



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>(51) International Patent Classification <sup>6</sup> :</b><br><br><b>C02F 1/74, 3/02</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 99/52829</b><br><br><b>(43) International Publication Date:</b> 21 October 1999 (21.10.99)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><b>(21) International Application Number:</b> PCT/DK99/00186</p> <p><b>(22) International Filing Date:</b> 30 March 1999 (30.03.99)</p> <p><b>(30) Priority Data:</b><br/>0459/98 1 April 1998 (01.04.98) DK</p> <p><b>(71) Applicant (for all designated States except US):</b> UNICON<br/>BETON HOLDING A/S [DK/DK]; Køgevej 172, DK-4000<br/>Roskilde (DK).</p> <p><b>(72) Inventor; and</b><br/><b>(75) Inventor/Applicant (for US only):</b> LEBECH, Finn [DK/DK];<br/>Køgevej 172, DK-4000 Roskilde (DK).</p> <p><b>(74) Agent:</b> HOFMAN-BANG &amp; BOUTARD, LEHMANN &amp; REE<br/>A/S; Hans Bekkevolds Allé 7, DK-2900 Hellerup (DK).</p> |           | <p><b>(81) Designated States:</b> AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b><br/><i>With international search report.</i><br/><i>In English translation (filed in Danish).</i></p> |
| <p><b>(54) Title:</b> A METHOD AND A DEVICE FOR THE TREATMENT OF WATER</p> <div> </div> <p><b>(57) Abstract</b></p> <p>The invention relates to treatment of water, comprising initiating formation of drops from an introduced amount of water and division of the formed drops to form microdrops preferably by division at least 50–60 times. The invention also relates to an apparatus for performing the invention.</p>                                                                                                                                                                                          |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |                                          |    |                                              |    |                          |
|----|--------------------------|----|------------------------------------------|----|----------------------------------------------|----|--------------------------|
| AL | Albania                  | ES | Spain                                    | LS | Lesotho                                      | SI | Slovenia                 |
| AM | Armenia                  | FI | Finland                                  | LT | Lithuania                                    | SK | Slovakia                 |
| AT | Austria                  | FR | France                                   | LU | Luxembourg                                   | SN | Senegal                  |
| AU | Australia                | GA | Gabon                                    | LV | Latvia                                       | SZ | Swaziland                |
| AZ | Azerbaijan               | GB | United Kingdom                           | MC | Monaco                                       | TD | Chad                     |
| BA | Bosnia and Herzegovina   | GE | Georgia                                  | MD | Republic of Moldova                          | TG | Togo                     |
| BB | Barbados                 | GH | Ghana                                    | MG | Madagascar                                   | TJ | Tajikistan               |
| BE | Belgium                  | GN | Guinea                                   | MK | The former Yugoslav<br>Republic of Macedonia | TM | Turkmenistan             |
| BF | Burkina Faso             | GR | Greece                                   |    |                                              | TR | Turkey                   |
| BG | Bulgaria                 | HU | Hungary                                  | ML | Mali                                         | TT | Trinidad and Tobago      |
| BJ | Benin                    | IE | Ireland                                  | MN | Mongolia                                     | UA | Ukraine                  |
| BR | Brazil                   | IL | Israel                                   | MR | Mauritania                                   | UG | Uganda                   |
| BY | Belarus                  | IS | Iceland                                  | MW | Malawi                                       | US | United States of America |
| CA | Canada                   | IT | Italy                                    | MX | Mexico                                       | UZ | Uzbekistan               |
| CF | Central African Republic | JP | Japan                                    | NE | Niger                                        | VN | Viet Nam                 |
| CG | Congo                    | KE | Kenya                                    | NL | Netherlands                                  | YU | Yugoslavia               |
| CH | Switzerland              | KG | Kyrgyzstan                               | NO | Norway                                       | ZW | Zimbabwe                 |
| CI | Côte d'Ivoire            | KP | Democratic People's<br>Republic of Korea | NZ | New Zealand                                  |    |                          |
| CM | Cameroon                 |    |                                          | PL | Poland                                       |    |                          |
| CN | China                    | KR | Republic of Korea                        | PT | Portugal                                     |    |                          |
| CU | Cuba                     | KZ | Kazakstan                                | RO | Romania                                      |    |                          |
| CZ | Czech Republic           | LC | Saint Lucia                              | RU | Russian Federation                           |    |                          |
| DE | Germany                  | LI | Liechtenstein                            | SD | Sudan                                        |    |                          |
| DK | Denmark                  | LK | Sri Lanka                                | SE | Sweden                                       |    |                          |
| EE | Estonia                  | LR | Liberia                                  | SG | Singapore                                    |    |                          |

