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(54) **AN APPARATUS FOR DETECTING FIRE AND PREVENTING EXPLOSION OF TRANSFORMER AND A METHOD THEREOF**

VORRICHTUNG ZUR DETEKTION VON FEUER UND ZUR VERHINDERUNG DER EXPLOSION
EINES TRANSFORMATORS UND VERFAHREN DAFÜR

APPAREIL DE DÉTECTION D'INCENDIE ET DE PRÉVENTION D'EXPLOSION DE
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Description**TECHNICAL FIELD**

[0001] The present disclosure relates to an apparatus and a system for detecting fire and preventing explosion in an electrical transformer system. Embodiments of the present disclosure relates to an apparatus and a system for detecting fire, fluid leakage and preventing explosion in the electrical transformer.

BACKGROUND OF DISCLOSURE

[0002] Conventionally, electrical systems such as but not limiting to electrical transformers [hereinafter referred to as transformer], exhibits performance losses in windings and in core which are multifactorial. Such losses in the transformer generate heat. This heat can damage the insulation layer provided on the windings, causing insulation faults. This insulation fault generates an electric arc, which trips a supply relay of the transformer (circuit breaker) by the action of an electrical protection system configured to safeguard the transformer. The electric arc decomposes dielectric oil enclosed in an enclosure of the transformer, to release hydrogen, acetylene and other by-products within the enclosure. The released gases, rapidly increases the pressure inside the enclosure, which causes deflagration. Deflagration results in extensive tearing of the mechanical connections (bolts, welds and other mechanical joints) within the enclosure of the transformer. Tearing of mechanical connections brings the released gases in contact with the oxygen present in the surrounding air. Acetylene being inflammable in presence of oxygen, immediately ignites, causing the transformer to burn. This fire in the transformer can spread to other on-site equipment, causing extensive damage. The fire may also trigger explosion of the transformer. Typically, explosion of the transformer occurs due to short-circuit caused by overloads, voltage surges, progressive deterioration of the insulation, insufficient oil level and failure of an insulating component. However, uncontrolled fire can also be a trigger for transformer explosion.

[0003] To overcome the aforementioned limitations, fire protection systems are configured in the transformers, as shown for example in US 7 869 167 B2. These fire protection systems are actuated by combustion of dielectric oil or by fire detectors. However, these systems operate with a significant time lag. Thus, it is necessary to limit the combustion of the equipment, and to prevent the fire from spreading to neighbouring plants or surrounding equipment's.

[0004] In order to mitigate combustion of the equipment, the decomposition of the dielectric oil is to be controlled. This is achieved by use of silicone oils instead of conventional mineral oils within the enclosure of the transformer. However, these precautions reduce the pressure built-up in the enclosure, due to decomposition of the silicone oil by few milliseconds. This time interval is not feasible for engaging any precautionary means for preventing explosion of the transformer.

[0005] Prior to this technology, to mitigate the aforementioned problems, a method for prevention, protection and detection against explosion and resulting fire in a transformer existed. Prior method includes steps of detecting a break in the insulation of the transformer using a pressure sensor. Subsequently, the coolant contained in enclosure of the transformer is depressurised, using a valve. A pressurized inert gas is injected into the bottom of the enclosure, to stir the coolant and prevent the oxygen from entering the enclosure. The injection of pressurised inert gas into the enclosure cools the hot parts of the transformer.

[0006] Additionally, in order to dissipate the heat generated in the transformer due to winding and core losses, natural or forced convection means of cooling or extinguishing are employed. Conventionally, the transformers are cooled by forced convection, using dielectric oil. During heat transfer, oil in the transformer expands due to its heat content. A device is integrated within the transformer to release pressure developed in the enclosure, due to expansion of the oil. The relief of pressure developed in the enclosure of the transformer, inherently prevents explosion of the transformer. This method worked satisfactory and made it possible to prevent the enclosure of the transformer from burning and inherently exploding. However, the method does not provide an indication in advance to take corrective measures. Also, by the time the corrective action is taken, there would be a significant amount of electrical insulation break down in the transformer.

[0007] Hence, in the light of the foregoing discussion, there exist a need for an apparatus and system for detecting fire and preventing explosion of the transformer, and to overcome limitations stated above.

SUMMARY OF THE DISCLOSURE

[0008] One or more shortcomings of the prior art are overcome and additional advantages are provided through a system and a method of the present disclosure. Additional features and advantages are realized through the techniques of the present disclosure. Other embodiments and aspects of the disclosure are described in detail herein and are considered a part of the disclosure.

[0009] It is to be understood that the aspects and embodiments of the disclosure described above may be used in any combination with each other. Several of the aspects and embodiments may be combined together to form a further

embodiment of the disclosure.

[0010] In an embodiment of the present disclosure, an apparatus for detecting fire and preventing explosion in a transformer is disclosed. The apparatus comprises at least one voltage variation detection unit for determining ratio of an input voltage entering the transformer and an output voltage exiting the transformer. The at least one voltage variation detection unit provides a first input signal to at least one control unit, when ratio of the input voltage and the output voltage surpasses a preset threshold ratio. An over current detection unit for monitoring load on the transformer is provisioned in the apparatus. The over current detection unit provides a second input signal to at least one control unit when load on the transformer surpasses a preset load threshold. Also, at least one surge detection unit and at least one Rapid Pressure Rise Relay are configured in the apparatus, to detect oil surge and variation of oil pressure respectively within a transformer tank. A third input signal is provided to the at least one control unit, when the oil surge and the variation of oil pressure in the transformer tank surpasses a preset pressure threshold. Further, one or more circuit breakers is configured, for receiving input signals from either one of the at least one voltage variation detection unit, the over current detection unit, the at least one surge detection unit and the at least one rapid pressure rise relay. The one or more circuit breakers provides a fourth input signal to the at least one control unit, upon receipt of input signals. The at least one control unit receives either one of the first input signal, the second input signal, the third input signal and the fourth input signal, thereby generating a control signal for operating a drain valve and a gas release valve. The gas release valve comprises a primary gas valve and a secondary gas valve. The primary gas valve is configured with a primary inlet port fluidly connected to a gas source and a primary outlet port. The secondary gas valve is configured with a secondary inlet port, fluidly connected to the primary outlet port and a secondary outlet port fluidly connected to the transformer tank for routing gas into the transformer tank when the primary gas valve and the secondary gas valve are actuated. An exhaust port is configured to the secondary gas valve, to exhaust the gas leaked from either one of the primary gas valve and secondary gas valve to the atmosphere, when the primary gas valve and the secondary gas valve are in closed position.

[0011] In an embodiment, the at least one voltage variation detection unit provides first input signal to control unit, when the ratio of the input voltage and the output voltage surpasses 1:40 threshold ratio.

[0012] In an embodiment, the one or more circuit breakers cuts-off the transformer from receiving the input voltage when ratio of the input voltage and the output voltage surpasses the preset threshold ratio.

[0013] In an embodiment, the at least one control unit operates the drain valve for draining oil from the transformer tank.

[0014] In an embodiment, the at least one control unit operates the gas release valve to inject gas from a gas source to bottom of the transformer tank, for stirring the oil in order to reduce temperature and oxygen content in the transformer tank, thereby preventing explosion and fire within the transformer.

[0015] In an embodiment, the secondary outlet port of the secondary gas valve is connected to the transformer tank through a gas flow control valve and a non-return valve.

[0016] In an embodiment, the gas source is connected to the primary inlet port of the primary gas valve through a pressure regulator to control pressure of the gas entering the primary gas valve.

[0017] In another embodiment, an apparatus for detecting fire and preventing explosion in a transformer is provided. The apparatus comprises at least one Pressure monitoring Switch configured to detect pressure of oil routed through a drain pipe. The at least one pressure monitoring switch provides a first input signal to at least one control unit, when the pressure of oil routed through the drain pipe surpasses a preset value. The at least one pressure monitoring switch [PMS] further comprises at least one pressure switch for generating the first signal, when oil pressure in a pressure port of the pressure monitoring switch surpasses a preset value. At least one spring loaded plunger is provisioned in the PMS, which in contact with the pressure switch for operating the pressure switch. At least one diaphragm is attached to the spring loaded plunger for operating the at least one spring loaded plunger, based on the pressure of oil in the pressure port and entering the at least one diaphragm. Also, the pressure port is connected to drain pipe for receiving predetermined amount of oil, thereby maintaining pressure of oil routed through the drain pipe. Further, the apparatus comprises at least one voltage variation detection unit for determining ratio of an input voltage entering the transformer and an output voltage exiting the transformer. The at least one voltage variation detection unit provides a second input signal to at least one control unit, when ratio of the input voltage and the output voltage surpasses a preset threshold ratio. An over current detection unit for monitoring load on the transformer is provisioned in the apparatus. The over current detection unit provides a third input signal to the at least one control unit when load on the transformer surpasses a preset load threshold. Also, at least one surge detection unit and at least one Rapid Pressure Rise Relay are configured in the apparatus, to detect oil surge and variation of oil pressure within a transformer tank. A fourth input signal is provided to the at least one control unit, when the oil surge and the variation of oil pressure in the transformer tank surpasses a preset pressure threshold. Further, one or more circuit breakers is configured in the apparatus, for receiving input signals from either one of the at least one voltage variation detection unit, the over current detection unit, the at least one surge detection unit and the at least one rapid pressure rise relay. The one or more circuit breakers provides a fifth input signal to the at least one control unit, upon receipt of input signals. The at least one control unit receives either one of the first input signal, the second input signal, the third input signal, the fourth input signal and the fifth input signal, thereby

generating a control signal for operating a drain valve and a gas release valve. The gas release valve comprises a primary gas valve and a secondary gas valve. The primary gas valve is configured with a primary inlet port fluidly connected to a gas source and a primary outlet port. The secondary gas valve is configured with a secondary inlet port, fluidly connected to the primary outlet port and a secondary outlet port fluidly connected to the transformer tank for routing gas into the transformer tank when the primary gas valve and the secondary gas valve are operated by the at least one control unit. An exhaust port is configured to the secondary gas valve, to exhaust the gas leaked from either one of the primary gas valve and secondary gas valve to the atmosphere, when the primary gas valve and the secondary gas valve are in closed position.

[0018] In an embodiment, the pressure port is connected to at least one three-way ball valve to receive oil bypassed from the drain pipe.

[0019] In an embodiment, at least one three-way ball valve is connected to at least one two-way ball valve through a first hose pipe for receiving oil bypassed from the drain pipe.

[0020] In an embodiment, the at least one three-way ball valve is connected to the drain pipe by a second hose pipe for routing the oil bypassed back to the drain pipe.

[0021] In an embodiment, a gasket is provided between the pressure port and the diaphragm for preventing oil leakage.

[0022] In an embodiment, a plurality of support plates is provisioned to the at least one pressure monitoring switch for housing the at least one diaphragm.

[0023] In an embodiment, a system for detecting fire, detecting fluid leakage through a drain valve disposed in a drain pipe and preventing fire in a transformer is provided. The system comprises a fluid leakage detection unit for detecting fluid leakage in the drain pipe. The fluid leakage detection unit comprises a fluid collection compartment fluidly connected to downstream of the drain pipe for collecting fluid leaked through the drain valve in a closed position. The fluid collection compartment comprises at least one through hole provided on a top and a bottom side of the fluid collection compartment. The area surrounding the at least one through hole of the bottom side of the fluid collection compartment is configured as a fluid collection area to collect the leaked fluid. The bottom side of the fluid collection compartment is connected with a fluid discharge pipe that extends up to a predetermined height into the fluid collection compartment via the at least one through hole. Further, at least one fluid level switch is positioned at a predetermined location inside the fluid collection compartment to trigger an alarm upon collection of predetermined amount of fluid in the fluid collection area to indicate fluid leakage. The apparatus further comprises at least one pressure monitoring switch configured to detect pressure of oil routed through the drain pipe, thereby providing a first input signal to at least one control unit, when the pressure of oil routed through the drain pipe surpasses a preset value. The at least one pressure monitoring switch [PMS] further comprises at least one pressure switch for generating the first signal, when oil pressure in a pressure port of the at least pressure monitoring switch surpasses a preset value. At least one spring loaded plunger is provisioned in the at least one pressure monitoring switch, which in contact with the pressure switch for operating the pressure switch. At least one diaphragm is attached to the at least one spring loaded plunger for operating the at least one spring loaded plunger, based on the pressure of oil in the pressure port and entering the at least one diaphragm. Also, the pressure port is connected to the drain pipe for receiving predetermined amount of oil, thereby maintaining pressure of oil routed through the drain pipe. Further, the apparatus comprises at least one voltage variation detection unit for determining ratio of an input voltage entering the transformer and an output voltage exiting the transformer. The at least one voltage variation detection unit provides a second input signal to at least one control unit, when ratio of the input voltage and the output voltage surpasses a preset threshold ratio. An over current detection unit for monitoring load on the transformer is provisioned in the apparatus. The over current detection unit provides a third input signal to at least one control unit when load on the transformer surpasses a preset load threshold. Also, at least one surge detection unit and at least one Rapid Pressure Rise Relay are configured in the apparatus, to detect oil surge and variation of oil pressure within a transformer tank. A fourth input signal is provided to the at least one control unit, when the oil surge and the variation of oil pressure in the transformer tank surpasses a preset pressure threshold. Further, one or more circuit breakers is configured in the apparatus, for receiving input signals from either one of the at least one voltage variation detection unit, the over current detection unit, the at least one surge detection unit and the at least one rapid pressure rise relay. The one or more circuit breakers provides a fifth input signal to the at least one control unit, upon receipt of input signals. The at least one control unit receives either one of the first input signal, the second input signal, the third input signal, the fourth input signal and the fifth input signal, thereby generating a control signal for operating a drain valve and a gas release valve. The gas release valve comprises a primary gas valve and a secondary gas valve. The primary gas valve is configured with a primary inlet port fluidly connected to a gas source and a primary outlet port. The secondary gas valve is configured with a secondary inlet port, fluidly connected to the primary outlet port and a secondary outlet port fluidly connected to the transformer tank for routing gas into the transformer tank when the primary gas valve and the secondary gas valve are operated by the at least one control unit. An exhaust port is configured to the secondary gas valve, to exhaust the gas leaked from either one of the primary gas valve and secondary gas valve to the atmosphere, when the primary gas valve and the secondary gas valve are in closed position.

[0024] In another embodiment, a method for detecting fire, detecting fluid leakage through a drain valve disposed in

a drain pipe and preventing explosion of a transformer is disclosed. The method comprising acts of monitoring fluid level in a fluid collection compartment, wherein at least one fluid level switch positioned at a predetermined location inside the fluid collection compartment is configured to trigger an alarm upon detecting a predetermined level of fluid in a fluid collection area of the fluid collection compartment to indicate fluid leakage. The pressure of oil in a transformer tank routed through the drain pipe is monitored by at least one pressure monitoring switch, thereby providing a first input signal to the at least one control unit, when the oil pressure of oil routed through the drain pipe surpasses a preset value. Further, ratio between input voltage and output voltage is calculated, and provides a second input signal to at least one control unit when ratio of the input voltage and the output voltage surpasses a preset threshold ratio. A third input signal is provided to the at least one control unit when load on the transformer surpasses a preset load threshold. Excessive oil surge and rate of change of oil pressure in a transformer tank of the transformer is monitored by at least one surge detection unit and a Rapid Pressure Rise Relay [RPRR] respectively and thereby providing a fourth input signal to the at least one control unit. Further, a fifth input signal is provided to at least one control unit by one or more circuit breakers when the one or more circuit breaker receives either one of the first input signal, the second input signal, the third input signal and the fourth input signal. Lastly, the at least one control unit generates a control signal, when either one of the first input signal, the second input signal, the third input signal, the fourth input signal and the fifth input signal is received by the at least one control unit. The control signal operates a drain valve and a gas release valve, thereby detecting fire and preventing explosion of the transformer.

