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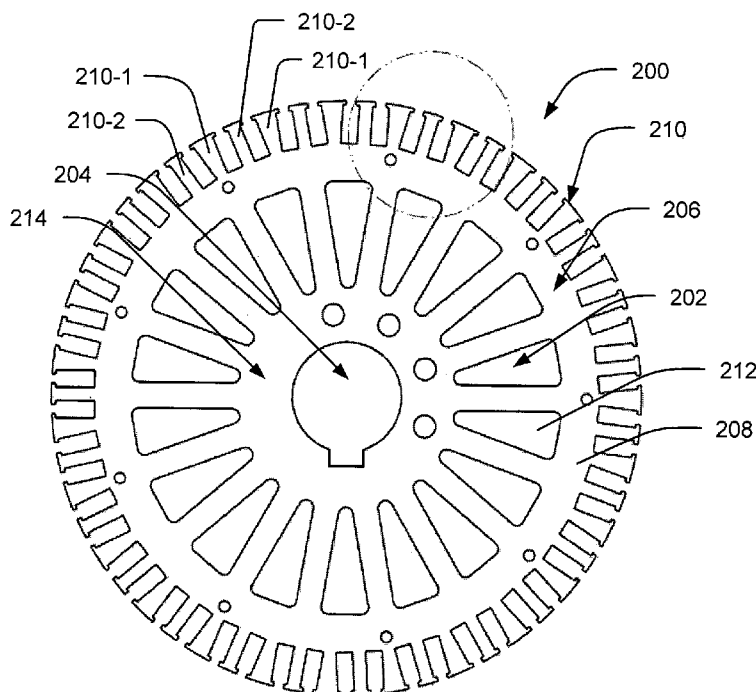
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(54) Title: ELECTRICAL MEMBER FOR ELECTRICAL MACHINES



(57) Abstract: An electrical member (200) for an electrical machine is described. In an embodiment, the electrical member (200) includes a body portion (208) having a cylindrical shape and a plurality of tapered teeth (210-1) and straight teeth (210-2), both extending in a radial direction from the body portion (208). Each tapered tooth (210-1) and straight tooth (210-2) has its side walls (216-1, 216-2, 218-1, 218-2) extending substantially parallel to a longitudinal axis of the body portion (208) in one direction and extending substantially radially in another direction. Each tapered tooth (210-1) is flanked by a straight tooth (210-2) on either side along a circumferential direction to form a slot (220) between a side wall (216-1) of one tapered tooth (210-1).



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TECHNICAL FIELD

[0001] The present subject matter, in general, relates to electrical machines and, in particular, relates to an electrical member for electrical machines.

BACKGROUND

5 [0002] Generally, electrical machines include motors and generators. Typically, an electrical machine includes electrical members, such as a rotating part known as rotor and a stationary part known as stator. As is well known, such electrical machines operate on the principle of electromagnetism. During operation of the electrical machine as a motor, a
10 magnetic field provided in the stator interacts with a magnetic field provided in the rotor. The interaction of the magnetic fields causes generation of an electromagnetic force, which further causes rotation of the rotor. On the other hand, during the operation of the electrical machine as a generator, torque is supplied to the rotor to rotate the rotor with reference to the stator, and magnetic field is provided on one or both the electrical members. Upon relative motion
15 between the rotor and the stator, the magnetic field, that is, magnetic flux linked with the other electrical member varies with time and an electro-motive force or a voltage is generated in the stator, which can be either directly fed to a load or can be stored for future use by the load.

[0003] Typically, to generate the magnetic field in the electrical member, either
20 permanent magnets are fixed to the electrical member, or the electrical member is wound with a conductor coupled to a power source to form an electromagnetic coil.

BRIEF DESCRIPTION OF DRAWINGS

[0004] The detailed description is described with reference to the accompanying figures.
25 In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and components.

[0005] Fig. 1a-1, fig. 1a-2, fig. 1b-1, and fig. 1b-2 illustrate conventional electrical members used in electrical machines.

[0006] Fig. 2a and fig. 2b illustrate an electrical member for an electrical machine, in accordance with an embodiment of the present subject matter.

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DETAILED DESCRIPTION

[0007] The subject matter described herein relates to an electrical member for an electrical machine, according to an embodiment of the present subject matter.

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[0008] With the advent of hybrid and electric vehicles, there is a growing interest in the automotive industry to develop electrical machines which utilize less space and are efficient in operation. Therefore, the direction of innovation in designing electrical machines is to develop electrical machines which have low losses and compact size for a given power rating, or for a given size, power rating should be more than the present rating. However, in general, close packaging of components in compact machines leads to greater electrical and magnetic interactions between the components, and may lead to high core losses in case of electrical machines using permanent magnets.

