

Description

[0001] The invention relates to an improved home appliance, preferably to a laundry treatment apparatus or a dishwasher and further in particular to a laundry treatment apparatus capable of washing and/or drying. The invention set forth below is in particular suitable for washing machines and dryers, especially tumble dryers, encompassing condensation dryers, heat pump dryers, exhaust or circulation ventilation dryers or washing machines with drying function.

[0002] In the art home appliances are known, which allow for the dispensing of a fluid for the purpose of cleaning components of such home appliances, e.g. for cleaning a component of a heat exchange system of the home appliance like a condenser surface. Such necessity for cleaning arises for example with dryers, especially condensate dryers or heat pump dryers, where one of the problems of efficiency over time is related to the soiling of the evaporator. The fluff removed by the laundry during the drying process is carried into the cooling system by the processing air. Part of the fluff is retained by the lint filter but small particles may overcome this barrier. This effects a reduction of the thermal exchange power of the surfaces and in worst case the clogging of the air path. WO 2009/050004A1 discloses a method and a device for cleaning a component arranged in a process air circuit of a dryer by a sudden gush of water, especially by a gush of condensed water stored in a storage chamber. Further cleaning devices of the above kind are known from DE 37 38 031 C2 and DE 43 33 901 C2. Herein fluff is removed by a flushing device which comprises jets provided with condensate water pressurized by a pump.

[0003] Devices of the above kind need a complex construction including powerful pumps for effectively cleaning the desired component by dispensing of pressurized fluid and/or a large amount of cleaning fluid for flushing.

[0004] In view of the above it is an object of the present invention to provide a home appliance and a method having or using a droplet spraying device allowing for a simple arrangement for providing droplets.

[0005] The invention is defined in claims 1 and 15, respectively. Particular embodiments are set out in the dependent claims.

[0006] A home appliance according to the present invention is in particular a laundry treatment apparatus or a dishwasher. Such laundry treatment apparatuses encompass washing machines, dryers, especially tumble dryers like condensate or heat pump dryers and washing machines with drying function. Generally a home appliance of the inventive kind can be any home appliance, wherein the dispensing of a liquid fluid, in particular the spray dispensing of a fluid, is provided. Fluids to be dispensed can be water, for example condensate water, cleansing agents, additives for fabric finishing or alike liquids.

[0007] A home appliance according to the present invention comprises a liquid supply channel and/or a liquid

reservoir as well as a droplet spraying device. Both the liquid supply channel and the liquid reservoir serve the purpose of feeding or supplying the droplet spraying device with the liquid, wherein also the liquid supply channel can serve as a liquid reservoir. The liquid reservoir and/or the liquid supply channel are meant to be arranged in fluid communication with the droplet spraying device, i.e. such, that liquid from the liquid supply channel and/or the liquid reservoir can be fed to the droplet spraying device in an appropriate manner. In a preferred embodiment, the droplet spraying device is arranged at a section of the liquid supply channel, preferably at an end region thereof. Generally the liquid supply channel and/or the liquid reservoir has an inlet for supplying liquid thereto. In an embodiment the liquid supply channel and/or the liquid reservoir may have an outlet for draining liquid therefrom. The liquid supply channel may be connected to a liquid source, for example to a fresh water tap or to (another) liquid reservoir. The liquid supply channel may be a flow-through channel adapted to flow the liquid through the channel, in particular adapted to flow the liquid to the droplet spraying device, further in particular through its inlet. In an embodiment controllable valve can be connected between the droplet spraying device and the liquid reservoir or liquid source, or the valve is provided between the liquid reservoir and the another liquid reservoir

[0008] It is to be noted that in this document and in the claims - unless otherwise indicated - the element "a droplet spraying device" is a single, discrete droplet spraying device or is a plurality of droplet spraying devices or is a multiple droplet spraying device. The multiple droplet spraying device is preferably an arrangement of a plurality (e.g. 2, 3, 4, ...) of discrete or coupled-together droplet spraying devices. For example one surface area of the liquid supply channel and/or the liquid reservoir comprises a distributed (e.g. linear or matrix-like) arrangement of adjacent droplet spraying devices.

[0009] One or more individual droplet spraying devices of a multiple droplet spraying device can each be supplied by a discrete supply channels and/or be fed by a discrete liquid reservoirs. A multiple droplet spraying device also may be fed from common liquid supply channel and/or a common liquid reservoir. Hereby combinations of discrete supply of one or more droplet spraying devices and common supply of further droplet spraying devices by one or more liquid supply channels and/or one or more liquid reservoirs may be provided. For example, multiple droplet spraying devices for bringing out fabric finishing additives each are supplied by a discrete liquid supply channel, for example in fluid connection to a common liquid reservoir, or each to another liquid reservoir. Preferably the multiple droplet spraying device for bringing out water or condensate water when cleaning an evaporator is supplied directly by a common liquid reservoir. In an embodiment also liquid can be supplied to one or more liquid supply channels and/or liquid reservoirs from different or same fluid sources / reservoirs.

[0010] The droplet spraying device according to the present invention, which is based on membrane vibration, comprises a membrane arranged in fluid connection with the liquid supply channel and/or the liquid reservoir. A fluid connection may be established such that liquid from the liquid supply channel and/or the liquid reservoir is brought into direct contact with the membrane. Liquid may be fed to the membrane by a liquid supply channel or a liquid reservoir apt for a capillary feed of the membrane or liquid may be deposited directly onto the membrane by the liquid supply channel and/or the liquid reservoir. Liquid may be supplied directly to a surface of the membrane, especially to a back surface thereof, alternatively for example to a front surface.

[0011] The membrane of the droplet spraying device is meant to generate droplets by being actuated by at least one actuator of the droplet spraying device, the droplets especially providing a fine aerosol spray or mist. The membrane has a plurality of openings. By providing openings, liquid can comfortably be fed to a backside of the membrane, whereas droplets emerge at a front side during operation. Such a perforate membrane can produce a powerful mist when vibrated by the actuator and allow for the convenient separation of a treatment region facing the front side of the membrane and a liquid supply next to the back side.

[0012] The openings of the membrane can have an average diameter such as to exert a capillary force onto the liquid and preventing escape of the liquid through the opening when the actuator is not operated (or when the actuator is operated such that the capillary or surface force can not be overcome). Operation of the actuator preferably is effected at a vibrational resonance frequency of the droplet spraying device, allowing for low driving energy.