[0025] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0026] The novel features and characteristic of the disclosure are set forth in the appended claims.

[0027] The embodiments of the disclosure itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of the illustrative embodiment when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings.

Figure 1 illustrates an apparatus for detecting fire and preventing explosion of a transformer, in accordance with an embodiment of the present disclosure.

Figure 2 illustrates a gas release valve of the apparatus, in accordance with an embodiment of the present disclosure.

Figure 3 illustrates the gas release valve connected to a gas source, in accordance with an embodiment of the present disclosure.

Figure 4 illustrates a pressure monitoring switch of apparatus, in accordance with an embodiment of the present disclosure.

Figure 5 illustrates configuration of valves in the pressure monitoring switch, in accordance with an embodiment of the present disclosure.

Figure 6 illustrates assembly of the pressure monitoring switch in the apparatus, in accordance with an embodiment of the present disclosure.

Figure 7 illustrates a system for detecting fire, detecting fluid leakage through a drain pipe and preventing explosion of a transformer, in accordance with an embodiment of the present disclosure.

Figure 8a illustrates perspective view of the fluid leakage detection device assembled in the system, in accordance with an exemplary embodiment of the present disclosure.

Figure 8b illustrates front view of the fluid leakage detection device, in accordance with an embodiment of the present disclosure..

[0028] It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present subject matter.

[0029] The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will

readily recognize from the following description that alternative embodiments of the system illustrated herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0030] While the embodiments in the disclosure are subject to various modifications and alternative forms, specific embodiment thereof has been shown by way of example in the figures and will be described below. It should be understood, however that it is not intended to limit the disclosure to the particular forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the scope of the disclosure.

[0031] It is to be noted that a person skilled in the art would be motivated from the present disclosure and modify the apparatus and a system for detecting fire and preventing explosion of transformer. However, such modification should be construed within the scope of the disclosure. Accordingly, the drawings show only those specific details that are pertinent to understand the embodiments of the present disclosure so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

[0032] The terms "comprises", "comprising", or any other variations thereof used in the disclosure, are intended to cover a non-exclusive inclusion, such that a method, system, assembly that comprises a list of components does not include only those components but may include other components not expressly listed or inherent to such system, or assembly, or device. In other words, one or more elements in a system preceded by "comprises... a" does not, without more constraints, preclude the existence of other elements or additional elements in the system or device.

[0033] To overcome the limitations mentioned in background of the disclosure, an apparatus for detecting fire and preventing explosion in a transformer is disclosed. The apparatus comprises at least one voltage variation detection unit for determining ratio of an input voltage entering the transformer and an output voltage exiting the transformer. The at least one voltage variation detection unit detects the ratio of input voltage to output voltage with a preset threshold ratio. The at least one voltage variation detection unit is configured to provide a first input signal to at least one control unit, when the ratio of the input voltage and the output voltage surpasses a preset threshold ratio. In an embodiment, the at least one voltage variation detection unit provides the first input signal when the ratio of input voltage and the output voltage surpasses 1:40 threshold ratio.

[0034] An over current detection unit is provisioned to the apparatus to monitor the load on the transformer. In an embodiment, the over current detection unit may be an over current relay. In an embodiment, the over current detection unit compares the difference value of current entering the transformer to the current exiting the transformer. If the difference value is greater than the preset load threshold, a second input signal is provided to the at least one control unit.

[0035] At least one surge detection unit and at least one rapid pressure rise relay [RRRR] is provisioned in the apparatus to detect oil surge and variation of oil pressure within a transformer tank of the transformer. The at least one surge detection unit is triggered, when the oil surge surpasses a preset pressure threshold. The at least one rapid pressure rise relay is triggered, when the variation of oil pressure in the transformer tank surpasses a preset pressure threshold. The at least one surge detection unit and the at least one rapid pressure rise delay, when simultaneously triggered provide a third input signal to the at least one control unit.

[0036] Further, one or more circuit breakers are provided in the apparatus and configured to receive input signals from either one of the at least one voltage variation detection unit, the over current detection unit, the at least one surge detection unit and the at least one rapid pressure rise delay. Upon receipt of input signal from either of the components, the one or more circuit breakers provides a fourth input signal to the at least one control unit.

[0037] Upon receipt of either of the first input signal, the second input signal, the third input signal and the fourth input signal the at least one control unit is configured to generate a control signal to operate a drain valve and a gas release valve simultaneously. The drain valve is configured to drain oil from the transformer tank upon receipt of control signal from the at least one control unit. Simultaneously, the gas release valve connected to a gas source, is operated by the at least one control unit to release gas from the bottom portion of the transformer tank. Supply of gas from bottom of the transformer tank reduces the temperature of oil and thereby, preventing fire and explosion of the transformer.

[0038] In an embodiment of the present disclosure, the apparatus further includes a pressure monitoring switch configured on a drain pipe of the transformer. The pressure monitoring switch is configured to monitor pressure of the oil, draining from the drain pipe of the transformer. The pressure monitoring switch includes at least one pressure switch, which produces an input signal to the at least one control unit, when the pressure of oil draining from the transformer tank surpasses the preset value. In an embodiment, the preset value of pressure is 7 mwc [meter water column]. The at least one pressure switch is in contact with at least one spring loaded plunger for operating the at least one pressure switch. The at least one spring loaded plunger in-turn is interfaced to at least one diaphragm. The at least one diaphragm receives oil from the transformer tank and based on the pressure of oil, the at least one diaphragm inflates which in-turn operates the at least one spring loaded plunger. The at least one spring loaded plunger further operates the at least one pressure switch to provide input signal to the at least one control unit. The pressure monitoring switch therefore provides the first input signal to the at least one control unit, when the pressure of oil draining from the drain pipe surpasses a

preset value.

[0039] The at least one voltage variation detection unit, over current detection unit, at least one surge detection unit and one or more circuit breakers provides the second input signal, the third input signal, the fourth input signal and a fifth input signal respectively to the at least one control unit, when the pressure monitoring switch provides the first input signal to the at least one control unit.

[0040] In another embodiment of the present disclosure, a system for detecting fire, detecting fluid leakage through the drain valve and preventing fire in a transformer is disclosed. The system includes the apparatus as described above to detect fire and prevent explosion of the transformer, along with a fluid leakage detection unit. The fluid leakage detection unit is configured to detect leakage of fluid in a fluid discharge pipe, which routes the oil from the transformer tank. The fluid leakage detection unit comprises a fluid collection compartment which is fluidly connected to downstream of the drain pipe. The fluid collection compartment is configured to collect fluid leaked through the drain valve, when the drain valve is in closed position. The fluid collection compartment further comprises at least one through hole at top and bottom sides. To the bottom side of the fluid collection compartment, a fluid discharge pipe is mounted so as to extend into the fluid collection compartment up to a predetermined height. This configuration enables, the area surrounding the at least one through hole to act as a fluid collection area for collecting the fluid leaked from the drain valve. At least one fluid level switch is provided in the fluid collection compartment at a predetermined location. The at least one fluid level switch is configured to trigger an alarm upon collection of a predetermined amount of fluid in the fluid collection area.

[0041] The following paragraphs describe the present disclosure with reference to Figures 1 to 8b. In the figures the same element or elements which have same function are indicated by the same reference signs. In an exemplary embodiment of the disclosure, the figures illustrate aspects involved in an apparatus and a system for detecting fire and prevent explosion of a transformer.

[0042] Figure 1 illustrates an exemplary embodiment of the apparatus (100) for detection of fire and preventing explosion of a transformer (30). The apparatus (100) is configured to generate a control signal to operate a gas release valve (6) for releasing a gas from a gas source (7) into a transformer tank (14) of the transformer (30), when there is a detection of fire in the transformer (30).

[0043] The apparatus (100) comprises, the transformer (30), having a transformer tank (14) on which a high voltage conductor (22) and a low voltage conductor (23) is provided. The high voltage conductor (22) and low voltage conductor (23) are configured to conduct current and voltage in and out of the transformer (30) for step-up or step down operation. In an embodiment, the high-voltage conductor (22) carries input current and low-voltage conductor (23) carries output current. The high voltage conductor (22) and low voltage conductor (23) are connected to a high and low voltage transformer bushings (15 and 16) [hereinafter also referred to as transformer bushings] respectively. The transformer bushings (15 and 16) are insulated devices, which allow voltage and/or current to conduct through the wall of the transformer (30).

[0044] Further, the transformer tank (14) is filled with oil (11). The oil (11) in the transformer tank (14) acts as a coolant for dissipating heat generated during working cycle of the transformer (30). The oil (11) is selected having properties such as but not limiting to dielectric/electric insulating property, high thermal capacity and low viscosity properties. In an exemplary embodiment, the oil (11) is preferably a dielectric combustible coolant fluid. The transformer (30) is connected to a transformer conservator (21), which is in fluid communication with the transformer tank (14) through a pipe or conduit (19). The transformer conservator (21) acts as a surge tank, to neutralize variation of oil pressure in the transformer tank (14). The pipe or conduit (19) is provided with an Electrical Transformer Conservator Isolation Valve [ETCIV] (20) [herein referred to as ETCIV]. The ETCIV (20) is configured to block the passage in the pipe or conduit (19), upon detecting rapid movement of oil (11) from the transformer conservator (21) to the transformer tank (14). This inherently denotes that there is an abrupt pressure increase or pressure decrease of oil (11) within the transformer tank (14). A signal box (10) interfaces the control unit (1) and the ETCI valve (20), to enable operating the ETCI valve (20) by the control unit (1).

[0045] A differential current and voltage sensing relay (26) is provided in the apparatus (100) for measuring differential current and voltage between incoming high voltage conductor (22) and outgoing low voltage conductor (23). The differential current and voltage sensing relay (26) includes at least one voltage variation detection unit (26a) [hereinafter referred to as voltage variation detection unit] and an over current detection unit (26b) to monitor the voltage and current of the transformer (30), respectively. The differential current and voltage sensing relay (26), the voltage variation detection unit (26a) and the over current detection unit (26b) are interfaced with at least one control unit (1) [hereinafter referred to as control unit] of the transformer (30). The voltage variation detection unit (26a) is configured to determine ratio of an input voltage entering, and an output voltage exiting the transformer (30). The ratio determined by the voltage variation detection unit (26a) is compared with a preset threshold ratio. The preset ratio value is stored in the control unit (1) of the transformer (30). In an embodiment, the preset value of the ratio is 1:40 for a step-up transformer. The voltage variation detection unit (26a) is configured to provide a first input signal to the control unit (1), when the ratio of the input voltage and the output voltage surpasses a preset threshold ratio.

[0046] The over current detection unit (26b) is configured to monitor load on the transformer (30). In an embodiment,

the load is determined by calculating difference in the input current and the output current of the transformer (30). In another embodiment, the load is determined by calculating ratio of the input current to the output current of the transformer (30). The load on the transformer (30) calculated by the over current detection unit (26b), is compared with a preset value. The preset load value is stored in the control unit (1). In an embodiment, the preset value for load on the transformer (30) is selected as per requirement. The over current detection unit (26b) is configured to provide a second input signal to the control unit (1), when the load on the transformer (30) surpasses the preset load threshold.

[0047] In an embodiment, the voltage variation detection unit (26a) and the over current detection unit (26b) are preferably electrical relays.

[0048] In an exemplary embodiment, the differential current and voltage sensing relay (26) monitors incoming and outgoing signals [voltage and current] of the transformer (30), to provide the first input signal and the second current signal to the control unit (1). The first input signal is provided to the control unit (1), when the voltage variation surpasses the preset threshold ratio. The second input signal is provided to the control unit (1), when the load variation surpasses the preset load threshold.

[0049] In another embodiment, the differential current and voltage sensing relay (26) trips or cuts the connection between the input terminals or output terminals of the transformer (30), when the voltage or current variation surpasses the preset limit.

[0050] The apparatus (100) further comprises at least one surge detection unit (18) [hereinafter referred to as surge detection unit] and at least one rapid pressure rise relay (RPRR) [hereinafter referred to as rapid pressure rise relay]. The surge detection unit (18) is assembled in the pipe or conduit (19), for sensing oil surge in the transformer tank (14). The oil surge is sensed by monitoring oil level from the transformer tank (14) towards the transformer conservator (21). In an embodiment, the surge detection unit (18) is a Buchholz relay. The rapid pressure rise relay (RPRR) [not shown in figures] detects the variation of oil pressure within the transformer tank (14) based on the oil surge occurring in the transformer tank (14). The oil surge and the variation of oil pressure are compared with a preset value stored in the control unit (1). The surge detection unit (18) and the rapid pressure rise relay [RPRR] collectively provide a third input signal to the control unit (1), when the oil surge and the variation of oil pressure surpasses the preset pressure threshold. Also, a fire detector (17) is configured on the transformer tank (14) to detect burning of the transformer (30).

[0051] In an embodiment, the surge detection unit (18) trips or cuts the connection between the input terminals or output terminals of the transformer (30), when the oil surge surpasses the preset surge threshold.

[0052] The apparatus (100) also includes one or more circuit breakers (24, 28), which are interfaced with the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR]. The one or more circuit breakers (24, 28) receives input signals from either of the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR]. The one or more circuit breakers (24, 28) are configured to provide a fourth input signal to the control unit (1), upon receipt of input signal from either of the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR]. The one or more circuit breakers (24, 28) trips or cuts the connection between the input terminals or output terminals of the transformer (30), upon receipt of input signals from either of the voltage variation detection unit (26a), the over current detection unit (26b) the surge detection unit (18) and the rapid pressure rise relay [RPRR].

[0053] In an embodiment, the one or more circuit breakers (24, 28), receives input signal from the voltage variation detection unit (26a), when the voltage variation in the transformer (30) surpasses the preset threshold ratio. Upon receipt of the input signal from the voltage variation detection unit (26a), the one or more circuit breakers (24, 28) provide the fourth input signal to the control unit (1).

[0054] In another embodiment, the one or more circuit breakers (24, 28) receives input signal from the over current detection unit (26b), when the load variation in the transformer (30) surpasses the preset load threshold. Upon receipt of the input signal from the over current detection unit (26b), the one or more circuit breakers (24, 28) provides the fourth input signal to the control unit (1).

[0055] In another embodiment, the one or more circuit breakers (24, 28) receives input signal from the surge detection unit (18), when the oil surge in the transformer tank (14) surpasses the preset surge limit. Upon receipt of the input signal from the surge detection unit (18), the one or more circuit breakers (24, 28) provide the fourth input signal to the control unit (1).

