

(19)



(11)

EP 2 926 360 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
21.09.2016 Bulletin 2016/38

(51) Int Cl.:
H01H 85/02 (2006.01) **H01H 85/20** (2006.01)
H01H 85/56 (2006.01) **H01H 85/30** (2006.01)

(21) Application number: **13805809.4**

(86) International application number:
PCT/EP2013/075180

(22) Date of filing: **29.11.2013**

(87) International publication number:
WO 2014/083192 (05.06.2014 Gazette 2014/23)

(54) FUSE HOLDER APPARATUS

SICHERUNGSHALTERVORRICHTUNG

DISPOSITIF PORTE-FUSIBLE

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **29.11.2012 GB 201221495**

(43) Date of publication of application:
07.10.2015 Bulletin 2015/41

(73) Proprietor: **Eaton Industries Manufacturing GmbH
1110 Morges (CH)**

(72) Inventor: **LEWIS, Carl
Henryd Clwyd LL32 8YY (GB)**

(74) Representative: **Eaton IP Group
EMEA
Route de la Longeraie 7
1110 Morges (CH)**

(56) References cited:
**EP-A1- 2 511 711 WO-A1-2014/026702
DE-A1- 3 411 323 DE-A1-102007 044 427
DE-U1- 20 001 323 GB-A- 2 458 298
US-A- 2 654 068 US-A1- 2007 257 807**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 926 360 B1

Description

[0001] This invention relates to fuse holder apparatuses, in particular to fuse holders and fuse pullers.

Background

[0002] A fuse is a well-known type of overcurrent device. A conventional fuse contains a metal wire or strip which melts when the current through it exceeds a predetermined threshold. When the metal wire or strip melts, further current flow through the fuse is prevented.

[0003] A fuse holder is a well-known device for holding a fuse in the supply line of an electrical supply. A fuse puller is a known device for inserting a fuse into and removing a fuse from a fuse holder. The fuse puller helps to protect a user from electric shock and blown fuse effects.

[0004] The fuse industry is a very well established industry. The functionality of fuses, fuse holders and fuse pullers has changed very little in recent years.

[0005] US-A-5002505 discloses a fuse holder for a cartridge fuse and a mating receptacle, the holder being installable in the mating receptacle and removed therefrom for fuse replacement. The fuse holder includes a visual indicator for denoting a blown or missing fuse.

[0006] US-A-6448785 discloses a fuse extractor and puller including a cylindrical fuse receiving portion, a lifting and inserting tower and a gripping head. The inserting tower incorporates a continuity detector a continuity detector including a light, for indicating the condition of a fuse.

[0007] WO 2014/026702A1 discloses a subassembly for a switch fuse arrangement, in particular a switch fuse arrangement for bus bar systems or installed devices, in particular having one or multiple switch fuse units to receive a fuse holder each, which is constructed such that it is able to receive a fuse insert, and having a measuring device for determining electric operating values of the switch fuse arrangement, wherein the measuring device has measuring electronics and at least one indicating device for indicating at least one of the electric operating values determined by the measuring device, and wherein the subassembly comprises at least one coil device, which is designed such that, by means of induction, it is able to provide energy for the measuring electronics and/or the at least one indicating device.

[0008] Document US 2007/257807 A1 discloses a circuit protector monitoring assembly comprising: at least one circuit protector defining an interruptible current path therethrough upon an occurrence of specified current conditions through the interruptible current path, a status element connected in parallel with the circuit protector and adapted to sense an operating state of the current path and wirelessly transmit information regarding the operating state of the current path, the information including a circuit protector identifier and a circuit protector location; and the status element comprising a housing

and an antenna projecting from the housing.

[0009] Document GB 2 458 298 A discloses a housing which is partially enclosing an electrically conductive device. The housing comprises a guidance means that defines a track for receiving a measurement probe. The guidance means is positioned so that the measurement probe can at least partially encircle the electrically conductive device without touching it.

[0010] At its most general, this invention provides a fuse puller which is arranged to measure a plurality of parameters relating to a supply line in which a fuse is held. Derivable from any given electrical installation is information about the electric supply and the load circuit to which the electric supply is connected. Therefore, by measuring a plurality of supply line parameters (i.e. parameters relating to the supply line), the fuse puller is able to utilise this information, e.g. by providing diagnostic information to a user. In contrast, prior art fuse pullers provide little or no information about an electric supply. For example, the fuse puller disclosed in US-A-6448785 only has an indicator for indicating whether a fuse is continuous, and is not capable of measuring other parameters.

[0011] According to one aspect of the invention, there is provided a fuse puller for inserting a fuse into and removing a fuse from a fuse holder, the fuse puller having: a fuse gripping portion for gripping a fuse; and a measuring circuit arranged to measure a plurality of supply line parameters when a fuse is gripped by said gripping portion and held in a supply line of an electric supply.

[0012] The fuse puller may be arranged to measure/detect some or all of the following supply line parameters: fuse continuity (e.g. whether the fuse has blown), supply line current, supply line voltage (which may be measured with reference to a neutral line of the supply line), ambient temperature, terminal temperature, supply line non-linearities associated with arc faults, power, energy consumption, time of fault(s), number of faults, fuse health, prediction of failure, preventative maintenance warning, incorrect/defective fuse installation notification, fuse life prediction, fuse change reporting, and reason for a blown fuse/broken circuit.

[0013] By way of example, fuse continuity (e.g. whether the fuse has blown) could be measured/detected using a voltage sensor, e.g. configured to measure the voltage between the two terminals of a fuse, e.g. by having the voltage sensor connected to a supply line input contact and a supply line output contact of the measuring circuit (see below). If the measured voltage is below a predetermined threshold, this may indicate that the fuse has a continuous state. If the measured voltage is above a predetermined threshold, this may indicate that the fuse has a discontinuous state.

[0014] By way of example, supply line current could be measured using a current sensor, e.g. which could be connected to a supply line input contact and a supply line output contact of the measuring circuit (see below). In this way, the current sensor may create a bypass to direct

some current through the current sensor (e.g. via transducer or a resistor). In general, the resistivity of the fuse will be very low - this could be taken into account (e.g. by setting the rating of the fuse in an appropriate current sensing algorithm) if high accuracy is needed. In some embodiments, the fuse puller may have an integrated current sensor (inductive or resistive) which connects to and is configured to have its data processed by the fuse puller.

[0015] By way of example, supply line voltage could be measured using a voltage sensor, e.g. which could be connected to two contacts in the fuse puller configured to be connected, respectively, to two contacts in the fuse holder that are configured to be connected, respectively, to the neutral line and a supply line of the electric supply when the fuse holder is held in the supply line.

[0016] By way of example, ambient temperature could be measured using a temperature sensor which could e.g. be located on a surface of the fuse puller. The temperature sensor could be configured to detect the ambient temperature. Preferably, care is taken to ensure that the temperature generated by the load current does not lead to misleading ambient temperature measurements.

[0017] By way of example, terminal temperature could be measured using one or more temperature sensors which could e.g. be located at one or more terminals of the fuse holder.

[0018] By way of example, supply line non-linearities associated with arc faults could be measured using an arrangement that is the same as/similar to the above described arrangement for measuring supply line current. For example, measured supply line current values may be processed through an arc-fault detection algorithm, which may also use measured supply line voltage values.

[0019] By way of example, power may be measured using supply line current and supply line voltage values, which may e.g. be measured as described above, e.g. to yield actual power consumption as a function of time $P(t)$. The real power and/or apparent power may also be derived.

