Nov. 1, 1966 J. D. EDICK 3,283,188

COIL CONSTRUCTION

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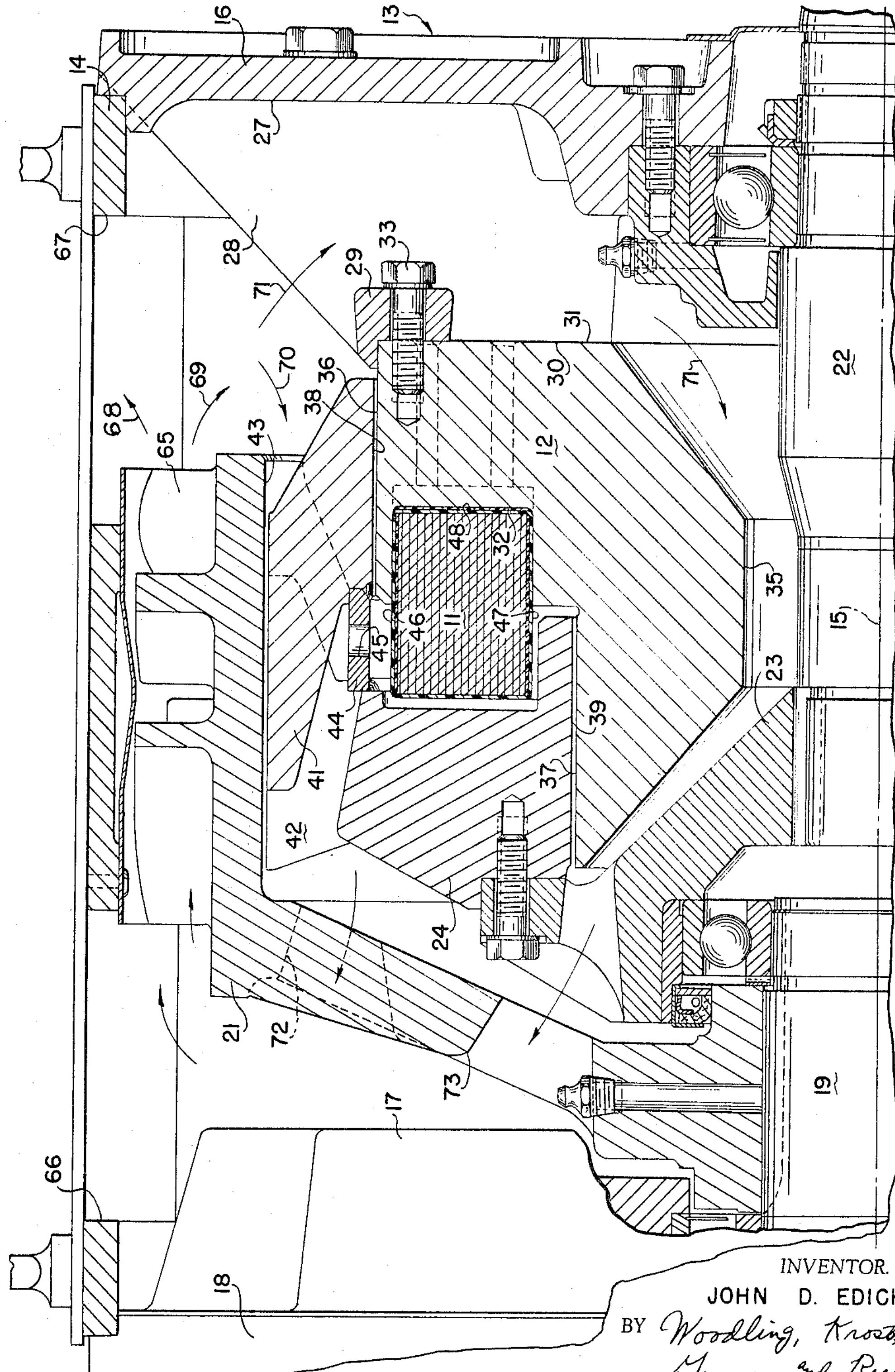

