hours. The aforesaid contact between the surface treatment medium and the surface of the article is more desirably effected for a period of time of substantially 20 minutes to substantially 2 hours.

**[0043]** In one embodiment, the method may comprise maintaining the absorbent member in a substantially static condition relative to the surface during the treatment of the surface.

**[0044]** The aforesaid treatment temperature may be between the melting and boiling points of the surface treatment medium. The aforesaid treatment temperature may be within a range of -60°C to 300°C. The treatment temperature is desirably within a range of -20°C to 250°C. The treatment temperature is more desirably within a range of 0°C to 200°C.

**[0045]** The step of arranging the absorbent member on or around the article may comprise heating the absorbent member for the aforesaid period of time.

**[0046]** In a first embodiment, the aforesaid treatment temperature may be within the range of 10°C to 90°C. The treatment temperature is desirably within the range of 25°C to 80°C. The treatment temperature may be within the range of 35°C to 75°C.

**[0047]** The treatment temperature ranges specified for the first embodiment may be suitable for use with surface treatment media comprising aqueous surfactant based solutions and/or aqueous solutions of inorganic and/or organic compounds.

**[0048]** In a second embodiment, the aforesaid treatment temperature may be within a range of 20°C to 180°C. The treatment temperature is desirably within a range of 70°C to 120°C. The treatment temperature may be within a range of 85°C to 105°C. The treatment temperature ranges specified for the second embodiment may be suitable for use with surface treatment media comprising polar aprotic solvents.

**[0049]** In a third embodiment, the aforesaid treatment temperature may be within a range of 0°C to 160°C. The treatment temperature is desirably within a range of 50°C to 110°C. The treatment temperature may be within a range of 65°C to 85°C.

**[0050]** The treatment temperature ranges specified for the third embodiment may be suitable for use with surface treatment media comprising hydrocarbon solvents.

**[0051]** In a fourth embodiment, the aforesaid treatment temperature may be within a range of -50°C to 170°C. The treatment temperature is desirably within a range of 0°C to 170°C. The treatment temperature may be within a range of 70°C to 120°C.

**[0052]** The treatment temperature ranges specified for the fourth embodiment may be suitable for use with surface treatment media comprising mono-basic, di-basic, and/or tribasic esters.

**[0053]** In a fifth embodiment, the aforesaid treatment temperature may be within a range of -60°C to 220°C. The treatment temperature is desirably within a range of -20°C to 180°C. The treatment temperature may be within a range of 0°C to 90°C.

**[0054]** The treatment temperature ranges specified for the fifth embodiment may be suitable for use with glycols and/or glycol ethers.

**[0055]** In a sixth embodiment, the aforesaid treatment temperature may be within a range of -50°C to 220°C. The treatment temperature may be within a range of -10°C to 180°C. The treatment temperature may be within a range of 10°C to 90°C.

**[0056]** The temperature ranges specified for the sixth embodiment may be suitable for use with cyclic carbonates.

**[0057]** In a seventh embodiment, the aforesaid treatment temperature may be within a range of -40°C to 170°C. The treatment temperature is desirably within a range of 0°C to 120°C. The treatment temperature may be within a range of 30°C to 60°C.

**[0058]** The temperature ranges specified for the seventh embodiment may be suitable for use with ketones and/or alcohols.

**[0059]** In an eighth embodiment, the aforesaid treatment temperature may be within a range of -50°C to 300°C. The treatment temperature is desirably within a range of 20°C to 250°C. The treatment temperature may be within a range of 50°C to 200°C.

**[0060]** The temperature ranges specified for the eighth embodiment may be suitable for use with ionic liquids.

**[0061]** In an ninth embodiment, the aforesaid treatment temperature may be within a range of 25°C to 70°C. The treatment temperature is desirably within a range of 35°C to 65°C. The treatment temperature may be within a range of

45°C to 60°C.

**[0062]** The temperature ranges specified for the ninth embodiment may be suitable for use with enzymatic solutions.

**[0063]** The step of heating the absorbent member may comprise the use of an electric heater, hot water or steam, or any other suitable heating arrangement.

**[0064]** The absorbent member may have a surface treatment medium thereon. The absorbent member may be impregnated with the surface treatment medium.

**[0065]** The article may comprise a substrate having a substance thereon. The method and apparatus may comprise a method and apparatus for removing the substance from the substrate. The method and apparatus may comprise a method and apparatus for cleaning a surface.

**[0066]** In one embodiment, the absorbent member may comprise a pad comprising a first flexible pad element formed of an absorbent material. The absorbent material is desirably capable of absorbing and retaining the surface treatment medium in intimate contact with the substrate.

**[0067]** The first flexible pad element may be chemically resistant to the surface treatment medium and, where appropriate, thermally resistant to the temperature used. The first flexible pad element may be a generally planar element.

**[0068]** In this embodiment, the absorbent member may further include a second flexible pad element, which may be chemically resistant to the surface treatment medium and, where appropriate, thermally resistant to the temperature used. In the embodiments where the second flexible pad element is used, the second embodiment provides the advantage that it protects the heater and/or the operator from the surface treatment medium.

**[0069]** The second flexible element may comprise a backing material. The second flexible pad element may be a generally planar element. The backing material may be provided to give protection for the heating element against the surface treatment medium during use. The backing material may include an insulating component.

**[0070]** The second flexible element may comprise a chemically and/or thermally stable film that may prevent leakage. This feature provides an advantage in one embodiment of providing chemical resistance and/or protection. Alternatively, the second flexible element may comprise an element having integral thermal insulation and chemical and/or thermal stability.

**[0071]** In one embodiment, the absorbent member may further include a third pad element, which may be a retaining element. The retaining element may be provided to retain the integrity of the first flexible element during use, for example when the absorbent member is placed on and/or removed from the substrate. The retaining element may be a generally planar element

**[0072]** The first flexible pad element may be formed from one or more of the following: a foamed, natural or artificial polymer such as rubber or polyurethane; a woven or non-woven textile comprising natural or synthetic fibres such as wool, polyester, cellulose, glass, carbon or ceramic; an organic, inorganic or mineral-based powder such as starch, zeolite or talc or a hollow fibre material..The hollow fibre materials may comprise cellulosic fibre pads.

**[0073]** The second flexible pad element may be formed of one or more of the following: a glass fibre or mineral wool, a cellulose padding material, or a high-temperature polymeric material, such as a polyimide film; a metallic foil or sheet, such as aluminium or steel, The polymer film may comprise a fluorinated polymer, nylon, a polyolefin, a block copolymer, or an elastomer.

**[0074]** The retaining element may be formed of a holding material capable of holding a powder, such as a non woven textile, microporous polymer sheeting, metallic, polymeric or woven gauze. The holding material may provide a scaffold to retain the powder material. The holding material may provide a substantially smooth surface.

**[0075]** The absorbent member may include an insulating element, which may comprise a glass fibre or mineral wool, a cellulose padding material, or a high-temperature polymeric material, such as a polyimide film.

**[0076]** The substance may comprise a contaminant. The substance may be chemically bonded to the substrate. The surface treatment medium may comprise a cleaning agent, which may be for removing a contaminant from the surface of the substrate. The cleaning agent may comprise a cleaning material. The surface treatment medium may comprise a cleaning formulation.

**[0077]** The substrate may have a surface having a layer of an oxide thereon.

**[0078]** The substrate may comprise a metallic substrate, which may be a ferrous based substrate, a light alloy such as an aluminium, a magnesium or a titanium alloy. Alternatively, the substrate may comprise a polymeric substrate, which may comprise a polyolefin, such as polyethylene or polypropylene, or other polymer. Alternatively, the substrate may comprise a ceramic material.

**[0079]** The surface treatment medium may comprise a liquid, which may comprise a solvent, such as an aqueous or non-aqueous solvent. The non-aqueous solvent may be an organic solvent. Alternatively, the liquid may comprise a soap solution or a liquid organic or inorganic compound. The surface treatment medium may be any suitable liquid capable of removing the substance from the substrate.

**[0080]** The surface treatment medium may comprise one or more selected from: aqueous/non aqueous, surfactant based solutions; aqueous/nonaqeous solutions of inorganic/organic compounds; polar aprotic solvents; hydrocarbon solvents; mono-basic, di-basic and/or tri-basic esters; glycols and/or glycol ethers; cyclic carbonates; ketones and/or

alcohols; ionic liquids; liquid organic or inorganic compounds; enzymatic solutions.

**[0081]** The aqueous/nonaqueous, surfactant based solutions may be for example cationic, anionic, non-ionic, amphoteric surfactant based solutions, but it will be appreciated by the skilled person that other aqueous/nonaqueous, surfactant based solutions may be used.

**[0082]** The aqueous/nonaqueous solutions of inorganic/organic compounds may be, for example hydrogen peroxide, sodium carbonate, sodium hypochlorite but it will be appreciated by the skilled person that other aqueous/nonaqueous solutions of inorganic/organic compounds may be used.

**[0083]** The polar aprotic solvents may be, for example dimethyl sulphoxide, n-methyl pyrrolidone but it will be appreciated by the skilled person that other polar aprotic solvents may be used.

**[0084]** The hydrocarbon solvents may be, for example d-limonene, pinene but it will be appreciated by the skilled person that other hydrocarbon solvents may be used.

**[0085]** The mono-basic, di-basic and/or tri-basic esters may be, for example ethyl lactate, butyl acetate, dimethyl succinate, triethyl citrate but it will be appreciated by the skilled person that other mono-basic, di-basic and/or tri-basic esters may be used.

**[0086]** The glycols and/or glycol ethers may be, for example diethylene glycol, monobutyl ether but it will be appreciated by the skilled person that other glycols and/or glycol ethers may be used.

