June 27, 1967 V. B. HONSINGER 3,328,735

ELECTRICAL TRANSFORMER

Filed March 15, 1965

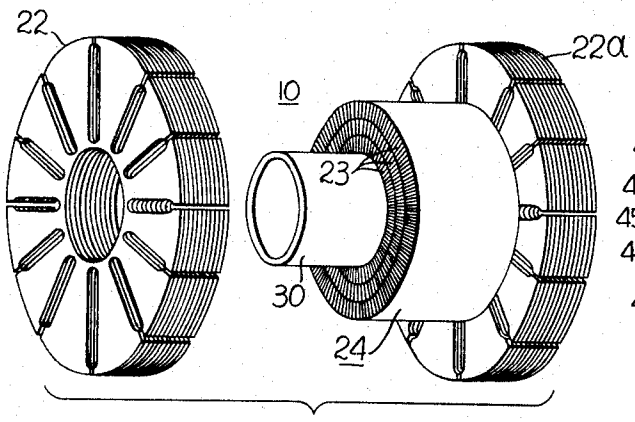


Fig. 1

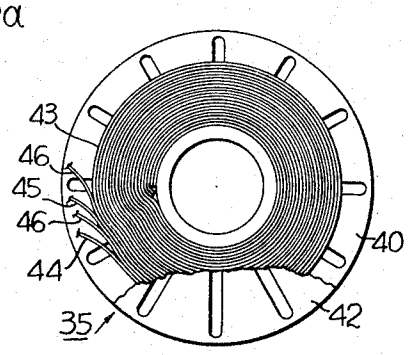


Fig. 3

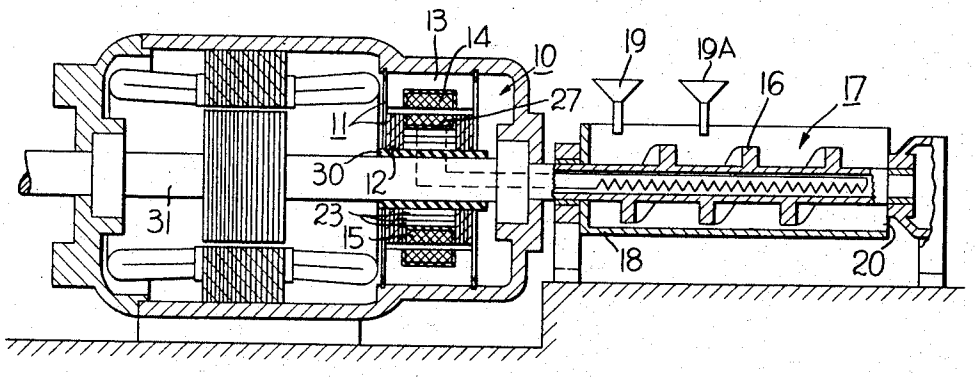


Fig. 2

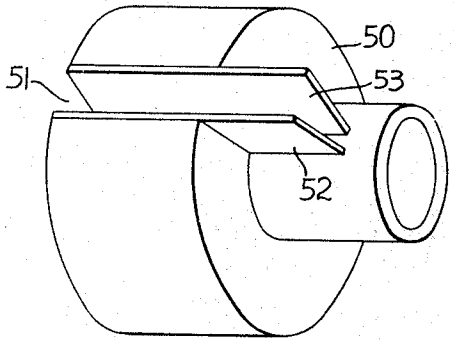


Fig. 4

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ELECTRICAL TRANSFORMER

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This invention relates to transformers and more specifically to a rotatable transformer in which the secondary winding of the transformer can be rotated and is adapted to be connected to a rotating load.

Rotatable transformers are used for the purpose of transferring electric current and power from a stationary member to a rotating member. Hence, rotating transformers are used as exciters to provide electrical energy to the field of an AC generator, to provide electrical power to illuminate a rotating structure such as a carrousel or to heat a rotating member such as a screw type conveyer used in certain chemical processes.