[0013] Generally the membrane may be formed from a sheet material, for example from an electro-formed sheet wherein the sheet material may be a metallic material, a metal compound, plastic material, or ceramic. Such membranes including openings can for example be produced by a photo-lithographic process in combination with an electroforming process. The membrane may be formed as circular disc, for example also comprising a circular layer of polymer.

[0014] The membrane can comprise a sheet with openings defined in an array. The openings can be tapered holes, i.e. holes of a cross-sectional area which is reduced in a direction from the back to the front side of the membrane. Such tapered holes may enhance the dispensing of droplets and are apt to reduce the necessary amplitude of a vibration of the membrane for generating droplets of a desired size. Such tapered conical perforations can for example be formed in a polymer layer of the membrane.

[0015] An actuator can be a piezoelectric and/or an electrostrictive actuator, for example also a piezomagnetic or a magnetostrictive actuator which comprises one or more of electrostrictive, magnetostrictive or piezoelec-

tric elements adapted to deflect. Advantageously the actuator comprises an element enabled to deflect according to an external excitation, for example by applying an AC voltage. Upon bending or deflecting the membrane operatively connected to the actuator is vibrated (actuated). Such bending can be caused by an applied field, e.g. an electric or magnetic field. It should be noted that fields for actuating the membrane via deflecting of an excitable element or the actuator, respectively, are in particular alternating fields. Such alternating fields in particular allow for vibration of the membrane for the generation of droplets.

[0016] An actuator can be formed integrally with the membrane, e.g. such, that the membrane is part of the actuator or the actuators or wherein the membrane itself is the actuator. The membrane may also be supported on the actuator. Alternative examples for suitable actuators may include a coil arrangement which supports the membrane, the coil arrangement comparable to that of a speaker, e.g. a dome tweeter or cone speaker.

[0017] The membrane may comprise one or more electrodes and one or more backing electrodes arranged at a distance or with a gap from the membrane, wherein in particular the one or more backing electrodes are arranged facing a front side and/or backside of the membrane. Such an actuator structure resembles an electret structure as used for example in an electret microphone or speaker. The one or more backing electrodes may be formed on or arranged at a body of the droplet spraying device or at or in the liquid supply channel and/or liquid reservoir.

[0018] Preferably the droplet spraying device is supplied with liquid without the requirement of a pump (e.g. only a liquid supply in fluid connection with the membrane is provided). Because of its possible small and slim but simple and rigid layout the droplet spraying device offers the chance to place the droplet spraying device in positions, where common nozzles can not be applied. Additionally the dimension of the droplets, the amount of mist and the direction of the mist flow or the droplets respectively can be managed by the device characteristic and/or by an electronic board connected therewith. Such a driving board can be a low-cost low voltage electronic board, the energy consumption of which is negligible. The droplet spraying device is highly adaptable to flat surfaces, applicable for a wide range of liquids and not sensible to clogging. Moreover there is no dead time in the build-up of droplets.

[0019] In an embodiment the home appliance has one or more such droplet spraying devices, each in fluid connection with a liquid channel and/or a liquid reservoir. A plurality of droplet spraying devices can be arranged adjacent to each other or spatially distributed. For example, one or more droplet spraying devices can be arranged at or in one component of the home appliance and one or more droplet spray devices can be arranged at another component. A droplet spraying device may be installed neighboring or in a compartment of the home appliance,

for example neighboring a laundry storing compartment, especially such that spraying droplets into the compartment is possible, whereas another droplet spraying device is for example arranged next to a heat exchanging device of said appliance, in particular for cleaning the same. A heat exchanging device of the (a) home appliance can be a condenser, evaporator or radiator for dissipating heat.

[0020] As already mentioned, the invention can be carried out advantageously in connection with a home appliance comprising a heat exchanging device. Such home appliances are in particular dryers, e.g. condensation and heat pump dryers or washing machines with drying function. In such home appliances the droplet spraying device can be configured to spray liquid supplied to the membrane by the liquid supply channel and/or the liquid reservoir onto one or more surfaces of the heat exchanging device, in particular to spray liquid onto the heat exchanging surfaces of the heat exchanging device. Convenient surfaces for being sprayed are especially evaporator surfaces of a heat pump dryer which need cleaning or washing as fluff is otherwise expected to soil or clog those. Advantageously the droplet spraying device based on the actuator-operated membrane is able to work with a liquid in form of condensed water normally present in such a home appliance and to give a powerful and directed mist to remove fluff stuck on the evaporator surfaces.

[0021] In an embodiment the droplet spraying device can be arranged above the heat exchanging device or the component to be cleaned by sprayed droplets and/or in or close to an air supply channel for flowing air to the heat exchanging device, wherein in particular the air supply channel is part of a processing air channel. Advantageously the droplet spraying device thereby can be arranged to spray droplets into the air supply channel at a region upstream the heat exchanging device, in particular be arranged next to or in the air supply channel upstream the heat exchanging device. In both cases the droplets may advantageously experience an accelerating force, i.e. by gravity or the process air flow within the air supply channel in a direction which supports the droplet spray effect exerted by the droplet spraying device and in the consequence the removal of residue.

[0022] Preferably the home appliance includes a compartment for articles to be treated. Such a compartment may be a laundry storage compartment, e.g. of a dryer or a washing machine, a dishwasher compartment, etc. With alike home appliances the droplet spraying device is arranged such, that droplets can be sprayed into the compartment. An alike configured droplet spraying device preferably sprays liquids or additives, e.g. a fabric finishing additive, a liquid detergent, a conditioner, a deodorant, a fragrance, a de-wrinkling agent, a proofing, antibacterial, rinse or softening agent, etc. into the compartment for appropriate treatment of the articles to be treated. Such liquids can be stored in or be fed by a corresponding liquid reservoir and/or the liquid supply chan-

nel.

[0023] For spraying droplets into the compartment the droplet spraying device may be arranged at a wall section forming part of the enclosure of the compartment or the droplet spraying device may be arranged within the compartment. For example, in case of a dishwasher the droplet spraying device may be arranged at a wall of the dishes storing compartment and/or at a dishes storing basket. It may be useful to arrange the droplet spraying device at a movable element of the home appliance, for example a spray arm of the same. Such a movable element can be arranged inside the compartment, for example in case of a dishwasher.