**[0087]** The cyclic carbonates may be, for example propylene carbonate but it will be appreciated by the skilled person that other cyclic carbonates may be used.

**[0088]** The ketones and/or alcohols may be, for example butyl carbitol, γ-butyrolactone but it will be appreciated by the skilled person that other ketones and/or alcohols may be used.

**[0089]** The ionic liquid may be, for example 1-ethyl,3-methyl, imidazolium, tetrachloro-aluminium [EMI][TCA] but it will be appreciated by the skilled person that other ionic liquids may be used.

**[0090]** The enzymatic solutions may be, for example, solutions of protease, lipase, cellulase but it will be appreciated by the skilled person that other enzymatic solutions may be used.

**[0091]** The apparatus may comprise an inert member arranged on the absorbent member. It will be understood that in the embodiments described herein, the inert member comprises a material that is chemically resistant to the surface treatment medium.

**[0092]** The inert member may comprise a thermally insulating material. This feature provides the advantage in some embodiments of the invention that it prevents or mitigates heat transfer into or out of the apparatus.

**[0093]** The apparatus may comprise a force applying member for applying a force to the absorbent member to maintain intimate contact of the absorbent member and the surface treatment medium with the substance.

**[0094]** The apparatus may comprise a plurality of layers. The apparatus may comprise a first layer comprising the absorbent member, and a second layer comprising the heating arrangement. The first and second layers may be in contact with each other.

**[0095]** The apparatus may further comprise a third layer, which may comprise the inert member. The third layer may be arranged on the second layer.

**[0096]** The apparatus may comprise a fourth layer, which may comprise the force applying member.

**[0097]** The apparatus may be generally flat for application to a planar surface. In a variation of this configuration, the apparatus may be curved for application to a curved surface. In the first embodiment, the force applying member may comprise a weight for applying the force to the absorbent member.

**[0098]** Alternatively, the inert member may be arranged between the absorbent member and the heating arrangement. The inert member may be sufficiently thermally conductive to allow heat to be conducted to the absorbent member.

**[0099]** The force applying member may comprise a weight for applying the force to the absorbent member.

**[0100]** In a further variation, the apparatus may comprise a container for holding the article. The absorbent member may be provided in first and second parts engageable with one another to surround the article.

**[0101]** The absorbent member may define a recess, or a pair of opposed recesses in which the article can be received. The opposed recesses are preferably aligned with one another and may effect intimate contact between the article and the absorbent member.

**[0102]** The force applying member may comprise a casing to hold the absorbent member. The casing may be secured in a closed position to apply the force to the absorbent member.

**[0103]** After the above treatment steps, the method may comprise subjecting the article to a rinsing or washing stage to remove the contaminant therefrom.

**[0104]** Embodiments of the invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a sectional side view of a first embodiment of a surface treatment apparatus;

Figure 2 is a sectional side view of a variation of the first embodiment;

Figure 3 is a sectional side view of a second embodiment of a surface treatment apparatus;

Figure 4 is a perspective view of a third embodiment of a surface treatment apparatus;

Figure 5 is a sectional side view of an absorbent member;

Figure 6 is a sectional side view of a sixth embodiment of a surface treatment apparatus;

Figure 7 is a graph showing comparative results in the cleaning of a surface in accordance with an embodiment of the invention;

Figure 8 is a graph showing comparative results in the cleaning of a surface in accordance with another embodiment of the invention; and

Figure 9 shows the results of an XPS Survey of a contaminated aluminium sheet before and after cleaning.

**[0105]** Referring to Figure 1, there is shown a diagrammatic sectional side view of a first embodiment of an apparatus 10 for treating an article 12. The article 12 comprises a substrate 14 and a contaminant 16 on the surface 18 of the substrate 14.

**[0106]** In some circumstances, for example where the substrate 14 is in the form of a metal, an oxide may form on the surface of the metal. While not wishing to be limited to any particular theory, it is believed that the contaminants form chemical bonds with the oxide on the surface 18.

**[0107]** The apparatus 10 comprises an absorbent member in the form of a pad 20 comprising an absorbent material, which can be impregnated with a suitable surface treatment medium, in the form of a solvent or cleaning agent. If desired, the pad can be supplied impregnated with the surface treatment medium. The pad 20 is described in more detail below.

**[0108]** The apparatus 10 includes a mounting member, in the form of a receiving member 23 defining a recess 25. The pad 20 is held within the recess 25. The mounting member 23 includes a sealing arrangement 27 which defines the recess 25.

**[0109]** The receiving member 23 includes a main part 23A extending over the pad 20. The sealing arrangement 27 is in the form of downwardly depending wall members extending from the main part 23A to seal against the article 12, or in some cases against a further component of the apparatus 10.

**[0110]** In the embodiments described herein, the surface treatment medium comprises a cleaning agent for removing a contaminant from the surface of the substrate 14. The cleaning agent can be selected from the cleaning agents listed in Table 1 below.

**[0111]** It will be appreciated by the skilled person that the list of cleaning agents in Table 1 is not an exhaustive list, and other cleaning agents can be used.

**[0112]** The substrate may be selected from substrates listed in Table 1 below. It will be appreciated by the skilled person that the list of substrates in Table 1 is not an exhaustive list, and other substrates can be used.

**[0113]** The pad 20 has a facing portion 22 which is arranged in intimate contact with the surface 18 of the substrate 14, and thereby also in intimate contact with the contaminant 16 on the surface 18.

**[0114]** A heating arrangement 24 is provided in the receiving member 23. The heating arrangement extends over the pad 20 to provide heat to the pad 20, thereby heating the surface treatment medium and the contaminant 16.

**[0115]** The heating arrangement 24 can be any suitable heating arrangement, for example and electric heater or assembly to receive hot water or steam. The heating source or power supply 26 provides the electric power, or supplies the heating medium, to the heating arrangement 24.

**[0116]** An example of the pad 20 is shown in Figure 5, and comprises a first flexible pad element 21A, which is generally planar in configuration. The first flexible element is formed of an absorbent material to absorb the surface treatment medium.

**[0117]** The first flexible pad element 21A may be formed from one or more of the following: a foamed, natural or artificial polymer such as rubber or polyurethane; a woven or non-woven textile comprising natural or synthetic fibres such as wool, polyester, cellulose, glass, carbon or ceramic; an organic, inorganic or mineral-based powder such as starch, zeolite or talc or a hollow fibre material.. The hollow fibre materials may comprise cellulosic fibre pads.

**[0118]** It will be appreciated by the skilled person that the first flexible pad element 21A could be formed of other suitable absorbent materials.

**[0119]** The pad 20 further comprises a second flexible pad element 21B, also generally planar in configurations and provided on one face of the first flexible pad element 21A. The first flexible pad element 21A is generally of the same size and shape as the second flexible pad element 21B.

**[0120]** The second flexible pad element 21B is formed of a material which is chemically and thermally resistant in the

context of the cleaning regime used in any particular cleaning application, and protects the heating arrangement 24 from the cleaning agent.

**[0121]** The second flexible pad element 21B constitutes a backing material for the first flexible pad element 21A.

**[0122]** The second flexible pad element 21B may be formed from one or more of the following: a glass fibre or mineral wool, a cellulose padding material, or a high-temperature polymeric material, such as a polyimide film; a metallic foil or sheet, such as aluminium or steel, The polymer film may comprise a fluorinated polymer, nylon, a polyolefin, a block copolymer, or an elastomer.

**[0123]** It will be appreciated by the skilled person that the second flexible pad element 21B could be formed of other suitable chemically and thermally resistant materials.

**[0124]** The pad 20 also includes a third pad element 21C, in the form of a retaining element. The third pad element 21C acts to retain the integrity of the absorbent material during the use of the pad 20, particularly when the pad 20 is being placed on or removed from the article 12 to be cleaned. The third pad element 21C is provided on the opposite face of the second pad element 21 B to the face to which the first pad element 21A is attached.

**[0125]** If desired, in some embodiments, the heating arrangement 24 can be incorporated as an integral part of the pad 20. An example of this is shown in Figure 5, in which the heating arrangement 24 is represented schematically as heating elements 24A within the third pad element 21C. Alternatively, the heating elements 24A could be provided on the second flexible pad element 21 B.

**[0126]** Where the heating arrangement 24 is provided as an integral part of the pad 20, an inert element 21D can be provided on the third pad element 21C, on the opposite face of the third pad element 21C to the face to which the second pad element 21 B is attached. The inert element 21 D is particularly useful if the pad 20 is arranged as a pocket or pouch, and the heating elements 24A are provided on the second flexible pad element 21 B.

**[0127]** Referring to Figures 1 to 4, where the heating arrangement 24 is provided separately to the pad 20, a resistant element, in the form of an inert member 28, is arranged over the heating arrangement 24 to prevent leakage of the surface treatment medium from the apparatus 10. The inert member 28 is formed of a material that is chemically resistant to the surface treatment medium and which is thermally insulating.

**[0128]** The receiving member 23 constitutes the heating arrangement 24 and the inert member 28.

**[0129]** A force applying member in the form of a weight 30 is provided at an upper region of the apparatus 10 to apply a force to the pad 20 to maintain the intimate contact between the pad 20 and the contaminant 16. The weight 30 may be an integral part of the apparatus 10, or it may be an external weight.

**[0130]** In use, the apparatus 10 is arranged on the article 12, such without the pad 20 contact the contaminant 16 on the surface 18. The weight 30 presses down on to the pad 20 and effects intimate contact between the pad 20 and the surface 18, thereby effecting intimate contact between the pad 20 and the contaminant 16.

**[0131]** The heating arrangement 24 is then switched on to apply heat to the apparatus 10 to heat the pad 20. The heating arrangement 24 applies the heat for a predetermined period of time, in the range of 20 minutes to two hours, although the period of time could be as low as five minutes or as long as 24 hours.