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[0009] For example, for an electrical machine having a certain size, high power can be designed without being affected by losses by providing high magnetic and electric loading to the machine. Accordingly, conventional electrical machines use compact sized electromagnets, formed by providing windings on one or both of the electrical members. i.e., the stator as well as the rotor. The windings are usually formed by inserting a conductor through a plurality of slots in the electrical member and winding the conductor around the electrical member. Further, high electrical and magnetic loading can be achieved by provided large number of the turns of the windings or by passing high current through the windings, or both. Such operational conditions can lead to substantial copper losses due to high resistance which can, in turn, cause heating of the electrical machine and may reduce the power deliverability. The effect is aggravated by low fill factor achieved by the windings of the conventional electrical machines. The fill factor can be understood as ratio of volume of each slot through which the conductor passes to the volume of the conductor(s) that fills up that slot. In case of a low fill factor, large amount of air gaps are present between the electrical

member and the windings which does not allow the heat from the windings to be transferred easily to the surroundings.

[0010] For example, in a conventional electrical member, a plurality of teeth is provided on a peripheral wall of a body of the electrical member. Each tooth is formed by parallel side walls, each side wall having length in a longitudinal direction and width in a radial direction of the electrical member. Such design of teeth is provided in the conventional electrical members because of ease in manufacturing. Between the side walls of adjacent teeth, the slots are formed for inserting the conductors to provide the windings. In such conventional electrical machines, the walls of adjacent teeth forming the slot are tapered away or flared in the direction in which the teeth extend. When conductors are inserted into the slots, a substantial amount of space remains unoccupied because of the flared shape of the slot. Consequently, the fill factor achieved by conductors, say having rectangular cross section, in such electrical members is considerably low, for example, substantially less than 80%.

[0011] In another type of conventionally used electrical member, the teeth are formed on the peripheral wall of the body portion in such a way that one side wall of one tooth is parallel to a facing side wall of the adjacent tooth. The facing side wall can be understood as that wall of the adjacent tooth which faces the side wall of the first tooth for forming the slot between the two teeth. As a result, the slot formed between the two adjacent teeth has parallel walls and with such a shape of the slots, a high fill factor can be achieved. However, in this case, the two side walls of one tooth are tapered away or flared in the direction in which the tooth extends. Therefore, the distance between two adjacent slots along a length of the teeth varies. In such a case, when U-shaped conductors are used to form the windings, conductors having different span, i.e., distance between the two limbs, have to be used even when being inserted into the same pair of slots. For instance, in case of an inner electrical member, the distance between the adjacent slots in which the limbs are to be inserted is less towards the centre of the body portion and gradually increases towards the direction in which the teeth extend, with the conventional construction of the teeth. In such a case, the cost associated with the electrical member is considerably high since the same electrical member uses different sized U-shaped conductors. In addition, the flared teeth configuration usually suffers from loss in the region in towards the neck of the teeth, in proximity of the body portion of the electrical member.

[0012] The present subject matter describes an electrical member for an electrical machine, according to an embodiment of the present subject matter. The electrical member as described herein has a compact size, high fill factor, and a low resistance. Accordingly, the electrical machine using such an electrical member has high power density and can be used in various portable applications including hybrid and electrical vehicles. In an example, the electrical member can be a stator or a rotor of the electrical machine.

[0013] According to an embodiment of the present subject matter, the electrical member includes a body portion having a cylindrical structure, and a plurality of teeth extending from the body portion in a radial direction from the body portion. In an implementation, the plurality of teeth can extend from a peripheral wall of the body portion in a direction away from the body portion. For example, in case the electrical member is the outer component of the electrical machine, the plurality of teeth can extend inwards, that is, towards a centre of the body portion, whereas if the electrical member is an inner component of the electrical machine, the plurality of teeth can extend outwards, that is, away from the centre of the body portion. The plurality of the teeth can be provided for winding a plurality of conductors to form the electromagnet on the electrical member.

[0014] According to an embodiment, the plurality of teeth can be provided as two separate sets of teeth, arranged alternately on the peripheral wall of the body portion. In an embodiment, the teeth can include a plurality of tapered teeth. Each tapered tooth can have two side walls extending substantially perpendicular to a surface of the body portion and along a radial direction. The surface of the body portion can be understood as a plane perpendicular to a central longitudinal axis of the electrical member. In an example, in which the electrical member is an inner member, the side walls taper away from each other in the direction in which the tapered tooth extends, i.e., the tapered tooth can have a flared profile of the side walls with respect to each other along the radial direction. In another example, in which the electrical member is an outer member and the teeth are provided to extend inwardly, the side walls of the tapered tooth can taper towards each other in the direction in which the tapered tooth extends.

[0015] Further, in said embodiment, the other set of teeth include a plurality of straight teeth. As mentioned for the tapered teeth, the side walls of the straight teeth are substantially

perpendicular to the surface of the body portion and extend along the radial direction. In said implementation, the side walls of each straight tooth are parallel to each other.