[0056] In another embodiment, the one or more circuit breakers (24, 28) receives input signal from the rapid pressure rise relay [RPRR], when the oil pressure variation in the transformer tank (14) surpasses the preset limit. Upon receipt of the input signal from the rapid pressure rise relay [RPRR], the one or more circuit breakers (24, 28) provides the fourth input signal to the control unit (1).

[0057] In an embodiment, the one or more circuit breakers (24, 28) receives input signals from combinations of the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR]. Upon receipt of the input signals, the one or more circuit breakers (24, 28) provide the fourth input signal to the control unit (1).

[0058] In an embodiment, the one or more circuit breakers (24, 28) provides the fourth input signal to the control unit (1), upon receipt of either of the first input signal, the second input signal and the third input signal from the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR] respectively, either alone or in combination.

[0059] The apparatus (100) also includes a drain pipe (9) with one end connected to the transformer tank (14) and the other end connected to an oil sump (8). The drain pipe (9) is configured to route the oil drained out from the transformer tank (14) to the oil sump (8). In an embodiment, the drain pipe (9) is connectable in any position, which enables the drain pipe (9) to route oil (11) from the transformer tank (14). In an exemplary embodiment, the drain pipe (9) is connected on top portion of the transformer tank (14). In another embodiment, a pump [not shown in figures] is configured with the drain pipe (9) to enable draining of the oil (11) stored in the transformer tank (14).

[0060] A drain valve (4) is configured to the drain pipe (9). The drain valve (4) allows routing of the oil (11). The drain valve (4) operates based on a control signal received from the control unit (1). In an embodiment, the drain valve (4) is selected from a group such as but not limiting to ball valves, butterfly valves and solenoid valves. In an exemplary embodiment, the drain valve (4) is a solenoid valve. The drain valve (4), includes a lifting magnet (5) which upon receipt of the control signal is displaced from its rest position [not shown in figures]. Displacing the lifting magnet from rest position, will unblock the passage in the drain pipe (9), thereby allowing oil (11) to flow from the transformer tank (14) to the oil sump (8).

[0061] In an embodiment, the transformer tank (14) is placed on a ground level (12) with wheels of the transformer (13) in contact with the ground level (12).

[0062] Further, the apparatus (100) includes a conduit (45), with one end fluidly connected to a gas source (7) provisioned in a fire extinguishing compartment of the apparatus (100), and the other end connected to the transformer tank (14). The conduit (45) is configured to route a gas, from the gas source (7) to the transformer tank (14). In an embodiment, the conduit (45) is provisioned such that it will enable the gas routed to the transformer tank (14) to swirl contents within the transformer tank (14). The conduit (45) and the drain pipe (9) are spaced apart by a predetermined head or height, so that the gas entering the transformer tank (14) will not instantaneously exit out of the transformer tank (14). In an exemplary embodiment, the conduit (45) and the drain pipe (9) are provisioned on opposite portions of the transformer tank (14) i.e. bottom and top portion respectively. This exemplary configuration of conduit (45) and the drain pipe (9) enables to drain oil (11) from the transformer tank (14) and also simultaneously allow filling of gas. The gas is selected such that it comprises properties such as but not limiting to inertness/dielectricity and high thermal capacity properties. In an exemplary embodiment, the gas is nitrogen. The gas routed to the transformer tank (14) reduces temperature of the oil (11) and also reduces the oxygen content in the transformer tank (14), thereby preventing explosion of the transformer (30). The gas also, blocks any damage or rupture occurred to the transformer tank (14) due to heating, by forming a layer or an envelope of gas in the ruptured or damaged region.

[0063] A gas release valve (6), as shown in figure 2 is provisioned in the conduit (45), to route gas from the gas source (7) to the transformer tank (14) upon receiving control signal from the control unit (1). The gas release valve (6) comprises a primary gas valve (6a) and a secondary gas valve (6b) connected in series. The primary gas valve (6a) includes an inlet port (6d) connected to the gas source (7) and an outlet port (6e) connected to an inlet port (6f) of the secondary valve (6b). Outlet port (6g) of the secondary gas valve (6b) is connected to the transformer tank (14). This configuration of the primary gas valve (6a) and the secondary gas valve (6b) detects the gas leakage and exhausts the leaked gas to the atmosphere. The primary gas valve (6a) holds the gas and prevents it to reach the inlet port (6f) of the secondary gas valve (6b), when the primary gas valve (6b) is in closed condition. When the primary gas valve (6a) is opened, the gas is supplied to secondary gas valve (6b). If the secondary valve is also opened, the gas is routed to the transformer tank (14). However, during operation, both the primary and secondary gas valves (6a, 6b) operate simultaneously with common operating device in gas releasing unit (6). In an embodiment, the primary and secondary gas valves (6a, 6b) are selected from group such as but not limiting to ball valves and spring loaded valves.

[0064] In an exemplary arrangement, the primary gas valve (6a) consists of at least one spring loaded plunger [not shown] for releasing gas from the inlet port (6d) to the outlet port (6e). The secondary gas valve (6b) comprises at least one spring loaded plunger for releasing the gas from the inlet port (6f) to the outlet port (6g), and at least one gas exhaust port (6h) to exhaust the leaked gas. The spring-loaded plunger in the secondary gas valve (6b) operates by either closing the outlet port (6g) or the exhaust port (6h). Exhaust port (6h) is another outlet port of the secondary gas valve (6b), which is used to exhaust the leaked gas. Thus, the secondary gas valve (6b) in stationary position, does not permit flow of gas to the transformer tank (14) and instead directs the leaking gas to the exhaust gas port (6h) releasing the gas into atmosphere. In order to open the outlet port (6h), an external force is required on the secondary spring loaded plunger of the secondary gas valve (6b). The external force is applied through electromechanical device which operates only after receipt of all operating signals from the at least one control unit (1). In one embodiment, if the gas is routed to the transformer (30) when both the spring-loaded plungers of the primary gas valve (6a) and the secondary gas valve (6b) remains in depressed condition, gas leakage is detected by the secondary gas valve (6b). In another embodiment, if the gas is routed to the transformer (30), when both the spring-loaded plungers of the primary gas valve (6a) and

secondary gas valve (6b) are in relieved condition, the secondary gas valve (6b) supplies the gas to the transformer (30) through a non-return valve (37).

[0065] A pressure regulator (34) [shown in figure 3] is configured to the gas source (7) to monitor pressure of gas routed to the transformer tank (14). The pressure regulator (34) is provided with at least one contact manometer (34a) for measuring the gas pressure in the gas source (7) and at least one pressure gauge (34b) for measuring input pressure of the gas being routed to the transformer tank (14). The pressure regulator (34) is also attached with pressure setting knob (34d) operable by an operator to vary the pressure level of the gas being routed in to the primary gas valve (6a). If the input pressure of the gas being routed surpasses predetermined gas injection pressure the pressure setting knob (34d) is used to reduce the pressure. In an embodiment, the predetermined gas injection pressure is above 10 bar. The pressure regulator (34) includes a safety relief valve (34c), to maintain pressure of gas entering the transformer tank (14). In an embodiment, the safety valve (34c) relieves pressure of the gas, by discharging gas to the atmosphere until the pressure is within predetermined limit. In an embodiment, the predetermined pressure limit of gas flow is 10 bar. The gas outlet from the safety valve (34c) is routed to the outlet of the secondary valve (6b) via a gas flow control valve (6c). The gas flow control valve (6c) controls the flow rate of the gas to the transformer tank (14). Further, outlet of the gas flow control valve (6c) is connected to an inlet of Non-return valve (37), wherein outlet of the Non-return valve (37) is connected to transformer tank (14).

[0066] Further, a pressure monitoring switch [PMS] (31) [as shown in figure 4] comprises an oil receiving end (31a) [also referred to as pressure port], at least one diaphragm (31b), at least one pressure switch (31c) enclosed in a casing (31d), at least one spring loaded plunger (31e) and a plurality of support plates (31f) which acts as housing for the diaphragm (31b). The pressure port (31a) is connected to the diaphragm (31b) using fastener means and a gasket is provided to avoid oil leakage. In an exemplary embodiment, the fastener means is a mounting nut. The diaphragm (31b) is attached to the spring-loaded plunger (31e) which is in contact with the pressure switch (31c). In an embodiment, the pressure switch (31c) is a Normally Contact (NC) switch.

[0067] The PMS (31) as shown in figure 5 is in fluid communication with the drain pipe (9). The PMS (31) is positioned between plurality of ball valves (41, 42). The plurality of ball valves (41, 42) are fluidly connected to the drain pipe (9) through first and second hose pipes (43, 44) respectively. In an exemplary embodiment, the plurality of ball valves (41, 42) are selected from a group such as but not limiting to two-way ball valve and three-way ball valves. In the present disclosure, both two-way ball valve (41) and three-way ball valve (42) are used for routing oil (11) from the drain pipe (9) to the PMS (31). One opening of the two-way ball valve (41) is connected to the drain pipe (9) for bypassing oil (11) from the drain pipe (9) and other opening of the two-way ball valve (41) is connected to a first opening of the three-way ball valve (42) for receiving the bypassed oil (11). In one embodiment, a second opening of the three-way ball valve (42) is connected to an oil receiving end (31a) of the PMS (31) for routing bypassed oil (11) to the PMS (31). The PMS (31) receives the bypassed oil from the three-way ball valve (42) and measures the current static oil pressure.

[0068] In one embodiment, both the two-way ball valve (41) and the three-way ball valve (42) are provided with at least one operating handle/lever. The operating handle is used to regulate the valve condition based on the requirement. For example, as shown in figure 6, when the lever attached to the two-way ball valve (41) is in horizontal position, then the two-way ball valve (41) is in operating condition/open condition. However, if the position of the two-way ball valve (41) is vertical, it indicates that the two-way ball valve (41) is in closed condition. Further, if the position of the lever attached to the three-way ball (42) valve is vertical, then the three-way valve (42) is said to be in open condition. But, if the position of the lever attached to the three-way ball valve (42) is horizontal, it indicates that the three-way valve (42) is in closed condition. In an embodiment, testing of the system (101) is performed, when both the valves (41, 42) are in closed condition. The valves (41, 42) can be opened and closed manually using the operating handle/lever whenever operator desires to do so. When both the valves (41, 42) are said to be closed, oil (11) is not bypassed to the PMS (31). This valve configuration enables to conduct the online testing of the apparatus (100) used for detecting fire and preventing explosion of transformer (30).

[0069] The PMS (31) senses variation in the oil pressure of the bypassed oil (11) during oil draining activity. As soon as variation in the bypassed oil pressure takes place, the spring-loaded plunger (31e) is depressed which results into change of state of pressure switch (31c) from contact state to non-contact state. Also, the PMS (31) provides a first input signal to the control unit (1), upon detection of variation of pressure of the bypassed oil (11). In an embodiment, the preset oil pressure is 68,64 kPa (7 mwc [meter water column]).

[0070] In an embodiment, when the PMS (31) of the apparatus (100) provides the first input signal to the control unit (1), the components i.e. the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18) and the RPRR, the one or more circuit breakers (24, 28) provide second input signal, third input signal, fourth input signal and fifth input signal respectively.

[0071] Further, the control unit (1) includes a power supply device (2) for operating the control unit (1) and a selector switch [not shown in figures] for change-over between the modes of operation of the control unit (1). The control unit (1) also includes a plurality of mechanical latch contactor [not shown in figures], with each of the plurality of mechanical contactors interfaced with components of the apparatus (100). That is, the plurality of mechanical contactors are interfaced

with each of the differential current and voltage sensing relay (26), the voltage variation detection unit (26a), the over current detection unit (26b), the surge detection unit (18), the rapid pressure rise relay (RPRR) and the one or more circuit breakers (24, 28). The control unit (1) controls the components of the apparatus (100) via the plurality of mechanical contactor.

[0072] In an embodiment, the plurality of the mechanical contactors includes a first contactor, a second contactor, a third contactor, a fourth contactor and a fifth contactor [not shown in figures]. The first contactor is interfaced with the voltage variation detection unit (26a). The second contactor is interfaced with the over current detection unit (26b). The third contactor is interfaced with the surge detection unit (18). The fourth contactor is interfaced with the one or more circuit breakers (24, 28). The fifth contactor is interfaced with a cable monitoring system (29). The cable monitoring system (29) interconnects all the components of the apparatus (100) with the plurality of mechanical contactors of the control unit (1), thereby enable the control unit (1) to control operations of the components of the apparatus (100).

[0073] The control unit (1) also includes a memory unit [not shown in figures] which is configured to store the preset values of the components of the apparatus (100). In an embodiment, the memory unit also stores computations required to compute the ratio of input current/voltage with output current/voltage. In another embodiment, the memory unit also stores computations required to compute differences between input current/voltage with the output current/voltage. In an embodiment, the memory unit is selected from group such as but not limited to RAM, ROM or any other storage device, which serves the purpose of storing the preset values and computations of the components of the apparatus (100). The at least one control unit (1) includes a processing unit [not shown in figures] to process or perform computations based on the input received from the components. The processing unit may comprise at least one data processor for executing program components for executing user- or system-generated requests. The processor may include specialized processing units such as integrated system (bus) controllers, memory management control units, floating point units, graphics processing units, digital signal processing units, etc. The processing unit may include a microprocessor, such as AMD Athlon, Duron or Opteron, ARM's application, embedded or secure processors, IBM PowerPC, Intel's Core, Itanium, Xeon, Celeron or other line of processors, etc. The processing unit may be implemented using mainframe, distributed processor, multi-core, parallel, grid, or other architectures. Some embodiments may utilize embedded technologies like application-specific integrated circuits (ASICs), digital signal processors (DSPs), Field Programmable Gate Arrays (FPGAs), etc. The processing unit may be disposed in communication with one or more input/output (I/O) devices via I/O interface. The I/O interface may employ communication protocols/methods such as, without limitation, audio, analog, digital, monoaural, RCA, stereo, IEEE-1394, serial bus, universal serial bus (USB), infrared, PS/2, BNC, coaxial, component, composite, digital visual interface (DVI), high-definition multimedia interface (HDMI), RF antennas, S-Video, VGA, IEEE 802.n /b/g/n/x, Bluetooth, cellular (e.g., code-division multiple access (CDMA), high-speed packet access (HSPA+), global system for mobile communications (GSM), long-term evolution (LTE), WiMax, or the like), etc.

[0074] The control unit (1), upon receipt of either of the input signals from the components, generates a control signal. The control signal operates a drain valve (4) and a gas release valve (6) of the apparatus (100). Operating the drain valve (4) will drain oil (11) from the transformer tank (14), via the drain pipe (9). Simultaneously, the control signal operates the gas release valve (6) as shown in figure 2, to route gas into the transformer tank (14). (46).

[0075] Thus, gas is supplied to the transformer (30) via the gas release unit (6), whenever the at least one control unit (1) detects possible occurrence of fire and/or explosion in the transformer (30) i.e. receives at least one of the input signals from the components of the transformer (30). Thereby, detecting fire and preventing explosion of the transformer.

[0076] Figure 7 in one exemplary embodiment of the present disclosure illustrates a system (101) for detecting fluid leakage, fire and preventing explosion of the transformer (30). The system (101) is configured with a fluid leakage detection unit (102) to the apparatus (100).