[0020] By way of example, energy consumption may be measured by integrating power (e.g. $P(t)$) over a period of time, e.g. to provide a function of time $E(t)$.

[0021] By way of example, time of fault(s) could be logged and stored in a memory, e.g. a flash-EEPROM memory, together with a time-stamp derived from a local clock included in the fuse-puller.

[0022] By way of example, number of fault(s) could be stored in a memory, e.g. a flash-EEPROM memory. Different fault-modes could be assigned to different counters, e.g. so that each fault type could be counted separately.

[0023] By way of example, fuse health could be measured e.g. by measuring the impedance of the fuse, e.g. using the same components used to measure the supply line current, fuse continuity and/or supply line voltage. The impedance of the fuse could be measured periodically, e.g. so as to allow fuse health to be tracked the

fuse health over time.

[0024] By way of example, a preventative maintenance warning could be issued if an abnormal condition is detected, e.g. via the fuse health measurement. The preventative maintenance warning may be issued locally on the fuse-puller (e.g. via a LED) or via a remote communication path.

[0025] The measuring circuit preferably at least measures the following supply line parameters: fuse continuity, supply line current and supply line voltage since, as observed above, many other supply line parameters can be determined from these parameters.

[0026] The fuse puller may be arranged to quantitatively measure at least one of the supply line parameters. In other words, the fuse puller may measure the magnitude (i.e. amount) of a supply line parameter. This is different to, for example, the fuse puller of US-A-6448785, which is only capable of indicating the continuity of a fuse, i.e. whether a fuse is continuous or not. Measuring supply line parameters quantitatively allows the magnitude of parameters such as supply line current and supply line voltage to be measured, which may be useful for calculating other parameters and/or diagnostic purposes.

[0027] For the avoidance of any doubt, the fuse puller being arranged to quantitatively measure one or more supply line parameters may be an alternative to, or in addition to, the fuse puller being arranged to measure one or more other supply line parameters non-quantitatively.

[0028] The fuse puller may include a display unit for displaying the supply line parameters measured by the measuring circuit. The display unit may include a display screen and/or other display features such as LEDs or light pipe apertures. The display unit allows a user to view the supply line parameters, e.g. for diagnostic purposes.

[0029] The display unit may include a user interface, to allow a user to control the measuring circuit. For example, the user interface may allow a user to change the parameters being measured by the measuring circuit and/or to change the parameters being displayed by the display unit. Suitable user interface features may be buttons or switches.

[0030] The measuring circuit may include a supply line input contact and a supply line output contact, the input and output contacts being arranged so that, when a fuse is gripped by the gripping portion and held in the supply line of an electric supply, the input contact electrically connects to an input side of the supply line with respect to the fuse and the output contact electrically connects to an output side of the supply line with respect to the fuse (i.e. with the contacts electrically connected to the supply line on opposite sides of the fuse). Having these contacts on opposite sides of the fuse permits the measuring circuit to measure parameters such as fuse continuity.

[0031] In one convenient arrangement, the supply line input and output contacts are arranged to electrically connect to the input and output sides of the supply line with

respect to the fuse by, when the fuse is held by the gripping portion, physically contacting opposite ends of the fuse. Any suitable arrangement between the fuse and the supply line input and output contacts may be used. For example, the supply line input and output contacts may be spring contacts. Alternatively, the supply line input and output contacts may be part of a hinged assembly, wherein the gripping portion grips a fuse by a toggle action.

[0032] The measuring circuit may include a power supply unit (PSU) for powering the measuring circuit. The power supply unit is preferably arranged to be electrically connected to the supply line and a neutral line of the electrical supply. This allows the PSU to be powered from the supply line and neutral line, rather than using a battery for example. It is useful for the power supply unit to be connected to the neutral line of the electric supply because this allows power to be supplied to the measuring circuit even if the fuse is blown.

[0033] The electric connection between the PSU and to the supply line may conveniently be provided by the supply line input contact or the supply line output contact described above. Preferably, the electric connection between the PSU and to the supply line is provided by the supply line input contact because this enables the PSU to be powered from the supply line and neutral line even when the fuse is blown.

[0034] The measuring circuit may include a neutral terminal connected to the PSU, for electric connection to the neutral line of the electric supply. Therefore, the neutral terminal represents one possible means of providing an electrical connection between the PSU and the neutral line of the electric supply, e.g. by using a cable.

[0035] The fuse puller may include one or more analogue to digital converters (ADCs) for converting analogue signals representative of supply line parameters into digital signals representative of supply line parameters. For example, the analogue signals may be representative of one or more of the following supply line parameters: supply line current, supply line voltage, ambient temperature, terminal temperature, temperature measured from a temperature sensitive area on a PCB of the fuse puller, impedance of the fuse (which may be taken as being indicative of fuse health, see above). Preferably, at least one ADC is electrically connected to the supply line input and supply line output contacts, as this may allow the ADC to produce digital signals representative of the supply line current and supply line voltage, for example.

[0036] The fuse puller may also include a digital signal processor for processing the digital signals from the one or more ADCs. The processor may be configured to calculate additional supply line parameters based on the digital signals from the one or more ADCs.

[0037] The digital signal processor may include a memory for storing supplementary parameters. The supplementary parameters may include on or more of a unique internal identifier of the fuse puller, the configu-

ration of the measuring circuit, and information regarding identification and characteristics of the fuse.

[0038] The measuring circuit may include a communications unit for producing and/or receiving data signals.

5 This may allow the measuring circuit to communicate with other devices, for example other fuse pullers or external devices. The communications unit may be connected to the digital signal processor. The data signals produced by the communications unit may include signals representative of the supply line parameters or supplementary parameters (e.g. for sending to an external device) and/or control signals (e.g. for controlling other fuse pullers).

10 **[0039]** The measuring circuit may include a data terminal connected to the communications unit, for connection to an external device. Therefore, the data terminal represents one possible means of connecting the measuring circuit to an external device.

15 **[0040]** A part of the measuring circuit may be located on a module which is detachably mounted/mountable to the fuse puller. By having part of the measuring circuit located on a detachable module, it is possible to use that part of the measuring circuit with other fuse pullers. This saves on expense, since it is not necessary to provide each fuse puller with the part of the measuring circuit located on the detachable module. The shape of the detachable module may assist a user in inserting/removing a fuse using the fuse puller, e.g. by incorporating a grip.

20 **[0041]** The detachable module may be attached to the fuse puller by any suitable attachment. For example, the detachable module may be slidably attached to the fuse puller, e.g. so that the detachable module is a slidably removable face.

25 **[0042]** The detachable module may include security features, such anti-tamper features and/or biometric sensing features.

30 **[0043]** The above described display unit may be located on the detachable module. This means that expensive components (such as the display screen) can be reused with multiple fuse pullers, without having to provide each fuse puller with the display unit. The display unit could be located on a detachable module with a clear body illuminated by one or more LEDs arranged to provide a user with a supply line parameter (e.g. fuse continuity).

35 **[0044]** A wireless communications device may be located on the detachable module. The wireless communications device may connect to the communications unit to allow the communications unit to communicate wirelessly.

40 **[0045]** There may be a plurality of different detachable modules provided, each module having different function.

[0046] The fuse puller may be arranged to be used with a conventional fuse holder, so that the fuse puller may be used as a retrofit device.

