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(54) **DEVICE FOR IRRADIATION WITH UV LIGHT, WASHING MACHINE AND METHOD FOR IRRADIATION WITH UV LIGHT**

(57) A device for irradiation of fluid with UV light having for disinfection purposes has a fluid passage for fluid flowing through it, at least one UV light source being arranged within the fluid passage and an energy source for the UV light source being arranged completely outside the fluid passage. Energy transfer means are provided for the wireless and contactless transmission of energy

from the energy source to the at least one UV light source. This energy transmission can be inductively, such that the UV light source is activated directly or via an oscillating circuit. The energy transmission can also take place with microwaves. The device can be integrated into a washing machine with UV light sources inside a drum.

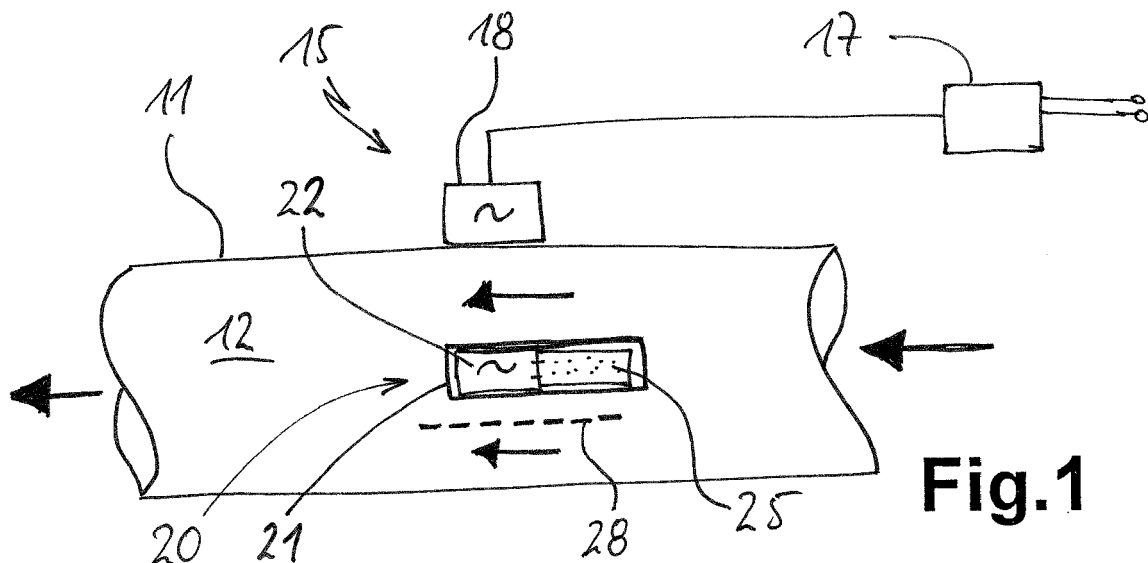


Fig.1

Description

Technical field and prior art

[0001] The invention is directed to a device for irradiation with UV light, in particular for disinfection of fluid. Furthermore, the invention is directed to a washing machine and a pump with such a device as well as to a method for irradiation with UV light.

[0002] The effect of irradiation of fluid or other articles with UV light for disinfection purposes is known, even to take place in household appliances such as washing machines. It is pointed to WO 2015/169348 A1. A part of a fluid pipe is provided with a transparent window, and outside of the fluid pipe along this transparent window a UV light source is provided irradiating the inside and in particular fluid flowing through the fluid pipe with UV light.

[0003] From DE 102010038692 A1 another washing machine is known with a UV light source arranged not along a fluid pipe, but at a mechanical switch for controlling a flow of fluid in a household device in several directions.

Summary of the invention

[0004] It is an object of the invention to provide a device for irradiation with UV light, a washing machine, a pump and a corresponding method for irradiation with UV light to overcome problems of the prior art, wherein preferably a better implementation of functions into such a device for irradiation with UV light is possible, especially for disinfection of fluid, and that in particular can be implemented and used without major inconvenience for a user in respect of safety issues and for manufacturers of appliances.

[0005] This object is solved by a device with the features of claim 1, a corresponding washing machine with the features of claim 9, a pump with the features of claim 12 and a method with the features of claim 13. Advantageous and preferred configurations of the invention are the subject of the further claims and are explained in more detail below. In this case, some of the features are described only for the device, only for the washing machine or the pump or only for the corresponding method for irradiation with UV light. However, regardless of this, they are intended to be able to apply by themselves for the device, for the washing machine and the pump and for the method independently of one another. The invention is also directed to a washing machine and dryer combined in one device, which in the context of this invention is also regarded as a washing machine. The wording of the claims is made to the content of the description by means of express reference.

[0006] A device according to the invention for irradiation with UV light has a fluid passage for receiving fluid and/or flowing through of fluid, which fluid passage may be a pipe or a closed channel, alternatively a tank or a container. The device is provided with at least one UV

light source, which is arranged within the fluid passage. Preferably the at least one UV light source is fully or completely arranged inside the fluid passage. This means that no part of the UV light source protrudes from the fluid passage or pokes out of it, so no complicated sealing is necessary. The device has an energy source for the at least one UV light source, which energy source is arranged completely outside the fluid passage. The energy source can be affixed to the outside of the fluid passage, but does not protrude into the fluid passage or pokes into it. Energy transfer means for a wireless and contactless transmission of energy from the energy source to the at least one UV light source are provided to allow for both of them not to stick or extend through a wall or outside of the fluid passage. This provides for the fluid passage to be watertight in a safe and easy manner.

[0007] It is possible with the invention to make a fluid passage very watertight on the one hand, while on the other hand a UV light source can be integrated into it and thus irradiate any fluid therein from inside for high efficiency and higher penetration of light inside the fluid. The provision of the special energy transfer means enables the division between the UV light source and the energy source.

[0008] The UV light source can be used for disinfection purposes on the one hand, which is generally known from the prior art mentioned before. Furthermore, the UV light can be used on the other hand for purposes such as activating special substances or treating laundry, which is described in further detail later on.

[0009] In an embodiment of the invention, the fluid passage can be a closed channel for fluid flowing through, preferably a pipe or a tube with an inlet and with an outlet. It can in particular be a round tube. The fluid is then irradiated with UV light for a rather short time.

[0010] In an alternative embodiment, the fluid passage can be a tank or a container, such as a water tank or a receptacle housing of a washing machine in which a drum is provided rotating therein during a washing process. In these cases the fluid is or stays inside the fluid passage for some time, which allows for more efficiency in irradiating.

