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Title: ADAPTING PATIENT ROOM AMBIENT STIMULI TO PATIENT HEALING STATUS

Abstract: The invention relates to an ambiance creation system capable of creating an atmosphere in a patient room which doses the sensory load depending on the patient status, e.g., healing status such as the patient's condition, pain level, recovery stage or fitness. The atmosphere can be created by the ambiance creation system 100 capable of controlling lighting, visual, audio and/or fragrance effects in the room. The state of the atmosphere may be determined from sensor measurements, e.g., measurements of the patient's body posture, bed position, emotions or the amount of physical activity. The state of the atmosphere may also be determined from information retrieved from a patient information system 151 which contains patient status information. Such a patient information system can either be kept up to date by the hospital staff or by data reported by the patient himself as patient feedback e.g. on perceived pain level.

FIG. 1

[Continued on next page]
| TR | CA | BE | BR | CH | CO | CY | CZ | DE | DK | EE | ES | FI | FR | GB | GR | HU | IE | IT | LI | LT | LU | LV | NL | NO | PL | PT | RO | RS | SK | SI | SL |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Declared under Rule 4.17:

- as to applicant’s entitlement to apply for and be granted a patent (Rule 4.17(H))

Published:

- with international search report (Art. 21(3))
Adapting patient room ambient stimuli to patient healing status

FIELD OF THE INVENTION
The invention relates to a method for improving comfort for patients, in particular to improve comfort for improving healing of a patient.

BACKGROUND OF THE INVENTION
Current healing environments in patient rooms employ constant ambient healing settings thereby providing patients recovering e.g. from a stroke, operation or other major event with an overload of stimuli shortly after this event while providing an underload of stimuli later in the healing process. This may negatively affect the healing process.

Hospitals may offer rooms having different levels of stimuli. This however requires moving the patient from room to room in response to his or hers healing status which may slow down patient healing and requires significant logistics.

Accordingly, there is a need to improve hospital environments for improving patient comfort, the healing process and the workload of hospital personnel.

US 2011035057 discloses a person-support apparatus that operates according to a set of default operating parameters processes information corresponding to an occupant of the person-support apparatus from a receiver to determine if an optimal value for an operating parameter is different from the default value, modifies a default operating parameter to an optimal value based on the information corresponding to the occupant of the person-support apparatus to create a modified operating parameter, and operates the person-support apparatus utilizing the modified operating parameter.

Whereas US 2011035057 may improve operating parameters of a person-support apparatus such as a hospital bed, the inventor of the present invention has appreciated that other improvements are of benefit, and has in consequence devised the present invention.

SUMMARY OF THE INVENTION
It would be advantageous to achieve improvements of the ambient environment of lights, television, monitors, audio devices and other ambient stimuli devices used in hospitals. It would also be desirable to enable device states of such stimuli devices to
be adapted to a patient to improve the healing process of a patient. In general, the invention preferably seeks to alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination. In particular, it may be seen as an object of the present invention to provide a method that solves the above mentioned problems, or other problems, of the prior art.

To better address one or more of these concerns, in a first aspect of the invention a patient room controller is presented that comprises a data processor configured for receiving input information relating to the healing status of a patient and for providing output information for adjusting an ambient stimuli device of the patient room, where the data processor is configured for determining a state of the ambient stimuli device on basis of the input information and generating the output information in dependence of the determined state.

Patients recovering from a stroke, operation or other event typically suffer from an overload of stimuli shortly after this event, while suffering from an underload of stimuli later on in the healing process resulting in boredom. This problem may be solved according to the first aspect since the ambient stimuli to which the patient exposed is controlled according to healing status of the patient. Thereby, a bad health may result in input information which is processed to generate ambient stimuli which only exposes the patient with a low sensory load, whereas a healthy patient or a patient showing improved health result in input information which is process to generate stimuli which exposes the patient with a high sensory load to avoid boredom.

In an embodiment the input information is provided from a patient information system configured for storing patient information records where the patient information system is accessible by clinical personnel. Use of information from a patient information system for determining states of the ambient stimuli device may be advantageous since the patient information may have been entered by qualified clinical personnel and therefore is highly descriptive for the patient's actual health so as to enable setting of a suited ambient state.