FIG. I

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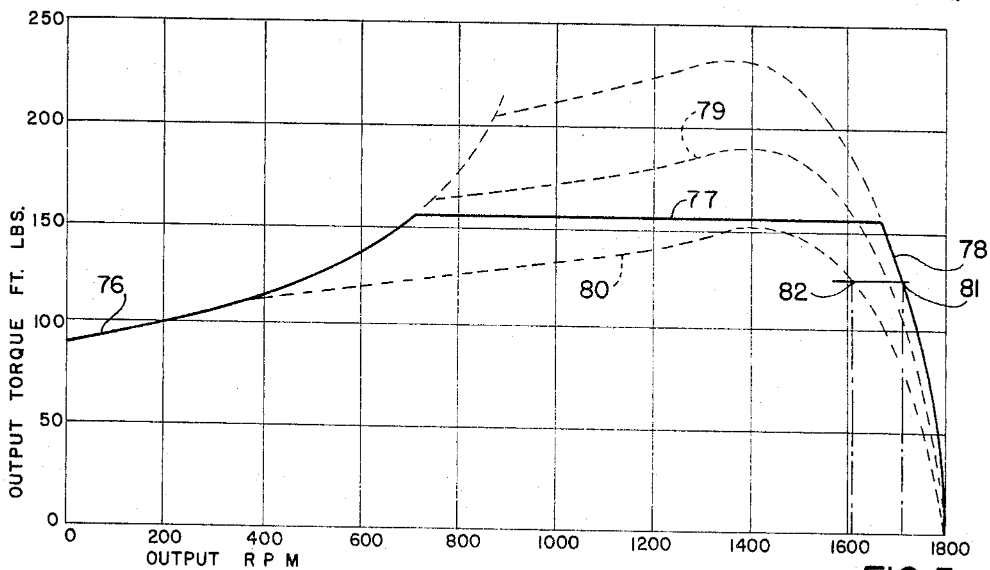

FIG. 5

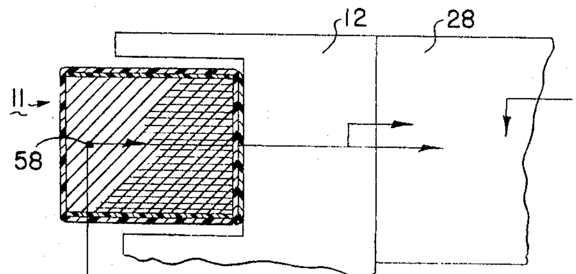

FIG. 3

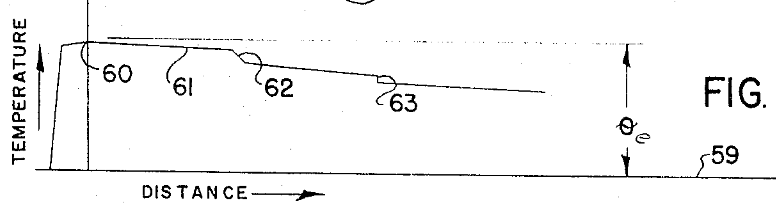

FIG. 4

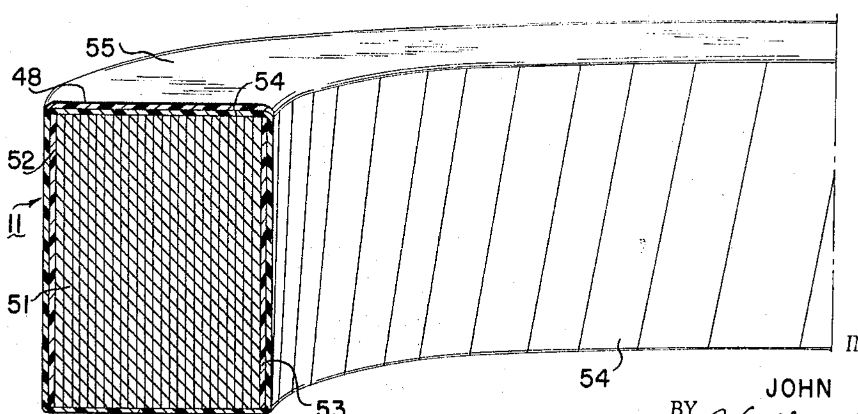

FIG. 2

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3,283,188

COIL CONSTRUCTION

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10 Claims. (Cl. 310—105)

