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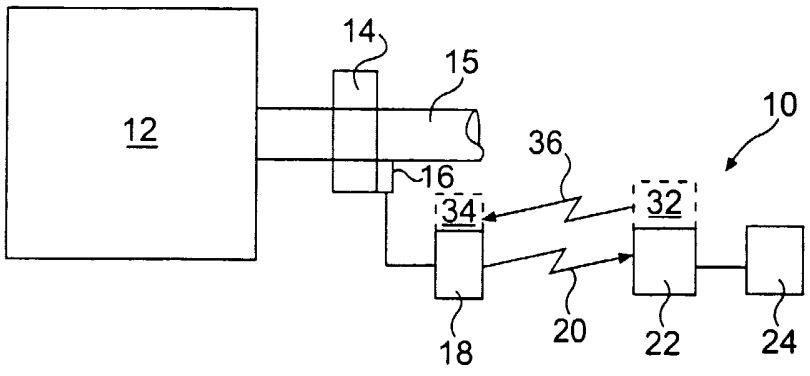
(54) Title: SYSTEM AND METHOD FOR MONITORING A PRESSURIZED SYSTEM



(57) Abstract: A system and method for monitoring a pressure reduction device are provided. The system includes a release sensor that provides an indication when the pressure reduction device activates. A wireless transmitter is connected to the release sensor and sends a wireless transmission having an activation signal when the indication is provided by the release sensor. A receiver receives the wireless transmission from the transmitter and generates a warning when the activation signal is identified.

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SYSTEM AND METHOD FOR MONITORING A PRESSURIZED SYSTEM

BACKGROUND OF THE INVENTION

[01] This invention generally relates to a method and system for monitoring a pressurized system. More particularly, the present invention relates to a method and system for monitoring a pressure reduction device.

[02] Pressure reduction devices, such as, for example, pressure relief devices and pressure release devices, are commonly used to protect systems that contain a pressurized fluid from experiencing potentially hazardous over-pressure conditions. A pressure relief devices may be designed to activate, or open, when the pressure of the fluid within the system reaches a predetermined pressure limit that indicates an over-pressure condition for the particular system. The predetermined pressure limit is variable and depends upon the design considerations of the particular system.

[03] A pressure reduction device may be designed to activate, or open, in response to an event requires release of pressurized fluid from within the pressurized system. The event may be internal or external to the pressurized system. The condition or conditions that establish the event requiring fluid release are variable and depends upon the design considerations of the particular system.

[04] The pressure relief devices, which may be, for example, rupture disks, pressure relief valves, safety valves, control valves, tank vents, explosion panels, or other such devices, are connected to the system so that at least a

portion of the pressure relief device is exposed to the fluid within the system. When the fluid reaches or exceeds the predetermined pressure limit, the force of the fluid on the pressure relief device acts on the pressure relief device to activate the pressure relief device, thereby creating an opening. Fluid may then escape from the system through the opening to relieve the over-pressure condition.

[05] The pressure release devices, which may be, for example, rupture disks, pressure relief valves, safety valves, control valves, butterfly valves, globe valves, ball valves, gate valves, tank vent, explosion panels, or other such devices, are connected to the system so that at least a portion of the pressure release device is exposed to the fluid within the system. When an event requiring release of the fluid is experienced, the pressure release device may be opened automatically or manually. The pressure release device may be automatically opened in response to the force of the fluid on the pressure release device or an external signal generated by a control system. The pressure release device may be manually opened by an operator. Fluid may escape from the system through the opening created by the opening of the pressure release device.

[06] In some systems, it is important to closely monitor the system and the pressure reduction device to determine, as quickly as possible, when the pressure reduction device activates. Quick notification of the activation of the pressure reduction device will allow an operator or automated system to take responsive action. The response taken will depend upon the particular

system and may include: taking corrective action to remedy the cause of an over-pressure condition; triggering the implementation of additional safety functions; providing notification of fluid release for system audit purposes; providing notification of the opening and/or closing of the pressure reduction device for system audit purposes; triggering the summons of safety personnel; or providing notification of pressurized system function.

[07] In other systems, it is important to closely monitor the system and the pressure reduction device to determine, as quickly as possible, when the pressure reduction device exhibits leakage. Quick notification will allow an operator or automated system to respond to the leakage. The response taken will depend upon the particular system and may include: taking corrective action to remedy the cause of the leakage condition; triggering the implementation of additional safety functions; or providing notification of fluid release for system audit purposes.

[08] In other systems, it is important to closely monitor the system and the pressure reduction device to determine the amount of fluid discharged. Based upon the release pressure of the fluid, the time for which the device is open, the fluid characteristics of the pressurized fluid, and the size of the opening created by the pressure reduction device, an accurate calculation of the amount of fluid discharged can be quickly made.

[09] Some pressure reduction devices may include a sensor that indicates when the pressure relief device has activated and the amount, or degree, of opening. Some of these sensors include an electrical circuit. The electrical

circuit is routed through the pressure reduction device such that the opening of the pressure reduction device interrupts the circuit. The interruption in the circuit senses that the pressure reduction device has activated and that fluid is escaping from the system. The sensor may be reconnected when the pressure reduction device re-closes. The time at which the sensor circuit is interrupted and reconnected, as well as the opening amount by of the pressure reduction device, may be recorded.