[0011] The energy transfer means may in one basic embodiment of the invention comprise a microwave device outside of the fluid passage with at least one microwave generator and at least one microwave antenna. They can be mounted on the outside of the fluid passage, preferably externally on an outside wall of the fluid passage. The UV light source in this case is an electrodeless microwave lamp and may in particular have emission lines in the long-wave range. Such electrodeless microwave lamps are known in the art, also for generating UV light. The fluid passage should then in the region of the microwave antenna be permeable for the microwaves. It can for example be made of PTFE in this region with some kind of window or as a section of the fluid passage, in particular a section for a length of the fluid passage of between two times and twenty times the length of the

microwave antenna. PTFE is resistant against microwaves and at the same time permeable for microwaves.

[0012] A frequency of the microwave generator may advantageously be chosen in the ISM band, preferably be greater than 2 GHz. A frequency may in particular be between 2.1 GHz and 2.8 GHz, for example 2.4 GHz.

[0013] The microwave generator may be provided with a voltage-controlled oscillator, which preferably may be provided with an amplifier chain for providing the output power. In particular an operating frequency corresponding to a plasma impedance in the UV light source is controlled. Alternatively or additionally a reflection measurement of the microwaves can be provided as a control variable for an analog locked loop all in the microwave generator.

[0014] An energy transfer to the UV light source via the generation of microwaves has the advantage that no further parts or components are necessary, the UV light source can be activated directly by the microwaves focused on it from the antenna.

[0015] In another basic embodiment of the invention an energy transfer takes place inductively, such that the energy transfer means comprises an induction device outside of the fluid passage. At least one induction generator and at least one external induction coil are provided. They can be mounted externally on an outside wall of the fluid passage, which is in particular preferred for the external induction coil. The UV light source can be an induction lamp being inductively coupled to the external induction coil. Such an inductively coupled induction lamp may advantageously be excited from the outside and be designed for an inductively coupled ring discharge. Such lamps are known to the person skilled in the art.

[0016] In this case the inductively coupled induction lamp can be excited in or from the inside and may have an integrated coupler for this purpose, which preferably is a ferrite coupler. A ferrite coupler can have the form of a rod. This integrated coupler may run at least partly within the induction lamp or may be surrounded by the induction lamp. In particular, the integrated coupler can be inside the induction lamp with up to 40% to 70% of its length.

[0017] In an even further basic embodiment of the invention the energy transfer takes also place via induction, wherein the energy transfer means comprise an induction device with at least one induction generator and with an external oscillating circuit having the external inductor coil. This external inductor coil should preferably be mounted externally on an external side or outer wall of the fluid passage. The energy transfer means also have at least one internal oscillating circuit with at least one internal inductor coil, wherein an inductive coupling with an energy transfer between the external oscillating circuit and the internal oscillating circuit during operation is provided. This energy can then be used from the internal oscillating circuit in the form electrical energy which may be used to power the at least one UV light source inside

the fluid passage connected to the internal oscillating circuit for its operation and its energy supply. In particular an adaptation circuit can be provided between the internal oscillating circuit and the UV light source the UV light source, for example for making a DC current from the AC current of the internal oscillating circuit.

[0018] In this embodiment it is possible for the UV light source to be a UV LED, which can be preferred for its low power consumption and high efficiency, also in the UV bandwidth. Such a UV LED may also be provided with an electrical power supply from the internal oscillating circuit together with an energy storage means, for example a rechargeable battery or a capacitor. An energy supply may then be a direct or galvanic electrical power supply, respectively. The energy storage means can be charged by the internal oscillating circuit which again is powered by the external oscillating circuit with its external inductor coil.

[0019] Such an energy storage means may allow for an energy transfer into the fluid passage to only take place discontinuously or in intervals, respectively. This can in particular be advantageous if a relative movement between the outer components and the inner components takes place, for example in a washing machine where the external inductor coil is in a fixed position and the internal oscillating circuit with the UV light source is rotating in a drum. An energy transfer may in this case be possible only for one or two seconds or for an even shorter burst.

[0020] It is possible for the device to comprise an inductively heatable heating element within the fluid passage to be inductively coupled with the external induction coil arranged externally outside the fluid passage or the external oscillating circuit for an inductive energy transmission, respectively. In this case the inductively heatable heating element preferably consists of magnetizable material. Such a way of transmitting energy for a heating process is known. This allows for some kind of secondary use of the external oscillating circuit with the external inductor coil. The fluid may then not only be irradiated with UV light but also be heated.

[0021] A washing machine according to the invention may have a device as described before, wherein in this case the fluid passage is a receptacle housing for a drum of the washing machine. The drum rotates in the receptacle housing, preferably on a turning shaft fixed at the receptacle housing and driven from outside. The receptacle housing cannot rotate, but is fixed or hinged elastically inside the washing machine. At least a part of the energy transfer means are arranged on an outside of the receiving housing, wherein the at least one UV light source is arranged in the receptacle housing. So the energy transfer should at least be through the receptacle housing or its wall, respectively. So at least the water inside the receptacle, which is usually also inside the drum for its major part, can be irradiated with UV light. Further advantageous options are available also.

[0022] In a preferred embodiment of such a washing

machine, the UV light source can be arranged inside the drum itself. This allows not only for better and more direct irradiation of water inside the drum, but also of the laundry and/or other substances or particles or liquids inside the drum. It is then preferred if also other components for energizing the UV light source as explained before are arranged inside the drum, preferably close to or together with the UV light source.

[0023] The UV light source can preferably be arranged within a protrusion on an inner wall of the drum. Such protrusions are known, for example in the form of vanes or paddles, and are often provided for the purpose of moving the laundry and also for better shoveling water onto the laundry from above. There may in particular be two to four protrusions, which are preferably identical, being provided on the inner wall of the drum. In at least one of these protrusions a UV light source should then be arranged having a radiation direction into the interior of the drum, preferably towards a center point of the drum. In addition or as an alternative, a radiation direction could be into the interior of the protrusion, because water alone is present there for some time without any perturbing clothes blocking the UV radiation. This water can be shoveled from the lower part of the drum up to the upper part for a better washing process. It is also possible to keep water in the protrusion for a specified time to allow for a UV treatment of the water or any substances therein. In one embodiment, in each of the protrusions a UV light source may be arranged with a radiation direction into the interior of the drum and/or with radiation direction into the interior of the protrusion. Using a coating of TiO₂ inside the drum allows also for a cleaning function of the drum inside in addition to the washing process. These protrusions may be designed in removable manner to allow for easy detachment or replacement. This may also allow for replacement of the conventional protrusions against protrusions with UV devices for the purpose as described before. On the outside of the receptacle housing an energy transfer means may be affixed and connected to a control and an energy source of the washing machine.