The invention relates in general to the construction of an electrical coil and, more particularly, to the construction of a combined coil and core wherein heat generated in the coil may be readily dissipated through the core. The coil and core construction of the invention may comprise a magnetic core having first and second surfaces spaced apart in a first direction, a toroidal coil wound from metal strip conductor with the layers thereof substantially parallel at a given circumferential position and substantially parallel to said first direction. The layers of strip conductor have edges which define a coil surface generally parallel to the core second surface and a metallic oxide powder and binder mixture is disposed between said coil surface and said magnetic core second surface to establish good heat transfer characteristics in said first direction from the ends of the layers of strip conductor into the magnetic core and through the magnetic core to the core first surface for heat dissipation thereat.

Many electrical coil and core assemblies do not have any particular heat dissipation problem. In the typical electrical transformer with a typical core arrangement such as using E-I laminations, there is only about 30% of the coil which is surrounded by the iron core and about 70% of the coil which is not encased by the core and, hence, available for air cooling at these exposed surfaces of the coil. Other types of coil and core constructions, however, have been coil encased to a much greater degree. In particular, some dynamoelectric machines and, as an example, an eddy current clutch may have a construction wherein the coil is, for all practical purposes, completely encased in a magnetic circuit so that the coil cannot be seen and has no exposed surface areas for contact with cooling air. Such coil and core constructions had, in the past, the disadvantage of being unable to permit energization of the coil at a high rate because the heat generated therein could not escape and the coil would damage the insulation thereon by overheating.

Accordingly, an object of the present invention is to provide a coil construction which provides for ready dissipation of generated heat.

Another object of the invention is to provide a combined coil and core construction wherein heat is dissipated through the coil and through the core primarily only in a first direction along a good heat flow path.

Another object of the invention is to provide a combined coil and core construction wherein heat flow is provided along heat conductive path which still retains the necessary electrical insulating properties.

Another object of the invention is to provide a combined coil and core construction with a heat flow path generally parallel to the axis of the coil to a surface cooled by air flow from blower means.

Another object of the invention is to provide a combined coil and core construction with improved heat dissipation even though all peripheral portions of the coil are encased in a magnetic circuit substantially entirely preventing air flow over any surface of the coil.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view through a dynamoelectric machine embodying the coil construction of the invention;

FIGURE 2 is a sectional isometric view of the coil construction before assembly to the core;

FIGURE 3 is a partial sectional view of the coil and core construction;

FIGURE 4 is a graph of temperature vs. distance relating to FIGURE 3; and,

FIGURE 5 is a graph of torque vs. r.p.m. of an eddy current clutch embodying the invention.

FIGURE 1 illustrates a coil **11** which illustrates one embodiment of the invention. This coil **11** is shown as combined with a core body **12** and the combined coil and core body are shown as being embodied in a dynamoelectric machine **13**. This dynamoelectric machine is illustrated as being an eddy current clutch having a frame or housing **14**. This housing has an axis **15** with end bells **16** and **17**. The end bell **17** may also serve as the end bell of a motor **18** driving an input shaft **19** for the eddy current clutch **13**. An eddy current drum **21** is driven by the input shaft **19** within the housing **14**. The end bell **16** journals an output shaft **22** to which is fixed a non-magnetic bearing hub **23** which is journalled relative to the input shaft **19** to maintain coaxial alignment of the input and output shafts. A magnetic permeable rotor **24** is carried on the bearing hub **23** for cooperation with the core body **12**.

The end bell **16** has an inner surface **27** and a plurality of axially parallel radially disposed fins **28**. The end bell **16** is preferably made from some non-magnetic material such as stainless steel or cast aluminum and the fins **28** are integral therewith for rigidity and heat transfer. An annular mounting ring **29** is integral with and joins all the radial fins **28**. This mounting ring **29** and the inner ends of the radial fins **28** have a mounting surface **30** which is a mounting surface on the housing **14**. This mounting surface is in a plane normal to the axis **15** and is preferably machined smooth.