[10] When the sensor determines that the pressure reduction device has opened or exhibits leakage, this fact needs to be recorded and/or communicated to an operator or automated system who has the capability to react to the situation. The conventional sensor systems are typically hard-wired to an alarm, or other indicator, that is activated when the sensor identifies that the pressure reduction device has functioned. The alarm alerts the operator or automated system to the function of the pressure reduction device. This alarm or other indicator is typically remote from the location at which the pressure reduction device is installed. However, because the alarm is hard-wired, or directly connected to the sensor, there is significant cost to installation, especially for existing systems. There may be further inconvenience if the pressurized system is located in a remote location or in a remote part of a processing facility while the information is required at a central monitoring location.

[11] In light of the foregoing, there is a need for a method and system for monitoring a pressurized system that solves one or more of the problems set forth above.

SUMMARY OF THE INVENTION

[12] Accordingly, the present invention is directed to a method and system for monitoring a pressurized system that obviates one or more of the limitations and disadvantages of prior art systems. The advantages and purposes of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The advantages and purposes of the invention will be realized and attained by the elements and combinations particularly pointed out in the appended claims.

[13] To attain the advantages and in accordance with the purposes of the invention, as embodied and broadly described herein, the invention is directed to a monitoring system for a pressure reduction device that includes a release sensor that provides an indication when the pressure reduction device activates. A transmitter is connected to the release sensor and sends a wireless transmission having an activation signal when the indication is provided by the release sensor. A receiver receives the wireless transmission from the transmitter and generates a warning signal when the activation signal is identified.

[14] In another aspect, the invention is directed to a monitoring system for a pressurized system that includes a pressure reduction device. A release

sensor provides an indication when the pressure reduction device activates. A transmitter is connected to the release sensor and sends a wireless transmission having an activation signal when the indication is provided by the release sensor. A receiver receives the transmission from the transmitter and generates a warning signal when the activation signal is identified.

[15] In yet another aspect, the present invention is directed to a method of monitoring a pressure reduction device. According to the method, an indication is provided when a pressure relief deduction device activates. A wireless transmission is sent after the indication is provided. The wireless transmission includes an activation signal. The wireless transmission is received and a warning signal is generated when the activation signal is identified.

[16] In still another aspect, the present invention is directed to a monitoring system for a pressurized system. The monitoring system includes a pressure reduction device and a release sensor that is configured to provide an indication when the pressure reduction device activates. A transmitter is connected to the release sensor and is configured to send a wireless transmission having a status signal when a first predetermined period of time elapses without the release sensor providing the indication. A receiver is configured to receive the wireless transmission from the transmitter.

[17] In another aspect, the present invention is directed to a monitoring system for a pressurized system. The monitoring system includes a pressure reduction device and a release sensor that is configured to provide an

indication when the pressure reduction device activates. A transmitter is connected to the release sensor and is configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor. The activation signal includes at least one of an identity and a location for the activated pressure relief device. A receiver is configured to receive the wireless transmission from the transmitter and to generate a warning signal when the activation signal is identified.

[18] In still another aspect, the present invention is directed to a monitoring system for a pressurized system. The monitoring system includes a pressure reduction device and a release sensor that is configured to provide an indication when the pressure reduction device activates. A transmitter is connected to the release sensor and is configured to send a wireless transmission that has an identifying prefix that identifies the wireless transmission as being generated by the transmitter. A receiver is configured to receive the wireless transmission from the transmitter having the identifying prefix.

[19] In yet another aspect, the present invention is directed to a monitoring system for a pressurized system. The monitoring system includes a pressure reduction device and a release sensor that is configured to provide an indication when the pressure reduction device activates. A transmitter is connected to the release sensor and is configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor. A receiver is configured to receive the wireless transmission.

An annunciator is in communication with the receiver and is configured to provide an external alert when the wireless transmission having the activation signal is received.

[20] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[21] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the invention and together with the description, serve to explain the principles of the invention. In the drawings,

[22] Fig. 1 is a schematic and diagrammatic view of a monitoring system for a pressurized system in accordance with the present invention;

[23] Fig. 2 is a schematic and diagrammatic view of a sensor and transmitter for a pressure reduction device in accordance with the present invention;

[24] Fig. 3 is a schematic and diagrammatic view of another embodiment of a monitoring system for a pressurized system in accordance with the present invention; and

[25] Fig. 4 is a flowchart illustrating a method for monitoring a pressurized system in accordance with the present invention.

DETAILED DESCRIPTION

[26] Reference will now be made in detail to the presently preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. An exemplary embodiment of a monitoring system for a pressure reduction device is shown in Fig. 1 and is designated generally by reference number 10.

[27] As illustrated in Fig. 1, a pressure reduction device 14 is connected to a system 12 that contains a pressurized fluid or a fluid that may become pressurized. Pressure reduction device 14 may be, for example, a pressure relief device, such as, for example, a rupture disk, a pressure relief valve, a safety valve, an explosion vent, a control valve, or another type or relief device. Pressure reduction device 14 may also be a pressure release device, such as, for example, a rupture disk, a pressure relief valve, a safety valve, a control valve, a butterfly valve, a globe valve, a ball valve, a gate valve, a tank vent, or an explosion panel.

[28] Pressure reduction device 14 is connected to system 12 so that at least a portion of pressure reduction device 14 is exposed to the pressurized fluid. This connection may be accomplished in a variety of manners, such as, for example, placing pressure reduction device 14 in a vent pipe 15.

