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(54) CLEANER HEAD MEMBER, CLEANER HEAD ASSEMBLY AND WET CLEANING APPARATUS

(57) Provided is a cleaner head member (100) attachable to and/or detachable from a cleaner head (102) of a wet cleaning apparatus. The cleaner head member comprises a connector (108) that is connectable to a complementary connector (110) of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head. The cleaner head member also comprises a pliable support substrate (114). A dirt inlet structure (122A, 122B) is defined in and/or is arranged on a surface (124) of the pliable support substrate. The dirt inlet structure extends across at least part of the surface. A pliable cleaning member (116) is also included in the cleaner head member. The pliable cleaning member comprises a porous layer (118) having pores for receiving liquid from a surface to be cleaned. The pliable cleaning member is arranged on the surface of the pliable support substrate to cover the dirt inlet structure. The dirt inlet structure receives the liquid initially received by the pores of the porous layer and carries the liquid to the dirt conduit. Also provided is a cleaner head assembly (104) comprising the cleaner head member and the cleaner head. Further provided is a wet cleaning apparatus comprising the cleaner head member or the cleaner head assembly.

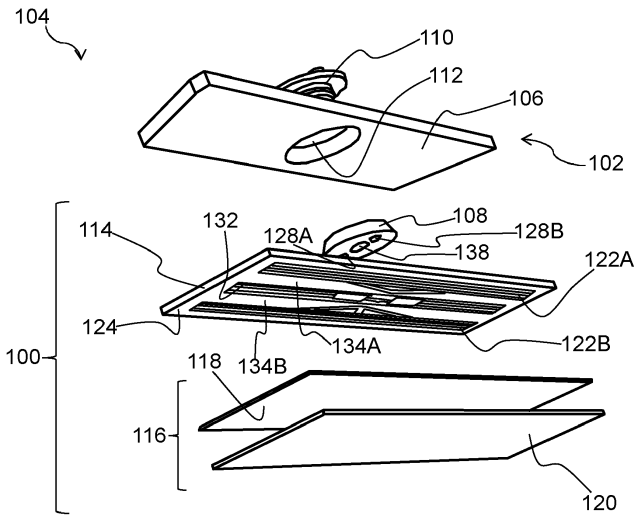

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] This invention relates to a cleaner head member that is attachable and/or detachable from a cleaner head of a wet cleaning apparatus. The invention also relates to a cleaner head assembly comprising the cleaner head member and the cleaner head. The invention further concerns a wet cleaning apparatus comprising the cleaner head member or the cleaner head assembly.

[0002] The cleaner head member and wet cleaning apparatus can be used, for example, for cleaning a floor, an indoor surface, or a window.

BACKGROUND OF THE INVENTION

[0003] Wet cleaning apparatuses, for example wet mopping devices, are known which remove water from a surface to be cleaned. Such wet cleaning apparatuses can also apply cleaning liquid, e.g. water, to the surface to be cleaned, and then remove the liquid, e.g. with a suitable cloth.

[0004] Some wet cleaning apparatuses have powered pick-up functionality for removing the water from the surface to be cleaned. Wet vacuum cleaners, for instance, may pick up liquid by generating sufficient airspeed (e.g. at least 10 m/s) and/or brushpower to exert enough shear force on liquid droplets to cause them to enter the device. Typical power consumption values for such vacuum cleaners are relatively high, for example in the order of several hundred watts.

[0005] A further challenge can arise when the wet cleaning apparatus is arranged to deliver cleaning liquid as well as pick up the liquid using suction. Providing both functionalities can, in at least some designs, risk that the cleaning liquid is used inefficiently.

[0006] There can also be a risk that poorly controlled delivery of the cleaning liquid, during or even after use, results in soaking of the environment with the cleaning liquid. Such soaking of the surface to be cleaned may not, in at least some circumstances, be easily addressed by the pick-up functionality of the apparatus, particularly when a relatively low power pick-up system is employed.

SUMMARY OF THE INVENTION

[0007] Additional challenges have been encountered relating to dirt particles clogging pick-up components of the wet cleaning apparatus, and/or wear of such components during use of the wet cleaning apparatus.

[0008] It would be desirable to address one or more of the above-mentioned technical challenges, particularly in a way that is realizable using an efficient (and inexpensive) production/assembly process.

[0009] The invention is defined by the claims.

[0010] According to examples in accordance with an aspect of the invention, there is provided a cleaner head member attachable to and/or detachable from a cleaner head of a wet cleaning apparatus, the cleaner head member comprising: a connector that is connectable to a complementary connector of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head; a pliable support substrate; a dirt inlet structure defined in and/or arranged on a surface of the pliable support substrate, the dirt inlet structure extending across at least part of the surface; a cleaning liquid outlet structure defined in and/or arranged on the surface of the pliable support substrate, the cleaning liquid outlet structure being arranged to deliver cleaning liquid received therein towards the surface to be cleaned, the cleaning liquid outlet structure being separated from the dirt inlet structure by region(s) of the pliable support substrate; and a pliable cleaning member comprising a porous layer having pores for receiving liquid from a surface to be cleaned, the pliable cleaning member being arranged on the surface of the pliable support substrate to cover the dirt inlet structure, the dirt inlet structure being arranged to receive said liquid received by the pores of the porous layer and to carry the liquid to the dirt conduit.

[0011] The capability to detach the cleaner head member from the cleaner head may facilitate cleaning of one or both of the cleaner head member and the cleaner head. Alternatively or additionally, detachment of the cleaner head member may enable replacement of the cleaner head member, for instance when the cleaner head member becomes overly worn and/or is no longer able to hold an underpressure when wet.

[0012] The pliability of the pliable support substrate and the pliable cleaning member may assist the cleaner head member to follow contours on the surface being cleaned and/or may assist cleaning of the cleaner head member after use, for example by washing of the cleaner head member in a washing machine.

[0013] Such cleaning of the cleaner head member, when detached from the cleaner head, may assist to remove dirt particles that may build up inside and clog the cleaner head member during use.

[0014] By the region(s) of the pliable support substrate separating the dirt inlet structure from the cleaning liquid outlet structure, the risk of cleaning liquid in the cleaning liquid outlet structure being drawn directly into the dirt inlet structure can

be lessened or removed. Thus, there may be a greater chance of the cleaning liquid reaching the surface being cleaned. The cleaning liquid may consequently be used more efficiently.

[0015] Implicit in the function of the dirt inlet structure and the cleaning liquid outlet structure defined in and/or arranged on the pliable support substrate is that a bulk of the pliable material from which the pliable substrate is formed may provide a flow barrier, in particular for liquid, e.g. water, so that the liquid from the surface being cleaned and the cleaning liquid delivered towards the surface being cleaned follow the flow paths defined by the dirt inlet structure and the cleaning liquid outlet structure.

[0016] In some embodiments, the pliable material comprises, e.g. is, a polymeric material and/or elastomeric material.

[0017] Particular mention is made of silicone rubber and ethylene-vinyl acetate, in other words a copolymer of ethylene and vinyl acetate, for the pliable material.

[0018] In embodiments in which the pliable support substrate is formed from ethylene-vinyl acetate, ethylene may, for example, account for 60 to 90 wt.% of the copolymer.

[0019] In some embodiments, the pliable support substrate is formed from a closed cell foam material, for example an ethylene-vinyl acetate closed cell foam material. In such embodiments, pliability may be provided, at least in part, by the foam structure, with the closed cell structure of the foam providing the flow barrier that ensures that the liquid from the surface to be cleaned and the cleaning liquid delivered towards the surface to be cleaned follow the flow paths defined by the dirt inlet structure and the cleaning liquid outlet structure.

[0020] Such a closed cell foam material may facilitate an efficient (and inexpensive) production/assembly process for fabricating the cleaner head member.

[0021] In some embodiments, the connector is an integral part of the pliable support substrate.

[0022] In other words, the connector may be formed by the pliable support substrate.

[0023] This can be implemented, for example, when injection molding is used to fabricate the pliable support substrate.

[0024] In some embodiments, the connector is connectable to the complementary connector to provide a cleaning liquid conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head, with the sealed dirt conduit and the cleaning liquid conduit being separate from each other. The connector may thus provide an integrated connector for coupling the wet cleaning apparatus's underpressure generator and cleaning liquid supply respectively to the dirt inlet structure and the cleaning liquid outlet structure of the cleaner head member.

[0025] In some embodiments, the cleaner head member comprises at least one cleaning liquid distibrution strip for arranging over the cleaning liquid outlet structure, with the at least one cleaning liquid distribution strip delimiting a plurality of apertures arranged along a length of the cleaning liquid distribution strip, through which apertures the cleaning liquid is deliverable from the cleaning liquid outlet structure towards the surface to be cleaned. This may enable relatively uniform cleaning liquid delivery onto the surface to be cleaned.

[0026] In at least some embodiments, the pliable cleaning member is sealingly attached to the pliable support substrate around the dirt inlet structure. This sealing attachment may assist to maintain an underpressure in the dirt inlet structure with or without the flow being applied by the underpressure generator included in the wet cleaning apparatus.

[0027] The sealing attachment can be implemented in any suitable manner, such as by gluing and/or welding the pliable cleaning member, e.g. the porous layer or a pliable intermediate substrate thereof, around the dirt inlet structure.

[0028] It is noted more generally that in embodiments in which the cleaner head member comprises the pliable intermediate substrate, this may be arranged between the porous layer and the pliable support substrate.

[0029] The pliability of the pliable intermediate substrate may assist the cleaner head member to follow contours on the surface being cleaned and/or may assist cleaning of the cleaner head member after use, for example by washing of the cleaner head member in a washing machine.

[0030] In such embodiments, a further dirt inlet structure may be defined in and/or arranged on the pliable intermediate substrate for fluidly connecting the pores of the porous layer to the dirt inlet structure of the pliable support substrate.

[0031] Alternatively or additionally, a further cleaning liquid outlet structure may be defined in and/or arranged on the pliable intermediate substrate for delivering cleaning liquid in the cleaning liquid outlet structure towards the surface to be cleaned. In such embodiments, the further cleaning liquid outlet structure may be separated from the further dirt inlet structure by region(s) of the pliable intermediate substrate.

[0032] The pliable intermediate substrate can be manufactured from any suitable pliable material, e.g. that provides a flow barrier, in particular for liquid, e.g. water, so that the liquid from the surface being cleaned and the cleaning liquid delivered towards the surface being cleaned follow the flow paths defined by the further dirt inlet structure and the further cleaning liquid outlet structure when present.

[0033] In some embodiments, the pliable material of the pliable intermediate substrate comprises, e.g. is, a polymeric material and/or elastomeric material.

[0034] The pliable material of the pliable intermediate substrate may, for instance, be the same as that used for the pliable support substrate.

[0035] Particular mention is made of silicone rubber and ethylene-vinyl acetate, in other words a copolymer of ethylene and vinyl acetate, for the pliable material.

[0036] In embodiments in which the pliable intermediate substrate is formed from ethylene-vinyl acetate, ethylene may, for example, account for 60 to 90 wt.% of the copolymer.

[0037] In some embodiments, the pliable intermediate substrate is formed from a closed cell foam material, for example an ethylene-vinyl acetate closed cell foam material. In such embodiments, pliability may be provided, at least in part, by the foam structure, with the closed cell structure of the foam providing the flow barrier that ensures that the liquid from the surface to be cleaned and the cleaning liquid delivered towards the surface to be cleaned follow the flow paths defined by the further dirt inlet structure and the further cleaning liquid outlet structure.

[0038] It is also reiterated that such a closed cell foam material may facilitate an efficient (and inexpensive) production/assembly process for fabricating the cleaner head member.

[0039] Turning to the porous layer of the pliable cleaning member, when the porous layer is dry, the porous layer may be regarded as being in an "air transport state" in which air is transported through each of the dry pores of the porous layer. A "liquid transport state" corresponds to liquid, e.g. water, being transported through the (wetted) pores of the porous layer. When there is no longer a feed of liquid to the pores, a "fluid block state" may be adopted. The "fluid block state" corresponds to the state at which the surface tension of the (residual) liquid retained in the wetted pores of the porous layer prevents fluid transport through the pores. In the latter state, a surface or barrier is created at the boundary between air and liquid, e.g. water. This barrier can assist to maintain the underpressure between the porous layer and the underpressure generator. The pressure needed to "break" this barrier can be termed a "breaking pressure".

[0040] In some embodiments, the porous layer is formed from a polyester and/or a polyamide. Such materials have been found to be suitably hydrophilic to enable the porous layer to be adequately wetted by water, e.g. water received from the surface being cleaned.

[0041] Alternatively or additionally, the porous layer may comprise one or more of a woven fabric, e.g. a microfiber woven fabric, a mesh, and a perforate membrane.

[0042] Such a mesh, e.g. a monofilament mesh, and/or perforate membrane may represent a relatively straightforward way of providing pores with a well-defined geometry, which may be beneficial for reasons explained below. In the case of a perforate membrane, pores may for example be defined by subjecting a membrane, e.g. a polymer membrane, to laser ablation. In such embodiments, the pores may have a polygonal, e.g. square, or circular cross-sectional shape.

[0043] In the case of a mesh, e.g. a monofilament mesh, the pores may be defined by the manner in which the wires, e.g. polymer wires, of the mesh are woven and/or welded. In such embodiments, the pores may have, for example, the above-mentioned square cross-sectional shape.

[0044] For example, the porous layer may comprise, e.g. be defined by, a plain weave woven mesh or a twill weave woven mesh.

[0045] In embodiments in which the porous layer comprises, e.g. is defined by, a woven fabric, e.g. a microfiber woven fabric, the woven fabric can comprise, for example, polyester fibers, polyamide fibers, and combinations of polyester and polyamide fibers.

[0046] It is noted that the term "microfiber woven fabric" as used herein may refer to a fabric formed of synthetic fibers, with the fabric being formed of threads whose titre is less than 1 decitex.

[0047] In some embodiments, the porous layer has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is less than or equal to 105 μm. The 105 μm upper limit for the limiting pore diameter, equivalent to a minimum bubble point pressure of 2000 Pa, may assist to ensure that sufficient underpressure is maintainable by the porous layer 118.

[0048] Alternatively or additionally, the porous layer has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is greater than or equal to 6 μm. It has been found empirically that a limiting pore diameter equal to or greater than 6 μm may assist to maintain a relatively large underpressure whilst ensuring that pores still enable efficient liquid transport therethrough. The latter may also be assisted by minimizing the thickness of the porous layer, for example to less than 200 μm, preferably less than 150 μm.

[0049] In some embodiments, the porous layer has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is greater than or equal to 8 μm, most preferably at least 11 μm.

[0050] In some embodiments, the limiting pore diameter of the porous layer as measured using ASTM F316 - 03, 2019, Test A is 11 to 15 μm.

