

DIGITIZED PRESSURE GAUGE

FIELD OF THE INVENTION

[0001] The present invention relates to a digitized pressure gauge for pressure vessels such as portable fire extinguishers. In particular, the present invention relates to a pressure gauge configured to actuate a switch or sensor based upon a pressure in the vessel reaching a predetermined pressure, wherein actuation of the switch or sensor occurs when one or more pressure gauge components is caused to rotate beyond a threshold angle of rotation by a pressure sensor element. The present invention further relates to a fire extinguisher incorporating the pressure gauge, and a computer-implemented system and method of remotely detecting actuation of the switch or sensor.

BACKGROUND OF THE INVENTION

[0002] Portable fire extinguishers are well known devices that are operable to extinguish fires and, in particular, provide users with the ability to quickly and safely extinguish a small fire preventing its spread and major damage to property. Such extinguishers are typically mounted on walls and in other easy to access areas throughout homes and buildings to facilitate access to such devices in the event of a fire. Fire extinguishers will typically contain a material that is suitable for extinguishing a particular fire.

[0003] Some examples of extinguishing materials (also referred to as extinguishing agents) include water for class A (eg. paper and wood) fires, foam for class A, class B (eg. paint and petrol) and to a limited extent class F (eg. fryers and chi pans) fires, dry chemical powder ABE for class A, class B and class E (eg. computers and generators) fires, dry chemical powder BE for class B, class E and to a limited extent class F fires, Carbon Dioxide (CO₂) for class E and to a limited extent class A and class B fires, and wet chemical for class A and class F fires.

[0004] A fire extinguisher typically comprises a cylindrical body containing pressurized fire extinguishing material, a pressure indicator gauge at the top of the cylinder indicating the pressure inside (or at least whether the pressure is within an optimal pressure zone), a handle and associated valve assembly, and a discharge hose which typically includes a nozzle through which fire extinguishing material passes when the valve assembly is operated by activating the handle. The handle typically includes a carry handle portion

that allows for easy grasping, lifting and carrying of the extinguisher, and an operating lever handle portion configured to be depressed (squeezed) towards the carry handle portion to activate the valve assembly.

[0005] The pressure gauge of a fire extinguisher will typically include an indicator having a rotatable pointer that is caused to rotate to different positions along a visual scale according to the pressure inside the fire extinguisher. In a particular example, the optimal working range of a fire extinguisher in some jurisdictions is 11 to 18.5 bar, and the scale will typically identify this optimal operating range, eg. by including a green colour band between these two pressures. The scale may also indicate pressures below (eg. 0 to 11 bar) and above (eg. 18.5 to 28 bar) the optimal working range of 11 to 18.5 bar, and those additional bands are typically coloured red. Accordingly, by viewing the pressure gauge indicator, an operator or inspector of the fire extinguisher is able to observe the position of the pointer and therefore whether the pressure inside the fire extinguisher is inside or outside an optimal operating pressure range.

[0006] There are a number of different types of pressure gauges that are used in fire extinguishers. One example is the bourdon tube pressure gauge which includes a pressure sensor element in the form of bourdon tube that is arc-shaped and typically has an oval cross section. The bourdon tube is fixed and connected to the chamber in which pressure is to be sensed, with the other end being non-clamped and hence free to move when pressure acts on the inside of the free (non-clamped) end of the tube. The displacement of the free end creates angular movement in an associated rack and pinion through a mechanical linkage, which causes the pointer (which is pivoted on the pinion) to move over the scale in order to indicate the pressure. In this regard, there are typically two or more layered sections associated with fire extinguisher pressure gauges, wherein a topmost section accommodates the pointer and additional visual scale components, and one or more additional sections that sit below the topmost section accommodates the bourdon tube, rack and pinion, and mechanical linkage components.

[0007] There are various circumstances in which a fire extinguisher may experience a drop in pressure below the lower end of an optimal operating range (eg below 11 bar). For example, there may be a slow leak (due to a damaged valve or other component) that over time releases gas from inside the cylinder. Such pressure drops can cause the extinguisher to become ineffective and potentially unsafe to use. For this reason, the

pressure gauge must undergo regular maintenance inspections (typically monthly). Such manual inspections typically require significant resources and hence are costly.

[0008] There is a need to be able to monitor when the pressure inside a fire extinguisher drops below a predetermined level so that appropriate action can be taken to address same, without the need for regular site inspections.

[0009] Another problem arises from the use of conventional fire extinguishers in that portable extinguishers that are known to the Applicant are not generally capable of providing notifications to relevant responders and/or on-site personnel regarding the loss of pressure inside the cylinder so that remedial action can be taken as quickly as possible (eg. replacing or recharging the fire extinguisher so that it is operable again).

[0010] The present invention seeks to ameliorate the problems discussed herein, or at least provide an alternative solution.

[0011] The reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any suggestion, that the prior art forms part of the common general knowledge.

SUMMARY OF THE INVENTION

[0012] In one aspect, the present invention provides a pressure gauge for a pressurized vessel, the pressure gauge including, a pressure sensor including an element that is displaced according to a change in pressure in the pressurized vessel, a cam configured to transmit, through a rocker arm, pressurized displacement of the pressure sensor element to a rotatable pointer shaft, wherein, the cam arrangement is configured to rotate according to displacement of the pressure sensor element, thereby causing the rocker arm to rotate, the rocker arm is configured to cause the pointer shaft to rotate according to rotation of the rocker arm, and the pointer shaft includes a pointer configured, by way of rotation of the pointer shaft, to provide a visual indication of the pressure inside the pressurized vessel, and a device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond a threshold angle of rotation, wherein rotation beyond the threshold angle of rotation is indicative of the pressure inside the vessel moving above or below a predetermined pressure.

[0013] In an embodiment, the cam is configured to cause the rocker arm to rotate in a first direction as pressure inside the pressurized vessel increases, and in an opposed second direction as pressure in the pressurized vessel decreases.