[0024] A compartment may at least partly be formed by a rotatable drum, e.g. in case of a washing machine or a dryer, in particular a tumble dryer. The droplet spraying device can be positioned and/or configured to spray droplets into the drum. Herein the droplet spraying device may be arranged at a front and/or rear closure element, the front or rear closure element covering or closing a front or rear opening of the drum, respectively. Such an arrangement allows e.g. for easy liquid supply architecture for supplying liquid to the droplet spraying device.

[0025] Preferably the droplet spraying device is arranged at a loading door for closing a loading opening and/or be arranged at a gasket arranged between a loading opening and the compartment. Such a position enables the feed of additives to the droplet spraying device by advantageously being able to make use of short liquid supply channel lengths, especially when liquid is to be supplied from a liquid reservoir meant to be serviced by a user.

[0026] Alternatively or additionally a droplet spraying device is arranged in an air flowing channel upstream the compartment, wherein in particular the air flowing channel is part of a process air channel and/or part of an air circulation channel. Such an arrangement allows for introducing mist generated by the droplet spraying device directly into an air flow towards the compartment, for example a laundry storage compartment, and in the consequence for an improved disposition.

[0027] According to an operation method, the home appliance is operated in a first operation mode and in a second operation mode. In the first operation mode the vibration frequency and/or speed and/or the amplitude of the membrane is higher than in the second mode of operation. In the first operation mode the frequency may match a resonant frequency of the droplet spraying device for maintaining resonant vibration.

[0028] In the first operation mode, which in particular is the droplet generation mode, the membrane sprays the supplied liquid completely, substantially or at least partially. In a second operation mode of the droplet spraying device, which in particular does not spray droplets, the liquid may be completely, substantially or at least partially flown through the liquid supply channel and/or the liquid reservoir, e.g. in the direction to an outlet of the same. In the second operation mode the droplet spraying

device may act as a pump or can for example be deactivated. In the second operation mode the droplet spraying device for example may be deactivated and the liquid is flown through the liquid supply channel and/or the liquid reservoir so as to flush the membrane. In a pumping mode of operation, which may correspond with the second operation mode, the droplet spraying device may for example exert a pumping or sucking force for sucking liquid into the liquid supply channel and/or the liquid reservoir. Alternatively or additionally in the second mode of operation the liquid at the backside of the membrane is pumped out of the droplet spraying device. For example in this mode the device is acting as a membrane-like pump.

[0029] According to an embodiment of the method, in a first step liquid supplied to the membrane is sprayed by the droplet spraying device, and in a succeeding step (see above first and second operation modes), the liquid supply channel and/or reservoir are washed by the liquid previously sprayed or by liquid from another reservoir or by liquid supplied from a fresh water tap. Such a further reservoir can for example be a condensed water tank. After such a washing phase another liquid can be supplied to the membrane via the liquid supply channel and/or the liquid reservoir. Consequently, only one liquid supply channel and/or liquid reservoir in fluid communication with the droplet spraying device for various liquids, e.g. additives, may be needed.

[0030] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

- Fig. 1 a schematic view of a dryer with a heat pump system;
- Fig. 2 a more detailed schematic view of a droplet spraying device arranged at a component of the heat pump system of the dryer;
- Fig. 3 a more detailed schematic view of the droplet spraying device;
- Figs. 4 to 6 each schematic views of an embodiment in which a droplet spraying device and a liquid supply is shown in different arrangements as compared to Fig. 3;
- Figs. 7a and b exemplary schematic views of the droplet spraying device, wherein Fig. 7a shows a top view and Fig. 7b depicts a sectional view;
- Fig. 8 a schematic view of another embodiment of a dryer, wherein droplet spraying devices are configured to spray droplets into a compartment or air cir-

ulation duct; and

- Fig. 9 a schematic view of another embodiment of the droplet spraying device having flaps.

[0031] In the following different arrangements of one or more droplet spraying devices 26 or one or more multiple droplet spraying devices 27 are disclosed. The arrangement embodiments can be combined in an arbitrary manner and design aspects relating to the spraying devices 26/27 and/or its liquid supply 22, 22a, 22b, 24, 24b can be combined or provided with one or more of the other embodiments. The same reference numerals are used to indicate the identical or functionally the same function of an element in the different embodiments.

[0032] Fig. 1 depicts a home appliance 2 where the depicted embodiment is a tumble dryer, especially a heat pump tumble dryer. A tumble dryer of this kind is generally well known in the art and comprises a heat pump system 4, including a heat exchanger device having a vaporizer or evaporator 6, a condenser 8, a compressor 10 and an expansion device 12 (for example a capillary tube 12). The process air flow within the heat pump system 4 is guided through a compartment 14 of the home appliance 2, i.e. through a compartment 14 for articles to be treated, e.g. a drum 14, wherein the airflow within a process air channel for circulating the air is depicted by arrows A in Fig. 1. The articles to be treated are textiles or laundry. In case the home appliance is a dishwasher, the articles are dishes or the like.

[0033] The heat exchanger device 6 of the dryer 2 is endangered of being soiled or clogged by fluff transported out of the compartment 14 with the process air flow. Although fluff filters 16 are arranged in the flow path, for example at an outlet 18 of the compartment 14, fine particles still are comprised within the air leaving the compartment 14. To avoid clogging or reduction in efficiency, the heat exchanger device 6 of the home appliance 2 is cleaned or washed regularly as explained below.

[0034] For washing the heat exchanger device 6 condensed water generated in the heat pump cycle, i.e. at surfaces of the evaporator 6, can advantageously be used. Such condensed water is collected in a collector device 20, e.g. in a collector tray or collector tank 20. Therefrom it can e.g. be fed to a condensate tank 21, a liquid reservoir 22 and/or a liquid supply channel 24, which are provided to supply water to a droplet spraying device 26. The condensed water from the collector device 20 can be conveyed by means of a pump 28 and/or a suitable duct structure 30 to the tank 21, the reservoir 22 and/or the channel 24. Pump 28 can e.g. be automatically operated when triggered by a switch signal from a float switch 32.

[0035] Figs. 2 to 6 each exemplarily visualize schematic details of the dryer 2. The heat exchanger 6, in particular at least one surface thereof, and further in particular a heat exchanging surface thereof, is to be cleaned

by a droplet spraying device 26. The heat exchanger 6 depicted is an evaporator 6 of the dryer 2 with a heat pump system 4 as described above, but may generally be any heat exchanger device 6 in need of cleaning, e.g. in a dryer or a washing machine with drying function.