In an embodiment the input information is provided from measured conditions of a patient. Use of information based on measurements of patient conditions may be advantageous since measurements may be performed frequently or continuously so that the state of the one or more ambient stimuli devices can be adjusted immediately when a change of the patient's health permits such an adjustment.
The measured conditions may comprise measurements of one or more of:
location/position, physical activity, body posture, blood pressure, heart rate, skin
conductivity, respiration rate, body temperature, skin color and facial expressions.

In an embodiment the state of the ambient stimuli device comprises a setting
of intensity, color, color difference and/or contrast of a lighting system. Advantageously, the
processor may be configured to control spatial color differences or gradients of colored light
e.g. of light projected onto a wall; or the processor may be configured to control temporal
changes of light color. Such color contrast control may be particular beneficial for creating a
pleasant atmosphere for a patient.

In an embodiment the state of the ambient stimuli device comprises a setting
for an audio system for a type and a volume of music or sound. Advantageously, the music or
sounds, e.g. nature sounds such whale song, may be generated in dependence of the input
information so the e.g. no sound or music is present at an early stage of the healing process
whereas calming nature sounds may be presented later in the healing process, and
entertaining music is presented in a late state of the healing process so that the sensory load is
continuously dosed to suit the patient's need.

In an embodiment the state of the ambient stimuli device comprises a setting
of a type or a scene of still images or a setting of a type or a scene of video to be displayed.
For example, a type of images may comprise nature-scene images and a scene of a still image
may be a scene showing e.g. a waterfall. Similarly, a type of video may comprise a nature-
scene video and a scene of a video may be a scene showing volcanic eruption.

In a related embodiment the state of the ambient stimuli device enables control
of presentation of images on a display in dependence of the input information so as to change
a view of a scene in dependence of the input information. Advantageously, this embodiment
may enable changes of the sensory load of images or video in dependence of the input
information, e.g. by adjusting the presented image information from a distant view with little
image information to a close view with increased image information.

In an embodiment the data processor is further configured to enable the setting
of a state of the ambient stimuli device to be selectable by the patient from a selection of
selectable state, where the number or types of selectable states in the selection depends on
time or the healing status. Advantageously, the ambient stimuli may be controlled by the
patient itself by enabling the patient to choose an ambient state from a number of selectable
states, which selection of selectable states is not static but adjusted in dependence of other
parameters such as time or input information.
In an embodiment the controller comprises a monitoring unit for monitoring and storing information comprising states of the ambient stimuli device and input information relating to the healing status of a patient so as to enable detection of effects of a setting of a state of the ambient stimuli device on the input information. According to this embodiment the effects of different ambient settings may be monitored and stored for use for tailoring future ambient settings to the patient using knowledge of what ambient settings are effective for improving the patients feeling of comfort or improving healing.

A second aspect of the invention relates to a patient room system comprising,
- the patient room controller according to the first aspect, and
- one or more ambient stimuli devices which are controllable by the patient room controller.

A third aspect of the invention relates to a method for adjusting an ambient state in a patient room in dependence of a healing status of a patient, the method comprises
- receiving input information relating to the healing status of a patient,
- determining a state of an ambient stimuli device on basis of the input information, and
- adjusting the ambient stimuli device of the patient room using output information determined in dependence of the determined state of the ambient stimuli device.

In summary the invention relates to an ambience creation system capable of creating an atmosphere in a patient room which doses the sensory load depending on the patient status, e.g. healing status such as the patient’s condition, pain level, recovery stage or fitness. The atmosphere can be created by the ambience creation system capable of controlling lighting, visual, audio and/or fragrance effects in the room. The state of the atmosphere may be determined from sensor measurements, e.g. measurements of the patient’s body posture, bed position, emotions or the amount of physical activity. The state of the atmosphere may also be determined from information retrieved from a patient information system which contains patient status information. Such a patient information system can either be kept up to date by the hospital staff or by data reported on by the patient itself as patient feedback e.g. on perceived pain level.