[0014] In an embodiment, the pointer shaft is rotatably biased in a direction that causes the rocker arm to be biased towards said second direction, the rocker arm thereby biased in a configuration that opposes a force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element.

[0015] In an embodiment, the rocker arm includes a first end having a fixed pivot axis, and a second free end that rotates about the rocker arm fixed pivot axis, wherein the second free end rotates in said first direction when the pressure inside the pressurized vessel is such that the rotating force imparted on the rocker arm by the cam is caused to exceed the opposed rotating force imparted on the rocker arm by the rotatably biased pointer shaft.

[0016] In an embodiment, the rocker arm second end rotates about the rocker arm fixed pivot axis in said second direction when the pressure is such that the rotating force imparted on the rocker arm by the rotatably biased pointer shaft is caused to exceed the opposed rotating force imparted on the rocker arm by the cam.

[0017] In an embodiment, the pointer shaft is rotatably spring-biased.

[0018] In an embodiment, the cam includes a pivotable cam member including, a first edge portion having a fixed pivot axis that extends perpendicularly to the rocker arm fixed pivot axis and enables the cam member to rotate about the cam member fixed pivot axis, and a second edge portion that extends at an alternate angle as compared with the first edge portion, thereby forming a contact edge for contacting the pressure sensor element such that displacement of the pressure sensor element causes the pressure sensor element to abut against the contact edge and thereby cause rotation of the cam member in the direction of displacement of the pressure sensor element, wherein the second edge portion of the cam member extends through an aperture in the rocker arm and, based on the rotating force imparted on the rocker arm by the rotatably biased pointer shaft, is configured to make contact with an internal edge of the aperture such that rotation of the cam member about the cam member pivot axis causes rotation of the rocker arm about the rocker arm pivot axis.

[0019] In an embodiment, the second edge portion extends substantially perpendicularly to the first edge portion forming a substantially perpendicular contact edge between the first and second edge portions.

[0020] In an embodiment, the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle of rotation includes a device arranged and configured to be actuated based on said rotation beyond the threshold angle. For example, the device may be a limit switch, proximity sensor, or any other type of switch or sensor capable of being actuated based on rotation of the cam, pointer shaft and/or pointer beyond the threshold angle.

[0021] In an embodiment, the device is a sensor or switch located such that rotation of the rocker arm in said second direction represents rotation of the rocker arm towards the sensor or switch, and rotation of the rocker arm in said first direction represents rotation of the rocker arm away from the sensor or switch.

[0022] In an embodiment, the sensor or switch is actuated by a trigger cam associated with the rocker arm when the rocker arm has been rotated sufficiently towards the sensor or switch.

[0023] In an embodiment, the sensor or switch is a limit switch having an actuating lever, wherein the trigger cam associated with the rocker arm is positioned such that the trigger cam is moved together with the rocker arm to depress the actuating lever when the rocker arm has been rotated in said second direction to at least the threshold angle of rotation.

[0024] In an embodiment, the trigger cam is suspended from the rocker arm and disposed at a height to cause the actuating lever to be depressed as the trigger cam is moved there towards.

[0025] In an embodiment, the trigger cam further includes an angled contact surface that facilitates depressing of the limit switch lever.

[0026] In an embodiment, the limit switch is normally open and the rocker arm trigger cam is positioned to close and thereby actuate the limit switch when the rocker arm is caused to rotate towards the limit switch to at least the threshold angle of rotation.

[0027] In an embodiment, the predetermined pressure corresponds with the lowest pressure associated with a predetermined pressure range such that the limit switch is triggered when the vessel pressure reaches the lowest pressure associated with the predetermined pressure range.

[0028] In an embodiment, the pressurised vessel and pressure gauge are components of a portable fire extinguisher, and the predetermined pressure range is based on regulatory and/or safety standards applicable to the portable fire extinguisher.

[0029] In an embodiment, the predetermined pressure range is 11 to 18.5 bar (considered a normal operating range for portable fire extinguishers) and the threshold angle is such that the limit switch will be actuated when the pressure inside the vessel moves below 11 bar (eg. above 18.5 bar).

[0030] In an embodiment, the gauge is configured to actuate another switch or sensor when the pressure inside the vessel moves above the upper end of the pressure range.

[0031] In an embodiment, a geared relationship exists between the rocker arm and pointer shaft.

[0032] In an embodiment, the geared relationship is a gear-pinion relationship, wherein the pinion is associated with the rocker arm and is configured to engage a gear associated with the pointer shaft.

[0033] In an embodiment, the pressure gauge includes layered sections comprising, a base section for accommodating the pressure sensor, and the fixed pivot axis and contact edge of the cam member, a mid-section (core assembly portion) for accommodating the rocker arm including the rocker arm fixed pivot axis, the second edge portion of the cam member that extends through the rocker arm aperture, the trigger cam, the limit switch, and the base of the pointer shaft, and an upper section for accommodating the top of the pointer shaft and the pointer associated therewith, wherein the three layered sections are supported inside a housing.

[0034] In an embodiment, each of the mid and upper sections includes a base plate that separates the respective sections, wherein each base plate is maintained in a spaced apart configuration by a plurality of structural frame members.

[0035] In an embodiment, the pointer shaft extends through an aperture in the upper section base plate in order to support the pointer inside the upper section of the gauge.

[0036] In an embodiment, the cam member extends through an aperture in the mid section base plate to enable the second edge portion of the cam member to extend through the rocker arm aperture located in the mid section.

[0037] In an embodiment, each pivot axis is defined by a pivot pin.

[0038] In an embodiment, the upper section further includes a visual scale associated with the upper section base plate, above which the pointer moves (rotates) to provide the visual indication relating to the pressure inside the pressurized vessel.

