VENTILATED TRANSFORMER ENCLOSURE

A transformer enclosure includes a base structure, a wall secured to the base structure, and an airflow aperture located in a lower portion of the wall. A roof structure is secured to the wall and has an overhang portion extending beyond the wall outward from the enclosure. The overhang portion has a roof top panel and a roof bottom panel. The roof bottom panel has a roof airflow aperture. The transformer enclosure can include means for enclosing a volume and airflow means for cooling a transformer within the enclosed volume, where the airflow means includes a plurality of opposing channels.
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BACKGROUND

The invention generally relates to transformer enclosures. More particularly, the invention relates to the ventilation of transformer enclosures.

Transformers and other electrical devices are often housed in an enclosure. The enclosures are used for a variety of reasons, such as to provide mechanical protection to the transformer, as a safety measure to keep people and animals from coming into contact with electrical current, to provide easy mounting and inter-wiring of several electrical devices, and to protect electrical devices from the effects of the environment, e.g., rain, snow, temperature, and the like.

Transformer enclosures often accumulate heat produced by the transformer that could raise the temperature inside the enclosure to undesirable levels and cause damage to the electrical devices, or worse, fire. To compensate, an enclosure can include some form of ventilation to exhaust hot air from the enclosure and replace it with cooler air from outside the enclosure, thus maintaining an acceptable temperature range inside the enclosure. The configuration of these enclosures must admit enough cooling airflow without leaving the electrical devices therein vulnerable to effects of the environment.

SUMMARY

In one aspect of the invention, a transformer enclosure includes a base structure, a wall secured to the base structure, and an airflow aperture located in a lower portion of the wall. A roof structure is secured to the wall and has an overhang portion extending beyond the wall outward from the enclosure. The overhang portion has a roof top panel and a roof bottom panel. The roof bottom panel has a roof airflow aperture.

In another aspect of the invention, a transformer enclosure includes means for enclosing a volume and airflow means for cooling a transformer within the enclosed volume. The airflow means includes an airflow aperture in an underside of an overhang portion of a roof structure of the enclosure.
In another aspect of the invention, a transformer enclosure includes means for enclosing a volume and airflow means for cooling a transformer within the enclosed volume. The airflow means includes a plurality of opposing channels.

BRIEF DESCRIPTION OF THE DRAWINGS

Objects and advantages of the present invention will become apparent to those skilled in the art upon reading this description in conjunction with the accompanying drawings, in which like reference numerals have been used to designate like elements, and in which:

FIG. 1 depicts an embodiment of a transformer enclosure according to an embodiment of the invention; and

FIG. 2 depicts a side view of an enclosure according to an embodiment of the invention.

FIGs. 3A-C depict some exemplary configurations for the airflow apertures according to an embodiment of the invention.

FIG. 4 depicts an airflow aperture with an airflow adjustment means according to an embodiment of the invention.

FIG. 5 depicts an airflow aperture configured as a plurality of opposing channels that are offset.

FIG. 6 depicts an enclosure having one or more cooling fans according to an embodiment of the invention.

DETAILED DESCRIPTION

A transformer enclosure according to an embodiment includes means for enclosing a volume. FIG. 1 depicts an embodiment of a transformer enclosure 100 according to an embodiment of the invention. The transformer enclosure 100 includes a base structure 102. The base structure 102 may include means for supporting a transformer (not shown) within the enclosure, such as brackets 104. One or more walls 110 are secured to the base structure 102, typically at a bottom portion 112 of the wall 110. Here, the bottom portion 112 of the wall 110 can be at any portion near the bottom of the wall, and not necessarily the bottom edge. The wall 110 is preferably substantially perpendicular to the base structure 102, e.g., at an angle of approximately
90°, such as between 80°-100°. As will be appreciated, in other embodiments, the wall 110 and base structure 102 form an angle substantially different from 90°, such as 30°, 45°, 60°, 120°, 135°, 150°, and any of various angles therebetween. The wall 110 is preferably secured around the perimeter of the base structure 102. Alternatively, the wall 110 is secured at any point of the base structure 102.

Although a rectangular enclosure is depicted in FIG. 1, it will be understood that the enclosure wall 110 may form any of a number of geometric shapes, such polygonal, i.e., triangle, square, pentagon, etc., or can be circular, oval, elliptical, and the like. Moreover, any number of walls 110 may be employed. Support members (not shown) that extend from the base structure 102 can optionally be used to provide a structural frame for the enclosure 100 and/or to support the walls 110.

