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STATIONARY INDUCTION APPARATUS

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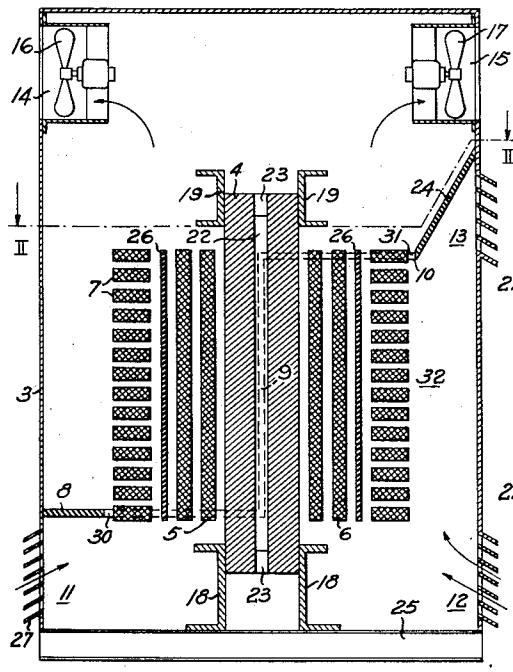


Fig. 1

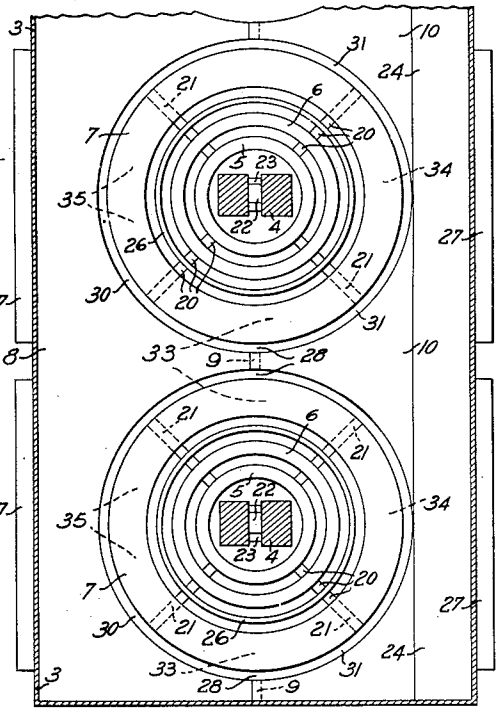


Fig. 2

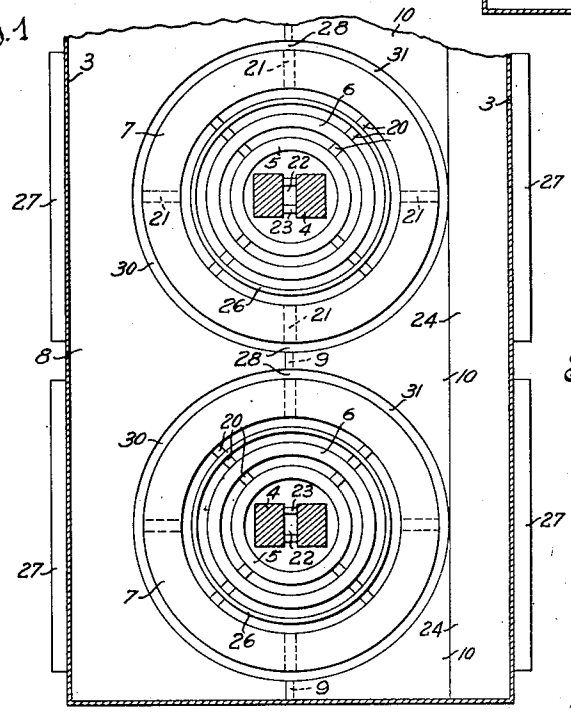


Fig. 3

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STATIONARY INDUCTION APPARATUS

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9 Claims. (Cl. 175—361)

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This invention relates in general to stationary induction apparatus and more particularly to a cooling and ventilating system for encased stationary induction apparatus of the type including transformers, reactors and the like.