## A method and a device for the treatment of water

In connection with the treatment of water, the crude water is aerated according to the prior art to add to the water a greater content of oxygen which contributes to the conversion of iron and manganese bicarbonate into sparingly soluble compounds, ferrous hydroxide and pyrolusite and causes separation of CO<sub>2</sub>, hydrogen sulphide and methane. According to the prior art, the aeration takes place e.g. in that the water is introduced over a perforated tray and drops freely from there as drops toward a basin, or in that the water flows down over oxidation steps.

These known methods have some effect on the water in respect of achieving the intended result, as described above. However, in many cases this treatment is not sufficient. In many cases the insufficiency is caused by an ever poorer crude water quality with a larger content of harmful substances, which must be removed, e.g. by aeration.

Accordingly, the object of the present invention is to provide a method by means of which crude water may be treated to achieve a satisfactory water quality with respect to content of components which can be removed or at least reduced by aeration.

According to the invention, such a method comprises an initiating formation of drops from an introduced water amount and division of the formed drops by mechanical action to form microdrops.

Such a formation of microdrops results in a considerably larger surface of the drops relative to the volume of the drops, and improved oxidation can thus take place. The

mechanical action ensures that the intended division takes place. It has been found that a division of 50-60 times or optionally more causes formation of drops of a size which is sufficiently small for a satisfactory oxidation to take place, and thereby for a satisfactory water quality to be obtained.

According to an expedient embodiment, a microorganism culture may additionally be added to the water prior to the initiating drop formation. Hereby, components of the crude water which are not converted by the oxidation alone, may moreover be removed or reduced by the metabolism of the microorganisms. In this connection, the concrete microorganism culture may be selected depending on the crude water content of components whose amount is to be reduced.

Particularly expediently, the formed microdrops are introduced into a sedimentation container after completed oxidation. After settling in such a container the water may be conveyed to the user.

The invention also relates to an apparatus for performing the method described in the foregoing.

Such an apparatus comprises means for forming drops at the initiation of the process, and, in the direction of the gravitational force below these means, additional means for causing division of the drops by contact with these.

In an advantageous embodiment, the means for the initiating drop formation comprise a plate with holes, the drops being formed by the flow of the water through these holes.

The means for causing division of the drops preferably comprise wire-shaped elements mutually spaced in the direction of the gravitational force. The wire-shaped elements are hereby advantageously arranged in a mutually intersecting pattern. Such a structure involves a good certainty of drop division, and it has moreover been found by tests that good environmental conditions are hereby formed for an optionally added microorganism culture. At least 50-60 layers of the mutually spaced wire-shaped elements are preferably arranged in the direction of the gravitational force to obtain an expedient fine division of the drops, as described above. Preferably, however, more of these layers are arranged so that also the drops which statistically drop through a layer in a gap between two wire-shaped elements, will obtain a division of 50-60 times. Thus, 70-80 layers of wire-shaped elements are expediently arranged. In this connection, the mutual spacing between parallel or substantially parallel wire-shaped elements in the same layer is expediently between 5 and 15 mm, preferably about 10 mm. The spacing between the wires in the same layer will affect the statistical fall of drops, which are thus not divided as there is no contact. A too small spacing between the wires may cause gathering of already divided drops.