**[0132]** The heat may be applied to raise the temperature of the pad 20 to a desired treatment temperature. The temperature to which the pad 20 is raised is dependent upon the contaminant, the cleaning agent, and the substrate 14, as shown in Table 1 below.

**[0133]** Table 1 shows a range of cleaning agents, the temperature ranges at which they can be employed, the substrates on which they can be used, and the contaminants the respective cleaning agents can remove.

| Table 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cleaning Agent** | **Examples** | **Temperature Ranges** | | | **Substrates** | **Contaminants** | **Technology Sectors** |
| Aqueous, Surfactant-based | Cationic, Anionic, Non-ionic, Amphoteric Surfactants | 10-90°C | 25-80°C | 35-75°C | Alloys, Metals, Polymers, Ceramics, Glass | Oils, Fats, Hydrocarbons, Fatty Acids | Hygiene, Janitorial, Construction |
| Aqueous Solutions of Inorganic Compounds | Hydrogen Peroxide, Sodium Carbonate, Sodium Hypochlorite | 10-90°C | 25-80°C | 35-75°C | Ceramics, Glass, Metals, Textiles, Polymers | Bacterial, Hydrocarbons, Fats | Hygiene, Biotechnology |
| Polar Aprotic Solvent | Dimethyl Sulphoxide, n-Methyl Pyrollidone | 20-180°C | 70-120°C | 85-105°C | Polymers, Glass, Aluminium, Textiles | Urethane Foams, Adhesives, Resins | Aerospace, Automotive |
| Hydrocarbon Solvent | d-Limonene, Pinene | 0-160°C | 50-110°C | 65-85°C | Polymers, Ceramics, Metals | Hydrocarbons, Silicones | Electronics, Medical Devices |
| Mono-basic, Di-basic, Tribasic Esters | Ethyl lactate, butyl acetate, dimethyl succinate, triethyl citrate | -50-170°C | 0-170°C | 70-120°C | Cellulose derivatives, Vinyl resins, Recycled Paper, Semiconductors, Metals | Natural Resins, Inks, Dyes, Fluxes | Paper Manufacturing, Conservation, Electroplating |
| Glycols / Glycol Ethers | Diethylene glycol monobutyl ether | -60-220°C | -20-180°C | 0-90°C | Glass, Wood, Semiconductors | Dyes, Lacquers, Varnishes | Glass-Cleaning, Semi-conductor Manufacture, Printing |
| Cyclic carbonates | Propylene Carbonate | -50-220°C | -10-180°C | 10-90°C | Metals, Ceramics | Paint, varnishes | Conservation |
| Ketones / Alcohols | Butyl Carbitol, γ-butyrolactone | -40-170°C | 0-120°C | 30-60°C | Epoxy Components, Polymers | Fluxes, Adhesives | Electronics |
| Ionic Liquids | [EMI][TCA] (1-ethyl,3-methyl imidazolium tetrachloro-aluminium) | -50-300°C | 20-250°C | 50-200°C | Steel, Ceramics | Radionucleides, Lanthanides | Nuclear Industry, Semi-conductor Manufacture |
| Enzymatic Solutions | Protease, Lipase, Cellulase | 25-70°C | 35-65°C | 45-60°C | Ceramics, Metals, Textiles, Polymers, Minerals | Proteins, Oils, Fats, Starch, Cellulose | Hygiene, Veterinary, Janitorial, Waste Disposal |

**[0134]** After the predetermined period of time for heating the apparatus 10 has elapsed, the apparatus 10 is lifted from the article. The contaminant is then wiped off the surface 18 or is removed in a post-treatment rinsing or washing stage.

**[0135]** It will be understood by those skilled in the art that the apparatus shown in Figure 1 can be modified to treat both sides of a planar article, if desired

**[0136]** Whilst not wishing to be limited to any particular theory, it is believed that the surface treatment medium absorbed on the pad 20, together with the application of heat and / or pressure for the predetermined time, breaks the chemical bonds between the contaminant 16 and the outer surface of the substrate 18.

**[0137]** Referring to Figure 2, there is shown a variation of the first embodiment, which is suitable for use where the surface 18 is curved. In Figure 2, the features have been given the same reference numeral as in Figure 1. The apparatus 10 shown in Figure 2 is curved to the same extent as the article 12.

**[0138]** The apparatus 10 shown in Figure 2 is used in a similar way to the apparatus 10 shown in Figure 1, and described above.

**[0139]** Referring to Figure 3, there is shown a second embodiment of the invention, which is similar to the embodiment shown in Figure 1, but the heating arrangement 24 is provided over the inert member 28. In this embodiment, the inert member 28 is thermally conductive to allow heat to be conducted to the pad 20.

**[0140]** The apparatus 10 shown in Figure 3 is used in a similar way to the apparatus shown in Figure 1, as would be understood by those skilled in the art.

**[0141]** Figure 4 shows a third embodiment, suitable for treating articles where the external surface is not planar or is complex. In the third embodiment, the pad 20 is held within a chemically inert casing 128.

**[0142]** The casing 128 is in the form of first and second receiving members in the form of first and second casing members 128A, 128B pivotally attached together at a hinge 130. The first and second casing members 128A and 128B can be pivotally moved from the open position shown in Figure 4 to a closed position about the hinge 130 and locked in the closed position by a lock 131.

**[0143]** The pad 20 is in the form of a first pad member 20A mounted within the first casing member 128A, and a second pad member 20A mounted within the second casing member 128A. The first pad member 20A defines a first recess 132A, and the second pad member 20B defines a second recess 132B. The pad members 20A, 20B provide respective facing portions 22A, 22B to engage the article 12.

**[0144]** The first and second pad members 20A and 20B receive the article 12 in their respective recesses 132A, 132B, when the first and second casing members 128A, 128B are in their closed position. The recesses 132A and 132B are arranged to correspond with the shape of the region of the article 12 to be received therein. The recesses 132A, 132B can receive the aforesaid regions of the article in a manner that provides intimate contact between the facing portions 22A, 22B and the respective regions of the article 12.

**[0145]** When the casing 128 is closed, the first and second casing members 128A and 128B apply a force to the first and second pad members 20A and 20B to provide the intimate contact between the article and the first and second pad members 20A and 20B.

**[0146]** The heating arrangement 24 is provided within the first casing member 128A between the first casing member 128A and the first pad member 20A. The heating source 26 supplies electricity or heating fluid to the heating arrangement 24 to heat the pad 20 when the casing 128 is closed and locked.

**[0147]** A pressure control means 133 is provided to increase or decrease pressure within the casing 128, when the casing 128 is closed. The pressure control means 133 may comprise a pump to pump air into the casing 128, thereby increasing pressure therein, or to pump air out of the casing 128, thereby decreasing the pressure therein. The pressure control means 133 is connected to the casing 128 by piping 135. This feature provides the advantage in this embodiment of allowing the use of volatile treatment agents, such as hydrofluorocarbons, by preventing evaporation of the volatile treatment agent at the temperatures used.

**[0148]** The casing members 128A, 128B also act as the inert member, preventing leakage of the cleaning agent and transfer of heat to / from the environment. In use, the pad members 20A, 20B are first impregnated with the solvent or cleaning agent, if the pad members 20A, 20B have not been supplied so impregnated.

**[0149]** The article 12 is then arranged in the first and second recesses 132A, 132B. The first and second casing members 128A, 128B are closed, and then locked by means of the lock 131.

**[0150]** When the casing 128 is locked, with the casing members 128A, 128B in the closed condition, the casing members 128A, 128B press inwardly on the respective pad members 20A, 20B to effect the intimate contact of the pad 20 with the article 12, at a substantially uniform pressure.

**[0151]** The heating arrangement 24 is then switched on to heat the pad 20 to a temperature in the range in the range specified in Table 1 for the relevant cleaning agent.

**[0152]** After heating, the lock 131 is released, the casing 128 opened, and the article 12 is taken out. The contaminant can then be removed from the article 12 by washing, rinsing or wiping it off.

**[0153]** Figure 6 is a diagrammatic sectional side view of a further embodiment of a surface treatment apparatus, generally designated 410, for cleaning the surface of an article 412, providing a substrate to be cleaned.

**[0154]** The surface treatment apparatus 410 comprises an absorbent member 420 in the form of a pad of a non-woven material, such as cellulose or viscose. The absorbent member 420 has a facing portion thereon, in the form of a facing layer 422, which contacts the surface of the article 412 to clean it, as described below.

**[0155]** Alternatively, the absorbent member 420 may have a facing portion, which may be a part of the absorbent member 420.

**[0156]** The absorbent member 420 is provided to absorb a surface treatment medium which, in the embodiment shown, is in the form of a cleaning agent.

**[0157]** The facing layer 422, or the absorbent member 420 when the absorbent member provides its own facing portion, is formed of a material which has a smoothness of substantially 5 on the American Association of Textile Colorists and Chemists. (AATCC) scale,

**[0158]** A receiving member 424 is provided, which defines a recess 426, to receive the absorbent member 420. The receiving member 424 has an edge arrangement 428 and a main portion 430. The edge arrangement 428 extends from the main portion 430, and depends therefrom, to define the recess 426.

**[0159]** The edge arrangement 428 comprises a wall member 432 which is attached to, and depends downwardly from, the main portion 424. A sealing member 434 extends from the lower edge of the wall member 432. The sealing member 434 is provided to seal against a base member 436, upon which the receiving member is supported. Alternatively, if the article 412 too large to be received in the recess 426, the sealing member 434 can engage the surface of the article 412 itself. The purpose of the sealing member is to prevent leakage of the surface treatment medium.

