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(54) OPERATING DEVICE, SENSOR DEVICE AND LIGHTING SYSTEM

(57) An operating device for providing electrical energy to a light source (2) comprising a main power supply (5) for providing the electrical energy to a connected light source, and, preferably, an auxiliary power supply (6) for supplying electrical energy to a control unit (7) of the operating device, the control unit (7) being connected to the main power supply (5) to control the electrical energy supplied to the light source (2). The auxiliary power supply (6) is connected to an auxiliary bus interface (9) for supplying electrical energy to one or more sensor device(s) (3), and the operating device (1) is configured to communicate with the sensor device(s) (3) by powerline communication over the auxiliary bus interface (9). The operating device (1) and a sensor device (3) configured to be able to receive electrical energy from a power supply and to communicate via this power supply connection establishes a lighting system for enabling direct communication between a sensor device (3) and an operating device (1)

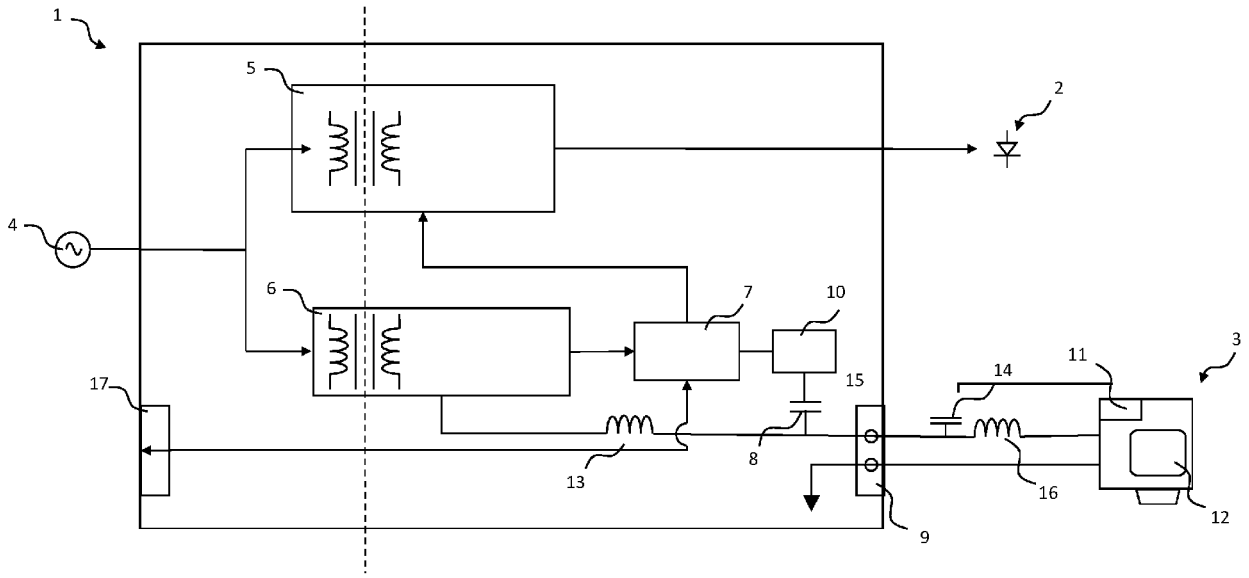

Fig. 1

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Description

[0001] The invention regards to an operating device connected to a sensor device, the respective sensor device and a lighting system comprising the operating device and the sensor device.

[0002] Over the last decades lighting systems have rapidly developed. Using LEDs (light emitting diodes) as light sources offers a wide variety of controlling lighting situations in buildings or even in outside applications. The emitted light that is produced by an LED is controlled by means of an operating device, which supplies the LEDs with electrical energy and which in particular controls the current supplied to the LED. In response to the provided electrical characteristics, the LED produces light as desired.

