Restricted Breathing Equipment

INSTRUCTIONS

GENERAL

Restricted Breathing is a means used on larger Westinghouse transformers to prevent deterioration of oil and insulation by the exclusion of oxygen and moisture from the oil. The original oxygen content of the air in the tank is depleted by oxidizing a small percentage of the oil, leaving inert gas above the oil.

The system consists of using a breathing regulator on a transformer tank which is essentially tight, preventing breathing except under extreme conditions of load cycle or ambient temperatures. Sufficient gas space is provided above the oil to prevent breathing during normal operation. Only sufficient breathing occurs during extreme conditions to limit the pressure to 10 pounds per square inch and vacuum to −5 pounds per square inch.

Fittings are provided on the Mercury Breathing Regulator so that the gas space above the transformer oil may be blown out initially with nitrogen. A sampling valve is also supplied so that the oxygen content of the gas space may be determined by the use of a gas analyzer.

CONSTRUCTION

Breathing Regulator—The breathing regulator works on the U-tube principle, with the surface area of the tube on the transformer side twice that of the other. Figure 1 shows a cross-sectional view of the regulator. The long center tube, operating as the transformer pressure leg of the U-tube, has twice the surface area of the long front tube which acts as the atmospheric pressure leg of the U-tube.

At atmospheric pressure, the levels of the two mercury columns are the same. As the pressure in the transformer increases, the Mercury level in the transformer tube is forced down with a rise in level of the other column of twice this value. At 10 pounds pressure, the Mercury level in the transformer tube reaches the bottom of the tube and any further increase in pressure causes the gas in the tube to bubble through the mercury, past the glass wool filter and out into the outside air.

A breather or throttle plug in the air exhaust pipe, in addition to glass wool in the space above the mercury column, serves to lower the velocity of the gas stream and remove any mercury globules formed by the gas stream when the transformer is exhausting to atmosphere.

When the transformer cools, the pressure on the transformer tube decreases, and the atmospheric pressure forces the mercury down in the front tube, causing the transformer column to rise, until equilibrium is reached. With a 5 pound vacuum in the transformer, the mercury in the front tube is at the bottom of the tube. Any further increase in the vacuum within the transformer (due to decrease in oil temperature) will result in the atmospheric pressure forcing air to bubble past the lower end of the tube up through the mercury and then pass into the transformer gas space. Glass tape, installed in the upper end of the center tube above the mercury column, filters the mercury from the air stream.

Shut-Off Valve—A three-way shut-off valve with blowout fitting, located above the breathing regulator, connects the breathing regulator to the gas space, above the transformer oil, through a pipe attached to the transformer tank. The three positions of the valve are as follows:

(1) Shut-off (clockwise). This shuts off the gas space and connects the breathing regulator to the blow-out fitting. This position is used to seal the gas space, and also for testing the operating pressure of the breathing regulator.

(2) Mid-position. In this position of the valve, the gas space, the breathing regulator, and the blow-out fitting are connected together. This position is used when it is desired to blow-out the gas space, initially with dry nitrogen. In blowing out the gas space, the sampling valve must be opened.

(3) Operating (counter-clockwise). In this position, the blow-out fitting is closed and the gas space is connected to the breathing regulator.

Sampling Valve—The sampling valve is a needle valve, connected to the gas space, above the oil, through a pipe attached to the tank wall. This valve is used as an exhaust valve in blowing-out the gas space. It may also be used for obtaining sample of the gas in the gas space for oxygen content analysis.

Pressure Alarm Switches—Pressure alarm switches are supplied only when ordered special. These switches are operated by pressure in the gas space and serve to give an alarm whenever the pressure or vacuum in the transformer is abnormally high. These switches are single-pole, double-throw so that the alarm circuit may be set up to either open or close on abnormal pressure or vacuum. These switches have approximately 2 pounds differential; that is, if high alarm operates, the pressure must fall 2 pounds for switch to reset; if low alarm operates, the vacuum must decrease 2 pounds for switch to reset. They can be reset by hand by pushing down on the bellows until the switch "clicks" for high alarm and pulling up for low alarm.