[0016] Further, according to an aspect of the present subject matter, the two sets of teeth are provided in an alternate configuration on the peripheral wall of the body portion, i.e., each tapered tooth is flanked by a straight tooth on either side along a circumferential direction on the peripheral wall. Further, between a side wall of one tapered tooth and a side wall of an adjacent straight tooth, a slot is formed which is adapted to receive one or more conductors for forming windings of the electrical member. In said embodiment, the walls of the slot, i.e., the side wall of the tapered tooth and the side wall of the adjacent straight tooth are substantially parallel.

[0017] Further, according an aspect, the slots formed along the periphery of the body portion, between the alternately arranged tapered and straight teeth can be formed as a slot set, each having a pair of slots. In an embodiment, the two slots in the slot set are formed by one straight tooth sandwiched between two tapered teeth, that is, a first tapered tooth and a second tapered tooth. Therefore, one slot is formed between a side wall of one tapered tooth and one side wall of the straight tooth, and the other slot is formed between the other side wall of the straight tooth and a side wall of the subsequent tapered tooth. The two slots so formed are substantially parallel to each other. Accordingly, a first side wall of the first tapered tooth, the two side walls of the straight tooth, and a first side wall of the second tapered tooth, forming the slot set are parallel. In addition, as would be understood by a person skilled in the art, since the tapered teeth and parallel teeth are provided in an alternating configuration, the losses associated with the tapered or flared teeth are averaged out with the substantially low losses associated with the straight teeth, and therefore, the overall losses associated with the electrical member are considerably low as compared to the conventional configurations.

[0018] Further, in an implementation, a plurality of conductors is inserted into the slot sets formed on the peripheral wall of the body portion, to form the windings of the electrical member. In said implementation, each conductor is formed as a U-shaped conductor having two limbs for inserting the conductor into two different slots. In addition, in an implementation, the windings of the electrical member can be single layer windings. Accordingly, one limb of the U-shaped conductor is inserted into one slot of the slot set and

other limb is inserted into the other slot of the slot set, and a U-bend of the conductor is positioned on the straight tooth. In said implementation, therefore, coil pitch of the windings is 1. In an example, four conductors can be inserted into one slot set, i.e., each slot of the slot set can accommodate the limbs of four different conductors.

5 [0019] In addition, in an embodiment, each conductor inserted into the slot has a rectangular cross-section. As described above, the two slots of the slot set are parallel to each other. In such a case, according to the present subject matter, a considerably high fill factor is achieved. In an example, the fill factor can be about 80%. As a result of the high fill factor, the contact area between the conductors and the teeth and the body portion is considerably
10 high. Consequently, the heat generated in the windings is dissipated more effectively from the abutting components. This, in turn, enhances thermal stability and operational capability of the electrical machine at high loading. For example, for the electrical member as described in the present subject matter, a short time rating, indicative of the load that the machine can withstand for a predefined short period, is high. In effect, the electrical machine deploying the
15 electrical member as described in the present subject matter has a high power density and can be effectively used, say in electric and hybrid vehicles.

[0020] In addition, the side walls of the straight tooth, on which the U-bend of the conductor is disposed in the inserted position, are parallel to each other. Therefore, all the conductors inserted into the same slot set can have the same span, i.e., distance between the
20 two limbs. Accordingly, the assembly of the electrical member is convenient and allows for high productivity in manufacturing the electrical member.

[0021] Additionally, on the free ends of the limbs, each conductor can be coupled with other similar conductors from other slots and form the entire windings of the electrical element. In an implementation, the windings formed by the plurality of conductors can be
25 connected to one phase of an electrical system. For example, in case of a motor, the conductors in one slot set can all be coupled to one phase of a multi-phase power source. On the other hand, in case of an alternator, the conductors can all be coupled to a single phase of the appliances coupled to the alternator. In such a case, the insulation of the windings coupled to different phases is achieved and adverse affects, such as proximity effect, which may

otherwise influence the current distribution in adjoining multi-phase conductors, are prevented.

[0022] These and other advantages of the present subject matter would be described in greater detail in conjunction with the figures in the following description.

5 [0023] Fig. 1a-1, fig. 1a-2, fig. 1b-1, and fig. 1b-2 illustrate conventional electrical members 100 and 102, respectively. Fig. 1a-1 shows one type of a conventional electrical member 100. As shown in fig. 1a, the conventional electrical member 100 is formed as having a plurality of teeth 104 on a peripheral wall of a body 106 of the electrical member 100. Each tooth 104 is formed as having parallel side walls, the side walls being perpendicular to a plane
10 of the electrical member and extending in a radial direction. Such design of teeth is provided in the conventional electrical members 100 because of ease in manufacturing.

[0024] Between the side walls of adjacent teeth 104, a slot 108 is formed. Therefore, the slots 108 are usually formed as an interstitial space between two adjacent. Fig. 1a-2 illustrates a magnified view of the teeth 104 and the slot 108 formed there between. As can be seen from
15 fig. 1a-2, since the teeth are provided along the circumference of a circle, the two walls of the adjacent teeth 104, forming the slot 108, taper away from each other, i.e., the slot 108 formed between the two teeth 104 has a flared shape in the direction in which the teeth 104 extend.

