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(54) **On-load tap changer.**

(57) An on-load tap changer of the present invention comprises a switch 18 including an arc interrupting unit 20, a vessel 16 containing therein the switch, an electrically insulating oil disposed within the vessel for electrically insulating the switch, and a closed oil passage loop 43 for circulating the insulating oil therealong. The loop includes a conduit 38 having an inlet at the bottom portion of the interior of the vessel, the conduit upwardly extending inside of the vessel and exiting from the upper portion of the vessel, extending through a position lower than the vessel, and connecting to an upper portion of the vessel, the conduit having formed therein a hole 44 at a position higher than the arc interrupting unit, the hole being inside of the vessel. A float valve 46 is provided in the vessel for closing the hole in the conduit when the level of the insulating oil within the vessel is at or higher than the hole and opening the hole when the level of the insulating oil within the vessel is lower than the hole.

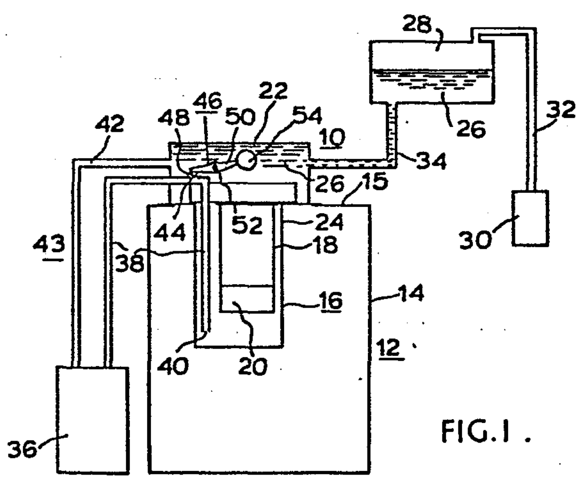

FIG.1.

EP 0 150 132 A2

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ON-LOAD TAP CHANGER

BACKGROUND OF THE INVENTION

This invention relates to an on-load tap changer, and more particularly, to an oil-cleaning system for an oil-filled on-load tap changer.

A diverter switch of a conventional on-load tap changer is basically a switch for switching a load current of a transformer to a preselected tap by the tap selector at zero current. In order to facilitate the extinguishing of an electric arc generated at the time of current commutation, the diverter switch is enclosed within a vessel filled with an electrically insulating oil. The insulating oil is gradually polluted and degraded as it is decomposed to form foreign materials such as carbon and sludge by the electric arcing upon each tap change, thereby degrading the electrically insulating properties. Therefore, the on-load tap changer for use with a high-voltage transformer is provided with an hot-line oil filter, which is a kind of a filter with a pump in it, and the insulating oil is filtered through the oil filter once a day as is well known in the art.

The conduit connecting the vessel for the diverter switch and the oil filter is arranged such that polluted oil at the bottom of the vessel of the tap-changer is suctioned into the conduit and pumped through the oil filter of the oil filter to return to the upper portion of the tap changer vessel. Since the tap changer is typically suspended from the top of the transformer tank, and the oil filter is positioned outside the transformer tank and is placed on the same level as the bottom of the transformer tank. Also, since the suction conduit from which the oil enters for cleaning is typically constructed and incorporated as one of the parts of the tap changer, the conduit rises from the bottom portion of the vessel and extends outwardly through the upper portion of the vessel which is secured to the upper tank of the transformer. Furthermore, since the vessel is suspended from the top plate of the transformer tank, the vessel is usually positioned at a level which is higher than that of the oil filter.

The conventional on-load tap changer thus constructed has the following disadvantageous characteristics.

When insulating oil leaks from the filter or the pump of the oil filter, the insulating oil within the conduits and the vessel flows out through the leak and the oil level within the vessel falls. This lowering of the insulating oil continues until the oil level reaches the level at the inlet of the suction conduit because the conduit has an inverted U-shape which causes the U-shaped conduit to function as a siphon conduit. Therefore, the oil leakage from the oil filter may cause most of the insulating oil within the tap-changer vessel to flow outside of the system. If the oil level becomes lower than the interrupting unit, then the arcs will not be extinguished, leading to short-circuits between the taps.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an on-load tap changer which is free from the above-mentioned drawback.

Another object of the present invention is to provide an on-load tap changer in which there is no risk of most of electrically insulating oil flowing out from the tap changer system.

A further object of the present invention is to provide an on-load tap changer in which there is no risk of the level of insulating oil falling due to an oil leak and the interrupting unit of the tap changer being exposed.