[29] Pressure reduction device 14 may be configured to activate, or open, when the fluid within system 12 reaches a predetermined pressure limit or when a predetermined event that requires release of fluid from system 12

occurs. The predetermined pressure limit may be indicative of an over-pressure condition for system 12 and may vary from system to system. The predetermined event may depend upon user requirements and the operating characteristics of the particular system. The activation, or opening, of pressure reduction device 14, creates an opening in pressure reduction device 14.

[30] As is known in the art, it is also possible for a pressure reduction device to develop a leak or otherwise allow fluid to escape from the pressurized system. For the purposes of the present disclosure, any change in state of the pressure reduction device is considered to be an activation of the pressure reduction device 14. For example, an activation of the pressure reduction device 14 may include an opening of the pressure reduction device 14, the development of a leak or other unexpected allowance of fluid flow through the pressure reduction device 14, and a closing of pressure reduction device 14.

[31] The opening created by the activation of pressure reduction device 14 allows fluid to escape from system 12. As fluid escapes system 12, the pressure within system 12 subsides. Vent pipe 15 may direct the escaping fluid into a reservoir (not shown). Alternatively, if the system fluid is not hazardous, vent pipe 15 may direct the escaping fluid to the environment.

[32] In accordance with the present invention, a release sensor provides an indication when the pressure reduction device activates and creates an expected or unexpected fluid pathway. The release sensor may also provide

an indication of the amount of opening of the pressure reduction device, i.e. the size of the created opening. The release sensor may include a mechanism, such as an electrically powered circuit or a pressure switch, that is connected to the pressure reduction device. The activation of the pressure reduction device triggers the mechanism, such as, for example, by interrupting the circuit. The triggering of the mechanism provides the indication that the pressure reduction device has activated.

[33] As schematically illustrated in Fig. 1, a release sensor 16 is operably connected to or associated with pressure reduction device 14. Release sensor 16 may be any device readily apparent to one skilled in the art that may provide an indication when pressure reduction device 14 activates and/or an indication of size of the opening created by the activation of pressure reduction device 14. In the exemplary embodiment illustrated in Fig. 2, pressure reduction device 14 is a reverse-buckling rupture disk 26 disposed between an inlet safety head 23 and an outlet safety head 25. Release sensor 16 includes a wire 28 disposed proximate outlet safety head 25. Wire 28 is connected to a power source 30, which may be a battery. Power source 30 may be a part of release sensor 16 or may be included in transmitter 18 (described in greater detail below). Power source 30 and wire 28 form an electrically-powered circuit that traverses the fluid flow path of rupture disk 26.

[34] Pressurized fluid from the system acts on rupture disk 26 in the direction indicated by arrows 27 (referring to Fig. 2). Rupture disk 26 will rupture when the force exerted on rupture disk 26 by the pressurized fluid

exceeds the material strength of rupture disk 26. The rupture of rupture disk 26 will break wire 28 and create an opening through which fluid may escape the system. Should rupture disk 26 exhibit leakage, the space between 26 and 28 would become sufficiently pressurized to break an appropriately configured wire 28.

[35] When wire 28 is broken the electrically-powered circuit changes from a closed circuit to an open circuit. In this embodiment, the opening of the circuit provides the indication that the pressure reduction device has activated. The present invention contemplates, however, that different types of release sensors adapted for use with various pressure reduction devices may provide different indications that the pressure reduction device has activated. The release sensor may also provide an indication as to the size of the opening created by the opening of the pressure reduction device. In addition, the release sensor may provide an indication if and when the pressure reduction device closes to stop the flow of fluid through the created opening.

[36] In accordance with the present invention, a transmitter is connected to the release sensor. The transmitter sends a wireless transmission having an activation signal when the indication is received from the release sensor. The transmitter may also send a wireless transmission that includes a status signal if a predetermined time period elapses without activation of the pressure reduction device.

[37] As illustrated in Fig. 1, a transmitter 18 is operably connected to release sensor 16 by, for example, a length of shielded cable. Transmitter 18

is configured to emit a wireless transmission 20. In the currently contemplated embodiment, wireless transmission 20 is a RF transmission that has a frequency of around 900 MHz. The present invention contemplates, however, that wireless transmission 20 may occur at any licensed or unlicensed RF frequency band or at some other acceptable frequency.

[38] In the currently contemplated embodiment, wireless transmission 20 may include two types of signals: a status signal and an activation signal. Transmitter 18 emits the status signal to provide notice that monitoring system 10 is operating normally. In the currently contemplated embodiment, the status signal is sent on a periodic time basis, such as, for example, every minute. The status signal includes a basic code to indicate that the pressure reduction device is still being monitored, but has not yet activated. The status signal may further include additional information regarding the status of the pressure reduction device and release sensor. This additional information may include, for example, information relating to the current voltage or percentage life of battery 30, or other power source, in release sensor 16.

[39] Transmitter 18 emits the activation signal when release sensor 16 provides the indication that pressure reduction device 14 has activated, i.e. pressure reduction device 14 has either opened or closed. The activation signal may be sent once or on a repeated basis, such as, for example, every second. Transmitter 18 may be programmed to emit a generic activation signal or transmitter 18 may be programmed to emit a unique activation signal

that provides additional information, such as the identity and/or location of the particular pressure reduction device 14 that activated.