[0039] In an embodiment, the visual scale includes a first zone reflecting the predetermined pressure range and having a first colour associated therewith, and one or more additional zones reflecting one or more pressure ranges outside of the predetermined pressure range and having a second colour associated therewith. For example, the colour green may be used for the displayed pressures inside the predetermined pressure range, and the colour red may be used for any displayed

pressures outside the predetermined pressure range (eg below or above the predetermined pressure range).

[0040] In an embodiment, the vessel is pressurised such that the pressure inside the vessel is within the predetermined pressure range, and the force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element is such that the rocker arm is substantially aligned with a corresponding pressure within the first zone of the visual scale.

[0041] In an embodiment, the one or more additional zones includes a second zone below the predetermined pressure range, and a third zone above the predetermined pressure range, wherein the second zone includes an indication reflecting nil pressure inside the vessel.

[0042] In an embodiment, when the vessel is not pressurized, there is no force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element, hence the rocker arm is rotated to a maximum extent of rotation in said second direction wherein the pointer is substantially aligned with the indication on the visual scale that indicates nil pressure inside the vessel.

[0043] In an embodiment, the pressure sensor element includes a pressure sensing diaphragm or a bourdon tube.

[0044] In an embodiment, the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle of rotation (ie. a switch or sensor) is hard wired or wirelessly connected to a communication module operable to receive a signal based on actuation of the device that detects rotation (ie. opened or closed depending on the particular configuration) such that receipt of the signal indicates that the pressure inside the vessel has moved outside a predetermined pressure range, and to transmit data relating to said actuation to a remote monitoring service (eg. drop in pressure below a predetermined operating range).

[0045] In an embodiment, the communication module is affixed to the fire extinguisher.

[0046] In a second aspect, the present invention provides a pressurized vessel including a pressure gauge configured in accordance with any one or more of the preceding statements of invention.

[0047] In a third aspect, the present invention provides a portable fire extinguisher including a pressure gauge configured in accordance with any one or more of the preceding statements of invention.

[0048] In a fourth aspect, the present invention provides a computer-implemented method of detecting when pressure inside a fire extinguisher has decreased below a predetermined operating range, the fire extinguisher including a pressure gauge configured in accordance with any one or more of the preceding statements of invention, the method including, receiving, by a communication module associated with the fire extinguisher, from the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond a threshold angle of rotation, a first signal indicating that one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle, and based on receiving the first signal, transmitting, by the communication module, a second signal to a remote monitoring service, the second signal confirming that the pressure inside the fire extinguisher has decreased to a pressure below a predetermined operating pressure of the fire extinguisher.

[0049] In an embodiment, the method further includes, processing, by the communication module, the first signal to identify information relating to the decrease in pressure below the predetermined operating pressure of the fire extinguisher including at least a date and time associated with detecting same, wherein transmitting a second signal to the remote monitoring service includes transmitting the information relating to the decrease in pressure below the predetermined operating pressure including the date and time associated with same.

[0050] In an embodiment, the method further includes, storing data relating to instances of detecting decreases in pressure below the predetermined operating pressure locally (eg. in one or more local databased) or remotely (eg cloud storage), wherein such data is subsequently accessed by users using data communication devices, including one or more of smart phones, tablets, fixed computing devices or any other portable or fixed computing device capable of connecting to the remote monitoring service through an available network.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Embodiments of the invention will now be described in further detail with reference to the accompanying figures in which:

[0052] Figure 1 illustrates a perspective view of a fire extinguisher including a pressure gauge configured in accordance with an embodiment of the present invention, including an enlarged perspective view of the pressure gauge.

[0053] Figure 2A illustrates a perspective view of the pressure gauge of Figure 1 shown in isolation.

[0054] Figure 2B illustrates an exploded, perspective view of the pressure gauge of Figure 1 shown in isolation.

[0055] Figure 3A illustrates a perspective view of the mid-section (core assembly portion) of the pressure gauge of Figures 1-2, including a rocker arm, pointer shaft, pointer, and limit switch.

[0056] Figure 3B illustrates a perspective view of the upper section of the pressure gauge of Figures 1-2 including the pointer and a visual scale, including a cross-sectional cutaway section exposing the mid-section components.

[0057] Figure 4A illustrates a top view of the visual scale and pointer in the upper section of the pressure gauge when the vessel is depressurised.

[0058] Figure 4B illustrates a cross-sectional side view of the pressure gauge of Figure 4A showing components in the base section including the pressure sensor element and cam member, the mid-section including the cam member, rocker arm with associated trigger cam, pointer shaft and limit switch, and the upper section including the pointer and visual scale.

[0059] Figure 4C illustrates an enlarged cross-sectional view of the cam member, rocker arm with associated trigger cam, and limit switch of Figure 4B, wherein the limit switch is actuated by the trigger cam.

[0060] Figure 5A illustrates a top view of the visual scale and pointer when the vessel is pressurised and the pressure in the vessel is within a predetermined pressure range.

[0061] Figure 5B illustrates a cross-sectional side view of the pressure gauge of Figure 5A showing components in the base section including the pressure sensor element and cam member, the mid-section including the cam member, rocker arm with associated trigger cam, pointer shaft and limit switch, and the upper section including the pointer and visual scale.

[0062] Figure 5C illustrates an enlarged cross-sectional view of the cam member, rocker arm with associated trigger cam, and limit switch of Figure 5B, wherein the limit switch is no longer actuated by the limit switch.

[0063] Figure 6A illustrates a top view of the visual scale and pointer when the pressure in the vessel has reduced to the lower end of the predetermined pressure range.

[0064] Figure 6B illustrates a cross-sectional side view of the pressure gauge of Figure 6A showing components in the base section including the pressure sensor element and cam member, the mid-section including the cam member, rocker arm with associated trigger cam, pointer shaft and limit switch, and the upper section including the pointer and visual scale.

[0065] Figure 6C illustrates an enlarged cross-sectional view of the cam member, rocker arm with associated trigger cam, and limit switch of Figure 6B, wherein the limit switch is no longer actuated by the trigger cam.