The core body **12** has first and second axially spaced surfaces **31** and **32**, respectively. These first and second surfaces are generally on opposite axial ends of the core body **12** and the first surface **31** is a smooth planar surface complementary to the mounting surface **30**. Bolts **33** may be used to secure the core body **12** to the mounting surface **30** to rigidly mount the core body **12** to the housing **14**. The smooth machined surfaces **30** and **31** permit good heat transfer therebetween. The core body **12** is toroidal in shape with an inner surface **35** and first and second air gap surfaces **36** and **37**, respectively.

The magnetic rotor **24** has first and second air gap surfaces **38** and **39**, respectively, for parasitic cooperation with the air gap surfaces **36** and **37**, respectively. The magnetic rotor **24** also has a first set of a plurality of teeth **41** and a second set of a plurality of teeth **42** which are interdigitated and cooperate with the inner surface **43** of the eddy current drum **21**. The first set of teeth **41** are carried on the magnetic rotor **24** by a non-magnetic ring **44** having a series of apertures **45**. The coil **11** has an outside diameter surface **46** and inside diameter surface **47** and a first axial end surface **48**.

FIGURES 2 and 3 better show the construction of the coil **11**. This coil is a layer wound from metal foil or strip conductor **51**. This may be aluminum strip or copper if preferred. The layers of the metal strip conductor are wound in the coil **11** to be parallel to the axis **15**. The metal strip conductor **51** is preferably insulated by an adhering varnish film such as an isonel varnish film in the order of .0003 to .0005 inch thick. This adhering insulating film covers both surfaces and both edges of the strip conductor. The width of the metal strip conductor **51** is the same as the axial length of the coil **11** and, accordingly, there is an unbroken heat conductive path axially through the coil at each conductor layer of this coil. This materially improves the heat transfer characteristic through the coil in a first direction which, in this case, is parallel to the axis **15**.

The preferred way to insulate the entire coil **11** is to use two insulating strips **52** and **53**. The insulating strip **52** is placed around the periphery at the outside diameter and the insulating strip **53** is placed around the periphery at the inside diameter of the coil **11**. These insulating strips are as wide as the strip conductors **51** and provide the primary ground insulation, or insulation to ground, for the outside diameter and inside diameter of the coil with respect to the core body **12**. These insulaitng strips **52** and **53** may conveniently be made of a glass-mica-Mylar strip about .040 inch thick. Next, the coil may be wrapped with a loose weave glass fiber tape **54** in a spiral half lap winding. The glass tape **54** may be an untreated tape to assure openness of the pores therein and may be thin in the order of .0075 inch so that the two layer thickness established by the half lap wrapping is about .015 inch thick. Next, a thin paste mixture of metallic oxide and binder **55** may be applied on the first axial end surface **48** of the coil **11**. It may be applied with a spatula, for example, to impregnate the open pores of the glass tape **54**. This mixture **55** may be relatively thin in the order of .050 to .100 inch thick. The metallic oxide used is preferably beryllium oxide which may be of low purity for economy. Even such commercially available low purity beryllium oxide is still about 99.9% pure and, hence, has excellent electrical resistance properties coupled with high thermal conductivity. The binder used is only sufficient to work the metallic oxide powder into a paste to bind it together and may be an electrical insulating varnish such as an isonel varnish or an epoxy varnish. This binder material gradually sets or cures and, since the paste **55** is generally a fluid, it seeks its own level when disposed horizontally as in FIGURE 2, to cure to a fairly smooth surface. Next, the coil **11** may be prepared to have a smooth surface for mounting to the coil mounting surface **32** by any suitable means. A satisfactory way has been found by spreading another thin layer of the same paste mixture on this coil end surface **48**. Then, a relatively stiff insulating washer such as one made from Teflon, which does not stick to the cured binder, may be placed on this coil to just cover the coil end surface **48**. Next, a temporary wrap of a heat shrinking tape may be spiral wrapped around the coil and this insulating washer. The coil assembly may then be cured with heat with the heat shrinking the tape to pull the insulating washer tightly against the coil axial end surface **48** as the paste is cured. After this second cure, the temporary tape wrapping is removed and the washer is removed to reveal a smooth planar axial end surface **48**. A final step may be to dip the entire coil in an insulating varnish and bake it as has been customary for many years. This impregnates all outer surfaces of the glass tape **54** for good electrical insulating properties.