[40] Transmitter 18 may be further programmed to include an identifying prefix with each wireless transmission 20. The identifying prefix may uniquely identify the transmission as being generated by a wireless transmitter of monitoring system 10. In this manner, wireless transmissions 20 of monitoring system 10 may be differentiated from other transmissions that may be traveling through the same air waves.

[41] In accordance with the present invention, a receiver receives the transmissions sent by the transmitter. The receiver operates at the same frequency range as the wireless transmitter. The receiver generates an informational signal, such as, for example, a warning signal, when the activation signal is received and identified. The receiver may be placed in a fixed position relative to the transmitter. Alternatively, the receiver may be a moveable device and utilize conventional wireless technology, such as a pager or cellular phone.

[42] As illustrated in Fig. 1, a receiver 22 is in communication with transmitter 18. Receiver 22 is configured to receive transmissions sent in the same frequency band used by transmitter 18. The present invention contemplates that receiver 22 and transmitter 18 may communicate through any number of communication protocols, including, for example: short range wireless standards such as bluetooth; 3rd generation digital phone service; global system for mobile communication "GSM"/code-division multiple access

"CDMA"; short message service "SMS"; wireless Ethernet "Wi-Fi"; or wireless application protocol "WAP."

[43] If wireless transmission 20 includes an identifying prefix, receiver 22 ensures that the first portion of wireless transmission 20 matches the identifying prefix. If the identifying prefix does not match, receiver 22 may disregard the transmission. If the identifying prefix matches the expected prefix, receiver 22 determines whether wireless transmission 20 includes an activation signal or a status signal. If wireless transmission 20 includes an activation signal, receiver 22 generates a warning signal to indicate that pressure reduction device 14 has opened or closed. Receiver 22 may also generate a warning signal that indicates the amount of opening in pressure reduction device 14. The warning signal may be an illuminated light, a generated sound, or a communication with an annunciator (as described in greater detail below).

[44] If wireless transmission 20 includes a status signal, receiver 22 processes the status information. If receiver 22 determines that there is a problem with the release sensor, such as, for example, a low power supply, receiver 22 may generate a warning signal to inform the operator that the power supply should be replaced or otherwise maintained.

[45] Receiver 22 may include an internal timing device that measures the time between wireless transmissions 20 from transmitter 18. If a predetermined time period passes without receipt of a transmission, receiver

22 may generate a warning signal to inform an operator that no transmissions have been received and that there is a potential problem with transmitter 18.

[46] Alternatively, as illustrated in Fig. 1, receiver 22 may be equipped with a transmitter 32 and transmitter 18 may be equipped with a receiver 34 to allow two-way communication. If the predetermined time period passes without receipt of transmission 20, transmitter 32 may send a transmission 36 having an interrogation signal to receiver 34. If receiver 34 and transmitter 18 are operating normally, transmitter 18 will generate a transmission 20 having a status signal upon receipt of the interrogation signal. If, however, no response to the interrogation signal is received by receiver 22, receiver 22 may generate a warning signal to inform the operator that there is a potential problem with transmitter 18.

[47] As also illustrated in Fig. 1, monitoring system 10 may include an annuciator 24 in communication with receiver 22. Receiver 22 may communicate the informational or warning signal to annuciator 24. The warning signal may include, for example, an indication that the power source is low, an indication of a communication problem with transmitter 18, or an indication that pressure reduction device 14 has opened or closed. It is contemplated, however, that this information may also be directly communicated from transmitter 18 to annuciator 24.

[48] Annunciator 24 provides an alert in response to the warning generated by receiver 22 . Annunciator 24 may be physically connected to receiver 22 and the alert may be the activation of a device such as a light, light emitting

diode, sound generating device, a display monitor that displays a message corresponding to the warning signal, or a combination of such techniques. The present invention further contemplates that annuciator 24 may be a remote paging device such as, for example, a pager or a cellular phone with wireless communication between receiver 22 and annunciator 24.

[49] As shown in Fig. 3, a monitoring system 38 according to the present invention may be used with multiple pressure reduction devices 42, 52, 62 that are engaged with multiple sealed systems 40, 50, 60 or that are engaged in different locations within the same sealed system. As shown, a release sensor 44, 54, 64 is connected to each of pressure reduction devices 42, 52, 62 and to a wireless transmitter 46, 56, 66.

[50] Each release sensor 44, 54, 64 provides an indication when the corresponding pressure reduction devices 42, 52, 62 activates. When an indication is generated, the respective wireless transmitter 46, 56, 66 generates a wireless transmission 48, 58, 68 having an activation signal. A receiver 70 is placed in communication with transmitters 46, 56, 66 to receive wireless transmissions 48, 58, 68. Multiple receivers 71 may be provided to simultaneously receive wireless transmissions from multiple transmitters 46, 56, 66 so that loss of transmission reception by one receiver does not create an overall system communication problem.

[51] Each transmitter 46, 56, 66 may be programmed to include an identifying code at the beginning of each wireless transmission. The identifying code may be unique to each transmitter 46, 56, 66 or the

identifying code may be common across all transmitters 46, 56, 66. Receiver 70 may be programmed to process only those transmissions that have the appropriate identifying code. In this manner, receiver 70 can effectively ignore other, random transmissions that were not sent by a transmitter of monitoring system 10.

[52] The operation of the aforementioned monitoring system will now be described with reference to the attached drawings and, in particular, with reference to an exemplary method 80 for monitoring a pressurized system as illustrated in Fig. 4.