In prior art systems for encased transformers, air under pressure has been permitted to flow between the windings in order to provide for a more rapid cooling of the transformer, motor driven fans being used to provide the movement of air. The efficiency of these prior art cooling systems was limited by the restrictions to the air flow caused by the baffle arrangement utilized for directing of the air flow through the windings and this was especially true when windings had both vertical and horizontal passageways. The restrictions to air flow found in prior art baffle arrangements prevented efficient self-cooling of the windings when the forced air circulation was not in operation.

It is an object of the present invention to provide an improved cooling and ventilating structure and system in stationary induction apparatus such as transformers and the like, that will avoid the above disadvantages.

It is also an object of the present invention to provide encased electrical apparatus of the above type with baffle means dividing the casing so that an efficient flow of air may be obtained either with natural or forced flow.

It is also an object of the present invention to provide a baffle arrangement for encased electrical apparatus of the above type which will provide efficient air flow through both longitudinal and lateral passageways between portions of the windings.

It is also an object of the present invention to provide a baffle structure for encased electrical apparatus of the above type, which baffle structure is unsymmetrical with respect to the apparatus windings so as to provide a turbulent flow of air through the lateral passageways in the apparatus.

Objects and advantages other than those above set forth will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic showing of an encased transformer illustrating an embodiment of the present invention;

Fig. 2 is a section view taken on the line II—II of Fig. 1; and

Fig. 3 illustrates a modification of the embodiment shown in Figs. 1 and 2.

The invention is illustrated in the drawings in

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an exemplary manner by a diagrammatic showing of an encased transformer which comprises generally a casing 3 and a core member 4 supported therein by the frame members 25, 13 and 19. The windings 5, 6 and 32 are shown as surrounding the core member, the windings 5 and 6 being illustrative of a divided low voltage winding wound in cylindrical form, and the winding 32 being shown as a spaced stack of disk coils 7 which illustrate a high voltage winding.

The winding 5 is shown as spaced from the core 4 and the windings 5, 6 and 32 are shown as spaced from each other and from the insulating barrier 26 by means of spacers 20 to provide vertical or longitudinal passages adjacent each of the windings. The coils 7 of the winding 32 are spaced by means of spacers 21 to form lateral or horizontal passages therebetween. The core 4 is split into two sections spaced apart by spacers 23 to form a passageway 22 between the two sections.

The casing 3 is divided into two portions by means of baffle structure, of a modified Z-shape in cross section and composed of elements 8, 9 and 10 arranged so that the passage 22 through the core and the passages between and adjacent the windings 5, 6 and 32 extend from one portion of the casing to the other. The lower baffle 8 extends from one side of the casing 3 to substantially the center line of the multiple cores, surrounding the left half of the windings as shown in Figs. 2 and 3, but leaving a passageway 30 between the baffle and the winding 32. The upper baffle 10 extends in a generally similar manner from the right hand side of the casing 3 to the center line of the multiple cores and surrounds the right half of the windings 32, leaving a passageway 31 therebetween. The division of the casing into two portions is completed by vertical baffles 9 connecting the inner edges of the baffles 8 and 10 where they extend to the center line of the cores. The baffle 9 is spaced from the windings 32 to provide passageways 28.

The lower portion of the casing is provided with openings 11, 12 and 13 which are shown as protected by louvers 27. The upper portion of the casing is shown as having openings 14 and 15 adjacent which are mounted motor driven fans 16 and 17. Additional openings may be provided in the bottom of the transformer. The portion 24 of the baffle 10 is placed at an angle so as to prevent contact with the winding 32, either accidental or otherwise, through the louvers 27 at the opening 13.