The enclosure 100 can preferably accommodate large transformers, such as transformers power rated for 113KVA - 15,000 KVA. These transformers produce a substantial amount of heat. For example, it is not unusual for the transformer to reach temperatures of 220° C.

The enclosure 100 preferably complies with National Electrical Manufacturers Association (NEMA) 250-1997 Standards. For example, under this standard, an enclosure of Type 3R is constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by the formation of ice on the enclosure. The enclosure may also be constructed to satisfy other specific types of the 250 standard, such as Type 1, 2, 3, 3S, 4, 4X, and 5.

The enclosure 100 includes airflow means for cooling a transformer within the enclosed volume. In one embodiment, the airflow means is an airflow aperture 150 in an underside of an overhang portion 142 of a roof structure 140 of the enclosure 110. The roof structure 140 is secured to the wall 110 and has an overhang portion 142 extending beyond the wall 110 outward from the enclosure. The roof structure 140 has a roof top panel 144 and the overhang portion has a roof bottom panel 146. The roof bottom panel includes the roof airflow aperture 150.

At least one of the walls 110 includes an airflow aperture 120, preferably at a lower portion of the wall 110. Here, a lower portion of the wall 110 means that most or
all of the aperture is positioned in the lower half of the wall 110. Some of the walls 110 do not have apertures, such as end wall 130. In FIG. 1, although three walls 110 are shown in the front of the enclosure 100, each with airflow aperture 120, some of these walls 110 may not include an airflow aperture 120. The same applies to walls on the sides and back of the enclosure 100.

With reference to FIG. 2, a side view of an enclosure 200 according to an embodiment of the invention is shown. The enclosure 200 includes airflow means for cooling a transformer 215 within the enclosed volume 210 of the enclosure 200. The heat produced by the transformer 215 causes convection airflow. That is, the heat given off by the transformer 215 rises to the top of the enclosed volume 210 and exits through a roof airflow aperture 250 on an underside of an overhang of roof structure 244. The reduction in pressure caused by the exiting heated air draws cooler air into the enclosed volume 210 through airflow aperture 220. The process continues as long as the air is heated by the transformer 215, which causes a continuous airflow through the enclosed volume 210 and over (and through) the transformer 215, thus cooling the transformer. Also depicted in FIG. 2, additional sides of the enclosure 200 can optionally include an additional airflow aperture 221 and/or roof airflow aperture 251 to increase airflow through the enclosed volume 210 and/or to provide airflow on additional sides of the transformer 215. The airflow aperture 220 is preferably located to guide the airflow into the enclosure 200 and through the center of the transformer cast coil.

FIGs. 3A-C illustrate some exemplary configurations for the airflow aperture 220 and/or the roof airflow aperture 250. The aperture 250 is sized to permit adequate airflow through the enclosure based on calculations for heat produced, enclosed volume, ambient or outside temperature, and other considerations. The aperture can be a single opening, or can be a plurality of openings 301. The aperture(s) can be an opening in the wall or roof structure or can be formed in a ventilation panel that is secured to an opening in the wall or roof structure. The aperture(s) may be of any shape and quantity. For example, one or more slit-shaped apertures 311 may be formed.

In another embodiment shown in FIG. 3C, the aperture(s) are configured as a plurality of offset members on a ventilation panel. The ventilation panel includes a
frame 321 and one or more members 322 displaced toward one side of the frame 321 and, in an alternating fashion, one or more members 323 displaced toward the other side of the frame 321. The offset members 322, 323 are opposingly displaced to form an offset configuration that allows air to enter while providing good mechanical protection. Alternatively, this offset configuration can be formed in the surface of the enclosure itself (without a frame) by bending, or otherwise displacing, members in opposite directions.

In a preferred embodiment shown in FIG. 5, the aperture(s) are configured as a plurality of opposing channels 500, 502 that are offset. One or more channels 500 include protruding air guides 501 and are configured facing one or more opposing channels 502 that also include protruding air guides 503. The channels 501, 502 are offset as shown so that air flows through the channels 501, 502 around the air guides 501, 503 as shown by the arrow 505. Objects, such as snow, rain, dirt, and other obstructions, are prevented from flowing through the aperture due to the offset and the S-shaped direction of the airflow 505. In addition, turbulence is created by the airflow around the air guides 501, 503, which further limits entry of foreign objects.

