

APPLICATION FOR PATENT

TITLE

Electrical Safety Devices and Apparatuses for Preventing Flow of Electric Current Based on Temperature Sensing

5 CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from US Provisional Patent Application No. 63/463,906, filed May 4, 2023, whose disclosure is incorporated by reference in its entirety herein.

TECHNICAL FIELD

10 The present disclosure relates to electrical devices and apparatuses, and in particular safety devise and apparatuses that detect increased temperature in electrical components and prevent flow of electrical current in response to detected temperature increase.

BACKGROUND OF THE INVENTION

Electrical assemblies are used to convey electrical power from a source, typically a mains power supply, to a destination device. Electrical assemblies can include, for example, electrical extension cables, electrical devices powered by mains power (such as DC charging devices and electronic appliances), and electrical wall outlets. Components of electrical assemblies can include electrical cables and/or wire assemblies, electrical plugs, and electrical sockets. These components can malfunction, for example due to loosened electrical contacts, loose wiring, or exposed wiring, which can cause an increase or unintended flow of electric current, which can result in an increase in temperature of the components, and which may ultimately lead to electrical fire.

SUMMARY OF THE INVENTION

25 The present disclosed subject matter, also referred to herein as the disclosure, includes safety apparatuses and devices that detect increased temperature in components of electrically assemblies, such as electrical plugs, electrical sockets, and electrical cables having electrical wire assemblies, and prevent a flow of electrical current to or through some or all of the components of the electrical assemblies in response to detected temperature increase. In certain exemplary embodiments, the detection of temperature increase is performed by thermal switch having a thermal sensor arrangement which may be in a normally open configuration or a normally closed configuration. In such embodiments, actuation of the thermal switch may create a short circuit or open circuit in response to detected temperature increase to prevent the flow of electrical current.

30 The electrical assemblies can include electrical contacts or wiring that are connected, either directly or indirectly, to a mains power supply wall outlet, and in certain exemplary embodiments the short circuit or open circuit effectuated by the thermal switch can cause a prevention of flow

of electric current to all circuits connected to the mains power supply wall outlet, for example all circuits having associated circuit breakers housed in a circuit breaker box that also houses a circuit breaker that is associated with the mains power supply wall outlet.

According to the teachings of an embodiment of the present disclosure, there is provided a safety apparatus. The safety apparatus comprises: an electrical assembly including: an electrical cable for carrying electric current, an electrical plug electrically connected to a first portion of the electrical cable, the electrical plug for electrically coupling to a mains power supply to provide flow of electric current from the mains power supply through the electrical cable, and at least one electrical socket electrically connected to a second portion of the electrical cable for receiving electric current through the electrical cable; and an electrical safety device coupled to the electrical assembly and configured to: collect at least one temperature reading from one or more portions of the electrical assembly, and prevent flow of electric current through the electrical cable if one or more of the collected at least one temperature reading satisfies a threshold criterion.

Optionally, the electrical safety device is integrated with the electrical assembly.

Optionally, the electrical safety device is mounted to the electrical assembly.

Optionally, the electrical safety device is deployed in the at least one electrical socket.

Optionally, the electrical safety device is deployed in the electrical plug.

Optionally, the electrical safety device is deployed in or on a portion of the electrical cable.

Optionally, when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

Optionally, the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the mains power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

Optionally, the electrical safety device includes a thermal cutoff electrically connected to the electrical assembly.

Optionally, the thermal cutoff is a thermal switch that is configured to operate in a normally open configuration.

Optionally, the thermal switch is electrically coupled to a zero element and a ground element of the electrical assembly, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is

electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

Optionally, the thermal cutoff is a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical assembly.

Optionally, when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

Optionally, the thermal cutoff is a thermal fuse.

There is also provided according to the teachings of an embodiment of the present disclosure a safety apparatus. The safety apparatus comprises: an electrical assembly including: a wire assembly including one or more wires for carrying electric current, an electrical plug electrically connected to a first portion of the wire assembly, the electrical plug for electrically coupling to a mains power supply to provide flow of electric current from the mains power supply through the wire assembly, and at least one electrical output component electrically connected to a second portion of the wire assembly for receiving electric current through the wire assembly; and an electrical safety device coupled to the electrical assembly and configured to: collect at least one temperature reading from one or more portions of the electrical assembly, and prevent flow of electric current through the wire assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

Optionally, the electrical assembly is an electrically powered device.

Optionally, the at least one electrical output component includes at least one electrical socket.

Optionally, the at least one electrical output component includes a DC output.

Optionally, when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

Optionally, the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the mains power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

Optionally, the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the electrical assembly and that is configured to operate in

a normally open configuration, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

Optionally, the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical assembly, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

There is also provided according to the teachings of an embodiment of the present disclosure a safety apparatus. The safety apparatus comprises: a socket adapter device including: an electrical plug for electrically coupling to a mains power supply to receive electric current from the mains power supply, at least one electrical socket, and an electrical connection arrangement providing an electrical connection between the electrical plug and the at least one socket; and an electrical safety device coupled to the socket adapter device and configured to: collect at least one temperature reading from one or more portions of the socket adapter device, and prevent flow of electric current to the at least one electrical socket if one or more of the collected at least one temperature reading satisfies a threshold criterion.

Optionally, the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the socket adapter device and that is configured to operate in a normally open configuration, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

Optionally, the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the socket adapter device, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

There is also provided according to the teachings of an embodiment of the present disclosure a safety apparatus. The safety apparatus comprises: an electrical socket assembly including: a backbox, an electrical wire assembly housed inside the backbox, the electrical wire

assembly including one or more wires electrically connected to a mains power supply and configured to carry electric current from the mains power supply, and a faceplate mounted to the backbox and including an electrical receptacle electrically connected to the electrical wire assembly, the electrical receptacle configured to receive an electrical plug and to convey electric current from the mains power supply through the electrical wire assembly to the electrical plug when the electrical plug is received in the electrical receptacle; and an electrical safety device coupled to the electrical wire assembly and configured to: collect at least one temperature reading from one or more portions of the electrical wire assembly, and prevent flow of electric current through the electrical wire assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

Optionally, when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

Optionally, the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

Optionally, the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the electrical socket assembly and that is configured to operate in a normally open configuration, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

Optionally, the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical socket assembly, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

There is also provided according to the teachings of an embodiment of the present disclosure an electrical safety device for electrically connecting to an electrical wiring assembly that is electrically connected to a mains power supply for carrying electric current from the mains power supply, the electrical wiring assembly having a plurality of insulated electrical wires

including a first insulated electrical wire that is a zero wire and a second insulated electrical wire that is a live wire. The electrical safety device comprises: a thermal cutoff including at least one temperature sensor configured to sense temperature; and a pin assembly electrically connected to the thermal cutoff, the pin assembly including a first pin and a second pin, the first pin configured
5 to penetrate insulation of the first insulated electrical wire so as to contact electrically conductive material of the first insulated electrical wire at a first contact point, the electrical safety device is configured to: collect at least one temperature reading from one or more portions of the electrical wiring assembly in proximity to the first contact point, and prevent flow of electric current through the electrical wiring assembly if one or more of the collected at least one temperature reading
10 satisfies a threshold criterion.

