TRANSFORMER WITH IMPROVED ARRANGEMENT FOR PROVIDING A GROUNDING CONNECTION

Inventors: Chester A. Krasienko; Stanley G. Harmeyer, both of Fort Wayne, Ind.

Assignee: General Electric Company, Fort Wayne, Ind.

Filed: Feb. 2, 1973

Appl. No.: 328,890

U.S. Cl. 336/192, 174/51, 336/12, 336/92

Int. Cl. H01f 15/10

Field of Search 174/51; 336/192, 336/5, 12, 105, 92, 40

References Cited

UNITED STATES PATENTS

2,220,615 11/1940 Pittman et al. 174/51 X
3,435,125 3/1969 Krogh et al. 174/51 UX

Primary Examiner—Thomas J. Kozma
Attorney—Radford M. Reams et al.

ABSTRACT

A dry-type transformer including a housing with a core and coil assembly mounted in the housing. An electrically insulative terminal board is mounted in the housing and a plurality of terminals are mounted on the terminal board in spaced apart relationship to each other and to the housing. An elongated ground strap is selectively mounted to one of the terminals in first and second positions. One end of the ground strap is squared off and the other end has an attachment foot. When the ground strap is in its first position its squared off end is in interferring relationship with the adjacent edge of the terminal board and its attachment foot is spaced on the housing a distance at least equal to the normal spacing between the adjacent terminals. When the ground strap is in its second predetermined position the attachment foot is in juxtaposition to one wall of the housing and is bolted to the wall of the housing to provide electrical connection between the ground strap and the housing.

9 Claims, 6 Drawing Figures
TRANSFORMER WITH IMPROVED ARRANGEMENT FOR PROVIDING A GROUNDING CONNECTION

BACKGROUND OF THE INVENTION

When using fairly high voltage transformers it is desirable to ground the neutral or common terminal of the secondary winding of the transformer to a good, permanent ground, such as a water pipe for instance. It is also desirable to ground the housing or case of the transformer to the same permanent ground. If a short occurs within the windings of a transformer having such a grounding arrangement and the current to ground will cause the appropriate fuse or circuit breaker to trip. Also if something occurs which causes the transformer winding to become grounded to the housing the circuit breaker or fuse will trip. A case or housing ground connection which is external to the housing and visible is advantageous as it simplifies visual inspection for the proper grounding connection. It is also advantageous for the neutral or common terminal of the transformer secondary to be electrically connected to the case at ground potential so that both grounding functions are served by the one external ground connection. Thus, visible inspection for housing grounding also will determine whether the windings are also grounded.

In the past it has been common for transformer manufacturers to provide a stud or grounding bolt which is permanently attached to the case to provide for the external connection of the case to ground and also to provide a means for connecting the neutral conductors of the load cables to ground. It also has been a common practice for transformers to be shipped from the manufacturer with a flexible cable or braided lead connected from the neutral of one of the transformer windings to the grounding stud. One problem with such arrangements is that, in the event the flexible cable is not connected to the ground stud when the transformer arrives at a use site the windings will not be connected to the case. The installer may assume that the transformer windings are connected to the case and merely ground the case and then energize the windings. This can cause a dangerous situation to occur, if in fact, there also is a malfunction in the windings.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a transformer with a new and improved grounding arrangement.

It is a further object of the present invention to provide a new and improved transformer which may be shipped with all of the components necessary for connecting the windings to the case but with the connection not made.

It is still a further object of the present invention to provide such a new and improved transformer in which the windings will not become accidentally connected to the housing during shipment.

It is still a further object of the present invention to provide a new and improved transformer including winding connection components which are spaced from the transformer housing in one position and connectable to the transformer housing in another position.

The present invention, according to one embodiment thereof, provides a dry-type transformer including a housing with a coil and core assembly mounted therein. A terminal board of electrically insulative material is mounted in the housing. A plurality of terminals of electrically conductive material are mounted on the terminal board in spaced apart relationship to each other and to the housing to facilitate connection of the core and coil assembly to a source of electric energy and to a load. There is a ground strap and mounting means for selectively mounting the ground strap to one of the terminals in first and second predetermined positions. The length of the ground strap and the position with respect to the housing of the terminal to which it is connected are so interrelated that, when the ground strap is in its first predetermined position, it is substantially spaced from the housing and from other line or load terminals; and, when the ground strap is in its second predetermined position, it is in juxtaposition to the housing.