[0077] The fluid leakage detection unit (102) in an exemplary configuration is assembled to the drain pipe (9) [as shown in figure 8a]. In an embodiment, the fluid leakage detection unit (102) is integrated at bottom portion of the drain pipe (9). The drain pipe (9) is divided into an upper fluid drain pipe (9a) and a lower drain pipe (9b). The upper drain pipe (9a) has one end connected to the transformer tank (14) and the other end connected to inlet port (4a) of the drain valve (4). The lower drain pipe (9b) has one end connected to an outlet port (4b) of the drain valve (4) and the other end of the lower drain pipe (9b) is connected to the top side portion of a fluid collection compartment (3). In an embodiment, the drain valve (4) is disposed between the upper drain pipe (9a) and lower drain pipe (9b). The upper drain pipe (9a) and the lower drain pipe (9b) are connected the drain valve (4) using fasteners. In an embodiment, the fastener interconnecting the drain pipe (9) and the drain valve (4) are selected from group such as but not limiting to nut, bolts and rivets.

[0078] Further, as shown in Figure 9b, the lower drain pipe (9) is configured with an extended diverging portion (9c). In an embodiment, the fluid collection compartment (3) is attached to extended diverging portion (9c). The fluid collection compartment (3) is attached to the extended diverging portion (9c), by methods such as but not limiting to welding, soldering, brazing and fastening. The fluid collection compartment (3) is configured to collect oil leaked from the drain pipe (9), when the drain valve (4) is in closed position. The fluid collection compartment (3) has at least one through hole (4) or passageway at each of its top side and bottom sides. The at least one through hole (38) provisioned on top side is connected to the diverging portion (9c) and the at least one through hole provisioned at the bottom side of the

compartment (3) is connected to a fluid discharge pipe (32). In an embodiment, the drain pipe (9) and the at least one through hole (38) are co-axial. This configuration, enables the oil (11) to directly flow through the at least one through hole (38) to an oil sump (8), via the fluid discharge pipe (32). Further, a drain plug (3b) is configured in the fluid collection compartment (3), to drain the oil (11) collected due to the extended diverging portion (9c).

[0079] Further, the fluid collection compartment (3) is provided with a fluid collection area (39) [shown in figure 8b]. The fluid collection area (39) is provisioned at bottom of the fluid collection compartment (3). In an embodiment, the fluid collection area (39) is an area surrounding the at least one through hole (4) and is configured to collect oil leaked from the drain valve (4). The oil leaked from the drain valve (4), upon reaching the extended diverging portion (9c) loses its pressure due to the divergent portion of the drain pipe (9). Thus, the oil (11) flows along the walls of the fluid collection compartment (3) and thereby gets collected in the fluid collection area (39). The fluid collection area (39) is formed by connection of the fluid discharge pipe (32) to the bottom part of the fluid collection compartment (3). The fluid discharge pipe (5) extends up to a predetermined height into the fluid collection compartment (3) through the at least one through hole (38). In an embodiment, the fluid discharge pipe (5), extends up to a predetermined height based on the volume of the fluid collection area (39) required. Also, the extended portion of the fluid discharge pipe (32) into the fluid collection compartment (3) acts as a sidewall to prevent flow of collected oil into the oil sump (8) via the fluid discharge pipe (32).

[0080] The fluid collection compartment (3) is further provided with at least one fluid level switch (3c). The fluid level switch (3c) is positioned at predetermined location of the fluid collection compartment (3). In an embodiment, the fluid level switch (3c) is positioned at one of the corners of bottom portion of the fluid collection compartment (3). Further, at least one cutout (3a) of predetermined size and shape is made to one of the side faces of the fluid collection compartment (3). In an embodiment, the shape of the cutout (3a) can be varied which includes but are not limiting to square, rectangular, circle, oval, and any other shape which serves the purpose. The size of the cutout (3a) is configured such that it will enable an operator to reach the fluid level switch (3c). The cutout (3a) also enables the operator to peep into the fluid collection compartment (3). Further, predetermined number of locking holes are formed that surround the cutout (3a) portion. A locking plate (3d) having same numbers of locking holes as that of the cutout (3a), is attached to the fluid collection compartment (3) to conceal the cutout (3a). In an embodiment, the number of locking holes provisioned to the locking plate (3d) is about 2 to about 10 in number. This configuration of locking plate (3d) prevents draining of oil through the drain pipe (9) and through the cutout (3a). Also, a trigger alarm [not shown] is configured to the fluid leakage detection unit (102), to alert the operator upon detection of fluid leakage in the system (101).

[0081] During use of the transformer, the fluid leakage detection unit (102) monitors fluid leakage in the transformer (30). The fluid leakage detection unit (102) is configured to detect leakage of oil (11) in the drain pipe (9), during closed position of drain valve (4). The fluid leakage detection unit (102) detects leakage, when oil (11) collected in the fluid collection compartment (3) surpasses a preset value. Upon detection of leakage, the at least one fluid level switch (3c) triggers an alarm to alert the operator of the oil leakage.

[0082] Further, during use of the transformer (30), the pressure of the oil (11) drained from the transformer tank (14) is monitored by the PMS (31). When the pressure of oil (11) draining out from the drain pipe (9) surpasses the preset value, the pressure switch (31c) provides a first input signal to the at least one control unit (1).

[0083] Similarly, when an abnormal situation is sensed by monitoring variation between the incoming and outgoing voltage and current signals to the transformer (30), the voltage variation unit (26a) and the over current detection unit (26b) provides a second input signal and the third input signal to the control unit (1) respectively.

[0084] During use of the transformer (30), when the surge detection unit (18) and the rapid pressure rise relay [RPRR] detects an oil surge and variation of oil pressure above the preset value within the transformer tank (14), a fourth input signal is provided to the control unit (1).

[0085] Further, due to interface of the voltage variation unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR], with the one or more circuit breakers (24, 28), a fifth input signal is provided to the control unit (1) by the one or more circuit breakers (24, 28). The fifth input signal is provided to the control unit (1), when the one or more circuit breakers (24, 28) receives signal from either of the voltage variation unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR].

[0086] Upon receiving either of the first input signal, the second input signal, the third input signal, the fourth input signal and the fifth input signal, the at least one control unit (1) operates the drain valve (4) and the gas release valve (6), simultaneously. Upon release of the drain valve (4), the oil (11) in the transformer tank (14) drains out. Due to release of the gas release valve (6), gas from the gas source (7) is routed from bottom portion of the transformer tank (14). Circulation of gas to the bottom portion of the transformer tank (14) swirls the oil (11) present in the transformer tank (14), thereby evenly cooling the oil (11). Also, the swirling of oil (11) due to flow of gas removes oxygen in the transformer tank (14), thereby reducing oxygen content in the transformer tank (14). Also, the gas rises up in the transformer tank (14) and forms an envelope over a crack or rupture occurred to the transformer tank (14). The circulated gas therefore prevents explosion and resulting fire of the transformer (30).

[0087] In an embodiment, as described in description to apparatus (100), in absence of PMS (31), the control unit (1) receives either of the first input signal, the second input signal, the third input signal and the fourth input signal from the

voltage variation unit (26a), the over current detection unit (26b), the surge detection unit (18) and the rapid pressure rise relay [RPRR] and the one or more circuit breakers (24, 28) respectively.

Advantages:

[0088] The present disclosure provides an apparatus, which is configured to route a gas into the transformer tank from the bottom portion, thereby cooling the oil and eliminating oxygen collection from the transformer tank.

[0089] The present disclosure provides an apparatus, wherein the gas routed to the transformer tank, is also configured to create an envelope or a layer around cracks or ruptures on the transformer tank, thereby preventing explosion of the transformer.

[0090] The present disclosure provides an apparatus and a system to detect fluid leakage, thereby inherently preventing issues related to transformer heating and explosion.

[0091] The present disclosure provides an apparatus and a system to detect fire provides a time interval for the operator to take preventive measure in case of danger of explosion of the transformer.

[0092] While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the scope being defined by the following claims.

REFERRAL NUMERALS

[0093]

REFERRAL NUMERALS	DESCRIPTION
100	Apparatus for detecting fire and preventing explosion of a transformer
101	System for detecting fire, detecting fluid leakage and preventing explosion of a transformer
102	Fluid leakage detection unit
1	Control unit
2	Power supply device
3	Fluid collection compartment
3a	Cutouts on side faces of fluid collection compartment
3b	Drain plug
3c	Fluid level switch
3d	Locking plate
4	Drain valve
4a	Inlet port of the drain valve
4b	Outlet port of the drain valve
5	Lifting Magnet in drain valve
6	Gas release valve
6a	Primary gas valve
6b	Secondary gas valve
6c	Flow control valve
6d	Primary inlet port
6e	Primary outlet port
6f	Secondary inlet port
6g	Secondary outlet port
6h	Exhaust port

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(continued)

	REFERRAL NUMERALS	DESCRIPTION
5	7	Gas source
	8	Oil sump
	9	Drain pipe
	9a	Upper drain pipe
10	9b	Lower drain pipe
	9c	Diverging portion of drain pipe
	10	Signal box
15	11	Oil in transformer tank
	12	Ground level
	13	Wheels of the transformer
	14	Transformer tank
20	15	High voltage transformer bushing
	16	Low voltage transformer bushing
	17	Fire detectors
25	18	Surge detection unit
	19	Conduit
	20	Transformer conservator isolation valve
	21	Transformer conservator
30	22	High voltage conductor
	23	Low voltage conductor
	24, 28	Circuit breaker
35	25	Input line of the transformer
	26	Differential current sensing electrical relay
	26a	Voltage variation detection unit
	26b	Over current detection unit
40	27	Output line of the transformer
	29	Cable monitoring system
	30	Transformer
45	31	Pressure monitoring switch
	31a	Pressure port of Pressure monitoring switch
	31b	Diaphragm of Pressure monitoring switch
	31c	Pressure switch of Pressure monitoring switch
50	31d	Casing of Pressure monitoring switch
	31e	Spring loaded plunger of Pressure monitoring switch
	31f	Plurality of support plates
55	32	Fluid discharge pipe
	33	Fluid level switch
	34	Pressure regulator

(continued)

REFERRAL NUMERALS	DESCRIPTION
34a	Manometer
34b	Pressure gauge
34c	Relief valve
34d	Setting knob
38	Through hole in fluid collection compartment
39	Fluid collection area in fluid collection compartment
41	Two-way valve
42	Three-way valve
43	First hose pipe
44	Second hose pipe
45	Conduit

Claims

1. An apparatus (100) for detecting fire and preventing explosion in a transformer (30), the apparatus (100) comprising:

at least one voltage variation detection unit (26a) for determining a ratio of an input voltage entering the transformer (30) and an output voltage exiting the transformer (30), wherein the at least one voltage variation detection unit (26a) is configured to provide a first input signal to at least one control unit (1), when the ratio of the input voltage and the output voltage surpasses a preset threshold ratio;

an over current detection unit (26b) configured for monitoring a load on the transformer (30), thereby providing a second input signal to the at least one control unit (1) when the load on the transformer (30) surpasses a preset load threshold; at least one surge detection unit (18) and at least one Rapid Pressure Rise Relay, RPRR, configured for detecting oil surge and variation of oil pressure within a transformer tank (14) of the transformer (30), thereby providing a third input signal to the at least one control unit (1), when the oil surge and the variation of oil pressure in the transformer tank (14) surpasses a preset pressure threshold;

one or more circuit breakers (24, 28) configured for receiving input signals from either one of the at least one voltage variation detection unit (26a), the over current detection unit (26b), the at least one surge detection unit (18) and the at least one rapid pressure rise relay, RPRR, wherein the one or more circuit breakers (24, 28) provides a fourth input signal to the at least one control unit (1); and

the at least one control unit (1) is configured to generate a control signal for operating a drain valve (4) and a gas release valve (6) upon receipt of either one of the first input signal, the second input signal, the third input signal and the fourth input signal,

wherein, the gas release valve (6) comprises:

a primary gas valve (6a) configured with a primary inlet port (6d) fluidly connected to a gas source (7), and a primary outlet port (6e);

a secondary gas valve (6b) configured with a secondary inlet port (6f), fluidly connected to the primary outlet port (6e), and a secondary outlet port (6g) fluidly connected to the transformer tank (14) for routing gas into the transformer tank (14), when the primary gas valve (6a) and the secondary gas valve (6b) are operated by the at least one control unit (1); and

an exhaust port (6h) configured to exhaust the gas leaked from either one of the primary gas valve (6a) and secondary gas valve (6b) to the atmosphere, when the primary gas valve (6a) and the secondary gas valve (6b) are in closed position.

2. The apparatus (100) as claimed in claim 1, wherein the at least one voltage variation detection unit (26a) is configured to provide a first input signal to the at least one control unit (1), when the ratio of the input voltage and the output voltage surpasses 1:40 threshold ratio.

3. The apparatus (100) as claimed in claim 1, wherein the one or more circuit breakers (24, 28) is configured to cut-off the transformer (30) from receiving the input voltage when the ratio of the input voltage and the output voltage surpasses the preset threshold ratio.

4. The apparatus (100) as claimed in claim 1, wherein the at least one control unit (1) is configured to generate a control signal for operating the drain valve (4) for draining oil from the transformer tank (14).

5. The apparatus (100) as claimed in claim 1, wherein the at least one control unit (1) is configured to generate a control signal for operating the gas release valve (6) to inject gas from a gas source (7) to the bottom of the transformer tank (14), for stirring the oil (11) in order to reduce temperature and oxygen content in the transformer tank (14), thereby preventing explosion and fire within the transformer (30).

6. The apparatus (100) as claimed in claim 1, wherein the secondary outlet port (6g) of the secondary gas valve (6b) is connected to the transformer tank (14) through a gas flow control valve (6c) and a non-return valve (37).

7. The apparatus (100) as claimed in claim 1, wherein the gas source (7) is connected to the primary inlet port (6d) of the primary gas valve (6a) through a pressure regulator (34) to control pressure of the gas entering the primary gas valve (6a).

8. The apparatus (100) as claimed in claim 1, for detecting fire and preventing explosion in a transformer (30), the apparatus (100) further comprising:

at least one Pressure monitoring Switch (31) configured to detect pressure of oil (11) routed through a drain pipe (9), thereby providing an input signal to at least one control unit (1), when the pressure of oil (11) routed through the drain pipe (9) surpasses a preset value, wherein the at least one pressure monitoring switch (31) comprises:

at least one pressure switch (31c) for generating the input signal, when oil pressure in a pressure port (31a) of the pressure monitoring switch (31) surpasses a preset value;

at least one spring loaded plunger (31e) in contact with the at least one pressure switch (31c) for operating the at least one pressure switch (31c);

at least one diaphragm (31b) attached to the at least one spring loaded plunger (31e) for operating the at least one spring loaded plunger (31e), based on the pressure of oil (11) in the pressure port (31a) and entering the at least one diaphragm (31b); and

the pressure port (31a) is connected to the drain pipe (9) for receiving a predetermined amount of oil (11), thereby maintaining the pressure of oil (11) routed through the drain pipe (9); and

wherein the at least one control unit (1) is configured to generate a control signal for operating a drain valve (4) and a gas release valve (6) upon receipt of the at least one Pressure monitoring Switch (31).