**[0160]** A resistant layer 438 is provided over the absorbent member 420, and is arranged in the recess 426 between the absorbent member 420 and the receiving member 424. The resistant layer is in the form of a film, for example of a polyimide, such as sold under the trade mark KAPTON.

**[0161]** The resistant layer 438 comprises a cover portion 439 to cover the absorbent member 420, and an edge portion 441 depending from the cover portion 439, and extending around the absorbent member 420. The edge portion 441 contributes to the sealing by the receiving member.

**[0162]** The resistant layer 438 is chemically inert to the surface treatment medium, and thereby provides a barrier to prevent the surface treatment medium contacting the receiving member 424, which may cause damage to any heating or cooling elements in the receiving member 424. The heating and cooling elements are described below.

**[0163]** The resistant layer 438 is also thermally stable at temperatures at which the cleaning takes place.

**[0164]** Temperature control means in the form of heating and/or cooling elements 440 are provided in the receiving member 424, which are connected to a heater/cooler 442. The heater/cooler 442 may provide a heated or cooled fluid via a conduit arrangement 444 to the heating/cooling elements 440.

**[0165]** Alternatively, the heating /cooling elements 440 may be electrically operated to heat or cool the receiving member, in which case, the feature designated by the numeral 442 represents an electrical controller, and the numeral 444 designates an appropriate cabling arrangement for the electrical power.

**[0166]** The receiving member 424 is formed of a material that is thermally stable at the cleaning temperatures used. The receiving member is also chemically inert to the various surface treatment media that can be used.

**[0167]** In the embodiment described, the receiving member 424 is thermally and chemically insulating, thereby allowing the surface treatment apparatus 410 to operate at temperatures that are greater or less than room temperature without any, or any significant, heat transfer with the surroundings.

**[0168]** The receiving member 424 may include a pressure control means to apply a substantially uniform pressure across the absorbent member. The pressure control means may comprise a weight 446 within the receiving member 424. the weight 446 is shown in broken lines in Figure 6.

**[0169]** Alternatively, the pressure control means may comprise securing means to secure the receiving member to the base member 436, in a similar way to the lock 131 shown in Figure 4.

## Examples

**[0170]** Examples of the use of embodiments of the invention will now be described:

Example A:

**Removal of Surface Hydrocarbon Contamination from Aluminium Sheet**

Cleaning Agent:

**[0171]**

| | |
|---|---|
| De-ionised water | 58% |
| Diethylene glycol monobutyl ether | 38% |
| Sodium Carbonate | 4% |

**[0172]** Pad Material: Cellulose non-woven, backed by PETG / ACLAR polymeric film, no retaining film.
**[0173]** Flat device configuration, with ~ 2kg weighted cover
**[0174]** The surface was heated to 70°C for 30 minutes, removed from system and washed with deionised water followed by air drying at room temperature.

Results:

**[0175]** Quadrupole SIMS analysis of the cleaned surface, in comparison with the uncleaned surface and two proprietary cleaning methods used in the aerospace industry showed that this treatment i.e. according to the embodiment in Example A, gave the best removal of hydrocarbon ion species, referenced to substrate aluminium ion intensity, in each case. The results are represented below in Table A, and shown in Graph A in Figure 7.

Table A

| Hydrocarbon Fragment | | Uncleaned | Turco ® | Trichloroethylene | Example A |
|---|---|---|---|---|---|
| 41+ | (C3H5+) | 118.3 | 42.5 | 67.3 | 17.4 |
| 55+ | (C4H7+) | 80.8 | 15.3 | 53.4 | 5.0 |
| 71+ | (C5H11+) | 11.5 | 6.5 | 9.8 | 1.0 |

Example B:

**Bactericidal Action in Milk Residues Innoculated with Staphylococcus Aureus**

**[0176]** Superbrush finish stainless steel sheet was inoculated with 100µl of staphylococcus Aureus suspension ($10^8$ cells) in milk, and allowed to dry.
**[0177]** The material was subjected to a number of soil / clean cycles (1/3/6) using:

a) Water
b) 5% household detergent formulation
c) Surface Treatment Technology according to an embodiment of the invention, namely:

Cleaning Agent:

**[0178]**

| | |
|---|---|
| Tartaric Acid | 1.25% |
| Surfactant | 2.5% |
| Deionised water | 96% |

**[0179]** Pad Material: Cellulose non-woven, backed by PETG / fluoropolymer film, no retaining film.
**[0180]** Flat device configuration, with ~ 2kg weighted cover
**[0181]** Heated to 75°C for 30 minutes, removed from system, rinsed with deionised water and rubbed using a crockmeter followed by air drying at room temperature.

Results:

**[0182]** Residual Total Viable Cell Count was measured by swabbing the surface and incubating on TVA plates for 24 hours, followed by counting of viable colonies. Viable count of samples wiped without detergent gradually increased with the number of soil/clean cycles, reaching a maximum of $1.3 \times 10^4$ cells /$cm^2$ removed by swabbing. Samples cleaned using household detergent had a higher TVC count after one cycle, and lower TVC counts after the third and sixth cycle

in comparison with water. The surface treatment method according to an embodiment of the invention had no viable microbial cells detected after all examined cleaning cycles. The results are represented below in Table B, and shown in Graph B in Figure 8.

Table B

| No. of Soiling Cycles | Water | Household Detergent | Example B |
|---|---|---|---|
| **1 cycle** | 1.15 | 23.6 | 0 |
| **3 cycles** | 3.65 | 2.45 | 0 |
| **6 cycles** | 7.7 | 3.8 | 0 |

**Example C:**

**Removal of Expanded Polyurethane Foam from Aluminium Sheet**

Cleaning Agent:

**[0183]**

Polar aprotic solvent 100%

**[0184]** Pad Material: Woven cellulosic fibre, backed by aluminium foil, no retaining film.
**[0185]** Flat device configuration, with ~ 2kg weighted cover
**[0186]** Heated to 70°C for 20 minutes, removed from system, rinsed with deionised water
**[0187]** Prior to treatment the foam contamination was not easily removable except by scraping, causing scratch damage to the surface of the aluminium sheet. After treatment contamination could be easily wiped from the surface using a damp cloth.

**Example D**

**XPS Analysis of Cleaning Polyurethane from Aluminium Sheet**

**[0188]** Aluminium sheet coated with a layer of expandable polyurethane foam was analysed by X-ray photoelectron spectroscopy (XPS or ESCA), before and after cleaning by the cleaning process.
**[0189]** XPS is a surface analysis technique that measures the topmost 10 nanometers ($10x10^{-9}$ meters) of the sample surface. All elements excluding hydrogen and helium can be measured quantitatively by XPS.
**[0190]** The XPS survey spectra from the aluminium surface, before and after cleaning, are presented in Figure 9.
**[0191]** The element compositions of the top 10 nanometer depth of the exposed surfaces are calculated from the peak intensities in Figure 9 and are listed in Table D.
**[0192]** Surface Element Concentrations: Before and After Cleaning Aluminium

Table D

| Element | Surface Before Cleaning (Atomic Percent) | Surface After Cleaning (Atomic Percent) |
|---|---|---|
| Carbon | 76.5 | 33.3 |
| Nitrogen | 3.2 | 1.0 |
| Oxygen | 15.6 | 35.5 |
| Fluorine | -- | 0.5 |
| Magnesium | -- | 2.3 |
| Aluminium | -- | 20.1 |
| Silicon | 3.8 | 5.7 |
| Phosphorus | -- | 1.6 |

(continued)

| Element | Surface Before Cleaning (Atomic Percent) | Surface After Cleaning (Atomic Percent) |
|---|---|---|
| Sulphur | 0.7 | -- |
| Chlorine | 0.3 | -- |
| Zinc | -- | 0.1 |

**[0193]** The surface composition before cleaning is typical of an organic coating, as it contains high levels of carbon with oxygen and nitrogen also present.

**[0194]** Those expert in the interpretation of XPS composition data will observe that the surface composition after cleaning is typical of a clean aluminium surface. The carbon detected is due to organic species adsorbed from the atmosphere; oxygen, fluorine and phosphorus originate from the oxide overlayer on the aluminium; while magnesium, silicon and zinc originate from the aluminium substrate.

**[0195]** In addition to the composition after cleaning in Table D, the shape of the background distributions in the second graph in Figure 9 and the presence of plasmon loss peaks associated with the aluminium 2p and 2s photoelectron peaks confirms that metallic aluminium is close to the topmost surface of the sheet after cleaning.

**[0196]** There are thus described herein simple and effective embodiments of a method and apparatus for removing contaminants from the surface of the substrate.

**[0197]** It is believed that the method in the above described embodiments is effective, because the heat and the solvent, cleaning agent applied to the contaminant for a prolonged period of time breaks the chemical bonds between the contaminant and the oxide on the service of the substrate. Further chemical bonds are then formed with the solvent, cleaning formulation or soap, allowing the contaminant to be easily removed.

**[0198]** Various modifications can be made without departing from the scope of the invention.

## Claims

1. A method of treating a surface of an article with a surface treatment medium, said method comprising: providing a surface treatment apparatus comprising an absorbent member for holding the surface treatment medium, said absorbent member having a facing portion to contact the surface, a mounting member defining a recess to receive the absorbent member, wherein the mounting member has a sealing arrangement to provide a seal extending around the absorbent member; allowing the absorbent member to hold the surface treatment medium; effecting contact between the surface treatment medium and the surface for a sufficient period of time to effect the treatment of the surface; **characterised in that** the method further includes effecting engagement of the sealing arrangement either with the article or with a further component of the apparatus to form a seal against either said article or said further component to prevent leakage of the surface treatment medium from the apparatus.

2. A method according to Claim 1, comprising maintaining the absorbent member in a substantially static condition relative to the surface during the treatment of the surface.