[0066] Figure 7 illustrates a schematic diagram of a fire extinguisher including the pressure gauge illustrated in Figures 2 to 6, the fire extinguisher further including a communication module operable to receive a signal when the limit switch is closed by the trigger cam, and to transmit data relating to closing of the limit switch to a remote monitoring service which enables access to such data through an available network.

DETAILED DESCRIPTION OF EMBODIMENT(S) OF THE INVENTION

[0067] For simplicity and illustrative purposes, the present disclosure is described by reference to embodiments thereof. In the following description, numerous details are set forth in order to provide a thorough understanding of the present disclosure. It will be readily apparent however, that the present disclosure may be practiced without limitation to the specific details of the one or more embodiments. In other instances, some features, or aspects thereof, have not been described in detail to avoid unnecessarily obscuring the present disclosure.

[0068] According to one aspect, the present invention relates to a pressure gauge 100 for a vessel 105 that is configured to be pressurized (eg. a portable fire extinguisher), as shown according to an embodiment of the present invention in Figures 1-3. The pressure gauge 100 enables the monitoring of when pressure inside the vessel 105 drops below a predetermined pressure level (or more generally, outside of a predetermined pressure range) so that appropriate action can be taken to address same without the need for regular visual inspections. The use of the pressure gauge 100 further enables notifications to be transmitted to relevant responders and/or on-site personnel regarding the loss of pressure inside the cylinder (or more generally, movement of pressure outside of a predetermined pressure range) so that remedial action can be taken as quickly as possible (eg. in the case of a fire extinguisher, replacing or recharging the fire extinguisher to ensure that it is operable).

[0069] In the embodiment shown in Figures 1-3, the pressure gauge 100 includes a pressure sensor 110 (this feature is shown clearly in Figures 4-6) which is located in a base section 115 of the pressure gauge. The pressure sensor 110 includes an element 120 that becomes displaced in a direction 125 (towards the mid 130 and upper 135 sections of the pressure gauge 100) based upon an increase in pressure in the vessel 105, and in the opposite direction 140 when the pressure in the vessel 105 decreases.

[0070] It will be appreciated that the process by which a change in pressure in the vessel 105 causes displacement of the pressure sensor element 120 is known in the art and hence will not be described in detail herein in the interest of brevity. It will also be understood that whilst the pressure sensor 110 illustrated includes a diaphragm element

120 that raises from the floor of the base section 115 when the vessel 105 is sufficiently pressurised, moves further in direction 125 as pressure increases, and lowers back towards the floor in direction 140 as the pressure decreases, different types of pressure sensor could be utilized to perform a similar function. For example, a bourdon tube or similar element that is capable of becoming displaced based upon a change in pressure in the vessel could equally be used.

[0071] The pressure gauge 100 further includes a cam 145 that is actuated by displacement of the pressure sensor element 120, as well as a rocker arm 150. The cam 145 is configured to transmit, through the rocker arm 150, pressurized displacement of the pressure sensor element 120 to a rotatable pointer shaft 155 and associated pointer 160 responsible for providing a visual indication to a user (not shown) regarding the pressure inside the vessel 105. In particular, the cam 145 is configured to rotate according to the displacement of the pressure sensor element 120, which causes the rocker arm 150 to rotate in a configuration that is described in additional detail further below. Rotation of the rocker arm 150 causes the pointer shaft 155 (and hence pointer 160) to rotate correspondingly.

[0072] In this way, the pointer 160 is rotated to a position along a visual scale 165 to indicate a pressure 170 inside the vessel 105 (eg. pressure of 9 bar, etc) and/or a characteristic 175 of the pressure inside the vessel (eg. pressure within safe operating range, outside of safe operating range, etc).

[0073] A limit switch 180 is shown as a means of detecting when the rocker arm 150, and in particular a trigger cam 185 associated with the rocker arm 150, has been caused to rotate beyond a threshold angle of rotation according to a change in pressure in the vessel 105. In the particular embodiment shown, the limit switch 180 is positioned and configured to be actuated when the pressure inside the vessel 105 has dropped below a predetermined pressure (e.g. 11 bar). The predetermined pressure in this instance is the lower end of a suitable operating pressure range for fire extinguishers of 11 to 18.5 bar, although other pressures / pressure ranges may be selected depending on the particular application.

[0074] The present invention is not limited to the use of a limit switch 180 as a means of detecting whether the rocker arm 150 has been rotated to an extent that indicates

pressure inside the vessel 105 has moved above or below the predetermined pressure of 11 bar. As will become apparent, any suitable sensing or switching device may be utilized in place of the limit switch 180.

[0075] Further, the present invention is not limited to detecting when pressure has moved outside a predetermined range based on detecting rotation of the rocker arm component. In some circumstances, it may be more practical or convenient to measure the movement or rotation of another component or components and to use this measurement to confirm when pressure inside the vessel has increased or decreased above or below a predetermined pressure, or outside of a predetermined operating range. For example, a device that detects when one or more of the cam 145, rocker arm 150, pointer shaft 155, and/or pointer 160 has been caused to rotate beyond a threshold angle of rotation could equally be used, where rotation of the relevant component(s) beyond a threshold angle confirms that the pressure inside the vessel 105 has moved above or below the predetermined pressure (or outside of a predetermined pressure range).

[0076] It will be appreciated that in the accompanying Figures, an actuation lever 190 is associated with the limit switch 180 that is actuated by the trigger cam 185 suspended from the rocker arm 150 when the trigger cam 185 is caused to move laterally to depress the actuation lever 190. Such movement is caused by pressure in the vessel 105 falling below the predetermined pressure of 11 bar (the lower end of the predetermined operating range of 11 to 18.5 bar). This occurs based on the pressure sensor element 120 causing, via the cam 145, the rocker arm 150 to move (rotate) in a first direction 195 as pressure in the vessel 105 increases, and in a second (opposite) direction 200 towards the limit switch 180 as pressure in the pressurized vessel 105 decreases.