[0036] In Figs. 2 to 6 the heat exchanger 6 is arranged in a section of an air circulation channel 4a, which in particular is part of the process air channel defined within the dryer 2. The air supply channel 4a is meant for guiding process air (indicated by arrows A) through at least a portion of the heat pump system 4. In the air supply channel 4a downstream the heat pump system 4 a fan 34 may be arranged, Fig. 2. Furthermore, as depicted in Figs. 2 and 3, a filter element 16, may be arranged at an inlet of the air supply channel 4a, upstream the heat pump system 4. The collector device 20 collects condensed water from the heat exchanger 6 for feeding it to the droplet spraying device 26. In the embodiment of Fig. 1 the condensed water is supplied to the device 26 via condensate line 30, condensate tank 21, liquid supply channel 24 and liquid reservoir 22 (Fig. 2).

[0037] The droplet spraying devices 26 shown in Figs. 2 to 6 each comprise a membrane 36 with a plurality of openings 38 and at least one actuator 40 for actuating the membrane 36, as for example is exemplified in Figs. 7a and 7b. A droplet spraying device 26 can comprise e.g. a first annulus 42, known as "invar" which for example is formed of nickel-iron alloy. Bonded to the annulus 42 may be a second, in particular piezoelectric annulus 44 as well as the perforate membrane 36, in particular a circular membrane 36. On top of the second annulus 44 a driving electrode 46 can be formed. By applying a voltage, for example a sinusoidal voltage, to the first annulus 42 and the driving electrode 46, the actuator 40 comprising the first 42 and second annulus 44 and the electrode structure 46 can be actuated, whereupon the membrane 36 is put to vibration. It shall be noted, that in Fig. 7b a liquid reservoir 22 in fluid connection with the membrane 36 is exemplified by the dotted line.

[0038] As for example depicted in Figs. 3 and 4, the droplet spraying device 26, in particular its membrane 36, is arranged such that droplets emerging from a front side of the membrane 36 can be sprayed onto the heat exchanger surface to be cleaned. For an enhanced spraying capability multiple droplet spraying devices 26 may be arranged within the home appliance 2. Each droplet spraying device 26 of a such multiple droplet spraying device 27 includes a membrane 36 in direct fluid connection with the liquid reservoir 22 (Fig. 3) or the liquid supply channel 24 (Fig. 4), wherein fluid is supplied to a backside of the membrane 36 and in operation droplets emerge from a front side, indicated by arrows B.

[0039] In the embodiments of Figs. 2 and 3 the droplet spraying device 26 forms a walls section of the liquid reservoir 22.

[0040] The liquid reservoir 22 contains the liquid to be sprayed by the droplet spraying devices 26, e.g. condensed water supplied from the collecting device 20, wa-

ter from tap, liquid fed by a user, etc. The liquid is fed through an inlet 22a to the liquid reservoir 22. The liquid reservoir 22 can further have an outlet 22b for emptying the reservoir 22, e.g. by making use of a pumping action of the droplet spraying device 26 or for flushing the reservoir 22 in the context of cleaning the same. The outflow of liquid through the outlet 22b can be controlled by a valve shown in Fig. 2, which is generally closed and can be opened by demand. Alternatively or additionally, the liquid reservoir 22 can have an outlet 22b comprising a level drain as shown in Fig. 3. Liquid drained out of the liquid reservoir 22 via outlet 22b is indicated by arrow C and may also be collected by the collecting device 20 for further use or can be drained away.

[0041] Here the droplet spraying devices 26 are situated bordering the liquid reservoir 22. In doing so no further liquid supply means for feeding fluid from the liquid reservoir 22 to the membrane 36 is necessary. A suitable liquid reservoir 22 can hereby be designed with a small frame.

[0042] To establish a fluid connection between the droplet spraying device 26 and the liquid reservoir 22, the membrane 36 can span a cut-out or through-hole established in the wall of the liquid reservoir 22 such that liquid contained within the reservoir 22 contacts the membrane 36, i.e. its backside. The membrane 36 can be situated within a corresponding through-hole, e.g. at the bottom of or within the wall structure of the liquid reservoir 22 or next to a port of such a through hole. Herein also the actuator 40 can be arranged in such a manner. In such an arrangement the membrane 36 seals the cut-out or through-hole if not actuated.

[0043] In Fig. 2 and 3 the droplet spraying device 26, in particular together with the liquid reservoir 22, is situated at a structural part of the home appliance 2 neighboring the component 6 to be sprayed upon. The arrangement, in particular close to the air supply channel 4a for flowing air to the heat exchanging device 6, is such that droplets can be sprayed onto the evaporator 6. In an advantageous arrangement the droplet spraying device 26, in particular together with the liquid reservoir 22 (and/or a liquid supply channel 24), is positioned above the heat exchanger 6 such that droplets to be sprayed can additionally be accelerated by gravity. The term 'above' relates to the operational orientation of the home appliance (here dryer 2).

[0044] Advantageously the droplet spraying devices 26, in particular the multiple droplet spraying device 27, are formed integrally with the liquid reservoir 22 and/or a liquid supply channel 24, i.e. as a single module. By doing so the at least one droplet spraying device 26 (e.g. a plurality of devices 26 in the multiple spray device 27) can be mounted easily, i.e. via mounting the liquid reservoir 22 or a liquid supply channel 24 at the predetermined position, respectively.

[0045] Figs. 4 to 6 each exemplarily depict a liquid supply to the droplet spraying devices 26 and its membrane 36, respectively, wherein each membrane 36 is in fluid

communication with the liquid supply channel 24. The supply channel 24 can be fluid connected to a line 30 in fluid connection with the collector device 20 (Fig. 4), or be fluid connected to the liquid reservoir 21 or 22 (Figs. 5 and 6) or generally be fluid connected to a liquid source.

[0046] In Fig. 4 downstream of an inlet 24a a supply line for example branches into one liquid supply channel 24 per membrane 36 such that liquid can be supplied individually to each device 26 / membrane 36. A liquid supply channel 24 hereby acts as a liquid reservoir 22. For example it is designed to provide liquid by a capillary action, e.g. in cooperation with the actuated membrane 36. The droplet spraying devices 26 depicted in Fig. 4 are situated on a structural part of the home appliance 2 (dryer) neighboring the evaporator 6, the arrangement enabling them to spray droplets onto the evaporator 6 to be cleaned.

