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NL Octrooicentrum

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**Hendrik Jannes Cappon te Kapelle.
Karel Jacob Keesman te Bennekom.
Mateo Jozef Jacques Mayer te Amersfoort.**45 Octrooischrift uitgegeven:
27.03.201374 Gemachtigde:
Ir. A.A.G. Land c.s. te DEN HAAG.54 **Device and method for a UV disinfection reactor.**

57 The present invention relates to a device and method for disinfection of a liquid by UV radiation comprising at least one first cylindrical or rectangular fluid channel with a fluid inlet and a fluid outlet that is equipped with at least one UV radiation source, at least a second and preferably also a third fluid side channel both connected to the first cylindrical or rectangular fluid channel, acoustic wave generating means that are connected to the second and optionally to the third fluid side channels respectively and that are capable to produce wave interference in at least the first cylindrical or rectangular fluid channel, control means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines are formed in the first cylindrical or rectangular fluid channel whereby a significant angle of at least 5 degrees exists between at least two node lines and the axial direction of the first cylindrical or rectangular fluid channel. With the device and method according to the present invention, it is possible to capture particles, such as micro-organisms, in the node lines or node regions thereby increasing the residence time of these particles in the UV disinfection reactor. The result is a considerably higher disinfection efficiency of the UV reactor. Additionally, the acoustic vibrations in the reactor prevent reactor fouling and fouling of the UV radiation source.

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Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

Device and method for a UV disinfection reactor

The present invention relates to a device and method for disinfection of a liquid by UV radiation comprising at least one first cylindrical or rectangular fluid channel with a fluid inlet and a fluid outlet that is equipped with at least one UV radiation source, at least a second
5 and preferably also a third fluid side channel both connected to the first cylindrical or rectangular fluid channel, acoustic wave generating means that are connected to the second and optionally to the third fluid side channels respectively and that are capable to produce wave interference in at least the first cylindrical or rectangular fluid channel, control
10 means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines are formed in the first cylindrical or rectangular fluid channel whereby a significant angle of at least 5 degrees exists between at least two node lines and the axial direction of the first cylindrical or rectangular fluid channel. With the device and method according to the present invention, it is possible to capture particles, such as micro-organisms, in the node lines or node regions thereby increasing the
15 residence time of these particles in the UV disinfection reactor. The result is a considerably higher disinfection efficiency of the UV reactor. Additionally, the acoustic vibrations in the reactor prevent reactor fouling and fouling of the UV radiation source.

Introduction

20 For disinfection of drinking water and waste water, UV disinfection is a popular technique since it is non chemical and leaves no residuals. Disinfection of water by UV radiation according to prior art usually comprises application of a UV-C gas discharge lamp placed in a quartz tube that is on its turn placed in a cylinder i.e., the reactor, through which the water to be disinfected is pumped. A challenge in UV disinfection is to ensure that all micro-
25 organisms in the fluid leaving the reactor are killed by the UV radiation. Transmission of UV-C radiation to all fluid elements of water in the reactor may be hindered by the presence of particles in the water and fouling of the quartz tube. Additionally, because of the residence time distribution of the water in the reactor, it may be the case that the exposure of a significant volume fraction of water to the UV radiation is too short to ensure that all micro-
30 organisms are killed by the UVC radiation. A solution to this latter problem is to design a reactor that behaves from a residence time distribution point of view as a plug flow reactor i.e., ideally mixed in the radial direction. However, such a design requires a relatively low fluid velocity in the tube and also small fluid channels resulting in large and expensive reactors. For tubular reactors with larger diameters, usually baffles are placed to create
35 turbulence. However, this will increase the resistance and thus increase the pumping costs. The technology according to the present invention comprises a device and method for a UV disinfection reactor that is significantly smaller than prior art UV reactors and yet very

efficient.

Description of the technology according to the present invention

According to a first aspect, the present invention relates to at least one first cylindrical or
5 rectangular fluid channel equipped with a fluid inlet and a fluid outlet and at least one UV
radiation source. This first cylindrical or rectangular fluid channel is preferably equipped with
at least an inlet and an outlet to enable a continuous fluid flow through the channel.