[0051] In some embodiments, pores of the porous layer extend across the porous layer's thickness and open out at opposite sides of the porous layer, with a linear central axis of each pore extending across the thickness and passing through an intermediate point surrounded by a pore wall of the respective pore; the pore wall being arranged about the linear central axis. In such embodiments, each pore can be regarded as a through-hole that axially extends through the thickness of the porous layer.

[0052] A path of least resistance to fluid flow across the porous layer may be defined along the linear central axes of the pores.

[0053] Pores of the porous layer, whose linear central axis extends across the porous layer's thickness and passes through an intermediate point surrounded by a pore wall of the respective pore, are considered to be better defined than, for

example, pores defined between fibers of a woven fabric.

[0054] In particular, the pores of the porous layer may have a pore size distribution that can be selected to be separate from, in other words not overlapping with, a pore size distribution of a further porous layer arranged on the porous layer. In particular, the pore size distribution of the porous layer may be shifted to larger pore sizes than the pore size distribution of the further porous layer.

[0055] This may mean that dirt particles that are sufficiently small to initially pass through the further porous layer also pass through the porous layer when the porous layer and the further porous layer are subjected to the underpressure generated by the wet cleaning apparatus's underpressure generator. This may make the porous layer less liable to be clogged by such dirt particles during use.

[0056] More generally, the pliable cleaning member may include a further porous layer, e.g. a surface interaction layer, with the porous layer being arranged between the further porous layer and the pliable support substrate.

[0057] The further porous layer may, for example, be in the form of a disposable, e.g. single-use, cloth or wipe.

[0058] The further porous layer can be formed from any suitable material, such as viscose, polyester or polyvinylalcohol.

[0059] Preferably the material forming the further porous layer is biodegradable and/or sustainable.

[0060] The further porous material, e.g. the above-mentioned cloth or wipe, can be fixed to the cleaner head member, the cleaner head and/or the pliable support substrate in any suitable manner, for example via hooks-loops fasteners and/or via flexible grippers.

[0061] In embodiments in which the flexible grippers are employed, such flexible grippers may, for example, be integrated into the pliable material of the pliable support substrate.

[0062] Such pores can be defined in any suitable manner, for example by laser ablation of a polymeric membrane, or by a woven structure of a mesh, e.g. a monofilament mesh.

[0063] In some embodiments, each pore of the porous layer has a polygonal, e.g. square, or circular cross-sectional shape perpendicular to the linear central axis.

[0064] Such a polygonal, e.g. square, or circular cross-sectional shape perpendicular to the linear central axis may mean that the pore wall provides a consistent surface, in particular a relatively well-defined rim between a surface of the pore wall and exterior surface(s) of one or both sides of the porous layer. This can assist to increase the breaking pressure.

[0065] In some embodiments, the thickness of the porous layer is less than 200 μm, preferably less than 100 μm.

[0066] Such a maximum thickness may contribute to minimizing of flow resistance through the porous layer.

[0067] According to another aspect, there is provided a cleaner head member attachable to and/or detachable from a cleaner head of a wet cleaning apparatus, the cleaner head member comprising: a connector that is connectable to a complementary connector of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head; a pliable support substrate, a dirt inlet structure being defined in and/or arranged on a surface of the pliable support substrate, the dirt inlet structure extending across at least part of the surface, the pliable support substrate being formed from a closed cell foam material; and a pliable cleaning member comprising a porous layer having pores for receiving liquid from a surface to be cleaned, the pliable cleaning member being arranged on the surface of the pliable support substrate to cover the dirt inlet structure, the dirt inlet structure being arranged to receive said liquid received by the pores of the porous layer and to carry the liquid to the dirt conduit.

[0068] According to another aspect, there is provided a cleaner head assembly comprising: the cleaner head member according to of the embodiments described herein; and a cleaner head comprising the complementary connector for connecting to the connector of the cleaner head member, the cleaner head member being attachable to and/or detachable from the cleaner head.

[0069] According to a further aspect, there is provided a wet cleaning apparatus comprising: the cleaner head member or the cleaner head assembly according to any of the emodiments described herein; and an underpressure generator for subjecting the porous layer to an underpressure via the dirt inlet structure when the cleaner head member is attached to the cleaner head.

[0070] The underpressure generator may be configured to provide a pressure difference between an inside of the wet cleaning apparatus and atmospheric pressure for drawing fluid through the porous layer, with the pressure difference being in a range of 2000 Pa to 15000 Pa, preferably 2000 Pa to 13500 Pa.

[0071] Alternatively or additionally, the underpressure generator may be configured to generate a flow through the porous layer that is at most 2000 cm^3/minute.

[0072] The wet cleaning apparatus may comprise, for example, a wet mopping device, a window cleaner, a sweeper, or a wet vacuum cleaner, such as canister-type, stick type, or upright type wet vacuum cleaner. The wet cleaning apparatus may in some examples comprise a robotic wet vacuum cleaner or a robotic wet mopping device configured to autonomously move the cleaner head on the surface to be cleaned, such as the surface of a floor. Particular mention is made of the wet cleaning apparatus being a wet mopping device.

[0073] The wet cleaning apparatus may be a battery-powered (or battery-powerable) wet cleaning apparatus, such as a battery-powered (or battery-powerable) wet mopping device, in which the underpressure generator, e.g. pump, is

powered (or powerable) by a battery electrically connected (or connectable) thereto.

[0074] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0075] For a better understanding of the invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:

FIG. 1 provides an exploded view of a cleaner head assembly according to a first example;
FIG. 2 shows a pliable support substrate of a cleaner head member included in the cleaner head assembly shown in FIG. 1;
FIG. 3 provides a view of a connector of the cleaner head member included in the cleaner head assembly shown in FIG. 1;
FIGs. 4A and 4B provide exploded views of a cleaner head assembly according to a second example;
FIG. 5 provides an exploded view of a cleaner head assembly according to a third example;
FIG. 6 shows a pliable intermediate substrate of the cleaner head member included in the cleaner head assembly shown in FIG. 5;
FIG. 7 shows the pliable support substrate of the cleaner head member included in the cleaner head assembly shown in FIG. 5;
FIGs. 8A and 8B provide views of the cleaner head assembly shown in FIG. 5 in a disassembled state in which the cleaner head and the cleaner head member are not attached to each other; and
FIGs. 9A and 9B provide views of the cleaner head assembly shown in FIG. 5 in an assembled state in which the cleaner head and the cleaner head member are attached to each other.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0076] The invention will be described with reference to the Figures.

[0077] It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the apparatus, systems and methods, are intended for purposes of illustration only and are not intended to limit the scope of the invention. These and other features, aspects, and advantages of the apparatus, systems and methods of the present invention will become better understood from the following description, appended claims, and accompanying drawings. It should be understood that the Figures are merely schematic and are not drawn to scale. It should also be understood that the same reference numerals are used throughout the Figures to indicate the same or similar parts.

[0078] Provided is a cleaner head member attachable to and/or detachable from a cleaner head of a wet cleaning apparatus. The cleaner head member comprises a connector that is connectable to a complementary connector of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head. The cleaner head member also comprises a pliable support substrate. A dirt inlet structure is defined in and/or is arranged on a surface of the pliable support substrate. The dirt inlet structure extends across at least part of the surface. A pliable cleaning member is also included in the cleaner head member. The pliable cleaning member comprises a porous layer having pores for receiving liquid from a surface to be cleaned. The pliable cleaning member is arranged on the surface of the pliable support substrate to cover the dirt inlet structure. The dirt inlet structure receives the liquid initially received by the pores of the porous layer and carries the liquid to the dirt conduit. Also provided is a cleaner head assembly comprising the cleaner head member and the cleaner head. Further provided is a wet cleaning apparatus comprising the cleaner head member or the cleaner head assembly.

[0079] FIG. 1 provides an exploded view of a cleaner head member 100 according to an example. The cleaner head member 100 is attachable to and/or detachable from a cleaner head 102 of a wet cleaning apparatus.

[0080] By the cleaner head member 100 being attachable to the cleaner head 102, the cleaner head member 100 may be attached to the cleaner head 102, for example to replace a previously used cleaner head member 100.

[0081] The capability to detach the cleaner head member 100 from the cleaner head 102 may facilitate cleaning of one or both of the cleaner head member 100 and the cleaner head 102. Alternatively or additionally, detachment of the cleaner head member 100 may enable replacement of the cleaner head member 100, for instance when the cleaner head member 100 becomes overly worn.

[0082] The cleaner head member 100 may be supplied to a user separately from the cleaner head 102, for example when the cleaner head 102 is already in the user's possession or the cleaner head 102 is sourced separately from the cleaner head member 100.

[0083] In some embodiments, the cleaner head member 100 and the cleaner head 102 are included in a cleaner head

assembly 104. In such embodiments, the cleaner head 102 and the cleaner head member 100 of the cleaner head assembly 104 may be conveniently supplied to the user, for example with the cleaner head member 100 already attached to the cleaner head 102 or with the user being required to assemble the cleaner head assembly 104 by attaching the cleaner head member 100 to the cleaner head 102.

[0084] The cleaner head member 100 or the cleaner head assembly 102 may be included in a wet cleaning apparatus that also includes an underpressure generator, e.g. a pump, for providing suction to the cleaner head member 100.

[0085] This suction may facilitate removal of dirt, e.g. dirty liquid, from a surface being cleaned using the wet cleaning apparatus, as will be described in more detail herein below.

[0086] The cleaner head member 100 may have any suitable shape. In some embodiments, such as shown in FIG. 1, the cleaner head member 100 has an elongate shape having a length that is larger than a width, for instance such that a footprint of the cleaner head member 100 on the surface being cleaned is oblong, or is at least substantially oblong.

[0087] Alternatively or additionally, the cleaner head member 100 can be regarded as a flat mop, e.g. a flat mop that is attachable to and/or detachable from a cleaner head 102 in the form of a nozzle.

[0088] Such a cleaner head 102, e.g. nozzle, may be of a wet cleaning apparatus or appliance that generates underpressure for suction, and delivers liquid, e.g. water, to distribute to the surface to be cleaned, for example a floor.

[0089] The wet cleaning apparatus may be, for example, a wet mopping device, a window cleaner, a sweeper, or a wet vacuum cleaner, such as canister-type, stick type, or upright type wet vacuum cleaner. The wet cleaning apparatus may in some examples be a robotic wet vacuum cleaner or a robotic wet mopping device configured to autonomously move the cleaner head on the surface to be cleaned, such as the surface of a floor. Particular mention is made of the wet cleaning apparatus being a wet mopping device.

[0090] The wet cleaning apparatus may be a battery-powered (or battery-powerable) wet cleaning apparatus, such as a battery-powered (or battery-powerable) wet mopping device, in which the underpressure generator, e.g. pump, is powered (or powerable) by a battery electrically connected (or connectable) thereto.

[0091] In some embodiments, such as shown in FIG. 1, the cleaner head 102 comprises a support element 106, e.g. a rigid support element 106, for supporting the cleaner head member 100 thereon when the cleaner head member 100 is attached to the cleaner head 102.

[0092] The support element 106 can be formed from any suitable material. In some embodiments, the support element 106 is formed from a plastic material, e.g. a thermoplastic material.

[0093] The support element 106 can be fabricated in any suitable manner. In some embodiments, the support element 106, e.g. the support element 106 formed from the plastic material, is fabricated by a molding process, for instance by injection molding.

[0094] Referring again to FIG. 1, the cleaner head member 100 comprises a connector 108, in other words an interface part, that is connectable to, in other words interfaceable with, a complementary connector 110 of the cleaner head 102 to provide a sealed dirt conduit between the cleaner head member 100 and the cleaner head 102 when the cleaner head member 100 is attached to the cleaner head 102. The underpressure generator may be fluidly connected to the cleaner head member 100 via the connector 108 and the complementary connector 110.

[0095] The sealed conduit may assist to minimize or avoid leakage of the underpressure at the connection between the cleaner head 102 and the cleaner head member 100 defined by the connector 108 and the complementary connector 110.

[0096] The complementary connector 110 may be mounted in the cleaner head 102 in any suitable manner. In some embodiments, such as shown in FIG. 1, the complementary connector 110 is mounted in an opening 112 delimited by the support element 106.

[0097] The attachment of the cleaner head member 100 to the cleaner head 102 may, for example, be defined by connection of the connector 108 and the complementary connector 110 to each other. In some embodiments, the cleaner head member 100 and/or the cleaner head 102 may include one or more fasterners, provided in addition to the connector 108 and the complementary connector 110, for attaching the cleaner head member 100 to the cleaner head 102.

[0098] The design of the connector 106 and the complementary connector 110 is further described, by way of illustrative non-limiting example, herein below.

[0099] The cleaner head member 100 comprises a pliable support substrate 114. The pliable support substrate 114 supports thereon a pliable cleaning member 116 comprising a porous layer 118 having pores for receiving liquid from the surface being cleaned. The pliability of the pliable support substrate 114 and the pliable cleaning member 116 may assist the cleaner head member 100 to follow contours on the surface being cleaned and/or may assist cleaning of the cleaner head member 100 after use, for example by washing of the cleaner head member 100 in the user's washing machine.

[0100] Such cleaning of the cleaner head member 100, when detached from the cleaner head 102, may assist to remove dirt particles that may build up inside and clog the cleaner head member 100 during use.

[0101] The pliable support substrate 114 and the pliable cleaning member 116 can be regarded as stacked layers of the cleaner head member 100. In at least some embodiments, the cleaner head member 100 can be in the form of a planer, e.g. flat, mop that is attachable to and/or detachable from the cleaner head 100 of the wet cleaning apparatus.

[0102] The connector 108, in other words interface part, may be mounted to the pliable support substrate 114. In at least

some embodiments, the connector 108 is permanently affixed to the pliable support substrate 114.

[0103] Such mounting and/or permanent affixing of the connector 108 to the pliable support substrate 114 can be implemented in any suitable manner, for example by at least part of the connector 108 being clamped between layers of the cleaner head member 100 and/or by adhering the connector 108 to the pliable support substrate 114, e.g. using adhesive and/or adhesive tape.

[0104] In some embodiments, the connector 108 is an integral part of the pliable support substrate 114.

[0105] In other words, the connector 108 may be formed by the pliable support substrate 114.

[0106] This can be implemented, for example, when injection molding is used to fabricate the pliable support substrate 114.

[0107] The porous layer 118 may assist to maintain the underpressure between the underpressure generator and the porous layer 118, with or without a flow being applied by the underpressure generator included in the wet cleaning apparatus.

[0108] When the porous layer 118 is dry, the porous layer 118 may be regarded as being in an "air transport state" in which air is transported through each of the dry pores of the porous layer 118. A "liquid transport state" corresponds to liquid, e.g. water, being transported through the (wetted) pores of the porous layer 118. When there is no longer a feed of liquid to the pores, a "fluid block state" may be adopted. The "fluid block state" corresponds to the state at which the surface tension of the (residual) liquid retained in the wetted pores of the porous layer 118 prevents fluid transport through the pores. In the latter state, a surface or barrier is created at the boundary between air and liquid, e.g. water. This barrier can assist to maintain the underpressure between the porous layer 118 and the underpressure generator. The pressure needed to "break" this barrier can be termed a "breaking pressure".

