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(54) MONITORING AND WARNING SYSTEM FOR INDIVIDUALS WORKING UNDER HAZARDOUS PPERATING CONDITIONS

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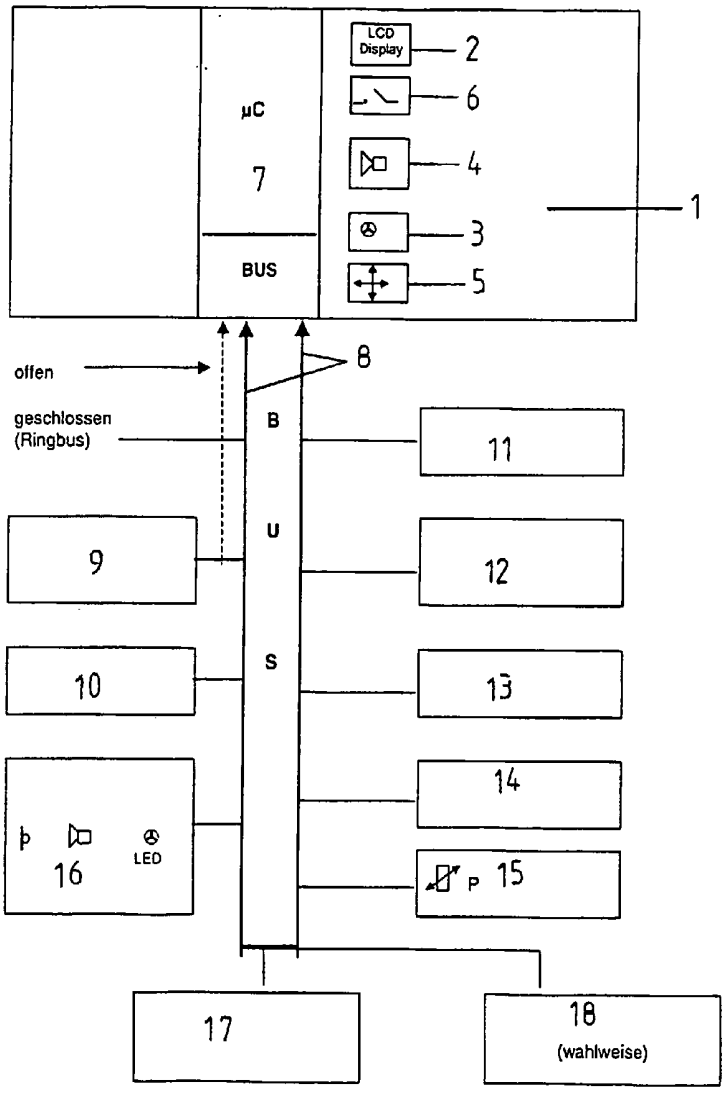
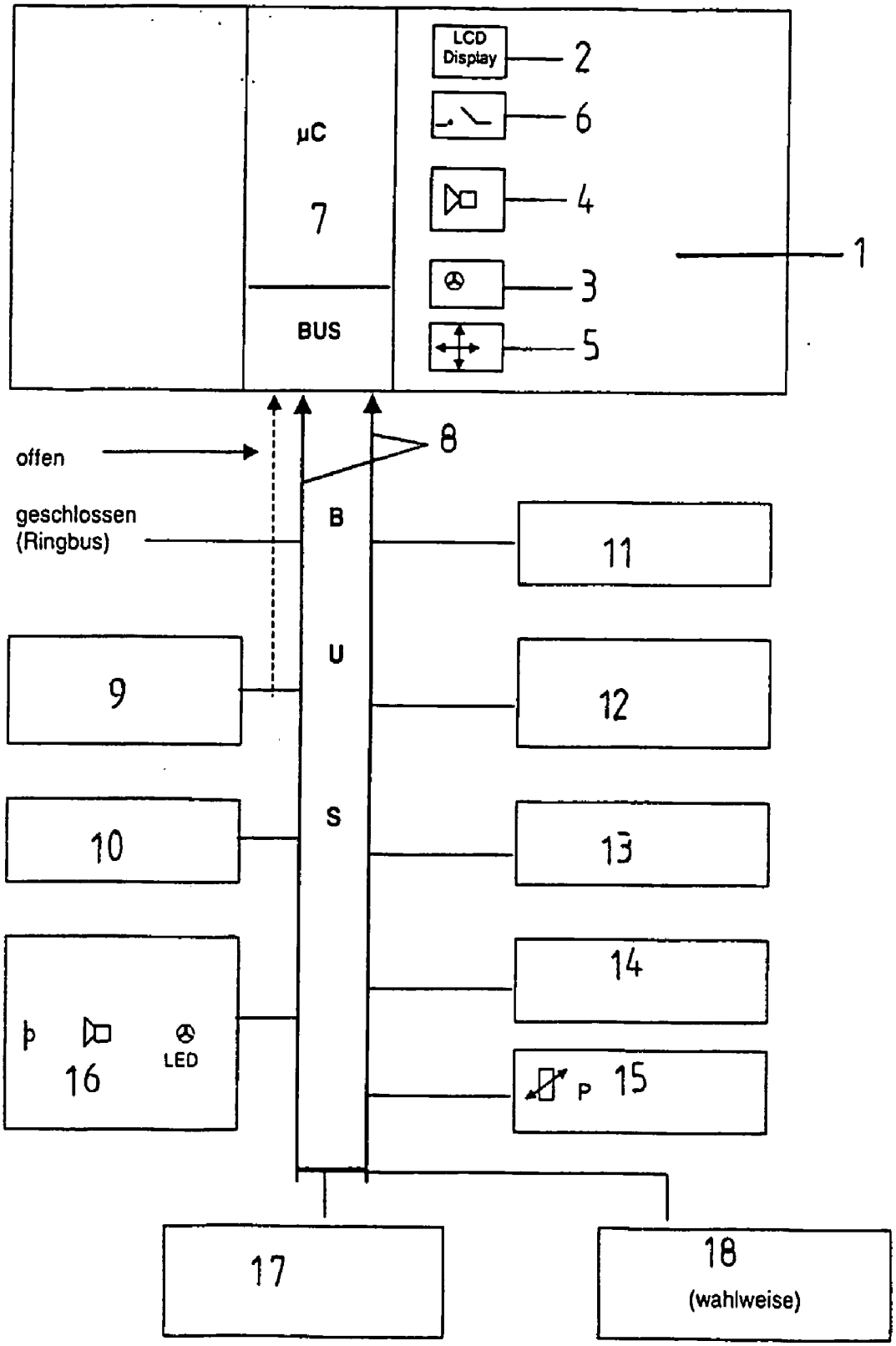
(57) **ABSTRACT**