45 **[0047]** In another aspect of the invention, there is provided a fuse holder apparatus which includes a fuse holder for holding a fuse in a supply line of an electric supply; and a fuse puller as described above for inserting a fuse

into and removing a fuse from the fuse holder, the fuse puller being detachably mountable on the fuse holder. The fuse holder may be a conventional fuse holder.

[0048] The fuse holder may include fuse spring contacts for holding a fuse in the supply line of an electric supply. The spring fuse contacts may be embedded in the fuse holder or separate to the rest of the fuse holder.

[0049] The fuse puller is preferably configured so that a fuse is held in a supply line when the fuse is gripped by the gripping portion and the fuse puller is mounted to the fuse holder. The fuse puller preferably helps to protect a user from electric shock and blown fuse effects when it is used to insert a fuse into the fuse holder, e.g. by avoiding the dangers associated with inserting the fuse into the fuse holder by hand.

[0050] The fuse holder may include a neutral element for electrical connection to the neutral line of the electric supply, the neutral element being arranged to be electrically connected to the measuring circuit (preferably the PSU of the measuring circuit) when the fuse puller is mounted to the fuse holder. The neutral element therefore provides one possible means of providing an electrical connection between the PSU of the measuring circuit and the neutral line of the electric supply.

[0051] The fuse holder may include a data element for carrying data signals to and from the measuring circuit, the data element being arranged to be connected to the measuring circuit (preferably the communications unit of the measuring circuit) when the fuse puller is mounted to the fuse holder. The data element therefore provides one possible means of providing a connection between the communications unit and other devices (e.g. other fuse pullers and/or external devices).

[0052] The neutral element and/or data element may be a piece of electrically conductive material (e.g. copper). The neutral element and/or data element may be embedded in the body of the fuse holder. Alternatively, the neutral element and/or data element could be an insert which is held in the fuse holder, e.g. by using clips, push fit features or other locking devices such as screws or clip on covers.

[0053] A plurality of the fuse holders may be provided wherein the neutral elements of the fuse holders are electrically connected to form a neutral bus. Accordingly, by electrically connecting one of the neutral elements to the neutral line of the electric supply (e.g. using the neutral terminal on a fuse puller), the whole neutral bus becomes electrically connected to the neutral line of the electric supply. Therefore, the electric connection between the neutral line of the electric supply and the PSU of the measuring circuit can be provided by the neutral bus (e.g. as an alternative to the neutral terminal). The neutral bus may provide a particularly convenient way of connecting a plurality of fuse pullers to the neutral line of the electric supply.

[0054] A plurality of the fuse holders may be provided wherein the data elements of the fuse holders are electrically connected to form a data bus. This is preferably

in addition to the neutral elements forming a neutral bus. Accordingly, it is possible to send data signals from the communications unit of one measuring circuit to the communications unit of another measuring circuit via the data bus. Therefore, the data bus may allow a plurality of fuse pullers to communicate with one another and/or external devices.

[0055] The plurality of fuse holders may each be provided with attachment elements which allow the fuse holders to be detachably mounted to one another. This enables a fuse holder to be constructed so as to hold a desired number of fuses. The neutral elements may be arranged and/or shaped so as to form the neutral bus when the fuse holders are mounted to one another. The data elements may be arranged and/or shaped so as to form the data bus when the fuse holders are mounted to one another.

[0056] The neutral elements and/or data elements may have any suitable contact arrangement so as to form the neutral bus and/or data bus when the fuse holders are mounted to one another. For example, any of the following contact arrangements could be used: point spring loaded connectors, spring connectors having a wiping action when assembled to contact pads in the fuse holder, a male and female plug and socket, a contact pair which ensure a gas tight seal. The contact arrangement is preferably arranged to be covered by the body of the fuse puller and/or the fuse holder so as to protect against foreign bodies and contact contamination.

[0057] Alternatively, the plurality of fuse holders may be formed as an integral unit.

[0058] In another aspect of the invention, there is provided a fuse holder as described above.

[0059] In a further aspect of the invention, there is provided a detachable module as described above.

[0060] In a yet another aspect of the invention, there is provided a kit of parts for assembling a fuse holder apparatus as set out above. The kit may e.g. comprise at least one fuse puller as described above. The kit may e.g. comprise at least one fuse holder as described above.

[0061] Embodiments of our proposals are discussed below, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a fuse holder apparatus including a fuse puller and four fuse holders.

Figs. 2(a)-(e) are perspective views of the fuse puller of Fig. 1.

Fig. 3 is a schematic view of the fuse puller of Fig. 1.

Figs. 4(a) and 4(b) are perspective views of one of the fuse holders shown in Fig. 1.

[0062] Fig. 1 shows a fuse holder apparatus 10 which includes a fuse puller 20 and four fuse holders 50. Each

fuse holder 50 is arranged to hold a fuse (not shown) between fuse spring contacts 52, 54, so as to hold the fuse in a supply line of an electric supply (not shown). The four fuse holders are detachably mounted to one another and are mounted on a din rail 15.

[0063] The fuse puller 20 is arranged to insert a fuse into and remove a fuse from each of the fuse holders 50. The fuse puller 20 is detachably mounted to one of the fuse holders 50, so as to hold a fuse (not shown in Fig. 1) between the fuse spring contacts 52, 54 and therefore to hold the fuse in the supply line of the electrical supply. A display module 40 which includes a display screen 41 is detachably mounted to the fuse puller 20, by a sliding attachment.

[0064] Fig. 2 shows the fuse puller 20 in more detail. The fuse puller 20 has a gripping portion 25 for gripping a fuse 70.

[0065] The fuse 70 is securely held by the gripping portion 25 so that the fuse 70 can be placed in a supply line 90 of an electric supply (see Fig. 3) by mounting the fuse puller 20 to one of the fuse holders 50. This allows for the fuse 70 to be correctly and easily installed into the fuse holder 50. The fuse puller 20 helps to protect users from any arc flash when the fuse 70 blows and also acts as a cover for any live parts in the fuse holders 50. The fuse puller 20 may also enable hot swapping of fuses in a fuse holder (i.e. swapping the fuse whilst the supply line is live).

[0066] The fuse puller 20 may include a neutral terminal 22 for electrical connection (e.g. by cable) to a neutral line of the electric supply. The neutral terminal 22 is located in a recessed portion of a casing of the fuse puller 20, which helps to protect the neutral terminal 22. The fuse puller 20 also includes a data terminal 24 for connection (e.g. by a cable) to an external device. In this example, the neutral terminal 22 is located at an opposite (in this case upper) end of the fuse puller 20 from the data terminal 24 (which is located at a lower end of the fuse puller 20).

[0067] Fig. 3 shows the fuse puller 20 in more detail. In Fig. 3, the fuse 70 is held in a supply line 90 of an electric supply. The fuse puller 20 includes a measuring circuit 30 which measures a plurality of supply line parameters. The measuring circuit 30 includes a supply line input contact 26 and a supply line output contact 27. The supply line input contact 26 and the supply line output contact 27 physically contact the ends of the fuse 70 held by the gripping portion 25 (see Fig. 2c). Therefore, because the fuse 70 is held in the supply line 90, the supply line input contact 26 is electrically connected to the input side of the supply line 90 with respect to the fuse 70 (i.e. the side of the fuse closer to the electric supply) and the supply line output contact 27 is electrically connected to the output side of the supply line 90 with respect to the fuse 70.

The input/output contacts 26, 27 provide an input to the measuring circuit 30, to allow the measuring circuit 30 to measure various supply line parameters.