9. The apparatus (100) as claimed in claim 8, wherein the pressure port (31a) is connected to at least one three-way ball valve (42) to receive oil (11) bypassed from the drain pipe (9).

10. The apparatus (100) as claimed in claim 9, wherein at least one 3-way ball valve (42) is connected to at least one two-way ball valve (41) through a first hose pipe (43) for receiving oil (11) bypassed from the drain pipe (9).

11. The apparatus (100) as claimed in claim 9, wherein at least one three-way ball valve (42) is connected to the drain pipe (9) by a second hose pipe (44) for routing the oil (11) bypassed back to the drain pipe (9).

12. The apparatus (100) as claimed in claim 8, wherein the predetermined oil pressure level is up to about 68,64 kPa (7 mwc [meter water column]).

13. The apparatus (100) as claimed in claim 8 comprising a gasket provided between the pressure port (31a) and the at least one diaphragm (31b) for preventing oil leakage.

14. The apparatus (100) as claimed in claim 8 comprising a plurality of support plates (31f) for housing the at least one diaphragm (31b).

15. A system (101) for detecting fire, detecting fluid leakage through a drain valve (4) disposed in a drain pipe (9) and preventing fire in a transformer (30), the system (101) comprising an apparatus (100) for detecting fire and preventing explosion in a transformer (30) according to one of claims 8 to 14, and a fluid leakage detection unit (102), comprising:

a fluid collection compartment (3) fluidly connected to downstream of the drain pipe (9) for collecting fluid leaked through the drain valve (4) in a closed position, wherein, the fluid collection compartment (3) comprises:

at least one through hole (38) provided on a top and a bottom side of the fluid collection compartment (3), wherein area surrounding the at least one through hole (38) of the bottom side of the fluid collection compartment (3) is configured as a fluid collection area (39) to collect the leaked fluid;

the bottom side of the fluid collection compartment (3) is connected with a fluid discharge pipe (32) that extends up to a predetermined height into the fluid collection compartment (3) via the at least one through hole (38); and at least one fluid level switch (33) positioned at a predetermined location inside the fluid collection compartment (3) to trigger an alarm upon collection of predetermined amount of fluid in the fluid collection area (39) to indicate fluid leakage.

16. A method for detecting fire, detecting fluid leakage through a drain valve (4) disposed in a drain pipe (9) and preventing explosion of a transformer (30) using a system (101) according to claim 15, said method comprising acts of:

monitoring fluid level in a fluid collection compartment (3), wherein at least one fluid level switch (33) positioned at a predetermined location inside the fluid collection compartment (3) is configured to trigger an alarm upon detecting a predetermined level of fluid in a fluid collection area (8) of the fluid collection compartment (3) to indicate fluid leakage;

monitoring pressure of oil (11) in a transformer tank (14) routed through the drain pipe (9), thereby providing a first input signal to the at least one control unit (11), when the pressure of oil routed through the drain pipe (9) surpasses a preset pressure threshold;

calculating a ratio between input voltage and output voltage, and providing a second input signal to at least one control unit (1) when the ratio of the input voltage and the output voltage surpasses a preset threshold ratio, and providing a third input signal to the at least one control unit (1) when the load on the transformer (30) surpasses a preset load threshold;

detecting excessive oil surge and rate of change of oil pressure in a transformer tank (14) of the transformer (30) by at least one surge detection unit (18) and a Rapid Pressure Rise Relay, RPRR, respectively and thereby providing a fourth input signal to the at least one control unit (1);

providing a fifth input signal to at least one control unit (1) by one or more circuit breakers (24, 28) when the one or more circuit breaker (24) receives either one of the first input signal, the second input signal, the third input signal and the fourth input signal, and

receiving either one of the first input signal, the second input signal, the third input signal, the fourth input signal and the fifth input signal by the at least one control unit (1), and thereby generating a control signal for operating a drain valve (4) and a gas release valve (6) thereby detecting fire and preventing explosion of the transformer (30).

Patentansprüche

1. Gerät (100) zum Erfassen von Feuer und zum Verhindern einer Explosion in einem Transformator (30), wobei das Gerät (100) umfasst:

wenigstens eine Spannungsschwankungs-Erfassungseinheit (26a) zum Bestimmen eines Verhältnisses einer Eingangsspannung, die in den Transformator (30) eintritt, und einer Ausgangsspannung, die aus dem Transformator (30) austritt, wobei die wenigstens eine Spannungsschwankungs-Erfassungseinheit (26a) dazu eingerichtet ist, ein erstes Eingangssignal für wenigstens eine Steuereinheit (1) bereitzustellen, wenn das Verhältnis der Eingangsspannung und der Ausgangsspannung ein voreingestelltes Schwellenverhältnis überschreitet;

eine Überstromerfassungseinheit (26b), die zum Überwachen einer Last auf dem Transformator (30) eingerichtet ist, wodurch ein zweites Eingangssignal für die wenigstens eine Steuereinheit (1) bereitgestellt wird, wenn die Last auf dem Transformator (30) eine voreingestellte Lastschwelle überschreitet;

wenigstens eine Anstiegserfassungseinheit (18) und wenigstens ein Rapid Pressure Rise Relay, RPRR, das dazu eingerichtet ist, einen Ölanstieg und einer Änderung des Öldrucks innerhalb eines Transformator tanks (14) des Transformators (30) zu erfassen, wodurch ein drittes Eingangssignal an die wenigstens eine Steuer-

einheit (1) geliefert wird, wenn der Ölanstieg und die Änderung des Öldrucks in dem Transformatortank (14) einen voreingestellten Druckschwellwert überschreitet;
 einen oder mehrere Schutzschalter (24, 28), die dazu eingerichtet sind, Eingangssignale von einer der wenigstens einen Spannungsschwankungs-Erfassungseinheit (26a), der Überstromerfassungseinheit (26b), der wenigstens einen Überspannungserfassungseinheit (18) und dem wenigstens einen Druckschnellanstiegsrelais, RPRR, zu empfangen,
 wobei der eine oder die zahlreichen Schutzschalter (24, 28) ein viertes Eingangssignal für die wenigstens eine Steuereinheit (1) bereitstellen; und
 die wenigstens eine Steuereinheit (1) dazu eingerichtet ist, ein Steuersignal zum Betätigen eines Ablassventils (4) und eines Gasfreigabeventils (6) bei Empfang eines von dem ersten Eingangssignal, dem zweiten Eingangssignal, dem dritten Eingangssignal und dem vierten Eingangssignal zu erzeugen, wobei das Gasfreigabeventil (6) umfasst:

ein primäres Gasventil (6a), das mit einem primären Einlassanschluss (6d), der in Fluidverbindung mit einer Gasquelle (7) steht, und einem primären Auslassanschluss (6e) eingerichtet ist;
 ein sekundäres Gasventil (6b), das mit einem sekundären Einlassanschluss (6f), der in Fluidverbindung mit dem primären Auslassanschluss (6e) steht, und einem sekundären Auslassanschluss (6g) eingerichtet ist, der mit dem Transformatortank (14) in Fluidverbindung steht, um Gas in den Transformatortank (14) zu leiten, wenn das primäre Gasventil (6a) und das sekundäre Gasventil (6b) durch die wenigstens eine Steuereinheit (1) betätigt werden; und
 einen Auslassanschluss (6h), der dazu eingerichtet ist, Gas, das entweder aus dem primären Gasventil (6a) oder dem sekundären Gasventil (6b) entweicht, an die Atmosphäre abzugeben, wenn das primäre Gasventil (6a) und das sekundäre Gasventil (6b) in geschlossener Position sind.

2. Gerät (100) nach Anspruch 1, bei dem die wenigstens eine Spannungsschwankungs-Erfassungseinheit (26a) dazu eingerichtet ist, ein erstes Eingangssignal an die wenigstens eine Steuereinheit (1) zu liefern, wenn das Verhältnis der Eingangsspannung und der Ausgangsspannung das Schwellenverhältnis 1:40 überschreitet.
3. Gerät (100) nach Anspruch 1, bei dem der eine oder die mehreren Schutzschalter (24, 28) dazu eingerichtet sind, den Transformator (30) von dem Empfang der Eingangsspannung abzutrennen, wenn das Verhältnis zwischen der Eingangsspannung und der Ausgangsspannung das voreingestellte Schwellenverhältnis überschreitet.
4. Gerät (100) nach Anspruch 1, bei dem die wenigstens eine Steuereinheit (1) dazu eingerichtet ist, ein Steuersignal zur Betätigung des Ablassventils (4) zum Ablassen von Öl aus dem Transformatortank (14) zu erzeugen.
5. Gerät (100) nach Anspruch 1, bei dem die wenigstens eine Steuereinheit (1) dazu eingerichtet ist, ein Steuersignal zum Betätigen des Gasablassventils (6) zu erzeugen, um Gas von einer Gasquelle (7) in den Boden des Transformatorrentanks (14) einzuspritzen, um das Öl (11) zu rühren, um die Temperatur und den Sauerstoffgehalt in dem Transformatorrentank (14) zu verringern und dadurch eine Explosion und ein Feuer in dem Transformator (30) zu verhindern.
6. Gerät (100) nach Anspruch 1, bei dem der sekundäre Auslassanschluss (6g) des sekundären Gasventils (6b) über ein Gasflusssteuerventil (6c) und ein Rückschlagventil (37) mit dem Transformatortank (14) verbunden ist.
7. Gerät (100) nach Anspruch 1, bei dem die Gasquelle (7) mit dem primären Einlassanschluss (6d) des primären Gasventils (6a) über einen Druckregler (34) verbunden ist, um den Druck des in das primäre Gasventil (6a) eintretenden Gases zu steuern.
8. Gerät (100) nach Anspruch 1 zum Erfassen von Feuer und zum Verhindern von Explosionen in einem Transformator (30), wobei das Gerät (100) weiterhin umfasst:
 wenigstens einen Drucküberwachungsschalter (31), der dazu eingerichtet ist, den Druck des durch ein Ablassrohr (9) geleiteten Öls (11) zu erfassen, wodurch ein Eingangssignal für wenigstens eine Steuereinheit (1) bereitgestellt wird, wenn der Druck des durch das Ablassrohr (9) geleiteten Öls (11) einen voreingestellten Wert überschreitet, wobei der wenigstens eine Drucküberwachungsschalter (31) umfasst:

wenigstens einen Druckschalter (31c) zum Erzeugen des Eingangssignals, wenn der Öldruck in einem Druckanschluss (31a) des Drucküberwachungsschalters (31) einen voreingestellten Wert überschreitet;
 wenigstens einen durch eine Feder vorgespannten Kolben (31e) in Kontakt mit dem wenigstens einen Druck-

schalter (31c) zum Betätigen des wenigstens einen Druckschalters (31c); und wenigstens eine Membran (31b), die an dem wenigstens einen federbelasteten Kolben (31e) angebracht ist, um den wenigstens einen federbelasteten Kolben (31e) basierend auf dem Druck des Öls (11) in dem Druckanschluss (31a) und dem Eintritt in die wenigstens eine Membran (31b) zu betätigen; wobei
 5 der Druckanschluss (31a) mit dem Ablassrohr (9) verbunden ist, um eine vorbestimmte Menge an Öl (11) aufzunehmen, wodurch der Druck des durch das Ablassrohr (9) geleiteten Öls (11) aufrechterhalten wird; und die wenigstens eine Steuereinheit (1) dazu eingerichtet ist, bei Empfang des wenigstens einen Drucküberwachungsschalters (31) ein Steuersignal zur Betätigung eines Ablassventils (4) und eines Gasablassventils (6) zu erzeugen.

10 **9.** Gerät (100) nach Anspruch 8, bei dem der Druckanschluss (31a) mit wenigstens einem Drei-Wege-Kugelventil (42) verbunden ist, um Öl (11) aufzunehmen, das von der Ablaufleitung (9) umgeleitet wird.

15 **10.** Gerät (100) nach Anspruch 9, bei dem wenigstens ein 3-Wege-Kugelventil (42) mit wenigstens einem 2-Wege-Kugelventil (41) über eine erste Schlauchleitung (43) zur Aufnahme von Öl (11) verbunden ist, das von der Ablaufleitung (9) umgeleitet wird.

20 **11.** Gerät (100) nach Anspruch 9, bei dem wenigstens ein Drei-Wege-Kugelventil (42) über eine zweite Schlauchleitung (44) mit der Ablaufleitung (9) verbunden ist, um das umgeleitete Öl (11) zurück zur Ablaufleitung (9) zu leiten.

12. Gerät (100) nach Anspruch 8, bei dem der vorbestimmte Öldruckpegel bis zu etwa 68,64 kPa (7 mwc [Meter Wassersäule]) beträgt.

25 **13.** Gerät (100) nach Anspruch 8, umfassend eine Dichtung, die zwischen dem Druckanschluss (31a) und der wenigstens einen Membran (31b) vorgesehen ist, um Ölaustritte zu verhindern.

14. Gerät (100) nach Anspruch 8, umfassend eine Vielzahl von Trägerplatten (31f) zur Aufnahme der wenigstens einen Membran (31b).

30 **15.** System (101) zum Erfassen von Feuer, zum Erfassen eines Fluidaustritts durch ein in einem Abflussrohr (9) angeordnetes Ablassventil (4) und zum Verhindern von Feuer in einem Transformator (30), wobei das System (101) ein Gerät (100) zum Erfassen von Feuer und zum Verhindern einer Explosion in einem Transformator (30) nach einem der Ansprüche 8 bis 14 umfasst, und
 eine Fluidaustritts-Erfassungseinheit (102), umfassend:
 35 ein Fluidsammelabteil (3), das stromabwärts des Ablassrohrs (9) in Fluidverbindung angeschlossen ist, um Fluid, das durch das Ablassventil (4) ausgetreten ist, in einer geschlossenen Position zu sammeln, wobei das Fluidsammelabteil (3) umfasst:

40 wenigstens ein Durchgangsloch (38), das auf einer Oberseite und einer Unterseite des Fluidsammelabteils (3) vorgesehen ist, wobei der das wenigstens eine Durchgangsloch (38) der Unterseite des Fluidsammelabteils (3) umgebende Bereich als Fluidsammelbereich (39) zum Sammeln des ausgetretenen Fluids eingerichtet ist; wobei die Unterseite des Fluidsammelabteils (3) mit einem Fluidabflussrohr (32) verbunden ist, das sich bis zu einer vorbestimmten Höhe in das Fluidsammelabteil (3) über das wenigstens eine Durchgangsloch (38) erstreckt; und

45 wenigstens einen Fluidpegelschalter (33), der an einer vorbestimmten Stelle innerhalb des Fluidsammelabteils (3) positioniert ist, um bei Ansammlung einer vorbestimmten Fluidmenge in dem Fluidsammelbereich (39) einen Alarm auszulösen, um Fluidaustritte anzuzeigen.