Optionally, when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

Optionally, the electrical safety device causes the prevention of flow of electric current to
15 all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the mains power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

Optionally, the plurality of insulated electrical wires includes a third insulated electrical
20 wire that is a ground wire, the second pin is configured to penetrate insulation of the third insulated electrical wire so as to contact electrically conductive material of the third insulated electrical wire at a second contact point, the thermal cutoff is a thermal switch that is configured to operate in a normally open configuration, and when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between
25 the zero wire and the ground wire so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

Optionally, the thermal cutoff is a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to the zero wire, and when the one
30 or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero wire.

There is also provided according to the teachings of an embodiment of the present disclosure a safety method for performing on an electrical assembly that includes one or more of an electrical cable, an electrical socket, or an electrical plug. The safety method comprises:

collecting, by an electrical safety device, at least one temperature reading from one or more portions of the electrical assembly, and preventing, by the electrical safety device, flow of electric current through the electrical assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

5 Unless otherwise defined herein, all technical and / or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the disclosure pertains. Although methods and materials similar or equivalent to those described herein may be used in the practice or testing of embodiments of the disclosure, exemplary methods and / or materials are described below. In case of conflict, the patent specification, including definitions, 10 will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the present disclosure are herein described, by way of example only, with reference to the accompanying drawings. With specific reference to the drawings in detail, it 15 is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the disclosure. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the disclosure may be practiced.

Attention is now directed to the drawings, where like reference numerals or characters indicate corresponding or like components. In the drawings:

20 FIG. 1 is an isometric view of a safety apparatus having an electrical assembly implemented as an extension cable and an electrical safety device integrated in part of the extension cable, according to embodiments of the present disclosure;

FIG. 2 is a cross-sectional view of an electrical plug of the electrical assembly of FIG. 1, showing the deployment of electrical safety device in the electrical plug;

25 FIG. 3 is a schematic representation of the electrical safety device implemented as a normally open thermal switch, and conceptually illustrating the coupling of the electrical safety device with zero and ground elements of the electrical assembly, according to embodiments of the present disclosure;

30 FIG. 4 is a diagram schematically illustrating an electrical assembly with an electrical safety device connected to a mains power supply, as well as one or more circuits connected to the mains power supply via a residual current device, and also a transceiver device connected to the electrical safety device;

FIG. 5 is a schematic representation of the electrical safety device, similar to FIG. 3, but showing the electrical safety device implemented as a normally closed thermal switch, and

conceptually illustrating the coupling of the electrical safety device with a zero element of the electrical assembly, according to embodiments of the present disclosure;

FIG. 6A is a front view illustrating a schematic representation of an electrical plug of the electrical assembly of FIG. 1, showing the electrical plug with its cover and prongs removed, and
5 showing the coupling of the electrical safety device with zero and ground elements of the electrical assembly within the electrical plug;

FIG. 6B is a cross-sectional view of an electrical plug in an electrical assembly similar to that of FIG. 1, showing the electrical safety device in the electrical plug and electrical contacts corresponding to the prongs of the electrical plug;

10 a front view illustrating a schematic representation of an electrical plug of the electrical assembly of FIG. 1, showing the electrical plug with its cover and prongs removed, and showing the coupling of the electrical safety device with zero and ground elements of the electrical assembly within the electrical plug;

FIG. 7 is an isometric view illustrating a schematic representation of a safety apparatus
15 having an electrical assembly implemented as an extension cable reel and an electrical safety device integrated in part of the extension cable reel, according to embodiments of the present disclosure;

FIG. 8 is an isometric view of a safety apparatus, taken from an electrical plug side of the safety apparatus, having an electrical assembly implemented as a socket adapter device with an
20 electrical plug and a pair of electrical sockets and having one or more electrical safety devices integrated in one or more parts of the socket adapter device, according to embodiments of the present disclosure;

FIG. 9 is an isometric view of the safety apparatus of FIG. 1, taken from an electrical socket side of the safety apparatus;

25 FIG. 10 is a cross-sectional view of the safety apparatus of FIGS. 8 and 9, showing electrical contacts of the electrical plug and electrical sockets of the socket adapter device, and showing deployment location of a pair of the electrical safety devices;

FIG. 11 is an exploded view of the safety apparatus of FIGS. 8 and 9, showing the electrical safety devices and an electrical connection arrangement that provides electrical connection
30 between common elements of the electrical plug and electrical sockets of the socket adapter device;

FIG. 12 is a front view illustrating a schematic representation of a safety apparatus having an electrical wall socket assembly and an electrical safety device coupled with an electrical wire assembly of the electrical wall socket assembly, according to embodiments of the present disclosure; and

FIG. 13 is a plan view illustrating a schematic representation of an electrical safety device having a housing and a pair of electrical contacts with associated pins for penetrating insulation of insulated electrical wires of an electrical assembly, according to embodiments of the present disclosure.

5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present disclosure includes safety apparatuses and devices that detect increased temperature in components of electrically assemblies, such as electrical plugs, electrical sockets, and electrical cables, and prevent a flow of electrical current to or through some or all of the components of the electrical assemblies in response to detected temperature increase.

10 The principles and operation of the safety apparatuses and devices according to present disclosure may be better understood with reference to the drawings accompanying the description.

Embodiments of the present disclosure are applicable for use with various types of electrical assemblies, and are of particular value when used with electrical assemblies that are used in homes, businesses, schools, or any other structures having one or more electrical outlets (sockets) that output mains electricity (voltage and current) via a connection to an electrical grid. The various types of electrical assemblies with which embodiments of the present disclosure can be used to advantage are typically smaller-scale electrical assemblies, as opposed to large-scale or industrial-type assemblies such as electrical generating facilities that distribute electrical power to the electrical grid. Examples of electrical assemblies with which embodiments of the present disclosure can be used to advantage include, but are not limited to, electrical extension cable assemblies having an electrical cable connected to an electrical plug and one or more electrical sockets, electrical wall outlets, electrical devices having an electrical cable connected to an electrical plug and a DC output, and electrical appliances having an electrical cable and an electrical plug, electrical cables having an electrical plug or an electrical socket at one end thereof and wiring at an opposite end thereof.

25 Within the context of this document, a mains power supply electrical outlet (also referred to as a “mains voltage power supply wall outlet”, “wall outlet” or “wall socket”), is a fixed-in-place mains power supply that output mains power (electricity, i.e., voltage and current) via a connection to an electrical grid.

30 Within the context of the present disclosure, a “mains power supply” (also referred to as a “mains voltage power supply”), refers to a power supply that supplies mains power (electricity, i.e., voltage and current) via a connection to an electrical grid, typically power of at least 100 volts AC. A “mains power supply electrical outlet” (also referred to as a “mains voltage power supply wall outlet”, “wall outlet” or “wall socket”), as used within the context of the present disclosure,

refers to a fixed-in-place mains power supply, often on internal and external walls of a building, that output mains power (electricity, i.e., voltage and current). As an example, a wall outlet in the United States typically supplies power in the range of 100-120 volts AC, while a wall outlet in Europe typically supplies power in the range of 220-240 volts AC.

5 Before explaining at least one embodiment of the disclosure in detail, it is to be understood that the disclosure is not necessarily limited in its application to the details of construction and the arrangement of the components and / or methods set forth in the following description and / or illustrated in the drawings and / or the examples. The disclosure is capable of other embodiments or of being practiced or carried out in various ways.