The mutual spacing between the layers of wire-shaped elements is preferably 30-60 mm, and more preferably 40-50 mm. This ensures that sufficient kinetic energy is added to the drops for rotation to take place, while ensuring that a complete system still has a limited height.

It has been found expedient to build such a system of tubular elements with an interlaced structure. In this connection, a row of such pipes are placed side by side to form a pipe layer. A plurality of such pipe layers are stacked to form a pipe column. Each pipe layer thus forms

two layers of wire-shaped elements mutually spaced, except in the pipe areas adjoining each other in the same layer. In this connection, the pipe layers are expediently arranged with the pipe axes rotated 90 degrees  
5 relative to overlying and underlying pipe layers. This has been found to give a particularly good result, and at the same time an increased mechanical stability is achieved.

10 Preferably, means are arranged in the apparatus for collecting the microdrops below the means for dividing the drops. The drops or the caught drops, which form an amount of water, are expediently introduced into a settling container, which forms part of the apparatus in  
15 this connection.

The invention will be explained more fully below with reference to the drawing, in which a preferred embodiment of the invention is shown schematically, and in which

20

fig. 1 shows an apparatus, seen from the side,

fig. 2 shows an apparatus, seen from above, and

25 fig. 3 shows a pipe element associated with the apparatus shown in figs. 1 and 2, and

fig. 4 shows four interconnected pipe elements, as shown in fig. 3 and seen from the end.

30

Fig. 1 illustrates a system which uses apparatuses according to the invention for performing the method according to the invention. Such a system comprises a pipe connection 1 from a bore well and a pump 2 for pumping  
35 the water from the bore well. The crude water is conveyed via the pipe 1 to a distribution system consisting of a

plate 3 with holes 4. This plate 3 with holes 4 serves to initiate formation of drops. Relatively large drops are involved in this connection. The drops leaving the plate 3 through the holes 4 in it then fall down under the action of gravity and hereby contact rows of wire-shaped elements, which, in the example shown, are formed by tubular elements 5, 6 arranged side by side with horizontal pipe axes to form pipe layers, a plurality of such pipe layers being arranged on top of each other. The pipe layers are arranged such that every second pipe layer 6 is rotated 90°. In the structure shown, 15 pipe layers are provided. In this constellation, in the event that a large content of components is to be reduced, it will be necessary to recirculate the water to achieve sufficient oxidation. As also mentioned in the preamble to the description, 30-40 pipe layers will expediently be provided. The pipe layers are arranged in a housing 7 which is open at the top and at the bottom. When the water drops leave the lowermost pipe layer at the lower end of the housing 7, the water is collected in a collection basin or a settling container 8, in which solids, if any, can precipitate, and from which the cleaned water may be discharged and transported to the place of use.

Fig. 2 shows the plate 3 more clearly seen from above. In this connection, the holes 4 have a diameter of about 1-2 mm. This diameter may be selected depending on the surface tension of the water, the water pressure, etc.

Fig. 3 shows a pipe element which is used for the construction of the pipe layers in the housing. The pipe layers are composed of wire-shaped elements 9 which are arranged in intersecting manner in the pipe wall. By their mutually intersecting pattern, the wire-shaped elements 9 form rhomboid holes in the pipe wall. Fig. 4

shows four such pipe elements in an interconnected state.  
It appears that circular pipe elements 5 are involved.

P a t e n t   C l a i m s :  
-----

1. A method for the treatment of water, comprising:  
5 initiating formation of drops from an introduced amount of water;  
  
division of the formed drops by mechanical action to form  
10 microdrops.
2. A method according to claim 1, c h a r a c t e r -  
i z e d in that the drops formed by the initiating drop  
formation are divided at least 50-60 times.  
15
3. A method according to claim 1 or 2, c h a r a c -  
t e r i z e d in that a microorganism culture is added  
to the water prior to the initiating drop formation.
- 20 4. A method according to claim 1, 2 or 3, c h a r a c -  
t e r i z e d in that the formed microdrops are intro-  
duced into a sedimentation container.
5. An apparatus for performing the method according to  
25 any one of claims 1-4, c h a r a c t e r i z e d by com-  
prising:  
  
means for forming drops at the initiation of the process,  
and  
30 in the direction of the gravitational force below these  
means, means for causing division of the drops by contact  
with these.
- 35 6. An apparatus according to claim 5, c h a r a c -

t e r i z e d in that the means for the initiating drop formation comprise a plate with holes, the drops being formed by the flow of the water through these holes.