The above-mentioned and other features and objects of this invention, as well as one manner of obtaining them, will become more apparent, and the invention itself will be more fully understood by reference to the following description taken in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat schematic front perspective view of a three phase, dry-type transformer incorporating one form of the present invention, with the ground strap in a first predetermined position and with the front of the housing removed for purposes of illustration;

FIG. 2 is another somewhat schematic front perspective view of the transformer of FIG. 1, with the ground strap in a second predetermined position and with the front of the housing removed;

FIG. 3 is an enlarged, fragmentary view showing the ground strap in its first predetermined position and illustrating certain details of the ground strap and its interrelationship to the terminal board and one terminal;

FIG. 4 is an enlarged, fragmentary front elevational view illustrating the second predetermined position of the ground strap;

FIG. 5 is a plan view of the ground strap and shown in FIGS. 1-4; and

FIG. 6 is an electrical circuit diagram of a typical connection arrangement for a three phase transformer as illustrated in FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and more particularly to FIGS. 1 and 2 there is illustrated, in somewhat schematic form, a dry-type transformer 10. The illustrative transformer 10 is of the three phase type having three sets of windings 11, 12, and 13. Each of the windings sets 11-13 includes a primary winding and a secondary winding. The windings are mounted on a core generally illustrated at 14. The core 14 is supported on a generally c-shaped frame 15 which in turn is mounted to the base or bottom wall 16 of the transformer housing 17. The transformer housing also includes a pair of spaced-apart side walls 18 and 19, a top wall 20, a back wall and a removable front wall which, for purposes of illustration, has been removed.

The frame 15 normally is connected to the bottom wall 16 by some suitable means such as being bolted.
and resilient sound deafening pads may be positioned between the frame 15 and the wall 16. Often core clamps are used to hold the laminations of the core in a compact body. One such clamp is shown at 14a. The sound deafening pads may be positioned between frame 15 and the core clamps. The bottom wall is supported on a pair of angle irons 21 so that the housing and thus the transformer core and coil assembly is spaced above the supporting surface to allow free air flow around the transformer housing. Additionally, the bottom wall 16 and the front wall, which is not illustrated, may be lowered to provide for air flow within the transformer housing, as is well known in the art.

In smaller size transformers an elongated terminal board generally illustrated at 22 is mounted directly to c-frame 15 or is supported from the c-frame 15 or core clamp 14a by a pair of brackets, one of which is illustrated at 23. The terminal board extends generally between the side walls 18 and 19 and is constructed from a suitable electrically insulative material. By way of example a typical terminal board may be constructed of resin impregnated glass fibers. A number of terminals $H_1$, $H_2$, $H_3$, $X_1$, $X_2$, $X_3$, and $X_4$ are mounted to the terminal board in spaced apart relationship to each other and to the walls of the housing by some suitable means such as mounting bolts 24. The terminal closest to the side wall 19 is designated by the reference numeral $X_9$.

The illustrative transformer core and coil assembly is a typical three phase transformer in which normally the primary or input windings are connected in a delta fashion and the output windings are connected in a wye fashion. This connection arrangement is shown schematically in FIG. 6 in which the input windings 25, 26 and 27 are connected in delta fashion using the terminals $H_1$, $H_2$, and $H_3$ while the output windings 28, 29 and 30 are connected in a wye configuration using terminals $X_1$, $X_2$, $X_3$, and $X_4$ with the terminals $X_1$, $X_2$, and $X_3$, being connected to the distal ends of the output windings and the terminal $X_4$ being connected to the common or neutral ends of all of the windings 28-30. These connections are shown generally in FIGS. 1 and 2 by the leads 31.

Each of the terminals $H_1$, $H_2$, $H_3$, $X_1$, $X_2$, $X_3$, and $X_0$ extends below the lower edge of the terminal board 22 and may be provided with an opening therein for facilitating connection of appropriate terminals to a source of electric energy and to a load. It will be understood that a load may be one or more devices or circuits which are connected to the output of the transformer and that the transformer may in fact be either a step up or a step down transformer.

In order to provide for connection of the transformer core and coil assembly, and more particularly the secondary neutral terminal $X_9$ to the housing there is provided a ground strap 32. As best seen in FIG. 5 the ground strap 32 is formed from an elongated heavy gauge strip of electrically conducted material such as copper. The strap is squared off at one end 33 and has attachment foot 34 at the other end, which is bent so as to extend generally perpendicular to the main body of the strap. The strap includes an elongated opening 35 adjacent the squared off end 33 and the opening 35 extends generally parallel to the longitudinal axis of the main body of the ground strap. Additional openings such as those shown at 36 may be provided in the main body of the ground strap to facilitate attachment of the neutral conductor for cables which connect the transformer to one or more devices or circuits in the transformer load. Also, if desired, one of the openings 36 may be used for an internal attachment of a grounding conductor which leads to a water pipe or other ground. Additionally, there is an opening 37 provided in the attachment foot 34 for facilitating the connection of the ground strap 32 to the wall 19 of transformer housing 17.