According to a second aspect, the present invention relates to at least a second and
preferable also a third fluid side channel, both connected to the first cylindrical or rectangular
10 fluid channel. Preferably, at least one fluid side channel is connected to acoustic wave
generating means. More preferably two fluid side channels are connected to acoustic wave
generating means. Most preferably more than two fluid side channels are connected to
acoustic wave generating means.

According to a third aspect, the present invention relates to control means for controlling the
15 acoustic wave generating means of at least a second cylindrical fluid side channel.

Preferably more than one cylindrical fluid side channels are equipped with controlling means
for controlling the acoustic wave generating means. Most preferably, the controlling means
for controlling the acoustic wave generating means are controlled by the use of at least a
microprocessor and software.

According to a fourth aspect, the present invention relates to at least one sensor for sensing
20 properties of the fluid present in the first cylindrical or rectangular fluid channel. Preferably
the sensing principle of at least one sensor for sensing the fluid properties in the first
cylindrical or rectangular channel is based upon at least one of the following sensing
techniques: acoustic measurements, light scattering measurements, light reflection
25 measurements, conductivity measurements, pH measurements, temperature
measurements, impedance measurements, dielectric measurements. In case temperature
measurements are applied, these measurements preferably comprise temperature
measurements using infrared technology and / or PTCs and / or NTCs and / or Pt100
sensing elements preferably placed in the fluid of the first cylindrical or rectangular fluid
30 channel and / or connected to the inner wall and / or outer wall of the first cylindrical or
rectangular fluid channel.

The signal(s) produced by the sensor(s) for sensing the fluid properties are preferably fed to
a microprocessor, preferably to a microcontroller, preferably by the use of an analog to
digital converter.

35 According to a fifth aspect, the present invention relates to software for controlling the
acoustic wave generating means. Preferably the software contains a feed back loop from
the sensor to the acoustic wave generating means.

According to a sixth aspect, the present invention relates to software for controlling the acoustic wave generating means in such a manner that wave interference occurs so that node lines are produced in the first cylindrical or rectangular fluid channel. In these node lines particles will collect resulting in a fluid filter and / or a particle concentration device.

- 5 Preferably, a significant angle of at least 5 degrees exists between at least two node lines and the axial direction of the first cylindrical or rectangular fluid channel respectively.

Figure 1 gives a schematic overview of the technology according to the present invention. It is noted that figure 1 is one of the many possible embodiments of the technology according to the present invention and the present invention is by no means limited to figure 1.

- 10 The arrows 1 and 2 in figure 1 show the flow direction of the fluid. C1 relates to the first cylindrical or rectangular fluid channel. It is noted that the cylindrical or rectangular shape of the first fluid channel is a preferred embodiment. It is stressed that a large number of other geometrical shapes of the first fluid channel are technically feasible and part of the technology according to the present invention. Fluid channels C2 and C3 relate to the
- 15 second and third fluid side channel respectively. A1 and A2 relate to the first and second acoustic sound generating means respectively. The angle β relates to the angle between the first cylindrical or rectangular fluid side channel and the second fluid side channel. According to the present invention, this angle is at least 5 degrees. It is noted that the angles between the different fluid side channels and the first cylindrical or rectangular fluid
- 20 channel may be different. It is also noted that the location at which each fluid side channel is connected to the first cylindrical or rectangular fluid channel is a design parameter. Further, it is noted that other shapes of the fluid side channels than cylindrical or rectangular are possible. Finally, it is noted that the UV radiation source may consist of a gas discharge tube placed in a quartz tube that is placed on its turn inside of the first cylindrical or
- 25 rectangular fluid channel. Also other UV radiation sources e.g., UV LEDs, can be applied. Now the basics aspects of the technology according to the present invention have been explained, a number of preferred embodiments will be discussed.

- A first preferred embodiment of the present invention comprises application of the technology according to the present invention as a disinfection system for fluids in general
- 30 and for drinking water in particular.

A UV reactor according to the present invention is more efficient than prior art UV disinfection systems for the following reasons:

1. The residence time of particles i.e., micro-organisms, in the reactor is much longer than the residence time of the water to be purified. As a results of decoupling the
- 35 residence time distribution of the water and the micro-organisms, a design parameter is obtained to achieve disinfection in a UV reactor with much smaller dimensions than prior art reactors.