[0025] As a result, when conductors are inserted into the slots 108 for forming windings of the electrical member 100, a substantial amount of space remains unoccupied because of the flared shape of the slot 108. Consequently, the fill factor achieved in such electrical
20 members 100 is considerably low. In addition, the large amount of air gaps in the electrical member 100 do not allow the heat from the windings to be transferred easily to the surroundings, which adversely affects the operational capability of the electrical machine implementing such electrical members 100.

25 [0026] Other type of conventionally used electrical member 102 is shown in fig. 1b-1 and fig. 1b-2, which seeks to overcome the shortcomings of the previous type of electrical member 100. Fig. 1b-1 illustrates a front view of the electrical member 102 and fig. 1b-2 illustrates a magnified view of the electrical member 102. As seen from fig. 1b-1 and fig. 1b-2, teeth 110 are provided on the peripheral wall of a body portion 112 in such a way that one
30 side wall of one tooth 110 is parallel to facing side wall of the adjacent tooth 110. The facing

side wall can be understood as that wall of the adjacent tooth 110 which faces the side wall of the first tooth. As a result, a slot 114 formed between the two adjacent teeth 110 has parallel walls. With the provision of such slots 114, a high fill factor can be achieved since the conductors can occupy a considerable air space in the parallel-walled slot 114.

5 [0027] However, as shown in fig. 1b-2, in this case, the two side walls of one tooth 110 are tapered away in the direction in which the tooth 110 extends. In such a case, the span of the conductors, such as U-shaped conductors having two limbs, to be positioned in the slots 114 is different. For example, consider a case in which coil pitch of the electrical member 102 is 1, i.e., one limb of the U-shaped conductor is inserted into one slot 114 and the other limb is
10 inserted into the immediately adjacent slot 114. In such a case, the distance between the adjacent slots 114 is less towards the centre of the body portion 112 and gradually increases towards the direction in which the teeth 110 extend. Accordingly, the conductors inserted in the slots 114 towards the centre of the body portion 112 have less span and the ones inserted in the peripheral portion of the slots 114 have a comparatively greater span. In such a case, the
15 cost associated with the electrical member 102 is considerably high since the same electrical member 102 requires different sized U-shaped conductors. In addition, the flared teeth configuration usually suffers from loss in the region in towards the neck of the teeth 110, in proximity of the body portion 112.

[0028] As will be understood from the foregoing description, in the conventional
20 electrical members 100, 102, either the each tooth 104 can be formed as having parallel side walls or the teeth 110 can be formed to have side walls parallel with the adjacent teeth 110. Therefore, conventionally, there is a trade-off between the fill factor and the overall cost of production of the electrical member 100, 102.

[0029] Fig. 2a and fig. 2b illustrate an electrical member 200 for an electrical machine, in
25 accordance with an embodiment of the present subject matter. Fig. 2a illustrates a front view of the electrical member 200 and fig. 2b illustrates a magnified view of a section of the electrical member 200. For the sake of brevity, the description of fig. 2a and fig. 2b is provided in conjunction. As an example, the electrical member 200 is a stator core of the electrical machine.

[0030] In an implementation, the electrical member 200 includes an inner member 202 having a central cavity 204 for inserting a central shaft (not shown) and an outer member 206 connected to the inner member 202. As will be understood, the electrical member 200 is mounted on the central shaft at the inner member 202.

5 [0031] In an implementation, the outer member 206 can have a body portion 208 formed as a cylinder and a plurality of teeth 210 on a peripheral wall of the body portion 208. The teeth 210 extend from the peripheral wall in a radial direction with reference to a central longitudinal axis of the electrical member 200. In said example, in which the electrical member 200 is an inner stator core of the electrical machine, the teeth 210 can extend away
10 from the central longitudinal axis of the electrical member 200. In another example, in which the electrical member 200 is an outer member, the teeth 210 can extend inwardly towards the central longitudinal axis of the electrical member 200. The plurality of teeth 210 can be provided for winding a coil on the teeth 210 to form an electromagnet. The structure of the teeth 210 is described in detail later.

15 [0032] In said implementation, the inner member 202 can be formed as a hollow cylindrical disc having a plurality of sectorial elements 212, extending in an axial direction on either side of the inner member 202. The sectorial elements 212, as can be seen, are formed as individual projections in the shape of a sector of a circle, with a width gradually decreasing from a circumference towards the central longitudinal axis of the electrical member 200.
20 According to an implementation, the sectorial elements 212 can be provided for forming magnets in the axial direction. In an example, the sectorial elements 212 can be formed of permanent magnets or as electromagnets. The electrical machine implementing the electrical member 200 as described herein has a compact size and high electric and mechanical power output. According to an example, the electrical machine, when operating as a motor, is
25 capable of producing substantially high torque with a compact size, and is capable of consuming substantially low currents when used in low torque applications. On the other hand, in another example, while operating as a generator, the electrical machine is capable of generating large amounts of electric power and can be used for high power applications, even with such a compact size.