[0077] The pointer shaft 155 is rotatably biased through use of a biasing means (shown by way of example as a coiled spring 205 in Figure 3) in a direction 210 that causes the rocker arm 150 to be biased in the second direction 200 towards the limit switch 180. This biased rotation caused by spring 205 opposes a force imparted on the rocker arm 150 by the cam 145 (which force causes the rocker arm 150 to move in the first direction 195) based on the pressure sensor element 120 being displaced in direction 125 when the vessel is pressurized.

[0078] It is to be understood that biasing of the pointer shaft 155 may be achieved using appropriate biasing means other than a spring without deviating from the scope of the present disclosure.

[0079] It will also be appreciated that one end of the rocker arm 150 is fixed whilst an opposed free end moves (rotates) in directions 195 and 200. In particular, the rocker arm 150 includes a first end 215 having a fixed pivot axis 220 (defined by a pivot pin extending through the rocker arm 150), and a second free end 225 that rotates about the rocker arm fixed pivot axis 220. This is shown most clearly in Figure 3. In this way, the second free end 225 rotates in the first direction 195 when the pressure inside the vessel 105 increases to an extent that causes the rotating force imparted on the rocker arm 150 by the cam 145 to exceed the opposed rotating force imparted on the rocker arm 150 by the rotatably biased pointer shaft 155. Accordingly, when pressure inside the vessel 105 increases to this extent, the pointer shaft 155 and pointer 160 rotate in direction 230 indicating an increase in pressure in the vessel 105. Similarly, the rocker arm second end 225 rotates about the rocker arm fixed pivot axis 220 in the second direction 200 when the pressure inside the vessel 105 decreases to an extent that causes the rotating force imparted on the rocker arm 150 by the rotatably biased pointer shaft 155 to exceed the opposed rotating force imparted on the rocker arm 150 by the cam 145. Accordingly, when pressure inside the vessel 105 decreases to this extent, the pointer shaft 155 and pointer 160 rotate in direction 210 indicating a decrease in pressure in the vessel 105.

[0080] In the embodiment shown, a gear-pinion relationship exists between the rocker arm second end 225 and the pointer shaft 155 which causes corresponding rotation between these two components, wherein a pinion 235 associated with the rocker arm 150 engages a gear 240 associated with the pointer shaft 155. It is to be understood that variations of the geared relationship described and illustrated herein may be possible and are considered within the scope of the present disclosure.

[0081] Figures 4-6 illustrate different states of pressurization of vessel 105, with Figures 4A-4C illustrating the various components of the pressure gauge 100 when there is no or minimal pressure inside the vessel 105, Figures 5A-5C illustrating the various components of the pressure gauge 100 when pressure in the vessel has increased to a pressure within the standard operating range of 11 to 18.5 bar, and Figures 6A-6C illustrating the various components of the pressure gauge 100 when pressure in the

vessel has decreased from the pressure shown in Figure 5 to the lower end of the standard operating range of 11 to 18.5 bar (ie. a pressure of 11 bar). It will be appreciated that as the pressure decreases to the lower end of the predetermined pressure (ie. 11 bar), it is at this precise point that the trigger cam 185 suspended from the rocker arm 150 will make contact with the limit switch actuation lever 190 and cause the lever to be depressed thereby actuating the limit switch 180.

[0082] It should be apparent to the skilled addressee based on a viewing of Figures 4 to 6, that the cam is in the form of a pivotable cam member 145. The cam member 145 includes a first edge portion 245 having a fixed pivot axis 250 that extends perpendicularly to the rocker arm fixed pivot axis 220 thereby enabling the cam member 145 to rotate about the cam member fixed pivot axis 250, and a second edge portion 255 that extends at an alternate angle as compared with the first edge portion 245, together forming a substantially perpendicular contact edge 260 for contacting the pressure sensor element 120. Displacement of the pressure sensor element 120 causes rotation of the cam member 145 in a direction that corresponds with the direction of displacement of the pressure sensor element 120 (ie. either direction 125 or 140). Whilst the two edge portions 245 and 255 of the cam member 145 are described individually for clarity purposes, it is clear in the embodiment shown that they are integrally formed and hence form part of the same structure, although other variations are possible.

[0083] The second edge portion 255 of the cam member 145 extends through an aperture 265 in the rocker arm 150 and, based on the rotating force imparted on the rocker arm 150 by the rotatably biased pointer shaft 155, the cam member second edge portion 255 is configured to make contact with an internal edge of the aperture 265 such that rotation of the cam member 145 about the cam member pivot axis 250 causes corresponding rotation of the rocker arm 150 about the rocker arm pivot axis 220.

[0084] It will be appreciated that the limit switch 180 is located such that rotation of the rocker arm 150 in the second direction 200 represents rotation of the rocker arm 150 towards the limit switch 180, and rotation of the rocker arm 150 in the first direction 195 represents rotation of the rocker arm 150 away from the limit switch 180. The limit switch 180 is actuated by the trigger cam 185 suspended from the rocker arm 150 when the rocker arm 150 has been rotated sufficiently towards the limit switch 180 to cause the trigger cam 185 to depress the limit switch lever 190. The trigger cam 185 is suspended

from the rocker arm 150 and is therefore disposed at a particular height within the mid-section 130 of the gauge 100 to cause the actuating lever 190 of the limit switch 180 to be depressed as the trigger cam is moved there towards.

[0085] Accordingly, depressing of the lever 190 and thereby actuating the limit switch 180 occurs when the rocker arm 150 has been rotated in the second direction 200 to at least a threshold angle of rotation representing a predetermined pressure in the vessel 105. In this embodiment, the limit switch 180 is therefore normally open and the rocker arm trigger cam 185 is positioned to actuate the limit switch (ie. cause the limit switch to close) when the rocker arm 150 is caused to rotate towards the limit switch 180 at least up to the threshold angle. In the embodiment shown, the trigger cam 185 further includes an angled contact surface that facilitates depressing of the limit switch lever 190.