[0068] The measuring circuit 30 includes a power supply unit (PSU) 31, an analogue front end 32 including one or more analogue to digital converters (ADCs), a digital signal processor 33, a display unit 34 and a communications unit 35.

[0069] The PSU 31 provides power to the other components of the measuring circuit 30. The PSU 31 is powered by electrical connection to the supply line 90 of the electric supply and the neutral line of the electric supply.

[0070] The PSU 31 electrically connects to the supply line 90 via the supply line input contact 26. Therefore, the PSU 31 is powered from the input side of the supply line, i.e. the side of the fuse 70 which is closer to the electrical supply. This means that an electrical connection from the PSU 31 to the supply line 90 can be maintained even if the fuse 70 is blown.

[0071] The PSU 31 electrically connects to the neutral line of the supply line via the neutral terminal 22 located on the fuse puller 20. However, instead of using the neutral terminal 22, the PSU 31 can alternatively be electrically connected to the neutral line of the electric supply via a neutral bus 60 (described later).

[0072] The analogue front end 32 is connected to the input/output contacts 26, 27 and may further be connected to the neutral terminal 22. The one or more ADCs included in the analogue front end 32 may be configured to produce digital signals representative of fuse continuity (e.g. by measuring the voltage between the input/output contacts 26, 27), the supply line current, supply line voltage (the supply line voltage is preferably measured with reference to the neutral line of the supply line, e.g. via the neutral terminal 22 or the neutral bus 60 described below). The digital signals produced by the one or more ADCs included in the analogue front end 32 are inputted into the digital signal processor 33.

[0073] The measuring circuit 30 may additionally include a temperature sensor (not shown) and a ground fault current sensor or arc fault current sensor (not shown). These sensors are also arranged to provide the digital signal processor 33 with digital signals representative of ambient temperature, terminal temperature (at either/both of the input/output contacts 26, 27 of the fuse holder, note that these temperature(s) will also be representative of the temperature at either/both of the fuse spring contacts 52, 54), and supply line non-linearities associated with arc faults.

[0074] From the digital signals inputted into the digital signal processor 33, the digital signal processor 33 may be able to determine the following supply line parameters: fuse continuity (e.g. whether the fuse has blown), supply line current, supply line voltage (which may be measured with reference to a neutral line of the supply line), ambient temperature, terminal temperature, supply line non-linearities associated with arc faults, power, energy, time of fault(s), number of faults, fuse health, prediction of failure, preventative maintenance warning, incorrect/defective fuse installation notification, fuse life prediction, fuse change reporting, and reason for a blown

fuse/broken circuit.

[0075] In addition, the digital signal processor 33 includes a memory which stores supplementary parameters which includes a unique internal identifier of the fuse puller 20, the configuration of the measuring circuit 30 and information regarding identification and characteristics of the fuse 70.

[0076] The display unit 34, which is located on the display module 40, allows the supply line parameters and the supplementary parameters to be viewed on the display screen 41. This enables a technician to observe the supply line parameters and the supplementary parameters, e.g. for the purposes of making a diagnostic assessment of the fuse 70.

[0077] The digital signal processor 33 is connected to a communications unit 35. The communications unit 35 is arranged to produce and receive data signals representative of the supply line parameters and the supplementary parameters.

[0078] The communications unit 35 is connected to the data terminal 24. The data terminal 24 is for connecting the communications unit 35 to an external device (not shown). By connecting the data terminal 24 to the external device, the external device is able to receive data signals from the communications unit 35. Therefore, a technician can use an external device to measure the supply line and supplementary parameters, without the need for a display module 42. The external device may also send signals to the communications unit 35, e.g. to control the digital signal processor 33.

[0079] The data terminal 24 may be configured, for example, to connect to any kind of wired bus (e.g. Modbus, CAN-bus) or to a gateway which couples to any other communication network (wired or wireless based; e.g. ethernet). The external device may be a PC, smartphone or any other MM-interface.

[0080] The communications unit 35 is also connected to a data bus 62 (described later).

[0081] Figs. 4a and 4b show the fuse holder 50 in more detail. The fuse holder 50 is provided with mounting elements, in the form of guide keyways 55, for detachably mounting the fuse holder 50 to other fuse holders 50. In this way, a plurality of the fuse holders 50 can be detachably mounted to one another to form a cluster, for example as shown in Fig. 1.

[0082] A neutral element 56 for electric connection to the neutral line of the electric supply is embedded in the fuse holder 20. The neutral element 56 is shaped so that, when a plurality of the fuse holders 20 are mounted to one another (e.g. as shown in Fig. 1), the neutral elements 56 electrically connect to form a neutral bus 60 for electric connection to the neutral line of the electric supply.

[0083] The neutral element 56 is arranged to be electrically connected to the PSU 31 of the measuring circuit 30 when the fuse puller 20 is mounted to the fuse holder 50. Accordingly, when the neutral bus 60 is connected to the neutral line of the electric supply, the PSU 31 on

the fuse puller 20 becomes electrically connected to the neutral line of the electric supply (via the neutral element 56). Therefore, the PSU 31 can be powered from the neutral bus 60 instead of the neutral terminal 22. Accordingly, it is possible to have a plurality of fuse pullers 20 whose measuring circuits 30 are powered from the neutral bus 60. This is a cheaper and simpler arrangement to having the measuring circuit 30 of each fuse holder 20 individually connected to the neutral line of the electric supply using the neutral terminals 22.

[0084] The neutral element 56 is also arranged to be electrically connected to the neutral terminal 22 of the measuring circuit 30 when the fuse puller 20 is mounted to the fuse holder 50. Therefore, by electrically connecting the neutral terminal 22 to the neutral line of the electric supply (e.g. by a cable), the neutral bus 60 becomes electrically connected to the neutral line of the electric supply (via the neutral element 56). This is one convenient way of electrically connecting the neutral bus 60 to the electrical supply.

[0085] A data element 58 for carrying data signals to and from the measuring circuit 30 is also embedded in the fuse holder 20. The data element 58 is also shaped so that, when a plurality of the fuse holders 20 are mounted to one another (e.g. as shown in Fig. 1), the data elements 58 electrically connect to form a data bus 62 for carrying data signals to and from the measuring circuit 30.

[0086] Thus, when the fuse holders 50 are mounted to one another, the data elements 58 are engaged to one another and build up a data bus 62 across the fuse holder cluster and to each fuse puller 20 placed on the fuse holder (thus connecting the communication unit 35 to the data bus).

[0087] The data element 58 is arranged to be electrically connected to the communications unit 35 of the measuring circuit 30 when the fuse puller 20 is mounted to the fuse holder 50. In this way, the communications unit 35 becomes connected to the data bus 62. This allows the communications unit 35 to communicate with other devices connected to the data bus 62, e.g. the communications units 35 of other fuse pullers 20 and/or external devices.

[0088] One of ordinary skill after reading the foregoing description will be able to affect various changes, alterations, and subtractions of equivalents without departing from the broad concepts disclosed. It is therefore intended that the scope of the patent granted hereon be limited only by the appended claims, as interpreted with reference to the description and drawings, and not by limitation of the embodiments described herein.