The windings 5, 6 and 32 are symmetrical

about the longitudinal plane through the multiple cores. By reason of the modified Z-shaped baffle structure, the flow of air through the longitudinal and lateral passages is not symmetrial with respect to the longitudinal plane through the multiple cores. With either one or both of the fans 14 or 15 in operation, air entering the inlets 11, 12 and 13 flows through the vertical and horizontal passages in a different manner on the right hand side of the windings than on the left hand side as viewed in Fig. 1. The dissimilarity of air flow on the two sides of the transformer provides a greater turbulence and cross flow than would be provided if symmetrical air flow was utilized, that is, with baffles 8 and 10 both at the top of the coil stack or at the bottom thereof.

On the left hand side of the transformer, the baffle 8 restricts the flow of air so that a relatively small amount passes up around the outside of the winding 32, most of the air flowing through the vertical passages, and some of the air from the vertical duct between the barrier 26 and the winding 32 flowing outwardly through the lateral passages between the coils 7. On the right hand side of the transformer, the baffle 10 being at the top of the stack, does not restrict the flow of air entering into the lateral passages between the coils 7. The flow of air in and through the winding passageways is quite complex and the exact direction of all the air currents will depend upon various factors such as the number and positioning of the spacers, the relative size of the various passageways and the thermal differences existing throughout the core and coils. Tests have proved conclusively that the dissimilar flow of air produced by the modified Z-shaped baffle structure is more efficient than with a straight horizontal cross baffle providing similar air currents on each side of the transformer.

As stated above, the number and positioning of the spacers 20 and 21 affects the cross flow of air between the coils 7. In Fig. 2 the spacers 20 and 21 are all shown as positioned on the same radial lines but not on a radial line through a longitudinal plane through the center lines of the cores. The cross flow of air in the lateral passages may take various paths. As seen from Fig. 2, air may enter the spaces 33 between the coils 7 from the right hand side of the transformer and flow across the windings to the left hand side. Air may enter the spaces 34 and circulate therein and pass up through the opening 31 or up through the vertical duct between the barrier 26 and the winding 32. If the spacers 20 between the winding 32 and the barrier 26 do not extend the full length of the vertical passage, the cross flow of air from the spaces 34 to the spaces 33 and 35 may take place by utilizing the vertical duct between the barrier 26 and the windings 32 to flow around the spacers 21. The spacers 20 between the winding 32 and the barrier 26 may be positioned only at the ends of the coil stack, or may be omitted if the winding 32 is supported at the outer side thereof. The cross flow of air also takes place around the outside of the winding 32 through the vertical passages 23 extending the full length between the vertical baffle 9 and the windings 32.

In Fig. 3 the entire structure is similar to that in Fig. 2 except for the positioning of the spacers 21. These spacers 21 are not on the same radial lines as the spacers 20, but are on the radial line through a longitudinal plane through the center

lines of the multiple cores. In this modification the spacers 20 between the winding 32 and the barrier 26 may also be full length, partial length, only at the ends of the coil stack or omitted altogether and, therefore, air flowing across the winding from the right to the left may utilize the vertical duct between the winding 32 and the barrier 26 as a part of the lateral passage around the spacers 21.

With the fans 14 and 15 deenergized, air will flow through the vertical and horizontal passages due to the fact that the coil stack is hotter at the top than at the bottom and the opening 13 may become an outlet or a partial outlet rather than an inlet. The flow of air is decreased with the fans deenergized, however, the circulation of air through the lateral passages will not be restricted as would be the case if the dividing baffle were entirely in one horizontal plane.

Although but two embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. Stationary induction apparatus comprising a core provided with windings thereon, said windings being spaced to provide lateral and longitudinal passages therebetween, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof for the flow of cooling fluid through said passages, and means for separating said first and second casing portions, said means comprising a baffle structure having a substantially step-shaped cross section in a plane normal to said longitudinal plane, said baffle structure extending between walls of said casing, whereby the flow of cooling fluid through said passages is dissimilar on opposite sides of said longitudinal plane.

2. Stationary induction apparatus comprising a core provided with windings thereon, said windings being spaced to provide lateral and longitudinal passages therebetween, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof, and means for separating said first and second casing portions, said means comprising a baffle structure having a modified Z-shaped cross section in a plane substantially normal to said longitudinal plane.