There are various methods of transferring electrical power from a stationary member to a rotating member such as a conventional exciter and contacts between a stationary and rotating member. However, both of these devices have drawbacks which restrict their use. For example, in the conventional exciter there is a magnetic flux linkage between the rotating and stationary members and the frequency of the voltage on the rotating member is dependent on the speed of the rotor and relative motion between the two members and, hence, is subject to considerable fluctuation. In the second method mentioned, current is transmitted between a rotating member such as a commutator or slip ring and a stationary member such as a carbon brush. In this system there is very little power loss and the frequency of the voltage of the transfer power is not dependent on the speed of relative motion. However, there is always a certain amount of sparking between the stationary and movable parts as well as a certain amount of wear and carbon dust formed. Hence, this type of structure is completely unacceptable under certain conditions such as an explosive atmosphere or in places where strict requirements are in effect as far as dust and the like are concerned. Hence, the use of sliding contacts are unacceptable in many industries such as the chemical and petrochemical industries.

The rotating transformers of the prior art are usually made of solid cores or annular laminations of iron. However, both of these cores provided a very high reluctance path for the magnetic flux. In order to obtain the current and voltage required for industrial use of these transformers, excessive heat was generated which in turn decreased the flux carrying capacity of the cores and rendered the transformers unacceptable.

The transformer of this invention overcomes the problems mentioned above by providing a magnetic core in which the individual laminations extend generally in a direction to provide a low reluctance path around the coils of the transformer. To accomplish this the iron laminations of the core are positioned so that the flat portion of the laminations extend generally parallel to the direction of the flux rather than transverse to it.

Therefore, it is the object of this invention to provide a new and improved transformer.

Another object of this invention is to provide a new and improved rotatable transformer.

Another object of this invention is to provide a new and improved core structure for a rotating transformer.

Other objects and advantages will be apparent from the following description when read in connection with the accompanying drawing, in which:

FIG. 1 is an exploded perspective view of a rotatable core of a rotating transformer of this invention;

FIG. 2 is a cross section view of a motor driven unit utilizing the transformer of this invention to provide current to a rotating heating element;

FIG. 3 illustrates an alternate embodiment of a rotating core for a transformer of this invention using a spirally wound coil, and

FIG. 4 is another embodiment of this invention showing a solid core with a portion cut that is used as both core and coil.

Referring more particularly to the drawings by characters of reference, the invention is illustrated in FIGS. 1 and 2 in connection with a rotatable transformer **10** having a core **11** made up of a rotating member **12** and a stationary member **13**. In the unit illustrated in FIG. 2, the rotating member is driven by an electric motor. Appropriate primary and secondary coils **14** and **15**, respectively, are wound in the core between the members **12** and **13**. The primary coil **14** which is stationary is connected to a suitable source of alternating current. The secondary coil **15** rotates with rotating core member **12** and is connected to a load such as the illustrated screw **16** of a conveyer **17** for moving and mixing materials. The conveyer has a tank **18** with two inlets **19**, **19***a* and a discharge **20**.

The stationary core member **13** can be of any suitable construction such as illustrated and described in copending United States patent application, Ser. No. 377,822 filed June 24, 1964. The laminations of the core are arranged to form an annular member and each lamination is positioned in a plane that includes the center line of the core. The leg portions of each lamination extend radially inward toward the center line of the core. The connecting portions of each the U-shaped laminations extend longitudinally parallel to the axis of the core.

The rotating member **12** of the illustrated core **11** is constructed of two axially spaced sets **22**, **22***a* of annular laminations and a plurality of arcuately spaced laminations **23** that lie in a plane that includes the center line of the core. These laminations **23** are arranged in side by side relation to form an annular member **24** that extends between the sets **22**, **22***a* of annular laminations. The annular laminations lie in a plane perpendicular to the axis of the core and the laminations **23**.

The sets **22**, **22***a* and the annular member **24** combine to form therebetween a torus **27** for housing the secondary windings or coil **15** of the transformer. A similar torus may be formed in the stationary core member. As illustrated in the drawing, the torus is rectangular in cross section and when viewed in a plane including the center line of the core it presents a rectangular winding window. Of course, the specific configuration of the winding window is not critical to this invention.

The secondary coil **15** of the transformer is wound or positioned within the torus **27**. The primary winding or coil **14** is wound in a similar torus in the stationary member **13**. The coils are concentric both with each other and with the core members. As with any conventional transformer, the coils can be used interchangeably as primary or secondary coils depending on the way they are connected. A nonmagnetic sleeve **30** may be positioned over the shaft **31** to confine the flux path to the core **11**.