In another embodiment, depicted in FIG. 4, the airflow aperture 220 and/or the roof airflow aperture 250 has an airflow adjustment means to variably increase and decrease aperture dimensions, thereby increasing and decreasing airflow. One or more members 400 are rotatably attached to a frame 410, which could simply be the surrounding enclosure surface, and are connected via a linkage 420 to a control means 430 to change the angle of the members 400 to when a side-to-side force 440 is applied to the linkage. The change in angle of the members 400 adjusts the overall aperture size, which adjusts the airflow. The control means 430 can be manual, such as a handle, or automatic, such as motor driven. The configuration of FIG. 4 is exemplary. Many other configurations can be used to achieve similar functionality for adjusting airflow.

FIG. 6 illustrates another embodiment of the invention. In this embodiment, one or more cooling fans 610, 620 are installed near the airflow aperture and/or the roof airflow aperture to increase airflow through the enclosure. Alternatively, the cooling fans 610, 620 can be installed near only one of the apertures or can be installed at any point inside the enclosure that increases airflow.
The enclosure according to the invention is suitable for outdoor applications. Airflow apertures are positioned at an underside of the roof structure. This configuration allows airflow while minimizing environmental effects, such as rain, snow, dirt, blowing rain, etc., from penetrating into the enclosure through the roof airflow apertures.

It will be appreciated by those of ordinary skill in the art that the invention can be embodied in various specific forms without departing from its essential characteristics. The disclosed embodiments are considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims, rather than the foregoing description, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced thereby.

It should be emphasized that the terms "comprises", "comprising", "includes", and "including", when used in this description and claims, are taken to specify the presence of stated features, steps, or components, but the use of these terms does not preclude the presence or addition of one or more other features, steps, components, or groups thereof.
WHAT IS CLAIMED IS:

1. A transformer enclosure, comprising:
   a base structure;
   a wall secured to the base structure;
   an airflow aperture located in a lower portion of the wall; and
   a roof structure secured to the wall and having an overhang portion extending
   beyond the wall outward from the enclosure, the overhang portion having a roof top
   panel and a roof bottom panel, the roof bottom panel having a roof airflow aperture.

2. The transformer enclosure of claim 1, comprising:
   a plurality of walls, at least one including the airflow aperture at the lower
   portion.

3. The enclosure of claim 1, wherein at least one of the airflow aperture
   and the roof airflow aperture includes a plurality of airflow apertures.

4. The transformer enclosure of claim 1, wherein at least one of the airflow
   aperture and the roof airflow aperture includes a ventilation panel having a plurality of
   airflow apertures.

5. The transformer enclosure of claim 1, wherein at least one of the airflow
   aperture and the roof airflow aperture includes offset members.

6. The transformer enclosure of claim 1, wherein at least one of the airflow
   aperture and the roof airflow aperture includes a plurality of opposing channels.

7. The transformer enclosure of claim 1, wherein at least one of the airflow
   aperture and the roof airflow aperture includes an airflow adjustment means.

8. The transformer enclosure of claim 7, wherein the airflow adjustment
   means is motor driven.
9. The transformer enclosure of claim 1, comprising:
a fan configured to increase airflow through the enclosure.

10. A transformer enclosure, comprising:
means for enclosing a volume; and
airflow means for cooling a transformer within the enclosed volume,
wherein the airflow means includes an airflow aperture in an underside of an
overhang portion of a roof structure of the enclosure.

11. The transformer enclosure of claim 9, comprising:
means for supporting the transformer within the enclosed volume.

12. The transformer enclosure of claim 9, wherein the airflow means comprises:
an airflow aperture located in a wall of the enclosure.

13. The transformer enclosure of claim 9, wherein the airflow means comprises:
a fan configured to increase airflow through the enclosure.

14. The transformer enclosure of claim 9, wherein the means for enclosing a
volume comprises:
a plurality of walls, at least one including the airflow aperture at the lower
portion.

15. The transformer enclosure of claim 9, wherein the airflow means comprises:
a plurality of airflow apertures.

16. The transformer enclosure of claim 9, wherein the airflow means comprises:
a ventilation panel having a plurality of airflow apertures.
17. The transformer enclosure of claim 9, wherein the airflow means comprises:
    offset members.

18. The transformer enclosure of claim 1, wherein the airflow means comprises:
    a plurality of opposing channels.

19. The transformer enclosure of claim 9, wherein the airflow means comprises:
    an airflow adjustment means.

20. The transformer enclosure of claim 19, wherein the airflow adjustment means is motor driven.

21. The transformer enclosure of claim 10, wherein the enclosure meets NEMA 250-1997 standards.

22. The transformer enclosure of claim 21, wherein the enclosure is Type 3R.

23. A transformer enclosure, comprising:
    means for enclosing a volume; and
    airflow means for cooling a transformer within the enclosed volume,
    wherein the airflow means includes a plurality of opposing channels.