[53] As illustrated in Fig. 1, pressurized system 12 is operated with a pressurized fluid. Monitoring system 10 monitors pressurized system 12 (step 82). Under normal operating conditions, when the fluid within system 12 remains below the predetermined pressure limit, pressure reduction device 14 will not activate. If release sensor 16 does not provide an indication that pressure reduction device 14 has activated (step 84) for a certain predetermined period of time, transmitter 18 will emit a wireless transmission 20 that includes a status signal (step 86). Wireless transmission 20 may include an identifying code that uniquely identifies the wireless transmission as being produced by monitoring system 10.

[54] Receiver 22 receives and processes wireless transmission 20 (step 88). If an identifying code is included with wireless transmission 20, receiver 22 verifies that wireless transmission 20 is part of monitoring system 10. If so, then receiver 22 analyzes the information provided in the status signal. This

information may include a representation of the voltage or other status of the power source of release sensor 16. If receiver 22 identifies a problem within the status signal, such as, for example, a low battery, receiver 22 generates a warning signal indicative of the particular problem. In addition, if receiver 22 does not receive any transmissions 20 from transmitter 18 for a certain period of time, receiver generates a warning signal that indicates a potential problem with transmitter 18.

[55] If the pressure of the fluid in system 12 reaches or exceeds the predetermined limit for the system, pressure reduction device 14 will activate to allow fluid to escape the system. Release sensor 16 provides an indication that pressure reduction device 14 has activated. The indication may be, for example, the opening of a battery-powered circuit or the operation of a pressure switch.

[56] In response to the indication, transmitter 18 sends a wireless transmission 20 having an activation signal (step 90). As described previously, this transmission may also include an identifying prefix. Transmitter 18 may send a series of wireless transmissions 20 with the activation signal to ensure that the transmission is received promptly.

[57] Receiver 22 receives and processes the activation signal (step 92). After receiver 22 verifies the identification prefix of wireless transmission 20, receiver 22 analyzes the information contained in the activation signal. The activation signal information may include a simple code indicating that pressure reduction device 14 has activated. In addition, the activation signal

may include more detailed information, such as, for example, the location and/or identity of the activated pressure reduction device.

[58] Receiver 22 then generates an informational signal, which may be, for example, a warning signal (step 94). The warning signal may be the activation of a light generating device or a sound generating device or the transmission of information to a remote annunciator device that generates an alert. In addition, the warning signal may be communicated to a local annunciator 24, which generates an alert (step 96). The alert may be implemented by displaying a message on a display monitor or by activating a remote paging device. It is contemplated that the message displayed or paged will contain as much information as possible regarding the problem. For example, the message may indicate that the power source is low, the transmitter is not transmitting, or the identity of an activated pressure reduction device.

[59] Release sensor 16 may also provide an indication as to the size of the opening created by pressure reduction device 14. The size of the opening may vary as a function of time. Accordingly, the indication of the size of the opening may also vary as a function of time. The information related to the size of the opening may be transmitted as part of the activation signal to receiver 22. Receiver 22 may generate an informational signal that communicates the size of the opening to an operator.

[60] Release sensor 16 may also provide an indication when the pressure reduction device 14 closes. The indication that pressure reduction device 14

has closed may be included in the activation signal sent by transmitter 18. The activation signal including the indication that pressure reduction device 14 has closed may be received by receiver 22.

[61] The information regarding the size of the opening created by pressure reduction device 14 and the amount of time that pressure reduction device 14 is open may be used to estimate the amount of fluid that escaped through pressure reduction device 14. Additional information, such as, for example, the pressure of the fluid within system 12 during the time that pressure reduction device 14 is open may also be used in the estimation. An informational signal that includes the estimation of the amount of escaped fluid may be presented on a display monitor or a remote paging device.

[62] The present invention, therefore, provides a system and method for monitoring a pressurized system. The described system and method allow for the quick detection of an activated pressure reduction device. Information relating to the activation of the pressure reduction device may be effectively and efficiently communicated to an operator or automated system at any location and distance from the pressure reduction device.

[63] It will be apparent to those skilled in the art that various modifications and variations can be made in the method and system for monitoring a pressure reduction device without departing from the scope or spirit of the invention. Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples

be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims and their equivalents.

WHAT IS CLAIMED IS:

1. A monitoring system for a pressure reduction device, comprising:

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor; and

a receiver configured to receive the wireless transmission from the transmitter and to generate an informational signal when the activation signal is identified.

2. The system of claim 1, further comprising an annunciator in communication with the receiver and configured to provide an alert when the activation signal indicates that the pressure reduction device has opened.

3. The system of claim 2, wherein the annunciator includes at least one of a display monitor, a pager, and a light emitting diode.

4. The system of claim 1, wherein the release sensor includes a wire configured to be broken when the pressure reduction device activates.

5. The system of claim 1, wherein the wireless transmission sent by the transmitter includes a status signal when a first predetermined period of time elapses without the release sensor providing the indication.

6. The system of claim 5, wherein the transmitter includes a battery and the status signal includes a representation of the battery voltage.

7. The system of claim 5, wherein the release sensor includes a battery and the status signal includes a representation of the battery voltage.

8. The system of claim 5, wherein the receiver generates a warning signal when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

9. The system of claim 1, wherein the transmitter sends a series of wireless transmissions having the activation signal upon receipt of the indication from the release sensor.