10 With general reference to the drawings, FIGS. 1 – 13 illustrate electrical safety devices and apparatuses, and related components thereof, according to various embodiments of the present disclosure. According to one set of embodiments, the electrical safety device is electrically coupled to an electrical assembly to form a safety apparatus. In certain embodiments, the electrical safety device may be integrated with part of the electrical assembly, while in other embodiments the
15 electrical safety device may be mounted to part of the electrical assembly by contacting one or more wires of the electrical assembly and securing the contact area with adhesive electrical insulation. The electrical assembly may take various forms, as will be discussed in further detail below. In one set of example embodiments, the electrical assembly includes an electric cable (having one or more wires) that carries electric current having electrically connected at a first
20 portion (or end) thereof an electrical plug that is configured to electrically couple to a mains power supply (for example via insertion into a wall outlet) and having electrically connected at a second portion (or end) thereof at least one electrical output component (e.g., socket / outlet, electrically powered device, etc.). Some non-limiting examples of implementations of the electrical assembly according to such embodiments include extension cables and power strips. In other embodiments,
25 the electrical assembly is a device that is powered by a mains power supply, such as, for example, a lamp, a DC charging device (such as a mobile phone charger), an electronic device (such as a desktop computer, a television, etc.), an electronic appliance (e.g., refrigerator, oven, microwave oven, toaster, dishwasher, washing machine, dryer, etc.), and the like. In another set of example embodiments, the electrical assembly is a socket adapter, which may be a multi socket adapter,
30 having an electrical plug that is configured to electrically couple to a mains power supply, and one or more electrical sockets that are electrically connected to the electrical plug via an electrical connection arrangement which may be a set of electrical contacts, one or more busbars, or a set of wires. According to another set of embodiments, the electrical safety device is integrated with, or

is connected to, a mains power supply electrical outlet to form a safety apparatus in the form of a safe wall outlet.

With particular reference to FIG. 1, there is shown a safety apparatus, generally designated **10**, according to non-limiting embodiments of the present disclosure. The safety apparatus **10** includes an electrical assembly **30** having integrated therein an electrical safety device, (represented in FIG. 1 as dashed rectangle **20** to indicate that the electrical safety device is integrated in a portion of the electrical assembly **30**). The electrical assembly **30**, represented here as an extension cable assembly, includes an elongated electrical cable **32** for carrying electric power (including electric current), an electrical plug (i.e., an AC plug) **36** electrically connected at a first portion (first end) of electrical cable **32**, and an electrical socket (i.e., outlet) **40** electrically connected at a second portion (second end) of the electrical cable **32** opposite the first portion. The electrical plug **36** is configured for electrically coupling to a mains power supply (for example via insertion into a wall outlet, not illustrated in FIG.1) to provide flow of electric current from the mains power supply through the electrical cable **32**, so that the electrical socket **40** receives electric current (power) from the mains power supply through the electrical cable **32**.

The electrical plug **36** includes a plug body **37** having multiple prongs (also referred to as “pins”) extending outward therefrom. In the illustrated embodiment, there are three prongs, which include a neutral prong **38a** (also referred to as a “zero” prong), a ground prong **38b** (also referred to as an “earth” prong, and a hot prong **38c** (also referred to as a “live” prong).

The electrical cable **32** includes a plurality of electrical wires, typically insulated electrical wires covered by a protective cable jacket. In the embodiment illustrated in FIG. 1, a segment of each of the electrical wires is represented by dashed lines to indicate that the electrical wires are internal to the cable **32**. In the illustrated embodiment, there are three electrical wires, which include a neutral wire **34a** (also referred to as a “zero” wire), a ground wire **34b** (also referred to as an “earth” wire), and a hot wire **34c** (also referred to as a “live” wire). Although only a section of the electrical wires **34a**, **34b**, and **34c** are shown in the figure, it should be understood that the electrical wires **34a**, **34b**, and **34c** run along the length of the electrical cable **32**, and connect between the electrical plug **32** and the electrical socket **40**, as will be discussed.

The zero wire **34a** is electrically connected to the zero prong **38a**, the ground wire **34b** is electrically connected to the ground prong **38b**, and the live wire **34c** is electrically connected to the live prong **38c**.

The electrical socket **40** is a receptacle for receiving a correspondingly configured electrical plug, for example of another extension cable or an electrically powered device, and includes multiple electrical contacts, represented in FIG. 1 as apertures **42a**, **42b**, **42c** in a socket

body **41**. In the illustrated embodiment, there are three electrical contacts, which include a neutral contact **42a** (also referred to as a “zero” contact), a ground contact **42b** (also referred to as a “earth” contact), and a hot contact **42c** (also referred to as a “live” contact). The zero wire **34a** is electrically connected to the zero contact **42a**, the ground wire **34b** is electrically connected to the ground contact **42b**, and the live wire **34c** is electrically connected to the live contact **42c**. This electrical connection provides electrical connection between the electrical socket **40** and the electrical plug **36**, thereby providing a path, via the electrical cable **32**, for the flow of electric current from the mains power supply to the electrical socket **40**.

As will be discussed, in certain embodiments the electrical safety device **20** includes a thermal cutoff and a set of electrical contacts, and is electrically coupled to one or more portions of the electrical assembly **30**, in particular a zero element and optionally a ground element via the electrical contacts. The thermal cutoff includes a thermal sensing arrangement, having one or more thermal sensors, that collects at least one temperature reading from one or more portions of the electrical assembly **30**. If one or more of the collected temperature readings satisfy a threshold criterion, for example above 40 degrees Celsius, the electrical safety device **20** operates to prevent flow of electric current through the electrical cable **32**, and preferably also causes a prevention of flow of electric current to all circuits connected to the mains power supply to which the electrical assembly **30** is coupled. As will be discussed, in certain embodiments, the prevention of the flow of current is effectuated by the thermal cutoff creating a short circuit between the zero element and the ground element, whereas in other embodiments the flow of current is effectuated by the thermal cutoff creating an open circuit by disconnecting from the zero element.

In one non-limiting configuration, the electrical safety device **20** is deployed in (i.e., integrated with) the electrical socket **40**. In another non-limiting configuration, the electrical safety device **20** is deployed in (i.e., integrated with) the electrical cable **32**. In yet another non-limiting configuration, the electrical safety device **20** is deployed in (i.e., integrated with) the electrical plug **36**. The electrical coupling of the electrical safety device **20** with the electrical assembly **30** depends on the deployment configuration, but in general includes electrically connecting the electrical safety device **20** with a zero element (either zero wire **34a**, or zero prong **38a**, or zero contact **42a**) and optionally also with a corresponding ground element (either ground wire **34b**, or ground prong **38b**, or ground contact **42b**) of the electrical assembly **30**. In embodiments in which the electrical safety device **20** is deployed in the electrical cable **32**, the location of the deployment can be selected so that the electrical safety device **20** is deployed at an identified critical failure point or points along the length of the electrical cable **32**. A point may be considered as a critical

failure point if that point tends to rise in temperature more rapidly or rise to a greater absolute temperature, as compared to other points along the electrical cable **32**.

