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(71) Applicant *(for all designated States except US)*: **ENSTO ELECTRIC OY** [FI/FI]; Veckjärventie 1, FIN-06100 Porvoo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **METTIÄINEN, Kimmo** [FI/FI]; Vanhapolku 4, FIN-06100 Porvoo (FI). **TOMPERI, Jarmo** [FI/FI]; Vilppulankuja 10, FIN-04430 Järvenpää (FI). **SORSA, Jami** [FI/FI]; Kesätuulentie 7 E 45, FIN-06100 Porvoo (FI). **RAE, Matti** [FI/FI]; Valkoinen Linja 4, FIN-06750 Tolkkinen (FI). **LEVÄNEN, Jukka** [FI/FI]; Koirapolku 3 A 2, FIN-04250 Kerava (FI). **UKSILA, Tommi** [FI/FI]; Meritullinkatu 11 B 27, FIN-00170 Helsinki (FI). **NYLUND, Emanuel** [FI/FI]; Kyrkotorget 9 E 11, FIN-06100 Borgå (FI). **RAUTIAINEN, Kimmo** [FI/FI]; Runeberginkatu 40 A 22, FIN-00260 Helsinki (FI). **LAAKKONEN, Rauno** [FI/FI]; Reimaritie 1 F, FIN-06150 Porvoo (FI).

(74) Agent: **KOLSTER OY AB**; Iso Roobertinkatu 23, P.O.Box 148, FIN-00121 Helsinki (FI).

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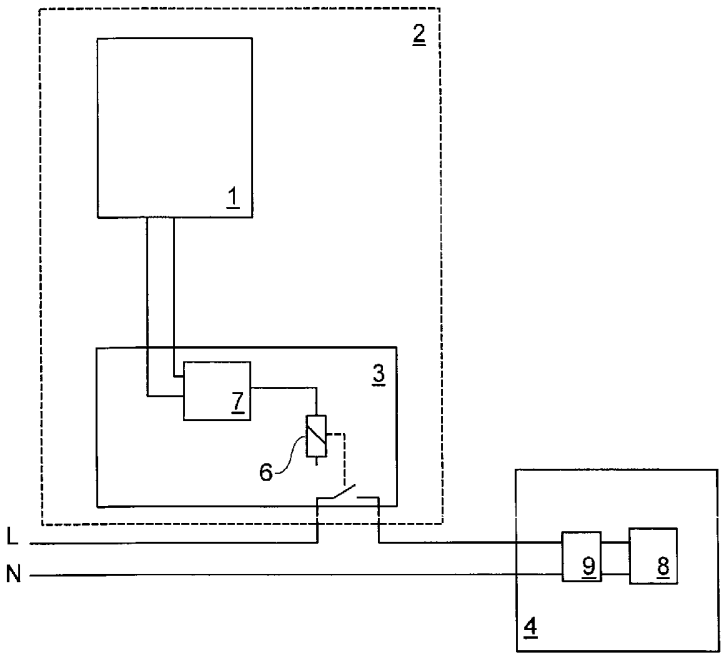
(54) Title: ARRANGEMENT IN OPERATION CONTROL SYSTEM



(57) Abstract: An arrangement in an operation control system, in which system timing control information is transmitted, wherein the system comprises control equipment (2) and an actuator (4), the control equipment comprising a control centre (3) that is arranged to control the actuator (4) by switching line voltage to the actuator. The control centre (3) of the control equipment (2) comprises a processor that is arranged to generate a timing pulse string and to control the actuator (4) according to the pulse string with the line voltage, and the actuator (4) comprises a processor that is arranged to read the timing pulse string and use the timing information.

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Declaration under Rule 4.17:

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ARRANGEMENT IN OPERATION CONTROL SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an arrangement in an operation control system, in which timing control information is transmitted to an actuator for the implementation of a timed operation. The timed operation can be the switching on of heating, for instance, according to specific provided conditions.