[0047] In Fig. 5 a liquid supply channel 25 connects to liquid reservoir 22, wherein the multiple droplet spraying device 27 is fed by only one liquid supply channel 25, i.e. a common liquid supply channel 25. By supplying liquid to multiple droplet spraying device 27 via a single supply channel 25, only little financial effort for supplying liquid is necessary. Fig. 5 further shows situating the droplet spraying devices 26 inside the air supply channel 4a neighboring the surface area of the evaporator 6 to be cleaned. By situating the droplet spraying devices 26 inside the air supply channel 4a, the spray effect can especially be focused to an area where most deposits (fluff) are to be expected.

[0048] Fig. 6 shows a related arrangement, wherein the droplet spraying devices 26 are arranged upstream of the evaporator 6. The spray direction of the droplet spraying devices 26, arrow B, hereby in particular matches the direction of the processing air flow, arrows A, such that a spray effect can be enhanced by the processing air flow.

[0049] It is to be noted that Figs. 3 and 4 further exemplify a driving structure 48 for one or more actuators 40. Such a driving structure 48 may comprise a low-voltage (AC) circuit, e.g. providing for actuation of multiple or all actuators 40 at once, e.g. by making use of a bus bar, or allowing for separate actuation of selected ones or each individual actuator 40. Driving structure 48 or at least part of it may be integrated in or on the liquid reservoir 22 and/or part of the liquid supply channel 24, e.g. printed or arranged thereon. The driving structure 48 may be controlled by an overall control device of the home appliance 2 (dryer) and/or comprise a stand-alone functionality. A control function can be implemented enabling the actuating of a selected one or a group of the droplet spraying devices 26 out of a plurality thereof in the multiple droplet spraying device 27, Figs. 5 and 6.

[0050] Fig. 8 further depicts dryer 2 in another embodiment, wherein droplet spraying devices 26 spray droplets into the compartment 14 for articles to be treated. The dryer 2 can generally be a home appliance like a dishwasher or a laundry treatment apparatus, for exam-

ple a laundry treatment apparatus with washing and/or drying function. The compartment 14 can be a laundry storage compartment 14 in case of the home appliance 2 being a washing machine and/or a dryer, e.g. a drum, or a dishes storing compartment 14 in case of a dish washer, i.e. a non-rotatable compartment 14. Such a home appliance 2 can also include a droplet spraying device 26 for purposes described above in connection with Fig. 1 to 7b.

[0051] The dryer 2 of Fig. 8 is adapted to spray droplets into the compartment 14 by a droplet spraying device 26 (or a multiple droplet spraying device 27 not depicted in Fig. 8). Such droplets can be droplets build up from various kinds of liquids, comprising one or more of: water, a liquid detergent, conditioner, deodorant, fragrance or de-wrinkling agent and a proofing, antibacterial, rinse or softening agent. For storing such liquids the home appliance 2 can comprise one or more suitable liquid reservoirs 22, especially such, which are meant to be filled by a selected liquid by a user. The articles to be treated within the compartment 14 are brought in interaction with the respective kind of liquid supplied to the droplet spraying device 26. Each droplet spraying device 26 (its membrane 36) is in fluid communication with the liquid supply channel 24 and/or the liquid reservoir 22.

[0052] To supply liquids into the compartment 14 by spraying droplets the droplet spraying device 26 in particular is arranged at a wall section 50 forming part of the enclosure of the compartment 14. Such a wall section 50 may be a stationary part of the compartment 14 not rotating with and closing the openings of the rotatable drum 52. For example the stationary part is a rear closure element 54 of drum 52, Fig. 7. If the home appliance is a dishwasher the droplet spraying device 26 can also be arranged at any section of the stationary wall of the dishwasher tub.

[0053] Fig. 8 also exemplarily depicts the arrangement of a droplet spraying device 26 neighboring a loading opening 56 of the compartment 14. Herein the droplet spraying device 26 is arranged such that droplets can be sprayed through the loading opening 56 of the drum 52 into the compartment 14. Appropriate positions for such an arrangement of the droplet spraying device 26 are for example a loading door 58 of the home appliance 2, a gasket arranged between the loading opening 56 and the compartment 14, and/or a stationary frame between the loading opening and the drum.

[0054] Another droplet spraying device 26 is arranged in an air flowing channel 60 upstream the compartment 14. In Fig. 8 air flowing channel 60 is part of a closed loop process air channel and/or part of an air circulation channel for air circulation within the dryer 2 (arrows A indicate the air flow). With such an arrangement a uniform distribution of the droplets with respect to their distribution over the articles to be treated can be achieved, as the droplets can be easily carried throughout the compartment 14 by the air flow entering or passing through the compartment, arrows A. In other embodiments not

shown, the dryer or washing machine can be of the exhaust process air type where ambient air is flown over a e.g. cross-flow) heat exchanger element and thereafter is exhausted to the outside of the home appliance.

[0055] Fig. 8 also depicts a valve 62, which e.g. may be installed in a liquid supply channel 24 for controlling liquid supply to the droplet spraying device 26. Additionally or alternatively a pump 64 for liquid supply is provided. A control device 66 for controlling one or more droplet spraying devices 26 via control line 68 is implemented.

[0056] Fig. 9 shows another exemplary embodiment of the droplet spraying device that can be used in any of the above configurations of Figs. 1 to 8. In this embodiment a first flap 72 is arranged at the inlet 22a and a second flap 70 is arranged at the outlet 22b of the liquid reservoir 22 (or the section of the liquid supply channel 24 where the droplet spraying device 26 is arranged in the alternative configuration). In a first operation mode of the device 26 the frequency of the voltage applied by driving structure 48 is high and correspondingly the vibration frequency of membrane 36 is high while its stroke D is low. At high frequency of the membrane 36 liquid droplets overcome the capillary or surface force of the openings 38 onto the liquid and droplets separate from the membrane's outside surface establishing spraying activity. Inlet flap 72 takes an intermediate position between opening and closing such that liquid is sucked into the inner volume of reservoir 22 (or channel section 24). In this first operation mode, ideally, outlet flap 70 is closed or nearly closed so that no or little fluid drains through outlet 22b (comparable to cardiac fibrillation).

[0057] In a second mode of operation the driving frequency is lower, thus the vibration frequency of the membrane 36 is lower and its stroke D is larger. Due to the lower vibration frequency, droplets do not release from the openings 38 and no liquid is sprayed. Instead a heart-like pumping activity is provided by the membrane and the liquid is pumped through the outlet 22b. Thus there is a liquid flow through the reservoir 22 (or the device section of channel 24). The liquid flow flushes away any deposits (e.g. fluff or scale) that may have collected in the reservoir (or in the channel 24/25 section), in particular on the membrane 36 and its openings 38.