[0086] The present disclosure is not limited to the use of a limit switch 180 as the device that detects when the cam, rocker arm, pointer shaft and/or pointer has been caused to rotate beyond a threshold angle of rotation that corresponds with a predetermined pressure in the vessel 105 being reached. Other suitable switches or sensors could be used, including a proximity sensor or any other type of detection device capable of being actuated based on detecting movement (eg. rotation) of any one of the moving components.

[0087] As previously described, the predetermined pressure at which the detection device is configured to be actuated will depend on the particular application in which the pressure gauge is being used. In the embodiment shown, the pressure gauge forms part of a portable fire extinguisher in which a suitable operating pressure range is 11 to 18.5 bar (based on regulatory and/or safety standards applicable to the portable fire extinguisher). The predetermined pressure in this instance is the lower end of the operating pressure range (ie. 11 bar) since this represents the pressure at which the fire extinguisher starts to become inoperable. Accordingly, the threshold angle of rotation will be selected to ensure that the limit switch 180, or other detection device, is actuated when the pressure inside the vessel moves to or below 11 bar.

[0088] Although not described or illustrated herein for brevity, it will be understood that the gauge 100 may be configured to actuate another switch or sensor (not shown) when the pressure inside the vessel moves up to or above the upper end of the suitable

operating pressure range (eg. above 18.5 bar). In other words, there may be applications that require monitoring of an increase in pressure beyond the upper limit of a predetermined pressure range, and the present gauge 100 may also be configured for use in such applications including by adding an additional switch or sensor as described above, or re-arranging one or more components described and illustrated herein in order to detect increase in pressure beyond a threshold value.

[0089] The construction of the pressure gauge 100 illustrated in Figures 1-6 is such that the pressure gauge 100 includes three layered sections, namely, a base section 115, a mid-section 130 and an upper section 135. The base section 115 accommodates the pressure sensor element 120 as well as the first edge portion 245, fixed pivot axis 250 and contact edge 260 of the cam member 145. The mid-section (core assembly portion) 130 accommodates the rocker arm 150 including the rocker arm fixed pivot axis 220, the second edge portion 255 of the cam member 145 that extends through the rocker arm aperture 265, the trigger cam 185, the limit switch 180, and the geared base associated with the pointer shaft 155. The upper section 135 accommodates the top of the pointer shaft 155 and the pointer 160 that rotates therewith.

[0090] As shown most clearly in Figures 1-2, the three layered sections are supported inside a housing 270 which also accommodates a front transparent screen 275 through which the visual scale 165 and pointer 160 may be viewed. In the embodiment shown, each of the mid and upper sections 130 and 135 includes a respective base plate 280 and 285 that separates the sections. In this regard, the housing includes an annular shoulder 290 above which sits the mid-section base plate 280, and an annular notch 295 for accommodating an O-ring 300 that secures the upper section base plate 285 in place and thereby acts to prevent movement of the components housed therein. Each base plate 280 and 285 is also maintained in a spaced apart configuration by a plurality of structural frame members 305.

[0091] Each of the base plates 280 and 285 also includes apertures at appropriate locations for enabling components to extend from one section into another where required. For example, the pointer shaft 155 extends through an aperture in the upper section base plate 285 in order to support the pointer 160 inside the upper section 135 of the gauge 100. Similarly, the cam member 145 extends through an aperture in the mid-

section base plate 280 to enable the second edge portion 255 of the cam member 145 to extend through the rocker arm aperture 265 located in the mid-section layer 130.

[0092] It will also be appreciated that the appearance of the visual scale 165 will differ depending on the particular application in which the pressure gauge 100 of the present invention is being used. In a particular embodiment relating to a portable fire extinguisher 105, the visual scale 165 may display different pressure characteristics 175 as well as specific pressures 170. For example, the different pressure characteristics may include a normal operating pressure zone 310 reflecting a normal operating pressure range (eg. between 11 and 18.5 bar) for a fire extinguisher which may include a particular identifier (eg. colour green), a low pressure zone 315 reflecting pressures between zero pressure and the lower end of the normal operating pressure range (eg. 11 bar), and a high pressure zone 320 reflecting pressures higher than the upper end of the normal operating pressure range (ie. higher than 18.5 bar), wherein the low and high pressure zones may also include a particular identifier (eg. colour red). As illustrated in the Figures herein, particular pressure values 170 may also be included, and these may (for example) represent the more important pressures that need to be monitored such as 0 bar, 11 bar, 18.5 bar, etc. The present disclosure is not limited to any one format or style of visual scale and is illustrated and described by way of example only.

[0093] When the vessel (105) is not pressurized, as shown in Figure 4 for example, there is no force imparted on the rocker arm 150 in the first direction 195 according to displacement of the pressure sensor element 120, hence the rocker arm 150 is rotated to a maximum extent of rotation in the second direction 200 wherein the pointer 160 is aligned with the lower end pressure (ie 0 bar) in the low pressure zone 315. When the vessel 105 is pressurised such that the pressure inside the vessel 105 increases to within the normal operating pressure range (ie above the predetermined pressure of 11 bar at which point the limit switch 180 is no longer actuated), the force imparted on the rocker arm 150 in the first direction 195 (according to displacement of the pressure sensor element 120) is such that the pointer 160 substantially aligns with the relevant pressure within zone 310 of the visual scale. As the pressure in the vessel 105 then decreases down to 11 bar or below, the limit switch 180 will be actuated (closed) and in this way, the gauge 100 is configured to record when the pressure inside the vessel 105 has dropped to a predetermined pressure value (eg. an unsafe or inoperable pressure).

