

CLAIMS

[Claim 1] A rotor comprising:

a rotor core; and

a plurality of secondary conductors disposed in the rotor core at an interval in a
5 circumferential direction of the rotor core, wherein:

the rotor core including a plurality of insertion holes formed so as to penetrate
the rotor core in an axial direction of the rotor core, the insertion holes into which the
secondary conductors are inserted,

the rotor core including a slot provided outside each of the secondary conductors
10 in a radial direction of the rotor core, the slot open to an outside in the radial direction,
each of the secondary conductors exposed to the outside in the radial direction
through the slot,

the rotor core including a pair of end surfaces provided so as to face each other
with the slot interposed between the pair of end surfaces in the circumferential direction;
15 and

at least one of each of the secondary conductors or each of the insertion holes
has a shape symmetrical in the circumferential direction with respect to a reference line
defined so as to intersect a center axis of the rotor core and pass through a center of each
of the secondary conductors in the circumferential direction,

20 the pair of end surfaces are asymmetrical in the circumferential direction with
respect to the reference line, and

in a slot rear end surface and a slot front end surface which form a pair of end
surfaces, the slot rear end surface is positioned in the rear with respect to the reference
line in the circumferential direction and the slot front end surface is positioned in the
25 front with respect to the reference line in the circumferential direction.

[Claim 2] A rotor core for an induction motor, the rotor core comprising:

a plurality of insertion holes formed so as to penetrate the rotor core in an axial direction of the rotor core, the insertion holes into which a secondary conductor is inserted;

5 a slot provided in a portion positioned outside each of the insertion holes in a radial direction of the rotor core, the slot open to an outside in the radial direction of the rotor core; and

a pair of end surfaces provided so as to face each other with the slot interposed between the pair of end surfaces in a circumferential direction of the rotor core,

10 each of the insertion holes being symmetrical in the circumferential direction with respect to a reference line defined so as to intersect a center axis of the rotor core and pass through a center of each of the insertion holes in the circumferential direction,

the pair of end surfaces being asymmetrical in the circumferential direction with respect to the reference line, and

15 in a slot rear end surface and a slot front end surface which form a pair of end surfaces, the slot rear end surface is positioned in the rear with respect to the reference line in the circumferential direction and the slot front end surface is positioned in the front with respect to the reference line in the circumferential direction.

[Claim 3] An induction motor comprising:

20 a stator being annular; and

the rotor according to claim 1 disposed in the stator.

[Claim 4] The induction motor according to claim 3, wherein

θ_f satisfies $0 \leq \theta_f \leq 0.45\theta_s$,

θ_b satisfies $-0.8\theta_f \leq \theta_b < 0$ when θ_f satisfies $0 \leq \theta_f \leq 0.25\theta_s$, and θ_b satisfies $\theta_f -$

25 $0.45\theta_s \leq \theta_b < 0$ when θ_f satisfies $0.25\theta_s < \theta_f \leq 0.45\theta_s$ wherein

θ_f represents a separation angle of a rotation front end portion of the slot with respect to a rotation front reference location of each of the secondary conductors toward a rotation front,

θ_b represents a separation angle of a rotation rear end portion of the slot with respect to a rotation rear reference location of each of the secondary conductors toward a rotation rear,

the rotation front reference location is a point where a straight line intersects an outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing through an end portion of a side surface of each of the secondary conductors on a rotation front side on an outside in a radial direction, and intersects the center axis of the rotor core,

the rotation front end portion is an end portion of an end surface of the pair of end surfaces on a rotation front side on an outside in a radial direction,

the rotation rear reference location is a point where a straight line intersects the outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing through an end portion of a side surface of each of the secondary conductors on a rotation rear side on an outside in a radial direction, and intersects the center axis of the rotor core,

the rotation rear end portion is an end portion of an end surface of the pair of end surfaces on a rotation rear side on an outside in a radial direction, and

θ_s satisfies $\theta_s = 360 [\text{deg}]/N_{\text{slot}}$ wherein N_{slot} means a number of slots of the stator.

[Claim 5] The induction motor according to claim 3, wherein

θ_b satisfies $0 \leq \theta_b \leq 0.5\theta_s$,

θ_f satisfies $-0.45\theta_b \leq \theta_f \leq 0$ when θ_b satisfies $0 \leq \theta_b < 0.45\theta_s$, and θ_f satisfies $4\theta_b - 2\theta_s \leq \theta_f \leq 0$ when θ_b satisfies $0.45\theta_s \leq \theta_b \leq 0.5\theta_s$ wherein

θ_f represents a separation angle of a rotation front end portion of the slot with
 5 respect to a rotation front reference location of each of the secondary conductors toward
 a rotation front,

θ_b represents a separation angle of a rotation rear end portion of the slot with
 respect to a rotation rear reference location of each of the secondary conductors toward a
 rotation rear,