With continued reference to FIG. 1, attention is also directed to FIGS. 2 and 3, which help demonstrate one non-limiting example deployment configuration in which the electrical safety device **20** is coupled with the electrical socket **40**. More particularly, FIG. 2 is a cross-sectional view of the electrical socket **40** illustrated in FIG. 1, showing the electrical safety device **20** deployed in (i.e., integrated with) the electrical socket **40**. Here, the electrical safety device **20** is implemented as a thermal cutoff having a housing **22** that carries or contains a thermal sensing arrangement (having one or more thermal sensors, represented schematically as **23** in FIG. 3) and that is coupled to a pair of electrical contacts **24** and **26**. FIG. 3 is a representation of the electrical safety device **20** integrated with the electrical socket **40**, that schematically shows the thermal sensor(s) **23** and the coupling of the thermal cutoff **20** to the zero element and ground element via the electrical contacts **24** and **26**, and also shows schematically and conceptually the switching functionality of the thermal cutoff **20** via a switching element of the thermal cutoff **20**, represented schematically in the drawings as switch element **21**. In FIG. 3, the electrical safety device **20** is shown as being electrically coupled with zero and ground elements of the electrical assembly **30**, represented schematically in the drawing as portions of the zero contact **42a** and the ground contact **42b** of the electrical socket **40**. These portions of the zero contact **42a** and the ground contact **42b** can be located, for example, in interior portions of the socket **40** that are internal to the socket body **41** (FIGS. 1 and 2). The first electrical contact **24** is electrically connected with the zero contact **42a**, and the second electrical contact **26** is electrically connected with the ground contact **42b**. It is noted that the electrical connection between the electrical contacts **24** and **26** and the respective zero and ground elements can also be made, for example, by connecting the electrical contacts **24** and **26** with the portions of the wires **34a** and **34c** that connect with the electrical contacts **42a** and **42c**. These portions of the wires **34a** and **34c** are located in interior portions of the socket **40** that are internal to a housing of the socket **40**.

In the embodiment illustrated in FIG. 3, the thermal cutoff **20** is implemented as a thermal switch that is configured to operate in a normally open configuration, whereby the switch element **21** is nominally only connected to the zero element of the electrical assembly **30**. This configuration is ideal for use in situations in which the electrical plug **36** and the electrical cable **32** include ground elements (ground prong **38b** and ground wire **34b**). Accordingly, when the thermal sensor(s) **23** of the thermal cutoff (switch) **20** senses that the temperature of the electrical cable **32** is above a threshold (i.e., satisfies a temperature threshold criterion), the thermal cutoff **20** closes (conceptually understood as the switch element **21** closing between the contacts **24** and

26 to connect to the ground element) to create a short circuit between the zero contact 42a and the ground contact 42b. This short circuit prevents the flow of electric current through the electrical cable 32, and more particularly prevents the flow of electric current from the mains power supply to the socket 40. By preventing the flow of electric current, the risk of electrical fires caused by increased temperature of electrical components of the electrical assembly 30 is significantly reduced, if not completely mitigated.

With continued reference to FIGS. 1 and 2, reference is also made to FIG. 4, which schematically illustrates a mains power supply 50 (e.g., wall outlet) to which the electrical assembly 30 is electrically coupled. In many situations, the mains power supply 50 is electrically connected to a residual-current device 52, which can be located, for example, in a circuit breaker box, and is electrically connected to one or more other electric circuits 54 (in many cases all of, or a large group of, the circuits in the building or structure in which the mains power supply is located). In such situations, the residual current (or leakage) resultant from the short circuit caused by the closing of the thermal cutoff 20 can trip (or trigger) the residual-current device 52 to prevent flow of electric current to all circuits 54 connected to the residual-current device 52. This shutoff of electric current to all circuits, effectuated by the thermal cutoff 20 and the residual-current device 52, adds another layer of fire protection. FIG. 4 also schematically shows the electrical safety device 20 connected to the electrical assembly 30 and connected to a transceiver device 70, which can be used to send alert notifications via one or more networks according to certain non-limiting embodiments, as will be discussed in subsequent sections of this document.

It is noted that in most developed countries and geographic regions, mains power supply wall outlets, and thus electrical plugs, sockets, and cables, often include ground elements. However, in many parts of the developing world, ground elements are often not present in many electrical outlets and plugs. Therefore, in order to accommodate such groundless outlets and plugs, embodiments of the electrical assembly 30 may not include any ground elements (i.e., no ground prong 38b, no ground wire 34b, and no ground contact 42b). However, the electrical safety device 20 according to certain embodiments of the present disclosure can still be deployed to operate with such groundless electrical assembly configurations. In such embodiments, for example as illustrated schematically in FIG. 5, the first electrical contact 24 is electrically connected with the zero element (contact 42a) and the second electrical contact 26 is not electrically connected to any component. Here, the thermal cutoff 20 can be implemented as a thermal switch that is configured to operate in a normally closed configuration, so that when the thermal sensor(s) 23 of the thermal cutoff (switch) 20 senses that the temperature of the electrical cable 32 is above a threshold, the thermal cutoff 20 opens (conceptually understood as the switch 21 opening and disconnecting from

contact **26**) to create an open circuit to disconnect from the zero contact **42a**. The creation of the open circuit has the same general effect on the flow of current as does the short circuit effectuated by the normally open configuration discussed above, i.e., the open circuit prevents the flow of electric current through the electrical cable **32**, and more particularly prevents the flow of electric current from the mains power supply to the socket **40**. However, since the normally closed configuration is primarily used in situations in which there is no ground connection and causes an open circuit when triggered, the open circuit may not trip any residual-current device, and therefore may not prevent flow of electric current to other circuits that are connected to the mains power supply.

As mentioned above, the electrical safety device **20** may alternatively, or in addition, be deployed in the electrical cable **32** and/or the electrical plug **36**. In embodiments in which the electrical safety device **20** is electrically coupled with the electrical plug **36**, the coupling can be provided via electrical connection of the electrical contacts **24** and **26** with the zero prong **38a** (zero element) and the ground prong **38b** (ground element), respectively. The electrical connection with the prongs **38a** and **38b** can be made, for example, by connecting the electrical contacts **24** and **26** with the portions of the wires **34a** and **34b** that connect with the base of the prongs **38a** and **38b** internal to the plug body plug **36**, for example as illustrated schematically in FIG. 6A (which shows a plug **36** with the plug body removed and the electrical safety device **20** connected to portions of the wires **34a** and **34b**). As another example, the electrical connection between the contacts **24**, **26** and the prongs **38a**, **38b** can be made by directly connecting the contacts **24**, **26** to the prongs **38a**, **38b** at, for example, a base portion of each of the prongs **38a**, **38b** that is internal to the plug body **37** of the plug **36**. FIG. 6B shows an example of the electrical safety device **20** in the electrical plug **36**, illustrating electrical contacts **39a**, **39b**, **39c** of the electrical plug **36** that respectively connect to the prongs **38a**, **38b**, **38c** (the electrical connection between the electrical safety device **20** and the electrical contacts of the electrical plug **36** is not shown in FIG. 6B). The base portions of the prongs **38a**, **38b**, **38c** can themselves be electrical contacts. Similarly, in embodiments in which the electrical safety device **20** is electrically coupled with the electrical cable **32**, the coupling can be provided via electrical connection of the electrical contacts **24** and **26** with the respective portions of the zero wire **34a** and the ground wire **34b** (for example at a portion(s) or segment(s) of the cable identified as critical failure points). Although the electrical coupling of the electrical safety device **20** to the electrical cable **32** is not illustrated here, the coupling is conceptually the same as is illustrated in FIG. 3, and can be made at any segment of the electrical cable **32**.