[0002] Today, a great deal of attention is paid to the economic utilization of energy in heating dwellings. Storage heating is typically used, in which for instance a concrete slab of a floor is heated with electric resistors in the slab during the time of inexpensive energy, i.e. night-rate electricity. The slab then heats up and stores the heat efficiently. The heat stored in the slab is released into room space and pleasantly heats the room.

[0003] Due to energy saving and general comfort, residential buildings and recreational dwellings often have operation control systems, with which it is possible to execute in a centralized manner functions related to the adjustment and control of temperature and other controllable functions. These functions include lowering the heating temperature in a controlled manner for the time of absence from the building. In addition, many systems have a remote control possibility, whereby control is possible through a mobile phone, for instance. By remote control, it is for instance possible to normalize the heating of a building after the temperature has been lowered.

[0004] The following is an example of executing controlled lowering of temperature. The user presses a button of a control equipment interface that lowers the temperature, whereby a control centre in the control equipment controls the actuator by supplying line voltage to the actuator. The control centre has a relay, for instance, that connects the line voltage to an input in the actuator that controls the thermostats to lower the heating. A typical temperature decrease in a system is 4 degrees.

[0005] With operation control systems, it is also possible to execute more versatile controls than just lowering the temperature by a specific predefined number of degrees. This type of control is for instance the optimum heating of floor heating, whereby a concrete slab is heated to a desired temperature in such a manner that its temperature reaches the target value at a specific time, i.e. typically at the time when the night-rate electricity changes to

normal day-rate electricity. However, this type of arrangement is difficult to implement in view of wiring and often requires a bus system suited for control and expensive equipment. In addition, the implementation of this type of control to sites that already have an operation control arrangement is difficult and often requires the replacement of the entire system. A problem with the present systems is their complexity and the fact that parts of possibly existing operation control systems cannot be efficiently utilized in providing new controls.

BRIEF DESCRIPTION OF THE INVENTION

[0006] It is an object of the present invention to provide an arrangement that avoids the above-mentioned drawback and enables the diversification of an operation control system in a simple manner without increasing the amount of wiring. This object is achieved by an arrangement of the invention that is characterized by what is stated in the characterizing part of claim 1.

[0007] The arrangement of the invention is based on the idea of using the present devices in a new way in such a manner that the voltage signal supplied to the actuator is supplied in timed pulses, whereby the information in the pulses is read in the processor of the actuator and the actuator executes the facility contained in the information.

[0008] With this type of arrangement, it is possible to implement versatile control for heating, for instance. A pulsed signal can contain all necessary control parameters without complex wirings or buses by utilizing the currently generally used voltage control.

BRIEF DESCRIPTION OF THE FIGURES

[0009] The invention will now be described in greater detail by means of preferred embodiments and with reference to the attached drawings, in which

Figure 1 is a block diagram of an arrangement of the invention,

Figure 2 shows an example of a used pulse signal, and

Figure 3 shows an example of defining the timing of storage heating.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Figure 1 is a simple block diagram of the arrangement of the invention. The block diagram shows control equipment 2 comprising a control device 1 and control centre 3. The control device 1 controls the control centre

that executes the actual control. All controls related to the system are typically collected in the control centre, and the connections related to the controls are typically implemented through relays or the like. The control device 1 is, in turn, a device that typically contains an interface for the manual control of functions and for activating the functions.

[0011] The control equipment 2 has a processor 7 or the like that reads the commands of the control device 1 and controls the relays of the control centre 3 as desired. According to the invention, the processor 7 is in the control centre. According to the invention, the processor is arranged to generate a timing pulse string that controls an actuator 4, such as a thermostat unit controlling heating.

[0012] According to the invention, the actuator is controlled with line voltage, i.e. the processor 7 of the control centre generates a pulse string on the basis of the control information and the control centre uses the string to switch on and off the line voltage connected to the actuator. According to the invention, the actuator comprises a processor 8 that is arranged to read the timing pulse string and execute the timing information.

[0013] As mentioned above, it is known to execute a standard temperature decrease by supplying line voltage to the actuator. Earlier, the actuator interpreted the line voltage as an instruction to make a predefined voltage decrease. In the system of the invention, the processor 8 in the actuator reads the pulse string that is provided using line voltage in a manner corresponding to the known simple voltage signal.