- 5 7. An apparatus according to claim 5 or 6, c h a r a c -  
t e r i z e d in that the means for causing division of  
the drops comprise wire-shaped elements mutually spaced  
in the direction of the gravitational force.
- 10 8. An apparatus according to claim 7, c h a r a c -  
t e r i z e d by comprising wire-shaped elements ar-  
ranged in a mutually intersecting pattern.
- 15 9. An apparatus according to claims 5-8, c h a r a c -  
t e r i z e d in that at least 50-60 layers of mutually  
spaced wire-shaped elements are arranged in the direction  
of gravitational force.
- 20 10. An apparatus according to claim 9, c h a r a c -  
t e r i z e d in that the mutual spacing between the  
layers of wire-shaped elements is 30-60 mm, preferably  
40-50 mm.
- 25 11. An apparatus according to claims 5-10, c h a r a c -  
t e r i z e d in that means are provided for collecting  
the microdrops below the means for dividing the drops.
12. An apparatus according to claims 5-11, c h a r a c -  
t e r i z e d by comprising a settling container.

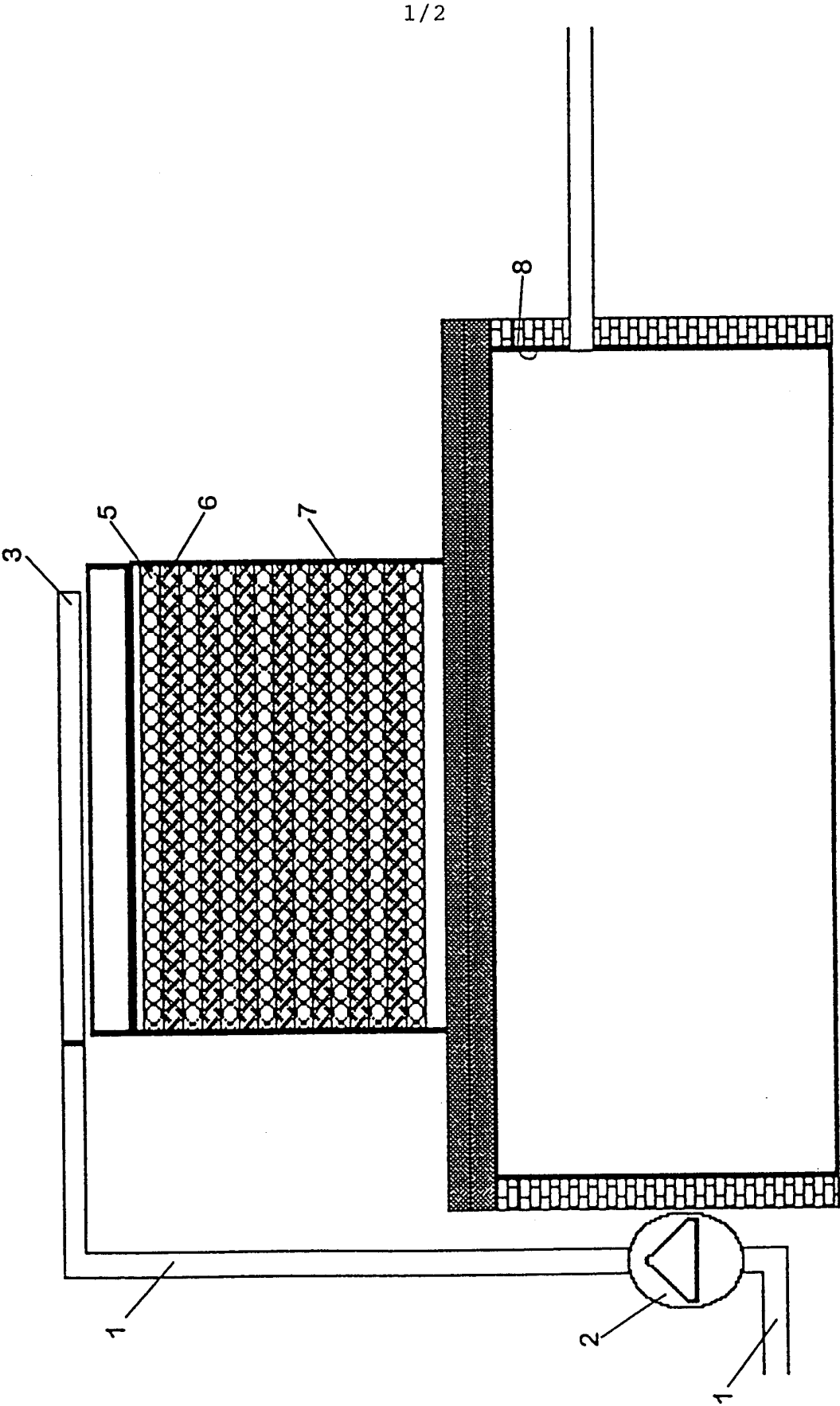


FIG. 1

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 99/00186

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C02F 1/74, C02F 3/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01F, C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                         | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | DK 168684 B1 (HEDE NIELSEN A/S), 24 May 1994<br>(24.05.94), column 3, line 4 - line 8, figure 1,<br>claims 1,5<br>--       | 1,5-8                 |
| Y         | US 4562015 A (MARCEL R. LEFEVRE), 31 December 1985<br>(31.12.85), column 4, line 66 - column 5, line 62,<br>figure 1<br>-- | 1,5-8                 |
| A         | DE 3818650 A1 (FOIDL, LEONHARD), 22 December 1988<br>(22.12.88), figure 1<br>--                                            | 1,5                   |

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

23 July 1999

Date of mailing of the international search report

26 -07- 1999

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Bo Bergström/MP

Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 99/00186

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                        |                       |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                     | Relevant to claim No. |
| A                                                     | <p>GB 2241697 A (D.L. HERBERTSON LIMITED),<br/>11 Sept 1991 (11.09.91), figures 3,3b,<br/>abstract</p> <p style="text-align: center;">--<br/>-----</p> | 1                     |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/99

International application No.