With the above objects in view, an on-load tap changer of the present invention comprises a switch including an arc interrupting unit, a vessel containing the switch, an electrically insulating oil disposed within the vessel for electrically insulating the switch, and a closed oil passage loop for circulating the insulating oil therealong. The loop includes a conduit having an inlet at the bottom portion of the interior of the vessel. The conduit upwardly extends inside of the vessel and exits from the upper portion of the vessel, extends through a position lower than the vessel, and connects to an upper portion of the vessel, the conduit having formed therein a hole at a position higher than the arc interrupting unit, the hole being positioned inside of the vessel. A float valve is provided in the vessel for closing the hole in the conduit when the level of the insulating oil within the vessel is at or higher than the hole and opening the hole when the level of the insulating oil within the vessel is lower than the hole.

In another embodiment of the present invention, a closed oil passage loop includes a first conduit which has an inlet at the bottom portion of the interior of the vessel, and which upwardly extends outside of the vessel and exits from a position higher than the arc interrupting unit and extends to a position lower than the vessel, and a second conduit connected to the first conduit to return the insulating oil to an upper portion of the vessel, and a small-diameter pipe connecting the first conduit at a position higher than the arc interrupting unit to the second conduit. The small-diameter pipe has an inside diameter sufficiently smaller than the inner diameter of the first conduit to permit most of the insulating oil supplied into the oil filter to be supplied from the inlet of the conduit at the bottom portion of the vessel rather than the upper portion of the vessel.

BRIEF DESCRIPTION OF THE DRAWING

The invention will become more readily apparent from the following detailed description of the preferred embodiment of the present invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagramatic view of an on-load tap changer constructed in accordance with the present invention; and

Fig. 2 is a diagramatic view of an on-load tap changer of another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An on-load tap changer 10 of the present invention is illustrated in Fig. 1 as being incorporated into an electrical power transformer 12 having a hermetic housing 14. The tap changer 10 comprises a hermetic vessel 16 within which a diverter switch 18 and an arc interrupter unit 20 are enclosed. The vessel 16 has an upper portion 22 and a lower portion 24 in communication with each other. The upper portion 22 of the vessel 16 is placed on the top plate 15 of the transformer housing 14 and the lower portion 24 of the vessel 16 is suspended into the interior of the transformer housing 14. The diverter switch 18 and the arc interrupting unit 20 are disposed within the lower portion 24 of the vessel 16. Therefore they are positioned within the transformer housing 14, but are isolated by the wall of the vessel 16 from the interior of the transformer housing 14.

The tap changer vessel 16 is substantially filled with an electrically insulating oil 26 in order to promote the quick extinction of the arc generated during tap changing. In order to absorb the volumetric expansion of the insulating oil 26 due to temperature changes, a conservater 28 connected to a breazer 30 by a conduit 32 is connected to the upper portion 22 of the tap-changer vessel 16 through a conduit 34. The tap changer 10 also comprises an oil filter 36 which includes a pump and a filter. It is seen that the bottom wall of the oil filter 36 is positioned at the same level as the bottom wall of the transformer housing 14 and therefore the oil filter 36 is positioned lower than the tap changer 10 which is positioned at the upper portion of the transformer housing 14.

The inlet of the oil filter 36 is connected to the bottom portion of the tap changer vessel 16 by a first conduit 38 having an inlet 40 at the bottom portion inside the tap changer vessel 16. The first conduit 38 has the shape of an inverted "U". This is because the tap changer 10 is typically designed as an assembled unit with at least part of the conduit 38 incorporated into the vessel 16 and it is not desirable to design the walls of the vessel 16 and the transformer housing 14 to be penetrated by the conduit 38. The outlet of the oil filter 36 is connected to the upper portion 22 of the tap changer vessel 16 through a second conduit 42. Thus, a closed oil passage loop 43 composed of the vessel 16, the inverted-U shaped conduit 38, the oil filter 36, and the second conduit 42 is formed.

According to the present invention, the inverted U-shaped conduit 38 has formed therein an air breezing hole 44 at its top portion. The hole 44 communicates the inside of the conduit 38 to the interior of the upper portion 22 of the tap changer vessel 16. The hole 44 can be closed by a float valve 46 comprising a valve 48 for fluid-tightly closing the hole 44, a rocking lever 50 carrying the valve 48 at its one end and pivotally supported at midpoint 52, and a float 54 supported on the other end of the lever 50. The float valve 46 is closed by the counterclockwise rotational moment on the lever 50 due to the buoyancy of the float 54 when the oil level is higher than a predetermined level, and is opened by the clockwise rotational moment due to the greater weight of the float 54.