[0014] In floor heating, the system of the invention can be used for instance to transmit information on the starting time of the heating, a desired change in temperature and the control mode of the heating.

[0015] Figure 2 shows by way of example a pulse signal used to transmit information. The figure shows that the proportions of the time line of the figure do not correspond to reality, since the pulse periods t2, t3 and t4 are significantly longer than t1. The signal of the example is made up of four different periods that can each be given its own significance. The signal of Figure 2 is especially suited for use with an electric storage heating system, and in the following, the signal and the invention is described with reference to such a system.

[0016] The control device 1, which may comprise several different control functions in addition to the facility of the invention, generates a control

signal according to the information provided by the user to the control centre 3 of the control equipment. The information related to the invention and provided by the user is the magnitude of the desired change of temperature. The information is typically provided in degrees either by directly giving a deviation, i.e. the difference relative to the setting in the control device, or by giving a new setting to the control device in absolute degrees. The setting given to the control device is a value, with which the control device controls in a centralized manner the thermostats connected to heating in normal operating conditions.

[0017] When the control device begins to transmit information on reducing heating, it first transmits a synchronization pulse, shown in Figure 2 during t1. The control centre then switches line voltage momentarily on and off to the actuator. Because processes related to heating are typically slow, there is no need to transmit information at a high frequency to the actuator, especially when line voltage is used. Low-frequency pulses are more reliable and the tolerances are bigger. Thus, in the example embodiment, the resolution of the pulses is 0.5 seconds. The length of the synchronization pulse is for instance one second, followed by a two-second pause. During this time, the receiving processor has time to prepare for the reception of the actual information.

[0018] The next section in the pulse string being transmitted is the magnitude of the deviation, with which the magnitude of the change in temperature is defined in relation to the temperature programmed to the control device. The pulse transmitted during t2 of Figure 2 is at most 73 seconds in the example. Of this time period, the uptime of the pulse defines the information content of the pulse. In other words, the receiving processor measures a time period of 73 seconds and calculates the ratio of the pulse length to this maximum time. When the system resolution is 0.5 seconds, 144 values that the receiving actuator processor can read can be placed in the time period t2. In the beginning of the pulse, there is a one-second standard start, i.e. the uptime of one second signifies the number zero.

[0019] The magnitude of the change in temperature can be scaled in such a manner that 1.5 seconds is selected for the length of the pulse, in which case the desired temperature deviation +20 degrees corresponds to the value 1 and the deviation -20 degrees corresponds to the value 177.

[0020] Information on the storage time, i.e. after how long a time should the target temperature be reached, is transmitted in the time period t3

of the signal in Figure 2. This value can be scaled in the signal in the same manner as the time period t2. The pulse length is then 1.5 seconds, which corresponds to a storage time of 10 minutes, for instance. The storage time is then at most 1440 minutes, which corresponds to the value 144. The pulse of the time period t3 also contains the corresponding standard start as the pulse of the time period t2.

[0021] As mentioned above, the control equipment can contain several different properties and functions. One of these is receiving measurement information on the outside temperature. This measurement information can be transmitted on with the arrangement of the invention in connection with storage heating, for instance. In the signal of Figure 2, the measurement information on the outside temperature is included in the time period t4. The time period t4 can be divided as the time periods t2 and t3 above. A 1.5-second pulse can be used in scaling in such a manner that the value 1 corresponds to the outside temperature of +30 degrees and the value 144 corresponds to the outside temperature of -30 degrees.

[0022] By using the above time periods for transmitting the presented information, it is possible to provide storage heating optimally in such a manner that the starting time of heating is calculated on the basis of the outside temperature. Figure 3 shows an example of compensating the outside temperature in storage heating. As earlier mentioned, storage heating is preferably provided in such a manner that the target temperature is reached at a desired time, i.e. at the time when the daily increase in the electricity rate takes place, for instance. This way, the maximum benefit is derived during the time of more expensive energy from the stored heat produced by electricity. As is understandable, the temperature of the outside air significantly affects the time used in heating the storage element.