Claims

1. A fuse puller (20) for inserting a fuse (70) into and removing a fuse from a fuse holder (10), the fuse puller having:

- a fuse
gripping portion (25) for gripping a fuse; and
a measuring circuit (30) arranged to measure a plurality of supply line parameters when a fuse is gripped by said gripping portion and held in a supply line (90) of an electric supply, wherein the measuring circuit includes a power supply unit (31) for powering the measuring circuit, **characterized in that** the power supply unit is arranged to be, when a fuse is gripped by the gripping portion and held in the supply line of an electric supply, electrically connected to the supply line and a neutral line of the electric supply.
2. A fuse puller according to claim 1 wherein the measuring unit is arranged to quantitatively measure at least one of the supply line parameters.
 3. A fuse puller according to claim 1 or 2 wherein the fuse puller includes a display unit (34) having a display screen (41) for displaying the supply line parameters.
 4. A fuse holder according to claim 3 wherein the display unit includes a user interface to allow a user to control the measuring circuit.
 5. A fuse puller according to any one of the previous claims wherein the measuring circuit includes a supply line input contact (26) and a supply line output contact (27), the input and output contacts being arranged so that, when a fuse is gripped by the gripping portion and held in the supply line of an electric supply, the input contact electrically connects to an input side of the supply line with respect to the fuse and the output contact electrically connects to an output side of the supply line with respect to the fuse.
 6. A fuse puller according to claim 5 wherein the input and output contacts are arranged to, when a fuse is held by the gripping portion, physically contact both ends of the fuse.
 7. A fuse puller according to claim 6 wherein the measuring circuit includes a neutral terminal (22) connected to the PSU (31), for electric connection to a neutral line of the electric supply.
 8. A fuse puller according to any one of the previous claims wherein the measuring unit (30) includes:

one or more analogue to digital converters for converting analogue signals representative of supply line parameters into digital signals representative of supply line parameters; and
a digital signal processor (33) for processing digital signals from the one or more analogue to
- digital converters.
9. A fuse puller according to any one of the previous claims wherein the measuring circuit includes a communications unit (35) for producing and/or receiving data signals.
 10. A fuse puller according to claim 9 wherein the measuring circuit includes a data terminal (24) connected to the communications unit, for connection to an external device.
 11. A fuse holder according to any one of the previous claims wherein a part of the measuring circuit is located on a module (40) which is detachably mounted to the fuse puller.
 12. A fuse holder according to claim 11 wherein the fuse puller includes the display unit of claim 3 or 4, and the display unit is located on the detachable module.
 13. A fuse holder apparatus (10) including:

a fuse holder (50)
for holding a fuse in a supply line (90) of an electric supply; and
a fuse puller (20) according to any one of the previous claims for inserting
a fuse (70) into and removing a fuse from the fuse holder, the fuse puller being detachably mountable on the fuse holder, wherein the fuse holder has a data element (58) for carrying data signals to and from the measuring circuit (30), the data element being arranged to be electrically connected to the measuring circuit when the fuse puller is mounted on the fuse holder.
 14. A fuse holder apparatus according to claim 13 wherein the fuse holder has a neutral element (56) for electric connection to a neutral line of the electric supply, the neutral element being arranged to be electrically connected to the measuring circuit when the fuse puller is mounted on the fuse holder.
 15. A fuse holder apparatus according to claim 14 having a plurality of the fuse holders, wherein the neutral elements of the fuse holders are connected to form a neutral bus and/or the data elements of the fuse holders are connected to form a data bus (62).
 16. A fuse holder apparatus according to any one of claims 13 to 15 wherein the plurality of fuse holders include attachment elements which allow the fuse holders to be detachably mounted to one another.
 17. A fuse holder apparatus according to any one of claims 13 to 15 wherein the plurality of fuse holders are formed as an integral unit.

18. A fuse holder for use in the fuse apparatus of any one of claims 13 to 17, having the features of the fuse holder of any one of claims 13 to 17.

19. A kit of parts for assembling a fuse holder apparatus according to any one of claims 13 to 17, the kit of parts having:

a fuse holder for holding a fuse in a supply line of an electric supply; and
a fuse puller according to any one of claims 1 to 12 for inserting a fuse into and removing a fuse from the fuse holder, the fuse puller being detachably mountable on the fuse holder.

Patentansprüche

1. Sicherungszieher (20) zum Einsetzen einer Sicherung (70) in einen und Entfernen einer Sicherung aus einem Sicherungshalter (10), wobei der Sicherungszieher aufweist:

einem Sicherungsgreifabschnitt (25) zum Greifen einer Sicherung; und
einen Messkreis (30), der angeordnet ist, mehrere Versorgungsleitungsparameter zu messen, wenn eine Sicherung durch vom Greifabschnitt ergriffen ist und in einer Versorgungsleitung (90) einer elektrischen Versorgung gehalten ist, wobei der Messkreis eine Stromversorgungseinheit (31) zum Versorgen des Messkreises mit Strom enthält, **dadurch gekennzeichnet, dass** die Stromversorgungseinheit angeordnet ist, wenn eine Sicherung vom Greifabschnitt ergriffen ist und in der Versorgungsleitung einer elektrischen Versorgung gehalten ist, elektrisch mit der Versorgungsleitung und einem Nullleiter der elektrischen Versorgung verbunden zu sein.

2. Sicherungszieher nach Anspruch 1, wobei die Messungseinheit angeordnet ist zumindest einen der Versorgungsparameter quantitativ zu messen.

3. Sicherungszieher nach Anspruch 1 oder 2, wobei der Sicherungszieher eine Anzeigeeinheit (34) mit einem Anzeigebildschirm (41) zum Anzeigen der Versorgungsleitungsparameter enthält.

4. Sicherungshalter nach Anspruch 3, wobei die Anzeigeeinheit eine Benutzerschnittstelle enthält, um einem Benutzer zu ermöglichen, den Messkreis zu steuern.

5. Sicherungszieher nach einem der vorangehenden Ansprüche, wobei der Messkreis einen Versorgungsleitungseingangskontakt (26) und einen Ver-

sorgungsleitungsausgangskontakt (27) enthält, wobei der Eingangs- und Ausgangskontakt angeordnet sind, sodass, wenn eine Sicherung vom Greifabschnitt ergriffen ist und in der Versorgungsleitung einer elektrischen Versorgung gehalten ist, der Eingangskontakt elektrisch mit einer Eingangsseite der Versorgungsleitung in Bezug auf die Sicherung verbunden ist und der Ausgangskontakt elektrisch mit einer Ausgangsseite der Versorgungsleitung in Bezug auf die Sicherung verbunden ist.

6. Sicherungszieher nach Anspruch 5, wobei der Eingangs- und Ausgangskontakt angeordnet sind, um, wenn eine Sicherung vom Greifabschnitt gehalten ist, beide Enden der Sicherung physisch zu kontaktieren.

7. Sicherungszieher nach Anspruch 6, wobei der Messkreis einen neutralen Anschluss (22), verbunden mit der PSU (31), zur elektrischen Verbindung mit einem Nullleiter der elektrischen Versorgung enthält.

8. Sicherungszieher nach einem der vorangehenden Ansprüche, wobei die Messeinheit (30) enthält:

einen oder mehrere Analog/Digital-Wandler zum Umwandeln analoger Signale, welche stellvertretend für Versorgungsleitungsparameter sind, in digitale Signale, welche stellvertretend für Versorgungsleitungsparameter sind; und
einen digitalen Signalprozessor (33) zum Verarbeiten digitaler Signale von dem einen oder den mehreren Analog/Digital-Wandlern.