[0033] According to an embodiment, the inner member 202 and the outer member 204 can be formed as separate elements and connected to each other. In an example, the inner member 202 and the outer member 204 can be connected to each other with a plurality of connecting elements, such as screws, rivets, and studs, or can be fixed by welding or gluing.

5 In another embodiment, the inner member 202 and the outer member 204 can be formed integrated to each other. In an implementation, the electrical member 200, including the inner member 202 and the outer member 204, can be formed by layers of laminations of magnetic material, such as soft iron, ferrite material, or steel. In another implementation, the electrical member 200 can be formed as a solid component of magnetic material.

10 [0034] Further, in an implementation, the inner member 202 and the outer member 204 can be connected through a structural member 214 which can impart strength to the electrical member 200 to withstand any reaction torque that may be exerted during operation. In one example, the structural member 214 can be formed of a non-magnetic material and can assist in confining the magnetic flux through the teeth 210 and sectorial elements 212 by
15 operationally isolating the inner member 202 and the outer member 204. In another case, the structural member 214 can be formed of a metallic alloy, such as an alloy of aluminum, say for cost reduction and high strength. However, in such a case small amount of eddy currents may be generated in the structural member 214, because of the structural member 214 being metallic. In order to mitigate the effect due to the eddy currents around the sectorial magnetic
20 elements, in another implementation, the structural member 214 is formed as having two parts – a first portion and a second portion, the two portions being operationally isolated by a separator made of a non-magnetic material, such as mica or enamel. The operational isolation between the first portion and the second portion can be understood as magnetic isolation and electrical isolation.

25 [0035] According to an aspect, the plurality of teeth 210 can be provided as two separate sets of teeth 210-1 and 210-2. In an embodiment, the teeth 210 can include a plurality of tapered teeth 210-1. Each tapered tooth 210-1 can have two side walls, namely, a first side wall 216-1 and a second side wall 216-2 extending substantially parallel to the central longitudinal axis of the body portion 208, i.e., the central longitudinal axis of the electrical
30 member 200, in one direction. In addition, in another direction, the first side wall 216-1 and the second side wall 216-2 can extend substantially along a radial direction.

[0036] In other words, the first side wall 216-1 and the second side wall 216-2 extend substantially perpendicular to a surface of the body portion 208 and along a radial direction with reference to the central longitudinal axis of the electrical member 200. The surface of the body portion 208 can be understood as a plane perpendicular to the central longitudinal axis of the electrical member 200.

[0037] In said embodiment, the side walls 216-1 and 216-2 can taper away from each other in the direction in which the tapered tooth 210-1 extends, i.e., the side walls 216-1 and 216-2 can have a flared profile with respect to each other along the radial direction. Further, in said embodiment, the other set of teeth 210-2 include a plurality of straight teeth 210-2. As mentioned for the tapered teeth 210-1, each straight tooth 210-2 can include a first side wall 218-1 and a second side wall 218-2. In said embodiment, similar to the tapered teeth 210-1, the first side wall 218-1 and the second side wall 218-2 of the straight tooth 210-2 extend substantially parallel to a longitudinal axis of the body portion (208) in one direction and extend substantially radially in another direction. In other words, the first side wall 218-1 and the second side wall 218-2 are substantially perpendicular to the surface of the body portion 208 and extend along the radial direction. In said implementation, the first side wall 218-1 and the second side wall 218-2 of each straight tooth 210-2 are parallel to each other.

[0038] Further, according to an aspect of the present subject matter, the two sets of teeth 210-1 and 210-2 are provided in an alternate configuration on the peripheral wall of the body portion 208, i.e., each tapered tooth 210-1 is flanked by a straight tooth 210-2 on either side along a circumferential direction on the peripheral wall. Further, between a side wall 216-1 of one tapered tooth 210-1 and a side wall 218-2 of an adjacent straight tooth 210-2, a slot 220 is formed which is adapted to receive one or more conductors (not shown) for forming windings of the electrical member 200. In said embodiment, the walls of the slot 220, i.e., the side wall of the tapered tooth 210-1 and the side wall of the adjacent straight tooth 210-2, are substantially parallel.

[0039] Further, according an aspect, the slots 220 formed along the periphery of the body portion 208, between the alternately arranged tapered teeth 210-1 and straight teeth 210-2 can be formed as a slot sets 222, each having a pair of slots 220. In an embodiment, the two slots 220 in the slot set 222 are formed by one straight tooth 210-2 sandwiched between two

tapered teeth 210-1. Therefore, one slot 220 is formed between a side wall 216-1 of one tapered tooth 210-1 and one side wall 218-2 of the straight tooth 210-2, and the other slot 220 is formed between the other side wall 218-1 of the straight tooth 210-2 and a side wall 216-2 of the subsequent tapered tooth 210-1. The two slots 220 so formed are substantially parallel to each other, i.e., the side wall 216-1 of one tapered tooth 210-1, the two side walls 218-1 and 218-2 of the straight tooth 210-2, and the side wall 216-2 of the other tapered tooth 210-1, forming the slot set 222 are parallel.