Reference Numeral List:

[0058]

2 home appliance

4 heat pump system

4a air channel

6 evaporator (component)

8 condenser

10 compressor

12 expansion device

5 14 compartment

16 fluff filter

18 outlet

10 20 collector device

21 condensate tank

15 22 liquid reservoir

22a inlet

22b outlet

20 24 liquid supply channel

24a inlet

25 25 liquid supply channel

26 droplet spraying device

27 multiple droplet spraying device

30 28 pump

30 condensate line

35 32 float switch

34 fan

36 membrane

40 38 opening

40 actuator

45 42 first annulus

44 second annulus

46 driving electrode

50 48 driving structure

50 wall section

55 52 drum

54 rear closure element

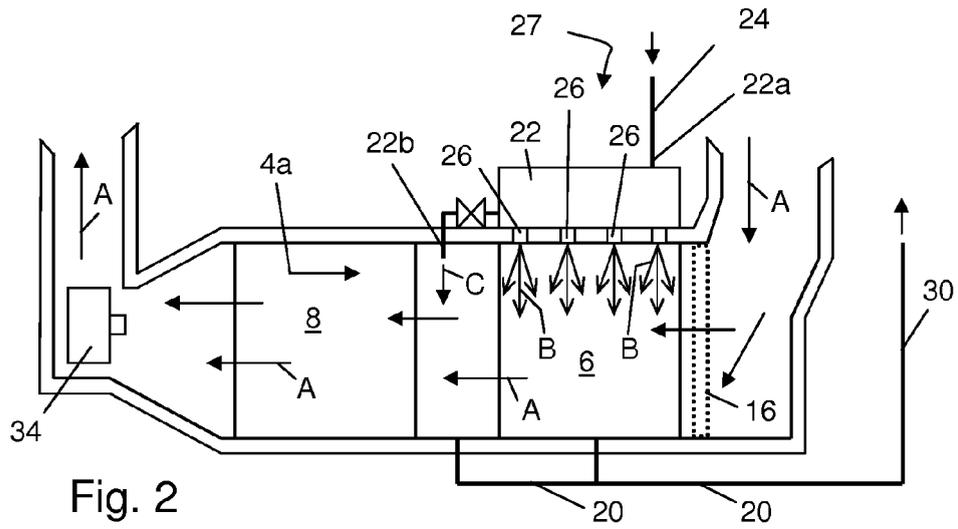
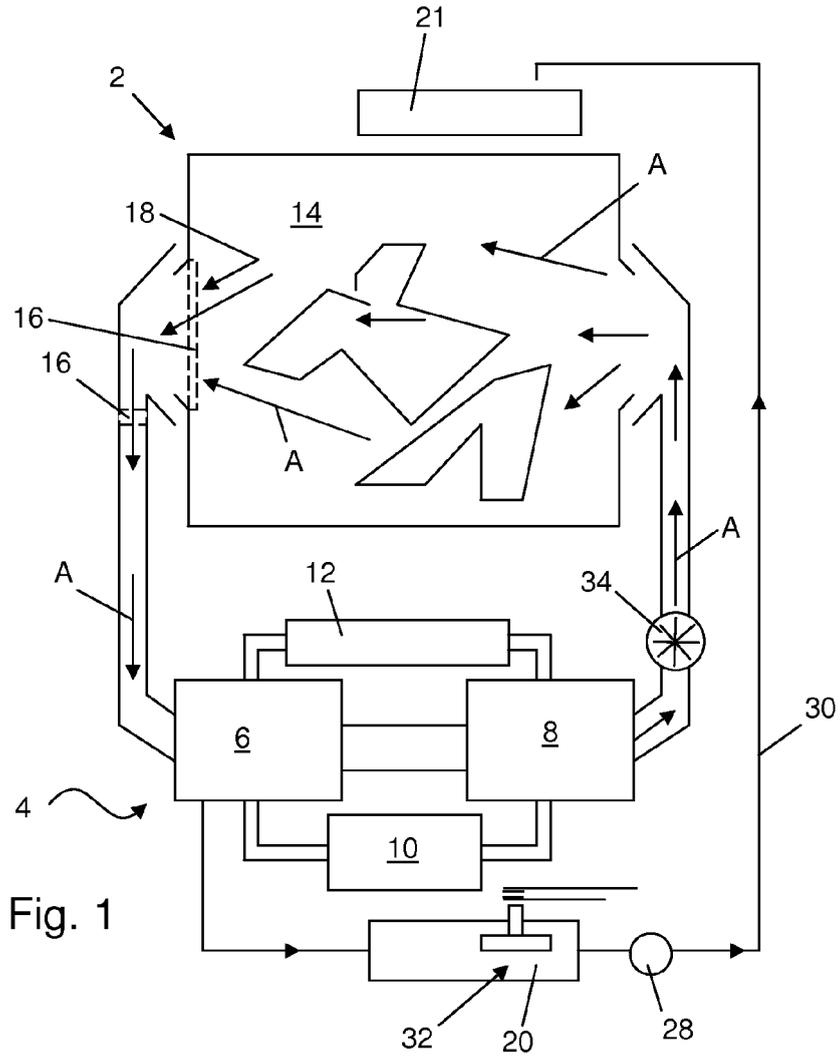
56	loading opening
58	loading door
60	air flowing channel
62	valve
64	pump
66	control device
68	control line
70	outlet flap
72	inlet flap
A	airflow (arrow)
B	Droplets
C	liquid from outlet 22b (arrow)
D	membrane stroke length