[0023] In Figure 3, the vertical axis shows the time and the horizontal axis the outside temperature. In the time on the vertical axis, the cheaper night-rate electricity is assumed to start at 10 p.m. and end at 6 a.m. On the vertical axis, it is also possible to show a percentage corresponding to the time used for heating from the full night-rate time. The time 10 p.m. then corresponds to 100% and 6 a.m. to 0%, and the percentages change linearly throughout the used time. The same percentage obtained from the figure can directly be used as a pulse ratio of the time period t3 in the above-mentioned heating that depends on the outside temperature. By experimentation and

computationally, it is possible to define a curve 30 that shows the ratio of the outside temperature to the time used to charge the storage element. The figure shows that a decrease in the outside temperature correspondingly increases the time used to charge the element. The time when heating is begun is calculated with the processor of the control centre on the basis of the curve 30 and the outside temperature. On the basis of this information, the actuator switches the heating on in an optimum manner. Figure 3 also shows how the curve 30 that is calculated for a specific setting shifts on the horizontal axis with the set temperature deviation.

[0024] The above time periods can be used in other ways to control the timing functions differing from the anticipatory action based on outside temperature described above. Information can be transmitted in time periods to control temperature, for instance, by using a P adjustment, in which case the time period transmits information on the length of a single period used for heating. One possible application of the system of the invention is to anticipate heating according to the local situation, in which case the outside temperature is not taken into account.

[0025] In the above heating control methods employing the system, some of the time periods remain unused. Because the same signal model can be used in several operations of different type, it is possible according to a preferred embodiment of the invention to also add to the signal a pulse related to the anticipation method, and the pulse can be considerably shorter in time than the actual information pulses related to heating. With such a number pulse, it is possible to indicate to the actuator a desired mode, and the processor of the actuator can then adapt to the correct mode.

[0026] Figure 1 shows in a simple manner the inter-connection of the control equipment 2 and actuator 4. The control device 1 of the control equipment controls the relay of the control centre in such a manner that the processor of the control centre controls the relay that switches on the line voltage to the actuator in the manner controlled by the processor. In the embodiment of Figure 1, the actuator has an opto-coupler 9 to which the line voltage is switched. The low-voltage side of the opto-coupler 9 is correspondingly connected to the processor 8 of the actuator that reads the incoming pulse string.

[0027] The invention is above explained with reference to storage heating in particular that can thus be a storing floor or the like. However, it is

clear that the system of the invention can also be applied to controlling other functions related to building engineering.

[0028] It is obvious to a person skilled in the art that while the technology advances, the basic idea of the invention can be implemented in many different ways. The invention and its embodiments are thus not restricted to the examples described above, but can vary within the scope of the claims.

CLAIMS

1. An arrangement in an operation control system, in which system timing control information is transmitted, wherein the system comprises control equipment (2) and an actuator (4), the control equipment comprising a control centre (3) that is arranged to control the actuator (4) by switching line voltage to the actuator, **characterized** in that the control centre (3) of the control equipment (2) comprises a processor that is arranged to generate a timing pulse string and to control the actuator (4) according to the pulse string with the line voltage, and the actuator (4) comprises a processor that is arranged to read the timing pulse string and use the timing information.

2. An arrangement as claimed in claim 1, **characterized** in that the timing pulse string comprises pulse periods having a predefined length.

3. An arrangement as claimed in claim 2, wherein the arrangement is arranged to be used in storage heating equipment, **characterized** in that one pulse period of the timing pulse string contains information on the magnitude of the change in heating.

4. An arrangement as claimed in claim 2 or 3, **characterized** in that one pulse period of the timing pulse string contains information on the length of the time to be used in heating.

5. An arrangement as claimed in claim 2, 3 or 4, **characterized** in that one pulse period of the timing pulse string contains information on the outside temperature.

6. An arrangement as claimed in any one of claims 2 to 5, **characterized** in that one pulse period of the timing pulse string contains information on the method to be used in heating.