3. A method according to Claim 1 or 2, wherein the sealing arrangement comprises an edge arrangement having a main edge member and a seal member extending from the main edge member, and the method comprises effecting engagement of the seal member with the article or with a further component of the apparatus to form the seal against said article or said further component to prevent leakage of the surface treatment medium from the apparatus.

4. A method according to Claim 3, comprising providing the seal between the seal member and the article to be treated, or between the seal member and a further component of the apparatus.

5. A method according to any preceding Claim, wherein the mounting member comprises a receiving member, the recess being defined in the receiving member, and the method includes arranging the absorbent member in the recess in the receiving member to effect the aforesaid contact between the surface treatment medium and the surface.

6. A method according to any preceding Claim, wherein the step of contacting the surface treatment medium with the surface of the article comprises effecting the aforesaid contact for a period of time of substantially 5 minutes to substantially 24 hours.

7. A method according to any preceding Claim, wherein the step of contacting the surface treatment medium with the surface of the article comprises effecting the aforesaid contact for a period of time of substantially 15 minutes to substantially 8 hours.

8. A method according to any preceding Claim, wherein the step of contacting the surface treatment medium with the surface of the article comprises effecting the aforesaid contact for a period of time of substantially 20 minutes to substantially 2 hours.

9. A surface treatment apparatus for treating a surface of an article with a surface treatment medium, the apparatus comprising: an absorbent member to hold the surface treatment medium, the absorbent member having a facing portion to contact the surface; a mounting member defining a recess to receive the absorbent member, **characterised in that** the mounting member comprises a main portion and a sealing arrangement extending around the absorbent member, the sealing arrangement comprising an edge arrangement; wherein the edge arrangement extends from the main portion to a region level with or beyond said facing portion to engage either the article or a further component of the apparatus to form a seal against either said article or said further component to prevent leakage of the surface treatment medium from the apparatus.

10. A surface treatment apparatus according to Claim 9, wherein the edge arrangement has a main edge member and a seal member extending from the main edge member, the seal member being configured to provide the aforesaid seal.

11. A surface treatment apparatus according to Claim 10, including a base member upon which the mounting member is mounted, such that the seal arrangement can form a seal by engaging the base member to provide the aforesaid seal.

12. A surface treatment apparatus according to Claim 11, wherein the base member is arrangeable below the mounting member.

13. A surface treatment apparatus according to any of Claims 9 to 11, wherein the main portion extends over the absorbent member, and the edge arrangement depends from the main portion.

14. A surface treatment apparatus according to any of Claims 9 to 11 wherein the base member is arrangeable above the mounting member.

**Patentansprüche**

1. Verfahren zur Behandlung einer Oberfläche eines Artikels mit einem Oberflächenbehandlungsmittel, wobei besagtes Verfahren umfasst: Bereitstellen einer Vorrichtung für Oberflächenbehandlung, die ein absorbierendes Element zum Halten des Oberflächenbehandlungsmittels umfasst, wobei besagtes absorbierendes Element einen Auflageteil zum Kontaktieren der Oberfläche aufweist, ein Montageelement eine Vertiefung zum Aufnehmen des absorbierenden Elements definiert, wobei das Montageelement eine abdichtende Einrichtung aufweist, um eine Dichtung bereitzustellen, die sich um das absorbierende Element herum erstreckt; dem absorbierenden Element zu erlauben das Oberflächenbehandlungsmittel zu halten; Kontakt zwischen dem Oberflächenbehandlungsmittel und der Oberfläche für eine ausreichende Zeit herbeizuführen, um die Behandlung der Oberfläche zu erwirken; **dadurch gekennzeichnet, dass** das Verfahren weiter Herbeiführen der Kupplung der Abdichteinrichtung mit entweder dem Artikel oder mit einer weiteren Komponente der Vorrichtung einschließt, um eine Dichtung gegen entweder besagten Artikel oder besagter weiterten Komponente zu bilden, um Leckage des Oberflächenbehandlungsmittels aus der Vorrichtung zu verhindern.

2. Verfahren nach Anspruch 1, das Beibehalten des absorbierenden Elements in einem im Wesentlichen statischen Zustand in Bezug auf die Oberfläche, während der Behandlung der Oberfläche, umfasst.

3. Verfahren nach Anspruch 1 oder 2, wobei die Abdichteinrichtung eine Kanteneinrichtung umfasst, die ein Hauptkantenelement aufweist und wobei sich ein Dichtungselement aus dem Hauptkantenelement erstreckt und, wobei das Verfahren das Herbeiführen der Kupplung des Dichtungselements mit dem Artikel oder mit einer weiteren Komponente der Vorrichtung umfasst, um die Dichtung gegen besagten Artikel oder besagte weitere Komponente zu bilden, um Leckage des Oberflächenbehandlungsmittels aus der Vorrichtung zu verhindern.

4. Verfahren nach Anspruch 3, das Bereitstellen der Dichtung zwischen dem Abdichtelement und dem zu behandelnden Artikel oder zwischen dem Abdichtelement und einer weiteren Komponente der Vorrichtung umfasst.

5. Verfahren nach einem beliebigen vorhergehenden Anspruch, wobei das Montageelement ein Aufnahmeelement umfasst, wobei die Vertiefung im Aufnahmeelement definiert ist und das Verfahren die Anordnung des absorbierenden Elements in der Vertiefung im Aufnahmeelement einschließt, um den zuvor genannten Kontakt zwischen dem Oberflächenbehandlungsmittel und der Oberfläche zu erwirken.

6. Verfahren nach einem beliebigen vorhergehenden Anspruch, wobei der Schritt Kontaktieren des Oberflächenbehandlungsmittels mit der Oberfläche des Artikels das Herbeiführen des zuvor genannten Kontakts für eine Zeit von im Wesentlichen 5 Minuten bis im Wesentlichen 24 Stunden umfasst.

7. Verfahren nach einem beliebigen vorhergehenden Anspruch, wobei der Schritt Kontaktieren des Oberflächenbehandlungsmittels mit der Oberfläche des Artikels das Herbeiführen des zuvor genannten Kontakts für eine Zeit von im Wesentlichen 15 Minuten bis im Wesentlichen 8 Stunden umfasst.

8. Verfahren nach einem beliebigen vorhergehenden Anspruch, wobei der Schritt Kontaktieren des Oberflächenbehandlungsmittels mit der Oberfläche des Artikels das Herbeiführen des zuvor genannten Kontakts für eine Zeit von im Wesentlichen 20 Minuten bis im Wesentlichen 2 Stunden umfasst.

9. Oberflächenbehandlungsvorrichtung zum Behandeln einer Oberfläche eines Artikels mit einem Oberflächenbehandlungsmittel, wobei die Vorrichtung umfasst: ein absorbierendes Element zum Halten des Oberflächenbehandlungsmittels, wobei das absorbierende Element einen Auflageteil zum Kontaktieren der Oberfläche aufweist; ein Montageelement eine Vertiefung zum Aufnehmen des absorbierenden Elements definiert, **dadurch gekennzeichnet, dass** das Montageelement einen Hauptteil und eine abdichtende Einrichtung aufweist, die sich um das absorbierende Element herum erstreckt; wobei die abdichtende Einrichtung eine Kanteneinrichtung umfasst; wobei sich die Kanteneinrichtung aus dem Hauptteil zu einem Bereich erstreckt, der mit besagtem Auflageteil auf gleicher Höhe ist oder sich über besagten Auflageteil hinaus erstreckt, um entweder den Artikel oder eine weitere Komponente der Vorrichtung in Eingriff zu bringen, um eine Dichtung gegen entweder besagten Artikel oder besagte weitere Komponente zu bilden, um Leckage des Oberflächenbehandlungsmittels aus der Vorrichtung zu verhindern.

10. Oberflächenbehandlungsvorrichtung nach Anspruch 9, wobei die Kanteneinrichtung ein Hauptkantenelement und ein Abdichtelement aufweist, das sich aus dem Hauptkantenelement erstreckt, wobei das Abdichtelement konfiguriert ist, die zuvor genannte Dichtung bereitzustellen.

11. Oberflächenbehandlungsvorrichtung nach Anspruch 10, die ein Basiselement einschließt, auf dem das Montageelement so montiert ist, dass die Abdichteinrichtung eine Dichtung durch in Eingriff bringen des Basiselements bilden kann, um die zuvor genannte Dichtung bereitzustellen.

12. Oberflächenbehandlungsvorrichtung nach Anspruch 11, wobei sich das Basiselement unter dem Montageelement anordnen lässt.

13. Oberflächenbehandlungsvorrichtung nach einem beliebigen der Ansprüche 9 bis 11, wobei sich der Hauptteil über das absorbierende Element hinaus erstreckt und die Kanteneinrichtung aus dem Hauptteil herabhängt.

14. Oberflächenbehandlungsvorrichtung nach einem beliebigen der Ansprüche 9 bis 11, wobei sich das Basiselement über dem Montageelement anordnen lässt.

## Revendications

1. Procédé servant à effectuer le traitement d'une surface d'un article avec un agent de traitement de surface, ledit procédé consistant en : la fourniture d'un appareil de traitement de surface comprenant un élément absorbant pour retenir l'agent de traitement de surface, ledit élément absorbant possédant une partie avant pour se solidariser avec la surface, un élément de montage définissant un renfoncement pour recevoir l'élément absorbant, dans lequel l'élément de montage comporte un assemblage étanche pour l'obtention d'une étanchéité s'étendant autour de l'élément absorbant ; permettant à l'élément absorbant de retenir l'agent de traitement de surface ; réalisant un contact entre l'agent de traitement de surface et la surface pendant une période temps suffisante pour réaliser le

traitement de la surface ; **caractérisé en ce que** le procédé comprend la réalisation d'un engagement de l'assemblage étanche soit avec l'article, soit avec un composant supplémentaire de l'appareil afin de former une étanchéité contre ledit article ou ledit composant supplémentaire de manière à empêcher la fuite de l'agent de traitement de surface de l'appareil.