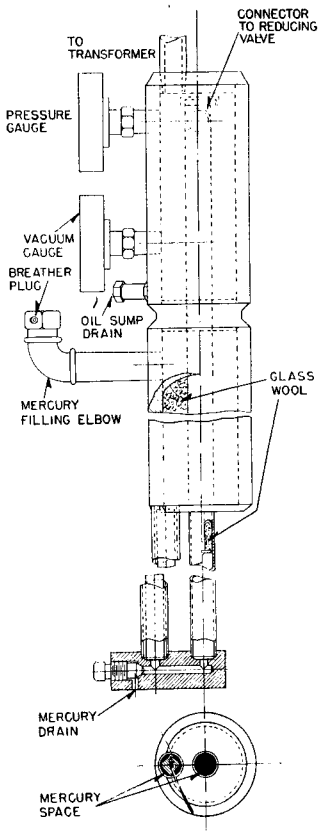

FIG. 1

Restricted Breathing Equipment—Continued

INSTRUCTIONS—Continued

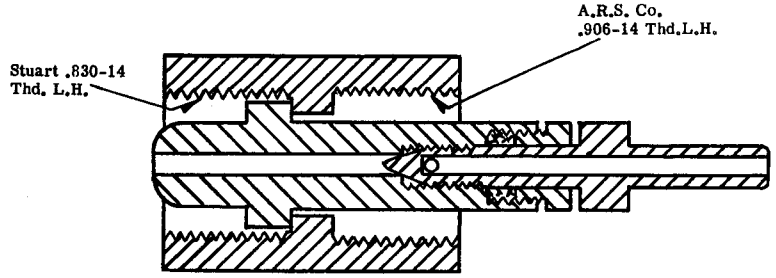

FIG. 2

De-oxygenation Fitting For Blowing Out—When the Restricted Breathing transformer is first put into service, air might be present in the space above the oil. It is desirable to start the transformer in service with inert gas above the oil so provision is made for blowing-out the gas space with nitrogen at the time the transformer is installed. The de-oxygenation fitting, Figure 2, is used to reduce the nitrogen pressure from 2,000 pounds per square inch in the cylinder to a convenient pressure which will safely and rapidly blow out the gas space. The union nut is made reversible so that one end will fit Air Reduction Sales Company and the other end Stuart Oxygen Company nitrogen cylinders. This pressure is variable by adjusting the needle in the stem.

INSTALLATION

Transformers with Mercury Breathing Regulators are usually shipped with the breathing regulator mounted on the transformer. To place in service it is only necessary to drain the oil sump and Mercury tube of any oil which might be present, fill the breathing regulator with mercury and make certain that all gasketed and pipe connections are tight.

The mercury for the breathing regulator should be poured through the filling elbow with vent plug removed. Care should be taken not to spill any mercury as it will attack solder, brass, and gold.

The blow-off pressure of the breathing regulator is determined by the amount and purity of the mercury. (Mercury can be cleaned by washing in benzene and filtering through several layers of cheese cloth). The blow-off pressure may be checked as follows: with the throttle plug screwed into the filling plug, seat the shut-off valve to shut-off (clockwise) and apply a dry air or nitrogen pressure at the blow-out fitting. The pressure indicated by the pressure gauge when the gas starts to flow from the throttle plug is the blow-off pressure. Add or drain mercury to obtain desired results. These small dial type pressure and vacuum gauges require a certain "start" pressure. The gauges should not be used for determining blow-out pressures of less than 5 pounds per square inch, since approximately 3 pounds pressure is required to move the pointer definitely off the pin. The vacuum at which the transformer breathes in is numerically one-half the blow-off pressure.

Oil in contact with gases will absorb or liberate the gases until the partial pressure of the gas within the oil equals that in the gas space. If oxygen is released when the oil is hot, it will be used up in oxidizing oil. If the oil is not hot, little oxidation takes place if oxygen is liberated into the gas space, and the oxygen content in the gas space increases. Thus, to assure that an explosive mixture is not present in the gas space when the unit is placed on the line, we recommend blowing out the gas space just before the unit is connected to the line.

CAUTION

Extreme care should be observed, when blowing out the gas space with nitrogen from a high pressure gas container, to permit the gas in the gas space

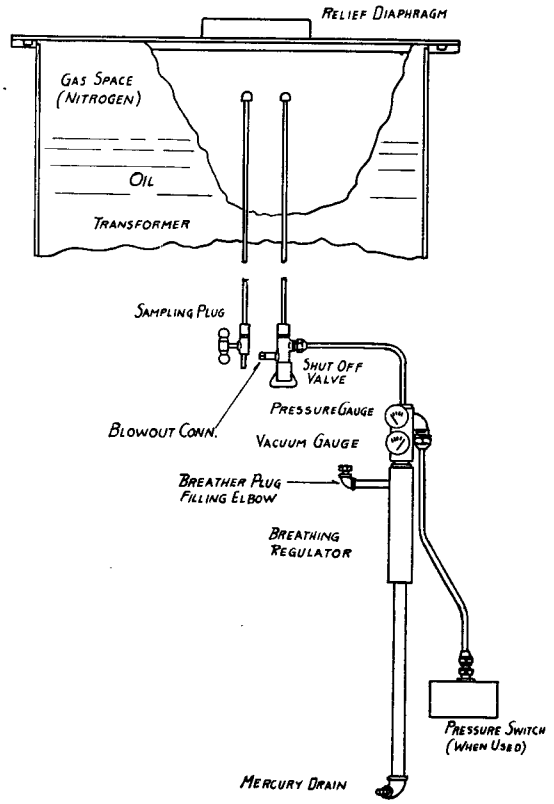

FIG. 3

Restricted Breathing Equipment—Continued

INSTRUCTIONS—Continued

to reach ambient temperature before sealing the tank off tight. The expansion of nitrogen from a very high pressure (1500 to 2000 pounds per square inch) to atmospheric pressure results in the nitrogen entering the gas space at a very low temperature. Unless the gas is free to expand as it warms up to ambient temperature, the pressure within the tank may increase to such a value as to rupture the relief diaphragm. If no diaphragm is provided, the pressure may distort the tank.