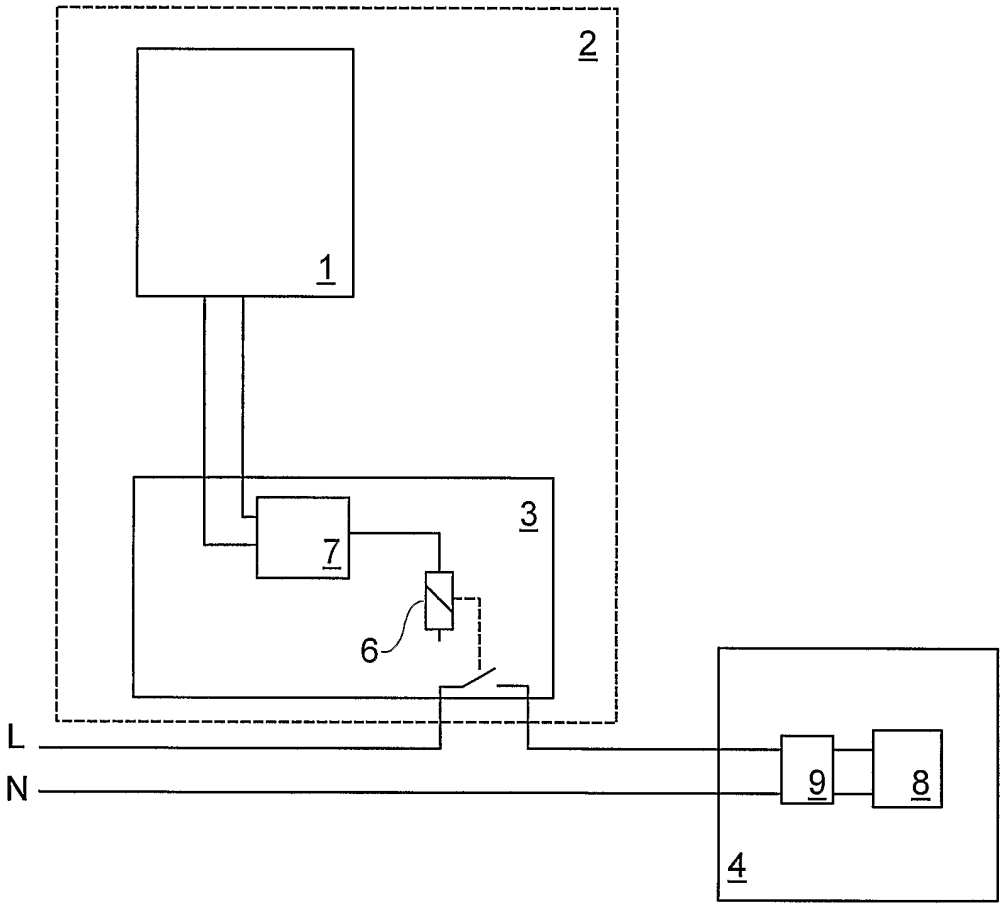

FIG 1

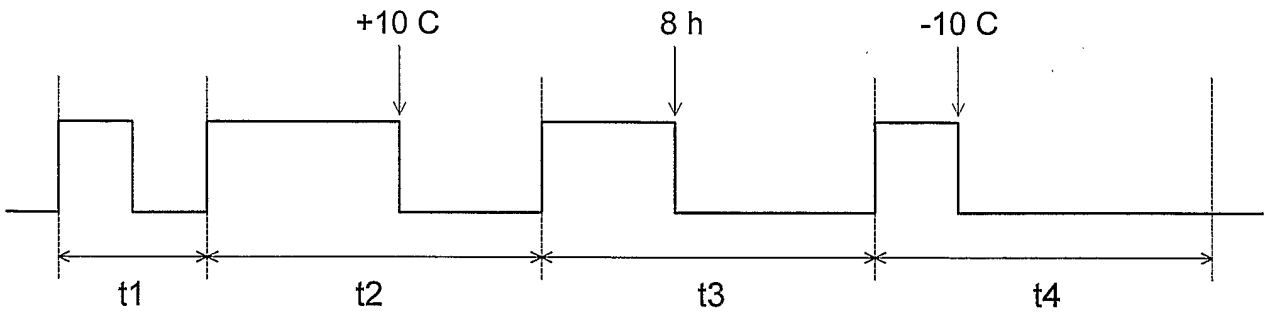
+10 C
8 h
-10 C
t1
t2
t3
t4

FIG 2

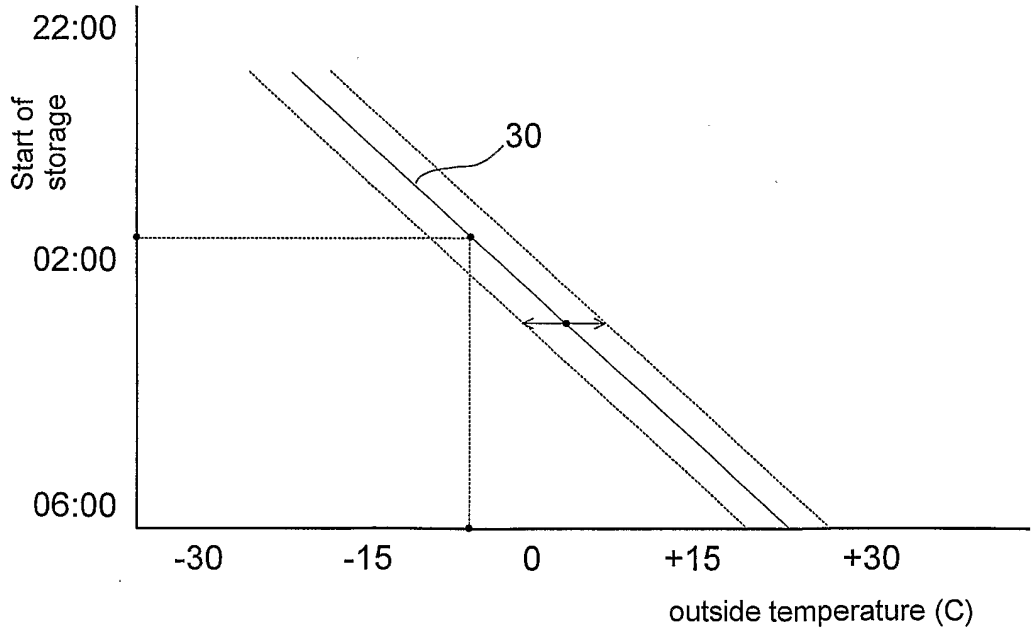
22:00
Start of storage
02:00
06:00
30
-30
-15
0
+15
+30
outside temperature (C)

FIG 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00506

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G08C 19/22, G05D 23/19
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)

IPC7: F24D, F24H, G05D, G08C, H05B

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)

EPO-INTERNAL,WPI,PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 4125678 A1 (AUDI AG), 4 February 1993 (04.02.93), column 1, line 1 - column 5, line 54, figures 1-3, abstract ---	1-6
Y	US 4540875 A (J.L.BUTTOLPH,III), 10 Sept 1985 (10.09.85), column 6, line 4 - column 8, line 39, figures 2-3, abstract ---	1-6
Y	DE 4447559 A1 (ELEKTROMANUFAKTUR ZANGENSTEIN HANAUER GMBH & CO), 21 March 1996 (21.03.96), page 2, line 1 - page 6, line 38, figures 1-6, abstract ---	1-6

[X] Further documents are listed in the continuation of Box C. [X] 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 application or patent but published on or after the international filing date
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"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 Sept 2003	26 -09- 2003
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 Roland Landström /itw Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00506

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5420578 A (C.O'BRIEN ET AL), 30 May 1995 (30.05.95), column 5, line 50 - column 14, line 16, figures 1-5, abstract -- --------	1-6

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

26/07/03

International application No.
PCT/FI 03/00506

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4125678 A1	04/02/93	NONE	
US 4540875 A	10/09/85	NONE	
DE 4447559 A1	21/03/96	DE 4432745 C	21/03/96
US 5420578 A	30/05/95	CA 2049618 A	19/01/93