A monitoring and warning system for firefighters and individuals exposed to similar risks comprises a number of monitoring, warning and control devices (**1, 9** to **16**) as well as a telemetry module (**17**) for transmitting information to a base station and for receiving commands. All units of the system are connected in a galvanic or galvanically separated manner to a shared open or closed bus (**8**) and, in fact, are used either for master/master operation or for master/slave operation. The system functions rapidly and in a noise-free manner while having a low level of complexity with regard to connections and being able to be easily retrofitted with additional units, and can also be used in potentially explosive areas.




LCD Display
2
6
µC
7
4
1
3
BUS
5
offen
8
geschlossen (Ringbus)
B
11
U
9
12
S
10
13
14
LED
16
P
15
17
18
(wahlweise)

MONITORING AND WARNING SYSTEM FOR INDIVIDUALS WORKING UNDER HAZARDOUS PPERATING CONDITIONS

[0001] This invention relates to a monitoring and warning system for people working in hazardous environments, preferably comprising a monitoring device (ICU) that consists of a microcomputer as well as data and alarm displays and alarm sensors and is connected to a compressed air breathing apparatus, a telemetric module and other monitoring and/or control units.

[0002] Operations in mining and tunnel construction, some industrial branches, the military as well as fire-fighting or rescue missions in areas contaminated by natural disasters or accidents present considerable hazards to the respective workers. Such hazards can be toxic and/or explosive gases, hazardous radiation or high temperatures. Rescue workers are equally exposed to hazards created by falling objects and exposure to other physical impacts or extreme physical strain. In addition, the time people can work when breathing from a compressed air breathing apparatus is limited to the capacity of the compressed air bottle and must not be exceeded.

[0003] Various interconnected electronic warning, monitoring, control and information devices (hereinafter called 'units' for short) are required to monitor operating conditions, gather site information, check vital functions, determine the position and alert the respective person in hazardous or even life-threatening conditions or to control and monitor specific apparatuses such as a pressure reducer connected to a compressed air breathing apparatus or an oxygen system. For example, a monitoring and warning system consisting of the following units is provided for fire fighters wearing compressed air breathing apparatuses:

[0004] a monitoring device (ICU) for the compressed air breathing apparatus mainly containing pressure, motion, and temperature sensors, alarm and data displays (LED and LCD) as well as acoustic alarms;

[0005] a gas warning device for toxic and/or explosive gases

[0006] a positioning device (such as GPS)

[0007] a pressure gauge for measuring and monitoring compressed air bottles

[0008] control devices for the pressure reducer and the oxygen system

[0009] a measuring instrument for monitoring vital functions, and

[0010] a camera/thermal imaging camera information system.