[0024] Each of the UV light sources can preferably be provided with its own energy supply in the form of an internal oscillating circuit in the case of an inductive energy transfer. Microwave radiation into the drum is also possible, but has proven to be more difficult and more risky. There usually is the window at the front side of the drum for visual inspection by the user of anything that happens in the drum. UV light can be shielded easier by a suitable coating on such a window that blocks off UV light, similar to sunglasses.

[0025] In an alternative embodiment, the UV light sources inside the drum can be connected to one single energy source inside the receptacle. This can be provided with an internal induction coil of an internal oscillating circuit would or running around the outer wall of the drum, such that a rather continuous energy transfer can take place from outside the receptacle. An external induction

coil can be arranged on an outside wall of the receptacle directly opposite the internal induction coil for inductive energy transfer.

[0026] It is further possible for the UV light source to be connected to an energy storage means as explained before, wherein the device for the energy transfer is an induction device as described before. The energy storage means are then connected to the internal oscillating circuit for charging. Also in the case of a washing machine, the energy storage means preferably are a capacitor and the UV light source preferably is a UV LED as described before.

[0027] In an alternative washing machine the at least one UV light source can be arranged between the receptacle housing and the drum. This serves for good UV radiation onto or into the water inside the receptacle housing, in particular in its lower region. Through the number of small holes usually provided in the drum for water flowing in and out, UV light can also come into the drum to a substantial amount. The advantage of the UV light sources to be stationary and not movable relative to the external energy source and transfer means outside of the receptacle housing could make up for a reduced input of UV light into the drum through these holes. It would be easier to provide a lot more UV light sources inside the receptacle housing and to provide them with energy in the manner described herein.

[0028] According to a further aspect of the invention a pump with a device as described before can be provided. In this case the fluid passage is a pump chamber or, alternatively, a pump inlet or outlet. The pump can be a heated pump installed in a domestic appliance in a preferred embodiment of this invention, so heating and disinfection is possible in one and the same pump, either at the same time or independent of each other.

[0029] The pump may in particular be an impeller pump having an annular pump chamber, so that the UV light source can advantageously be arranged within this pump chamber running at least partly around in the pump chamber. Only one single UV light source may be provided, which then may have at least partially a ring-like form, or even form a full ring. Alternatively, several UV light sources can be provided which are arranged along a ring, for example three to eight UV light sources.

[0030] In a method for irradiation with UV light by operating a device according to the invention, the at least one UV light source within the fluid passage is supplied with energy in wireless and contactless manner from outside the fluid passage as to emit UV light in operation. This may serve to disinfect fluid in the fluid passage, however, also alternative purposes such as treating laundry with UV light to remove stains is an option. Also the addition of washing active substances is possible that can be activated by UV light, either by direct activation or by cracking open microcapsules which contain these substances. The fluid in particular can flow through the fluid passage. It is also possible for the fluid to remain in the fluid passage for some time, for example seconds up to

minutes or even hours. Alternatively, the fluid can be in there such as in a water tank.

[0031] In a preferred embodiment, only one single energy source or only one controller or inverter, respectively, is provided both for the UV light source and for a drive motor of a household appliance in which the fluid passage is installed. Preferably a sinusoidal envelope curve can be generated in a drive voltage for the drive motor, preferably at a frequency between 5 Hz and 450 Hz, in particular between 10 Hz and 400 Hz. Individual voltage pulses are generated corresponding to a PWM modulation within the sinusoidal envelope curve with a higher frequency, preferably between 6 kHz and 30 kHz, wherein in particular the voltage pulses are generated within the sinusoidal envelope curve with a frequency between 6 kHz or 10 kHz and 20 kHz. This is preferably provided for an inductive energy transfer. If microwave activation of the UV light source is required, much higher frequencies are needed obviously.

[0032] In an embodiment of the invention for the operation of a washing machine as described above, wherein, in a preceding step, it is possible for washing-active substances being introduced into the drum or into the receptacle housing during the operation of the washing machine as mentioned before. These washing-active substances are designed in such a way that they can be activated by irradiation with UV light. In a subsequent step, the washing-active substances are then activated by irradiation with UV light from the UV light source. It is possible to carry out the steps of introducing the washing-active substances and activating the washing-active substances several times during one washing process with the washing machine.

[0033] It can advantageously be provided that the UV light source together with the energy source and/or the energy transfer means are designed in such a way that operation of the UV light source is only possible if a pump and/or a heating device of the washing machine are in operation. In this case of operation, the washing machine must be safely locked and cannot be opened. This provides for enhanced safety of a user. Provision of this is especially advisable in the case of the energy transfer means using microwaves as described before.

[0034] These and further features are evident not only from the claims but also from the description and the drawings, the individual features each being implemented by themselves or in multiples in the form of subcombinations for an embodiment of the invention and in different fields and being able to be advantageous and independent protectable embodiments for which protection is claimed here. The division of the application into individual sections and subheadings does not limit the general validity of the statements made thereunder.

Brief description of the drawings

[0035] In the following, an embodiment of the invention will be described in detail with reference to the drawings.

In the drawings show:

- fig. 1 a schematic view from the side of a fluid pipe with a device according to the invention for irradiation of fluid in the fluid pipe with UV light,
- 5 fig. 2 a slight deviation of the fluid pipe of fig. 1 with a UV lamp with a ferrite rod inside,
- fig. 3 another alternative fluid pipe corresponding to the one of fig. 1 with a UV lamp activated by a microwave device,
- 10 fig. 4 a detailed schematic view of an energy source for driving a motor of a washing machine or of a pump, which at the same time provides drive power for the motor and energy for the device,
- 15 fig. 5 a schematic view of a washing machine with an induction device on the outside of a receptacle housing and several UV lamps as inserts in protrusions on the inside of a drum and
- 20 fig. 6 a schematic view of a pump with an impeller and a ring-like pump chamber in which a ring-like UV lamp is arranged together with an induction device on the outside of the pump chamber.

Detailed description of the embodiments

[0036] Fig. 1 shows as an exemplary embodiment of the invention a fluid pipe 11 with a fluid 12 inside, for example water. This fluid 12 enters fluid pipe 11 on the right side through a kind of inlet and exits fluid pipe 11 through an outlet on the left side. As explained before, fluid pipe 11 could also generally be any other kind of pipe or fluid passage through which fluid flows, either continuously or in intervals. Alternatively, fluid pipe 11 could also be a tank for water or the like.