**2.** Procédé selon la Revendication 1, comprenant le maintien de l'élément absorbant dans une condition sensiblement statique relativement à la surface pendant le traitement de la surface.

**3.** Procédé selon la Revendication 1 ou 2, dans lequel l'assemblage étanche comporte un montage à bords possédant un élément de bord principal et un élément étanche s'étendant depuis l'élément de bord principal, et le procédé comprenant la réalisation de l'engagement de l'élément étanche avec l'article ou avec un composant supplémentaire de l'appareil afin de former l'étanchéité contre ledit article ou ledit composant supplémentaire de manière à empêcher la fuite de l'agent de traitement de surface de l'appareil.

**4.** Procédé selon la Revendication 3, comprenant la réalisation de l'étanchéité entre l'élément d'étanchéité et l'article à traiter, ou entre l'élément d'étanchéité et un composant supplémentaire de l'appareil.

**5.** Procédé selon l'une quelconque des revendications précédentes, dans lequel l'élément de montage comprend un élément de réception, le renfoncement étant défini dans l'élément de réception, et le procédé comprend l'aménagement de l'élément absorbant dans le renfoncement de l'élément de réception de manière à réaliser le susdit contact entre l'agent de traitement de surface et la surface.

**6.** Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de mise en contact de l'agent de traitement de surface avec la surface de l'article comprend la réalisation du susdit contact pendant une période de temps de sensiblement 5 minutes à sensiblement 24 heures.

**7.** Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de mise en contact de l'agent de traitement de surface avec la surface de l'article comprend la réalisation du susdit contact pendant une période de temps de sensiblement 15 minutes à sensiblement 8 heures.

**8.** Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de mise en contact de l'agent de traitement de surface avec la surface de l'article comprend la réalisation du susdit contact pendant une période de temps de sensiblement 20 minutes à sensiblement 2 heures.

**9.** Appareil de traitement de surface servant à effectuer le traitement d'une surface d'un article avec un agent de traitement de surface, l'appareil comprenant : un élément absorbant pour retenir l'agent de traitement de surface, l'élément absorbant possédant une partie avant pour se solidariser avec la surface ; un élément de montage définissant un renfoncement pour recevoir l'élément absorbant, dans lequel l'élément de montage comporte une partie principale et un assemblage étanche s'étendant autour de l'élément absorbant, l'assemblage étanche comprenant un montage à bords ; **caractérisé en ce que** l'assemblage étanche s'étend de la partie principale à un niveau régional avec ou au-delà de ladite partie avant pour s'engager soit avec l'article, soit avec un composant supplémentaire de l'appareil afin de former une étanchéité contre soit ledit article, soit ledit composant supplémentaire de manière à empêcher la fuite de l'agent de traitement de surface de l'appareil.

**10.** Appareil de traitement de surface selon la Revendication 9, dans lequel le montage à bords possède un élément de bord principal et un élément d'étanchéité s'étendant depuis l'élément de bord principal, l'élément d'étanchéité étant configuré pour réaliser la susdite étanchéité.

**11.** Appareil de traitement de surface selon la Revendication 10, comprenant un élément de base sur lequel l'élément de montage est monté, afin que l'assemblage étanche puisse former une étanchéité en engageant l'élément de base de manière à réaliser la susdite étanchéité.

**12.** Appareil de traitement de surface selon la Revendication 11, dans lequel l'élément de base est aménageable sous l'élément de montage.

**13.** Appareil de traitement de surface selon l'une quelconque des Revendications 9 à 11, dans lequel la partie principale s'étend par-dessus l'élément absorbant et le montage à bords dépend de la partie principale.

**14.** Appareil de traitement de surface selon l'une quelconque des Revendications 9 à 11, dans lequel l'élément de base est aménageable au-dessus de l'élément de montage.