[0109] The porous layer 118 can be formed from any suitable material. In some embodiments, the porous layer 118 is formed from a polyester and/or a polyamide. Such materials have been found to be suitably hydrophilic to enable the porous layer 118 to be adequately wetted by water, e.g. water received from the surface being cleaned.

[0110] Alternatively or additionally, the porous layer 118 may comprise one or more of a woven fabric, e.g. a microfiber woven fabric, a mesh, and a perforate membrane.

[0111] Such a mesh, e.g. a monofilament mesh, and/or perforate membrane may represent a relatively straightforward way of providing pores with a well-defined geometry, which may be beneficial for reasons explained below. In the case of a perforate membrane, pores may for example be defined by subjecting a membrane, e.g. a polymer membrane, to laser ablation. In such embodiments, the pores may have a polygonal, e.g. square, or circular cross-sectional shape.

[0112] In the case of a mesh, e.g. monofilament mesh, the pores may be defined by the manner in which the wires, e.g. polymer wires, of the mesh are woven and/or welded. In such embodiments, the pores may have, for example, the above-mentioned square cross-sectional shape.

[0113] For example, the porous layer 118 may comprise, e.g. be defined by, a plain weave woven mesh or a twill weave woven mesh.

[0114] In embodiments in which the porous layer 118 comprises, e.g. is defined by, a woven fabric, e.g. a microfiber woven fabric, the woven fabric can comprise, for example, polyester fibers, polyamide fibers, and combinations of polyester and polyamide fibers.

[0115] It is noted that the term "microfiber woven fabric" as used herein may refer to a fabric formed of synthetic fibers, with the fabric being formed of threads whose titre is less than 1 decitex.

[0116] In some embodiments, pores of the porous layer 118 extend across the porous layer's 118 thickness and open out at opposite sides of the porous layer 118, with a linear central axis of each pore extending across the thickness and passing through an intermediate point surrounded by a pore wall of the respective pore; the pore wall being arranged about the linear central axis. In such embodiments, each pore can be regarded as a through-hole that axially extends through the thickness of the porous layer 118.

[0117] A path of least resistance to fluid flow across the porous layer 118 may be defined along the linear central axes of the pores.

[0118] Pores of the porous layer 118, whose linear central axis extends across the porous layer's 118 thickness and passes through an intermediate point surrounded by a pore wall of the respective pore, are considered to be better defined than, for example, pores defined between fibers of a woven fabric.

[0119] In particular, the pores of the porous layer 118 may have a pore size distribution that can be selected to be separate from, in other words not overlapping with, a pore size distribution of a further porous layer 120 arranged on the porous layer 118. In particular, the pore size distribution of the porous layer 118 may be shifted to larger pore sizes than the pore size distribution of the further porous layer 120.

[0120] This may mean that dirt particles that are sufficiently small to initially pass through the further porous layer 120 also pass through the porous layer 118 when the porous layer 118 and the further porous layer 120 are subjected to the underpressure generated by the wet cleaning apparatus's underpressure generator. This may make the porous layer 118 less liable to be clogged by such dirt particles during use.

[0121] Such pores can be defined in any suitable manner, for example by laser ablation of a polymeric membrane, or by a

woven structure of a mesh, e.g. a monofilament mesh.

[0122] In some embodiments, each pore of the porous layer 118 has a polygonal, e.g. square, or circular cross-sectional shape perpendicular to the linear central axis. Such a polygonal, e.g. square, or circular cross-sectional shape perpendicular to the linear central axis may mean that the pore wall provides a consistent surface, in particular a relatively well-defined rim between a surface of the pore wall and exterior surface(s) of one or both sides of the porous layer 118. This can assist to increase the breaking pressure.

[0123] The rim between a surface of the pore wall and an exterior surface of the porous layer 118 may, for example, have a radius of curvature of 0.1 μm to 3 μm.

[0124] Such a radius of curvature, which may be significantly smaller than the pore radius, may assist to prevent the size of the liquid-air interface/surface from growing when pressure is applied. This may prevent the increase in force on the surface (force being equal to pressure multiplied by area), hence prevents the surface's edge from being overloaded sooner, thereby keeping the surface from collapsing/"exploding".

[0125] It is noted that such well-defined pores of the porous layer 118 contrast with the pores defined between fibers of a woven fabric in which a range of contact angles are effectively provided around the surfaces delimiting a given pore. The shapes of the upstream and downstream openings of such a woven fabric pore are also not as well-defined as the upstream and downstream rims of the porous layer. This means that in the case of a pore of a woven fabric, there may always be a place in the pore where the contact angle reaches its limit so that the liquid barrier can no longer maintain its position. The resultant barrier movement may enlarge the surface area on which the pressure acts; the total force on the barrier increasing, making it harder for the rest of the barrier to maintain its position, with further movement resulting, and so on.. This issue may be addressed by the well-defined pore geometry of each of the pores of the porous layer 118 according to embodiments of the present disclosure.

[0126] In summary, a contact angle between liquid and the surface of the porous layer 118 may always be present; an increase in pressure may move an edge of the barrier to a new position of equilibrium; if this shifting occurs while the barrier remains relatively small, higher breaking pressures can be obtained; if the shifting occurs while significantly increasing the surface area of the barrier, the breaking pressure may be lower.

[0127] In some embodiments, the thickness of the porous layer 118 is less than 200 μm, preferably less than 100 μm. Such a maximum thickness may contribute to minimizing of flow resistance through the porous layer 118.

[0128] The thickness of the porous layer 118 can be determined by using a precision gauge and two ground metal plates (with the upper plate by which the normal pressure is applied being 70 mm x 30 mm, and the lower plate on which the sample of the porous layer 118 is supported having a larger area than the 70 mm x 30 mm surface of the upper plate for ease of alignment) for receiving the porous layer 118 therebetween. The arrangement is configured to apply a pressure normal to the sample of the porous layer 118 (70 mm x 30 mm) of 864.2 N/m^2. The relevant measurement parameters are provided in Table 1:

Table 1

Metal plate parameters	Length	70 mm	Area of sample	2100 mm^2
	Width	30 mm	Total mass	185 g
	mass	85 g	Total force	1.81 N
	Fn (gauge force)	100 g	Pressure	864.2 N/m^2

[0129] In some embodiments, such as shown in FIG. 1, the pliable cleaning member 116 comprises the further porous layer 120 for contacting the surface to be cleaned, with the porous layer 118 being interposed between the further porous layer 120 and the pliable suppport substrate 114. In such embodiments, the further porous layer 120 may be regarded, for example, as a surface interaction layer.

[0130] Liquid received from the surface being cleaned may be transported through pores of the further porous layer 120 to the pores of the porous layer 118.

[0131] The further porous layer 120 may be arranged on the porous layer 118 in any suitable manner. In some embodiments, the further porous layer 120 is detachable from the porous layer 118, for example to facilitate cleaning of one or both of the porous layer 118 and the further porous layer 120. Alternatively or additionally, detachment of the further porous layer 120 may enable the further porous layer 120 to be replaced without having to replace the porous layer 118 at the same time.

[0132] In some embodiments, the further porous layer 120 is in the form of a disposable, e.g. single-use, cloth or wipe.

[0133] The further porous layer 120 can be formed from any suitable material, such as viscose, polyester or polyvinylalcohol.

[0134] Preferably the material forming the further porous layer 120 is biodegradable and/or sustainable.

[0135] The further porous material 120, e.g. the above-mentioned cloth or wipe, can be fixed to the cleaner head

member 100, the cleaner head 102 and/or the pliable support substrate 114 in any suitable manner, for example via hooks-loops fasteners and/or via flexible grippers.

[0136] In embodiments in which the flexible grippers are employed, such flexible grippers may, for example, be integrated into the pliable material of the pliable support substrate 114.

[0137] In other embodiments, the porous layer 118 and the further porous layer 120 are permanently affixed to each other, for example via welding, e.g. ultransonic welding, and/or via an adhesive.

[0138] Such permanent attachment of the porous layer 118 and the further porous layer 120 to each other may make manufacture of the cleaner head member 100 simpler and less expensive.

[0139] In some embodiments, the further porous layer 120 comprises one or more woven fabric layers, e.g. one or more microfiber fabric layers.

[0140] The woven fabric layer(s) can comprise, for example, polyester fibers, polyamide fibers, and combinations of polyester and polyamide fibers.

[0141] The further porous layer 120 may, more generally, be formed from a polyester and/or a polyamide.

[0142] In some embodiments, a pore size distribution of the porous layer 118 spans a range of pore sizes whose smallest pore size is larger than a largest pore size of a range of pore sizes spanned by the further porous layer 120.

[0143] This may mean that dirt particles passing through the further porous layer 120 may also pass through the porous layer 118 when the porous layer 118 and the further porous layer 120 are subjected to the underpressure generated by the wet cleaning apparatus's underpressure generator.

[0144] This may make the porous layer 118 less liable to be clogged by such dirt particles during use because dirt particles that are sufficiently small to initially pass through the further porous layer 120 also pass through the porous layer 118.

[0145] In some embodiments, the pores of the porous layer 118 are exclusively arranged in a region of the porous layer 118 that remains in contact with the further porous layer 120.

[0146] The maintaining of contact between the further porous layer 120 and the porous layer 118 may mean that any "broken" pores in the porous layer 118 may be kept supplied with liquid from the further porous layer 120, and thereby "repaired". This can assist maintenance of the underpressure between the underpressure generator and the porous layer 118.

[0147] Alternatively or additionally, the further porous layer 120 may have a porous structure configured to enable lateral fluid transport in a first direction within the further porous layer 120 as well as fluid transport in a second direction across a thickness of the further porous layer 120 towards the porous layer 118. Such a porous structure may be provided, for example, by the further porous layer 120 comprising, e.g. being defined by, the one or more woven fabric layers.

[0148] The lateral fluid transport provided in the further porous layer 120 can assist to keep the porous layer 118 supplied with liquid, thereby helping to repair broken pores of the porous layer 118.

[0149] ASTM F316 - 03, 2019, Test A provides a bubble point pressure measurement. Whilst this standard method was developed for nonfibrous membrane filters, the procedure can be replicated for the porous layer 118, as well as for the further porous layer 120 when present.

[0150] The bubble point test for determining the limiting pore diameter, in other words maximum pore size, is, in summary, performed by prewetting a sample of the porous layer 118, increasing the pressure of gas upstream of the porous layer 118 at a predetermined rate, and watching for gas bubbles downstream to indicate the passage of gas through the pores, e.g. maximum diameter pores, of the porous layer 118.

[0151] In common with the membrane filters described in ASTM F316 - 03, 2019, Test A, the porous layer 118 may (at least to an approximation depending on the pore structure/type of porous layer 118) have discrete pores extending from one side of the porous layer 118 to the other, similarly to capillary tubes. The bubble point test is based on the principle that a wetting liquid is held in these capillary pores by capillary attraction and surface tension, and the minimum pressure required to force liquid from these pores is a function of pore diameter. The pressure at which a steady stream of bubbles appears in this test is termed the "bubble point pressure".

[0152] It is noted that ASTM F316 - 03, 2019, Test A is based on an approximation of the pores as capillary pores having circular cross-sections, and hence the limiting pore diameter should be regarded as merely an empirical estimate of the maximum pore diameter based on this premise.

[0153] The testing apparatus mandated in ASTM F316 - 03, 2019, Test A is replicated, as is the test procedure.

1. The sample of porous layer 118 (2 inch (50.8 mm) diameter, held in a circular holder such as to have an open/active area having a diameter of 47 mm), is wetted completely by floating it on a pool of the liquid (noting that a vacuum chamber may be used to assist in wetting the sample, if necessary). For water-wettable samples, the sample is placed in water and soaked fully.
2. The wet sample of porous layer 118 is placed in the filter holder of the test apparatus.
3. A fine (100 by 100) mesh is placed onto the sample of porous layer 118; the fine mesh being a first part of the 2-ply construction mandated by the standard.

4. The second part of the 2-ply construction, in the form of a perforated metal component to add rigidity, is placed on the fine mesh.
5. A support ring is placed onto the stack and secured in place using bolts. A slight gas pressure can be applied at this point to eliminate possible liquid backflow.
6. The perforated metal component is covered with 2 to 3 mm of test liquid (Type IV water as mandated by the standard when the sample is wettable with water).
7. The gas pressure is then raised and the lowest pressure at which a steady stream of bubbles rises from the central area of the reservoir is recorded (see Fig. 5 of ASTM F316 - 03, 2019, Test A; noting that bubbles observed at the edge of the reservoir are neglected for the bubble point determination).

[0154] It is suitable to first raise the pressure relatively quickly, e.g. at about 200 Palsecond, to roughly determine the bubble point. Pressure can then be relieved from the sample to allow the water to run back into the sample. The pressure is then raised to roughly 80% of the expected pressure value, maintained at the 80% level for about 15 seconds (to ensure all "free" water is pressed out of the sample), and then raised again at a lower rate of $\leq$ 50 Palsecond until the constant flow of bubbles was observed.

[0155] The limiting pore diameter, d, is then determined from the recorded bubble point pressure, p, using equation 1 of ASTM F316 - 03, 2019, Test A: $d = C\gamma/p$, where γ is the surface tension in mM/m (72.75 for distilled water at 20°C), and C is 2860 when p is in Pa.

[0156] In some embodiments, the porous layer 118 has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is less than or equal to 105 μm. The 105 μm upper limit for the limiting pore diameter, equivalent to a minimum bubble point pressure of 2000 Pa, may assist to ensure that sufficient underpressure is maintainable by the porous layer 118.

[0157] Alternatively or additionally, the porous layer 118 has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is greater than or equal to 6 μm. It has been found empirically that a limiting pore diameter equal to or greater than 6 μm may assist to maintain a relatively large underpressure whilst ensuring that pores still enable efficient liquid transport therethrough. The latter may also be assisted by minimizing the thickness of the porous layer 118.

[0158] In some embodiments, the porous layer 118 has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is greater than or equal to 8 μm, most preferably greater than or equal to 11 μm.

[0159] In some embodiments, the limiting pore diameter of the porous layer 118 as measured using ASTM F316 - 03, 2019, Test A is 11 to 15 μm.

[0160] It has been observed that "self-repair" of "broken" pores of the porous layer 118, e.g. when the porous layer 118 is employed together with the above-mentioned further porous layer 120, e.g. a further porous layer 120 made of a woven fabric, may be enhanced when the limiting pore diameter of the porous layer 118 is 11 to 15 μm.

[0161] In some embodiments, the further porous layer 120 has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, equal to or less than 105 μm and/or equal to or greater than 15 μm.

[0162] It has been found empirically that a limiting pore diameter of the further porous layer 120 being equal to or greater than 15 μm may assist to maintain a relatively large underpressure whilst ensuring that pores are sufficiently large for efficient liquid transport through the further porous layer 120.