[0040] Further, in an implementation, a plurality of conductors is inserted into the slot sets 222 formed on the peripheral wall of the body portion 208, to form the windings of the electrical member 200. In said implementation, each conductor is formed as a U-shaped conductor having two limbs for inserting the conductor into two different slots 220. In addition, in an implementation, the windings of the electrical member 200 can be single layer windings. Accordingly, one limb of the U-shaped conductor is inserted into one slot 220 of the slot set 222 and other limb is inserted into the other slot 220 of the slot set 222, and a U-bend of the conductor is positioned on the straight tooth 210-2. In said implementation, therefore, coil pitch of the windings is 1. In an example, multiple conductors can be inserted into one slot set 222, i.e., each slot 220 of the slot set 222 can accommodate the limbs of more than one conductors.

[0041] In addition, the side walls 218-1 and 218-2 of the straight tooth 210-2, on which the U-bend of the conductor is disposed in the inserted position, are parallel to each other. Therefore, all the conductors inserted into the same slot set 222 can have the same span. Accordingly, the assembly of the electrical member 200 is convenient and allows for high productivity in manufacturing the electrical member 200. In addition, the overall cost of production of the electrical member 200 is considerable low since one type of conductors are used.

[0042] In addition, in an embodiment, each conductor inserted into the slot 220 has a rectangular cross-section, and a fill factor of about 80% is achieved. This is because, as described above, the walls of each slot 220 of the slot set are substantially parallel and the region of the slot 220 can be considerably filled by the rectangular cross-sectioned conductor. As a result of the high fill factor, the contact area between the conductors and the teeth 210

and the body portion 208 is considerably high. Consequently, the heat generated in the windings is dissipated more effectively from the abutting components 208, 210. This, in turn, enhances thermal stability and operational capability of the electrical machine at high loading. Accordingly, the electrical machine deploying the electrical member 200 as described in the present subject matter has a high power density and can be effectively used for various applications, including electric vehicles and hybrid vehicles.

[0043] It will be understood that although the description is provided with reference to an inner member, for example, the stator core, of the electrical machine, the aspects of the invention can be implemented in the outer member, say a rotor drum, of the electrical machine, in the same manner as described above. In addition, the above mentioned embodiment of the electrical member 200 is provided as an example, and the electrical member 200 with the configuration of the teeth 210 according to the present subject matter can be provided on any other type of electrical member.

[0044] Although the subject matter has been described in considerable detail with reference to certain embodiments thereof, other embodiments are possible. It is to be understood that the appended claims are not necessarily limited to the features described herein. Rather, the features are disclosed as embodiments of the electrical member 200 for the electrical machine.

I/We claim:

1. An electrical member (200) for an electrical machine, the electrical member (200) comprising:

a body portion (208) having a cylindrical shape;

5 a plurality of tapered teeth (210-1) extending in a radial direction from a peripheral wall of the body portion (208), wherein each tapered tooth (210-1) has a first side wall (216-1) and a second side wall (216-2) and wherein each side wall (216-1, 216-2) extends substantially parallel to a longitudinal axis of the body portion (208) in one direction and extends substantially radially in another direction, the first side wall (216-1) being tapered with respect to the second side wall (216-2) along the radial direction; and

10 a plurality of straight teeth (210-2) extending in the radial direction from the peripheral wall of the body portion (208), each straight tooth having a first side wall (218-1) and a second side wall (218-2) wherein each side wall (218-1, 218-2) extends substantially parallel to a longitudinal axis of the body portion (208) in one direction and extends substantially radially in another direction, the first side wall (218-1) being parallel to the second side wall (218-2) along the radial direction, wherein each tapered tooth (210-1) is flanked by a straight tooth (210-2) on either side along a circumferential direction on the peripheral wall to form a plurality of slots (220) between adjacent side walls (216-1, 216-2, 218-1, 218-2) on the peripheral wall.

2. The electrical member (200) as claimed in claim 1, wherein each slot (220) is formed between the first side wall (216-1) of one tapered tooth and the second side wall (218-2) of an adjacent straight tooth (210-2), wherein the first side wall (216-1) of the one tapered tooth (210-1) and the second side wall (218-2) of the adjacent straight tooth (210-2) are substantially parallel.

3. The electrical member (200) as claimed in claim 1, wherein the slot (220) is adapted to receive one or more conductors for forming windings of the electrical member (200).

4. The electrical member (200) as claimed in claim 1, wherein the electrical member (200) is one of a stator or a rotor of the electrical machine.