[0037] Outside the fluid pipe 11, a device 15 according to the invention for irradiation with UV light is provided. Device 15 has an external energy source 17 connected to external power, for example in a household. Energy source 17 may also comprise any kind of power controller or converter or the like, as is described later on with regard to fig. 4 as an example.

[0038] Device 15 furthermore comprises an induction device 18 being arranged outside fluid pipe 11 and, preferably, being fixed to this outside, for example with a fixing means that can also be removed. Induction device 18 has an induction coil which is not described in greater detail, as it can be easily realized by a person skilled in the art.

[0039] Inside fluid pipe 11, there is provided an insert 20 also being part of device 15. This insert 20 has a casing 21 which is water-tight on the one hand and, at least at its right end, is transparent or at least transmissive for UV light. Insert 20 may be fixed inside fluid pipe 11 by thin rods or fins or the like supporting themselves against the inside of fluid pipe 11.

[0040] In casing 21, an oscillating circuit 22 as described before is provided. This oscillating circuit 22 works together with induction device 18 for a contactless

and inductive energy transfer. Oscillating circuit 22 may correspond to the internal oscillating circuit described at the beginning and has an internal inductor coil together with a capacitance. These are both not shown in fig. 1, as they can be easily conceived by a person skilled in the art. Oscillating circuit 22 is connected with UV lamp 25 for its powering or operation, respectively. This means that the power that is transmitted inductively from induction device 18 to oscillating circuit 22 is used for electric powering of UV lamp 25. This is known to a person skilled in the art. There is no need to provide any switching means or the like inside insert 20, as a powering of UV lamp 25 can be controlled via the energy source 17.

[0041] In dashed lines a ferromagnetic heating element 28 is shown that may also be provided inside fluid pipe 11 as described before. As an alternative, it could be provided on the outside. It can be provided that inductive energy is not only transferred to the oscillating circuit 22, but also to this heating element 28. Such an energy transfer in two ways may be provided simultaneously for heating fluid 12 flowing through fluid pipe 11 and, at the same time, disinfecting it. In a further embodiment, by a variation of the frequency of the inductive energy transfer and a corresponding adaptation of the oscillating circuit 22 on the one hand to a first specific frequency and of the ferromagnetic heating element 28 on the other hand to a second specific frequency being different from the first, it is possible to separately power the UV lamp 25 on the one hand or the ferromagnetic heating element 28 the other hand. The ferromagnetic heating element 28 can be designed for a resonant frequency which is much lower than the one of oscillating circuit 22, for example only 30 kHz or even only 20 kHz. The induction device 18 can either use higher frequencies of about 1 MHz, for example, to generate UV radiation with UV lamp 25 inside fluid pipe 11. Alternatively, it can use a much lower frequency of for example 30 kHz or even only 20 kHz to activate the ferromagnetic heating element 28. Such an induction device 18 with a corresponding inverter that can operate with at least two resonant frequencies is known in the art.

[0042] An alternative embodiment of the invention is shown in fig. 2 with a similar fluid pipe 111 through which fluid 112 flows. A corresponding device 115 with an energy source 117 and an induction device 118 as in fig. 1 is provided. Inside fluid pipe 111, an insert 120 with a water-tight casing 121 is provided. In this casing 121, an oscillating circuit 122 is provided which, in this case, mainly consists of only an induction coil. This induction coil 122 is wound around a ferrite rod 126. This ferrite rod 126 protrudes with about half its length into a UV lamp 125 and in some way transfer the magnetic field into the UV lamp 125. In this case, UV lamp 125 is inductively coupled as is, for example, known from the company QL Company B.V. with lamps of the QL series. It can easily be conceived to also provide UV lamps with the same technology.

[0043] In a variation of this embodiment, the internal

oscillating circuit 122 could be dispensed of if the induction device 118 is sufficiently strong and adapted to directly induce the magnetic field into the ferrite rod 126 for activating UV lamp 125.

[0044] As a further variation of the invention, the internal oscillating circuit 122 could be changed so as to surround UV lamp 125 if this UV lamp is designed for an inductively coupled ring discharge. Such lamps are available from the company OSRAM under the name ENDURA EVG. It would also be easy to adapt them for radiation of UV light. In an even further embodiment the induction device 118 could be adapted to directly induce the magnetic field into the UV lamp 125, for example by providing an external induction coil of induction device 118 all around the fluid pipe 111. This should especially be feasible if the diameter of the fluid pipe is rather small.

[0045] Another embodiment of the invention is shown in fig. 3 with the fluid pipe 211 containing fluid 212 as before. Device 215 according to this embodiment of the invention again has an energy source 217 for powering the UV radiation source. However, in this case energy source 217 is coupled to a microwave device 219, which is directed into the fluid pipe 11 and onto a UV lamp 225, which in this case is an electrodeless microwave lamp, preferably with emission lines in the long-wave range. The microwave device 219 preferably has a microwave antenna designed for radiating microwaves into the fluid pipe 211. This means that the microwave radiation from the microwave device 219 directly provides for the UV lamp 225 to emit UV light. The UV lamp 225 in this case is preferably a microwave lamp or a plasma lamp as a special form of a gas discharge lamp energized by radio frequency power. Typically, such lamps use a noble gas or a mixture of these gases and additional materials such as metal halides, sodium, mercury or sulfur. In modern plasma lamps, a waveguide is used to constrain and focus the electrical field into the plasma. In operation, the gas is ionized, and free electrons, accelerated by the electrical field, collide with gas and metal atoms. Some atomic electrons circling around the gas and metal atoms are excited by these collisions, bringing them to a higher energy state. When the electron falls back to its original state, it emits a photon, resulting in ultraviolet radiation in this case, depending on a choice of the fill materials. One preferred choice is the so-called sulfur lamp, its bulb being filled with argon and sulfur.

[0046] As can be taken from fig. 3, a construction of such a device 215 is rather simple. It is only necessary to provide for the fluid pipe 211 as a whole or at least in the region of microwave device 219 to be permeable for the microwave radiation sent out by device 219.

[0047] The fluid pipe can for example be made from PTFE, which is not transmissive for UV radiation, but for radiation with frequencies of for example 1 MHz, especially microwave radiation.

[0048] In fig. 4, a more detailed embodiment of device 15 is shown with details of its external components. Energy source 17 in this case is a switch, for example con-

ected to the mains connection in a house. Energy source 17 is provided with control signals of a drive voltage U_D , which is varied according to the three examples shown on the right side. The pulses could be short or rather long. Also very long pulses are possible. A frequency of drive voltage U_D can be about 12 kHz.

[0049] As can also be taken from fig. 4, energy source 17 is connected to induction device 18, which in this case comprises a schematic induction coil wound around fluid pipe 11 where insert 20 is located inside. Furthermore, the energy source 17 powers a motor 30, which can be a drive motor or a pump motor as has been explained before.