50 **16.** Verfahren zum Erfassen von Feuer, zum Erfassen von Fluidaustritten durch ein Ablassventil (4), das in einer Ablassleitung (9) angeordnet ist, und zum Verhindern einer Explosion eines Transformators (30) unter Verwendung eines Systems (101) nach Anspruch 15, wobei das Verfahren die folgenden Vorgänge umfasst:

Überwachen eines Fluidpegels in einem Fluidsammelabteil (3), wobei wenigstens ein Fluidpegelschalter (33), der an einer vorbestimmten Stelle innerhalb des Fluidsammelabteils (3) positioniert ist, dazu eingerichtet ist, bei Erfassen eines vorbestimmten Fluidpegels in einem Fluidsammelbereich (8) des Fluidsammelabteils (3) einen Alarm auszulösen, um ein Austreten von Fluid anzuzeigen;

Überwachen des Drucks des Öls (11) in einem Transformatorentank (14), das durch das Ablassrohr (9) geleitet wird, wodurch ein erstes Eingangssignal für die wenigstens eine Steuereinheit (11) bereitgestellt wird, wenn

der Druck des durch das Ablassrohr (9) geleiteten Öls einen voreingestellten Druckschwellenwert überschreitet; Berechnen eines Verhältnisses zwischen Eingangsspannung und Ausgangsspannung und Bereitstellen eines zweiten Eingangssignals für wenigstens eine Steuereinheit (1), wenn das Verhältnis zwischen der Eingangsspannung und der Ausgangsspannung ein voreingestelltes Schwellenverhältnis überschreitet, und
 5 Bereitstellen eines dritten Eingangssignals für die wenigstens eine Steuereinheit (1), wenn die Last an dem Transformator (30) einen voreingestellten Lastschwellenwert überschreitet;
 Erfassen eines übermäßigen Ölanstiegs und einer Änderungsrate des Öldrucks in einem Transformatortank (14) des Transformators (30) durch wenigstens eine Anstiegserfassungseinheit (18) bzw. ein Druckschnellanstiegsrelais, RPRR, und dadurch Bereitstellen eines vierten Eingangssignals für die wenigstens eine Steuer-
 10 einheit (1);
 Bereitstellen eines fünften Eingangssignals für wenigstens eine Steuereinheit (1) durch einen oder mehrere Schutzschalter (24, 28), wenn der eine oder die mehreren Schutzschalter (24) eines von dem ersten Eingangssignal, dem zweiten Eingangssignal, dem dritten Eingangssignal und dem vierten Eingangssignal empfangen, und
 15 Empfangen eines des ersten Eingangssignals, des zweiten Eingangssignals, des dritten Eingangssignals, des vierten Eingangssignals und des fünften Eingangssignals durch die wenigstens eine Steuereinheit (1) und dadurch Erzeugen eines Steuersignals zum Betätigen eines Ablassventils (4) und eines Gasablassventils (6), wodurch ein Feuer erkannt und eine Explosion des Transformators (30) verhindert wird.

Revendications

1. Appareil (100) de détection d'incendie et de prévention d'explosion dans un transformateur (30), l'appareil (100) comprenant :

au moins une unité de détection de variation de tension (26a) pour déterminer un rapport d'une tension d'entrée entrant dans le transformateur (30) et d'une tension de sortie quittant le transformateur (30), dans lequel l'au moins une unité de détection de variation de tension (26a) est configurée pour fournir un premier signal d'entrée à au moins une unité de contrôle (1), lorsque le rapport de la tension d'entrée et la tension de
 30 sortie dépasse un rapport de seuil prédéfini ;
 une unité de détection de surintensité (26b) configurée pour surveiller une charge sur le transformateur (30), fournissant ainsi un deuxième signal d'entrée à l'au moins une unité de contrôle (1) lorsque la charge sur le transformateur (30) dépasse un seuil de charge prédéfini ;
 au moins une unité de détection de pic (18) et au moins un relai d'augmentation rapide de pression, RPRR
 35 (Rapid Pressure Rise Relay), configuré pour détecter un pic d'huile et une variation de pression d'huile au sein d'un réservoir de transformateur (14) du transformateur (30), fournissant ainsi un troisième signal d'entrée à l'au moins une unité de contrôle (1), lorsque le pic d'huile et la variation de pression d'huile dans le réservoir de transformateur (14) dépasse un seuil de pression prédéfini ;
 un ou plusieurs disjoncteurs (24, 28) configurés pour recevoir des signaux d'entrée d'un de l'au moins une unité
 40 de détection de variation de tension (26a), l'unité de détection de surintensité (26b), l'au moins une unité de détection de pic (18) et l'au moins un relai d'augmentation rapide de pression, RPRR,
 dans lequel l'un ou plusieurs disjoncteurs (24, 28) fournissent un quatrième signal d'entrée à l'au moins une unité de contrôle (1) ; et
 l'au moins une unité de contrôle (1) est configurée pour générer un signal de contrôle pour faire fonctionner
 45 une vanne d'évacuation (4) et une vanne de libération de gaz (6) sur réception d'un du premier signal d'entrée, du deuxième signal d'entrée, du troisième signal d'entrée et du quatrième signal d'entrée,
 dans lequel, la vanne de libération de gaz (6) comprend :

une vanne de gaz principale (6a) configurée avec un port d'admission principal (6d) raccordé de manière
 50 fluide à une source de gaz (7) et un port de sortie principal (6e) ;
 une vanne de gaz secondaire (6b) configurée avec un port d'admission secondaire (6f), raccordé de manière fluide au port de sortie principal (6e), et un port de sortie secondaire (6g) raccordé de manière fluide au réservoir de transformateur (14) pour acheminer un gaz dans le réservoir de transformateur (14), lorsque la vanne de gaz principale (6a) et la vanne de gaz secondaire (6b) sont actionnées par l'au moins une unité
 55 de contrôle (1) ; et
 un port d'échappement (6h) configuré pour faire s'échapper le gaz s'écoulant d'une de la vanne de gaz principale (6a) et la vanne de gaz secondaire (6b) vers l'atmosphère, lorsque la vanne de gaz principale (6a) et la vanne de gaz secondaire (6b) sont en position fermée.

2. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel l'au moins une unité de détection de variation de tension (26a) est configurée pour fournir un premier signal d'entrée à l'au moins une unité de contrôle (1), lorsque le rapport de la tension d'entrée et la tension de sortie dépasse un rapport de seuil de 1:40.
- 5 3. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel l'un ou plusieurs disjoncteurs (24, 28) sont configurés pour couper la réception par le transformateur (30) de la tension d'entrée lorsque le rapport de la tension d'entrée et la tension de sortie dépasse le rapport de seuil prédéfini.
- 10 4. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel l'au moins une unité de contrôle (1) est configurée pour générer un signal de contrôle pour faire fonctionner la vanne d'évacuation (4) pour évacuer une huile du réservoir de transformateur (14).
- 15 5. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel l'au moins une unité de contrôle (1) est configurée pour générer un signal de contrôle pour faire fonctionner la vanne de libération de gaz (6) pour injecter un gaz depuis une source de gaz (7) au fond du réservoir de transformateur (14), pour agiter l'huile (11) afin de diminuer une température et une teneur en oxygène dans le réservoir de transformateur (14), empêchant ainsi une explosion et un incendie au sein du transformateur (30).
- 20 6. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel le port de sortie secondaire (6g) de la vanne de gaz secondaire (6b) est raccordé au réservoir de transformateur (14) via une vanne de contrôle de flux de gaz (6c) et une vanne anti-retour (37).
- 25 7. L'appareil (100) tel que revendiqué à la revendication 1, dans lequel la source de gaz (7) est raccordée au port d'admission principal (6d) de la vanne de gaz principale (6a) via un régulateur de pression (34) pour contrôler une pression du gaz entrant dans la vanne de gaz principale (6a).
- 30 8. L'appareil (100) tel que revendiqué à la revendication 1, de détection d'incendie et de prévention d'explosion dans un transformateur (30), l'appareil (100) comprenant en outre :
au moins un commutateur de surveillance de pression (31) configuré pour détecter une pression d'une huile (11) acheminée via un tuyau d'évacuation (9), fournissant ainsi un signal d'entrée à au moins une unité de contrôle (1) lorsque la pression de l'huile (11) acheminée via le tuyau d'évacuation (9) dépasse une valeur prédéfinie,
dans lequel l'au moins un commutateur de surveillance de pression (31) comprend :
au moins un commutateur de pression (31c) pour générer le signal d'entrée, lorsqu'une pression d'huile dans un port de pression (31a) du commutateur de surveillance de pression (31) dépasse une valeur prédéfinie ;
au moins un plongeur à ressort (31e) en contact avec l'au moins un commutateur de pression (31c) pour faire fonctionner l'au moins un commutateur de pression (31c) ;
au moins un diaphragme (31b) rattaché à l'au moins un plongeur à ressort (31e) pour faire fonctionner l'au moins un plongeur à ressort (31e), selon la pression d'une huile (11) dans le port de pression (31a) et pour entrer dans l'au moins un diaphragme (31b) ; et
le port de pression (31a) est raccordé au tuyau d'évacuation (9) pour recevoir une quantité prédéterminée d'huile (11), maintenant ainsi la pression d'une huile (11) acheminée via le tuyau d'évacuation (9) ; et
dans lequel l'au moins une unité de contrôle (1) est configurée pour générer un signal de contrôle pour faire fonctionner une vanne d'évacuation (4) et une vanne de libération de gaz (6) sur réception de l'au moins un commutateur de surveillance de pression (31).
- 45 9. L'appareil (100) tel que revendiqué à la revendication 8, dans lequel le port de pression (31a) est raccordé à au moins une vanne directionnelle à sphère à trois voies (42) pour recevoir une huile (11) dérivée du tuyau d'évacuation (9).
- 50 10. L'appareil (100) tel que revendiqué à la revendication 9, dans lequel au moins une vanne directionnelle à sphère à trois voies (42) est raccordée à au moins une vanne directionnelle à sphère à deux voies (41) via un premier tuyau (43) pour recevoir une huile (11) dérivée du tuyau d'évacuation (9).
- 55 11. L'appareil (100) tel que revendiqué à la revendication 9, dans lequel au moins une vanne directionnelle à sphère à

trois voies (42) est raccordée au tuyau d'évacuation (9) via un deuxième tuyau (44) pour acheminer l'huile (11) dérivée du tuyau d'évacuation (9).

12. L'appareil (100) tel que revendiqué à la revendication 8, dans lequel le niveau de pression d'huile prédéterminé s'élève jusqu'à environ 68,64 kPa (7 mwc [meter water column]).

13. L'appareil (100) tel que revendiqué à la revendication 8, comprenant un joint disposé entre le port de pression (31a) et l'au moins un diaphragme (31b) pour empêcher une fuite d'huile.

14. L'appareil (100) tel que revendiqué à la revendication 8, comprenant une pluralité de plaques de support (31f) pour accueillir l'au moins un diaphragme (31b) .

15. Système (101) de détection d'incendie, de détection de fuite de fluide à travers une vanne d'évacuation (4) installée dans un tuyau d'évacuation (9) et de prévention d'incendie dans un transformateur (30), le système (101) comprenant un appareil (100) de détection d'incendie et de prévention d'explosion dans un transformateur (30) selon l'une des revendications 8 à 14, et une unité de de détection de fuite de fluide (102), comprenant : un compartiment de collecte de fluide (3) raccordé de manière fluïdique à un aval du tuyau d'évacuation (9) pour collecter un fluide ayant fui à travers la vanne d'évacuation (4) dans une position fermée, dans lequel, le compartiment de collecte de fluide (3) comprend :

au moins un trou traversant (38) placé sur un côté sommital et de fond du compartiment de collecte de fluide (3), dans lequel une zone entourant l'au moins un trou traversant (38) du côté de fond du compartiment de collecte de fluide (3) est configurée en tant que zone de collecte de fluide (39) pour collecter le fluide ayant fui ; le côté de fond du compartiment de collecte de fluide (3) est raccordé à un tuyau de décharge de fluide (32) qui s'étend jusqu'à une hauteur prédéterminée dans le compartiment de collecte de fluide (3) via l'au moins un trou traversant (38) ; et

au moins un commutateur de niveau de fluide (33) positionné à un emplacement prédéterminé à l'intérieur du compartiment de collecte de fluide (3) pour déclencher une alarme sur collecte d'une quantité prédéterminée de fluide dans la zone de collecte de fluide (39) pour indiquer une fuite de fluide.

16. Procédé de détection d'incendie, de détection de fuite de fluide à travers une vanne d'évacuation (4) installée dans un tuyau d'évacuation (9) et de prévention d'explosion d'un transformateur (30) utilisant un système (101) selon la revendication 15, ledit procédé comprenant des actions de :

surveillance d'un niveau de fluide dans un compartiment de collecte de fluide (3), dans lequel au moins un commutateur de niveau de fluide (33) positionné à un emplacement prédéterminé à l'intérieur du compartiment de collecte de fluide (3) est configuré pour déclencher une alarme sur détection d'un niveau prédéterminé de fluide dans une zone de collecte de fluide (8) du compartiment de collecte de fluide (3) pour indiquer une fuite de fluide ;

surveillance d'une pression d'une huile (11) dans un réservoir de transformateur (1) acheminée via un tuyau d'évacuation (9), fournissant ainsi un premier signal d'entrée à l'au moins une unité de contrôle (11), lorsque la pression de l'huile acheminée via le tuyau d'évacuation (9) dépasse un seuil de pression prédéfini ;

calcul d'un rapport entre une tension d'entrée et une tension de sortie et, fourniture d'un deuxième signal d'entrée à au moins une unité de contrôle (1), lorsque le rapport de la tension d'entrée et la tension de sortie dépasse un rapport de seuil prédéfini, et

fourniture d'un troisième signal d'entrée à l'au moins une unité de contrôle (1), lorsque la charge sur le transformateur (30) dépasse un seuil de charge prédéfini ;

détection d'un pic d'huile et d'un taux de changement de pression d'huile excessifs dans un réservoir de transformateur (14) du transformateur (30) par au moins une unité de détection de pic (18) et un relai d'augmentation rapide de pression, RPRR (Rapid Pressure Rise Relay), respectivement et fourniture ainsi d'un quatrième signal d'entrée à l'au moins une unité de contrôle (1) ;

fourniture d'un cinquième signal d'entrée à au moins une unité de contrôle (1) par un ou plusieurs disjoncteurs (24, 28) lorsque l'un ou plusieurs disjoncteurs (24) reçoivent un du premier signal d'entrée, du deuxième signal d'entrée, du troisième signal d'entrée et du quatrième signal d'entrée, et

réception d'un du premier signal d'entrée, du deuxième signal d'entrée, du troisième signal d'entrée, du quatrième signal d'entrée et du cinquième signal d'entrée par l'au moins une unité de contrôle (1), et ainsi génération d'un signal de contrôle pour faire fonctionner une vanne d'évacuation (4) et une vanne de

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libération de gaz (6) et ainsi détection d'incendie et prévention d'explosion du transformateur (30).