9. Sicherungszieher nach einem der vorangehenden Ansprüche, wobei der Messkreis eine Kommunikationseinheit (35) zum Erzeugen und/oder Empfangen von Datensignalen enthält.

10. Sicherungszieher nach Anspruch 9, wobei der Messkreis einen Datenanschluss (24) enthält, welcher für eine Verbindung mit einem externen Gerät mit der Kommunikationseinheit verbunden ist.

11. Sicherungshalter nach einem der vorangehenden Ansprüche, wobei ein Teil des Messkreises auf einem Modul (40) gelegen ist, welches abnehmbar am Sicherungszieher befestigt ist.

12. Sicherungshalter nach Anspruch 11, wobei der Sicherungszieher die Anzeigeeinheit nach Anspruch 3 oder 4 enthält, und die Anzeigeeinheit auf dem abnehmbaren Modul gelegen ist.

13. Sicherungshaltervorrichtung (10) enthaltend:

einen Sicherungshalter (50) zum Halten einer

Sicherung in einer Versorgungsleitung (90) einer elektrischen Versorgung; und einen Sicherungszieher (20) nach einem der vorangehenden Ansprüche zum Einstecken einer Sicherung (70) in den und Entfernen einer Sicherung von dem Sicherungshalter, wobei der Sicherungszieher abnehmbar an dem Sicherungshalter befestigt ist, wobei der Sicherungshalter ein Datenelement (58) zum Tragen von Datensignalen zum und vom Messkreis (30) hat, wobei das Datenelement angeordnet ist, um elektrisch mit dem Messkreis verbunden zu sein, wenn der Sicherungszieher am Sicherungshalter befestigt ist.

14. Sicherungshaltervorrichtung nach Anspruch 13, wobei der Sicherungshalter ein neutrales Element (56) für eine elektrische Verbindung mit einem Nullleiter der elektrischen Versorgung hat, wobei das neutrale Element angeordnet ist, elektrisch mit dem Messkreis verbunden zu sein, wenn der Sicherungszieher am Sicherungshalter befestigt ist.
15. Sicherungshaltervorrichtung nach Anspruch 14 mit mehreren Sicherungshaltern, wobei die neutralen Elemente der Sicherungshalter verbunden sind, um einen neutralen Bus zu bilden, und/oder die Datenelemente der Sicherungshalter verbunden sind, um einen Datenbus (62) zu bilden.
16. Sicherungshaltervorrichtung nach einem der Ansprüche 13 bis 15, wobei die mehreren Sicherungshalter Befestigungselemente enthalten, welche den Sicherungshaltern ermöglichen, abnehmbar aneinander befestigt zu sein.
17. Sicherungshaltervorrichtung nach einem der Ansprüche 13 bis 15, wobei die mehreren Sicherungshalter als eine ganzheitliche Einheit gebildet sind.
18. Sicherungshalter zur Verwendung in der Sicherungsvorrichtung nach einem der Ansprüche 13 bis 17 mit den Merkmalen des Sicherungshalters nach einem der Ansprüche 13 bis 17.
19. Bausatz von Teilen zum Zusammenbauen einer Sicherungshaltervorrichtung nach einem der Ansprüche 13 bis 17, wobei der Bausatz von Teilen aufweist:

einen Sicherungshalter zum Halten einer Sicherung in einer Versorgungsleitung einer elektrischen Versorgung; und einen Sicherungszieher nach einem der Ansprüche 1 bis 12 zum Einstecken einer Sicherung in den und Entfernen einer Sicherung aus dem Sicherungshalter, wobei der Sicherungszieher abnehmbar am Sicherungshalter befestigt ist.

tigbar ist.

Revendications

1. Extracteur de fusible (20) pour insérer un fusible (70) dans un porte-fusible (10) et l'en retirer, l'extracteur de fusible ayant :

une partie de préhension de fusible (25) pour saisir un fusible ; et
un circuit de mesure (30) aménagé pour mesurer une pluralité de paramètres de ligne d'alimentation lorsqu'un fusible est saisi par ladite partie de préhension et maintenu dans une ligne d'alimentation (90) d'une alimentation électrique, dans lequel le circuit de mesure comprend une unité d'alimentation électrique (31) pour alimenter le circuit de mesure, **caractérisé en ce que** l'unité d'alimentation électrique est aménagée pour, lorsqu'un fusible est saisi par la partie de préhension et maintenu dans la ligne d'alimentation d'une alimentation électrique, être connectée électriquement à la ligne d'alimentation et à une ligne neutre de l'alimentation électrique.
2. Extracteur de fusible selon la revendication 1, dans lequel l'unité de mesure est aménagée pour mesurer quantitativement au moins l'un des paramètres de la ligne d'alimentation.
3. Extracteur de fusible selon la revendication 1 ou la revendication 2, dans laquelle l'extracteur de fusible comprend une unité d'affichage (34) ayant un écran d'affichage (41) pour afficher les paramètres de la ligne d'alimentation.
4. Porte-fusible selon la revendication 3, dans lequel l'unité d'affichage comprend une interface utilisateur pour permettre à un utilisateur de commander le circuit de mesure.
5. Extracteur de fusible selon l'une quelconque des revendications précédentes, dans lequel le circuit de mesure comprend un contact d'entrée de ligne d'alimentation (26) et un contact de sortie de ligne d'alimentation (27), les contacts d'entrée et de sortie étant aménagés de sorte que, lorsqu'un fusible est saisi par la partie de préhension et maintenu dans la ligne d'alimentation d'une alimentation électrique, le contact d'entrée se connecte électriquement à un côté d'entrée de la ligne d'alimentation par rapport au fusible et que le contact de sortie se connecte électriquement à un côté de sortie de la ligne d'alimentation par rapport au fusible.
6. Extracteur de fusible selon la revendication 5, dans