The ground strap 32 is mounted to the $X_9$, terminal by suitable mounting means which conveniently may include a threaded bolt 38. The bolt may cooperate with a nut, not shown, for clamping the strap 32 and terminal $X_9$ together. Alternatively, if the terminal $X_9$ is of sufficient size, it may be threaded to receive the bolt 38 directly. In any event one or more lockwashers such as that illustrated at 39 may be included for assuring that the mounting of the ground strap to the terminal does not inadvertently become loose.

The ground strap is mounted to the terminal $X_9$ in first and second predetermined positions. The first predetermined position is illustrated in FIGS. 1 and 3 and in dashed line in FIG. 4 while the second position is illustrated in FIG. 2 and in solid line FIG. 4. The mounting bolt 38 extends through the elongated opening 35 so that the position of the ground strap with respect to the terminal $X_9$ may be adjusted. In either predetermined position of the ground strap the cooperation of the bolt 38 and elongated opening 35 assures proper longitudinal location of the ground strap. When the ground strap is in its first predetermined position the bolt 38 engages the ground strap at the end of opening 35 closest to its squared off end 33. When the ground strap is in its first position, the engagement of bolt 38 with the strap serves two functions. First, it assures that the squared off end 33 of the ground strap is in juxtaposition to the underside of terminal board 22, as best seen in FIG. 4, which prevents the ground strap from inadvertently turning about bolt 38. This prevents the ground strap from inadvertently coming into engagement with the side wall 19 or into engagement with another terminal such as the adjacent terminal $X_3$. The distance from the end of opening 35 to the attachment foot 34 is such that, when the ground strap is in its first predetermined position it is substantially less than the distance from the bolt 38 to bottom wall 16 of the housing. Thus, the ground strap is spaced substantially from the bottom wall of the housing as well as from side wall. Since the terminal board and the terminals are spaced inwardly of both the front and back of the housing the ground strap is substantially spaced from all portions of the housing. The various spacings involved are made such that, with the ground strap in its first position, the shortest distance between the ground strap and any part of the housing (normally between attachment foot 34 and bottom wall 16) is at least as great as the normal spacing between adjacent ones on the terminals.

A transformer normally is shipped with the ground strap in its first predetermined position. When the transformer is installed and it is connected to a source of electrical energy and to a load, the ground strap is moved from its first predetermined position to its second predetermined position by the installer. Since the squared off end 33 of the strap is in interference relationship with the underside of the terminal board 22, the bolt 38 must be loosened so that the strap may be moved away from the terminal $X_9$ and then rotated to its second predetermined position. Thereafter the bolt
3,760,314

5

38 is retightened. When the ground strap is in its second predetermined position the attachment foot 34 is in juxtaposition to the side wall 19 and a suitable connection means such as bolt 40, nut 41 and washers 42 are used to electrically connect the strap 32 to the wall 19. Convenienly the washers 42 are provided with integral teeth which dig into the material of the wall 19 and attachment foot 34 to assure a good electrical connection between the strap 32 and the wall 19. Since the strap is elongated and relatively wide a number of 10 openings such as those shown at 36 may be provided in the strap to provide convenient connections for the neutral conductors of cables interconnecting the transformer with a load and for an internal connection to ground if desired. When the ground strap is in its second predetermined position, engagement of the bolt 38 with the strap at the end of opening 35 closest to attachment 34 determines the minimum distance from the bolt 38 to the end of the attachment foot. The various components are designed so that this minimum distance is sufficient to assure that attachment foot 34 is in juxtaposition to housing wall 19 despite normal manufacturing tolerances.

With larger size transformers the terminals themselves become sufficiently large that a terminal board is not necessary in order to assure proper positioning of the terminals relative to each other and to the housing. The grounding arrangement as illustrated above is useful with such non-terminal board transformer constructions and will provide the components for interconnecting the transformer core and coil assembly to the transformer housing while assuring that such connections are not present during shipment. A mounting arrangement such as that generally illustrated by bolt 38 and lockwasher 39 normally will assure that the mounting strap does not move during shipment, even without a terminal board to cooperate with the squared off end 33 of the strap. However, if desired the appropriate terminal to which the strap is mounted may be provided with an integral ridge so that this additional feature of the present invention will be available with non-terminal board transformers.