The coil **11** may then be mounted to the core body **12** by using a material such as an epoxy resin which is an adhesive like a contact cement applied on the coil end surface **48** and/or on the core body axial end surface **32** and then the coil body assembled together. The weight of just the coil body **11**, with the axis **15** vertical, is sufficient to establish a tight bond between the coil **11** and core body **12**.

FIGURE 3 shows rather schematically the assembly of coil **11** and core body **12** as well as the radial fins **28**. In both FIGURES 2 and 3, the thickness of the insulation around the coil **11** is exaggerated in order to be able to illustrate this insulation in the drawing. Actually, the insulation at the coil axial end surface **48** is quite thin an is in the order of .050 inch thick with a high percentage of beryllium oxide powder providing a good heat transfer from the coil **11** to the core body **12**.

FIGURE 4 is a graph which illustrates temperature vs. distance. The hot spot of the coil **11** may be considered to be generally at a point **58**. A base line **59** illustrates

the temperature of the surrounding air and a point **60** in FIGURE 4 illustrates the elevated temperature of the hot spot **58**. From this point **60**, the temperature follows a curve **61** as the heat is dissipated into the air flow generally at the fins **28**. A knee **62** of the curve **61** is generally at the interface of the coil **11** and core body **12**. Another break **63** is provided in the curve at the interface of the core body **12** and support fins **28**. This curve **61** shows that there is a good heat transfer axially from the coil **11** through the core body **12** and into the radial fins **28** with little obstruction to the heat flow at the two interfaces.

The eddy current drum **21** has on the outer surface thereof an axial flow fan **65** which acts as a blower means to provide forced air circulation. This air flow may be in either axial direction depending upon the rotational direction of the drum **21**. The effect is the same, however, despite direction of air flow and air flow to the right will be described. The frame **14** has air inlet openings **66** and outlet openings **67**. The function of these openings is reversed, of course, with reversed air flow. About 75% of the air flow goes out the opening **67** as indicated by a path **68**. The remaining approximately 25% of air flow is recirculated internally in a path **69**. This air path **69** splits into two paths **70** and **71**. The path **70** is axially on the inside of the eddy current drum **21** between the sets of teeth **41** and **42** and through apertures **72** in the drum support to return to the intake of the axial flow fan **65**. The second air flow path **71** is down through the spaces between the radial fins **28** and the end bell inner surface **27** and the core body end surface **30**. This air flow path **71** continues between the core body inner surface **35** and the shaft **22** and flows over the bearing hub **23** to pass out through apertures **73** in the drum support to return to the intake of the axial flow fan **65**. It has been found that a ratio of about 7–1 of air flow through path **70** and **71** provides most efficient cooling of the eddy current clutch by cooling both the eddy current drum **21** and the coil **11**. This air flow path **71** provides air flow which scrubs the surfaces of the radial fins **28** and the core body end surface **30** to withdraw heat from the coil **11**. This positive air flow eliminates the so-called film thermal resistance which would occur on natural convection cooling.

The apertures **45** in the ring **44** permit a small movement of air through the air gap at surface **37**, **39** and pass the left face of the coil **11**. Because the air gap is rather small, in the order of .015 to .025 inch, this is not a large air flow but it does prevent a pocket of hot air from building up between the coil **11** and the magnetic rotor **24**. This permits the left face of the coil **11** to be cooler than the hot spot at point **58**.

FIGURE 4 illustrates the good heat transfer path axially from the coil **11** through the core body **12** to the radial fins **28** and thence to the air. This coil design is found to be about four times as efficient in heat transfer as the prior art layer wound round wire coil. A layer wound round wire coil typically has a space factor of about 70%, i.e. 30% of the coil cross sectional area is not conductive, being either insulation on the wire or dead air space. The strip wound coil of the present invention has a space factor of 90%, hence, only 10% of the coil cross sectional area is not conductive. This is a first factor in improved heat transmission.