[0050] Energy source 17 is kind of modulated with drive voltage U_D , wherein motor voltage U_M with regular 50 Hz looks as shown in fig. 4 on the lower right side. This allows for the use of parts and components already provided, which means that there is no need or major effort for integrating further parts or components. In this way also an inductive heating element explained before can be powered with the device according to the invention.

[0051] Further details will be given later with regard to the washing machine of fig. 5 and the pump of fig. 6.

[0052] Fig. 5 shows the integration of the invention with UV irradiation into a washing machine 33. Washing machine 33 has a housing 34 in which a receptacle housing 36 is provided with a drum 39 inside for the washing process itself. In the upper left corner of housing 34, a drawer 37 is provided for additives or washing detergents as is known in the art. Drawer 37 is connected with a fluid inlet 38 to receptacle housing 36 in its upper region.

[0053] In drum 39, which is rotated during the washing process by a drive motor which is not shown here, but may correspond to the motor of fig. 4, four protrusions 40a to 40d in vane-like form are provided on the inside. Such protrusions 40 are basically known for optimizing the washing process by moving pieces of laundry 41 in washing fluid 12. For the reason of being transmissive for UV light, protrusions 40a to 40d are provided with transparent windows on their tips, preferably made from robust glass or synthetic material.

[0054] On the upper side of receptacle housing 36, an induction device 18 with an energy source 17 is provided. This induction device 18 may for example correspond to the embodiment of fig. 1. In protrusion 40b, which is located directly underneath induction device 18, an insert 20b is provided which comprises an oscillating circuit 22b and a UV lamp 25b. UV lamp 25b is powered in the same manner by oscillating circuit 22b as described before with reference to fig. 1. UV radiation from UV lamp 25b can enter the drum via the transparent window on the tip of protrusion 40b.

[0055] It can easily be seen that the inductive energy transfer from induction device 18 to oscillating circuit 20b is only possible in the position shown in fig. 5 with a variation of an angle of about $\pm 5^\circ$. As this is foreseeably only a very short time when drum 39 is in rotation, which would result in the effect of the UV light radiation being

very small or even too small, some kind of energy storage in the insert 20 is preferred. This is shown in protrusion 40a, where an oscillating circuit 22a is connected to a capacitor 23a as an energy storage means, which again is powering UV lamp 25a. Capacitor 23a can easily be charged in a very short span of time by oscillating circuit 22a. This may not be of use during a step of spinning drum 39 to dry any laundry 41 placed therein with high speed. However, this is not a preferred time for UV light radiation anyway.

[0056] As a further alternative embodiment, not only one induction device 18 may be provided on the outside of receptacle housing 36, but several, for example two to four. This could provide for a much higher and accordingly much more efficient inductive energy transfer into the drum 39 to the UV lamps 25.

[0057] The UV lamp 25c of protrusion 40c is provided with a device only shown in dotted lines, which means that it can be any device as described before. UV lamp 25d of protrusion 40d is without any such additional device, which means that it is a type of UV lamp which can either be excited by microwaves as in fig. 3 or includes a ferrite rod or the like as in fig. 2.

[0058] In the case of UV lamp 25a, it is possible to radiate UV light into drum 39 on fluid 12 and/or onto laundry 41 inside during a rinsing or a washing step. In this way, not only a disinfection of the fluid 12 is possible, but also a UV light treatment of the laundry 41 itself. This may also serve for disinfection purposes or any purpose.

[0059] A major advantage of providing UV lamps in the protrusions 40 of drum 39 in washing machine 33 is that the angle of radiation is very wide, resulting in the radiation not only reaching the fluid 12, but also the laundry 41 inside drum 39 to a high degree.

[0060] As a further alternative, a special tank 37' might be provided in drawer 37, which special tank 37' includes washing active substances 43. The washing active substances 43 may be dosed into drum 39 via a dosing apparatus not shown here, so that the washing active substances 43 may enter drum 39 via the fluid inlet 38. They can also be flushed into drum 39 by additional fluid or fresh water entering drawer 37, respectively. These washing active substances 43 may be such that they can be activated by UV light, for example of UV lamps 25. The washing active substances 43 can have a positive effect onto the cleaning or washing, respectively, of the laundry 41. Such washing active substances 43 are known in the art, for example by encapsulating any active ingredients. In the washing active substances 43, also special enzymes can be activated, for example by breaking any encapsulation around them open with the UV radiation.

[0061] Another option of UV light radiation in drum 39 onto laundry 41 may be a cleaning effect. It is commonly known that UV light helps to remove stains, especially of organic substances as in vegetables and fruit.

[0062] The washing machine 33 is also a preferred application of the special way of energy supply according

to fig. 4. In this way, the drive motor of the drum can be controlled as well as the UV light radiation with only one controller.

[0063] One preferred wavelength for UV light is between 400 nm and 410 nm, whereas also smaller wavelengths of between 250 nm and 300 nm can be used.

[0064] Another field of application for the invention is a pump 46 as shown in fig. 6. Pump 46 is an impeller pump and has a pump housing 47 with an inlet 48 and an outlet 49. Inside pump chamber 50 an impeller 52 is provided for rotation, which is driven by motor 54. This results in the pump chamber 50 being in ring-like form or having an annular form, respectively. Such an impeller pump is for example known from WO 2014/198427 A1.

[0065] Inside pump chamber 50, a ring-like UV lamp 25 is provided. It needs not form a completely closed ring, but can be at least a part of a ring. On the outside of pump chamber 50, an induction device 18 is provided, which should run parallel to UV lamp 25 or, respectively, extend as far as UV lamp 25. Such an induction device 18 is regarded as preferable for an energy transfer inside pump chamber 50 to UV lamp 25 when compared to a microwave device as described with regard to fig. 3.

[0066] If the outside wall of pump chamber 50 should be made of metal due to heating elements being provided on its outside, for example thick film heating elements, as is described in WO 2014/198427 A1 mentioned before, it is also possible to provide the induction device 18 radially inside of UV lamp 25, for example between motor 54 and the inner wall of pump chamber 50. In this case, if these wall parts are made from suitable synthetic material, UV lamp 25 and an energy supply can also be adapted to use microwaves for an energy transfer.

[0067] During operation of the pump 46, disinfection of fluid pumped through it is advantageously possible. This would then correspond to fluid flowing through the fluid pipe 11 of figs. 1 to 3. In a pump it is very rare that a substantial amount of fluid is stored or stays in the pump chamber permanently. However, the UV light can serve in any case to disinfect even wet areas or also dry areas in a pump chamber, as it can be used in all the above mentioned cases for various purposes where UV light can be advantageous.