The operation of the electrical safety device **20**, when deployed in either of these deployment configurations, is in principle the same as described above with reference to FIGS. 2 – 4. Accordingly, when the thermal sensor(s) **23** of the thermal cutoff (switch) **20** senses that the temperature of the electrical plug **36** or cable **32** (or regions of the electrical assembly **30** in proximity to the electrical plug **36** or proximity to the contact points of the electrical cable **32**) is above a threshold, the thermal cutoff **20** triggers a short circuit between the zero prong **38a** or wire **34a** and the ground prong **38b** or wire **34b** (i.e., by closing the switch **21**) thereby preventing the flow of electric current through the electrical cable **32**. Furthermore, in embodiments in which the electrical plug **36** or cable **32** do not include a ground element (i.e., ground prong or ground wire), the electrical safety device **20** may be deployed similarly to as described with reference to FIG. 5. Accordingly, in such embodiments, the first electrical contact **24** is electrically connected with the zero prong **38a** or wire **34a** (i.e., zero element) and the second electrical contact **26** is not electrically connected to any component, thus triggering an open circuit (i.e., by opening the switch **21**) when the thermal sensor(s) **23** of the thermal switch **20** senses that the temperature of the electrical plug **36** or cable **32** (or regions of the electrical assembly **30** in proximity to the electrical plug **36** or proximity to the contact points of the electrical cable **32**) is above a threshold.

It should be appreciated that implementation of the thermal cutoff as a thermal switch provides an advantage of re-usability of the electrical safety device **20**, since the thermal switch may typically revert back to its initial position or state (i.e., back to open if in a normally open configuration, and back to closed if in a normally closed configuration) if and when the temperature of the component that triggered the switch falls below the threshold temperature. However, despite the fact that the thermal switch may revert back to its initial (“normal”) position, human intervention is typically required in order to restore the flow of electric current to the various circuits. In embodiments in which the thermal switch is in a normally open configuration (e.g., when the mains power supply and the electrical assembly include ground elements), the restoration of the flow of electric current may be as simple as manually resetting (i.e., switching “on”) a residual-current device connected to the circuit of the mains power supply and/or resetting a circuit breaker of the mains power supply. In embodiments in which the thermal switch is in a normally closed configuration (e.g., when the mains power supply and the electrical assembly do not include ground elements), the restoration of the flow of electric current may require manually re-opening the corresponding circuit. Despite the advantage of re-usability of the thermal switch implementation, other thermal cutoff implementations are contemplated herein, including, for example, implementation as a thermal fuse.

It is noted that although FIG. 1 illustrates a particular non-limiting construction of the electrical assembly **30** as an extension cable, other cable-based electrical assembly constructions fall within the scope of the present disclosure. For example, although the electrical assembly **30** illustrated in FIG. 1 is shown as having a single electrical socket **40**, it should be apparent that the electrical assembly according to embodiments of the present disclosure can include a plurality of electrical sockets, each being constructed similarly to the electrical socket **40**, arranged in serial or parallel. For example, in one non-limiting implementation, the electrical assembly can be implemented as a power strip having a block of electrical sockets electrically connected to a first end of an electrical cable and having an electrical plug connected at a second end of the electrical cable. In such embodiments, the electrical cable may be elongated but be of a shorter length than in the embodiment illustrated in FIG. 1. In certain embodiments, for example in embodiments in which the electrical assembly is implemented as a power strip, the electrical assembly can include a surge protector to limit the voltage supplied to the electrical socket **40**.

By way of another example, as illustrated schematically in FIG. 7, the electrical assembly according to embodiments of the present disclosure can be implemented as an extension cable reel, whereby the electrical cable **32** is further elongated in comparison to the embodiment illustrated in FIG. 1, and can be stowed by winding the electrical cable around a frame or drum **60**. It is noted that the deployment of the electrical safety device **20** in or on the electrical cable **32** in such frame-wound electrical assemblies has particular advantages, due in part to the fact that the winding of the electrical cable **32** around the frame **60** can, in certain cases, cause a rapid increase and/or a more significant absolute increase in the temperature of the components of the electrical assembly **30**. In such embodiments, the critical failure point of the electrical cable **32** may be at a distance of approximately 2 meters from the mains power supply (wall outlet), and therefore the electrical safety device **20** may be preferably deployed (mounted to, or integrated in, the electrical cable **32**) at or near such critical failure point.

It is noted that the electrical socket **40** (or sockets) is merely one type of electrical output component that can be electrically connected to the electrical cable **32**. In general, the electrical assembly **30** can include any suitable electrical output component, such as the exemplary electrical socket as well as any type of device that is powered by a mains power supply, including, but not limited to, DC charging devices (such as a mobile phone charger), electronic devices (e.g., desktop computers, televisions, etc.), and electronic appliances (e.g., refrigerator, oven, microwave oven, toaster, dishwasher, washing machine, dryer, etc.). Accordingly, the electrical assembly can include one or more electrical output components implemented as non-socket-type components, including, for example, an electrical output component in the form of a DC output component (for

example as part of a mobile phone charger), an illumination power component that provides power to an illumination component (e.g., a lightbulb), a heating power component that provides power to a heating element, and the like.

Referring now to FIGS. 8 – 11, there is illustrated a safety apparatus **100** according to another set of embodiments of the present disclosure. Here, the safety apparatus **100** includes an electrical assembly **300**, implemented as a socket adapter device, which may be a multi socket adapter, having integrated therein electrical safety device(s) **20** (represented in FIGS. 8 and 9 as dashed rectangles to indicate that the electrical safety device(s) is/are integrated in the electrical assembly **300**). The electrical assembly **300** includes a housing **302** having opposing first and second sides **304a**, **304b**. Here, an electrical plug **36** protrudes outward from a central region of the first side **304a**, and a pair of electrical sockets **40** are recessed in respective regions of the second side **304b**. The electrical plug **36** is configured for electrically coupling to a mains power supply (not illustrated) to provide flow of electric current from the mains power supply so that the electrical socket(s) **40** receive electric current from the mains power supply via the electrical plug **36**.

Parenthetically, it is noted that the socket adapter device **300** may, in certain embodiments, include a voltage adapter (converter) that is configured to convert between mains power high voltage of two or more regions or countries. For example, the voltage adapter can be configured to convert between 100-120 volts AC (as used in the United States) and 220-240 volts AC (as used in Europe). In other embodiments, the socket adapter device **300** may include a surge protector to limit the voltage supplied to the electrical socket(s) **40**.

It is noted that although only two electrical sockets are illustrated in FIGS. 9 – 11, it should be apparent that the electrical assembly may include any suitable number of electrical sockets, including a single socket or more than two sockets. For example, a single socket may be employed in embodiments in which the socket adapter device includes a voltage adapter.

As illustrated in FIGS. 10 and 11, the electrical assembly **300** includes an electrical connection arrangement **306** internal to the housing **302** that provides an electrical connection between the electrical plug **36** and the electrical socket(s) **40**, and in particular between common elements of the plug and sockets (e.g., ground to ground, zero to zero, live to live). The electrical connection arrangement **306** includes electrically conductive material, and can be implemented in various ways, including, for example, as one or more busbars or one or more wires. In the illustrated embodiment, busbars **306** provide electrical connection between the electrical contacts **42a**, **42b**, **42c** of each of the electrical sockets **40** and the corresponding electrical contacts **39a**, **39b**, **39c** (which although not shown in the drawings are located at the base of the corresponding prongs

38a, 38b, 38c, internal to the housing 302). In certain embodiments, the electrical contacts 24 and 26 of the thermal cutoff 20 may be electrically connected to the zero and ground elements via direct connection with appropriate portions of the busbars 306.