In general the various aspects of the invention may be combined and coupled in any way possible within the scope of the invention. These and other aspects, features and/or advantages of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.
BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

Fig. 1 shows a patient room system 190 comprising the patient room controller 100 which is connected to three ambient stimuli devices 131-133 and two input devices 151-152, and

Fig. 2A-B show how presentation of an image can be changed from distant view to a close view in dependence of the development of the patient's health.

DESCRIPTION OF EMBODIMENTS

Fig. 1 shows a patient room controller 100 of an embodiment of the invention where the patient room controller comprises a data processor 101 configured for receiving input information relating to the healing status of a patient and for providing output information for adjusting an ambient stimuli device 131-133 in a patient room.

The output information may be available via one or more output terminals 121-123 of the controller 100.

The output information which is available via different output terminals 121-123 may have the same signal format or may have different signal formats for each output terminal suited for specific protocols of different ambient stimuli devices.

Thus, the patient room controller 100 may be configured with a single output terminal 121 for controlling a single ambient stimuli device or the patient room controller may be configured with one or more output terminals 121-123 for controlling one or more ambient stimuli devices and possibly a plurality of different ambient stimuli devices.

Different ambient stimuli devices may be connectable to the patient room controller. Examples of ambient stimuli devices comprise lighting devices capable of generating different light colors and different light amplitudes, artificial daylight element devices capable of generating a light having a color and intensity corresponding to daylight at a given time of the day, blind and curtain control devices for controlling screening of windows, display devices for showing artificial nature views or other scenes in the form of still images or video, audio devices for reproducing or generating sounds or music, sound systems for masking other noises so that the patient is positively distracted, and fragrance devices for generating a specific fragrance.
The data processor of the patient room controller 100 is configured for determining a state of the ambient stimuli device on basis of the input information and generating the output information in dependence of the determined state.

Various stimuli states may be able to be set depending on the available types of ambient stimuli devices. For example ambient stimuli states may comprise a setting of intensity, color and/or contrast of a lighting system, e.g. a LED based lighting system, a setting of a type, category or a volume of music or sound, e.g. a setting which selects calming sea wave sounds, a setting of a type, a category or scene of displayed still images or video. For example, a display may be set by the output information signal to show nature images or video.

An important parameter in stimulus dosing caused by a specific ambient atmosphere is color contrast. Whereas the color contrast is typically fixed in rooms painted in fixed colors, use of light projectors enables colored wall washing with light of adjustable light colors and intensities whereby the color contrast in the patient room can be adapted to create a health improving color scheme. Thus, ambient stimuli devices in the form of light projectors or light panels may be used for used for creation of color contrast in dependence the input information.

Thus, in an embodiment the patient room controller is configured enable adjustment of an ambient stimuli device according to a determined state of a particular color contrast or color gradient of the stimuli device.

In an embodiment the patient room controller 100 and the processor 101 thereof are configured to control presentation of images displayed on a display 131 in dependence of the input information so as to change a view of a scene (e.g. a nature scene) or change the speed of displaying of which images of a scene. According to this embodiment, a view of a nature scene may be adjusted in dependence of the input information so the view moves from a quiet static distant view to a lively, dynamic close view, e.g. showing animals or more detail in the view. This embodiment may also enable displaying a growing flower, tree or animal over time by adjusting the time delay between displaying images of a scene which images have been recorded over time. Such presentation of simulated nature views may reduce stress and have a positive impact on the healing process of a patient. With the use of high resolution or 3D displays which due to ongoing increasing picture quality and price erosion may be feasible for use in hospital rooms for patient healing in future systems, the possibility to create stunning and immersive simulated nature experiences may be importing for patient healing.
As an example of how presentation of images displayed on a display may be controlled in dependence of the input information so as to change a view of a scene, Fig. 2A shows presentation of a nature view for patient just after an attack or surgery showing a quiet, distant nature view, and Fig. 2B shows presentation of a nature view for a patient after some recovering showing a lively, dynamic nature view offering more detail and more distraction.

Accordingly, the output information signal may be set to invoke a particular state of one or more ambient stimuli devices or different states of different ambient stimuli devices so as to create a specific atmosphere or ambient state in the patient room suited for the patient's particular healing state.