If the breathing regulator is connected to the gas space, it will relieve any pressures in excess of 10 pounds per square inch.

If oil gets on the Mercury, the breathing action will eventually form a Mercury-oil emulsion and the Mercury seal will become an oil seal. This is because the breathing operation forms tiny globules of Mercury which when coated with oil will not run together again. If this happens the breathing regulator can be cleaned with benzene or some other cutting solvent that will remove the oil. If emulsification has not gone too far, the Mercury also can be recovered this way.

MAINTENANCE

Drain the oil sump once a year to prevent any appreciable oil coming in contact with the mercury in the regulator.

Check blow-off pressure of breathing regulator to determine if mercury-oil emulsion may have occurred since last inspection. Refer to paragraphs under "Installation" for instructions.

RENEWAL PARTS

It is not likely that renewal parts will be required; but if so give description of part required and serial number or style number of transformer. Order from nearest Westinghouse Electric Corporation Office or direct from the Sharon, Pa., Works.

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September, 1945
Supersedes Issue dated May, 1945

Sealedaire Equipment

INSTRUCTIONS

GENERAL

Sealedaire is the Westinghouse name for a system in which the transformer tank is essentially tight, preventing breathing. The original oxygen content of the air in the tank is absorbed quickly into the oil, leaving inert gas above the oil.

A Mercury Breathing Regulator is supplied on the larger Sealedaire transformers. This regulator prevents breathing except under extreme conditions of load cycle and ambient temperatures.

Fittings are provided on the Mercury Breathing Regulator so that the gas space above the transformer oil may be blown out initially with Nitrogen. A sampling valve is also supplied so that the oxygen content of the gas space may be determined by the use of a gas analyzer.

BREATHING REGULATOR

The breathing regulator works on the U-Tube principle, with the area of one tube twice the other. Figure 1 shows a cross-sectional view of the regulator. The inner tube, operating as one leg of the U-tube, has twice the area of the space between the two tubes which acts as the other leg of the U-tube. Twice the pressure is required on the larger area to force the mercury to the bottom of the tube as is required on the smaller area. This makes it possible to obtain a range of 10 pounds pressure to 5 pounds vacuum in the transformer before any breathing takes place.

At atmospheric pressure, the levels of the two mercury columns are the same. As the pressure in the transformer increases, the mercury level in the inner tube is forced down with a rise in level of the other column of twice this value. At 10 pounds pressure, the mercury level in the inner tube reaches the bottom of the tube and any further increase in pressure causes the gas in the tube to bubble through the mercury, past the baffles and out into the outside air. Only enough gas is released to maintain 10 pounds pressure.

A breather or throttle plug in the air exhaust pipe, in addition to baffles and glass wool in the space above the mercury column, prevent loss of mercury in case of sudden increase in pressure within the transformer. The baffles and glass wool filters the mercury from the air stream and the throttle plug lowers the velocity of the air stream under extreme pressure conditions.

When the transformer cools, the pressure on the center tube decreases, and the atmospheric pressure forces the mercury down in the outside space, causing the center column to rise, until equilibrium is reached. With a 5 pound vacuum in the transformer the mercury in the outside space is at the bottom of the tube. Any further decrease in the pressure within the transformer (due to decrease in oil temperature) will result in the atmospheric pressure forcing air to bubble past the lower end of the tube up through the mercury and then pass into the transformer gas space.

The upper portion of the breathing regulator includes an oil sump to catch any oil which might be carried over into the piping from the transformer. This oil sump should be drained before putting the equipment in operation to prevent any appreciable oil coming in contact with the mercury of the breathing regulator.

On the side of the oil sump are mounted two dial type gauges. One indicates positive pressure in the gas space while the other indicates partial vacuum.

A three way shut-off valve with blow-out fitting, located above the breathing regulator, connects the breathing regulator to the gas space, above the transformer oil, through a pipe attached to the transformer tank. The three positions of the valve are as follows:

(1) Shut-off (clockwise). This shuts off the gas space and connects the breathing regulator to the blow-out fitting. This position is used to seal the gas space, and also for testing the operating pressure of the breathing regulator.