5. An electrical member (200) for an electrical machine, the electrical member (200) comprising:

a body portion (208) having a cylindrical shape; and

a plurality of tapered teeth (210-1) extending in a radial direction from a peripheral wall of the body portion (208), wherein each tapered tooth (210-1) has a first side wall (216-1) and a second side wall (216-2), the first side wall (216-1) and the second side wall (216-2) being substantially perpendicular to surface of the body portion (208) and extending along a radial direction, wherein the first side wall (216-1) is tapered with respect to the second side wall (216-2) along the radial direction;

a plurality of straight teeth (210-2) extending in the radial direction from the peripheral wall of the body portion (208), each straight tooth (210-2) having a first side wall (218-1) and a second side wall (218-2), wherein the first side wall (218-1) and the second side wall (218-2) are substantially perpendicular to surface of the body portion (208) and extend along the radial direction, the first side wall (218-1) being parallel to the second side wall (218-2) along the radial direction, and wherein each straight tooth (210-2) is flanked by a tapered tooth (210-1) on either side along a circumferential direction on the peripheral wall to form a slot set (222) having two slots (220) formed between a side wall (216-1) of one tapered tooth (210-1) and one side wall (218-2) of an adjacent straight tooth (210-2), and between other side wall (218-1) of the adjacent straight tooth (210-2) and a side wall (216-2) of a subsequent tapered tooth (210-1), and wherein the two slots (220) of the slot set (222) are substantially parallel to each other; and

one or more conductors inserted into the slot set (222) to form windings of the electrical member (200).

6. The electrical member (200) as claimed in claim 5, wherein each of the plurality of conductors is formed as U-shaped conductor having two limbs, one limb of the U-shaped conductor being inserted into one slot (220) of the slot set (222) and other limb

being inserted into other slot (220) of the slot set (222), and a U-bend of the conductor being positioned on the straight tooth (210-2).

5 7. The electrical member (200) as claimed in claim 5, wherein the plurality of conductors inserted into the slot set (222) are connected to one phase of an electrical system.

8. The electrical member (200) as claimed in claim 5, wherein each of the plurality of conductors has a rectangular cross-section.

10 9. The electrical member (200) as claimed in claim 5, wherein the windings are single layer windings.

10. The electrical member (200) as claimed in claim 5, wherein a coil pitch of the windings is 1.

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11. The electrical member (200) as claimed in claim 5, wherein a fill factor of the electrical member (200) is about 80%.

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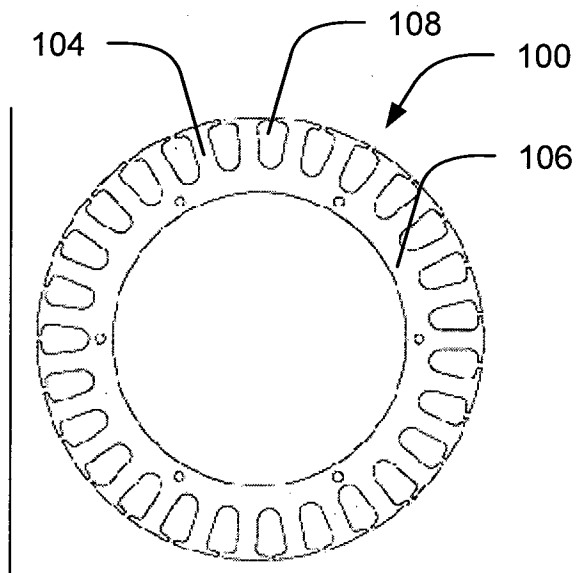