Claims

1. Device for irradiation with UV light having:

- a fluid passage for receiving fluid and/or flowing through of fluid,
- at least one UV light source which is arranged within the fluid passage,
- an energy source for the at least one UV light source, the energy source being arranged completely outside the fluid passage,
- energy transfer means for the wireless and contactless transmission of energy from the en-

ergy source to the at least one UV light source.

2. Device according to claim 1, wherein the fluid passage is a closed channel, preferably a pipe, in particular a round tube.
3. Device according to claim 1 or 2, wherein the energy transfer means comprise a microwave device outside of the fluid passage with at least one microwave generator and at least one microwave antenna, preferably being mounted externally on an outside wall of the fluid passage, the UV light source being an electrodeless microwave lamp, wherein in particular the frequency of the microwave generator lies in the ISM band, preferably greater than 2 GHz.
4. Device according to claim 3, wherein the microwave generator has a voltage-controlled oscillator, preferably with an amplifier chain for providing the output power, wherein in particular an operating frequency corresponding to a plasma impedance in the UV light source is controlled and/or a reflection measurement of the microwaves is provided as a control variable for an analog locked loop in the microwave generator.
5. Device according to claim 1 or 2, wherein the energy transfer means comprise an induction device outside of the fluid passage with at least one induction generator and with at least one external induction coil, preferably being mounted externally on an outside wall of the fluid passage, the UV light source being an inductively coupled induction lamp, wherein in particular the inductively coupled induction lamp is excited from the outside and is designed for an inductively coupled ring discharge.
6. Device according to claim 5, wherein the inductively coupled induction lamp is excited in or from the inside and has an integrated coupler, preferably a ferrite coupler, the integrated coupler running at least partly within the induction lamp or being surrounded by the induction lamp, in particular 40% to 70%.
7. Device according to claim 5, wherein the energy transfer means comprise an induction device with at least one induction generator, with an external oscillating circuit having the external inductor coil, preferably mounted externally on an external side of the fluid passage, and with an internal oscillating circuit having an internal inductor coil, wherein an inductive coupling with an energy transfer between the external oscillating circuit and the internal oscillating circuit during operation is provided.
8. Device according to one of claims 5 to 7, wherein the device comprises an inductively heatable heating element within the fluid passage for inductive

coupling with the external induction coil arranged externally outside the fluid passage or the external oscillating circuit for inductive energy transmission, respectively, wherein preferably the inductively heatable heating element consists of magnetizable material.

9. Washing machine with a device according to one of the preceding claims, wherein the fluid passage is a receptacle housing for a drum of the washing machine, the drum rotating in the receptacle housing and the receptacle housing being not rotatable, at least a part of the energy transfer means being arranged on the outside of the receiving housing, and the at least one UV light source being arranged in the receptacle housing. 5
10. Washing machine according to claim 9, wherein the UV light source is arranged inside the drum, preferably within a protrusion on the inner wall of the drum, in particular two to four protrusions being provided on the inner wall of the drum, wherein in each of the protrusions a UV light source is arranged with radiation direction into the interior of the drum and/or with radiation direction into the interior of the protrusion. 10 20 25
11. Washing machine according to claim 9 or 10, wherein the UV light source is connected to an energy storage means and the device has an induction device according to Claim 7, the energy storage means being connected to the internal oscillating circuit for charging, the energy storage means in particular being a capacitor and the UV light source being a UV LED. 30 35
12. Pump having a device according to one of the claims 1 to 8, wherein the fluid passage is a pump chamber, the pump preferably being a heated pump installed in a domestic appliance, in particular being an impeller pump having an annular pump chamber, the UV light source being arranged within the pump chamber. 40
13. Method for irradiation with UV light by operating a device according to one of the claims 1 to 8, wherein the at least one UV light source within the fluid passage is supplied with energy in wireless and contactless manner from outside the fluid passage and emits UV light in operation, the fluid in particular flowing through the fluid passage. 45 50
14. Method according to claim 13, wherein one single energy source is provided both for the UV light source and for a drive motor of a household appliance in which the fluid passage is installed, wherein preferably a sinusoidal envelope curve is generated in a drive voltage for the drive motor, preferably at a

frequency between 5 Hz and 450 Hz, wherein individual voltage pulses are generated within the sinusoidal envelope curve with a frequency between 6 kHz and 30 kHz, wherein the voltage pulses are generated within the sinusoidal envelope curve with a frequency between 10 kHz and 20 kHz.

15. Method according to claim 13 or 14 for the operation of a washing machine according to one of claims 9 to 11, wherein, in a preceding step, washing-active substances are introduced into the drum or into the receptacle housing during the operation of the washing machine, the washing-active substances being designed in such a way that they can be activated by irradiation with UV light, the washing-active substances being activated in a subsequent step by irradiation with UV light from the UV light source, wherein in particular the steps of introducing the washing-active substances and activating the washing-active substances are carried out several times during one washing process with the washing machine.