10 the rotation front reference location is a point where a straight line intersects an
 outer circumference circle of the rotor core, the straight line that bisects a central angle
 formed by the reference line with a straight line intersecting the center axis and passing
 through an end portion of a side surface of each of the secondary conductors on a rotation
 front side on an outside in a radial direction, and intersects the center axis of the rotor
 15 core,

the rotation front end portion is an end portion of an end surface of the pair of
 end surfaces on a rotation front side on an outside in a radial direction,

the rotation rear reference location is a point where a straight line intersects the
 outer circumference circle of the rotor core, the straight line that bisects a central angle
 20 formed by the reference line with a straight line intersecting the center axis and passing
 through an end portion of a side surface of each of the secondary conductors on a rotation
 rear side on an outside in a radial direction, and intersects the center axis of the rotor
 core,

the rotation rear end portion is an end portion of an end surface of the pair of end
 25 surfaces on a rotation rear side on an outside in a radial direction, and

θ_s satisfies $\theta_s = 360 [\text{deg}]/N_{\text{slot}}$ wherein N_{slot} means a number of slots of the stator.

[Claim 6] The induction motor according to claim 3, wherein

θ_f satisfies $0 \leq \theta_f \leq 0.45\theta_s$,

5 θ_b satisfies $-0.8\theta_f \leq \theta_b$ when θ_f satisfies $0 \leq \theta_f \leq 0.25\theta_s$, θ_b satisfies $-0.25\theta_s \leq \theta_b$ when θ_f satisfies $0.25\theta_s < \theta_f \leq 0.35\theta_s$, and θ_b satisfies $2\theta_f - 0.9\theta_s \leq \theta_b$ when θ_f satisfies $0.35\theta_s < \theta_f \leq 0.45\theta_s$ wherein

θ_f represents a separation angle of a rotation front end portion of the slot with respect to a rotation front reference location of each of the secondary conductors toward
10 a rotation front,

θ_b represents a separation angle of a rotation rear end portion of the slot with respect to a rotation rear reference location of each of the secondary conductors toward a rotation rear,

the rotation front reference location is a point where a straight line intersects an
15 outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing through an end portion of a side surface of each of the secondary conductors on a rotation front side on an outside in a radial direction, and intersects the center axis of the rotor core,

20 the rotation front end portion is an end portion of an end surface of the pair of end surfaces on a rotation front side on an outside in a radial direction,

the rotation rear reference location is a point where a straight line intersects the outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing
25 through an end portion of a side surface of each of the secondary conductors on a rotation

rear side on an outside in a radial direction, and intersects the center axis of the rotor core,

the rotation rear end portion is an end portion of an end surface of the pair of end surfaces on a rotation rear side on an outside in a radial direction, and

5 θ_s satisfies $\theta_s = 360 [\text{deg}]/N_{\text{slot}}$ wherein N_{slot} means a number of slots of the stator.

[Claim 7] The induction motor according to claim 3, wherein

θ_b satisfies $0 \leq \theta_b \leq 0.5\theta_s$,

θ_f satisfies $-0.8\theta_b \leq \theta_f$ when θ_b satisfies $0 \leq \theta_b \leq 0.25\theta_s$, and θ_f satisfies $-0.2\theta_s$
10 $\leq \theta_f$ when θ_b satisfies $0.25\theta_s < \theta_b \leq 0.5\theta_s$ wherein

θ_f represents a separation angle of a rotation front end portion of the slot with respect to a rotation front reference location of each of the secondary conductors toward a rotation front,

θ_b represents a separation angle of a rotation rear end portion of the slot with
15 respect to a rotation rear reference location of each of the secondary conductors toward a rotation rear,

the rotation front reference location is a point where a straight line intersects an outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing
20 through an end portion of a side surface of each of the secondary conductors on a rotation front side on an outside in a radial direction, and intersects the center axis of the rotor core,

the rotation front end portion is an end portion of an end surface of the pair of end surfaces on a rotation front side on an outside in a radial direction,

25 the rotation rear reference location is a point where a straight line intersects the

outer circumference circle of the rotor core, the straight line that bisects a central angle formed by the reference line with a straight line intersecting the center axis and passing through an end portion of a side surface of each of the secondary conductors on a rotation rear side on an outside in a radial direction, and intersects the center axis of the rotor

5 core,

the rotation rear end portion is an end portion of an end surface of the pair of end surfaces on a rotation rear side on an outside in a radial direction, and

θ_s satisfies $\theta_s = 360 [\text{deg}]/N_{\text{slot}}$ wherein N_{slot} means a number of slots of the stator.

10 [Claim 8] A method of designing the induction motor according to any one of claims 3 to 7, the method comprising:

calculating a magnetic flux in the induction motor according to positions of the pair of end surfaces, a number of stator slots formed in the stator, and a number of the secondary conductors, and designing the induction motor on a basis of a calculation

15 result.