For ideal transformer operation, each lamination should form a continuous uninterrupted path around the coils, and adjacent laminations should lie in substantially parallel planes to provide a magnetic path of minimum reluctance. In a rotating transformer it is impossible to provide these ideal conditions, but in the rotating transformer of this invention the laminations of the rotating core are arranged around the center line of the core in such a manner that the flat surface of each lamination lies in a plane that is substantially parallel to that portion of the flux path immediately adjacent the lamination. For example, the laminations in sets **22** and **22***a* extend radially outward in the direction of the flux around the coil in these areas. The laminations **23** extend axially along the shaft **31** which is the direction of the flux around the coil in that area. Hence, this preferred flux path is formed around the coil in such a manner that it flows parallel to the flat portions of the laminations at all places except the junction between the laminations **23** and the sets of laminations **22**, **22***a*. Because of this preferred arrangement of the laminations providing a low reluctance flux path, there is a minimum amount of eddy current formed in the core. Correspondingly, there is a minimum amount of heat generated which is extremely important in the rotating transformer structure because in the prior art transformers the amount of heat generated was a serious drawback to its commercial adoption.

As might be expected, the assembly of laminations **23** that make up the central member **24** of the core is not a simple matter. However, one satisfactory method of assembling these laminations is to affix the individual laminations at one end to a flexible member such as a strip of adhesive material and then wrap the strip of material with laminations adhering thereto around a mandrel or the like to form an annular member. The laminations can then be clamped by appropriate means to hold the laminations in a rigid position until the sets **22**, **22***a* are positioned on either end of the member **24** to form a rigid annular core **12**.

In an alternate embodiment of this invention as illustrated in FIG. 3, a rotating core **35** is made up of two sets of annular end laminations **40** and **42**, similar to the sets of end laminations in the embodiment of FIG. 1. However, between these laminations is a spirally wound member **43**. This member is made up of alternate layers of sheets of magnetic material **44** and electric conducting material **45**. It may be desirable in some applications to place a layer of electric insulating material **46** between the conductor **45** and the magnetic material **44**. The layers of magnetic material combine with the end laminations to form a low reluctance path for the flux around the coil in the same manner as the laminations in the first embodiment. In this embodiment the entire space between the end laminations can be filled by the spirally wound members because no additional space is required to form a torus or winding space for the coil.

A third embodiment is shown in FIG. 4 in which a solid annular core **50** has a V-shaped section **51** removed. The core is made of a magnetic material that is also an electric conductor so as to perform the functions of both the core and the coil of the transformer. An appropriate pair of connectors **52**, **53** are provided with the core **50** to connect the coil to an appropriate load.

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

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rotatable member for an electric transformer comprising:

two sets of annular iron laminations mounted on a shaft and being axially spaced from each other;

a first sheet of magnetic material and a second sheet of electric conducting material wound in the form of a helix and positioned between said sets, said first sheet providing a magnetic flux linkage between said sets of laminations;

electrical insulation positioned between said sheets, and lead wires connected to said second sheet to conduct electric current to said second sheet and thereby form a coil of said rotating member.

2. An electric transformer comprising:

an annular core having a coil mounted therein, a second core mounted for rotation within the bore of said first core, said second core comprising a sheet of electric conducting material and a sheet of magnetic material wound in the form of a helix,

electrical insulating material positioned between said sheets,

and lead wire connected to said electric conducting sheet to form the coil for said second core.

3. An electric transformer comprising:

an annular magnetic stationary member having a coil formed therein,

a generally solid cylindrical member composed of a single material having the characteristics of both electric and magnetic conductivity rotatably mounted within the bore of said stationary member,

said cylindrical member being positioned to form a substantially closed low reluctance magnetic circuit with said stationary member,

means for connecting said cylindrical member to an electric circuit to form a coil for said member.

4. An electric transformer comprising:

an annular magnetic core having an electric coil mounted therein;

a second magnetic core mounted for rotation within the bore of said first core, said second core comprising two sets of annular iron laminations mounted on a shaft and being axially spaced from each other; and a plurality of radially disposed laminations positioned between said sets, each of said radial laminations lying in a plane that includes the center line of said shaft and extending radially outward between said sets to a point inward of the periphery of said sets,

and electric windings positioned in said torus.

References Cited

UNITED STATES PATENTS

1,394,901	10/1921	Hobart	336—120 X
2,053,176	9/1936	Bouwers	336—234 X
2,498,702	2/1950	Naham	336—234 X
2,641,682	6/1953	McKenna	336—177 X
2,716,736	8/1955	Rex	336—177 X
2,878,425	3/1959	Kudoh	336—83 X
2,997,567	8/1961	Connelly	336—234 X

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