The insulation to ground at the coil end surface **48** is especially designed to minimize thermal resistance. It consists of several layers of open weave glass tape impregnated with and covered over by a mixture of metallic oxide powder and insulating varnish. The metallic oxide is preferably beryllium oxide and this cured varnish-beryllium oxide mixture has a dielectric strength of 150 volts D.C. per mil thickness in air and a high thermal conductivity of 30 B.t.u./hour/degree F./ft. This high thermal conductivity accounts for the relatively small knee or break **62** in the curve **61** of FIGURE 4. This is a second factor in the improved thermal cooling of the coil **11**. Further, the use of this ground insulation provides generous coil to ground resistance for the typically low voltage strip coil **11**. The coil **11** may be operated at a low voltage, for example 24 volts. However, the electrical standards require that the coil to ground insulation be able to withstand twice the rated coil voltage plus 1,000 volts, in this case about 1050 volts. This beryllium oxide mixture easily meets these electrical standards.

The smoothness of the mounting surfaces **30** and **31** and the tight mounting by the bolts **33** assures low contact thermal resistance at this point, as illustrated by the break **63** in FIGURE 4. The end bell **16** is preferably made from aluminum with good thermal conductivity and this additionally prevents any flux leakage from the rotor **24** through the core body **12**, the radial fins **28**, the housing **14**, and drum **21** back to the rotor **24** which would degrade the performance of the eddy current clutch **13**.

The combination of the strip wound coil **11**, high conductivity ground insulation **55**, core body **12**, high contact thermal conductance to the radial fins **28** and forced convection cooling of the fins **28** and core body **12** results in greatly improved coil power dissipating ability. Layer wound round wire coils in prior art construction have a characteristic thermal resistance of 1.00 degree C./watt. The strip wound coil in this improved construction has a thermal resistance of .25 degree C./watt. This is approximately four times as good which permits approximately four times as much wattage to be applied to the coil **11** for given frame size of dynamoelectric machine **13**. In the eddy current clutch **13**, as one illustration of use of the invention, this improved coil heat dissipating ability makes possible continuous operation of the eddy current clutch at higher excitation levels at the high speed end of the speed torque curve of the clutch. This effect is illustrated in FIGURE 5. This FIGURE 5 plots output torque in foot pounds against output r.p.m. with a curve **76** in solid lines illustrating the performance of the eddy current clutch **13**. The flat portion **77** of the curve shows that the clutch is capable of handling 50 H.P. in one particular frame size with this curve following the 15 amp. coil energization curve **78** at the high r.p.m. end of the curve. Curve **79** illustrates a 10 amp. coil energization curve and curve **80** illustrates a 7½ amp. coil energization curve. A point **81** on curve **78** may illustrate an output torque of 125 foot pounds of the eddy current clutch **13**. A particular volume/area ratio of coil **11** in a particular size of this coil is able to dissipate 15 amps. of energization at this point **81** which corresponds to 1710 r.p.m. on the output shaft. The typical prior art layer wound round wire coil construction, on the other hand, is able to dissipate only 25% of this power, since the ratio of thermal resistances is four to one for the two coil constructions, and this 125 foot pounds of torque, therefore, can be carried at only 1610 r.p.m., as shown at point **82** on curve **80**. This 100 r.p.m. difference in output speeds represents the improvement in eddy current clutch performance due to the unique coil construction. In this FIGURE 5, 1800 r.p.m. is the synchronous speed which is never to be reached but desired to be closely approached. The unique coil construction of the present invention permits the eddy current clutch **13** to approach twice as closely to this goal of synchronous speed.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A coil and core construction comprising, in combination, a magnetic core having first and second surfaces spaced apart in a first direction,
   - a toroidal coil wound from a metal strip conductor with the layers thereof being substantially parallel at a given circumferential position and substantially parallel to said first direction,
   - said core substantially surrounding paid coil,
   - said layers of strip conductor having edges defining a coil surface generally parallel to said core second surface,
   - and a beryllium oxide powder and binder mixture between said coil surface and said magnetic core second surface to establish good heat transfer characteristics in said first direction from the ends of said layers of strip conductor into said magnetic core and through said magnetic core to said core first surface for heat dissipation thereat.

2. A coil and core construction comprising, in combination, a magnetic core having first and second surfaces spaced apart in a first direction,
   - a toroidal coil wound from a metal strip conductor with the layers thereof being substantially parallel at a given circumferential position and substantially parallel to said first direction,
   - said core substantially surrounding said coil,
   - said layers of strip conductor each having an edge defining a coil surface generally parallel to said core second surface,
   - a beryllium oxide powder and binder mixture between said coil surface and said magnetic core second surface to establish good heat transfer characteristics in said first direction from the ends of said layers of metal strip into said magnetic core and through said magnetic core to said core first surface,
   - and air blower means to effect air flow over said core first surface to extract heat therefrom.