Ambient state is defined as a state of the ambient stimuli devices, e.g. a particular light intensity or color dynamic of a light source. Accordingly, an ambient state can also be understood as a state of the ambient atmosphere generated by a state of a stimuli device. The ambient atmosphere determines the sensory load which the patient is exposed to. The patient's perception of the ambient atmosphere may be different from the actual sensory load and, therefore, control of the ambient atmosphere generated by the ambient stimuli device on basis of objective input information may be important instead of controlling the ambient atmosphere on basis of the patient's perception of the ambient atmosphere.

The input information may be provided to the controller 100 via inputs 141-142 from various input information sources 151-152.

For example the input information may be provided or derived from a patient information system 151 which stores patient information records which records may have been created by clinical personnel. Accordingly, as patient information is updated in the information system, new states of the ambient stimuli device can be determined from the updated patient information and the ambient stimuli devices can be adjusted accordingly so that the ambient atmosphere in the patient room can be adapted to the progress of the patient's health.

The patient information system 151 may also have a capability to store information records which are created by the patient itself, e.g. records of the patient's own assessment of perceived pain level or fitness. Thereby, the stimuli devices 131-133 may be controlled immediately in dependence of the patient's well-being.

Accordingly, the input information derived from the patient information system may relate to one or more of: perceived level of pain, perceived level of boredom, fitness of patient, stage of recovery, amount of time after an operation or stroke, time of the day and scheduled activities and other data.
Alternatively or additionally the input information can be derived from measured conditions of a patient. Such measured conditions may be obtained from various clinical devices capable of measuring for example blood pressure, heart rate, skin conductivity, respiration rate, body temperature, skin color and facial expressions.

Input information may also be determined e.g. from motion sensors capable of determining location/position, physical activity and/or body posture of a patient. Thereby, if an increase in physical activity is measured the states of the ambient stimuli device can be modified to create an atmosphere in the patient room which matches the improved health of the patient, e.g. light intensity may be increased.

As examples the input information derived sensors may relate to one or more of: amount of physical movement (e.g. measured by on-the-body sensors, room sensors, or registered by a camera), the patient's body posture (e.g. measured by bed sensors capable of determining the position of the bed, or sensors such as computer vision cameras capable of detecting patient body posture), emotion measurements such as level of arousal or stress (e.g. measured by detecting facial expressions with a computer vision camera, or detecting arousal or stress through skin conductivity measurements), measurements of blood pressure, heart rate (in some patient rooms, such as a stroke unit these measurements are taken anyways, and could be used as input information).

It is known that some physiological measures are indicative of pain perceived by a patient. Accordingly, in an embodiment the input information may be derived from sensors configured to measure physiological values which are indicative of perceived level of pain.

The patient room controller may be provided with input information from a user input device, e.g. a touch screen, via an input interface. Thereby, by configuring the data processor to process input information from user input devices, the user is able to set a state of the ambient stimuli device, possibly from a selection of selectable states, where the number or types of selectable states in the selection depends on time or the healing status.

According to this embodiment the user is able to change the state of the ambient stimuli devices so as to create an atmosphere in the patient room which suits him or her. In order to limit the possible selectable states in the selection the number and/or types of selectable states may be determined by the processor as a function of the healing status or simply as a function of time. Thus, as time from an operation proceeds selectable states for creating increasingly vivid atmospheres may be included in the selection. Similarly, as the healing status derived from the input information shows health improvements, selectable
ambient states may be added to a list of selectable states and other selectable states may be removed from the list. The patient room controller 100 may have a memory for storing selectable states, from which memory relevant selectable states can be retrieved.

In an embodiment the controller comprises a monitoring unit 102 for monitoring and storing information comprising states of the ambient stimuli device and changes in the input information relating to the healing status of a patient. By storing such information is may be possible to detect what effect a setting of an ambient state or a sequence of states of the ambient stimuli device has on the on the healing statues of the patient.

Determination of such effects may be exploited to determine what ambient states are effective for improving healing for a given patient. In this way the patient room controller may be made intelligent by configuring e.g. the processor 101 to determine ambient states which are effective and determine ambient states which are not effective in improving the healing status so that ineffective states are not set in response to future changes in the input information, but rather the effective states may be approved to be selectable by the user or set by the processor 101 in response to future input information.