5 In the embodiment illustrated in FIGS. 8 – 11, the electrical plug 36 and each of the electrical sockets 40 has an electrical safety device 20 coupled thereto. It is noted, however, that any combination of coupling of electrical safety device to the plug 36 and sockets 40 can be employed, including a single electrical safety device 20 coupled to the plug 36 or a single electrical safety device 20 coupled to one of the sockets 40. The coupling of the electrical safety device 20 to the plug and sockets is similar to as in the embodiments described above. Thus, in embodiments
10 in which the electrical safety device 20 is electrically coupled with the electrical plug 36, the coupling can be provided via electrical connection of the electrical contacts 24 and 26 with respective zero and ground prongs of the electrical plug 36, where the electrical connections with the prongs can be made by connecting the electrical contacts 24 and 26 with the portions of the prongs that are internal to the plug 36 (i.e., within the housing 302). Similarly, in embodiments
15 in which the electrical safety device 20 is electrically coupled with one of the electrical sockets 40, the coupling can be provided via electrical connection of the electrical contacts 24 and 26 with respective portions of a zero contact and a ground contact of the socket (for example portions that are internal to the socket, e.g., within the housing 302). In certain embodiments, the coupling between the electrical safety device 20 and the electrical plug 36 and/or the electrical socket(s) 40
20 can be provided via electrical connection of the electrical contacts 24 and 26 with zero and ground portions of the busbars 306.

In the embodiment illustrated in FIGS. 8 – 11, the operation of the electrical safety device(s) 20, is in principle the same as in the embodiments described above. Accordingly, when the thermal sensor(s) of the thermal cutoff (switch) 20 senses that the temperature of the electrical
25 assembly 300 (electrical plug 36 or socket(s) 40) is above a threshold, the thermal cutoff 20 triggers a short circuit between the zero element and the ground element (i.e., by closing the switch), thereby preventing the flow of electric current to the electrical socket(s) 40.

It is noted that the electrical assembly 300 may also be configured without ground elements (i.e., no ground prong or ground contacts). In such embodiments, the electrical safety device 20
30 may be deployed similarly to as described with reference to FIG. 5, whereby the first electrical contact 24 is electrically connected with a zero element (which may be a zero prong, a zero contact, or a zero element of the appropriate busbar 306), and the second electrical contact 26 is not electrically connected to any component, thus triggering an open circuit (i.e., by opening the

switch) when the thermal sensor(s) of the thermal switch **20** senses that the temperature of the electrical assembly **300** (electrical plug **36** or socket(s) **40**) is above a threshold.

Referring now to FIG. 12, there is illustrated a safety apparatus **200** according to another set of embodiments of the present disclosure. Here, the electrical safety device **20** is integrated with, or connected to, a mains power supply electrical wall socket assembly **210** to form a safe wall socket. The electrical wall socket assembly **210** includes a backbox (or baseplate) **212**, an electrical wire assembly **214** that is housed inside the backbox **212**, and a faceplate **216** that is mounted to the backbox **212**. The electrical wire assembly **214** includes one or more wires that are electrically connected to the mains power supply, and is configured to carry electric current from the mains power supply. In the illustrate embodiment, the wires of the electrical wire assembly **214** include neutral (zero) wire **34a**, ground (earth) wire **34b**, and hot (live) wire **34c**. The faceplate **216** includes an electrical receptacle (socket) **40** that is electrically connected to the electrical wire assembly **214**, and that is configured to receive an electrical plug and to convey electric current from the mains power supply through the electrical wire assembly **214** to the electrical plug when the electrical plug is received in the electrical receptacle. The electrical receptacle **40** includes multiple electrical contacts, represented in FIG. 12 as apertures **42a**, **42b**, **42c**. The electrical contacts of the electrical receptacle **40** include neutral (zero) contact **42a**, ground (earth) contact **42b**, and hot (live) contact **42c**. The neutral wire **34a** is electrically connected to the neutral contact **42a**, the ground wire **34b** is electrically connected to the ground contact **42b**, and the live wire **34c** is electrically connected to the live contact **42c**.

The electrical safety device **20** is coupled to the socket assembly **210** in a fashion similar to as in the embodiments described above. Thus, the electrical safety device **20** can be coupled to the electrical socket assembly **210** via electrical connection of the electrical contacts **24** and **26** with respective portions of a zero element and a ground element of the electrical socket assembly **210**, for example portions of the zero wire **34a** and the ground wire **34b**, or portions of the zero contact **42a** and the ground contact **42b** that are internal to the electrical receptacle **40**.

The operation of the safety apparatus **200** is in principle the same as in the embodiments described above. Accordingly, when the thermal sensor(s) of the thermal cutoff (switch) **20** senses that the temperature of a portion or portions of the electrical wall socket assembly **210** (portion(s) / segment(s) of the electrical wire assembly **214**) is above a threshold, the thermal cutoff **20** triggers a short circuit (i.e., by closing the switch) between the zero element and the ground element, thereby preventing the flow of electric current through the electrical wire assembly **214**.

It is noted that the electrical wall socket assembly **210** may also be configured without ground elements (i.e., no ground wire or ground contact). In such embodiments, the safety

apparatus **200** may be deployed similarly to as described with reference to FIG. 5, whereby the first electrical contact **24** is electrically connected with a zero element, which may be a portion of the zero wire **34a** or a portion of the zero contact **42a**. Accordingly, when the thermal sensor(s) of the thermal switch **20** senses that the temperature of the electrical wall socket assembly **210** (portion(s) / segment(s) of the electrical wire assembly **214**) is above a threshold, the thermal switch **20** disconnects from the zero element to trigger an open circuit (i.e., by opening the switch).

The embodiments described thus far have pertained to electrical safety devices that are integrated in electrical assemblies. However, embodiments are contemplated herein in which electrical safety devices are externally mounted to one or more components of electrical assemblies. Referring now to FIG. 13, there is schematically illustrated an embodiment of the electrical safety device **20'** that is configured for electrically connecting to an electrical wiring assembly, that is electrically connected to a mains power supply, that carries electric current. The electrical wiring assembly has a plurality of insulated electrical wires. In certain embodiments, the plurality of insulated electrical wires includes an insulated neutral (zero) wire, an insulated ground (earth) wire, and an insulated hot (live) wire. In other embodiments, no ground wire may be present. In certain embodiments, the insulated electrical wires are part of an electrical cable, for example electrical cable **32** of FIG. 1, and are provided within a projective cable jacket. In other embodiments, the insulated electrical wires are not provided with a cable jacket, for example when part of an electrical wall socket, such as the electrical wire assembly **214** of FIG. 12.

The electrical safety device **20'** is identical in structure to the electrical safety device **20** described in previous embodiments, but also includes a pin assembly **25** having a pair of pins **27** and **29** that are in proximity to each other (e.g., within a few millimeters or one or two centimeters) which allow a user to externally mount the electrical safety device **20'** to electrical cables or electrical wiring by inserting the pins into the electrical wiring assembly. The pins **27** and **29** provide electrical contact points for forming an electrical connection between the electrical contacts **24** and **26** and the respective zero and ground wires. The pins **27** and **29** have pointed ends to enable the pins to penetrate insulation of the insulated wires, such that the pin **27** is configured to penetrate insulation of the zero wire of the electrical wiring assembly (e.g., wire **34a** in FIG. 1) so as to contact electrically conductive material of the zero wire at a first contact point along the zero wire. In embodiments in which a ground wire is present, the pin **29** is configured to penetrate insulation of the ground wire of the electrical wiring assembly (e.g., wire **34b** in FIG. 1) so as to contact electrically conductive material of the ground wire at a second contact point along the ground wire, where the second contact point is in proximity to the first contact point (due to the proximity of the pins **27** and **29**).