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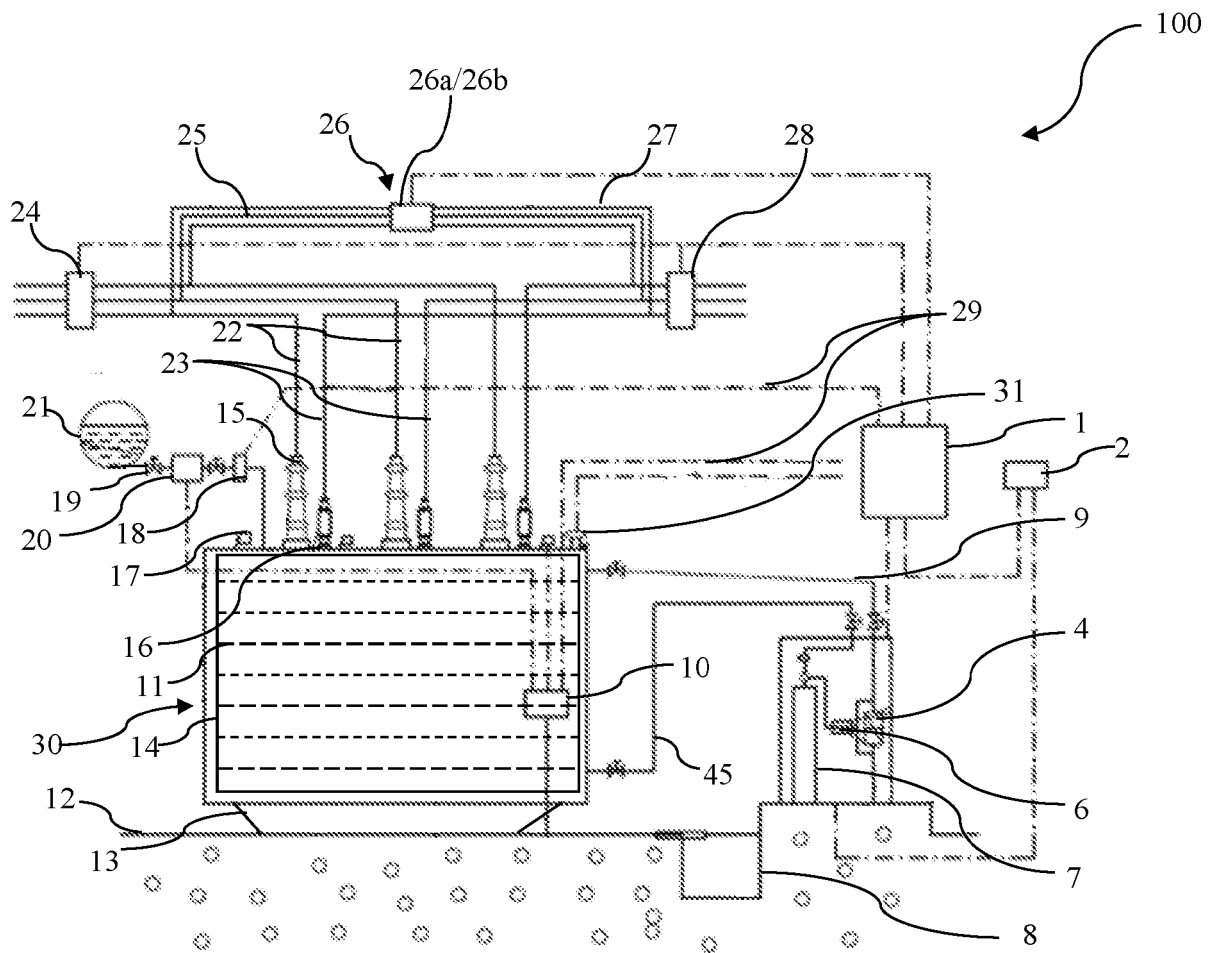