Fig. 1a-1

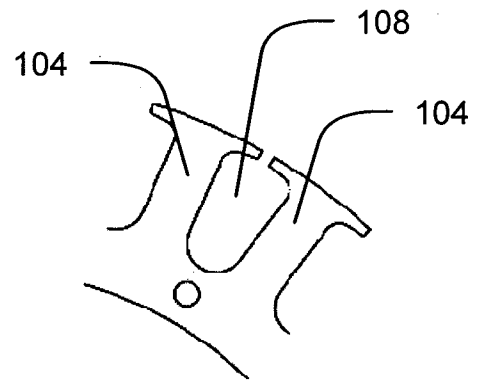


Fig. 1a-2

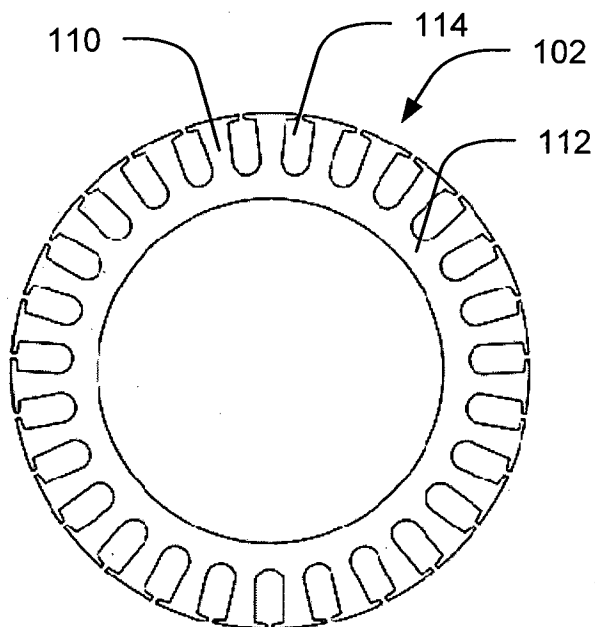


Fig. 1b-1

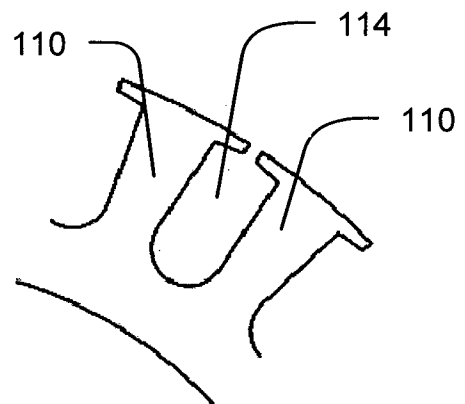


Fig. 1b-2

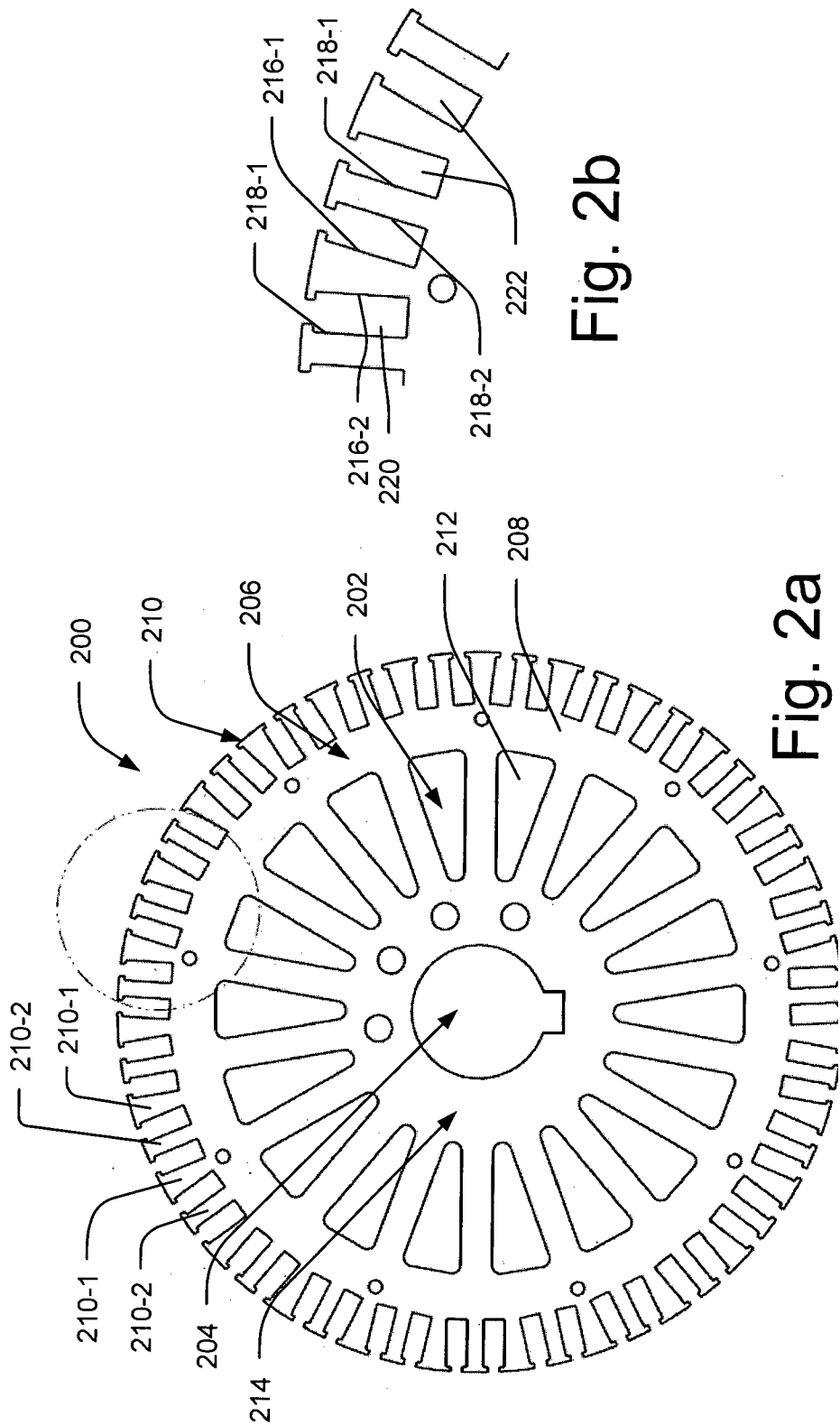


Fig. 2b

Fig. 2a