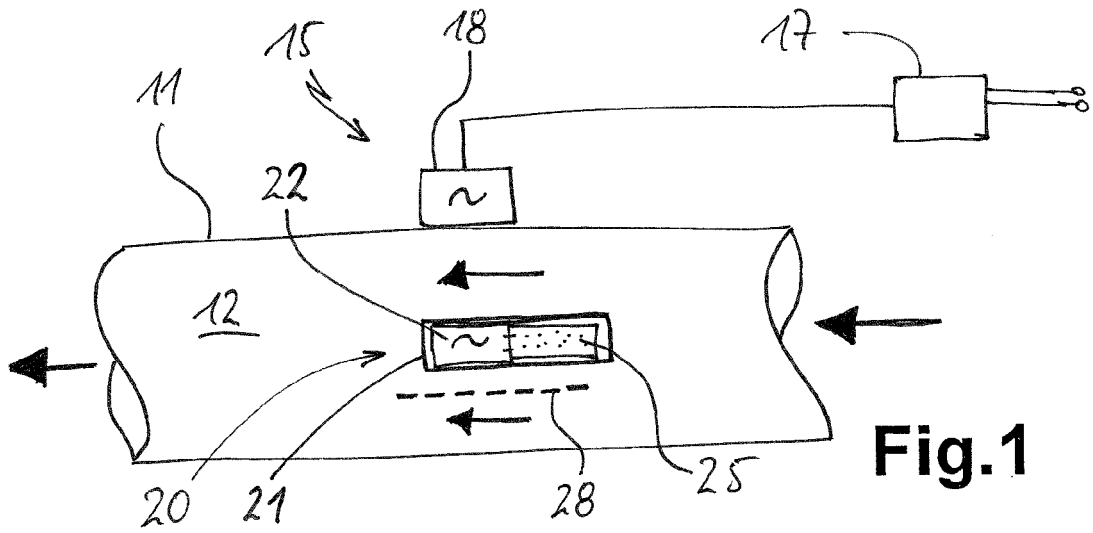


Fig.1

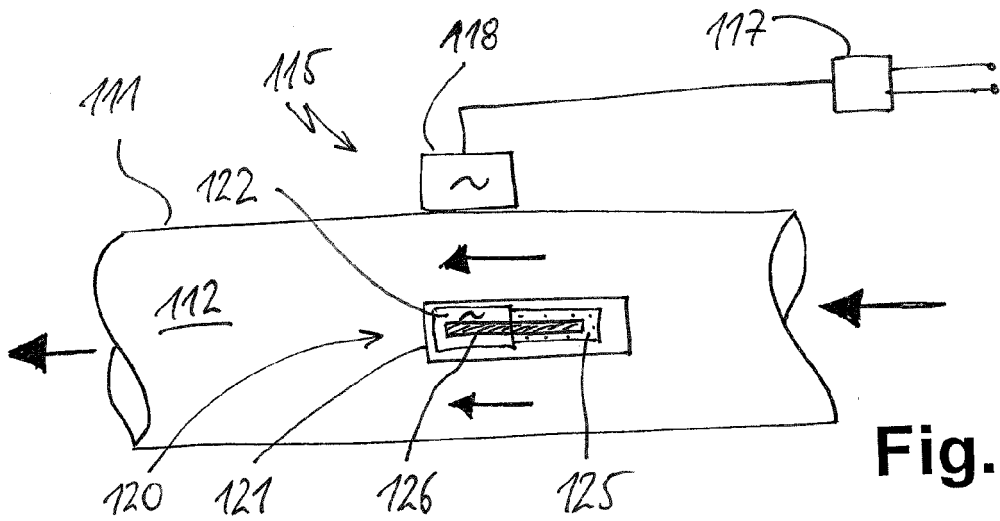


Fig.2

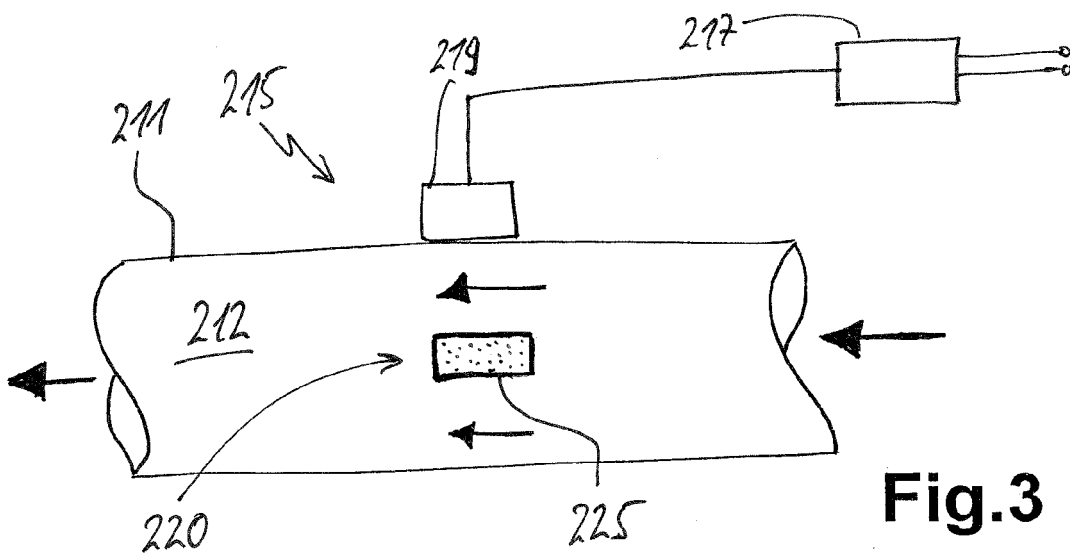


Fig.3

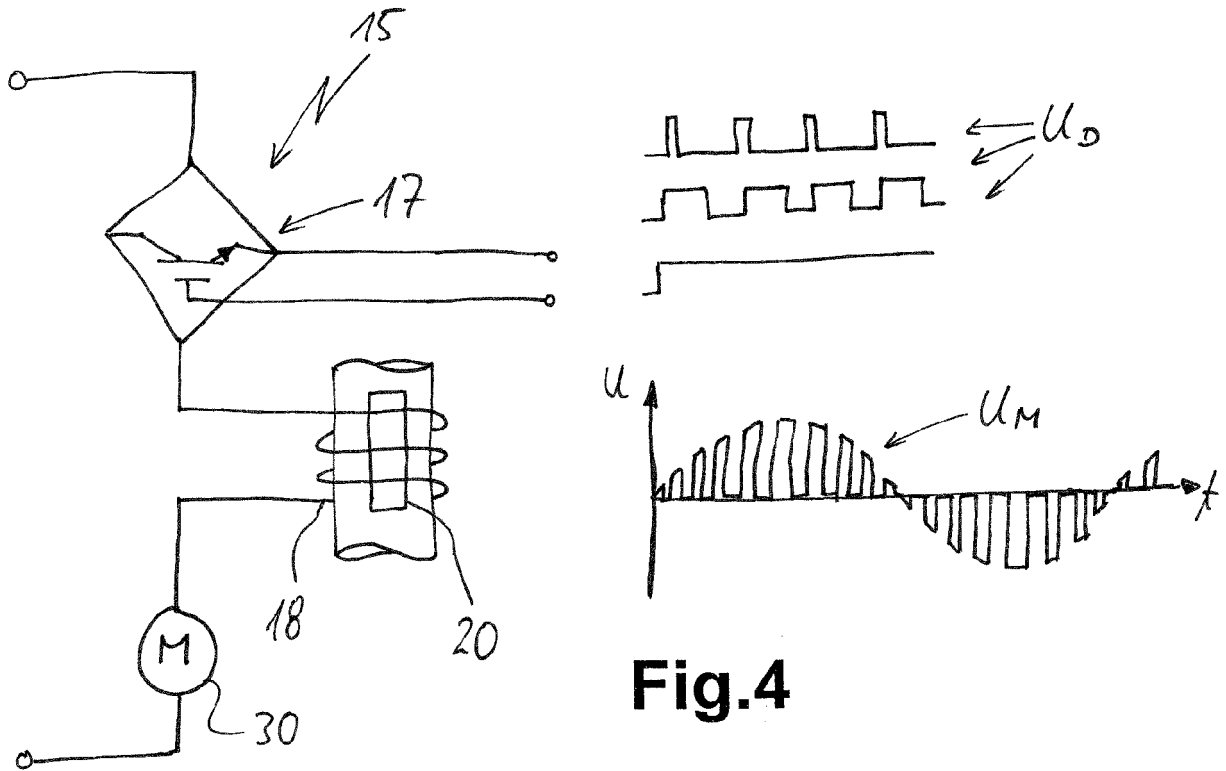