In embodiments in which the electrical wiring assembly is provided within a projective cable jacket (for example when the electrical safety device **20'** is to be externally mounted to an electrical cable), the pins of the pin assembly can be elongated so as to be able to penetrate the protective cable jacket to reach the electrically conductive material of the wires. As should be
5 apparent, in embodiments in which the electrical safety device **20'** is to be externally mounted to wiring of a wall outlet, the faceplate of the wall outlet should first be removed in order to allow a user access to the wiring assembly of the wall outlet.

Once the electrical safety device **20'** is mounted to the wiring assembly, adhesive electrical insulation (commonly referred to as "electrical tape") can be wrapped around the electrical safety
10 device and the mounted portion of the electrical cable or wiring in order to provide insulation to any exposed wiring, and also to secure the electrical safety device **20** to the electrical cable or wiring.

The operation of the electrical safety device **20** illustrated in FIG. 13 is in principle the same as in the embodiments described above in which the electrical safety device is integrated
15 with the electrical cable or electrical wiring assembly, and therefore description of such operation will not be repeated here.

According to certain embodiments, the electrical safety device **20** (and/or the safety apparatuses **10**, **100**, **200** or the electrical socket assembly **200**) of the present disclosure may be configured to provide alert notifications.

20 In one set of embodiments, the alert notifications can be provided by one or more indicator components that indicate the actuation of the switch, i.e., prevention of flow of electric current. In certain embodiments, the indicator components can be implemented as visual indicator components to provide a visual indication that the flow of electric current has been shut off. One non-limiting example of a visual indicator component is an illumination component, such as a
25 light-emitting diode (LED), which can be part of the thermal cutoff or electrically coupled to the thermal cutoff, and which can be actuated (illuminated) upon detection, by the thermal sensor(s), that the temperature of the electrical assembly is above a threshold. In other embodiments, the indicator components can be implemented as audible indicator components to provide an auditory indication that the flow of electric current has been shut off. One non-limiting example of an
30 auditory indicator component is a tone generator, which can be part of the thermal cutoff or electrically coupled to the thermal cutoff, and which can be actuated to output an audible tone or other sound upon detection, by the thermal sensor(s), that the temperature of the electrical assembly is above a threshold.

In another set of embodiments, the electrical safety device **20** (and/or the safety apparatuses **10**, **100**, **200** or the electrical socket assembly **200**) of the present disclosure may provide alert notifications to one or more users via communication with one or more networks that can include, for example, one or more cellular networks, one or more local area networks, the internet, and the like. The alert notifications can take various forms, including, but not limited to, text-based messages sent to a user's mobile device via messaging service (e.g., SMS, MMS, WhatsApp, etc.), and email notifications sent to a user's email address. In such embodiments, network communication can be provided, for example, by a transceiver device that is part of, or is electrically connected (i.e., attached) to, the electrical safety device **20** (and/or the safety apparatuses **10**, **100**, **200** or the electrical socket assembly **200**). In one non-limiting example implementation, the transceiver device can include a cellular transceiver that is configured to communicate with a cellular network. In such embodiments, the actuation of the thermal cutoff induces the transceiver device to transmit the alert notification via the network(s). FIG. 4 schematically illustrates a non-limiting example of an embodiment in which the electrical safety device **20** is connected to a transceiver device **70** which is operative send alert notifications when the electrical safety device **20** is actuated. It is noted that although FIG. 4 shows a transceiver device in the context of an embodiment in which there are circuits **54** connected to the mains power supply **50** (to which the electrical assembly is connected) via residual-current device **52**, transceiver device **70** can be used with any of the embodiments described herein, and it may be advantageous to use the transceiver device in embodiments in which there is no residual-current device that connects between the mains power supply and other circuits.

It is noted that the embodiments described herein include various electrical plugs that are configured to electrically couple to a mains power supply. Within the context of this document, an electrical coupling of an electrical plug to a mains power supply can be a direct coupling, for example via insertion into an electrical wall outlet, or can be an indirect coupling, for example via insertion into an electrical socket of an extension cable or a socket adapter or other assembly that has an electrical plug that is inserted into an electrical wall outlet.

Many of the embodiments disclosed herein have pertained to electrical safety devices used with electrical assemblies that have an electrical cable with an electrical plug at one end thereof and at least one electrical output component (e.g., socket / outlet, electrically powered device, etc.) at the other end thereof. It is noted, however, that the electrical safety devices according to the present disclosure may be used with other variants of such electrical assemblies, including variants in which an electrical cable is provided at one end with an electrical plug or electrical socket, and in which loose electrical wires (connected to the electrical plug or electrical socket) are at a second

end of the electrical cable (opposite the first end). Such embodiments allow a user to select an electrical connector component, such as at least one electrical socket or an electrical plug, to connect to the second end of the electrical cable via appropriate wiring connection.

5 The various embodiments described herein have pertained to electrical safety devices, for example in the form of thermal cutoffs, that collect at least one temperature reading of one or more components of electrical assemblies, and operate to prevent flow of electric current through components of the electrical assemblies if one or more of the collected temperature readings satisfy a threshold criterion, i.e., if one or more of the collected temperature readings is above a threshold temperature. The temperature criterion / temperature threshold at which the electrical safety
10 devices prevent electric current flow may be a pre-set parameter of the electrical safety device or may be an adjustable parameter that can be a temperature selected from an operating range of temperatures supported by the electrical safety device. For example, a thermal switch may have a pre-set temperature threshold of 40 degrees Celsius, whereas another thermal switch, for example provided by Texas Instruments of Dallas, Texas, may have a higher pre-set temperature threshold,
15 for example approximately 100 degrees Celsius. As another set of examples, Sensata Technologies of Attleboro, Massachusetts produces an array of thermal switches with different operational ranges, allowing for user-selection of preferred temperature thresholds within the operational range. Accordingly, the safety apparatuses according to the embodiments of the present disclosure may have pre-selected temperature thresholds or user-adjustable temperature thresholds, and the
20 selection of the type of electrical safety device to use with the various electrical assemblies discussed herein may differ in accordance with the particular application and may differ from electrical assembly to electrical assembly.

The descriptions of the various embodiments of the present disclosure have been presented for purposes of illustration, but are not intended to be exhaustive or limited to the embodiments
25 disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments. The terminology used herein was chosen to best explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

30 As used herein, the singular form, “a”, “an” and “the” include plural references unless the context clearly dictates otherwise.

The word “exemplary” is used herein to mean “serving as an example, instance or illustration”. Any embodiment described as “exemplary” is not necessarily to be construed as

preferred or advantageous over other embodiments and / or to exclude the incorporation of features from other embodiments.

5 It is appreciated that certain features of the disclosure, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the disclosure, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the disclosure. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

10 To the extent that the appended claims have been drafted without multiple dependencies, this has been done only to accommodate formal requirements in jurisdictions which do not allow such multiple dependencies. It should be noted that all possible combinations of features which would be implied by rendering the claims multiply dependent are explicitly envisaged and should be considered part of the disclosure.