(2) Mid-position. In this position of the valve, the gas space, the breathing regulator, and the blow-out fitting are connected together. This position is used when it is desired to blow-out the gas space, initially with dry nitrogen. In blowing out the gas space, the sampling valve must be opened.

(3) Operating (counter-clockwise). In this position, the blow-out fitting is closed and the gas space is connected to the breathing regulator.

PRESSURE ALARM SWITCHES

Pressure alarm switches are supplied only when ordered special. These

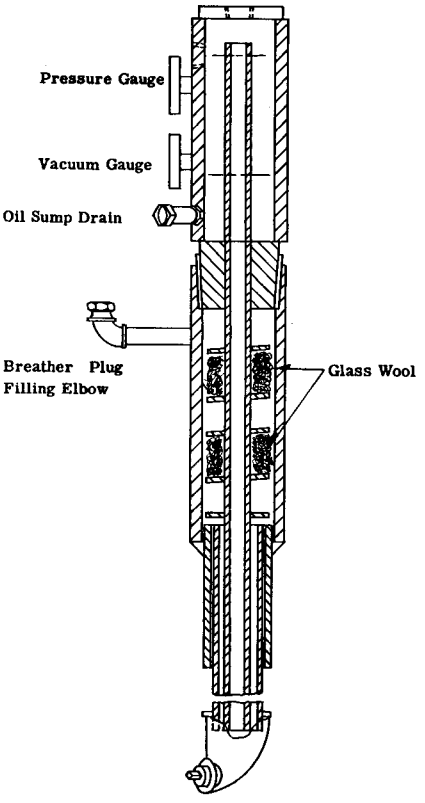


FIG. 1

Sealedaire Equipment—Continued

INSTRUCTIONS

switches are operated by pressure in the gas space and serve to give an alarm whenever the pressure in the transformer is abnormally high or abnormally low. These switches are single pole double throw so that the alarm circuit may be set up to either open or close on abnormal pressure

INSTALLATION

Sealedaire without Mercury Breathing Regulator requires no spe ial installation instructions other than to be sure that all gasketed and pipe connections are tight.

Sealedaire with Mercury Breathing Regulator is usually shipped mounted on the transformer. To place in service it is only necessary to drain the oil sump and Mercury tube of any oil which might be present, fill the breathing regulator with mercury and make certain that all connections are tight.

The mercury for the breathing regulator should be poured through the filling and vent plug. Care should be taken not to spill any mercury as it will attack solder and brass.

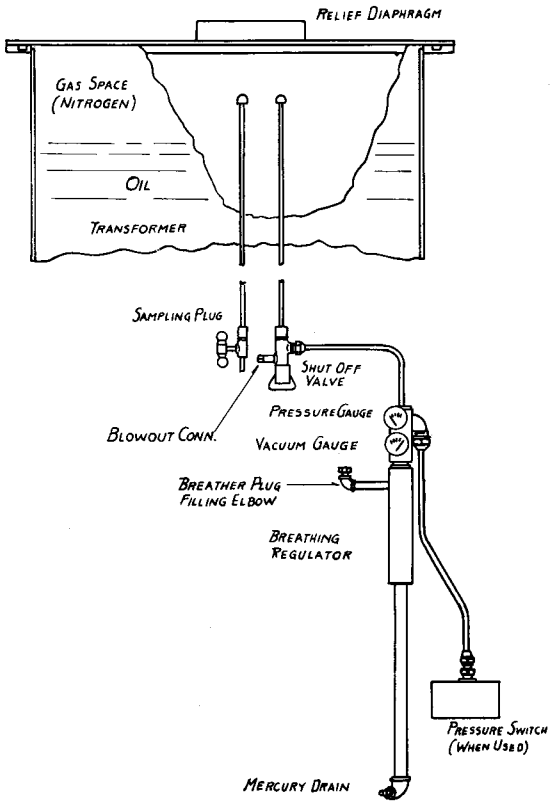
The blow-off pressure of the breathing regulator is determined by the amount and purity of the mercury. (Mercury can be cleaned by washing in benzene and filtering through several layers of cheese cloth). The blow-off pressure may be checked as follows: With the throttle plug screwed into the filling plug, seat the shut-off valve to shut-off (clockwise) and apply a dry air pressure at the blow-out fitting. The pressure indicated by the pressure gauge when the gas starts to flow from the throttle plug is the blow-off pressure. Add or drain mercury to obtain desired results. The vacuum at which the transformer breathes in is numerically one-half the blow-off pressure.

MAINTENANCE

Drain the oil sump once a year to prevent any appreciable oil coming in contact with the mercury in the regulator.

RENEWAL PARTS

It is not likely that renewal parts will be required but if so give description of part required and serial number or style number of transformer. Order from nearest Westinghouse Electric and Manufacturing Company Office or direct from the Sharon, Pa., Works.



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