10. The system of claim 1, wherein the transmitter and receiver are configured for two-way communication.

11. The system of claim 1, wherein the release sensor provides an indication of the size of an opening created by the pressure reduction device.

12. A monitoring system for a pressurized system, comprising:

a pressure reduction device;

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor; and

a receiver configured to receive the wireless transmission from the transmitter and to generate an informational signal when the activation signal is identified.

13. The system of claim 12, further comprising an annunciator in communication with the receiver and configured to provide an alert when the informational signal indicates that the pressure reduction device has opened.

14. The system of claim 12, wherein the annunciator includes at least one of a display monitor, a pager, and a light emitting diode.

15. The system of claim 12, wherein the release sensor includes a wire configured to be broken when the pressure reduction device activates.

16. The system of claim 12, wherein the wireless transmission sent by the transmitter includes a status signal when a first predetermined period of time elapses without the release sensor providing the indication.

17. The system of claim 16, wherein the transmitter includes a battery and the status signal includes a representation of the battery voltage.

18. The system of claim 16, wherein the release sensor includes a battery and the status signal includes a representation of the battery voltage.

19. The system of claim 16, wherein the receiver generates a warning signal when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

20. The system of claim 12, wherein the transmitter sends a series of wireless transmissions having the activation signal upon receipt of the indication from the release sensor.

21. The system of claim 12, further comprising a plurality of pressure reduction devices and a plurality of transmitters, one of the plurality of

transmitters corresponding to each of the plurality of pressure reduction devices.

22. The system of claim 12, further comprising a plurality of pressure reduction devices and a plurality of release sensors, and wherein the transmitter is configured to send the wireless transmission having the activation signal when the indication is provided by one of the plurality of release sensors.

23. The system of claim 21, wherein the pressure reduction device is a pressure relief device.

24 The system of claim 23, wherein the pressure relief device includes at least one of a rupture disk, a pressure relief valve, an explosion panel, and a control valve.

25. The system of claim 12, wherein the release sensor provides an indication of the size of an opening created by the pressure reduction device.

26. A method of monitoring a pressure reduction device, comprising the steps of:

providing an indication when a pressure reduction device activates;

sending a wireless transmission when the indication is provided, the wireless transmission including an activation signal; and

receiving the wireless transmission.

27. The method of claim 26, further including the step of generating an informational signal when the activation signal is identified.

28. The method of claim 26, further including the step of displaying a message on a display monitor.

29. The method of claim 26, further including the step of activating a light emitting diode when the warning signal is generated.

30. The method of claim 26, further including the step of activating a remote paging device when the warning signal is generated.

31. The method of claim 26, further comprising the step of sending a wireless transmission having a status signal on a periodic basis.

32. The method of claim 31, further comprising the step of generating the warning signal when a predetermined amount of time passes without receiving a wireless transmission from the transmitter.

33. The method of claim 26, further comprising the step of sending a series of wireless transmissions having the activation signal upon receiving the indication from the release sensor.

34. The method of claim 26, further comprising the steps of:

providing an indication when the pressure reduction device opens;

providing an indication of the size of an opening created by the pressure reduction device; and

providing an indication when the pressure reduction device closes.

35. The method of claim 34, further comprising the step of determining an amount of fluid released through an opening created by the pressure reduction device.

36. A monitoring system for a pressurized system, comprising:

a pressure reduction device;

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having a status signal when a first predetermined period of time elapses without the release sensor providing the indication; and

a receiver configured to receive the wireless transmission from the transmitter.

37. The system of claim 36, wherein the status signal includes information regarding the status of the pressure reduction device.

38. The system of claim 37, wherein the release sensor includes a power source and the information in the status signal includes the status of the power source.

39. The system of claim 37, wherein the transmitter includes a power source and the information in the status signal includes the status of the power source.

40. The system of claim 36, wherein the transmitter is configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor.

41. The system of claim 40, wherein the receiver is configured to generate a warning when the activation signal is identified.

42. The system of claim 36, wherein the receiver is configured to generate a warning when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

43 The system of claim 36, wherein the transmitter and receiver are configured for two-way communication.

44. The system of claim 43, wherein the receiver is configured to send an interrogation signal to the transmitter when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

45. The system of claim 44, wherein the receiver is configured to generate a warning when the transmitter does not respond to the interrogation signal.

46. A monitoring system for a pressurized system, comprising:

a pressure reduction device;

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor, the activation signal including at least one of an identity and a location for the activated pressure reduction device; and

a receiver configured to receive the wireless transmission from the transmitter and to generate a warning signal when the activation signal is identified.

47. The system of claim 46, further comprising an annunciator in communication with the receiver and configured to provide an alert when the receiver generates the warning signal.

48. The system of claim 46, wherein the wireless transmission sent by the transmitter includes a status signal when a first predetermined period of time elapses without the release sensor providing the indication.

49. The system of claim 48, wherein the release sensor includes a battery and the status signal includes a representation of the battery voltage.

50 The system of claim 48, wherein the transmitter includes a battery and the status signal includes a representation of the battery voltage.

51. The system of claim 48, wherein the release sensor includes a battery and the status signal includes a representation of the battery life remaining.

52. The system of claim 48, wherein the receiver generates the warning signal when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

53. A monitoring system for a pressurized system, comprising:

a pressure reduction device;

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having an identifying prefix that identifies the wireless transmission as being generated by the transmitter; and

a receiver configured to receive the wireless transmission from the transmitter having the identifying prefix.