[0094] Figure 7 illustrates an example of one of the advantages of the present invention, being the ability to remotely detect when the pressure in the fire extinguisher vessel 105 has reached a predetermined pressure (eg. decreased to 11 bar). In particular, the limit switch (180) may be hard wired (325) to a communication module (330) which is affixed to the fire extinguisher body (105), the communication module (330) operable to receive a signal from the limit switch (180) when the limit switch (180) is actuated (eg. closed by the depressing of lever 190) in a manner that indicates that a predetermined pressure has been reached (eg. pressure in the vessel 105 has decreased to a predetermined pressure), and to transmit data relating to actuation of the switch (180) to a remote monitoring service (335).

[0095] The signal from the limit switch (180) may be processed, either by the module (330) or at the remote monitoring service (335), to identify information relating to the vessel 105 reaching a predetermined pressure level. This may include, for example, a location of the fire extinguisher (105) affected, and a date and time associated with actuation of the limit switch 180. Such information may be subsequently forwarded to relevant user devices (340) through an available network (345) for the purpose of allowing users to act upon such information.

[0096] For example, the receiving devices (340) may be the property of remote emergency personnel or on-site personnel who are capable of addressing fire emergencies or equipment maintenance/inspection. There are clear benefits associated with being able to notify such personnel in substantially real-time, including in relation to a drop in pressure associated with a particular fire extinguisher, that may render the fire extinguisher inoperable. For example, since the location of the affected fire extinguisher (105) will be known, such notifications may enable relevant on-site personnel to immediately attend at the relevant location so that the potentially inoperable fire extinguisher can be quickly assessed. In particular, on-site personnel can check the status of the fire extinguisher and, if necessary, take steps necessary to replace or recharge the fire extinguisher. All data collected and transmitted by the communication module (330) may be subsequently stored such that a historical database of events is maintained. The skilled addressee will appreciate that such data is also useful for analytical purposes, including to improve processes, for report generation, etc.

[0097] It will be apparent to the person skilled in the relevant field of technology that the pressure gauge (100) of the present invention may be installed in newly manufactured fire extinguishers (105), but may also be easily retrofitted into existing fire extinguishers (105) since no part of the existing fire extinguisher (105) needs to be re-configured in order for the gauge (100) to be utilized. The gauge (100) simply needs to replace the existing pressure gauge. It will also be appreciated that different fire extinguishers may have different fastening means for securing a pressure gauge, such as different sized threaded sections, etc, hence the gauge (100) may be constructed accordingly in order to accommodate those existing parameters.

[0098] The benefits of the present invention should now be realized. What is provided is a digitized means of monitoring pressure in a vessel 105 such as a fire extinguisher, and which enables connection to a monitoring platform such that when pressure within the vessel 105 moves outside of a predetermined operating range (eg above or below a predetermined pressure), such events may be remotely monitored without the need for regular visual inspections.

[0099] It will be appreciated by persons skilled in the relevant field of technology that numerous variations and/or modifications may be made to the invention as detailed in the embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all aspects as illustrative and not restrictive.

[0100] Throughout this specification and claims which follow, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” and “comprising”, will be understood to imply the inclusion of a stated feature or step, or group of features or steps, but not the exclusion of any other feature or step or group of features or steps.

The claims defining the invention are as follows:

1. A pressure gauge for a pressurized vessel, the pressure gauge including:
 - a pressure sensor including an element that is displaced according to a change in pressure in the pressurized vessel;
 - a cam configured to transmit, through a rocker arm, pressurized displacement of the pressure sensor element to a rotatable pointer shaft, wherein:
 - the cam arrangement is configured to rotate according to displacement of the pressure sensor element, thereby causing the rocker arm to rotate,
 - the rocker arm is configured to cause the pointer shaft to rotate according to rotation of the rocker arm, and
 - the pointer shaft includes a pointer configured, by way of rotation of the pointer shaft, to provide a visual indication of the pressure inside the pressurized vessel; and
 - a device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond a threshold angle of rotation, wherein rotation beyond the threshold angle of rotation is indicative of the pressure inside the vessel moving above or below a predetermined pressure.
2. A pressure gauge according to claim 1, wherein the cam is configured to cause the rocker arm to rotate in a first direction as pressure inside the pressurized vessel increases, and in an opposed second direction as pressure in the pressurized vessel decreases.
3. A pressure gauge according to claim 2, wherein the pointer shaft is rotatably biased in a direction that causes the rocker arm to be biased towards said second direction, the rocker arm thereby biased in a configuration that opposes a force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element.
4. A pressure gauge according to claim 3, wherein the rocker arm includes a first end having a fixed pivot axis, and a second free end that rotates about the rocker arm

fixed pivot axis, wherein the second free end rotates in said first direction when the pressure inside the pressurized vessel is such that the rotating force imparted on the rocker arm by the cam is caused to exceed the opposed rotating force imparted on the rocker arm by the rotatably biased pointer shaft.

5. A pressure gauge according to claim 4, wherein the rocker arm second end rotates about the rocker arm fixed pivot axis in said second direction when the pressure is such that the rotating force imparted on the rocker arm by the rotatably biased pointer shaft is caused to exceed the opposed rotating force imparted on the rocker arm by the cam.

6. A pressure gauge according to claim 5, wherein the pointer shaft is rotatably spring-biased.

7. A pressure gauge according to claim 6, wherein the cam includes a pivotable cam member including:

a first edge portion having a fixed pivot axis that extends perpendicularly to the rocker arm fixed pivot axis and enables the cam member to rotate about the cam member fixed pivot axis, and

a second edge portion that extends at an alternate angle as compared with the first edge portion, thereby forming a contact edge for contacting the pressure sensor element such that displacement of the pressure sensor element causes the pressure sensor element to abut against the contact edge and thereby cause rotation of the cam member in the direction of displacement of the pressure sensor element,

wherein the second edge portion of the cam member extends through an aperture in the rocker arm and, based on the rotating force imparted on the rocker arm by the rotatably biased pointer shaft, is configured to make contact with an internal edge of the aperture such that rotation of the cam member about the cam member pivot axis causes rotation of the rocker arm about the rocker arm pivot axis.