In order to clean the insulating oil 26 of the tap changer 10, the pump (not shown) in the oil filter 36 is energized to suction the insulating oil 26 in the bottom portion of the tap changer vessel 16 from the inlet 40. It is to be noted that when the insulating oil 26 fills the upper portion 22 of the vessel 16, the buoyancy of the float 54 presses the valve 48 against the hole 44. Therefore, the insulating oil 26 is supplied into the oil filter 36 only from the inlet 40 at the bottom of the tap changer vessel 16 and no oil passes through the hole 44. The oil 26 supplied through the conduit 38 to the oil filter 36 passes through the filter (not shown) of the oil filter 36 to be cleaned. The filtered oil 26 is returned to the upper portion 22 of the vessel 16 and descend to the bottom portion of the vessel 16. Thus, the insulating oil 26 recirculates through the closed oil passage loop 43 composed of the vessel 16, the inverted U-shaped conduit 38, the oil filter 36, the conduit 42 and again the vessel 16. When the insulating oil 26 has been cleaned, the pump is deenergized.

If an oil leak occurs at the oil filter 36 which is lower than the bottom of the tap changer vessel 16, the insulating oil 26 within the tap changer vessel 16 flows out from the inlet 40 of the conduit 38 through the conduit 38 and from the leak in the oil filter 36. As the oil leak continues, the insulating oil 26 empties first from the conservator 28, and then the level of the insulating oil 26 within the upper portion 22 of the tap changer vessel 16 gradually descends. This gradual descending of the oil level causes the float 54 to also gradually descend due to gravity and when the oil level in the upper portion 22 of the tap changer vessel 16 reaches the hole 44 in the conduit 36, the float 54 cannot provide any force to press the valve 48 against the hole 44, thereby opening the air breazing hole 44 in the first conduit 38. Then, the air introduced within the vessel 16 from the breazer 30 flows into the small hole 44 to prevent the further lowering of the oil level in the tap changer vessel 16 because the insulating oil 26 in the upper portion 22 and the lower portion 24 of the vessel 16 is trapped in the vessel 16. The oil 26 within the section of the conduit 38 to the left of the small hole 44 and the oil in the oil filter 36 flows out through the leak in the filter 36. Therefore, even when an oil leak occurs in the oil filter 36, the insulating oil 26 around the arc interrupting unit 20 in the vessel is maintained.

As has been described, according to the present invention, the oil conduit has formed therein an air breazing hole at a position higher than the interrupting unit, and the hole can be opened by a float valve only when the insulating oil in the vessel is reduced to lower than the level of the hole in the conduit. Therefore, the insulating oil cannot be emptied from the tap changer vessel, thus preventing accidents such as short-circuiting among taps.

Fig. 2 illustrates another embodiment of the present invention, in which a closed oil passage loop 56 of this embodiment is different from the embodiment shown in Fig. 1 in that an inverted-U shaped first conduit 58 shown in Fig. 2 extends outside of the tap changer vessel 16 without passing through the upper portion 22 of the vessel 16. This design is often employed where space for the first conduit is not available within the tap changer vessel 16. The first conduit 58 has an inlet 60 in the bottom portion of the wall of the vessel 16 and extends through the top plate 19 of the tap changer 10. The first conduit 58 is communicated at a position higher than the interrupting unit of the tap changer through a flow resistance pipe 62 with a second conduit 64 having an outlet 65 connecting the oil filter 36 to the upper portion 22 of the vessel 16. The pipe 62 is designed to exhibit a very high flow resistance against the insulating oil 26 flowing therethrough as compared to the flow resistance in the section of the conduit 58 between the inlet 60 and the pipe 62. In the illustrated embodiment, the pipe 62 has a very small inner diameter compared to the inside diameter of the conduit 58.

In this embodiment, since the inner diameter of the pip 62 is sufficiently small compared to the inside diameter of the first conduit 58, the flow resistance of the small pipe 62 is very high compared to the flow resistance of the flow path in the conduit 58 through the inlet 60. Therefore, most of the insulating oil 26 supplied into the oil filter 36 is supplied from the inlet 60 at the bottom of the tap changer vessel 16 rather than from the upper portion

22 of the vessel 16 through the pipe 62 connected to the outlet end of the second conduit 64. The oil 26 supplied through the conduit 58 to the oil filter 36 passes through the filter (not shown) of the oil filter 36 to be cleaned. The filtered oil 26 is returned through the second conduit 64 to the upper portion 22 of the vessel 16 and descends to the bottom portion of the vessel 16. Thus, the insulating oil 26 recirculates through a closed oil passage loop 56 composed of the vessel 16, the first conduit 58, the oil filter 36, and the second conduit 64. When the insulating oil 26 has been cleaned, the pump is deenergized.