Fig.4

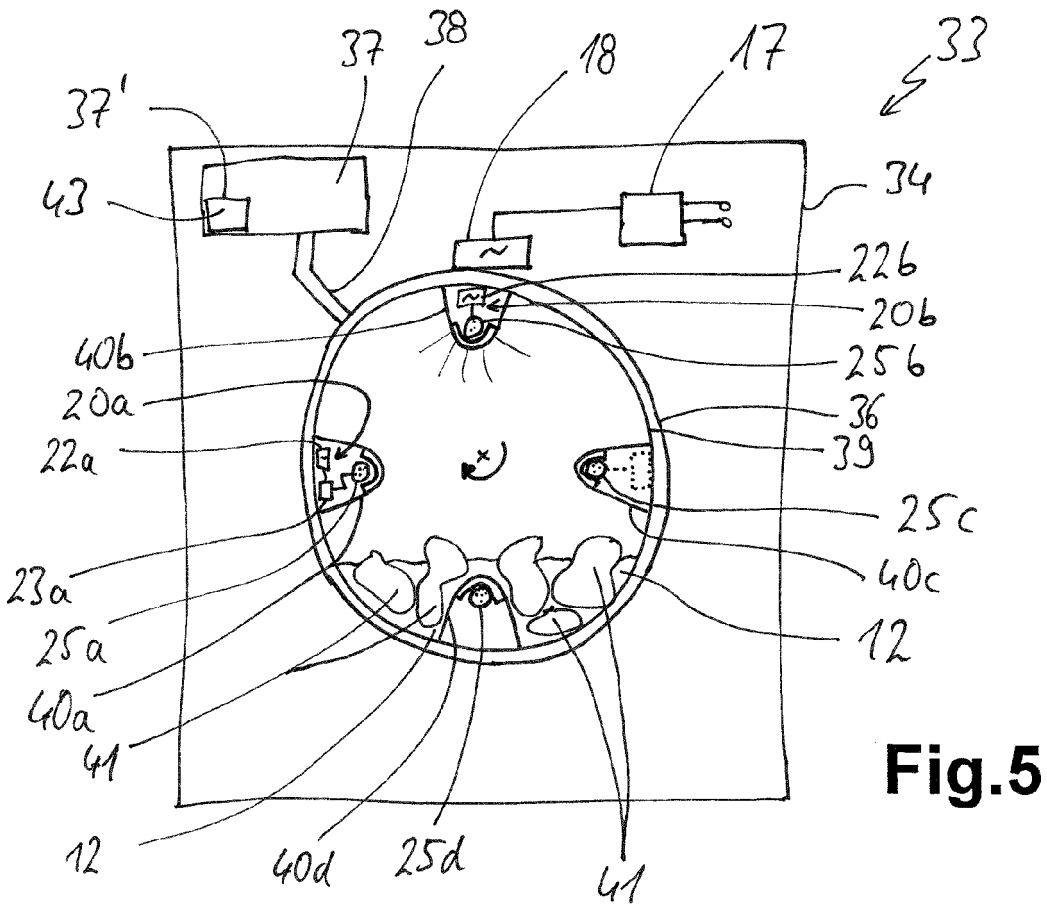


Fig.5

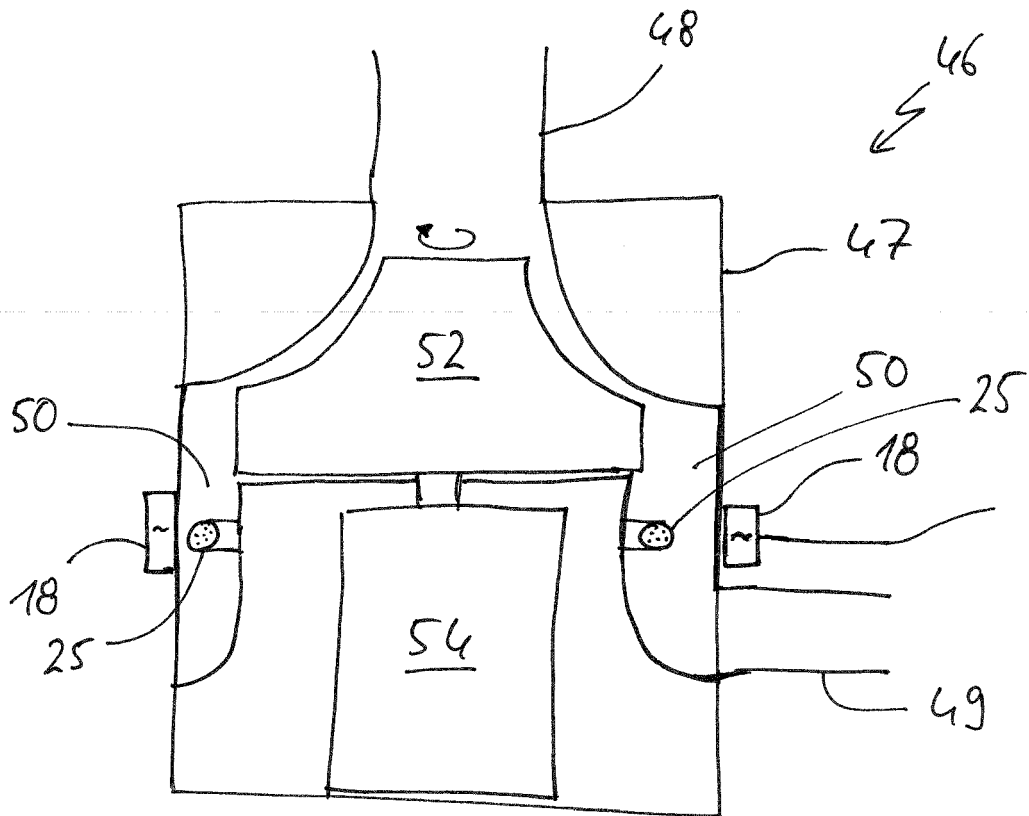


Fig.6



EUROPEAN SEARCH REPORT

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