Alternatively, the determination of such effects which shows the relation between ambient status setting and healing effects may be collected from a multitude of patients in order to determine which ambient states are effective for the majority of patients with similar health conditions.

It may be advantageous to provide an entire patient room system 190 which comprises both the patient room controller 100 and one or more ambient stimuli devices 131-133 since the controller 100 may then be specifically configured to control the associated stimuli devices 131-133.

The processor 101, the controller 100, the system 190 or other unit may fulfill the functions of several items recited in the claims. Thus, the processor 101 may be a computer having a storage and data processing electronics, where the storage may store a computer program capable of performing methods according to embodiments of the inventions such as the methods of the claims and where the processing electronics is capable of executing instructions of the computer program so as to carry out one or more of the functions: receiving input information relating to the healing status of a patient, determining a state of an ambient stimuli device on basis of the input information, and adjusting the ambient stimuli device of the patient room using output information determined in dependence of the determined state of the ambient stimuli device.
While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.
CLAIMS:

1. A patient room controller (100), comprising
   - a data processor (101) configured for receiving input information relating to
     the healing status of a patient and for providing output information for adjusting an ambient
     stimuli device (131-133) of the patient room, where the data processor is configured for
     determining a state of the ambient stimuli device on basis of the input information and
     generating the output information in dependence of the determined state.

2. A patient room controller according to claim 1, where the input information is
   provided from a patient information system (151, 152) configured for storing patient
   information records where the patient information system is accessible by clinical personnel.

3. A patient room controller according to claim 1, where the input information is
   provided from measured conditions of a patient obtained from a sensor (151, 152).

4. A patient room controller according to claim 1, where the state of the ambient
   stimuli device comprises a setting of intensity, color, color difference and/or contrast of a
   lighting system.

5. A patient room controller according to claim 1, where the state of the ambient
   stimuli device comprises a setting for an audio system for a type and a volume of music or
   sound.

6. A patient room controller according to claim 1, where the state of the ambient
   stimuli device comprises a setting of a type or a scene of still images or a setting of a type or
   a scene of video to be displayed.

7. A patient room controller according to claim 1, where the state of the ambient
   stimuli device enables control of presentation of images on a display (131) in dependence of
   the input information so as to change a view of a scene.
8. A patient room controller according to claim 1, wherein the data processor is further configured to enable the setting of a state of the ambient stimuli device to be selectable by the patient from a selection of selectable state, where the number or types of selectable states in the selection depends on time or the healing status.

9. A patient room controller according to claim 1, wherein the controller comprises a monitoring unit (102) for monitoring and storing information comprising states of the ambient stimuli device and input information relating to the healing status of a patient so as to enable detection of effects of a setting of a state of the ambient stimuli device on the input information.

10. A patient room system comprising
- the patient room controller according to claim 1, and
- one or more ambient stimuli devices which are controllable by the patient room controller.

11. A method for adjusting an ambient state in a patient room in dependence of a healing status of a patient, the method comprises
- receiving input information relating to the healing status of a patient,
- determining a state of an ambient stimuli device (131-133) on basis of the input information, and
- adjusting the ambient stimuli device of the patient room using output information determined in dependence of the determined state of the ambient stimuli device.
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/IB2012/052996

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. A61N5/Q6  A61M21/0Q

**ADD.**

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)
A61N  A61M

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

**Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)**
EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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**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 application or patent 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
  - **"A"** document member of the same patent family

**Date of the actual completion of the international search**
14 August 2012

**Date of mailing of the international search report**
28/08/2012

**Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016**

**Authorized officer**
Rodriguez Cossio, J

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**INTERNATIONAL SEARCH REPORT**

**Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☑ Claims Nos.: 11
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   
   see [FURTHER INFORMATION sheet](#) PCT/ISA/21 0

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☑ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☑ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
Continuation of Box 11.2

Claims Nos.: 11

Rule 39.1(i-v) PCT - Method for treatment of the human or animal body by therapy

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examination Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.
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