[0163] Equivalently, a bubble point pressure of the further porous layer 120 as measured using ASTM F316 - 03, 2019, Test A may be equal to or less than 13500 Pa.

[0164] In some embodiments, a limiting pore diameter of the further porous layer 120 as measured using ASTM F316 - 03, 2019, Test A is equal to or less than 105 μm. This upper limit for the limiting pore diameter assists to ensure that sufficient underpressure is maintainable by the further porous layer 120.

[0165] Equivalently, a bubble point pressure of the further porous layer 120 as measured using ASTM F316 - 03, 2019, Test A may be equal to or greater than 2000 Pa. Preferably, the bubble point pressure of the further porous layer 120 is 7000 Pa to 9000 Pa.

[0166] More generally, the underpressure generator of the wet cleaning apparatus may subject the porous layer 118 to the underpressure, preferably by being configured to generate a flow through the porous layer 118 that is at most 2000 cm^3/minute.

[0167] In some embodiments, the underpressure generator is configured to supply said suction by providing a flow through the porous layer 118 in the range of 15 to 2000 cm^3/minute, more preferably 80 to 750 cm^3/minute, even more preferably 100 to 300 cm^3/minute, and most preferably 150 to 300 cm^3/minute.

[0168] Such a flow, i.e. flow rate, may capitalise on the underpressure-maintaining capability of the porous layer 118, and may ensure sufficient liquid pick-up whilst limiting energy consumption.

[0169] The underpressure generator may be configured to provide a pressure difference between an inside of the wet cleaning apparatus and atmospheric pressure for drawing fluid through the porous layer 118, with the pressure difference being in a range of 2000 Pa to 15000 Pa, preferably 2000 Pa to 13500 Pa.

[0170] The pressure difference can be directly and positively verified in a given wet cleaning apparatus by, for example,

drilling a hole in a tube of the wet cleaning apparatus that fluidly connects the underpressure generator and pores of the porous layer 118 and using the hole to couple to a pneumatic pressure sensor itself having a tube with a membrane covering an end thereof; the sensor being thus connected using an airtight connection. The sensor may be arranged to avoid disturbing the flow, hence the skilled person will arrange the sensor to avoid, for instance, creating a bypass flow. No flow may be towards or from the sensor: only pressure is transmitted. In this way, the flow of the appliance may never be compromised (hence may remain at the set level in spite of the sensor installation).

[0171] The pressure sensor is connected between the porous layer 118 and the underpressure generator and as close to the porous layer 118 as possible, to minimise the influence of other factors, such as flow resistance etc., on the sensed pressure difference.

[0172] The sensing element/ membrane of the pressure sensor/gauge is ideally arranged/positioned in the pressure sensor so that the sensing element can be placed directly (without the requirement for connecting tubes) in the tube, or in a cavity behind the porous layer 118.

[0173] By positioning the membrane of the pressure sensor, in other words membrane pressure gauge, with the membrane positioned at, in other words in line with, the wall of the tube (or exposed to the cavity), measurement errors may be minimized, as will be appreciated by a person skilled in the art.

[0174] It is noted that air bubbles inside narrow tubes may generate resistance (capillary/surface tension effects), and hence may influence the measurement. Hence the skilled person will further appreciate that care is also to be taken that air bubbles (water-air surfaces) do not unduly influence the pressure difference measurement.

[0175] It is further noted that a column of water present between the pressure sensor and the porous layer 118 should be deducted from the measurement result (if such a column of water is present during the measurement), to compensate for the static pressure generated by the column of water.

[0176] Once the pressure sensor is arranged as described above, it may be ascertained that maintenance of the underpressure is due to the porous layer 118, and the further porous layer 120 when present, and not some other element, such as a valve. Any such element that influences the underpressure that is presented to the porous layer 118 should be rendered inoperable for the purpose of performing the measurement.

[0177] Component(s) that dispense cleaning liquid (should the wet cleaning apparatus be configured to deliver cleaning liquid) is/are disengaged when performing the pressure difference measurement.

[0178] The wet cleaning apparatus is turned on (in the desired setting), so that the pick-up system comprising the underpressure generator is activated. Recording of data from the pressure sensor is started.

[0179] The pick-up area of the cleaner head member 100 is suspended in a layer of water, at max. 5 mm depth.

[0180] The pick-up area is then lifted from the water without tilting it in any way (so that the cleaner head member 100 remains in a cleaning position, as if it were positioned to clean the floor), so that the water is no longer touching the porous layer 118 or the further porous layer 120, when present. At this point, "free water" will be removed from the porous layer 118 (and the further porous layer 120, when present), all pores will go into their "blocked state", and the breaking pressure is determinable. An equilibrium is established in an end regime in which the applied flow results in an underpressure which causes no more fluid blocks to break.

[0181] The breaking pressure obtained from this measurement result, at the end regime, is the "pressure difference between the inside of the wet cleaning apparatus and atmospheric pressure for drawing fluid through the porous layer 118." It is verified from the measurement result whether or not the 2000 Pa to 15000 Pa range, or the 2000 Pa to 13500 Pa preferred range, is satisfied.

[0182] The underpressure generator may, for example, comprise a positive displacement pump, such as a peristaltic pump.

[0183] Such a positive displacement pump can assist to maintain the underpressure after the underpressure generator has been deactivated, e.g. switched off, because the pump design inherently restricts backflow from the pump outlet. This, in turn, may alleviate problematic liquid release from the porous layer 118, for instance following cleaning of the surface to be cleaned and/or during stowing of the wet cleaning apparatus in a storage area after use.

[0184] The wet cleaning apparatus may include a dirty liquid collection tank. In such embodiments, the underpressure generator may be arranged to draw liquid through the porous layer 118 and to the dirty liquid collection tank.

[0185] Alternatively or additionally, the wet cleaning apparatus may comprise a cleaning liquid supply for supplying cleaning liquid for delivery towards the surface to be cleaned via at least one cleaning liquid outlet, e.g. included in the cleaner head. Such a cleaning liquid supply may, for example, comprise a cleaning liquid reservoir and a delivery arrangement, e.g. a delivery arrangement comprising a pump, for transporting the cleaning liquid towards the surface being cleaned.

[0186] The cleaning liquid supply may be configured to provide a continuous delivery of the cleaning liquid towards the surface to be cleaned. Such continuous delivery may, for instance, be provided at the same time as underpressure generator is supplying suction to the porous layer 118.

[0187] The cleaning liquid supply and the underpressure generator may, for instance, be configured such that the flow of the cleaning liquid delivered is equal to or lower than the flow provided by the underpressure generator. This may assist to

ensure that the surface to be cleaned does not become excessively wet with the cleaning liquid. For example, the flow of cleaning liquid may be in the range of 20 to 100 cm^3/minute, and the flow provided by the underpressure generator may be in the range of 40 to 2000 cm^3/minute, more preferably 80 to 750 cm^3/minute, even more preferably 100 to 300 cm^3/minute, and most preferably 150 to 300 cm^3/minute.

[0188] Referring to FIGs. 1 and 2, a dirt inlet structure 122A, 122B is defined in and/or arranged on a surface 124 of the pliable support substrate 114, with the dirt inlet structure 122A, 122B extending across at least part of the surface 124. The dirt inlet structure 122A, 122B is arranged to receive said liquid received by the pores of the porous layer 118 and to carry the liquid to the sealed dirt conduit provided by the connector 108 of the cleaner head member 100 being connected to the complementary connector 110 of the cleaner head 102.

[0189] As best illustrated by the exploded view provided in FIG. 1, the pliable cleaning member 116 is arranged on the surface 124 of the pliable support substrate 114 to cover the dirt inlet structure 122A, 122B.

[0190] In at least some embodiments, the pliable cleaning member 116, e.g. the porous layer 118 thereof, is permanently affixed to the pliable support substrate 114 so as to cover the dirt inlet structure 122A, 112B. Thus, the pliable cleaning member 116 may assist to retain liquid within the dirt inlet structure 122A, 122B defined in and/or arranged on the surface 124 of the pliable support substrate 114.

[0191] The pliable cleaning member 116, e.g. the porous layer 118 thereof, may be permanently affixed to the pliable support substrate 114 in any suitable manner. In some embodiments, the pliable cleaning member 116, e.g. the porous layer 118 thereof, may be welded to the pliable support substrate 114, e.g. in a process involving melting of one or both of the pliable support substrate 114 and the pliable cleaning member 116. Ultransonic welding may, for example, be used to permenantly affix the pliable support substrate 114 to the pliable cleaning member 116, e.g. the porous layer 118 thereof.

[0192] Alternatively or additionally, one or more of an adhesive and adhesive tape may be employed to affix, e.g. permanently affix, the pliable support substrate 114 to the pliable cleaning member 116, e.g. the porous layer 118 thereof.

[0193] In some embodiments, the pliable cleaning member 116 is sealingly attached to the pliable support substrate 114 around the dirt inlet structure 122A, 122B. This sealing attachment may assist to maintain an underpressure in the dirt inlet structure 122A, 122B with or without the flow being applied by the underpressure generator included in the wet cleaning apparatus.

[0194] The sealing attachment can be implemented in any suitable manner, such as by gluing and/or welding the pliable cleaning member 116, e.g. the porous layer 118 thereof in the case of the embodiment shown in FIGs. 1 and 2, around the dirt inlet structure 122A, 122B.

[0195] In embodiments in which the dirt inlet structure 122A, 122B is defined in the surface 124 of the pliable support substrate 114, the dirt inlet structure 122A, 122B may comprise, e.g. be defined by, at least one dirt inlet groove defined in and extending across the at least part of the surface 124.

[0196] In embodiments in which the dirt inlet structure 122A, 122B is arranged on the surface 124 of the pliable support substrate 114, the dirt inlet structure 122A, 122B may comprise, e.g. be defined by, an arrangement of protruding elements protruding from the surface 124 and extending across the at least part of the surface 124, with dirt path(s) being defined between protruding elements of the arrangement of protruding elements.

[0197] In some embodiments, and referring to FIGs. 1 to 3, the pliable support substrate 114 delimits one or more dirt inlet passages 126A, 126B that fluidly couple the dirt inlet structure 122A, 122B with corresponding opening(s) 128A, 128B defined in the connector 108.

[0198] Such opening(s) 128A, 128B may define the connector's 108 contribution to the sealed dirt conduit provided when the connector 108 and the complementary connector 110 are connected to each other.

[0199] The flow of liquid through the opening(s) 128A, 128B in the direction of the underpressure generator is denoted in FIG. 3 by the arrows 130A, 130B.

[0200] With continued reference to the embodiment shown in FIGs. 1 and 2, a cleaning liquid outlet structure 132 is defined in and/or is arranged on the surface 124 of the pliable support substrate 114 and is arranged to deliver cleaning liquid received therein towards the surface being cleaned, for example via a portion of the porous layer 118. The cleaning liquid outlet structure 132 may extend across at least part of the surface 124 of the pliable support substrate 114.

[0201] As best shown in FIG. 2, the cleaning liquid outlet structure 132 is separated from the dirt inlet structure 122A, 122B by region(s) 134A, 134B of the pliable support substrate 114.

[0202] By the region(s) 134A, 134B of the pliable support substrate 114 separating the dirt inlet structure 122A, 122B from the cleaning liquid outlet structure 132, the risk of cleaning liquid in the cleaning liquid outlet structure 132 being drawn directly into the dirt inlet structure 122A, 122B can be lessened or removed. Thus, there may be a greater chance of the cleaning liquid reaching the surface being cleaned. The cleaning liquid may consequently be used more efficiently.

[0203] The dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 can be tuned for equal fluid distribution in/on the pliable support substrate 114 that is connected, e.g. directly connected, to the connector 108.

[0204] The clean and dirty liquid distibution can be tuned by balancing the resistance of the pliable cleaning member 116, e.g. the porous layer 118, e.g. via selection of the material(s) and its surface area. Alternatively or additionally, different shapes and patterns of the dirt inlet structure 122A, 122B, e.g. grooves, and the cleaning liquid outlet structure 132, e.g.

grooves, may be employed.

[0205] In some embodiments, a cleaning liquid conduit between the cleaner head member 100 and the cleaner head 102 is provided by the connection between the connector 108 and the complementary connector 110 when the cleaner head member 100 is attached to the cleaner head 102. The connector 108 may thus provide an integrated connector 108 for coupling the wet cleaning apparatus's underpressure generator and cleaning liquid supply respectively to the dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 of the cleaner head member 100.

[0206] The sealed dirt conduit and the cleaning liquid conduit may be separate from each other. In this way, the risk of cleaning liquid being drawn towards the underpressure generator prior to reaching the cleaning liquid outlet structure 132 may be lessened or removed.

[0207] In embodiments in which the cleaning liquid outlet structure 132 is defined in the surface 124 of the pliable support substrate 114, the cleaning liquid outlet structure 132 may comprise, e.g. be defined by, at least one cleaning liquid outlet groove defined in and extending across the at least part of the surface 124.

[0208] In embodiments in which the cleaning liquid outlet structure 132 is arranged on the surface 124 of the pliable support substrate 114, the cleaning liquid outlet structure 132 may comprise, e.g. be defined by, an arrangement of protruding elements protruding from the surface 124 and extending across the at least part of the surface 124, with cleaning liquid path(s) being defined between protruding elements of the arrangement of protruding elements.

[0209] In at least some embodiments, and as best shown in FIG. 1, the pliable cleaning member 116, e.g. the porous layer 118 thereof, covers the cleaning liquid outlet structure 132.

[0210] In some embodiments, and referring to FIGs. 1 to 3, the pliable support substrate 114 delimits one or more cleaning liquid outlet passages 136 that fluidly couple the cleaning liquid outlet structure 132 with corresponding further opening(s) 138 defined in the connector 108.

[0211] Such further opening(s) 138 may define the connector's 108 contribution to the cleaning liquid conduit provided when the connector 108 and the complementary connector 110 are connected to each other.

[0212] The flow of liquid through the further opening(s) 138 in the direction of the surface to be cleaned is denoted in FIG. 3 by the arrow 140.

[0213] It is noted that the above-mentioned separation of the sealed dirt conduit and the cleaning liquid conduit can be implemented in any suitable manner. In some embodiments, such as shown in FIG. 3, the connector 108 comprises a wall 142, e.g. an annular wall 142, arranged between the opening(s) 128A, 128B and the further opening(s) 138 to keep the liquid in the opening(s) 128A, 128B separate from the cleaning liquid in the further opening(s) 138.

[0214] More generally, the connector 108 can have any suitable design provided that the connector 108 is capable of cooperating with the complementary connector 110 to define the sealed dirt conduit, and in certain embodiments the cleaning liquid conduit.

[0215] In some embodiments, such as shown in FIG. 3, the connector 108, in other words interface part, comprises a round shape comprising two concentric sealing areas: a sealing area for the opening(s) 128A, 128B, and another sealing area for the further opening(s) 138.