If an oil leak occurs in the oil filter 36 and the oil level in the upper portion 22 of the tap changer vessel 16 reaches the outlet 65 of the second conduit 64 which opens in the side wall of the upper portion 22 of the vessel 16, air introduced within the vessel 16 from the breazer 30 flows into the interior of the first conduit 58 through the outlet 65 of the second conduit 64 and through the small-diameter pipe 62, preventing further lowering of the oil level in the tap changer vessel 16 because the insulating oil 26 in the upper portion 22 and the lower portion 24 of the vessel 16 is trapped in the vessel 16. The oil 26 within the section of the conduit 38 to the left of the small-diameter pipe 62 and the oil filter 36 flows out through the leak in the filter 36. Therefore, even when an oil leak occurs in the oil filter 36, the insulating oil 26 around the arc interrupting unit 20 in the vessel is maintained.

While the present invention has been described in terms of a tap changer of a particular type, the invention may be equally applicable to on-load tap changer of other types such as a tap selector switch which has the functions of both a tap selector and a diverter switch.

What is claimed is:

1. An on-load tap changer comprising:

a switch including an arc interrupting unit;

a vessel containing said switch;

an electrically insulating oil disposed within said vessel for electrically insulating said switch;

a closed oil passage loop for circulating said insulating oil therealong, said loop including a conduit having an inlet at the bottom portion of the interior of said vessel, said conduit upwardly extending inside of said vessel and exiting from the upper portion of said vessel, extending through a position lower than said vessel and connecting to an upper portion of said vessel, said conduit having formed therein a hole at a position higher than said arc interrupting unit, said hole being positioned inside of said vessel; and

a float valve for closing said hole in said conduit when the level of said insulating oil within said vessel is at or higher than said hole and opening said hole when the level of said insulating oil within said vessel is lower than said hole.

2. An on-load tap changer as claimed in claim 1, wherein said switch comprises a diverter switch.

3. An on-load tap changer as claimed in claim 1, wherein said switch comprises a tap selector switch.

4. An on-load tap changer as claimed in claim 1, wherein said oil conduit includes an oil filter.

5. An on-load tap changer comprising:

a switch including an arc interrupting unit;

a vessel containing said switch;

an electrically insulating oil disposed within said vessel for electrically insulating said switch;

a closed oil passage loop for circulating said insulating oil therealong, said loop including a first conduit having an inlet at the bottom portion of the interior of said vessel, said conduit upwardly extending outside of said vessel and exiting from a position higher than said arc interrupting unit and extending to a position lower than said vessel, and a second conduit connected to said first conduit to return to an upper portion of said vessel; and

a pipe having a high flow-resistance connecting said first conduit at a position higher than said arc interrupting unit to said second conduit, said pipe having an inside diameter sufficiently smaller than the inner diameter of said first conduit to permit most of said insulating oil supplied into said oil filter to be supplied from said inlet of said conduit at the bottom portion of said vessel rather than from said upper portion of said vessel through said pipe.