[0003] The variety of parameters that can be adjusted in the operating devices incented developers to design integrated lighting systems, meaning a plurality of devices all being connected in a common network. One example for a bus system that can be used for such an integrated system is the DALI (digital addressable lighting interface) system. The different entities which shall be able to cooperatively fulfil a lighting task are connected to a common digital communication bus so that the different entities can communicate which each other. Apart from the possibility to have a central control unit capable of controlling devices which are mounted at a remote position, it is therefore possible to use signals from sensors that are mounted in a distributed manner. Having connected the different devices or entities to the bus system allows to forward signals so that for example an operating device can produce a reaction on a remotely recognised presence of a person, brightness in the environment or other physical parameters.

[0004] However, one drawback of such systems is that the bus system needs to be connected to all the devices that shall be addressable in the system or deliver signals used for control of light emission. Further, all the sensors that shall be included in the system need a dedicated power supply so that they are able to communicate via the bus system. In case that the different devices like luminaires and sensors shall be mounted in a new building, the additional workload and cost for the wiring maybe acceptable. However, there are other applications like a standing luminaire including its own dedicated sensor, where such additional wiring produces a significant amount of costs.

[0005] It would therefore be desirable to provide a lighting system including an operating device and a sensor, in which the costs for the system can be reduced without losing any of the advantageous system capabilities.

[0006] The problem is solved by an operating device, a sensor device and a system including the operating device and the sensor device according to the independent claims.

[0007] Advantageous aspects and feature combinations are defined in the dependent claims.

[0008] The operating device according to the present invention, the sensor device and the system comprising the operating device and the sensor device advantageously provide the desired functionality of enabling control of light emission taking into consideration environmental information obtained by the sensor device while simultaneously reducing the costs for system design and manufacturing compared to commonly known systems with separately provided entities, by synergistically using components which are included in the operating device also for the sensor device.

[0009] According to the invention, the operating device for providing electrical energy to a light source comprises a main power supply (converter) for providing the electrical energy to a light source, which is attachable to the operating device. The operating device further comprises a control unit, the control unit being connected to the main power supply to control the electrical energy supplied to the light source.

[0010] An auxiliary powerline is provided in the operating device, the auxiliary powerline being connected to an auxiliary bus interface for supplying electrical energy over the auxiliary bus interface to one or more sensor device(s), and the operating device is configured to communicate with the sensor device(s) by powerline communication over the interface. Contrary to solutions that are known from the prior art, the operating device according to the invention is capable of providing electrical energy to a sensor device which obtains information on the environment which may be used for controlling light emission of the light source connected to the operating device. Thus, a dedicated power supply for the sensor device is unnecessary.

[0011] Additionally, the sensor device and the operating device communicate with each other using powerline communication so that dedicated communication wiring connecting the operating device and the sensor device to the same external bus system becomes unnecessary. The operating device allows the same functionality because communication between the operating device and the sensor device is still possible while simultaneously the cost for manufacturing are significantly reduced.

[0012] The advantages become particularly apparent for systems like a standing luminaire or a down light, which often include a sensor device located in close proximity to the light. Thus, the communication between the operating device and the sensor device can be a direct communication without involving any external bus system. However, since the operating device may still be connected to an external bus system there is an indirect possibility to address and communicate with the sensor device via the operating device.

[0013] While it is generally possible to connect the auxiliary power line and thus the auxiliary bus interface to the main power supply, it is preferred to provide an auxiliary power supply for supplying electrical energy to the control unit and the auxiliary bus interface. Using a dedicated auxiliary power supply for the auxiliary powerline

(auxiliary bus) ensures a stable power supply which is not affected by the actual parameters set in the main power supply.

[0014] Advantageously, the control unit is adapted to communicate with the sensor device(s) by powerline communication. Adapting the control unit to be capable of direct powerline communication with the sensor device has the advantage, that in most cases information obtained by the control device is further processed in the control unit, which adapts the control parameters supplied in a control signal to the converter in order to adjust the electrical parameters provided to the light source. Thus, no indirect path for providing the obtained information of the sensor device to the control device is necessary.