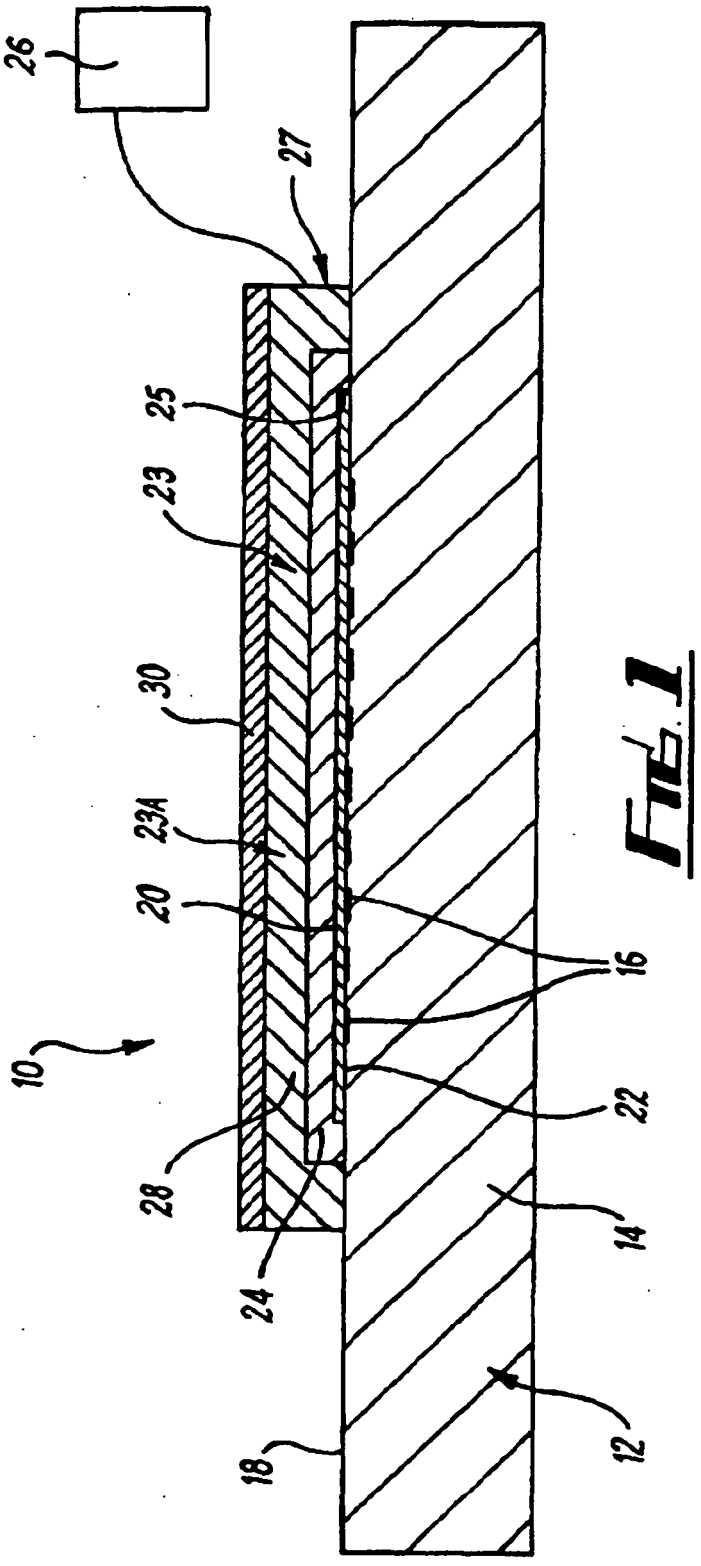



FIG. 1

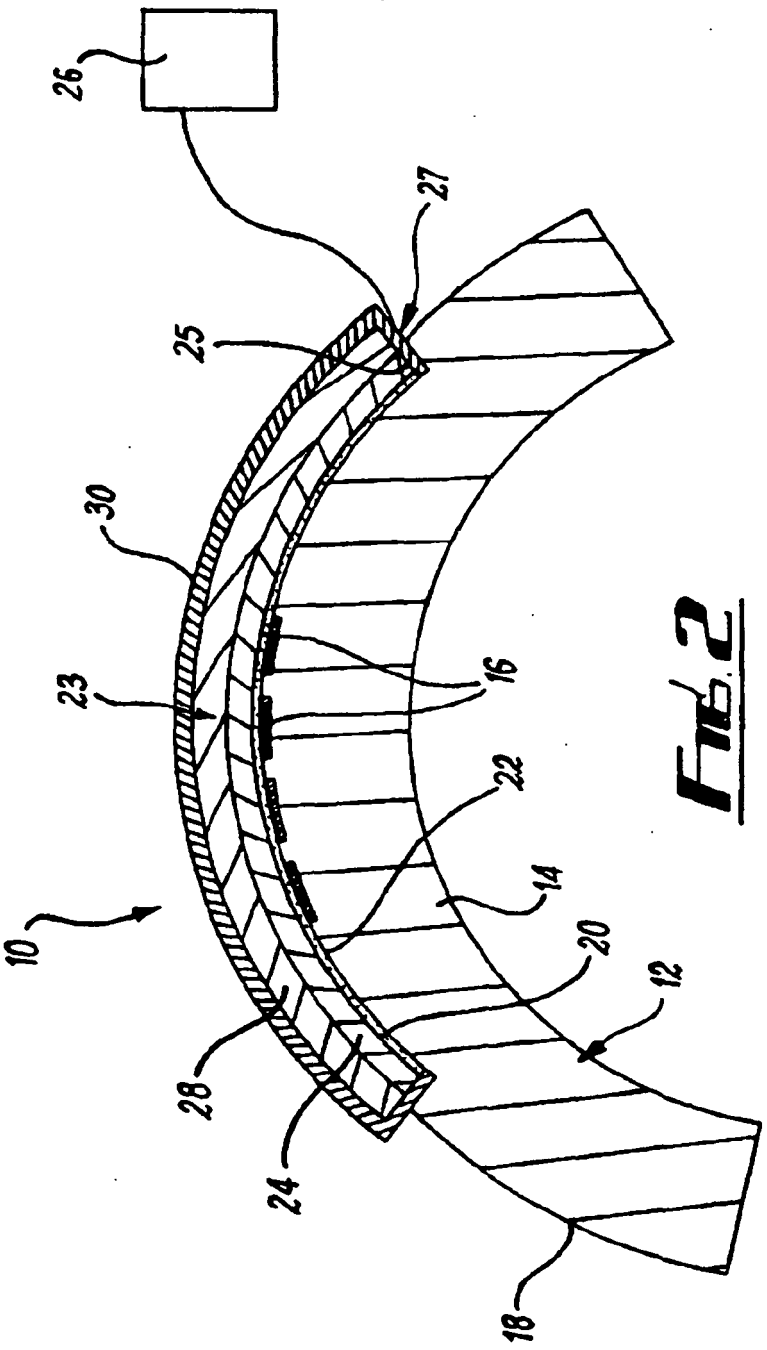



FIG. 2

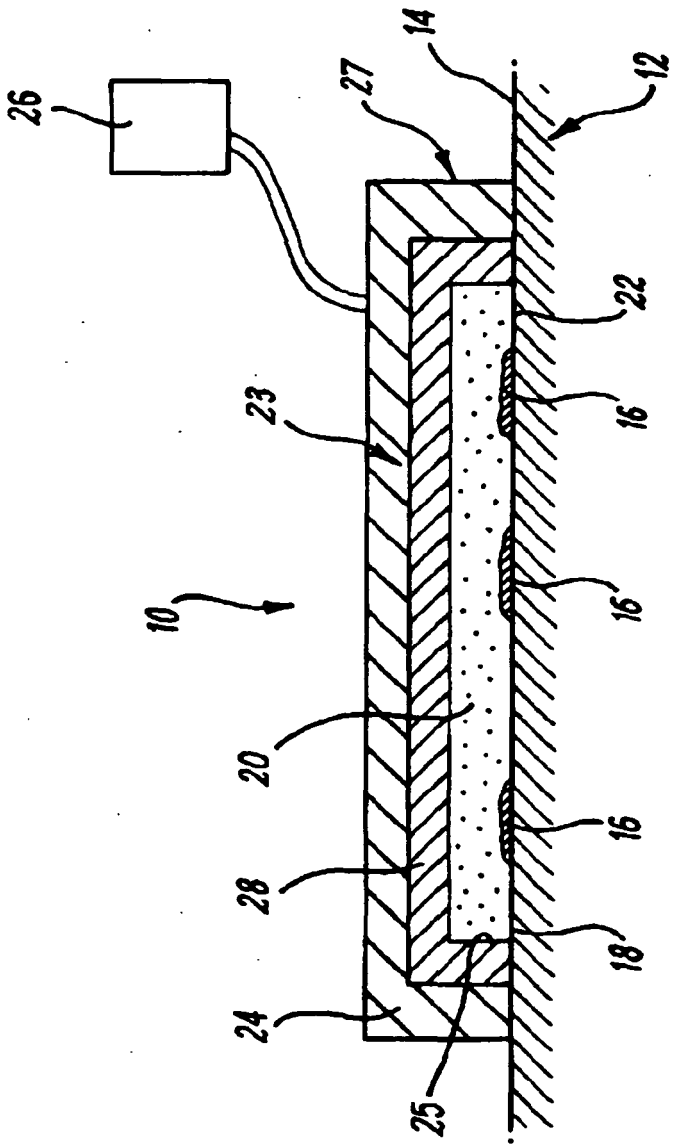



FIG. 3

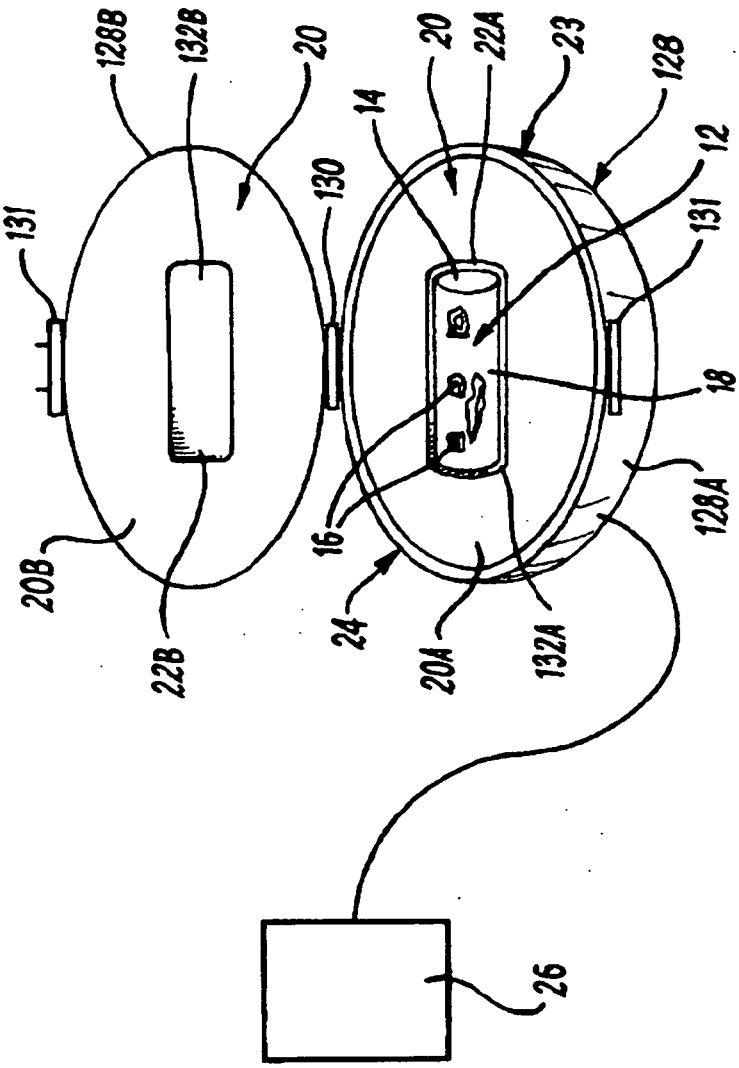

128B
132B
20
20
22A
23
128
14
12
130
131
131
18
16
128A
20B
22B
24
20A
132A
26

FIG. 4

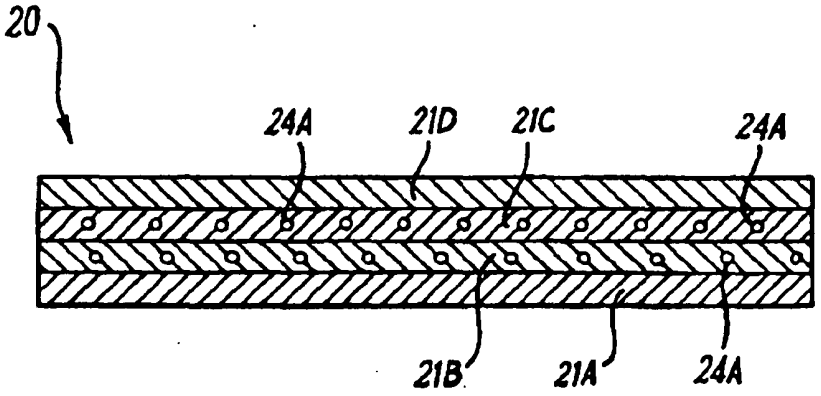
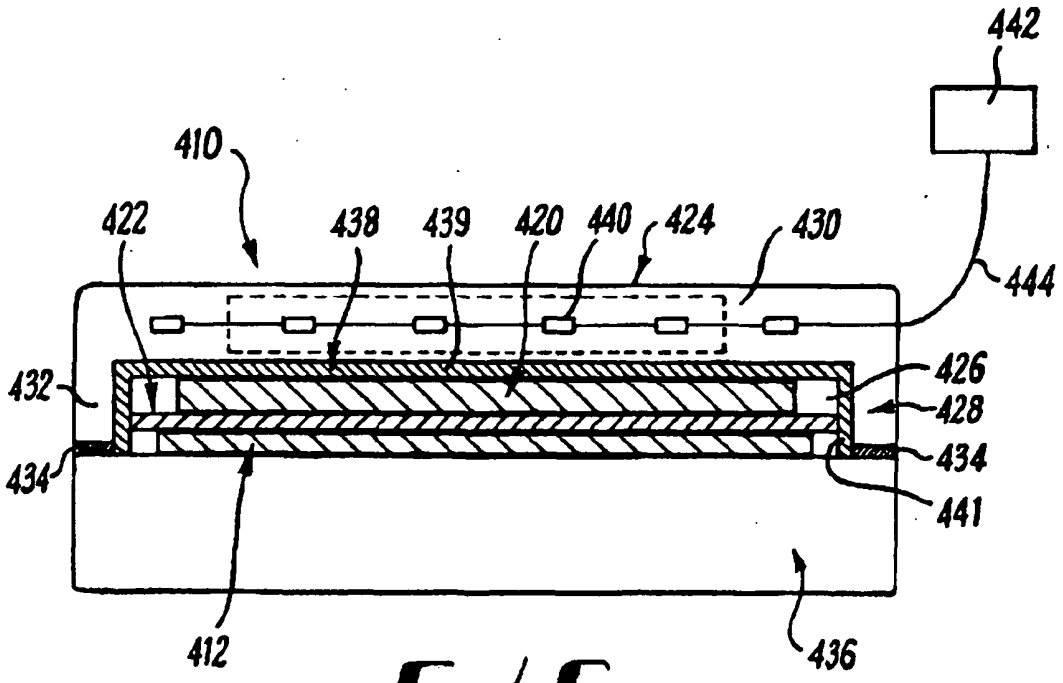