While in accordance with the patent statute there has been described what at present is considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention. For instance, the exemplification transformer has the X terminal closest to the right hand side wall and thus the terminal arrangement is so positioned for connection to that wall. In other transformers the ground strap may be sized and positioned for selective connection to one of the other walls, normally the other side, the top or the bottom. For instance single phase transformers have no X terminal. Sometimes the mid point of a single phase winding is grounded to a water pipe and/or enclosure. In such an instance, the ground strip most conveniently would be designed for attachment to the bottom wall of the enclosure. It is applicant's intention in the following claims to cover all such equivalent variations as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A dry-type transformer, including:
   a. a housing;
   b. a core and coil assembly mounted in said housing;
   c. a terminal board of electrically insulative material mounted in said housing;
   d. a plurality of terminals of electrically conductive material mounted on said terminal board in spaced apart relationship to each other and to said housing to facilitate connection of said core and coil assembly to a source of electric energy and to a load;
   e. a ground strap, mounting means for selectively mounting said ground strap to one of said terminals in first and second predetermined positions;
   f. the length of said ground strap and the position of said one of said terminals with respect to said housing being so interrelated that, when said ground strap is in its first predetermined position, it is substantially spaced from said housing and, when said ground strap is in its second predetermined position, it is in juxtaposition to said housing.

2. A dry-type transformer as set forth in claim 1, wherein: the distance between said ground strap and said housing, when said ground strap is in its first predetermined position, is at least as great as the normal distance between adjacent ones of said terminals.

3. A dry-type transformer as set forth in claim 1, wherein: said ground strap has an interferring relationship with said terminal board when said ground strap is mounted to said one of said terminals such that said ground strap must be dismounted from said one of said terminals to be moved between its first and second predetermined positions.

4. A dry-type transformer, including:
   a. a plurality of walls defining a housing;
   b. a core and coil assembly mounted in said housing;
   c. a plurality of terminals of electrically conductive material mounted on said housing in spaced apart relationship to each other and to said housing to facilitate connection of said core and coil assembly to a source of electric energy and to a load;
   d. an elongated ground strap, mounting means for selectively mounting said ground strap to one of said terminals in first and second predetermined positions;
   e. the length of said ground strap and the position of said one of said terminals with respect to said housing being so interrelated that, when said ground strap is in its first predetermined position, it is substantially spaced from said housing and, when said ground strap is in its second predetermined position, it is in juxtaposition to said housing.

5. A dry-type transformer, as set forth in claim 4, wherein: the distance between said ground strap and said housing, when said ground strap is in its first predetermined position, is at least as great as the normal distance between adjacent ones of said terminals.

6. A dry-type transformer as set forth in claim 4, wherein: said ground strap defines an opening therein elongated in the direction of the longitudinal axis of said ground strap; said mounting means includes a bolt to be received in said opening; said bolt engaging said ground strap at one end of said opening, when said ground strap is in its first predetermined position, for assuring that said ground strap is substantially spaced from said housing and said bolt engaging said ground strap at the other end of said opening, when said ground strap is in its second predetermined position, for assuring that said ground strap is in juxtaposition to said housing.

7. A dry-type transformer, including:
a. a plurality of walls forming a housing;
b. a core and coil assembly mounted in said housing;
c. an elongated terminal board of electrically insulative material mounted in said housing and extending generally perpendicular to one of said housing walls;
d. a plurality of terminals of electrically conductive material mounted on said terminal board in spaced apart relationship to each other and to said housing to facilitate connection of said core and coil assembly to a source of electric energy and to a load;
e. an elongated ground strap, said strap being squared-off at one end and having an attachment foot at its other end;
f. mounting means for selectively mounting said ground strap to the one of said terminals closest to said one of said housing walls in first and second predetermined positions;
g. said ground strap, when in its first predetermined position, extend from said one of said terminals in spaced relationship to said housing and generally parallel to said one housing wall and said attachment foot of said ground strap being in juxtaposition to said one housing wall when said ground strap is in its second predetermined position.

8. A dry-type transformer as set forth in claim 7, further including connection means for forming an electrical connection between said attachment foot and said one housing wall when said ground strap is in its second predetermined position.

9. A dry-type transformer as set forth in claim 7, wherein: said ground strap defines an opening therein adjacent said one end thereof and elongated in the direction of the longitudinal axis of said ground strap; said mounting means includes a bolt to be received in said opening; said bolt engaging said ground strap at the end of the opening closest to said one end of said ground strap, when said ground strap is in its first predetermined position, to assure that said one end of said ground strap is in juxtaposition to said terminal board and that said attachment foot is spaced from said housing; and said bolt engaging said ground strap at the end of the opening remote from said one end of said ground strap, when said ground strap is in its second predetermined position, to assure that said attachment foot is in juxtaposition to said one housing wall.

* * * * *