[0015] According to another advantageous aspect, the control unit is connected to the auxiliary bus interface via an interface circuit. Providing a dedicated auxiliary bus interface allows to separate the functionality of the control device and the communication interface so that for a plurality of different control devices it is possible to use the same auxiliary bus interface. Further, without adaptation of the control unit itself it is possible to adapt the entire system in case that in a plurality of different operating device types different auxiliary power supplies are used, which provide different auxiliary bus voltages

[0016] According to a particularly preferred aspect of the invention, the main power supply and the auxiliary power supply each comprise a transformer for establishing a SELV barrier (separated or safety extra low voltage barrier over potential isolation) in the operating device. Providing electrical power to the sensor device by the auxiliary power supply results in any parts that are connected to the sensor device lying on the same side of the SELV barrier. Thus, it is unnecessary to cross the barrier when transferring information to the control device. Otherwise, it would be needed to connect the sensor device to a dedicated power supply providing electrical energy to the sensor device, which needs a separate SELV barrier, thereby increasing costs of the luminaire.

[0017] Preferably, the operating device comprises a bus interface connected to the control unit for communicating via an external bus system. This bus system is provided in addition to the auxiliary bus system which is established on the other side of the SELV barrier. The bus interface, which is also connected to the control unit, allows to connect the luminaire to an external bus system, for example a DALI system. The DALI system, or any other bus system allowing to control the operating device and/or transmit information to other system devices, may thus still be used in order to include the inventive system into an building infrastructure, for example.

[0018] Further, the control unit may be configured to enable each connected sensor device and the operating device to be addressable as distinct entities. The control unit is configured to be addressable via two dedicated component addresses, one for the operating device itself and one for the sensor device which is connected to the operating device via the auxiliary bus. The communication between the sensor device and the control unit uses powerline communication (PLC). However, the sensor device is still addressable via the external bus system being connected to the operating device. This results in the functionality that is provided by known systems which use dedicated wiring for connecting the sensor device to a bus system can still be realized and the reduction in manufacturing costs does not result in a reduced functionality.

[0019] In addition to the operating device, which is described above, the sensor device needs to be adapted in order to be able to use the powerline communication and to receive its electrical energy from an interface provided at the operating device and connected to the auxiliary power supply of the operating device. The sensor device therefore comprises an interface for connecting to a power supply to supply the sensor device with electrical energy, wherein the sensor device is further configured to perform powerline communication over the interface. For achieving the advantageous effect, the sensor device is connected to the auxiliary power supply as power supply for the sensor device.

[0020] Combining the operating device according to the invention and the sensor device according to the invention results in a lighting system according to the invention. Preferably, the system is included in a luminaire such as a standing luminaire or a downlights. It is to be noted that the inventive system may even comprise additional device which may be further sensors, luminaires or any other component of a building infrastructure system.

[0021] An embodiment of the system according to the invention including the inventive operating device and the inventive sensor device is illustrated in figure 1. Further advantages and aspects of the present invention will become apparent taking into consideration below given details of the embodiment according to figure 1. An embodiment of the invention will now be explained in greater detail with reference to the attached drawings in which

Fig. 1 shows a block diagram of an embodiment of the inventive system including an operating device and a sensor device according to the present invention.

[0022] The structure and function of the system comprising the operating device and the sensor device according to the present invention will now be described with reference to figure 1. The system, which may entirely be included in a luminaire, specifically in a standing luminaire or a downlight, comprises an operating device 1. The operating device 1 is configured to supply a light source, preferably an LED or a plurality of LEDs, with electrical energy. The operating device 1 controls the light emission of the LED 2 based on information obtained from a sensor device 3.

[0023] In the inventive system, the operating device 1

and the sensor device 3 perform a direct communication. Thus, information on the environment obtained by the sensor device 3 is directly provided to the operating device 1. In response to the obtained information, the operating device 1 controls a voltage and/or current provided to the LED 2. By adjusting the voltage and/or current provided to the LED 2, light emission of the LED 2 can be controlled and adjusted as desired by a user or operator.