20
24A
21D
21C
24A
21B
21A
24A

FIG. 5


442
410
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426
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428
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434
441
412
436

FIG. 6

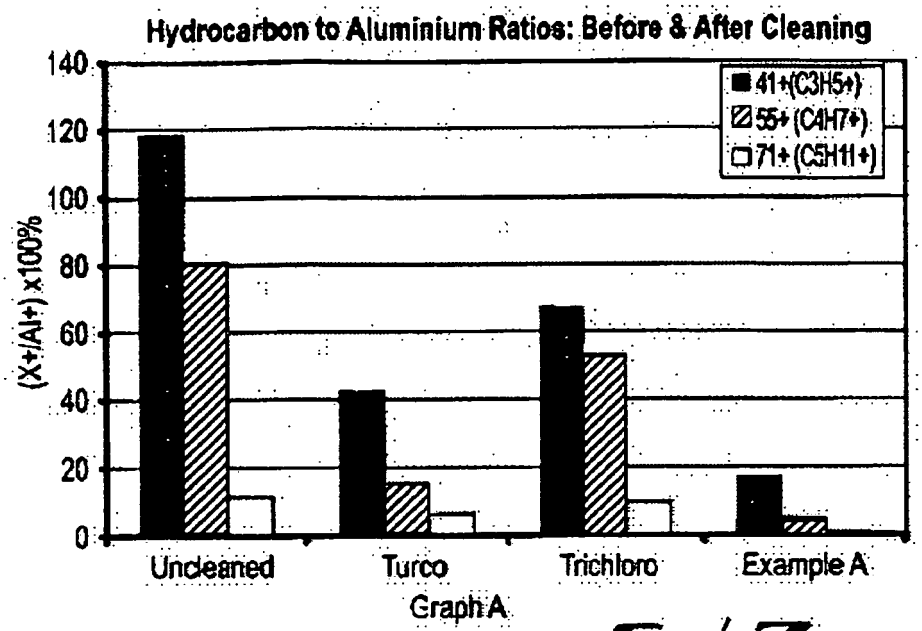

Hydrocarbon to Aluminium Ratios: Before & After Cleaning
140
120
100
80
60
40
20
0
(X+/Al+) x100%
41+(C3H5+)
55+ (C4H7+)
71+ (C5H11+)
Uncleaned
Turco
Trichloro
Example A
Graph A

FIG. 7

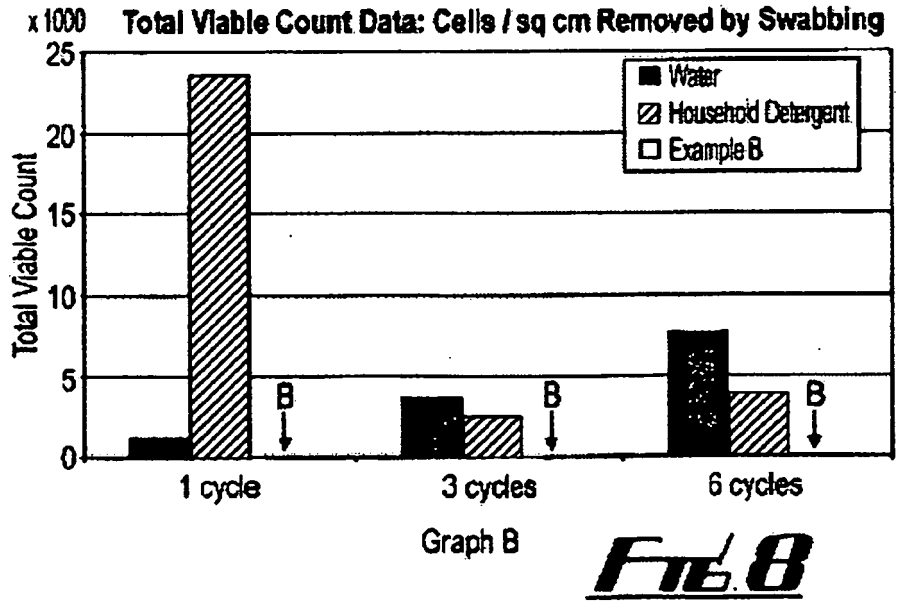
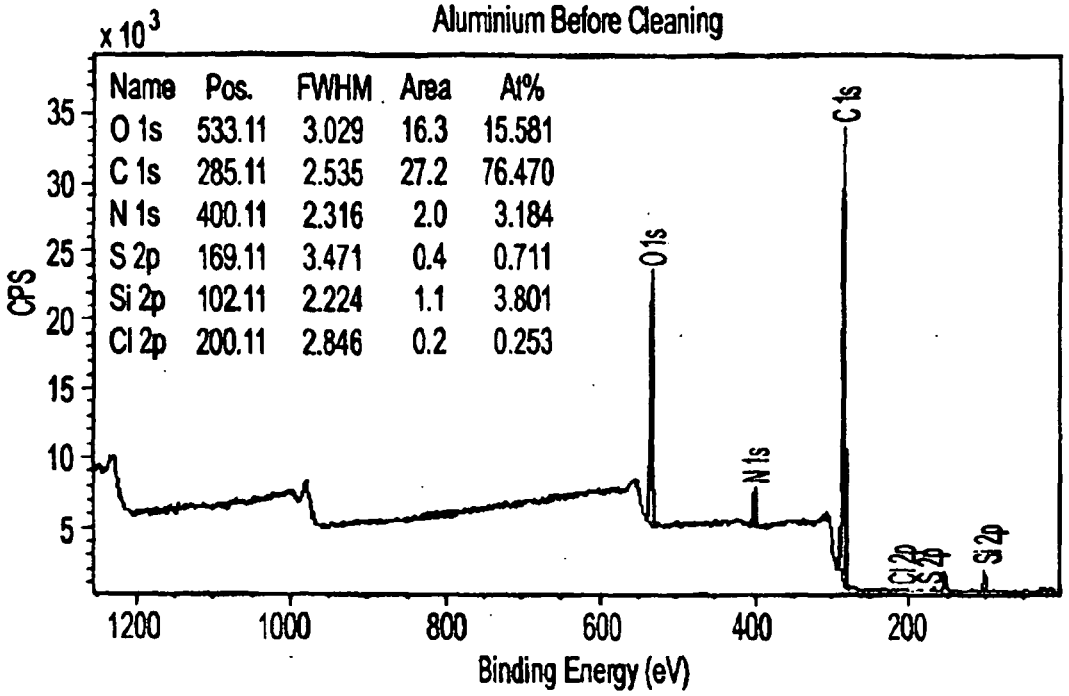
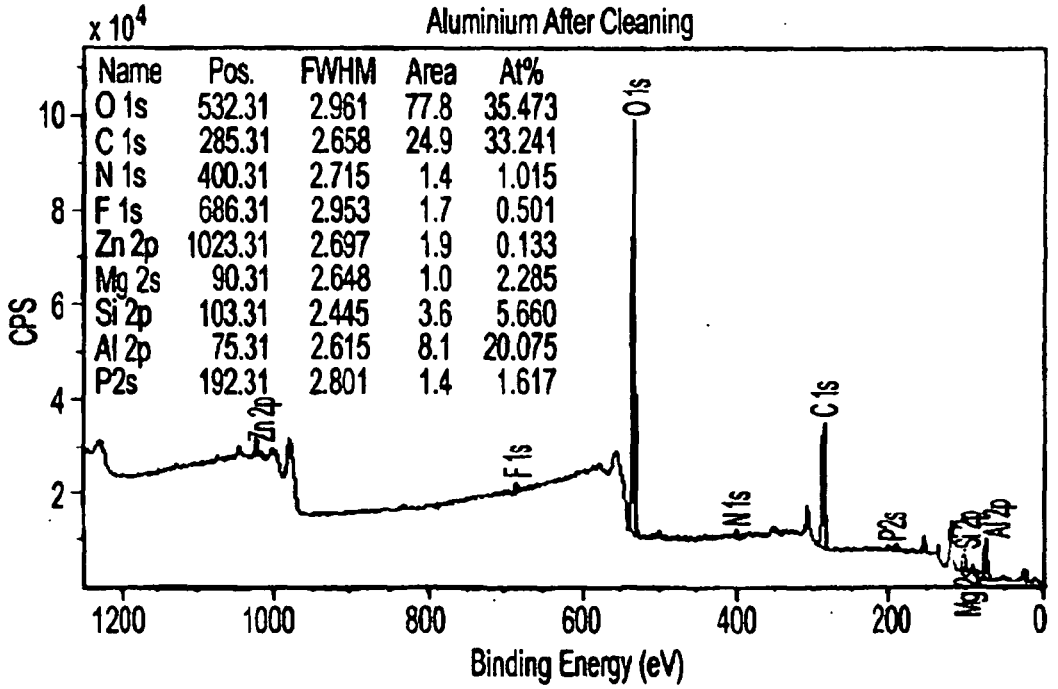

x 1000
Total Viable Count Data: Cells / sq cm Removed by Swabbing
25
20
15
10
5
0
Total Viable Count
Water
Household Detergent
Example B
B
B
B
1 cycle
3 cycles
6 cycles
Graph B

FIG. 8




XPS Survey: Polyurethane Foam on Aluminium Sheet Before Cleaning.




XPS Survey: Polyurethane Foam on Aluminium Sheet After Cleaning.

FIG. 9

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- US 4336073 A **[0003]**