54. The system of claim 53, wherein the wireless transmission includes an activation signal when the release sensor provides the indication and the wireless transmission includes a status signal when a predetermined period of time passes without the release sensor providing the indication.

56. The system of claim 54, wherein the receiver generates the warning signal when a second predetermined period of time passes without the receiver receiving the wireless transmission from the transmitter.

57. A monitoring system for a pressurized system, comprising:

a pressure reduction device;

a release sensor configured to provide an indication when the pressure reduction device activates;

a transmitter connected to the release sensor and configured to send a wireless transmission having an activation signal when the indication is provided by the release sensor;

a receiver configured to receive the wireless transmission; and

an annunciator in communication with the receiver and configured to provide an alert when the wireless transmission having the activation signal is received.

58. The system of claim 57, wherein the annunciator includes at least one of a display monitor, a pager, and a light emitting diode.

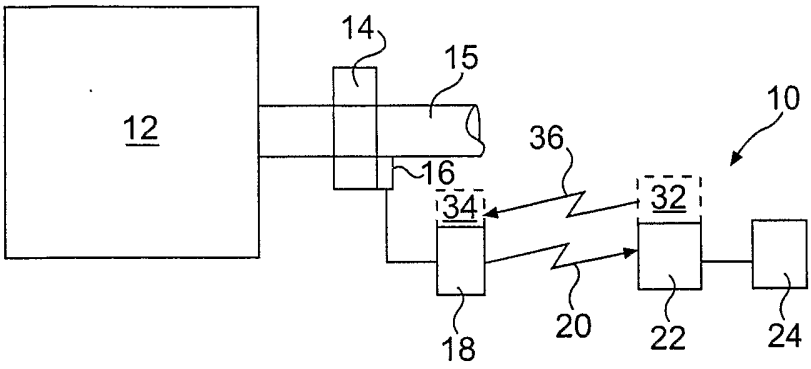

FIG. 1

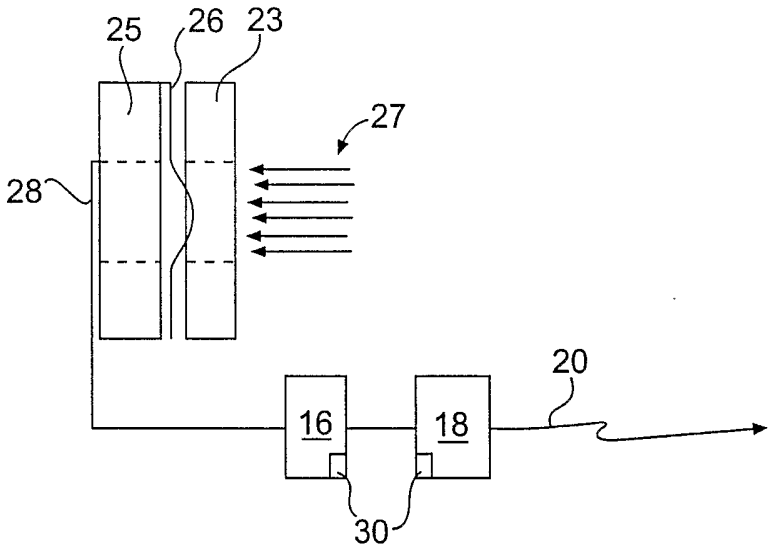

FIG. 2

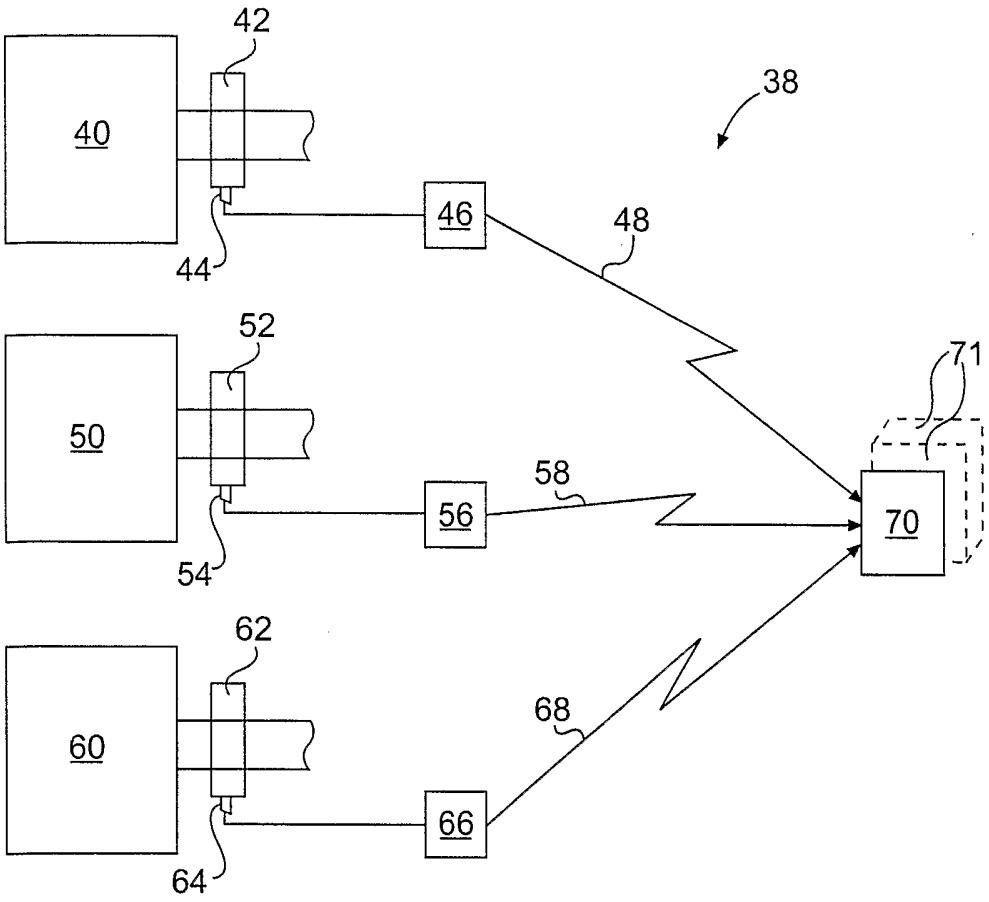

FIG. 3

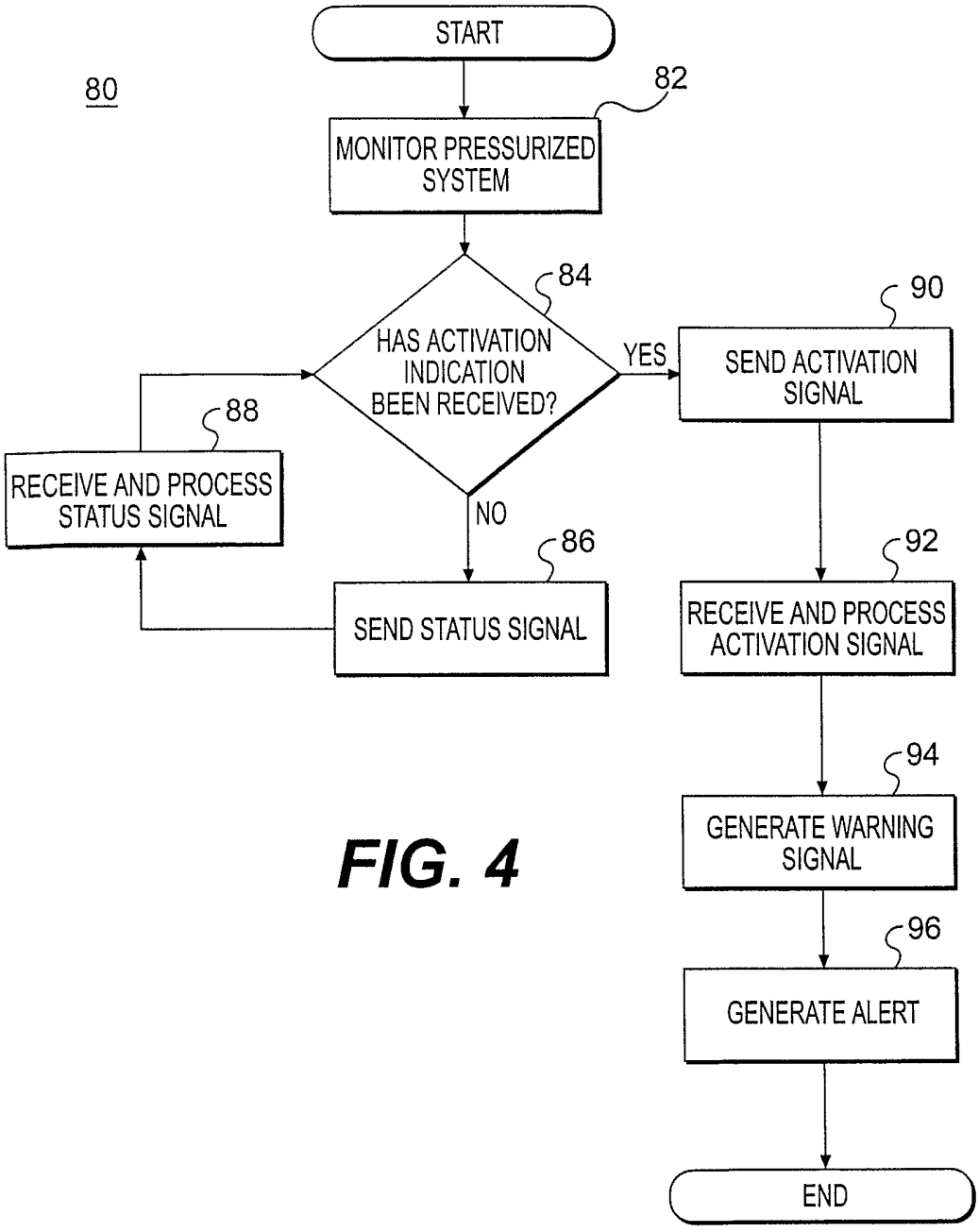
80
START
82
MONITOR PRESSURIZED SYSTEM
84
HAS ACTIVATION INDICATION BEEN RECEIVED?
YES
NO
88
RECEIVE AND PROCESS STATUS SIGNAL
86
SEND STATUS SIGNAL
90
SEND ACTIVATION SIGNAL
92
RECEIVE AND PROCESS ACTIVATION SIGNAL
94
GENERATE WARNING SIGNAL
96
GENERATE ALERT
END

FIG. 4