- lequel les contacts d'entrée et de sortie sont aménagés pour venir en contact physique avec les deux extrémités du fusible lorsqu'un fusible est maintenu par la partie de préhension.
7. Extracteur de fusible selon la revendication 6, dans lequel le circuit de mesure comprend une borne neutre (22) connectée au PSU (31) pour une connexion électrique avec une ligne neutre de l'alimentation électrique.
8. Extracteur de fusible selon l'une quelconque des revendications précédentes, dans lequel l'unité de mesure (30) comprend :
- un ou plusieurs convertisseurs analogiques-numériques pour convertir des signaux analogiques représentatifs de paramètres de la ligne d'alimentation en signaux numériques représentatifs de paramètres de la ligne d'alimentation ; et
 - un processeur de signaux numériques (33) pour traiter des signaux numériques venant des un ou plusieurs convertisseurs analogiques-numériques.
9. Extracteur de fusible selon l'une quelconque des revendications précédentes, dans lequel l'unité de mesure comprend une unité de communications (35) pour produire et/ou recevoir des signaux de données.
10. Extracteur de fusible selon la revendication 9, dans lequel le circuit de mesure comprend un terminal de données (24) connecté à l'unité de communications pour se connecter à un dispositif externe.
11. Porte-fusible selon l'une quelconque des revendications précédentes, dans lequel une partie du circuit de mesure est située sur un module (40) qui est monté de manière détachable sur l'extracteur de fusible.
12. Porte-fusible selon la revendication 11, dans lequel l'extracteur de fusible comprend l'unité d'affichage de la revendication 3 ou 4 et l'unité d'affichage est située sur le module détachable.
13. Appareil porte-fusible (10) comprenant :
- un porte-fusible (50) pour soutenir un fusible dans une ligne d'alimentation (90) d'une alimentation électrique ; et
 - un extracteur de fusible (20) selon l'une quelconque des revendications précédentes, pour insérer un fusible (70) dans le porte-fusible et l'en retirer, l'extracteur de fusible étant montable de manière détachable sur le porte-fusible, dans lequel le porte-fusible a un élément de données
- (58) pour acheminer des signaux de données au circuit de mesure (30) et en sens inverse, l'élément de données étant aménagés pour être connecté électriquement au circuit de mesure lorsque l'extracteur de fusible est monté sur le porte-fusible.
14. Appareil porte-fusible selon la revendication 13, dans lequel le porte-fusible présente un élément neutre (56) pour se connecter électriquement à une ligne neutre de l'alimentation électrique, l'élément neutre étant aménagé pour être connecté électriquement au circuit de mesure lorsque l'extracteur de fusible est monté sur le porte-fusible.
15. Appareil à porte-fusible selon la revendication 14 ayant une pluralité de porte-fusibles, dans lequel les éléments neutres des porte-fusibles sont connectés pour former un bus neutre et/ou les éléments de données des porte-fusibles sont connectés pour former un bus de données (62).
16. Appareil porte-fusible selon l'une quelconque des revendications 13 à 15, dans lequel la pluralité de porte-fusibles comprennent des éléments de fixation qui permettent de monter les porte-fusibles de manière détachable l'un sur l'autre.
17. Appareil porte-fusible selon l'une quelconque des revendications 13 à 15, dans lequel la pluralité de porte-fusibles sont formés en une unité d'un seul tenant.
18. Appareil porte-fusible selon l'une quelconque des revendications 13 à 17, ayant les caractéristiques du porte-fusible de l'une quelconque des revendications 13 à 17.
19. Kit de pièces pour assembler un appareil porte-fusible selon l'une quelconque des revendications 13 à 17, le kit de pièces présentant :
- un porte-fusible pour soutenir un fusible dans une ligne d'alimentation d'une alimentation électrique ; et
 - un extracteur de fusible selon l'une quelconque des revendications 1 à 12 pour insérer un fusible dans le porte-fusible et l'en retirer, l'extracteur de fusible étant montable de manière détachable sur le porte-fusible.