6. An on-load tap changer as claimed in claim 5, wherein said switch comprises a diverter switch.

7. An on-load tap changer as claimed in claim 5, wherein said switch comprises a tap selector switch.

8. An on-load tap changer as claimed in claim 5, wherein said oil conduit includes an oil filter.

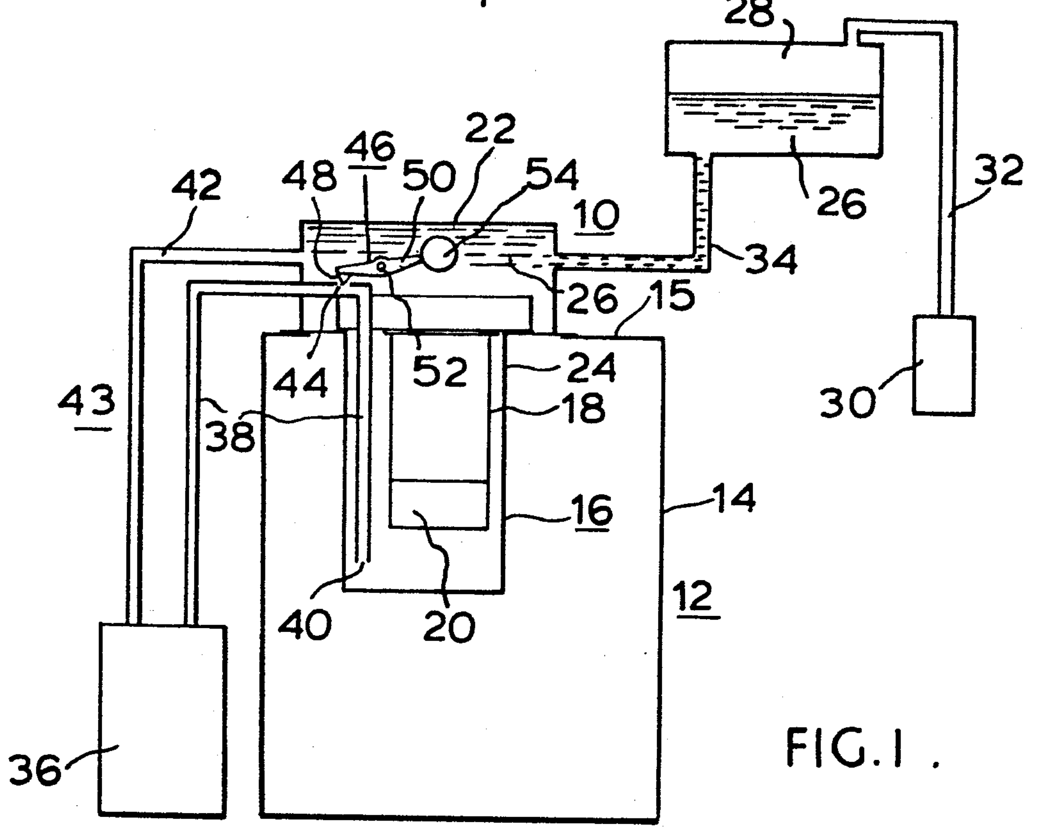
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FIG.1.

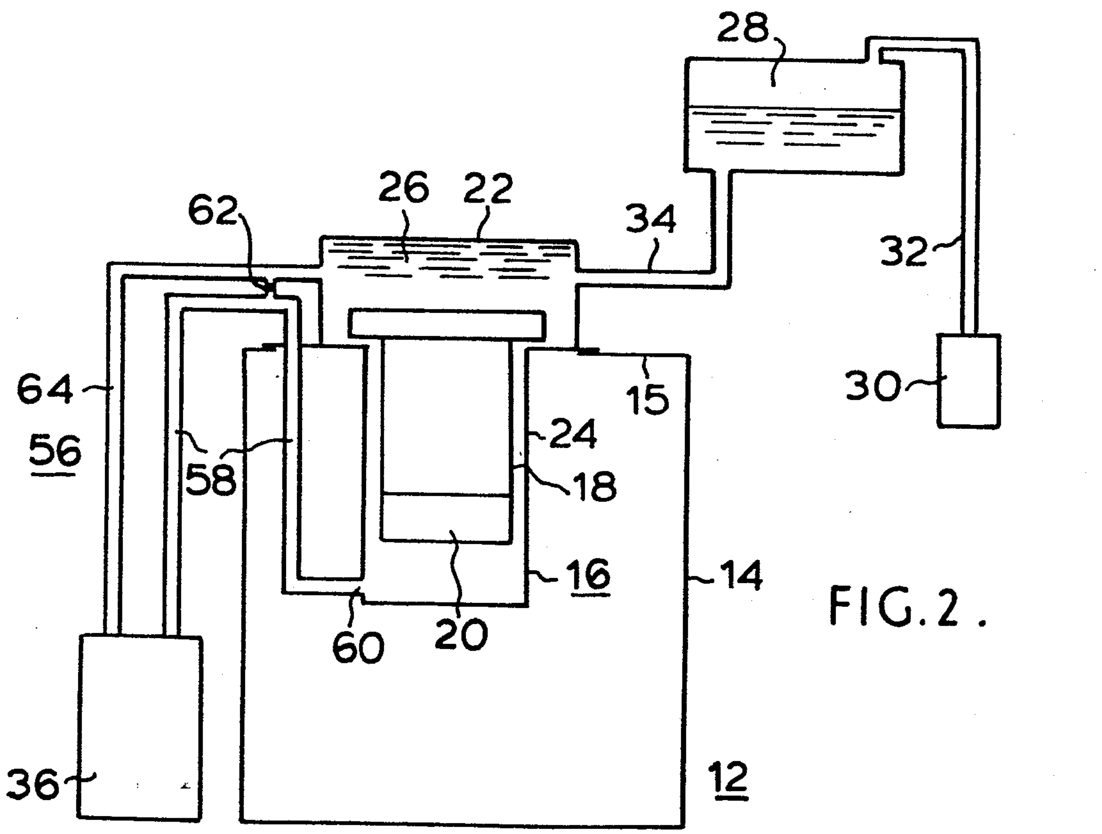
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FIG.2.