Claims

1. Home appliance (2), in particular dishwasher or laundry treatment apparatus, further in particular a laundry treatment apparatus capable of washing and/or drying, comprising a liquid supply channel (24, 30) and/or a liquid reservoir (21, 22) and a droplet spraying device (26, 27), the droplet spraying device comprising:
 - a membrane (36) arranged in fluid connection with the liquid supply channel (24, 30) and/or the liquid reservoir (21, 22), wherein the membrane (36) has a plurality of openings (38), at least one actuator (40) for actuating the membrane (36).
2. Home appliance (2) according to claim 1, wherein the home appliance (2) comprises a heat exchanging device (6), and wherein the droplet spraying device (26, 27) is configured to spray liquid supplied to the membrane (36) by the liquid supply channel (24, 30) and/or the liquid reservoir (21, 22) onto one or more surfaces of the heat exchanging device (6), in particular to spray liquid onto the heat exchanging surfaces of the heat exchanging device (6).
3. Home appliance (2) according to one of the preceding claims, wherein the droplet spraying device (26, 27) is arranged above the heat exchanging device (6) and/or in or close to an air supply channel (4a) for flowing air to the heat exchanging device (6), wherein in particular the air supply channel (4a) is part of a processing air channel.
4. Home appliance (2) according to one of the preceding claims, wherein the home appliance (2) comprises a compartment (14) for articles to be treated, in particular a laundry storage compartment (14) or a dishes storing compartment (14), wherein the droplet spraying device (26, 27) is configured to spray droplets into the compartment (14).
5. Home appliance (2) according to claim 4, wherein the droplet spraying device (26, 27) is arranged at a wall section (50, 54, 58) forming part of the enclosure of the compartment (14), wherein the droplet spraying device (26, 27) is configured to spray droplets into the compartment (14).
6. Home appliance (2) according to one of claims 4 and 5, wherein the droplet spraying device (26, 27) is arranged within the compartment (14), in particular arranged at a movable or stationary element thereof.
7. Home appliance (2) according to one of claims 4 to 6, wherein the droplet spraying device (26, 27) is arranged at a loading door (58) for closing a loading opening (56) and/or is arranged at a gasket arranged between a loading opening (56) and the compartment (14).
8. Home appliance (2) according to one of claims 4 to 7, wherein the home appliance (2) comprises a rotatable drum (52) forming at least part of the compartment (14) and the droplet spraying device (26, 27) is configured to spray droplets into the drum (52), wherein in particular the droplet spraying device (26, 27) is arranged at a front (58) and/or rear closure element (54), the front (58) or rear (54) closure element covering or closing a front (56) or rear opening of the drum (52), respectively.
9. Home appliance (2) according to one of the preceding claims, wherein the home appliance (2) comprises a compartment (14) for articles to be treated, in particular a laundry storage compartment (14) or a dishes storing compartment (14), wherein the droplet spraying device (26, 27) is arranged in an air flowing channel (60) upstream the compartment (14), wherein in particular the air flowing channel (60) is part of a process air channel and/or part of an air circulation channel.
10. Home appliance (2) according to one of the preceding claims, wherein the membrane (36) is supported by the actuator (40), wherein in particular the actuator (40) comprises one or more electrostriction, magnetostriction or piezoelectric (44) elements

adapted to deflect when electrically and/or magnetically excited.

11. Home appliance (2) according to one of the preceding claims, wherein the membrane (36) is part of the actuator (40) or the actuators (40) or wherein the membrane (36) is the actuator (40). 5
12. Home appliance (2) according to one of the preceding claims, wherein in a first operation mode the vibration frequency and/or speed and/or the amplitude of the membrane (36) is higher than in a second mode of operation. 10
13. Home appliance (2) according to claim 13, wherein in the first operation mode of the droplet spraying device (26, 27) the liquid is completely, substantially or at least partially sprayed by the membrane (36), and 15
in the second operation mode of the droplet spraying device (26, 27) the liquid is completely, substantially or at least partially flown through an outlet (22b) of the liquid supply channel (24) or the liquid reservoir (21, 22). 20
25
14. Method of operating a home appliance (2) according to any of the previous claims, wherein in a first step liquid supplied to the membrane (36) is sprayed by the droplet spraying device (26, 27), and 30
in a succeeding step the liquid reservoir (22) and/or the liquid supply channel (24) is washed by a liquid flow. 35
40
45
50
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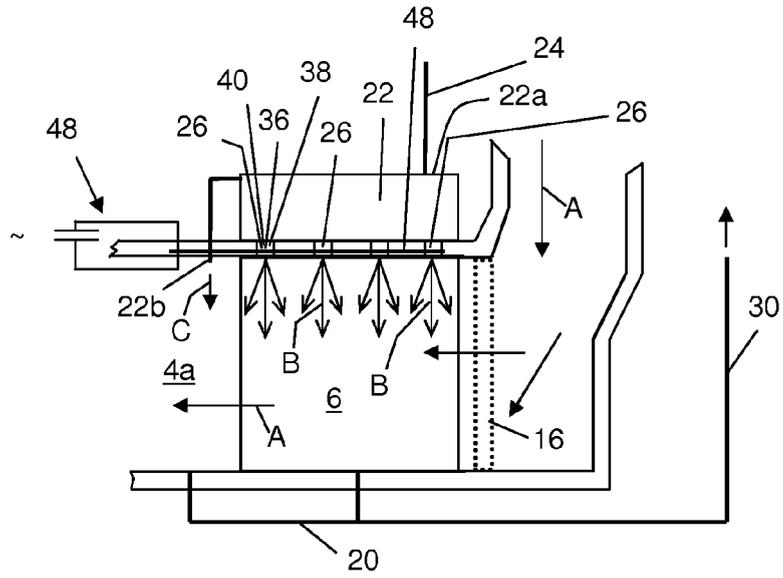