[0216] This may provide a relatively simple and user-friendly interface that is straightforward to seal in an airtight manner.

[0217] In such embodiments, the concentric sealing areas may be separated from each other by the annular wall 142.

[0218] In some embodiments, and as best shown in FIG. 2, the dirt inlet structure 122A, 122B comprises a first dirt inlet structure 122A and a second dirt inlet structure 122B that are arranged to receive liquid from different portions of the porous layer 118. In such embodiments, the first dirt inlet structure 122A may extend along at least part of the pliable support substrate's 114 length, and the second dirt inlet structure 122B may also extend along at least part of the the pliable support substrate's 114 length but with the first dirt inlet structure 122A being separated from the second dirt inlet structure 122B across the width of the pliable support substrate 114.

[0219] In some embodiments, and as best shown in FIG. 2, the dirt inlet structure 122A, 122B includes wider liquid transport branch(es) 142A, 142B that extend from the dirt inlet passage(s) 126A, 126B to a network of narrower liquid transport branches.

[0220] This branched dirt inlet structure 122A, 122B may assist to efficiently transport liquid from various portions of the porous layer 118 to the dirt conduit.

[0221] Alternatively or additionally, and still referring to FIG. 2, the cleaning liquid outlet structure 132 may include wider cleaning liquid delivery branch(es) 144 that extend from the cleaning liquid outlet passage(s) 136 to a network of narrower cleaning liquid delivery branches.

[0222] This branched cleaning liquid outlet structure 132 may assist to efficiently deliver cleaning liquid to various parts of the surface being cleaned, e.g. via the porous layer 118.

[0223] In embodiments, such as shown in FIGs. 1 and 2, in which the dirt inlet structure 122A, 122B comprises the first dirt inlet structure 122A and the second dirt inlet structure 122B, the cleaning liquid outlet structure 132 may be arranged between the first dirt inlet structure 122A and the second dirt inlet structure 122B.

[0224] This arrangement may provide efficient cleaning liquid delivery to and liquid pick-up from the surface being

cleaned.

[0225] The pliable support substrate 114 can be manufactured from any suitable pliable material, for instance that allows the pliable support substrate 114 to follow, together with the pliable cleaning member 116, contours on the surface being cleaned. The pliable material may also enable provision of the dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 therein and/or thereon.

[0226] Implicit in the function of the dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 defined in and/or arranged on the pliable support substrate 114 is that the pliable material's bulk provides a flow barrier, in particular for liquid, e.g. water, so that the liquid from the surface being cleaned and the cleaning liquid delivered towards the surface being cleaned follow the flow paths defined by the dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132.

[0227] In some embodiments, the pliable material comprises, e.g. is, a polymeric material and/or elastomeric material.

[0228] Particular mention is made of silicone rubber and ethylene-vinyl acetate, in other words a copolymer of ethylene and vinyl acetate, for the pliable material.

[0229] In embodiments in which the pliable support substrate 114 is formed from ethylene-vinyl acetate, ethylene may, for example, account for 60 to 90 wt.% of the copolymer.

[0230] Other polymeric and/or elastomeric materials, such as a polydiene, e.g. polybutadiene, a thermoplastic elastomer, and so on, can also be contemplated for the pliable material.

[0231] Alternatively or additionally, the pliable material can be less than 50 Shore A, preferably less than 20 Shore A, most preferably less than 10 Shore A.

[0232] In a non-limiting example, the pliable material is 4 Shore A silicone rubber.

[0233] In some embodiments, the pliable support substrate 114 is formed from a closed cell foam material, for example an ethylene-vinyl acetate closed cell foam material.

[0234] Such a closed cell foam material may facilitate an efficient (and inexpensive) production/assembly process for fabricating the cleaner head member 100.

[0235] The dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 can be provided in any suitable manner, for example by pressing a stamp, e.g. a heated stamp, into the pliable material, e.g. closed cell foam material, and/or by one or more of laser cutting and milling of the pliable material. Alternatively or additionally, the dirt inlet structure 122A, 122B and/or the cleaning liquid outlet structure 132 may be provided by molding, e.g. injection molding, of the pliable support substrate 114.

[0236] Reaction injection molding can, for example, be employed for fabricating the pliable material of the pliable support substrate 114, particularly when the pliable support substrate 114 is formed from the closed cell foam material.

[0237] In some embodiments, such as shown in FIGs. 4A and 4B, the cleaner head member 100 comprises at least one cleaning liquid distibrution strip 146 arranged or arrangeable over the cleaning liquid outlet structure 132. The at least one cleaning liquid distribution strip 146 may delimit a plurality of apertures 148 arranged along a length of the cleaning liquid distribution strip 146, through which apertures 148 the cleaning liquid is deliverable from the cleaning liquid outlet structure 132 towards the surface to be cleaned, for example via a portion of the porous layer 118.

[0238] In such embodiments, the cleaning liquid distribution strip 146 may be arranged along the length of the cleaner head member 100.

[0239] In some embodiments, the apertures 148 are dimensioned such that passage of the cleaning liquid, e.g. aqueous cleaning liquid, through the apertures 148 is restricted, due to the surface tension of the cleaning liquid, while the cleaning liquid outlet structure 132 is being filled, but with passage of the cleaning liquid through all of the apertures 148 at the same time being permitted once the cleaning liquid outlet structure 132 has been filled.

[0240] This may enable relatively uniform cleaning liquid delivery across the length of the cleaning liquid distibution strip 146.

[0241] The apertures 148 may have, for example, a diameter less than 1 mm, for example a diameter in the range of 0.1 to 1 mm, preferably 0.1 to 0.8 mm, most preferably 0.1 to 0.5 mm, such as about 0.3 mm.

[0242] The cleaning liquid distribution strip(s) 146 can be formed of any suitable material, such as a metal, a metal alloy, e.g. stainless steel, and/or a polymer. Forming the cleaning liquid distribution strip(s) 146 from a polymer can make the cleaning liquid distribution strip(s) 146 more lightweight and/or cheaper to manufacture.

[0243] The cleaning liquid distribution strip(s) 146 can be mounted in any suitable manner. In some embodiments, the cleaning liquid distibution strip(s) 146 is or are permanently affixed to the pliable support substrate 114, for example by welding, an adhesive and/or adhesive tape, etc.

[0244] In some embodiments, such as shown in FIGs. 5 to 9B, the pliable cleaning member 116 comprises a pliable intermediate substrate 150 arranged between the porous layer 118 and the pliable support substrate 114.

[0245] In some embodiments, the pliable support substrate 114 and the pliable intermediate substrate 150 may be permanently attached to each other, for example by the pliable support substrate 114 and the pliable intermediate substrate 150 being welded, e.g. ultransonically welded, and/or adhered to each other using an adhesive.

[0246] Referring in particular to FIG. 6, a further dirt inlet structure 152A, 152B may be defined in and/or arranged on the

pliable intermediate substrate 150 for fluidly connecting the pores of the porous layer 118 to the dirt inlet structure 122A, 122B of the pliable support substrate 114.

[0247] The further dirt inlet structure 152A, 152B may be defined in and/or arranged on a surface 154 of the pliable intermediate substrate 150, with the further dirt inlet structure 152A, 152B extending across at least part of the surface 154.

[0248] As best illustrated by the exploded view provided in FIG. 5, the porous layer 118 may be arranged on the surface 154 of the pliable intermediate substrate 150 to cover the further dirt inlet structure 152A, 152B. Moreover, a further surface 155 of the pliable intermediate substrate 150 that faces away from the surface 154 may cover the dirt inlet structure 122A, 122B of the pliable support substrate 114.

[0249] The pliable intermediate substrate 150 may delimit one or more further dirt inlet passages 156A, 156B that fluidly couple the further dirt inlet structure 152A, 152B with the dirt inlet structure 122A, 122B of the pliable support substrate 114, e.g. by extending across a thickness of the pliable intermediate substrate 150 between the surfaces 154, 155 of the pliable intermediate substrate 150.

[0250] In some embodiments, and referring to FIGs. 6 and 7, the further dirt inlet passage(s) 156A, 156B of the pliable intermediate substrate 150 may align with respective inlet points 158A, 158B of the dirt inlet structure 122A, 122B of the pliable support substrate 114.

[0251] In embodiments in which the further dirt inlet structure 152A, 152B is defined in the surface 154 of the pliable intermediate substrate 150, the further dirt inlet structure 152A, 152B may comprise, e.g. be defined by, at least one (further) dirt inlet groove defined in and extending across the at least part of the surface 154.

[0252] In embodiments in which the dirt inlet structure 152A, 152B is arranged on the surface 154 of the pliable support substrate 150, the further dirt inlet structure 152A, 152B may comprise, e.g. be defined by, an arrangement of (further) protruding elements protruding from the surface 154 and extending across the at least part of the surface 154, with dirt path(s) being defined between protruding elements of the arrangement of protruding elements.

[0253] A further cleaning liquid outlet structure 162 may be defined in and/or arranged on the pliable intermediate substrate 150 for delivering cleaning liquid in the cleaning liquid outlet structure 132 towards the surface to be cleaned, for example via a portion of the porous layer 118.

[0254] In such embodiments, the further cleaning liquid outlet structure 162 may be separated from the further dirt inlet structure 152A, 152B by region(s) 164A, 164B of the pliable intermediate substrate 150.

[0255] By the region(s) 164A, 164B of the pliable intermediate substrate 150 separating the further dirt inlet structure 152A, 152B from the further cleaning liquid outlet structure 162, the risk of cleaning liquid in the further cleaning liquid outlet structure 162 being drawn directly into the further dirt inlet structure 152A, 152B can be lessened or removed. Thus, there may be a greater chance of the cleaning liquid reaching the surface being cleaned. The cleaning liquid may consequently be used more efficiently.

[0256] The further cleaning liquid outlet structure 162 may comprise, e.g. be defined by, at least one cleaning liquid outlet groove defined in and extending across the at least part of the surface 154. Alternatively or additionally, the further cleaning liquid outlet structure 162 may comprise, e.g. be defined by, an arrangement of protruding elements protruding from the surface 154 and extending across the at least part of the surface 154, with cleaning liquid path(s) being defined between protruding elements of the arrangement of protruding elements.

[0257] In some embodiments, and referring to FIGs. 6 and 7, the pliable intermediate substrate 150 delimits one or more cleaning liquid outlet passages 166A, 166B that fluidly couple the further cleaning liquid outlet structure 162 with corresponding cleaning liquid dosing points 168A, 168B defined in the cleaning liquid outlet structure 132 of the pliable support substrate 114.

[0258] In some embodiments, and as best shown in FIG. 6, the further dirt inlet structure 152A, 152B comprises a first further dirt inlet structure 152A and a second further dirt inlet structure 152B that are arranged to receive liquid from different portions of the porous layer 118. In such embodiments, the first further dirt inlet structure 152A may extend along at least part of the pliable intermediate substrate's 150 length, and the second further dirt inlet structure 152B may also extend along at least part of the the pliable intermediate substrate's 150 length but with the first further dirt inlet structure 152A being separated from the second further dirt inlet structure 152B across the width of the pliable intermediate substrate 150.

[0259] In such embodiments, the further cleaning liquid outlet structure 162 may be arranged between the first further dirt inlet structure 152A and the second further dirt inlet structure 152B.

[0260] This arrangement, which may mirror the above-described arrangement of the dirt inlet structure 122A, 122B and the cleaning liquid outlet structure 132 of the pliable support substrate 114, may provide efficient cleaning liquid delivery to and liquid pick-up from the surface being cleaned.

[0261] The pliable intermediate substrate 150 can be manufactured from any suitable pliable material, for instance that allows the pliable intermediate substrate 150 to follow contours on the surface being cleaned. The pliable material may also enable provision of the further dirt inlet structure 152A, 152B and/or the further cleaning liquid outlet structure 162 therein and/or thereon.

[0262] In some embodiments, the pliable material of the pliable intermediate substrate 150 comprises, e.g. is, a

polymeric material and/or elastomeric material.

[0263] The pliable material of the pliable intermediate substrate 150 may, for instance, be the same as that used for the pliable support substrate 114.

[0264] Particular mention is made of silicone rubber and ethylene-vinyl acetate, in other words a copolymer of ethylene and vinyl acetate, for the pliable material.

[0265] In embodiments in which the pliable intermediate substrate 150 is formed from ethylene-vinyl acetate, ethylene may, for example, account for 60 to 90 wt.% of the copolymer.

[0266] Other polymeric and/or elastomeric materials, such as a polydiene, e.g. polybutadiene, a thermoplastic elastomer, and so on, can also be contemplated for the pliable material.

[0267] Alternatively or additionally, the pliable material can be less than 50 Shore A, preferably less than 20 Shore A, most preferably less than 10 Shore A.

[0268] In a non-limiting example, the pliable material is 4 Shore A silicone rubber.

[0269] In some embodiments, the pliable intermediate substrate 150 is formed from a closed cell foam material, for example an ethylene-vinyl acetate closed cell foam material.

[0270] The further dirt inlet structure 152A, 152B and/or the further cleaning liquid outlet structure 162 can be provided in any suitable manner, for example by pressing a stamp, e.g. a heated stamp, into the pliable material, e.g. closed cell foam material, of the pliable intermediate substrate 150 and/or by one or more of laser cutting and milling of the pliable material. Alternatively or additionally, the further dirt inlet structure 152A, 152B and/or the further cleaning liquid outlet structure 162 may be provided by molding, e.g. injection molding, of the pliable intermediate substrate 150.

[0271] Reaction injection molding can, for example, be employed for fabricating the pliable material of the pliable intermediate substrate 150, particularly when the pliable intermediate substrate 150 is formed from the closed cell foam material.

[0272] FIGs. 8A to 9B provide various views of a connector 108 and a complementary connector 110 according to a non-limiting example. The complementary connector 110 may include a dirt inlet channel 170 for establishing a fluid connection with the opening(s) 128A, 128B defined in the connector 108 of the cleaner head member 100.

[0273] The dirt inlet channel 170 may define the complementary connector's 110 contribution to the sealed dirt conduit provided when the connector 108 and the complementary connector 110 are connected to each other.

[0274] The dirt inlet channel 170 may be fluidly connected or connectable to the underpressure generator of the wet cleaning apparatus.

[0275] The complementary connector 110 may include a cleaning liquid outlet channel 172 for establishing a fluid connection with the further opening(s) 138 defined in the connector 108 of the cleaner head member 100.

[0276] The cleaning liquid outlet channel 172 may define the complementary connector's 110 contribution to the cleaning liquid conduit provided when the connector 108 and the complementary connector 110 are connected to each other.

[0277] The cleaning liquid outlet channel 172 may be fluidly connected or connectable to the cleaning liquid supply of the wet cleaning apparatus.

[0278] The dirt inlet channel 170 and the cleaning liquid outlet channel 172 may be separate from each other, for example via wall(s) and/or sealing member(s) 174, e.g. gasket(s), being arranged between the dirt inlet channel 170 and the cleaning liquid outlet channel 172.