2. Because of the acoustic vibrations in the reactor, fouling of the UV radiation source (such as the quartz tube in which the UV-C lamp is placed) and of the reactor are prevented completely, thereby increasing the effective amount of UV-C radiation transported from the UV-C source into the water.

5 The UVC reactor can be designed such that the residence time of micro-organisms, such as bacteria, in the reactor is very long since the reactor behaves as a filter or particle concentrator for these micro-organisms. As a result, the micro-organisms will stay in the reactor until their structure is destroyed by the UV-C radiation.

The present invention is not limited to the above described example embodiments thereof;

10 the rights sought are defined by the following claims, within the scope of which many modifications can be envisaged.

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Clauses

1. Device for disinfection of a liquid by UV radiation comprising
 - at least one first fluid channel with a fluid inlet and a fluid outlet equipped with at least one UV radiation source
 - 5 • at least a second and preferably also a third fluid side channel both connected to the first cylindrical or rectangular fluid channel whereby the angle between the first fluid channel and at least one fluid side channel is more than 5 degrees.
 - acoustic wave generating means connected to the second and optionally to the third fluid side channels respectively, the acoustic wave generating means being capable to produce wave interference in at least the first fluid channel
 - 10 • control means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines or node regions are formed in the first fluid channel as a result of wave interference whereby a significant angle of at least 5 degrees exists between at least two node lines or node regions and the axial direction of the first cylindrical or rectangular fluid channel, resulting in micro-organisms being trapped in and / or near the node lines or node regions.
 - 15
- 20 2. Device according to clause 1 further comprising at least a microprocessor and software to control the acoustic wave generating means thereby steering the concentration process of the micro-organisms in the node lines or node regions.
3. Device according to clauses 1 or 2 further comprising at least one sensor for sensing the fluid properties of the first cylindrical or rectangular fluid channel and a control loop to tune the acoustic sound generating means in order to achieve a desired micro-organism concentration performance.
- 25 4. Disinfection reactor for disinfection for drinking water according to one of the previous clauses 1-3.
5. Method for disinfection of a liquid by UV radiation characterized by a device described by one of the previous clauses 1-4.
- 30

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Conclusies

1. Inrichting voor desinfectie van een vloeistof door middel van UV straling gekenmerkt door
 - tenminste een eerste vloeistofkanaal met een instroomopening voor vloeistof, een uitstroomopening voor vloeistof en tenminste een UV stralingsbron
 - tenminste een tweede vloeistof zijkanaal dat werkzaam verbonden is met het eerste cilindrisch vloeistofkanaal en waarvan de axiale as een hoek van tenminste 5 graden maakt met de axiale as van het eerste vloeistofkanaal.
 - tenminste een inrichting voor het opwekken van acoustische golven die werkzaam verbonden is met het tweede vloeistof zijkanaal en die interferentie van de acoustische golven opwekt in tenminste het eerste cilindrisch vloeistofkanaal
 - middelen om de inrichtingen voor het opwekken van acoustische golven te regelen opdat tenminste twee knooplijnen of knoopgebieden worden gevormd in het eerste cilindrische vloeistofkanaal ten gevolge van interferentie met het kenmerk dat een significante hoek van tenminste 5 graden bestaat tussen tenminste twee knooplijnen of knoopgebieden en de axiale as van het eerste cilindrische vloeistofkanaal opdat micro-organismen in en / of nabij de knooplijnen worden ingevangen.
2. Inrichting volgens conclusie 1 vermeerderd met tenminste een microprocessor en software om de inrichtingen voor het opwekken van acoustische golven te regelen en daarmee het filtratie- en / of concentratieproces van de micro-organismen te sturen.
3. Inrichting volgens een van de voorgaande conclusies 1 of 2 vermeerderd met tenminste een sensor om de eigenschappen van de vloeistof in het eerste cilindrische vloeistofkanaal te meten en een control loop om de inrichtingen voor het opwekken van acoustische golven zodanig in te stellen dat de micro-organismen met de gewenste efficiency worden ingevangen in en / of nabij de knooplijnen.
4. Inrichting voor desinfectie van drinkwater volgens een van de voorgaande conclusies 1 t/m 3.
5. Werkwijze voor desinfectie van een vloeistof door middel van UV straling gekenmerkt door een inrichting volgens een van de voorgaande conclusies 1 t/m 4.