PCT/DK 99/00186

| Patent document<br>cited in search report |         |    | Publication<br>date | Patent family<br>member(s) |             | Publication<br>date |
|-------------------------------------------|---------|----|---------------------|----------------------------|-------------|---------------------|
| DK                                        | 168684  | B1 | 24/05/94            | CA                         | 1264735 A   | 23/01/90            |
|                                           |         |    |                     | EP                         | 0120497 A,B | 03/10/84            |
|                                           |         |    |                     | SE                         | 0120497 T3  |                     |
|                                           |         |    |                     | EP                         | 0259895 A,B | 16/03/88            |
|                                           |         |    |                     | JP                         | 59189290 A  | 26/10/84            |
|                                           |         |    |                     | US                         | 4858681 A   | 22/08/89            |
|                                           |         |    |                     | US                         | 4871014 A   | 03/10/89            |
| -----                                     |         |    |                     |                            |             |                     |
| US                                        | 4562015 | A  | 31/12/85            | NONE                       |             |                     |
| -----                                     |         |    |                     |                            |             |                     |
| DE                                        | 3818650 | A1 | 22/12/88            | AT                         | 140187 A    | 15/05/90            |
|                                           |         |    |                     | AT                         | 391753 B    | 26/11/90            |
|                                           |         |    |                     | DE                         | 8816674 U   | 08/03/90            |
| -----                                     |         |    |                     |                            |             |                     |
| GB                                        | 2241697 | A  | 11/09/91            | NONE                       |             |                     |
| -----                                     |         |    |                     |                            |             |                     |