[0279] In this way, the risk of cleaning liquid being drawn towards the underpressure generator prior to reaching the cleaning liquid outlet structure 132 may be lessened or removed.

[0280] Alternatively or additionally, one or more sealing member(s) 176 may provide a seal between the connector 108 and the complementary connector 110 for minimizing or preventing leakage of the underpressure in the dirt conduit.

[0281] The following embodiments are also disclosed:

1. A cleaner head member (100) attachable to and/or detachable from a cleaner head of a wet cleaning apparatus, the cleaner head member comprising:

a connector (108) that is connectable to a complementary connector of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head;

a pliable support substrate (114), a dirt inlet structure (122A, 122B) being defined in and/or arranged on a surface (124) of the pliable support substrate, the dirt inlet structure extending across at least part of the surface, the pliable support substrate being formed from a closed cell foam material; and

a pliable cleaning member (116) comprising a porous layer (118) having pores for receiving liquid from a surface to be cleaned, the pliable cleaning member being arranged on the surface of the pliable support substrate to cover the dirt inlet structure, the dirt inlet structure being arranged to receive said liquid received by the pores of the porous layer and to carry the liquid to the dirt conduit.

2. The cleaner head member (100) according to embodiment 1, wherein a cleaning liquid outlet structure (132) is defined in and/or arranged on the surface (124) of the pliable support substrate (114), the cleaning liquid outlet structure being arranged to deliver cleaning liquid received therein towards the surface to be cleaned, the cleaning liquid outlet structure being separated from the dirt inlet structure (122A, 122B) by region(s) (134A, 134B) of the pliable support substrate.

3. The cleaner head member (100) according to embodiment 2, wherein the connector (108) is connectable to the complementary connector to provide a cleaning liquid conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head, the sealed dirt conduit and the cleaning liquid conduit being separate from each other.

4. The cleaner head member (100) according to embodiment 2 or embodiment 3, comprising at least one cleaning liquid distibrution strip (146) for arranging over the cleaning liquid outlet structure (132), the at least one cleaning liquid distribution strip delimiting a plurality of apertures (148) arranged along a length of the cleaning liquid distribution strip, through which apertures the cleaning liquid is deliverable from the cleaning liquid outlet structure towards the surface to be cleaned.

5. The cleaner head member (100) according to any one of embodiments 1 to 4, wherein the pliable cleaning member (116) is sealingly attached to the pliable support substrate (114) around the dirt inlet structure (122A, 122B).

6. The cleaner head member (100) according to any one of embodiments 1 to 5, wherein the pliable cleaning member (116) comprises a pliable intermediate substrate (150) arranged between the porous layer (118) and the pliable support substrate (114), a further dirt inlet structure (152A, 152B) being defined in and/or arranged on the pliable intermediate substrate for fluidly connecting the pores of the porous layer to the dirt inlet structure (122A, 122B).

7. The cleaner head member (100) according to embodiment 6, wherein the pliable intermediate substrate (150) is formed from a closed cell foam material.

8. The cleaner head member (100) according to embodiment 6 or embodiment 7 as according to any one of embodiments 2 to 4, wherein a further cleaning liquid outlet structure (162) is defined in and/or is arranged on the pliable intermediate substrate (150) for delivering cleaning liquid in the cleaning liquid outlet structure (132) towards the surface to be cleaned, the further cleaning liquid outlet structure being separated from the further dirt inlet structure (152A, 152B) by region(s) (164A, 164B) of the pliable intermediate substrate.

9. The cleaner head member (100) according to any one of embodiments 1 to 8, wherein the porous layer (118) comprises one or more of a woven fabric, a mesh, and a perforate membrane.

10. The cleaner head member (100) according to any one of embodiments 1 to 9, wherein the porous layer (118) has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A, that is at most 105 μm and/or at least 6 μm.

11. The cleaner head member (100) according to any one of embodiments 1 to 10, wherein pores of the porous layer (118) extend across the porous layer's thickness and open out at opposite sides of the porous layer, a linear central axis of each pore extending across the thickness and passing through an intermediate point surrounded by a pore wall of the respective pore, the pore wall being arranged about the linear central axis, a path of least resistance to fluid flow across the porous layer being defined along the linear central axes of the pores.

12. The cleaner head member (100) according to embodiment 11, wherein pores of the porous layer (118) each have a polygonal or circular cross-sectional shape perpendicular to the linear central axis; optionally wherein pores of the porous layer each have a square cross-sectional shape perpendicular to the linear central axis.

13. The cleaner head member (100) according to any one of embodiments 1 to 12, wherein the porous layer (118) comprises a a perforate membrane and/or a mesh, preferably a plain weave woven mesh or a twill weave woven mesh.

14. The cleaner head member (100) according to any one of embodiments 1 to 13, wherein the porous layer's (118) thickness is less than 200 μm, preferably less than 100 μm.

15. A cleaner head assembly (104) comprising:

the cleaner head member (100) according to any one of embodiments 1 to 14; and
a cleaner head (102) comprising the complementary connector (110) for connecting to the connector (108) of the cleaner head member, the cleaner head member being attachable to and/or detachable from the cleaner head.

16. A wet cleaning apparatus comprising:

the cleaner head member (100) according to any one of embodiments 1 to 14 or the cleaner head assembly (104) according to embodiment 15; and
an underpressure generator for subjecting the porous layer (118) to an underpressure via the dirt inlet structure (122A, 122B) when the cleaner head member is attached to the cleaner head.

17. The wet cleaning apparatus according to embodiment 16, wherein the underpressure generator is configured to generate a flow through the porous layer (118) that is at most 2000 cm^3/minute.

18. The wet cleaning apparatus according to embodiment 16 or embodiment 17, wherein the underpressure generator is configured to provide a pressure difference between an inside of the wet cleaning apparatus and atmospheric pressure for drawing fluid through the porous layer (118), the pressure difference being in a range of 2000 Pa to 15000 Pa, preferably 2000 Pa to 13500 Pa.

[0282] Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.
[0283] The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.
[0284] If the term "adapted to" is used in the claims or description, it is noted the term "adapted to" is intended to be equivalent to the term "configured to".
[0285] Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A cleaner head member (100) attachable to and/or detachable from a cleaner head of a wet cleaning apparatus, the cleaner head member comprising:

a connector (108) that is connectable to a complementary connector of the cleaner head to provide a sealed dirt conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head;
a pliable support substrate (114);
a dirt inlet structure (122A, 122B) defined in and/or arranged on a surface (124) of the pliable support substrate, the dirt inlet structure extending across at least part of the surface;
a cleaning liquid outlet structure (132) defined in and/or arranged on the surface of the pliable support substrate, the cleaning liquid outlet structure being arranged to deliver cleaning liquid received therein towards the surface to be cleaned, the cleaning liquid outlet structure being separated from the dirt inlet structure by region(s) (134A, 134B) of the pliable support substrate; and
a pliable cleaning member (116) comprising a porous layer (118) having pores for receiving liquid from a surface to be cleaned, the pliable cleaning member being arranged on the surface of the pliable support substrate to cover the dirt inlet structure, the dirt inlet structure being arranged to receive said liquid received by the pores of the porous layer and to carry the liquid to the dirt conduit.

2. The cleaner head member (100) according to claim 1, wherein the pliable support substrate (114) is formed from a closed cell foam material.

3. The cleaner head member (100) according to claim 1 or claim 2, wherein the connector (108) is connectable to the complementary connector to provide a cleaning liquid conduit between the cleaner head member and the cleaner head when the cleaner head member is attached to the cleaner head, the sealed dirt conduit and the cleaning liquid conduit being separate from each other.

4. The cleaner head member (100) according to any one of claims 1 to 3, comprising at least one cleaning liquid

distibrution strip (146) for arranging over the cleaning liquid outlet structure (132), the at least one cleaning liquid distribution strip delimiting a plurality of apertures (148) arranged along a length of the cleaning liquid distribution strip, through which apertures the cleaning liquid is deliverable from the cleaning liquid outlet structure towards the surface to be cleaned.

5. The cleaner head member (100) according to any one of claims 1 to 4, wherein the pliable cleaning member (116) is sealingly attached to the pliable support substrate (114) around the dirt inlet structure (122A, 122B).

6. The cleaner head member (100) according to any one of claims 1 to 5, wherein the pliable cleaning member (116) comprises a pliable intermediate substrate (150) arranged between the porous layer (118) and the pliable support substrate (114), a further dirt inlet structure (152A, 152B) being defined in and/or arranged on the pliable intermediate substrate for fluidly connecting the pores of the porous layer to the dirt inlet structure (122A, 122B).

7. The cleaner head member (100) according to claim 6, wherein the pliable intermediate substrate (150) is formed from a closed cell foam material.

8. The cleaner head member (100) according to claim 6 or claim 7, wherein a further cleaning liquid outlet structure (162) is defined in and/or is arranged on the pliable intermediate substrate (150) for delivering cleaning liquid in the cleaning liquid outlet structure (132) towards the surface to be cleaned, the further cleaning liquid outlet structure being separated from the further dirt inlet structure (152A, 152B) by region(s) (164A, 164B) of the pliable intermediate substrate.

9. The cleaner head member (100) according to any one of claims 1 to 8, wherein the porous layer (118) comprises one or more of a woven fabric, a mesh, and a perforate membrane.

10. The cleaner head member (100) according to any one of claims 1 to 9, wherein the porous layer (118) has a limiting pore diameter, as measured using ASTM F316 - 03, 2019, Test A,that is at most 105 μm and/or at least 6 μm.

11. The cleaner head member (100) according to any one of claims 1 to 10, wherein pores of the porous layer (118) extend across the porous layer's thickness and open out at opposite sides of the porous layer, a linear central axis of each pore extending across the thickness and passing through an intermediate point surrounded by a pore wall of the respective pore, the pore wall being arranged about the linear central axis, a path of least resistance to fluid flow across the porous layer being defined along the linear central axes of the pores.

12. The cleaner head member (100) according to claim 11, wherein pores of the porous layer (118) each have a polygonal or circular cross-sectional shape perpendicular to the linear central axis; optionally wherein pores of the porous layer each have a square cross-sectional shape perpendicular to the linear central axis.

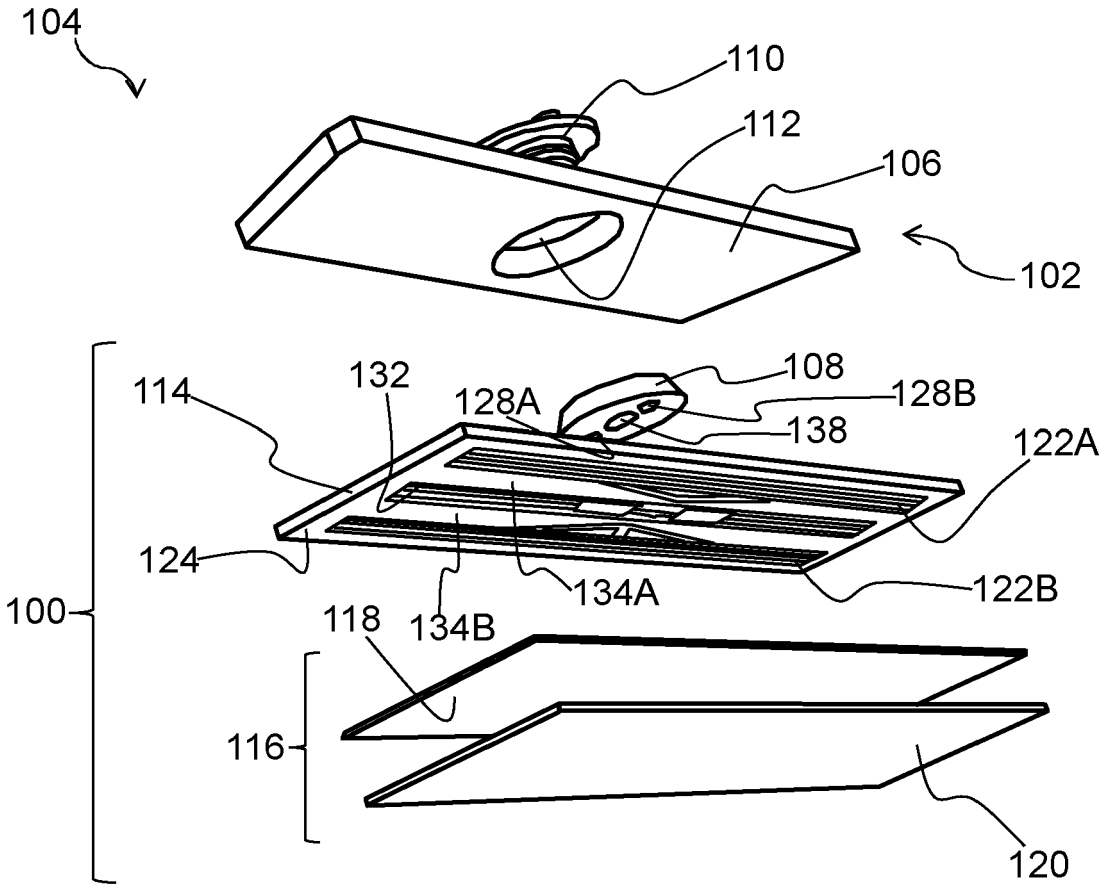
13. The cleaner head member (100) according to any one of claims 1 to 12, wherein the porous layer (118) comprises a a perforate membrane and/or a mesh, preferably a plain weave woven mesh or a twill weave woven mesh.

14. A cleaner head assembly (104) comprising:

the cleaner head member (100) according to any one of claims 1 to 13; and
a cleaner head (102) comprising the complementary connector for connecting to the connector of the cleaner head member, the cleaner head member being attachable to and/or detachable from the cleaner head.