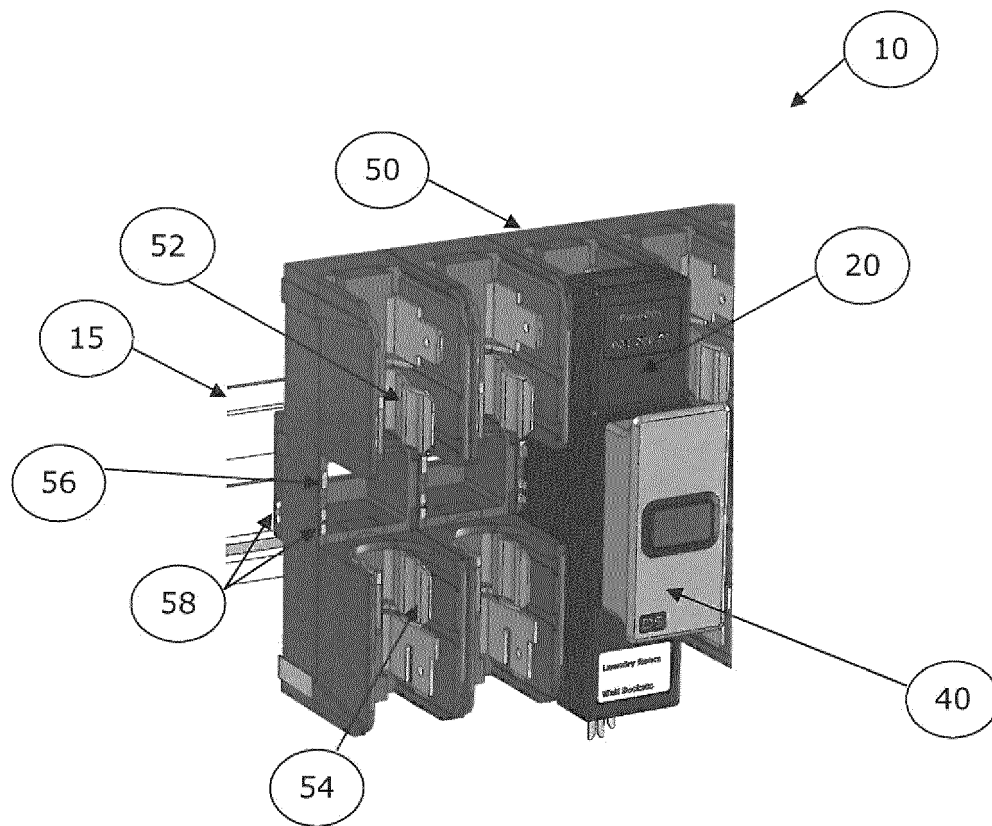


Fig. 1

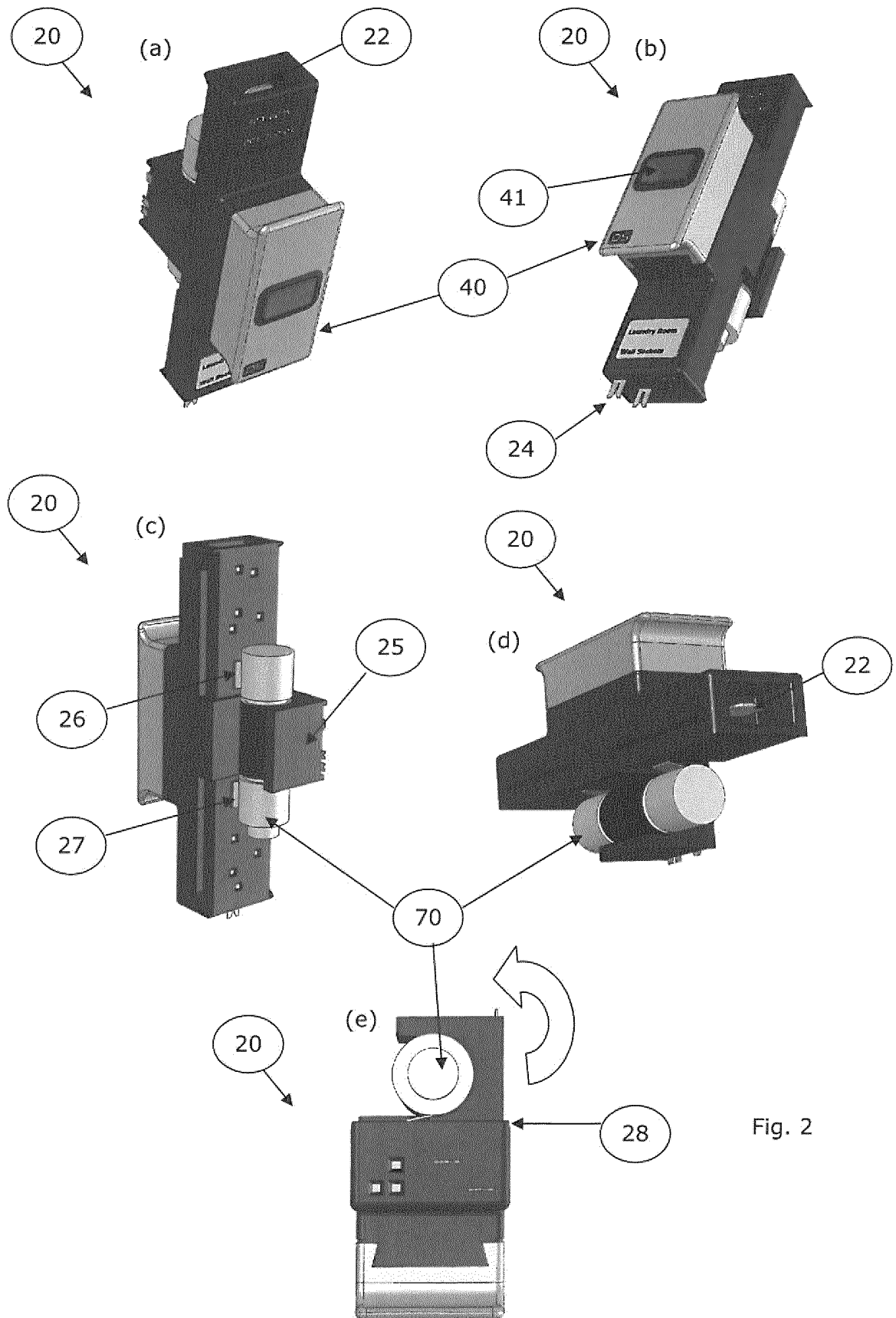


Fig. 2

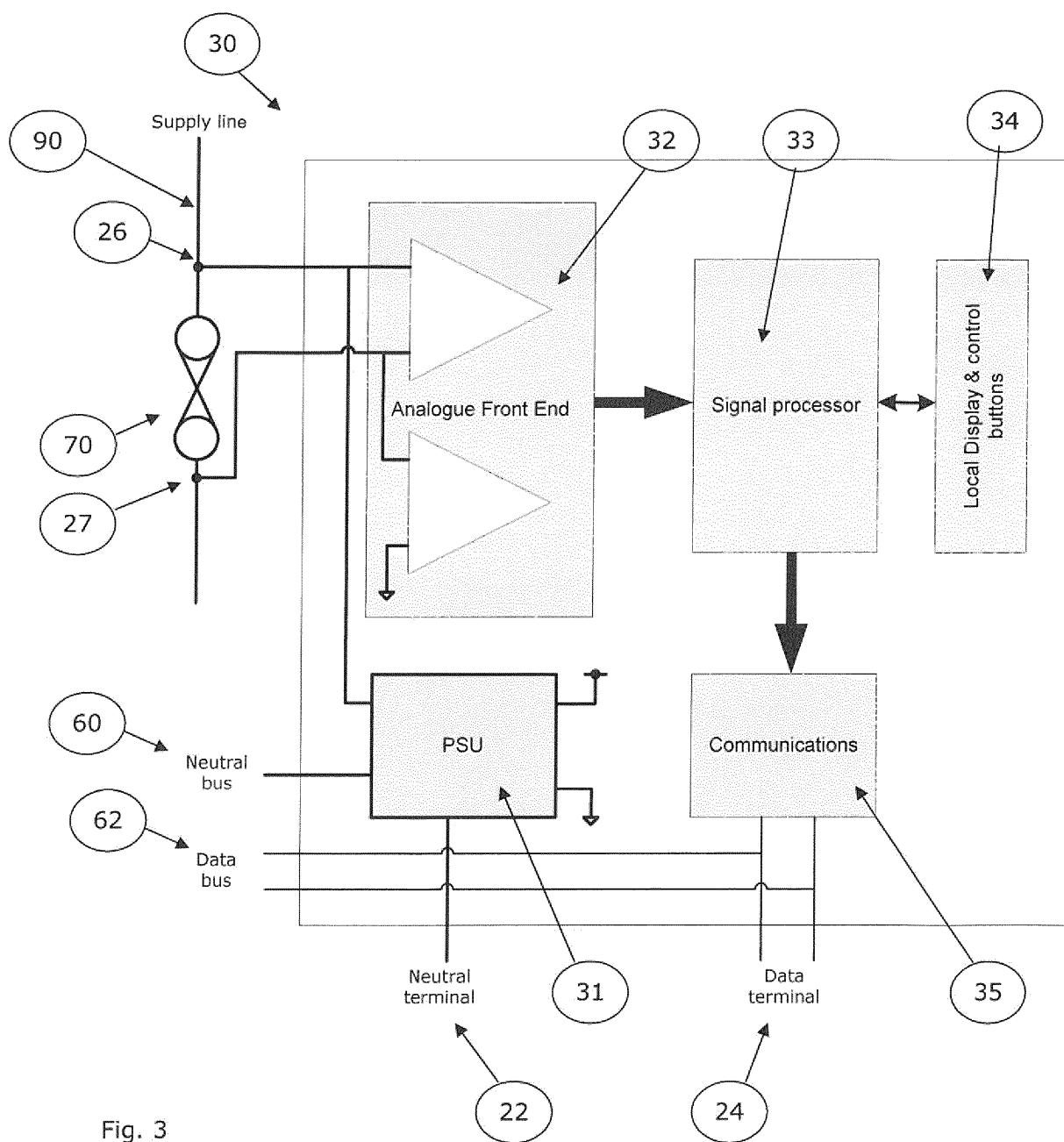


Fig. 3

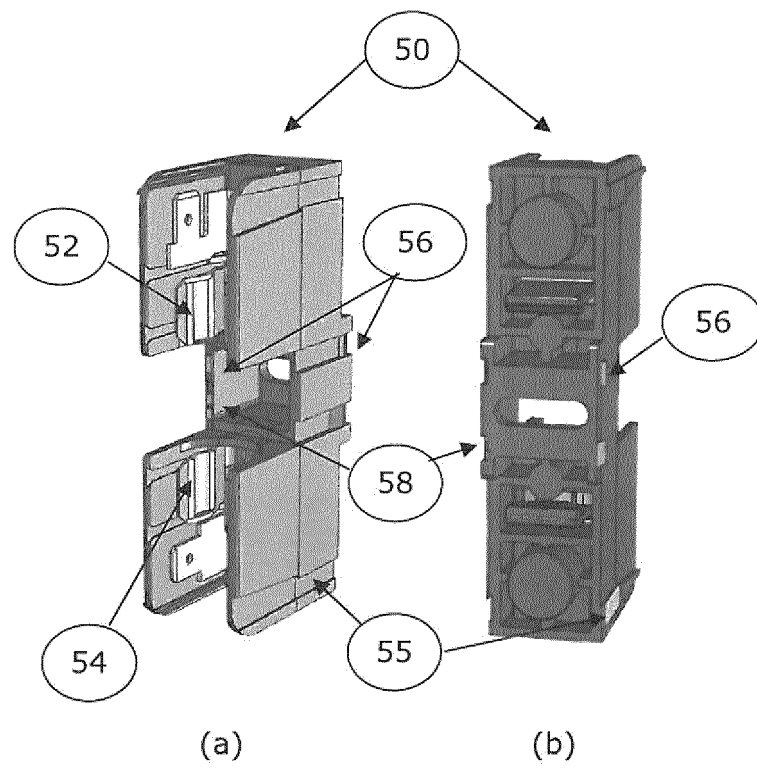


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5002505 A [0005]
- US 6448785 A [0006] [0010] [0026]
- WO 2014026702 A1 [0007]
- US 2007257807 A1 [0008]
- GB 2458298 A [0009]