3. Stationary induction apparatus comprising a core provided with windings thereon, said windings being spaced to provide lateral and longitudinal passages therebetween, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and said windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof, and a baffle structure having a substantially step-shaped cross section in a plane normal to said longitudinal plane, said baffle structure extending between walls of said casing and having an aperture in alignment with said longitudinal passages,

the edge of said aperture being adjacent said windings whereby said baffle and said windings cooperate to separate said casing portions, said longitudinal passages providing a rectilinear path for the flow of cooling fluid between said casing portions.

4. Stationary induction apparatus comprising a core and windings thereon, a casing surrounding said core and windings, a baffle structure extending between walls of said casing and said windings and dividing said casing into two portions having substantially L-shaped interlocked cross sections, one of said casing portions being provided with an inlet and the other said casing portion being provided with an outlet, and means for spacing said windings to form passageways therebetween extending from one to the other of said casing portions.

5. Stationary induction apparatus comprising a core provided with windings thereon, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof, means for separating said first and second casing portions, said means comprising a baffle structure having modified Z-shaped cross section in a plane normal to said longitudinal plane, and means for spacing said windings to form a longitudinal passageway therebetween extending from said first casing portion to said second casing portion and a lateral passageway extending from said longitudinal passageway to said first and second casing portions.

6. Stationary induction apparatus comprising a core provided with windings thereon, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof, means for separating said first and second casing portions, said means comprising a baffle structure having a substantially step-shaped cross section in a plane normal to said longitudinal plane, said baffle structure extending between walls of said casing, and means for spacing said windings to form a longitudinal passageway extending from said first casing portion to said second casing portion and a lateral passageway extending from said longitudinal passageway to said first and second casing portions, whereby the flow of cooling fluid through said lateral passageway is dissimilar on opposite sides of said longitudinal plane.

7. Stationary induction apparatus comprising a core provided with windings thereon, said windings being arranged substantially symmetrically about a longitudinal plane through said core and windings, a casing surrounding said core and said windings and provided with an inlet in a first portion thereof and an outlet in a second portion thereof, means for spacing said windings to form a longitudinal passageway therebetween extending from said first casing portion to said second casing portion and a lateral passageway extending from said longitudinal passageway to said

first and second casing portions, and a baffle structure having a substantially step-shaped cross section in a plane normal to said longitudinal plane, said baffle structure extending between walls of said casing and having an aperture in alignment with said longitudinal passageway, the edge of said aperture being adjacent said windings, whereby said baffle and said windings cooperate to separate said casing inlet and outlet portions, said longitudinal passage forming a rectilinear path for the flow of cooling fluid between said casing portions.

8. Stationary induction apparatus comprising a core and windings thereon, a casing surrounding said core and windings, a baffle structure extending between walls of said casing and said windings and dividing said casing into two portions having substantially L-shaped interlocked cross-sections, one of said casing portions being provided with an inlet and the other said casing portion being provided with an outlet, and means for spacing said windings to form a longitudinal passageway therebetween extending from one to the other of said casing portions and a lateral passageway extending from said longitudinal passageway to said casing portions.

9. Stationary induction apparatus to be cooled alternately by natural flow or forced flow of cooling fluid, said apparatus comprising a core and windings thereon, a casing surrounding said core and said windings, an inner baffle structure between walls of said casing and said windings and dividing said casing into a lower portion and an upper portion, means for separating said windings to form a passageway therebetween extending from one to the other of said casing portions, the lower part of a wall of said casing lower portion being provided with an inlet and a wall of said casing upper portion being provided with an outlet for the natural flow of cooling fluid through said inlet, said passageway and said outlet, the upper part of an outer wall of said casing defining said lower portion being provided with an aperture, said aperture cooperating with said inlet for the inflow of cooling fluid circulating by forced flow through said passageway and said outlet, said aperture cooperating with said outlet for the outflow of cooling fluid circulating by natural flow through said inlet and said passageway.

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