15. A wet cleaning apparatus comprising:

the cleaner head member (100) according to any one of claims 1 to 13 or the cleaner head assembly (104) according to claim 14; and
an underpressure generator for subjecting the porous layer (118) to an underpressure via the dirt inlet structure (122A, 122B) when the cleaner head member is attached to the cleaner head; optionally wherein the underpressure generator is configured to generate a flow through the porous layer that is at most 2000 cm^3/minute.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110
112
106
102
114
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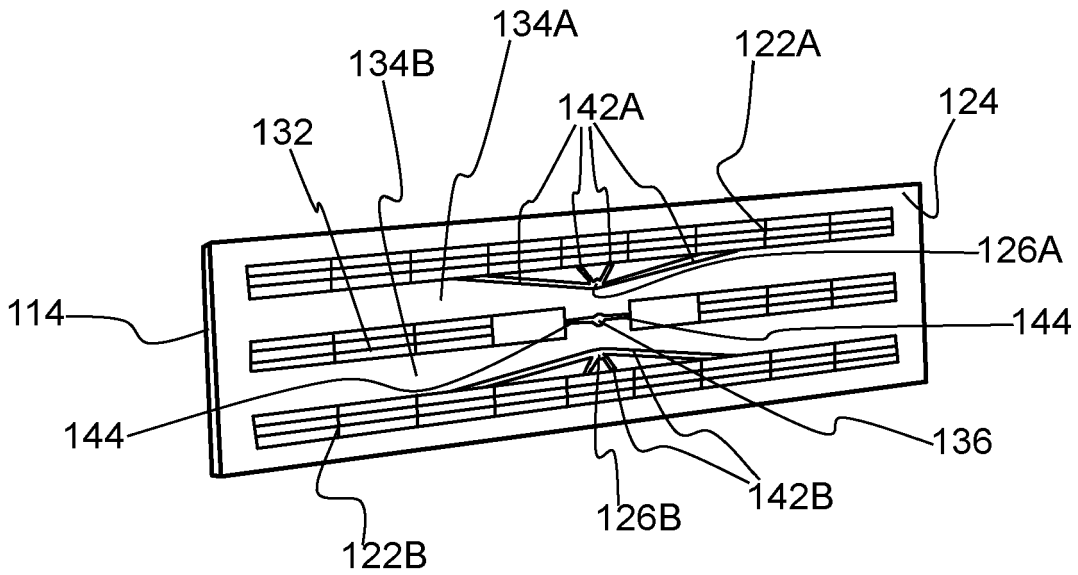
128A
108
128B
138
122A
124
134A
122B
100
118
134B
116
120

FIG. 1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124
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114
144
144
136
142B
126B
122B

FIG. 2

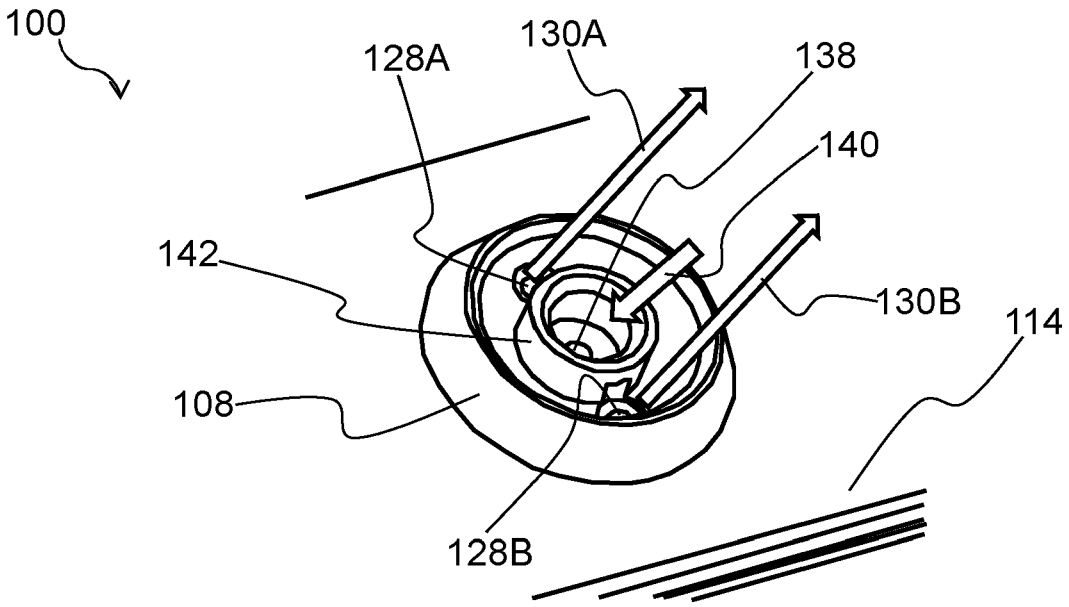
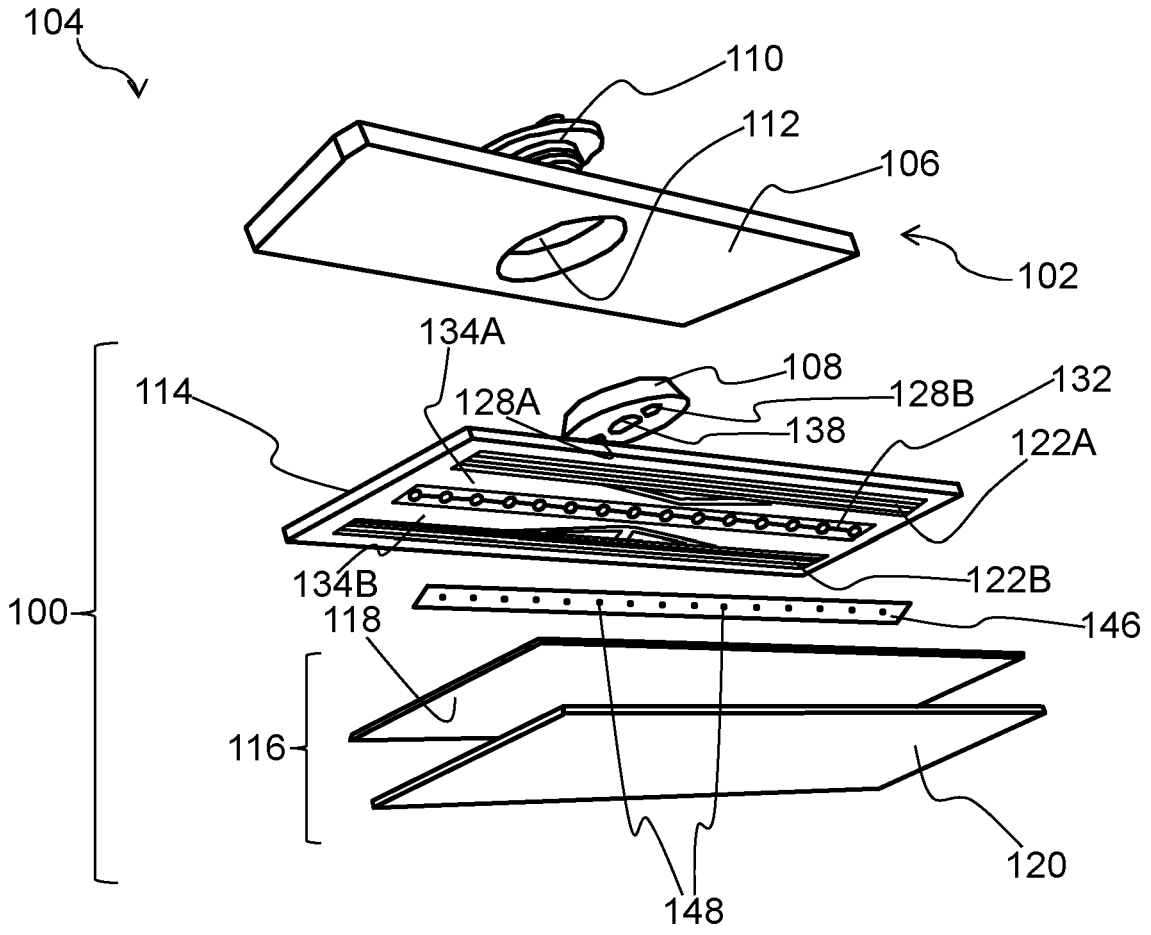


FIG. 3


104
110
112
106
102
134A
108
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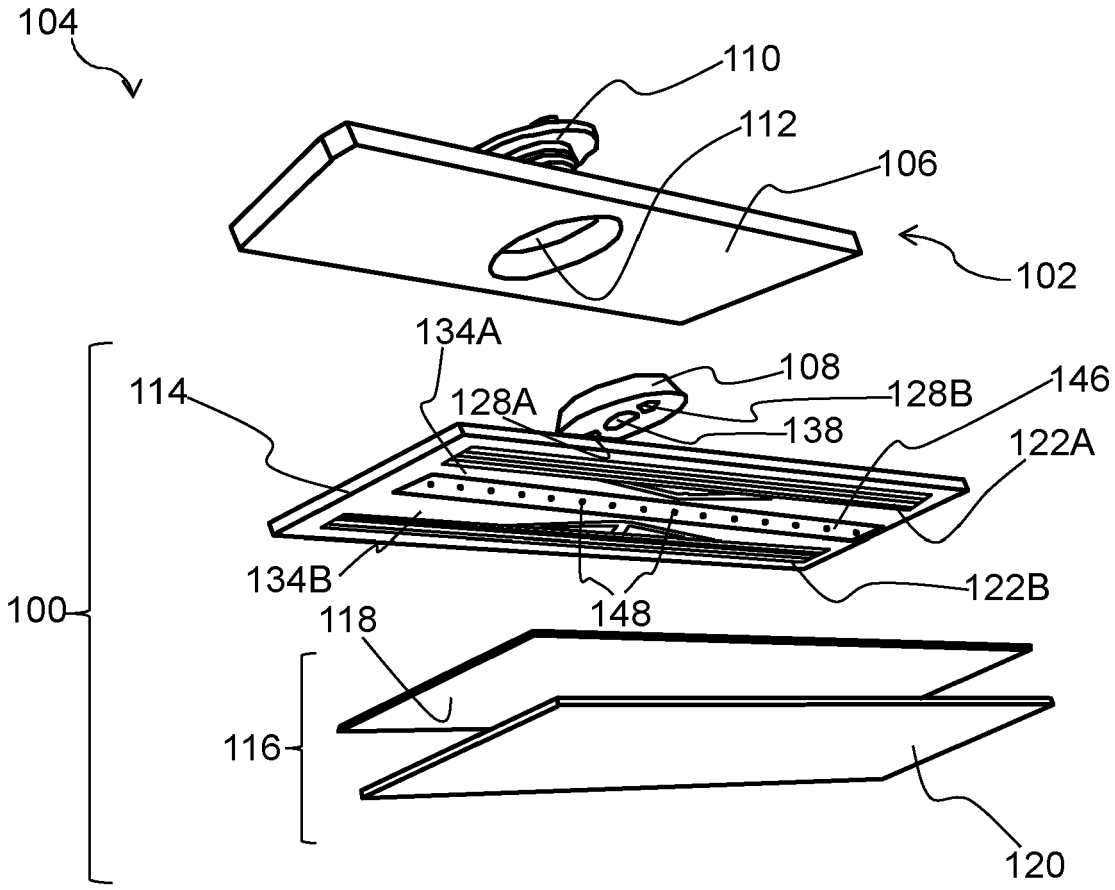
128A
128B
132
138
122A
134B
122B
100
118
146
116
120
148

FIG. 4A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110
112
106
102
134A
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114
128A
128B
146
138
122A
134B
148
122B
100
118
116
120