[0024] The electrical energy needed by the inventive system is received from a primary energy source, which is in the present embodiment illustrated as mains 4, which provides an AC voltage and current. Components which are commonly known for operating devices receiving an AC current and voltage and providing a DC current and voltage to an LED light source, like a rectifier and PFC (power factor correction) stage are neither explicitly mentioned nor shown in figure 1 in order not to overload the present explanation of the embodiment of the invention with information that can be assumed to be common knowledge of the skilled person.

[0025] The operating device 1 according to the invention includes a converter 5 for converting the electrical energy such that the LED 2 can be driven by the produced DC voltage and current. As it can be seen in the illustrated embodiment of fig. 1, the converter 5 includes a transformer unit, thereby establishing a SELV barrier in the converter 5. In addition to the converter 5, which is a main power supply of the operating device 1, the operating device 1 also comprises an auxiliary power supply 6.

[0026] Similar to the main power supply (converter 5), the auxiliary power supply 6 comprises a transformer so that the main power supply 5 and the auxiliary power supply 6 both established the SELV barrier in the operating device 1.

[0027] The auxiliary power supply 6 is connected to a control unit 7 in order to supply the control unit 7 with electrical energy. The electrical energy supplied by the auxiliary power supply 6 is independent from the electrical energy generated and provided by the main power supply for driving the LED 2. The control unit 7 adjusts the parameter used in the converter 5 by providing a control signal to the converter 5 and thus controls the converter 5 in order to adjust the electrical energy, which is supplied to the LED 2. The control unit 7 may be a microcontroller or any other component suitable to control the converter 5 as it is known from commonly known operating devices.

[0028] According to the invention, the auxiliary power supply 6 is not only provided in order to supply electrical energy to the control unit 7. The auxiliary power supply 6 is also connected to an auxiliary bus interface 9 via an auxiliary powerline. Thus, the auxiliary bus interface 9 allows an external device to be connected with the operating device 1 in order to receive electrical energy from the auxiliary power supply 6 for operation of the connected external device.

[0029] According to the inventive system, the sensor device 3 is connected to the auxiliary bus interface 9 so that the sensor device 3 can receive electrical energy, which is generated by the auxiliary power supply 6 over the SELV barrier. Using the electrical energy provided by the auxiliary power supply 6, the sensor device 3 obtains information on the environment by physically sensing the environment with its built-in sensing means 12. The built-in sensing means 12 produces a sensor signal which is output by the sensor device 3. The sensor device 3 may, for example, detect presence of a person, or measure brightness. The sensor may also be provided to receive signals received from neighboring luminaires or other building infrastructure devices.

[0030] It is to be noted that in the illustrated embodiment only a single sensor device 3 is connected to the operating device. However, the auxiliary bus interface 9 may be connected to a plurality of sensor devices 3. These plural sensor devices 3 may be of different types. It is also possible that only one, a part of the plurality of different sensor devices or even all of them are configured to make use of the operating device's 1 capability to communicate via the powerline providing the electrical energy to all connected sensor devices 3.

[0031] According to the invention, the communication between the sensor device 3 and the control device 7 is performed using powerline communication over the auxiliary bus interface 9. For enabling the control device 7 to communicate via powerline communication, an interface circuit 10 is connected between the auxiliary bus (auxiliary powerline) and the control unit 7. The interface unit 10 superimposes a modulation signal on the powerline voltage in order to convey information over the auxiliary bus.

[0032] Further, a capacitor 8 is provided between the interface circuit 10 and the auxiliary bus for coupling the interface circuit 10 with the auxiliary bus thereby enabling the interface circuit 10 to induce an information carrying signal onto the bus voltage.

[0033] A similar structure is provided on the sensor device's 3 side. In order to be able to communicate via powerline communication, the sensor device 3 comprises an interface 11 including respective circuitry, the interface 11 being connected via a capacitor 14 to the auxiliary bus interface 9.