15 Although the disclosure has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

WHAT IS CLAIMED IS:

1. A safety apparatus comprising:
an electrical assembly including:
an electrical cable for carrying electric current,
an electrical plug electrically connected to a first portion of the electrical cable, the
electrical plug for electrically coupling to a mains power supply to provide
flow of electric current from the mains power supply through the electrical
cable, and
at least one electrical socket electrically connected to a second portion of the
electrical cable for receiving electric current through the electrical cable;
and
an electrical safety device coupled to the electrical assembly and configured to:
collect at least one temperature reading from one or more portions of the electrical
assembly, and
prevent flow of electric current through the electrical cable if one or more of the
collected at least one temperature reading satisfies a threshold criterion.
2. The safety apparatus of claim 1, wherein the electrical safety device is integrated with
the electrical assembly.
3. The safety apparatus of claim 1, wherein the electrical safety device is mounted to the
electrical assembly.
4. The safety apparatus of claim 1, wherein the electrical safety device is deployed in the
at least one electrical socket.
5. The safety apparatus of claim 1, wherein the electrical safety device is deployed in the
electrical plug.
6. The safety apparatus of claim 1, wherein the electrical safety device is deployed in or
on a portion of the electrical cable.
7. The safety apparatus of claim 1, wherein when the one or more of the collected at least
one temperature reading satisfies the threshold criterion, the electrical safety device causes a
prevention of flow of electric current to all circuits connected to the mains power supply.
8. The safety apparatus of claim 7, wherein the electrical safety device causes the
prevention of flow of electric current to all circuits connected to the mains power supply by
triggering a residual-current device that is electrically connected to the mains power supply to
disconnect all circuits from the mains power supply when the one or more of the collected at least
one temperature reading satisfies the threshold criterion.

9. The safety apparatus of claim 1, wherein the electrical safety device includes a thermal cutoff electrically connected to the electrical assembly.

10. The safety apparatus of claim 9, wherein the thermal cutoff is a thermal switch that is configured to operate in a normally open configuration.

11. The safety apparatus of claim 10, wherein the thermal switch is electrically coupled to a zero element and a ground element of the electrical assembly, wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

12. The safety apparatus of claim 9, wherein the thermal cutoff is a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical assembly.

13. The safety apparatus of claim 12, wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

14. The safety apparatus of claim 9, wherein the thermal cutoff is a thermal fuse.

15. A safety apparatus comprising:

an electrical assembly including:

a wire assembly including one or more wires for carrying electric current,

an electrical plug electrically connected to a first portion of the wire assembly, the electrical plug for electrically coupling to a mains power supply to provide flow of electric current from the mains power supply through the wire assembly, and

at least one electrical output component electrically connected to a second portion of the wire assembly for receiving electric current through the wire assembly; and

an electrical safety device coupled to the electrical assembly and configured to:

collect at least one temperature reading from one or more portions of the electrical assembly, and

prevent flow of electric current through the wire assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

16. The safety apparatus of claim 15, wherein the electrical assembly is an electrically powered device.

17. The safety apparatus of claim 15, wherein the at least one electrical output component includes at least one electrical socket.

18. The safety apparatus of claim 15, wherein the at least one electrical output component includes a DC output.

19. The safety apparatus of claim 15, wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

20. The safety apparatus of claim 19, wherein the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the mains power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

21. The safety apparatus of claim 15, wherein the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the electrical assembly and that is configured to operate in a normally open configuration, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

22. The safety apparatus of claim 15, wherein the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical assembly, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

23. A safety apparatus comprising:

a socket adapter device including:

an electrical plug for electrically coupling to a mains power supply to receive electric current from the mains power supply,

at least one electrical socket, and

an electrical connection arrangement providing an electrical connection between the electrical plug and the at least one socket; and

an electrical safety device coupled to the socket adapter device and configured to:

collect at least one temperature reading from one or more portions of the socket adapter device, and

prevent flow of electric current to the at least one electrical socket if one or more of the collected at least one temperature reading satisfies a threshold criterion.

24. The safety apparatus of claim 23, wherein the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the socket adapter device and that is configured to operate in a normally open configuration, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

25. The safety apparatus of claim 23, wherein the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the socket adapter device, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

26. A safety apparatus comprising:

an electrical socket assembly including:

a backbox,

an electrical wire assembly housed inside the backbox, the electrical wire assembly including one or more wires electrically connected to a mains power supply and configured to carry electric current from the mains power supply, and

a faceplate mounted to the backbox and including an electrical receptacle electrically connected to the electrical wire assembly, the electrical receptacle configured to receive an electrical plug and to convey electric current from the mains power supply through the electrical wire assembly to the electrical plug when the electrical plug is received in the electrical receptacle; and

an electrical safety device coupled to the electrical wire assembly and configured to:

collect at least one temperature reading from one or more portions of the electrical wire assembly, and

prevent flow of electric current through the electrical wire assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

27. The safety apparatus of claim 26, wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

28. The safety apparatus of claim 27, wherein the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

29. The safety apparatus of claim 26, wherein the electrical safety device includes a thermal switch electrically coupled to a zero element and a ground element of the electrical socket assembly and that is configured to operate in a normally open configuration, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero element and the ground element so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

30. The safety apparatus of claim 26, wherein the electrical safety device includes a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to a zero element of the electrical socket assembly, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero element.

31. An electrical safety device for electrically connecting to an electrical wiring assembly that is electrically connected to a mains power supply for carrying electric current from the mains power supply, the electrical wiring assembly having a plurality of insulated electrical wires including a first insulated electrical wire that is a zero wire and a second insulated electrical wire that is a live wire, the electrical safety device comprising:

- a thermal cutoff including at least one temperature sensor configured to sense temperature;

- and

- a pin assembly electrically connected to the thermal cutoff, the pin assembly including a first pin and a second pin, the first pin configured to penetrate insulation of the first insulated electrical wire so as to contact electrically conductive material of the first insulated electrical wire at a first contact point,

wherein the electrical safety device is configured to:

- collect at least one temperature reading from one or more portions of the electrical wiring assembly in proximity to the first contact point, and

prevent flow of electric current through the electrical wiring assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.

32. The electrical safety device of claim 31, wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the electrical safety device causes a prevention of flow of electric current to all circuits connected to the mains power supply.

33. The electrical safety device of claim 32, wherein the electrical safety device causes the prevention of flow of electric current to all circuits connected to the mains power supply by triggering a residual-current device that is electrically connected to the mains power supply to disconnect all circuits from the mains power supply when the one or more of the collected at least one temperature reading satisfies the threshold criterion.

34. The electrical safety device of claim 32, wherein the plurality of insulated electrical wires includes a third insulated electrical wire that is a ground wire, wherein the second pin is configured to penetrate insulation of the third insulated electrical wire so as to contact electrically conductive material of the third insulated electrical wire at a second contact point, wherein the thermal cutoff is a thermal switch that is configured to operate in a normally open configuration, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch closes to create a short circuit between the zero wire and the ground wire so that a residual-current device that is electrically connected to the mains power supply prevents flow of electric current to all circuits connected to the residual-current device.

35. The electrical safety device of claim 31, wherein the thermal cutoff is a thermal switch that is configured to operate in a normally closed configuration in which the thermal switch is connected to the zero wire, and wherein when the one or more of the collected at least one temperature reading satisfies the threshold criterion, the thermal switch opens thereby disconnecting the thermal switch from the zero wire.

36. A safety method for performing on an electrical assembly that includes one or more of an electrical cable, an electrical socket, or an electrical plug, the safety method comprising:

collecting, by an electrical safety device, at least one temperature reading from one or more portions of the electrical assembly, and

preventing, by the electrical safety device, flow of electric current through the electrical assembly if one or more of the collected at least one temperature reading satisfies a threshold criterion.