FIG. 4B

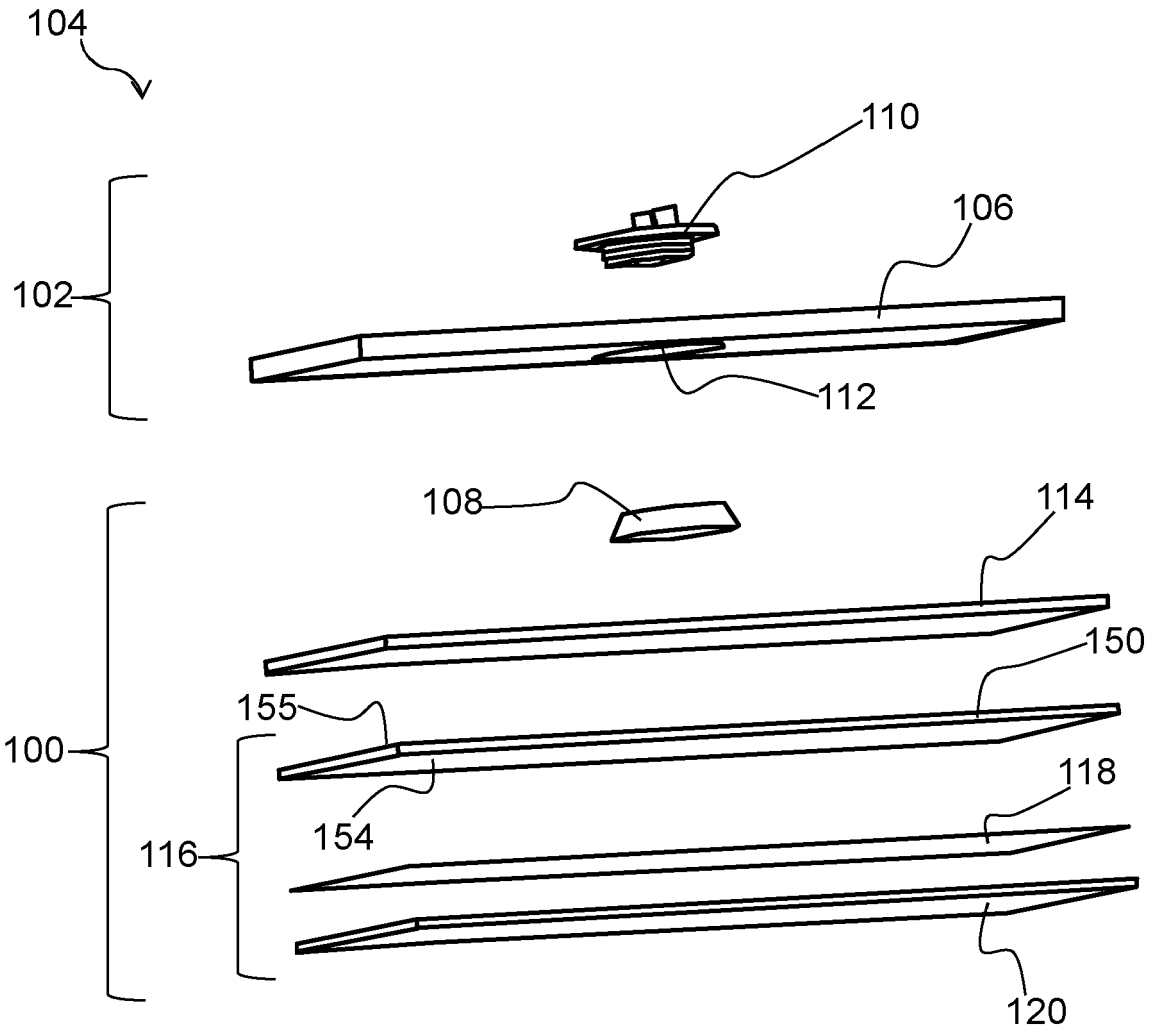


FIG. 5

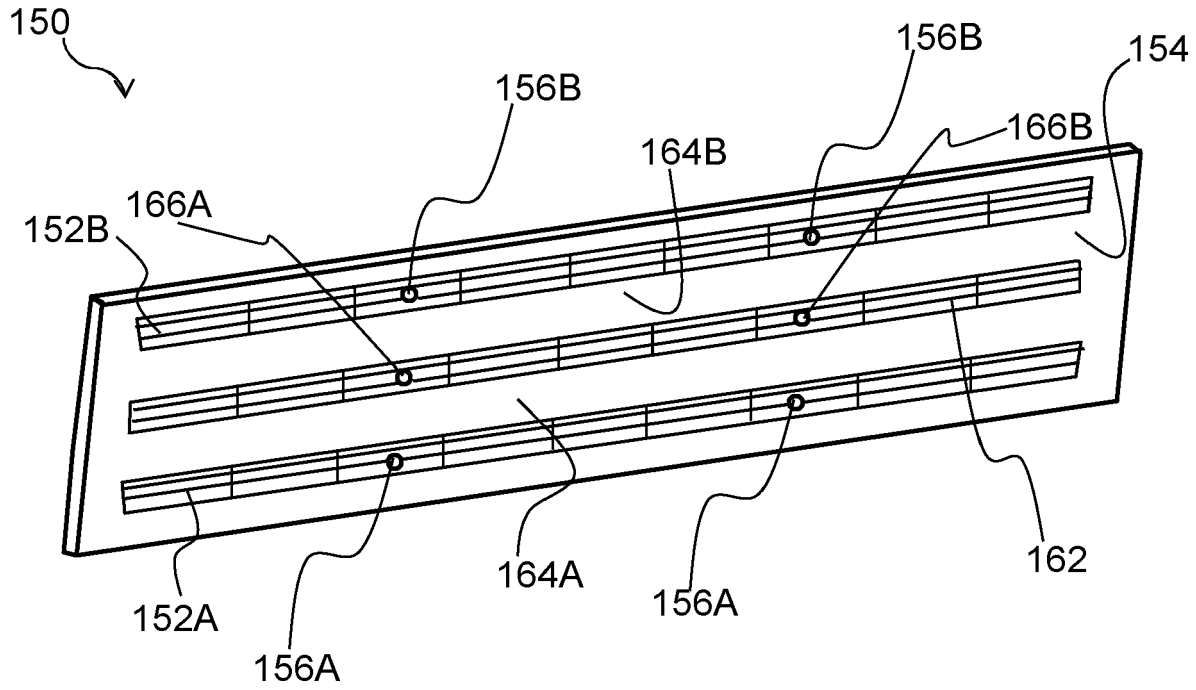

150
156B
156B
154
166B
164B
166A
152B
164A
156A
162
152A
156A

FIG. 6

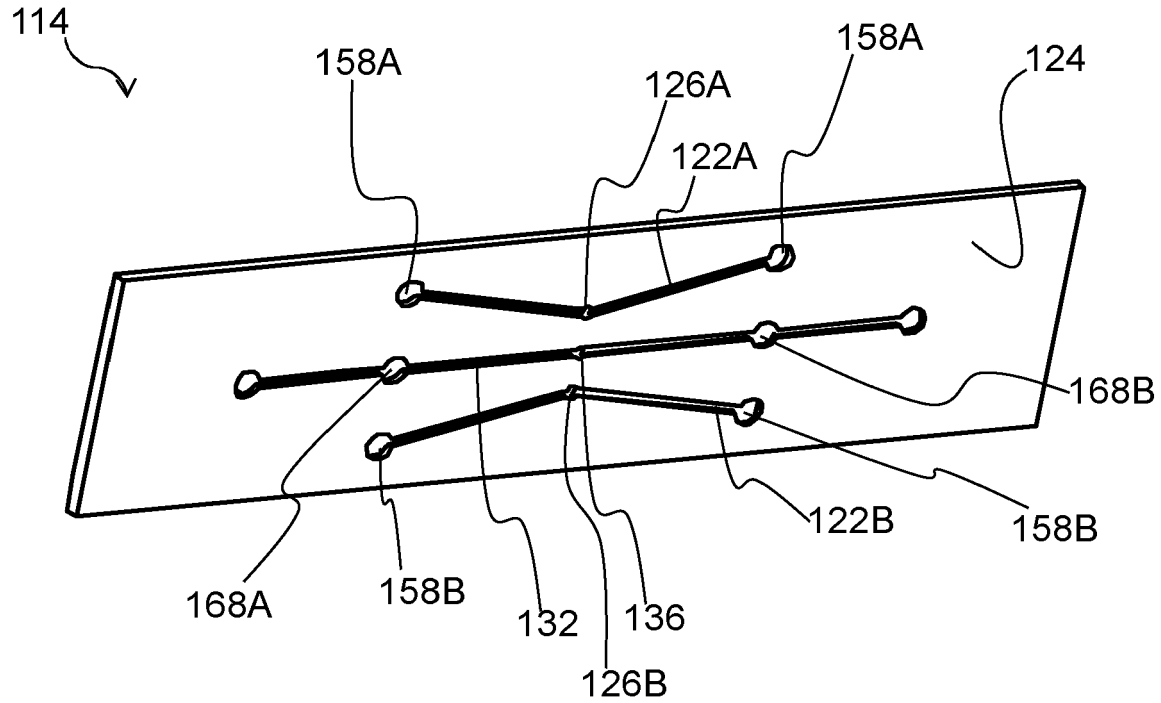

114
158A
158A
126A
124
122A
168B
122B
158B
168A
158B
132
136
126B

FIG. 7

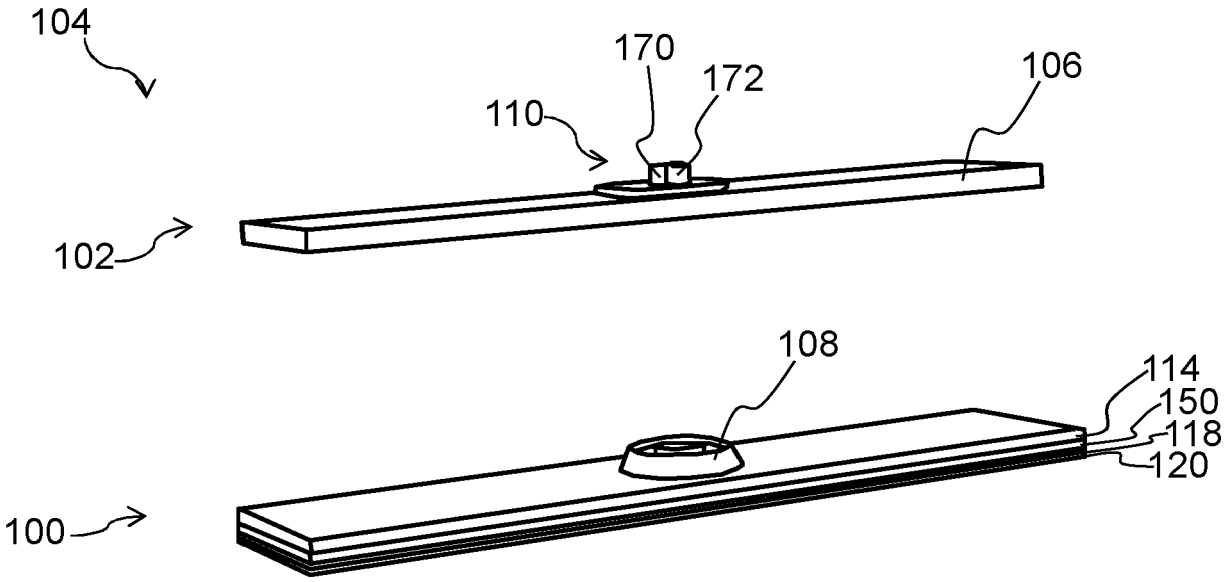
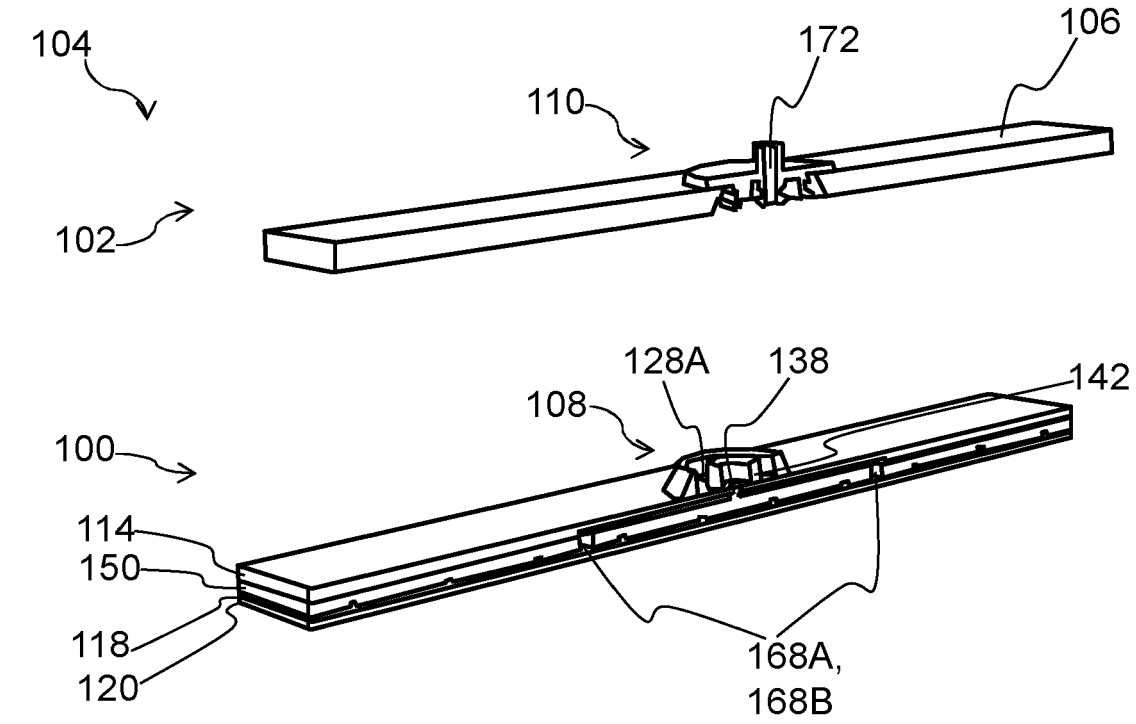

104
170
172
106
110
102
108
114
150
118
120
100

FIG. 8A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172
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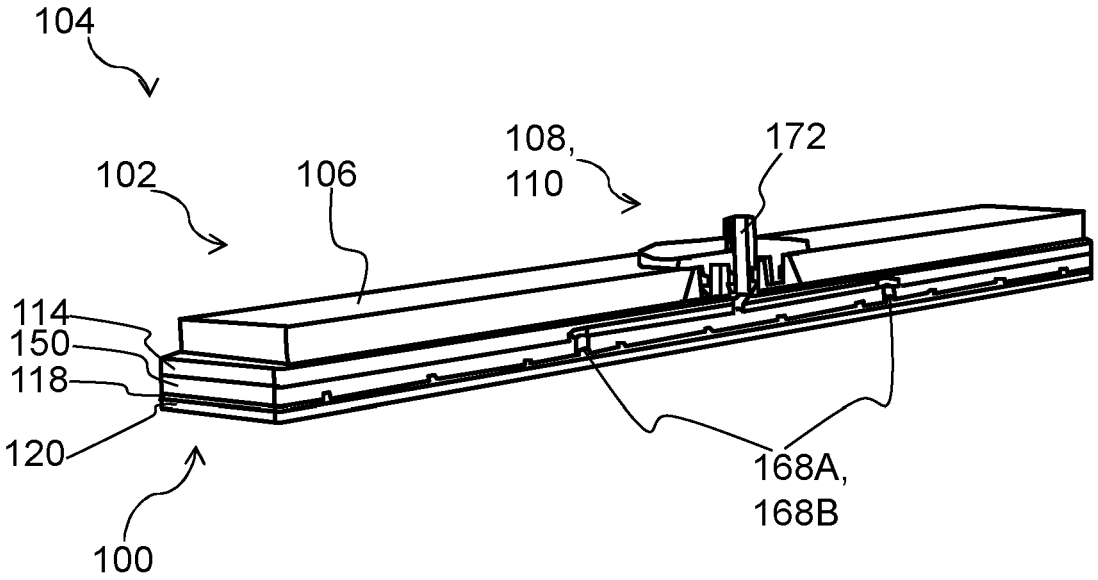
128A
138
142
108
100
114
150
118
120
168A,
168B

FIG. 8B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110
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114
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120
100
168A,
168B

FIG. 9A

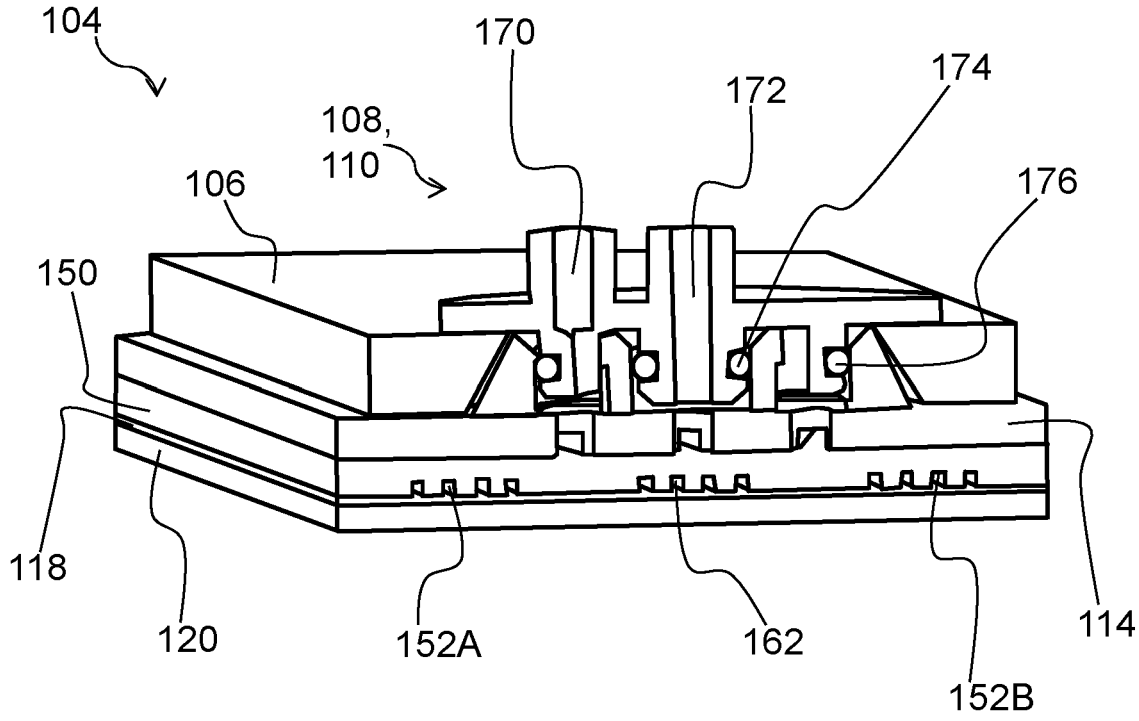
104
170
172
174
108,
110
106
176
150
118
120
152A
162
152B
114

FIG. 9B

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 December 2023	Jezierski, Krzysztof

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