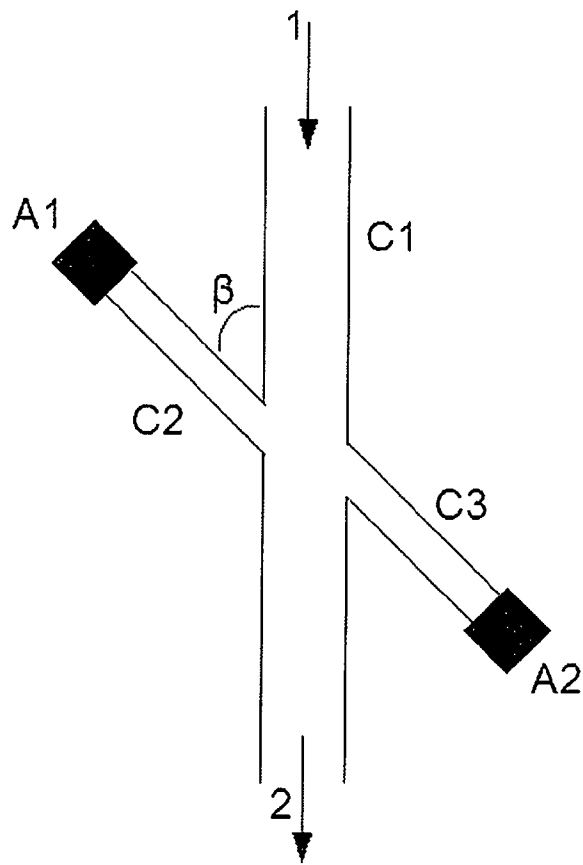


Figure 1.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
Nederlands aanvraag nr. 1039050	Indieningsdatum 19-09-2011
	Ingeroepen voorrangdatum
Aanvrager (Naam) Wetsus, centre of excellence for sustainable water technology	
Datum van het verzoek voor een onderzoek van internationaal type 24-12-2011	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN 57378
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC) C02F1/32 C02F1/36	
II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK	
Onderzochte minimumdocumentatie	
Classificatiesysteem	Classificatiesymbolen
IPC8	C02F
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen	
III. <input type="checkbox"/>	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)
IV. <input type="checkbox"/>	GEBREK AAN EENHEID VAN UITVINDING (opmerkingen op aanvullingsblad)

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 1039050

<p>A. CLASSIFICATIE VAN HET ONDERWERP INV. C02F1/32 C02F1/36 ADD.</p>		
<p>Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.</p>		
<p>B. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK</p>		
<p>Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen) C02F</p>		
<p>Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen</p>		
<p>Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden) EPO-Internal, COMPENDEX, WPI Data</p>		
<p>C. VAN BELANG GEACHTE DOCUMENTEN</p>		
<p>Categorie °</p>	<p>Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages</p>	<p>Van belang voor conclusie nr.</p>
X	<p>US 3 672 823 A (BOUCHER RAYMOND MARCEL GUT) 27 juni 1972 (1972-06-27) * figuren 1-3 * * bladzijde 1, regel 10 - regel 25 * * kolom 7, regel 73 - kolom 8, regel 20 * -----</p>	1-5
X	<p>FR 2 442 218 A1 (HYCO & AULAS ETS) 20 juni 1980 (1980-06-20) * bladzijde 1, regel 1 - regel 3 * * bladzijde 2, regel 28 - bladzijde 3, regel 7 * * bladzijde 3, regel 25 - bladzijde 4, regel 39 * * figuur 1 * ----- -/--</p>	1-5
<p><input checked="" type="checkbox"/> Verdere documenten worden vermeld in het vervolg van vak C. <input checked="" type="checkbox"/> Leden van dezelfde octroofamilie zijn vermeld in een bijlage</p>		
<p>° Speciale categorieën van aangehaalde documenten</p> <p>*A* niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft</p> <p>*D* in de octrooiaanvraag vermeld</p> <p>*E* eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven</p> <p>*L* om andere redenen vermelde literatuur</p> <p>*O* niet-schriftelijke stand van de techniek</p> <p>*P* tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur</p> <p>*T* na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding</p> <p>*X* de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur</p> <p>*Y* de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht</p> <p>*&* lid van dezelfde octroofamilie of overeenkomstige octrooipublicatie</p>		
<p>Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid</p> <p>26 april 2012</p>		<p>Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type</p>
<p>Naam en adres van de instantie</p> <p>European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016</p>		<p>De bevoegde ambtenaar</p> <p>Janssens, Christophe</p>