[0011] A telemetric module is another important unit of the system that is used to transmit system status and individual unit data to the base stations outside the immediate operating area to allow outside control over the people in the operating area. In addition, commands, information and messages from the base station are to be forwarded from the base station to the respective person via specific units.

[0012] Such complex electronic safety systems have considerable requirements regarding communication among the units and with the telemetric module as well as incorporating new components. Furthermore, compliance with applicable national or regional standards/regulations is required. Expensive additional measures have to be taken for an explosion-protected and trouble-free design and for integrating each unit.

[0013] It is therefore the problem of the invention to design a monitoring and warning system equipped with a telemetric module for bidirectional communication with a base station in such a way that simple and fail-safe connection setup, easy integration of additional units, and fast data transfer among system components and to the base station are ensured.

[0014] This problem is solved according to the invention by a monitoring and warning system comprising the characteristics described in claim **1**.

[0015] The inventive idea is that, in a device system worn by a person exposed to a hazard, all monitoring and alarm units, control units and the telemetric module are integrated in a common bus of open or closed design wherein the units are either switched for master-slave or for master-master operation. In master-slave operation, one of the units receives or controls the information of the other units in the system and forwards it to the telemetric module. In master-master operation with peer units, the units can exchange data among each other, and each unit can send its data directly to the telemetric module.

[0016] A system configured in this way requires less wiring and interconnecting. Additional units can easily be incorporated into the bus system. The status and data of each unit are transferred in parallel to a remote base station, which allows fast transfer. At the same time, messages and commands from the base station can be transferred to the units. The units can be coupled to the bus in such a way that the requirements of explosion protection and faultless operation of the monitoring and warning system are met. On the other hand, the bus link can be configured in such a way that information can be transferred in the opposite direction in the event of disconnected line or that the risk of a disconnected line is eliminated.

[0017] The subclaims and the description of a preferred embodiment of the invention below disclose other characteristics and useful improvements of the invention or other advantages.

[0018] For example, the bus can either be configured for parallel and fast transfer of data, address and control signals or for serial information transfer to reduce wiring.

[0019] According to another characteristic of the invention, each unit is connected to the bus by isolated connections and has its own power supply. This proposed solution is useful for monitoring and warning systems that are to be used in areas subject to explosion hazards.

[0020] A central power supply can be directly integrated in the bus if the system is used in areas not subject to explosion hazards.

[0021] A useful improvement of the invention is a star-shaped arrangement of the units where one unit has the master function, scans the data from the other units and transfers it to the telemetric module; another improvement is connecting the units in parallel to the bus, which reduces cabling. According to a preferred embodiment with

improved safety standards, a serial ring bus is provided and all information from all units is transferred serially while data can be transferred in the opposite direction if the bus is disconnected. Yet another conceivable improvement of the invention is a high-frequency connection via which data can be exchanged among the units without connecting cables and the risk of a disconnected line is eliminated. The HF connection also allows master-slave or master-master operation.

[0022] An embodiment of the invention is explained in greater detail below with reference to the figures. One single FIGURE shows a block diagram of a monitoring and warning system connected to a compressed air breathing apparatus (not shown) whose units are interconnected via a ring bus. The dashed lines in the FIGURE indicate that the bus may also have an open design.

[0023] The FIGURE shows a central monitoring unit **1** named ICU that is connected to a compressed air breathing apparatus and comprises a data display (LCD) **2**, an alarm display (LED) **3**, an acoustic alarm **4**, a motion detector **5** and function keys **6** and a microcomputer (SC) **7**. In addition to the monitoring device **1**, a first control unit **9** for an electronic pressure reducer of the compressed air breathing apparatus (not shown), a second control unit **10** for an oxygen system (not shown), a measuring unit **11** for monitoring the respective person's vital functions, a gas warning device **12** for detecting explosive and/or toxic gases, a positioning device **13** with a camera **14**, a pressure sensor **15** for determining the pressure in the compressed air bottle, a helmet/mask communication module **16** for data display in the wearer's immediate field of vision using a head-up display, and a telemetric module **17** for transferring the data from each unit to a central base station (not shown) or for receiving commands and messages from the base station to the units or the wearer are connected to a closed-type ring bus **8**. In addition, a central power supply **18** can optionally be connected to the ring bus **8** to supply power as required to all units of the monitoring and warning system. This power supply is not provided when the units are connected separately to the ring bus **8** and have their own power supplies so that the sytem is suitable for use in areas subject to explosion hazards. Other units can easily integrated into such a monitoring and warning system interconnected via a bus **8**.