[0034] In the embodiment, inductors 13 and 16 are provided in the auxiliary powerline for filtering unwanted disturbances on the auxiliary bus.

[0035] The auxiliary bus (powerline), which is established on the auxiliary powerline connecting the auxiliary power supply 6 with the auxiliary bus interface 9, enables a bi-directional communication between the control unit 7 and the sensor device 3. Thus, it is possible that the control unit 7 starts a communication with the sensor device 3, but also the sensor device 3 may start such communication. However, according to the invention it is not necessary that the communication is bi-directional. For example, in case that the sensor device 3 is only capable to provide a signal conveying information determined by

the sensor device, a unidirectional structure can be sufficient.

[0036] In the control unit 7, addresses for the operating device 1 but also for the connected sensor device 3 are stored. The control unit 7 itself is directly or indirectly connected to an external bus interface 17 (e.g. via an isolator not shown in fig. 1) of the operating device 1, connecting the operating device to an external bus system which may be a commonly known bus system provided for controlling the operating device 1 or monitoring system characteristics. Such an external bus system may be for example a DALI system, however, other bus systems which are known in the art may also be used.

[0037] Since the control unit 7 knows both addresses, the address of the operating device 1 itself but also the address of the sensor device 3, it is possible to transmit control signals over the bus interface 17 to the operating device 1 and/or the sensor device 3. Vice versa, it is also possible to read out information from the operating device 1 and also to receive information obtained by the sensor device 3a and use it for additional devices connected to the external bus system of the overall lighting system.

[0038] The sensor device 3 may be a presence detector, a brightness sensor or the like. The sensor device 3 may also be used to enables one control by receiving signals emitted from neighboring luminaires.

Claims

1. Operating device for providing electrical energy to a light source (2), the operating device (1) comprising a main power supply (5) for providing the electrical energy to the light source, a control unit (7) being connected to the main power supply (5) to control the electrical energy supplied to the light source (2),
characterized in
that the operating device comprises an auxiliary bus interface (9) for supplying electrical energy to one or more sensor device(s) (3), and the operating device (1) is configured to communicate with the sensor device(s) (3) by powerline communication over the auxiliary bus interface (9).

2. Operating device according to claim 1,
characterized in
that the operating device (1) further comprises an auxiliary power supply (6) for supplying electrical energy to the control unit (7), wherein the auxiliary power supply (6) is connected to the auxiliary bus interface (9).

3. Operating device according to claim 1 or 2,
characterized in
that the control unit (7) is adapted to communicate with the sensor device(s) (3) by powerline communication.

4. Operating device according to claim 3,
characterized in
that the control unit (7) is connected with the auxiliary bus interface (9) via an interface circuit (10).

5. Operating device according to any of the preceding claims,
characterized in
that the main power supply (5) and the auxiliary power supply (6) each comprise a transformer for establishing a SELV barrier.

6. Operating device according to any of the preceding claims,
characterized in
that the operating device (1) comprises a bus interface (17) connected to the control unit (7) for communicating via an external bus system.

7. Operating device according to any of the preceding claims
characterized in
that the control unit (7) is configured to enable each connected sensor device (3) and the operating device (1) to be addressable as distinct entities.

8. Sensor device comprising an interface (11) for connecting to a power supply to supply the sensor device (3) with electrical energy, wherein the sensor device (3) is further configured to perform powerline communication over the interface (11).

9. Lighting system comprising the operating device (1) according to any one of the claims 1 to 7 and at least one sensor device (3) according to claim 8.