8. A pressure gauge according to claim 7, wherein the second edge portion extends substantially perpendicularly to the first edge portion forming a substantially perpendicular contact edge between the first and second edge portions.

9. A pressure gauge according to either claim 7 or claim 8, wherein the pressure gauge includes layered sections comprising:

a base section for accommodating the pressure sensor, and the fixed pivot axis and contact edge of the cam member,

a mid-section for accommodating the rocker arm including the rocker arm fixed pivot axis, the second portion of the cam member that extends through the rocker arm aperture, the trigger cam, the limit switch, and the base of the pointer shaft, and

an upper section for accommodating the top of the pointer shaft and the pointer associated therewith.

10. A pressure gauge according to claim 9, wherein:

the three layered sections are supported inside a housing,

each of the mid and upper sections includes a base plate that separates the respective sections, and wherein each base plate is maintained in a spaced apart configuration by a plurality of structural frame members,

the pointer shaft extends through an aperture in the upper section base plate in order to support the pointer inside the upper section of the gauge, and

the cam member extends through an aperture in the mid section base plate to enable the second edge portion of the cam member to extend through the rocker arm aperture located in the mid section.

11. A pressure gauge according to either claim 9 or claim 10, wherein the upper section further includes a visual scale above which the pointer rotates to provide the visual indication relating to the pressure inside the pressurized vessel, wherein the visual scale includes a first zone reflecting the predetermined pressure range and having a first colour associated therewith, and one or more additional zones reflecting one or more pressure ranges outside of the predetermined pressure range and having a second colour associated therewith, wherein, when the vessel is pressurised such that the pressure inside the vessel is within the predetermined pressure range, the force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element

is such that the rocker arm is substantially aligned with a corresponding pressure within the first zone of the visual scale.

12. A pressure gauge according to claim 11, wherein the one or more additional zones includes a second zone below the predetermined pressure range, and a third zone above the predetermined pressure range, wherein the second zone includes an indication reflecting nil pressure inside the vessel such that when the vessel is not pressurized, there is no force imparted on the rocker arm in said first direction according to displacement of the pressure sensor element, hence the rocker arm is rotated to a maximum extent of rotation in said second direction wherein the pointer is substantially aligned with the indication on the visual scale that indicates nil pressure inside the vessel.

13. A pressure gauge according to any one of the preceding claims, wherein the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle of rotation includes a device arranged and configured to be actuated based on said rotation beyond the threshold angle, wherein the device is a sensor or switch located such that rotation of the rocker arm in said second direction represents rotation of the rocker arm towards the sensor or switch, and rotation of the rocker arm in said first direction represents rotation of the rocker arm away from the sensor or switch.

14. A pressure gauge according to claim 13, wherein the sensor or switch is actuated by a trigger cam associated with the rocker arm when the rocker arm has been rotated sufficiently towards the sensor or switch, wherein the sensor or switch is a limit switch having an actuating lever and the trigger cam associated with the rocker arm is positioned such that the trigger cam is moved together with the rocker arm to depress the actuating lever when the rocker arm has been rotated in said second direction to at least the threshold angle of rotation, and wherein the trigger cam is suspended from the rocker arm and includes an angled contact surface disposed at a height to cause the actuating lever to be depressed as the trigger cam is moved there towards.

15. A pressure gauge according to claim 14, wherein the limit switch is normally open and the rocker arm trigger cam is positioned to close and thereby actuate the limit switch when the rocker arm is caused to rotate towards the limit switch to at least the threshold angle of rotation.

16. A pressure gauge according to any one of the preceding claims, wherein the predetermined pressure corresponds with the lowest pressure associated with a predetermined pressure range such that the limit switch is triggered when the vessel pressure reaches the lowest pressure associated with the predetermined pressure range.

17. A pressure gauge according to any one of the preceding claims, wherein a gear-pinion relationship exists between the rocker arm and pointer shaft such that a pinion is associated with the rocker arm and is configured to engage a gear associated with the pointer shaft.

18. A pressure gauge according to any one of the preceding claims, wherein the pressure sensor element includes a pressure sensing diaphragm or a bourdon tube.

19. A pressure gauge according to any one of the preceding claims, wherein the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle of rotation is hard wired or wirelessly connected to a communication module operable to receive a signal according to actuation of the device that detects rotation such that receipt of the signal indicates that the pressure inside the vessel has moved outside a predetermined pressure range, and to transmit data relating to said actuation to a remote monitoring service, wherein the communication module is affixed to the fire extinguisher.

20. A pressurized vessel or a portable fire extinguisher including a pressure gauge configured in accordance with one or more of the preceding claims.

21. A computer-implemented method of detecting when pressure inside a fire extinguisher has decreased below a predetermined operating range, the fire extinguisher including a pressure gauge configured in accordance with any one or more of claims 1 to 19, the method including:

receiving, by a communication module associated with the fire extinguisher, from the device that detects when one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond a threshold angle of rotation, a first signal indicating that one or more of the cam, rocker arm, pointer shaft or pointer has been caused to rotate beyond the threshold angle; and

based on receiving the first signal, transmitting, by the communication module, a second signal to a remote monitoring service, the second signal confirming that the pressure inside the fire extinguisher has decreased to a pressure below a predetermined operating pressure of the fire extinguisher.

22. A method according to claim 21, further including:

processing, by the communication module, the first signal to identify information relating to the decrease in pressure below the predetermined operating pressure of the fire extinguisher including at least a date and time associated with detecting same, and

storing data relating to instances of detecting decreases in pressure below the predetermined operating pressure locally or remotely, wherein such data is subsequently accessible to users using data communication devices, including one or more electronic devices capable of connecting to the remote monitoring service through an available network.

wherein transmitting a second signal to the remote monitoring service includes transmitting the information relating to the decrease in pressure below the predetermined operating pressure including the date and time associated with same.