Figure 1

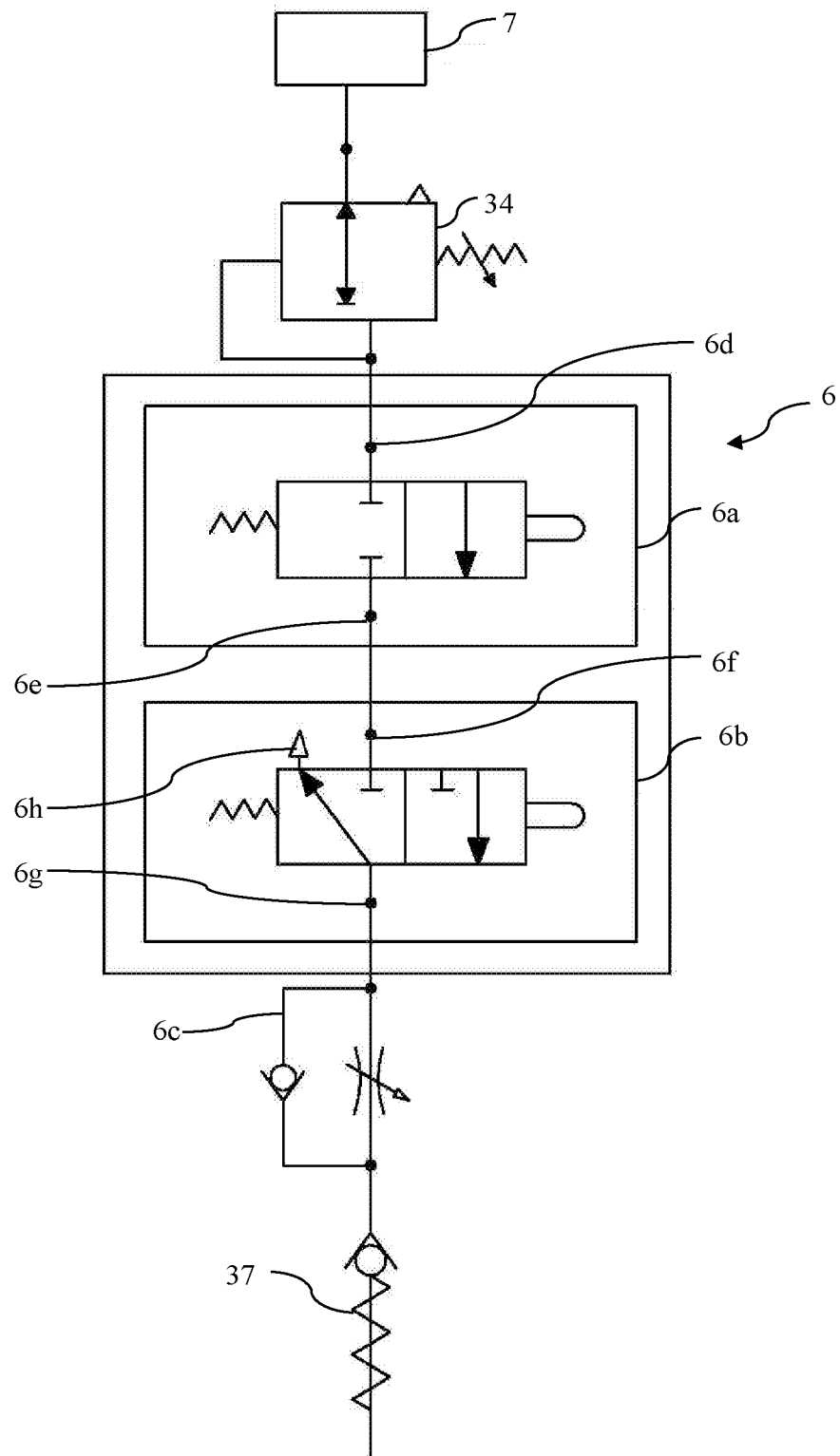


Figure 2

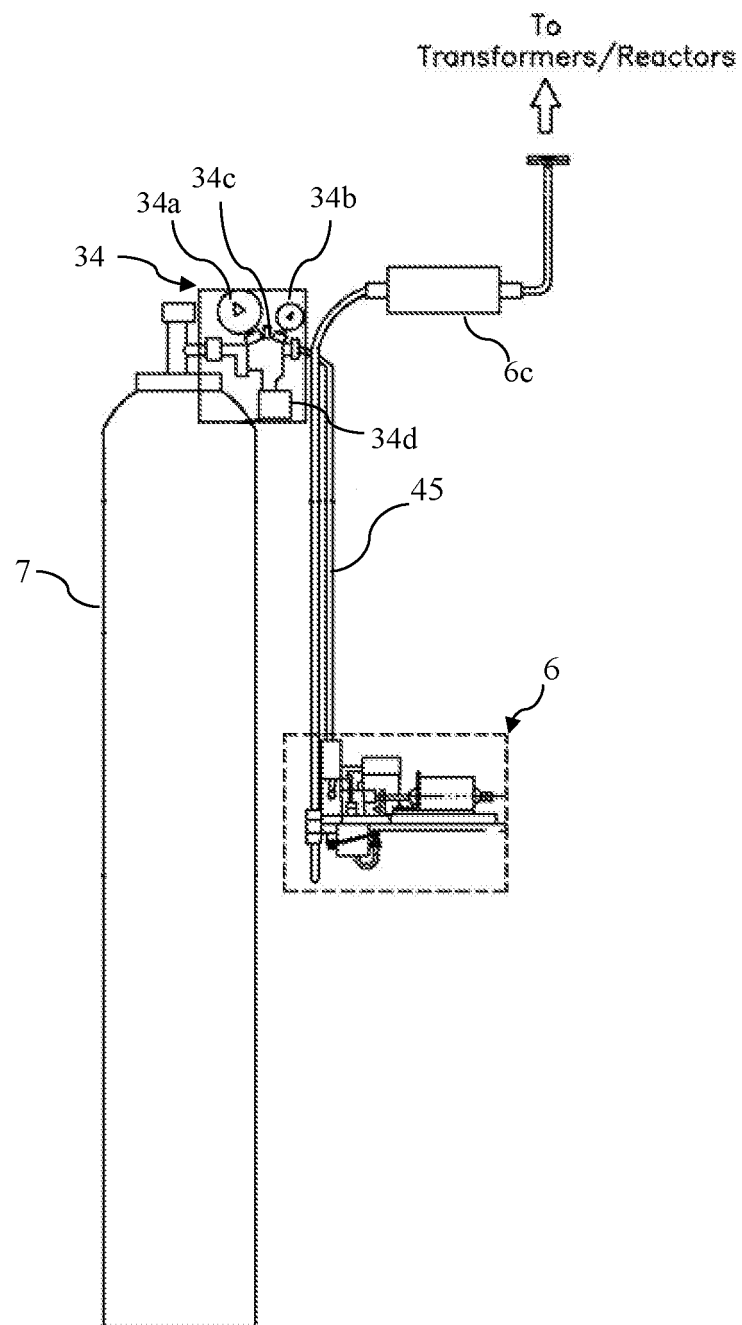


Figure 3

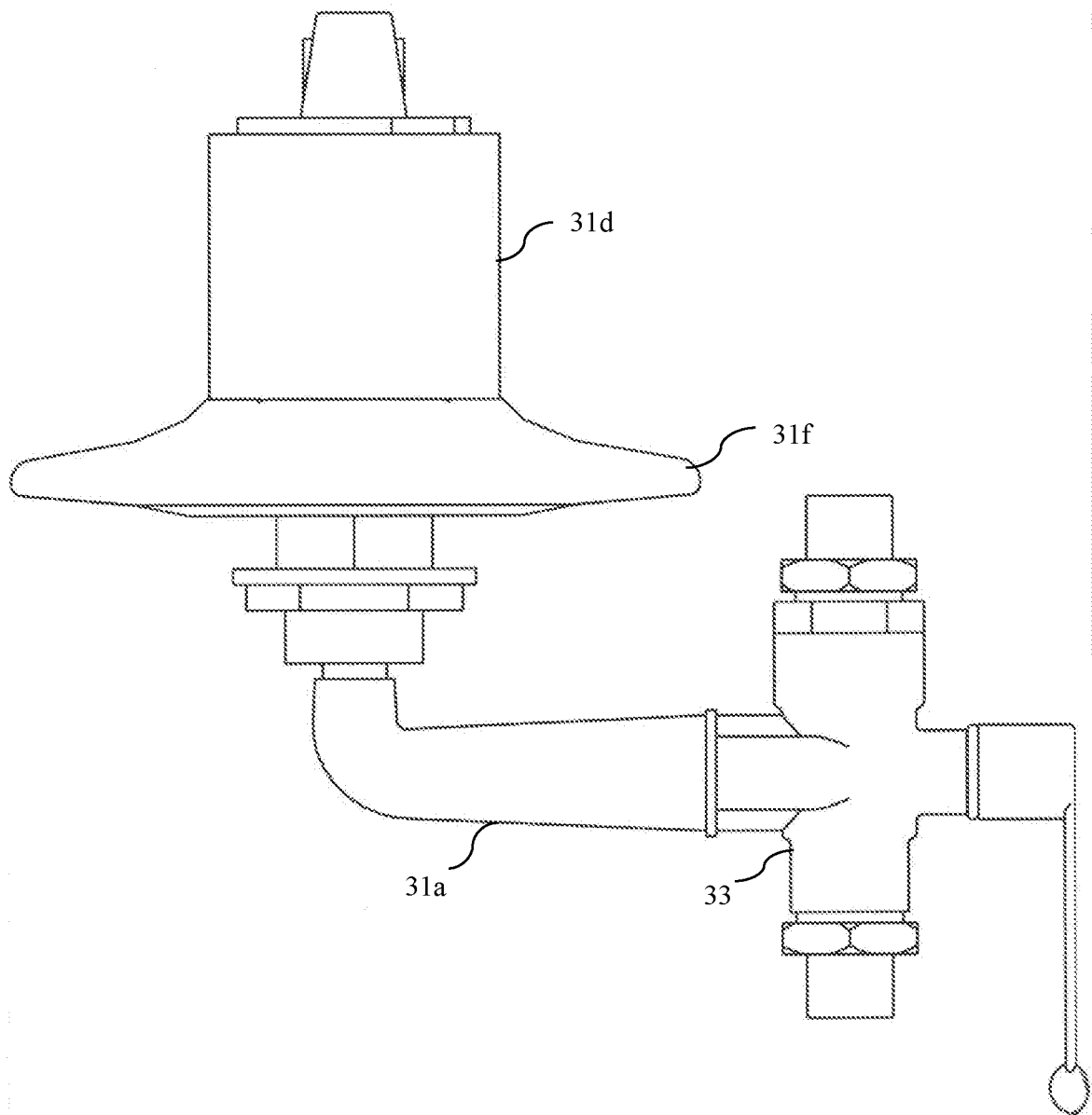


Figure 4

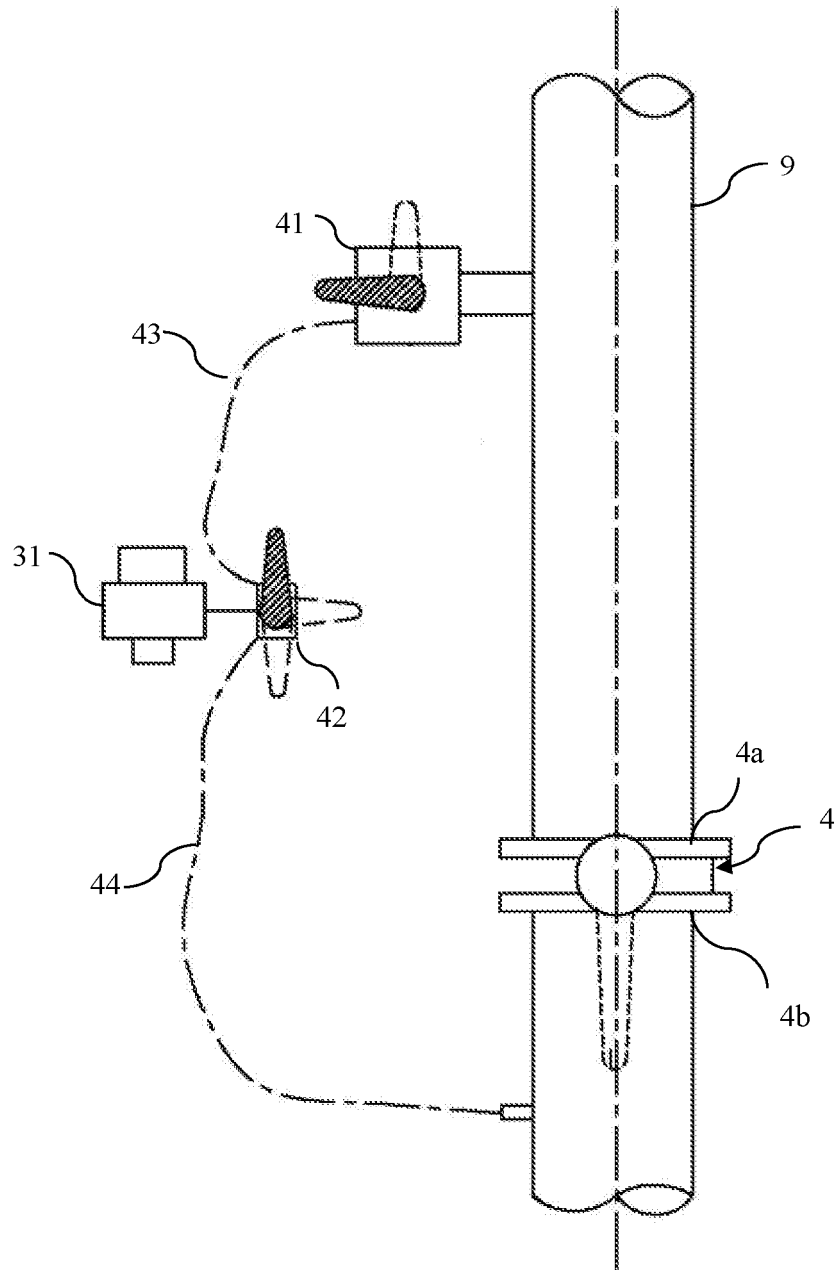


Figure 5

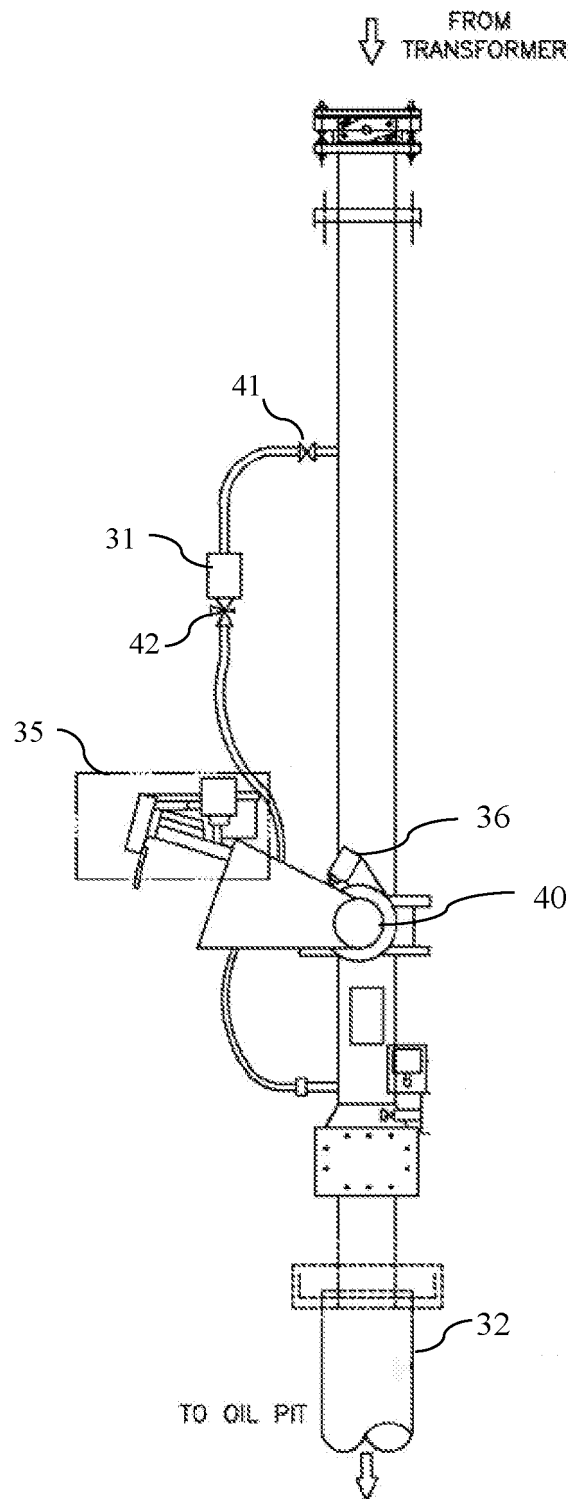


Figure 6

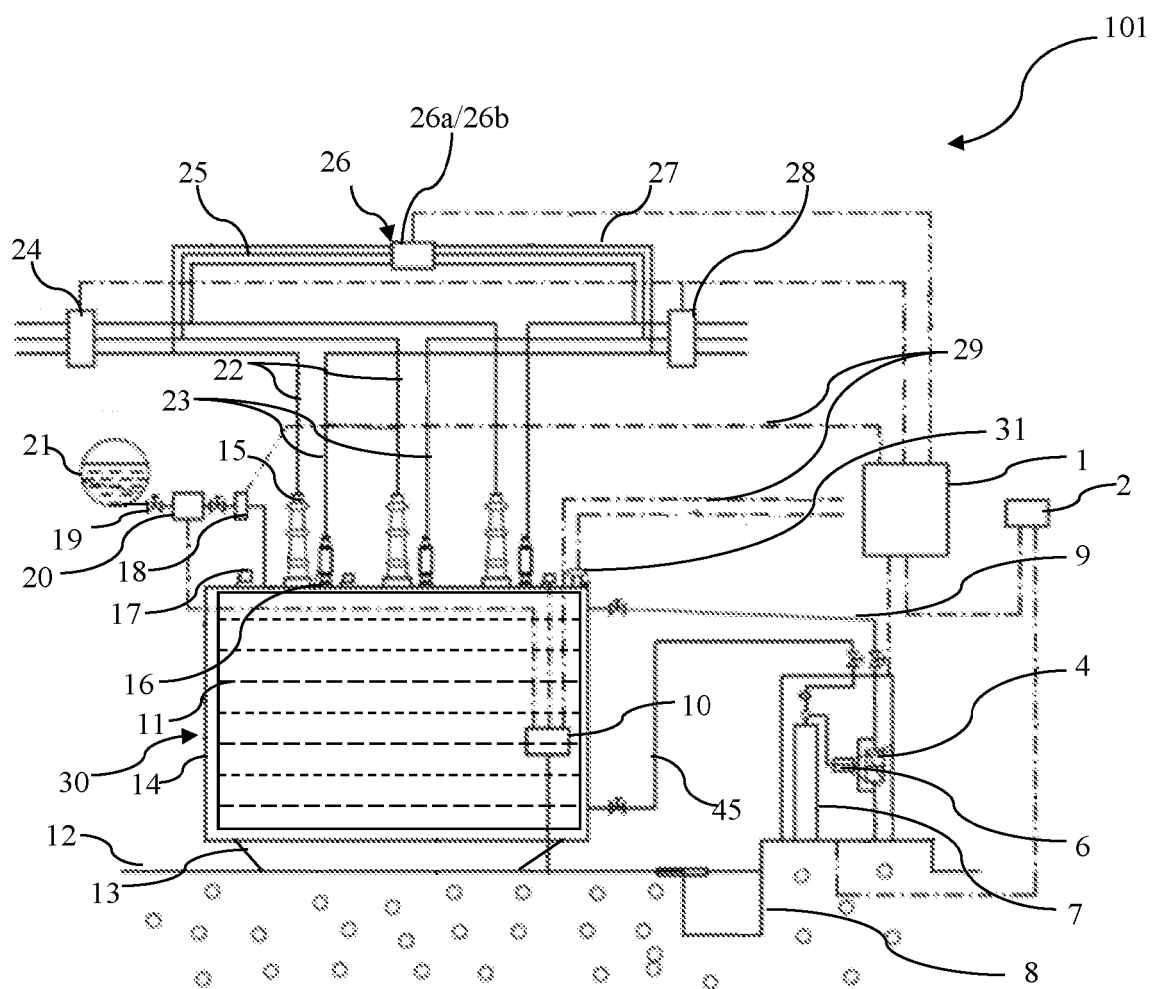


Figure 7

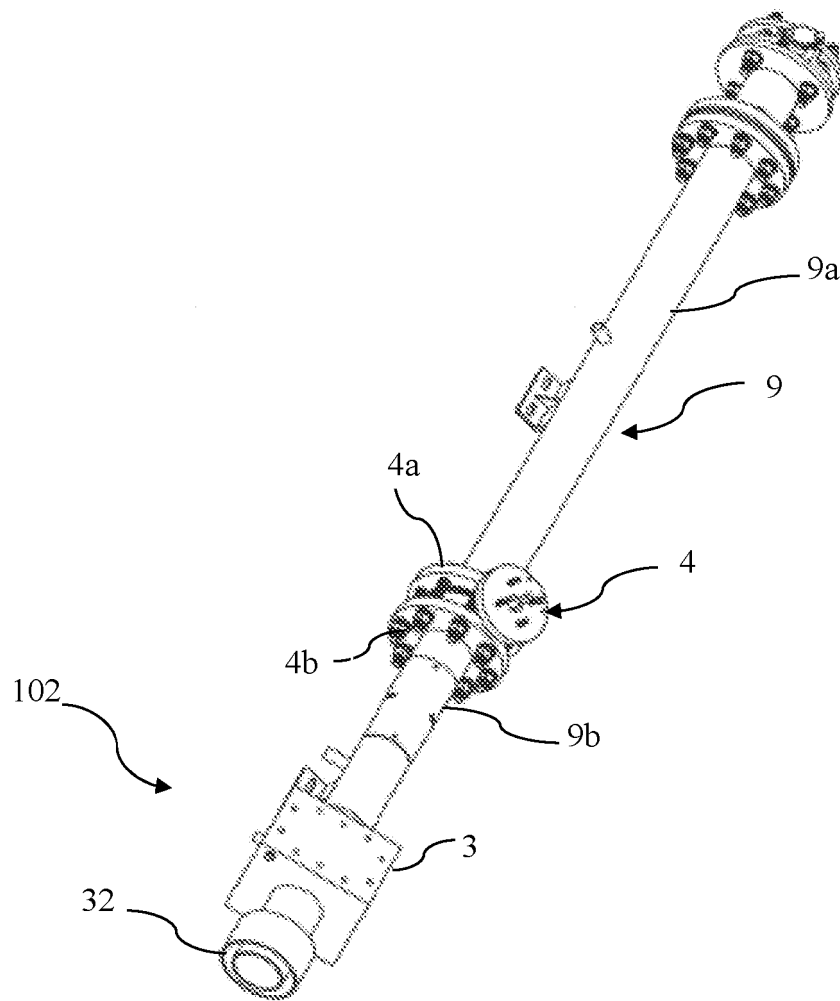


Figure 8a

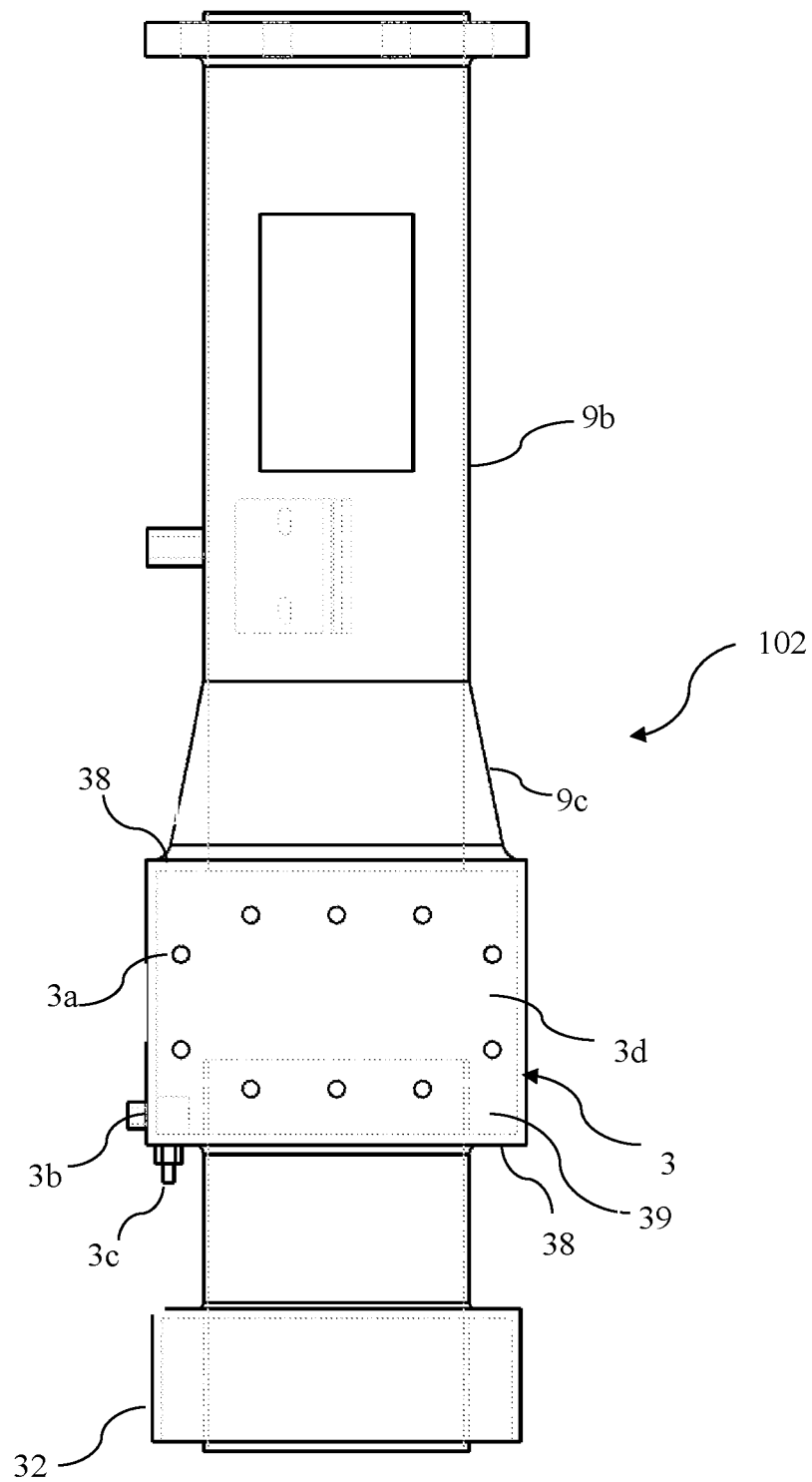


Figure 8b

REFERENCES CITED IN THE DESCRIPTION

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