Fig. 3

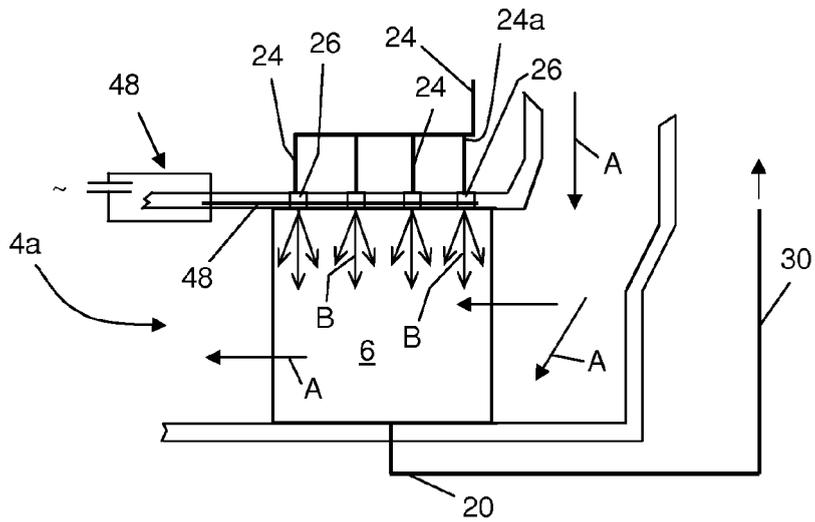


Fig. 4

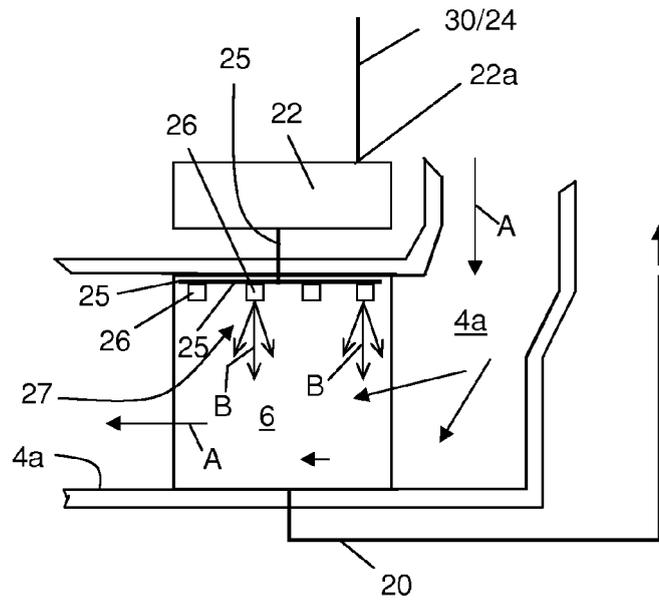


Fig. 5

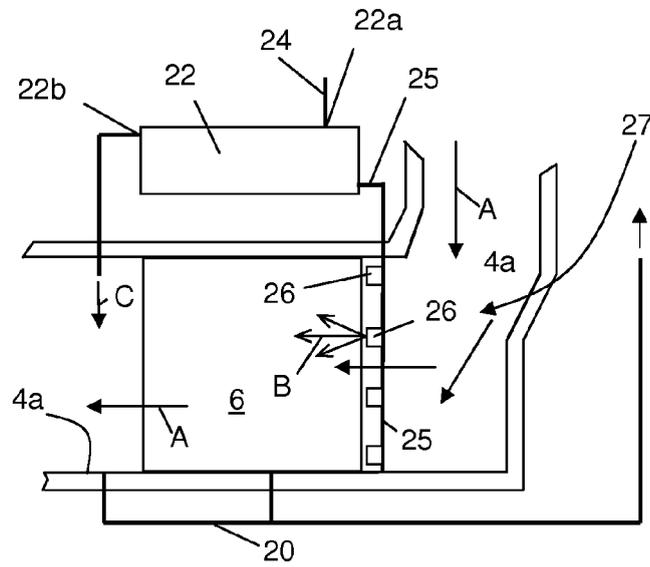


Fig. 6

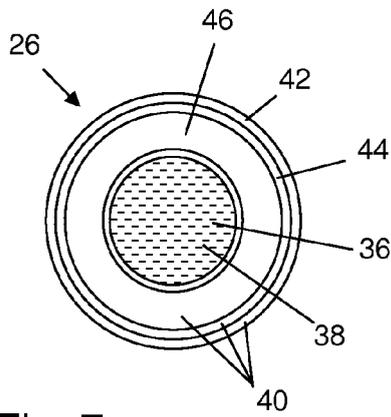


Fig. 7a

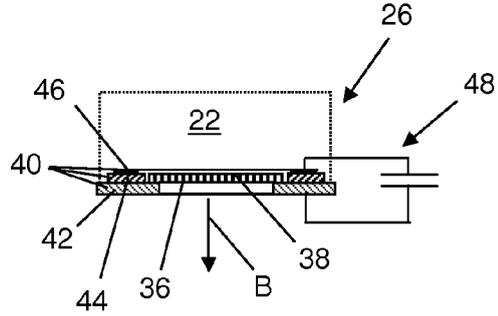


Fig. 7b

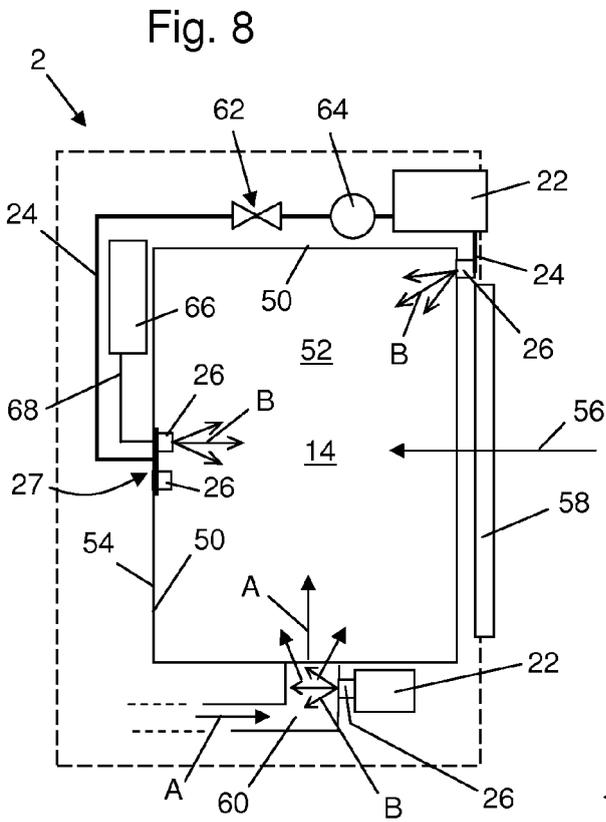


Fig. 8

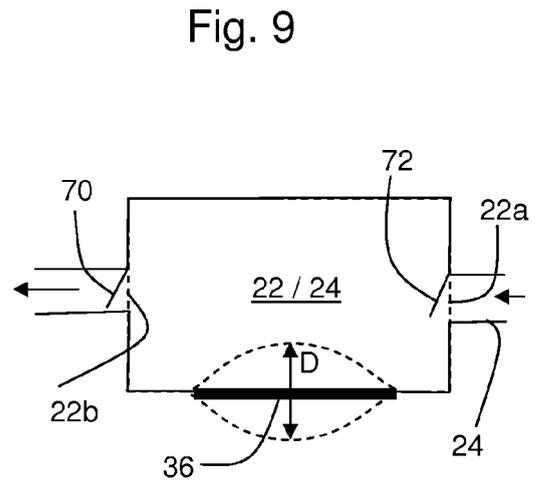


Fig. 9



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Application Number
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Place of search Munich		Date of completion of the search 7 July 2011	Examiner Kising, Axel
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Application Number
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 July 2011	Examiner Kising, Axel
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