3. A coil and core construction comprising, in combination, a housing having an axis and a mounting surface,
   - a stationary magnetic core coaxially in said housing and having first and second axial end surfaces,
   - means to mount said first axial end surface in good heat transfer relationship to the housing mounting surface,
   - a coaxial toroidal coil wound from a metal strip conductor,
   - the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,
   - a beryllium oxide powder and binder mixture between one axial end of said coil and said magnetic core second end surface to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially to said core first end surface and to the housing,
   - and air blower means to effect air flow over said first axial end surface of said magnetic core to extract heat therefrom.

4. A coil and core construction comprising, in combination, a housing having an axis,
   - a stationary magnetic core coaxially in said housing and having first and second axial end surfaces,
   - a coaxial toroidal coil wound from a metal strip conductor,
   - the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,
   - a beryllium oxide powder and binder mixture on the axial end of said coil adjacent said magnetic core second end surface to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially to said core first end surface,
   - said magnetic core forming part of a magnetic circuit completely surrounding the cross section of said coil

to eliminate substantially all air movement across surfaces of said coil,

and air blower means to effect air flow over said first axial end surface of said magnetic core to extract heat therefrom.

5. A coil and core construction in a housing with an axis,

said coil and core construction comprising, in combination, a stationary magnetic core coaxially in said housing,

a mounting surface on said housing and disposed in a plane perpendicular to said axis,

a smooth surface on said magnetic core secured to said mounting surface of said housing in good heat exchange relationship therewith,

a coil mounting surface coaxially on said magnetic core on the side axially opposite said housing mounting surface,

a coaxial toroidal coil wound from a metal strip conductor,

the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,

a beryllium oxide powder and varnish mixture on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially into said housing mounting surface,

said magnetic core forming part of a magnetic circuit completely surrounding the cross section of said coil to eliminate substantially all air movement across surfaces of said coil,

and air blower means to effect air flow over the axial end of said magnetic core to extract heat therefrom.

6. A coil and core construction in a housing with an axis,

said coil and core construction comprising, in combination, a stationary magnetic core coaxially in said housing,

a mounting surface on said housing disposed in a plane perpendicular to said axis,

a smooth surface on said magnetic core secured to said mounting surface of said housing in good heat exchange relationship therewith,

a coil mounting surface coaxially on said magnetic core on the side axially opposite said housing mounting surface,

a coaxial toroidal coil wound from a metal strip conductor,

the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,

an insulating varnish film adhering to both sides and both edges of said strip conductor,

loose weave glass fiber tape wound around all surfaces of said toroidal coil,

a beryllium oxide powder and varnish mixture impregnating said glass tape on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially into said housing mounting surface,

said magnetic core forming part of a magnetic circuit completely surrounding the cross section of said coil to eliminate substantially all air movement across surfaces of said coil,

and air blower means to effect air flow over the axial end of said magnetic core to extract heat therefrom.

7. A coil and core construction in a dynamoelectric machine having a housing with an axis and with an end bell on one end thereof,

said coil and core construction comprising, in combination, a stationary magnetic core coaxially in said housing,

a plurality of radially disposed aluminum fins carried on said end bell,

an annular mounting ring integral with said fins and spaced from said end bell,

a mounting surface on said ring and on said radial fins,

a smooth surface on said magnetic core secured to said mounting surface of said ring and radial fins in good heat exchange relationship therewith,

a coil mounting surface coaxially on said magnetic core on the side axially opposite said radial fins,

a coaxial toroidal coil wound from a metal strip conductor,

the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,

a beryllium oxide powder and varnish mixture on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially into said annular mounting ring and radial fins,

said magnetic core forming part of a magnetic circuit completely surrounding the cross section of said coil to eliminate substantially all air movement across surfaces of said coil,

and air blower means to direct air in a generally radial direction between said end bell and said magnetic core and flowing over said radial fins and the axial end of said magnetic core to extract heat therefrom.