**ONDERZOEKSRAPPORT BETREFFENDE HET
 RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
 VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
 de stand van de techniek
NL 1039050

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN		
Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	WO 2006/080969 A1 (ASHLAND LICENSING & INTELLECTU [US]; DE MEULENAER ERIC CORDEMANS [BE];) 3 augustus 2006 (2006-08-03) * figuur 1 * -----	1-5
A	JP 63 077592 A (EBARA RES CO LTD) 7 april 1988 (1988-04-07) * samenvatting * -----	1-5

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 1039050

In het rapport genoemd octrooigescrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 3672823	A	27-06-1972	CA 930924 A1 31-07-1973 US 3672823 A 27-06-1972
FR 2442218	A1	20-06-1980	GEEN
WO 2006080969	A1	03-08-2006	CN 101061071 A 24-10-2007 EP 1828059 A1 05-09-2007 JP 2008520473 A 19-06-2008 US 2008020079 A1 24-01-2008 WO 2006080969 A1 03-08-2006
JP 63077592	A	07-04-1988	GEEN



Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

WRITTEN OPINION

File No. SN57378	Filing date (<i>day/month/year</i>) 19.09.2011	Priority date (<i>day/month/year</i>)	Application No. NL1039050
International Patent Classification (IPC) INV. C02F1/32 C02F1/36			
Applicant Wetsus, centre of excellence for sustainable water technology			

This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the application
- Box No. VIII Certain observations on the application

	Examiner Janssens, Christophe
--	----------------------------------

WRITTEN OPINION

Application number
NL1039050

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - a sequence listing
 - table(s) related to the sequence listing
 - b. format of material:
 - on paper
 - in electronic form
 - c. time of filing/furnishing:
 - contained in the application as filed.
 - filed together with the application in electronic form.
 - furnished subsequently for the purposes of search.
3. In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	2, 3
	No: Claims	1, 4, 5
Inventive step	Yes: Claims	
	No: Claims	1-5
Industrial applicability	Yes: Claims	1-5
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 US 3 672 823 A (BOUCHER RAYMOND MARCEL GUT) 27 juni 1972
(1972-06-27)

D2 FR 2 442 218 A1 (HYCO & AULAS ETS) 20 juni 1980 (1980-06-20)

2 The present application does not meet the criteria of patentability, because the subject-matter of claims 1 and 5 is not new.

2.1 The document D1 discloses (the references below applying to this document):

A device (see in particular fig. 1) for the disinfection of a liquid by UV radiation comprising:

a) a first fluid channel (30) with a fluid inlet (32) and a fluid outlet (not shown in the picture) equipped with a UV radiation source (31);

b) a second fluid channel (35) connected to the first channel (30) whereby the angle between the first (30) and the second channel (35) is more than 5 degrees (see figure);

c) acoustic wave generating means (29) connected to the second channel (35) and capable of producing wave interference in the first fluid channel; and

d) control means (indeed: col.7, l.72- col.8, l.20, mentions explicitly that the light intensity and the acoustic energy level and frequency should be kept within a certain range. This can only be achieved if there is a certain control mechanism present, if not operating permanent, than at least operating at the starting (or re-starting) of the treatment).

2.2 The document D1 discloses further:

A method for disinfection of a liquid by UV radiation by this device (see col.1, l. 10-25).

2.3 A similar device and method is disclosed by the document D2 (see D2, fig. 1, and p.2, l. 28- p.4, l.39).

2.4 The subject-matter of the claims 1 and 5 is therefore not new in view of D1 and in view of D2.

3 Dependent claims 2-4 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/ or inventive step. The documents D1 and D2 do not disclose a microprocessor and software as controller, because they have been published at a moment that computers were not commonly used. It is common practice in the field of water treatment to replace manual and mechanical control mechanisms by computer regulated mechanisms. A person skilled in the art would not need to apply its inventive skill to come to the solution offered by the claims 2 and 3. Claim 4 does not add any feature to the device specified by one of the previous claims on which it depends.