10. Lighting system according to claim 9,
characterized in
that the lighting system is comprised in a luminaire.

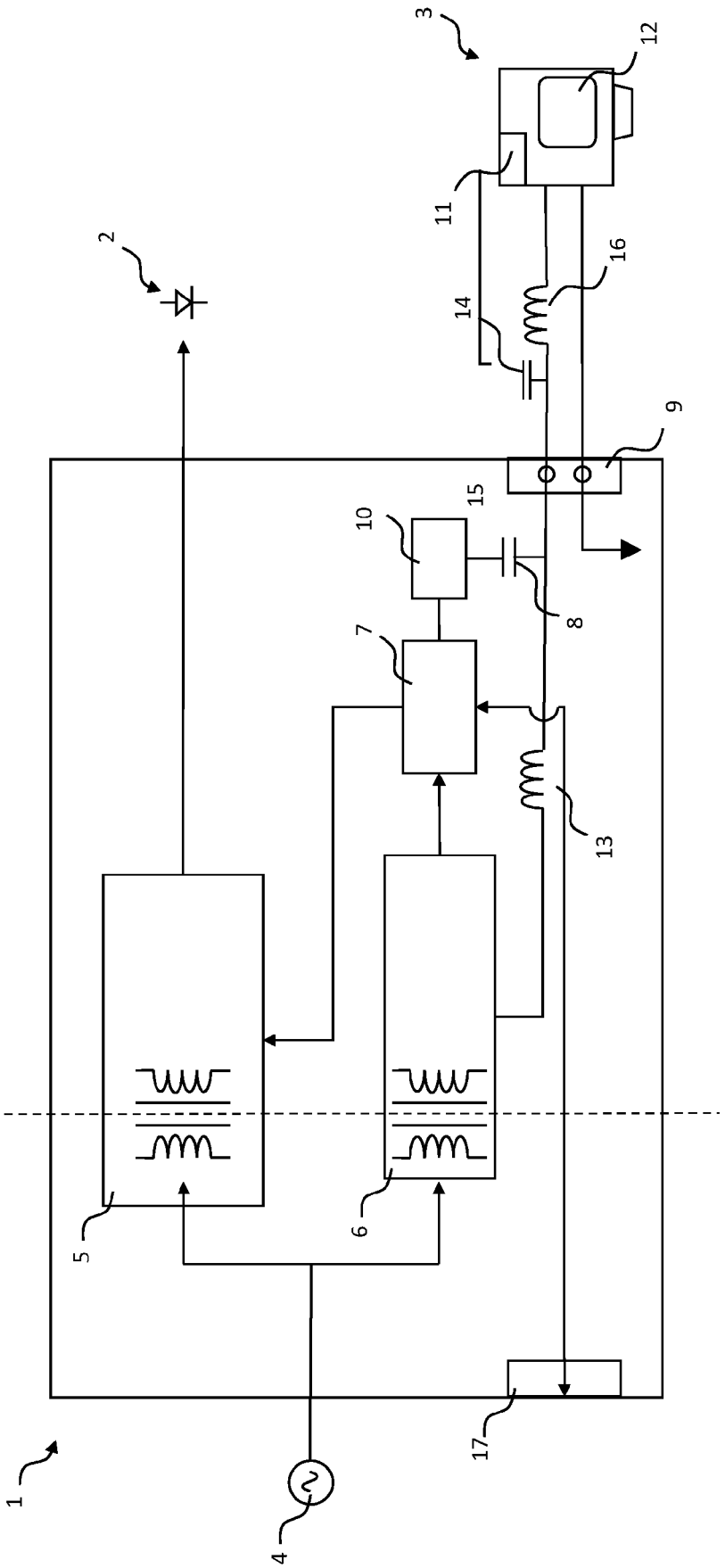

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 9917

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2019/207650 A1 (KEARNEY PHIL [US] ET AL) 4 July 2019 (2019-07-04) * paragraph [0037] - paragraph [0065]; figures 1, 2 *	1-10	INV. H05B45/382 H05B47/105 H05B47/185 H05B47/18
X	WO 2013/045189 A1 (OSRAM GMBH [DE]; DAI XUEWEI [CN] ET AL.) 4 April 2013 (2013-04-04) * page 8, line 1 - line 22 *	1,8,9	
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TECHNICAL FIELDS SEARCHED (IPC)

H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 October 2022	Plamann, Tobias

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 16 9917

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21-10-2022

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