8. A coil and core construction in an eddy current clutch having a housing with an axis and with an aluminum end bell on one end thereof,

said coil and core construction comprising, in combination, a stationary magnetic core coaxially in said housing,

a plurality of radially disposed fins carried on said end bell,

an annular mounting ring integral with said fins and spaced from said end bell,

a mounting surface on said ring and on said radial fins and disposed in a plane perpendicular to said axis,

a smooth surface on said magnetic core secured to said mounting surface of said ring and radial fins in good heat exchange relationship therewith,

a circular coil mounting surface coaxially on said magnetic core on the side axially opposite said radial fins,

a coaxial toroidal coil wound from a metal strip conductor,

the layers of said strip conductor being substantially parallel to said axis and the width of said strip establishing the axial length of said coil,

an insulating varnish film adhering to both sides and both edges of said strip conductor,

loose weave glass fiber tape wound around all surfaces of said toroidal coil,

a beryllium oxide powder and varnish mixture impregnating said glass tape on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of metal strip axially into said magnetic core and through said magnetic core axially into said annular mounting ring and radial fins,

said magnetic core forming part of a magnetic circuit completely surrounding the cross section of said coil to eliminate substantially all air movement across surfaces of said coil,

and air blower means to direct air in a generally radial direction between said end bell and said magnetic core and flowing over said radial fins and the axial end of said magnetic core to extract heat therefrom.

9. A coil construction in an eddy current clutch having a housing with an axis and carrying a stationary coaxial magnetic core as a part of a magnetic circuit completely encasing the coil,

said coil construction comprising, in combination, an aluminum end bell coaxially on one end of said eddy current clutch,

a plurality of radially disposed fins intergral with said end bell,

an annular mounting ring integral with said fins and spaced from said end bell,

a mounting surface on said ring and on said radial fins and disposed in a plane perpendicular to said axis,

a planar surface on said magnetic core secured to said mounting surface of ring and radial fins in good heat exchange relationship therewith,

generally radial air passages defined by said end bell and said magnetic core and between said radial fins,

a circular coil mounting surface coaxially on said magnetic core on the side axially opposite said radial fins,

a coaxial toroidal coil wound from an aluminum strip conductor,

said aluminum strip conductor being insulated with an insulating film adhering to both sides and both edges thereof,

the layers of said aluminum strip conductor being substantally parallel to said axis,

loose weave glass fiber tape wound around all surfaces of said toroidal coil,

and a varnish and beryllium oxide mixture impregnating said glass tape on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of aluminum strip axially into said magnetic core and through said magnetic core axially into said radial fins.

10. A coil construction in an eddy current clutch having a housing with an axis and carrying a stationary coaxial magnetic core as a part of a magnetic circuit completely surrounding all peripheral portions of the coil,

said coil construction comprising, in combination, an aluminum end bell coaxially on one end of said eddy current clutch,

a plurality of axially parallel radially disposed fins integral with said end bell,

an annular mounting ring integrally on said fins and spaced from said end bell,

a mounting surface on said ring and on said radial fins and disposed in a plane perpendicular to the axis of said eddy current clutch housing,

a planar surface on said magnetic core secured to said mounting surface of said ring and radial fins in good heat exchange relationship therewith,

air blower means to direct air in a generally radial direction between said end bell and said magnetic core and flowing over said radial fins and the end of said magnetic core to extract heat therefrom,

a circular coil mounting surface coaxially on said magnetic core on the side axially opposite said radial fins,

a toroidal coil wound from an aluminum strip conductor and coaxial with said core,

said aluminum strip conductor being insulated with an isonel varnish film on both sides and both edges thereof and adhering to said aluminum strip conductor,

the layers of said aluminum strip conductor being substantially parallel to said housing axis and the axial length of said coil being the width of said strip,

loose weave glass fiber tape single half lap wound around the periphery of the longitudinal cross sectional surfaces of said toroidal coil,

and a varnish and beryllium oxide mixture impregnating said glass tape on the axial end of said coil adjacent said coil mounting surface of said magnetic core to establish good heat transfer characteristics from the ends of said layers of aluminum strip axially into said magnetic core and through said magnetic core axially into said annular mounting ring and radial fins.

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MILTON O. HIRSHFIELD, *Primary Examiner.*

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