[0024] Each unit fulfills its respective functions within the overall system and passes the respective information on to the controlling devices, the alarm and data displays, the alarm sensors in the monitoring device (ICU) **1** or in the helmet/mask communication module **16** and—depending on mode of operation—either directly or via a master unit (such as the ICU **1**) to the telemetric module **17** to transfer the information from the monitoring and warning devices in parallel to the base station.

[0025] The system is not shut down even when the bus line is disconnected when the units are connected as shown via a ring bus **8** because the information can also be transferred in the opposite direction.

[0026] The FIGURE uses the '?' symbol to refer to a HF model for communication without a bus link (HF bus) where the power supply does not need an HF module as it is connected to at least one unit whose information is known to the power supply.

List of Reference Symbols

[0027] **1** Monitoring device (ICU)

[0028] **2** Data display (LCD) of **1**

[0029] **3** Alarm display (LED) of **1**

[0030] **4** Acoustic alarm of **1**

[0031] **5** Motion detector of **1**

[0032] **6** Function keys of **1**

[0033] **7** Microprocessor (AC) of **1**

[0034] **8** Bus (ring bus)

[0035] **9** First control unit (for pressure reducer)

[0036] **10** Second control unit (for oxygen system)

[0037] **11** Measuring unit (vital functions)

[0038] **12** Gas warning device (explosive and toxic gases)

[0039] **13** Positioning device (PSB)

[0040] **14** Camera

[0041] **15** Pressure sensor (compressed air bottle pressure)

[0042] **16** Helmet/mask communication module/head-up display

[0043] **17** Telemetric module

[0044] **18** Power supply

1. A monitoring and warning system for people working in hazardous environments, preferably comprising a monitoring device (ICU) that consists of a microcomputer as well as data and alarm displays and alarm sensors and is connected to a compressed air breathing apparatus, a telemetric module and other monitoring and/or control units, characterized in that all monitoring and warning devices (**1** and **11** through **16**), control units (**9**, **10**) and the telemetric module (**17**) of the system are interconnected via a common—open-type or closed-type—bus (**8**) and wherein the units (**1**, **9**-**16**) are switched either for master-slave or for master-master operation.

2. The monitoring and warning system according to claim 1, characterized in that it comprises a bus (**8**) with parallel transfer of data, address and control signals.

3. The monitoring and warning system according to claim 1, characterized in that it comprises a serial bus (**8**) for serial transfer of data, address and control signals over one and the same line section.

4. The monitoring and warning system according to any one of claims **1** through **3**, characterized in that each unit has its own power supply and is separately connected via optocouplers or a fiber optic connection to the bus (**8**) or is connected via a high-frequency radio connection for system operation in areas subject to explosion hazards.

5. The monitoring and warning system according to any one of claims **1** through **3**, characterized in that a common power supply (**18**) for all units (**1**, **9** through **16**) is incorporated into the bus (**8**) for system operation in areas not subject to explosion hazards and that the units are electrically connected to the bus (**8**).

6. The monitoring and warning system according to any one of claims **1** through **5**, characterized in that the units are connected in a star shape wherein one of the units operates as bus master for scanning the respective data from the other units and transferring this data to the telemetric module (**17**).

7. The monitoring and warning system according to any one of claims **1** through **5**, characterized in that the units of the system are connected in parallel to the bus (**8**).

8. The monitoring and warning system according to any one of claims **1** through **6**, characterized in that the units of the system are connected in series to a ring bus (**8**).

9. The monitoring and warning system according to any one of claims **1** through **5**, characterized in that the units of the system are connected via a high-frequency connection.

* * * * *

专利名称(译)	在危险操作条件下工作的个人的监测和警告系统		
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申请(专利权)人(译)	SCHUBERT AXEL LUBKOLL DIETER		
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摘要(译)

用于消防员和暴露于类似风险的个人的监视和警告系统包括若干监视，警告和控制装置（1,9至16）以及用于将信息发送到基站并用于接收命令的遥测模块（17）。。系统的所有单元以电流或电流分离的方式连接到共用的开路或闭路总线（8），并且实际上用于主/主操作或主/从操作。该系统快速且无噪音地运行，同时在连接方面具有低水平的复杂性并且能够容易地用额外的单元进行改装，并且还可以用于潜在爆炸区域。