CLAIMS

What is claimed is:

1. A rotating electrical machine comprising:

a stator;

a rotor; and

a casing that accommodates the stator and the rotor,

wherein at least one of

Condition 1: a thermal conductivity A of a non-oriented electrical steel sheet that is used for a core of the stator is in a range of 12 to 35 W/(m·K), a thermal conductivity B of a non-oriented electrical steel sheet that is used for a core of the rotor is in a range of 10 to 33 W/(m·K), and both the thermal conductivities have a relationship of an expression (1) of A > B, and

Condition 2: a thermal diffusivity A1 of the non-oriented electrical steel sheet that is used for the core of the stator is in a range of 3.0×10^{-6} to 9.0×10^{-6} $m^2/sW/(m \cdot K)$, a thermal diffusivity B1 of the non-oriented electrical steel sheet that is used for the core of the rotor is in a range of 2.5×10^{-6} to 8.5×10^{-6} $m^2/sW/(m \cdot K)$, and both the thermal diffusivities have a relationship of an expression (3) of A1 > B1

is satisfied,

wherein a chemical composition of each of the non-oriented electrical steel sheets that are used for the core of the stator and the core of the rotor includes, by mass%,

C: 0.0100% or less,

Si: 2.6% or more and 4.5% or less,

Mn: 0.1% or more and 3.0% or less,

P: 0.15% or less,

S: 0.0030% or less,

N: 0.0040% or less,

Al: 0.1% or more and 2.0% or less,

one or more selected from Sn and Sb: 0% to 0.200%,

Cr: 0% to 0.400%,

Ni: 0% to 5.0%,

Cu: 0% to 5.0%,

Ca: 0% to 0.010%,

Mg: 0% to 0.0100%,

a rare earth element (REM): 0% to 0.010%,

B: 0% to 0.0050%,

Ti: 0.0030% or less,

O: 0.0200% or less, and

a remainder consisting of Fe and impurities, and

wherein a value of an expression (2) below for the non-oriented electrical steel sheet that is used for the core of the stator is lower than a value of the expression (2) for the non-oriented electrical steel sheet that is used for the core of the rotor,

Expression (2): $9.9 + 12.4 \times Si\ (mass\%) + 6.6 \times Mn\ (mass\%) + 10.0 \times Al\ (mass\%)$.

2. The rotating electrical machine according to claim 1, wherein the expression (1) of condition 1 is $A > 1.003 \times B$ and the expression (3) of condition 2 is $A1 > 1.005 \times B1$.

3. The rotating electrical machine according to claim 1 or 2, wherein the condition 1 is satisfied.

4. The rotating electrical machine according to claim 1 or 2, wherein the condition 2 is satisfied.

5. The rotating electrical machine according to claim 1, wherein the chemical composition of the non-oriented electrical steel sheet includes P: less than 0.03% by mass%.

6. The rotating electrical machine according to any one of claims 1 to 5, wherein the chemical composition of the non-oriented electrical steel sheet includes Cr: 0.001% to 0.400% by mass%, and satisfies an expression (4)

Expression (4): Cr (mass%) × O (mass%) < 8.0×10^{-5}.

7. The rotating electrical machine according to any one of claims 1 to 6, wherein a grain size of the non-oriented electrical steel sheet that is used for the core of the rotor is less than 80 μm.

8. A stator core and rotor core set that is used for the rotating electrical machine according to any one of claims 1 to 7

wherein at least one of

Condition 1: a thermal conductivity A of a non-oriented electrical steel sheet that is used for a core of the stator is in a range of 12 to 35 W/(m·K), a thermal conductivity B of a non-oriented electrical steel sheet that is used for a core of the rotor is in a range of 10 to 33 W/(m·K), and both the thermal conductivities have a relationship of an expression (1) of A > B, and

Condition 2: a thermal diffusivity A1 of the non-oriented electrical steel sheet that is used for the core of the stator is in a range of 3.0×10^{-6} to 9.0×10^{-6} m^2/sW/(m·K), a thermal diffusivity B1 of the non-oriented electrical steel sheet that is used for the core of the rotor is in a range of 2.5×10^{-6} to 8.5×10^{-6} m^2/sW/(m·K), and both the thermal diffusivities have a relationship of an expression (3) of A1 > B1

is satisfied,

wherein a chemical composition of each of the non-oriented electrical steel

sheets that are used for the core of the stator and the core of the rotor includes, by mass%,

C: 0.0100% or less,

Si: 2.6% or more and 4.5% or less,

Mn: 0.1% or more and 3.0% or less,

P: 0.15% or less,

S: 0.0030% or less,

N: 0.0040% or less,

Al: 0.1% or more and 2.0% or less,

one or more selected from Sn and Sb: 0% to 0.200%,

Cr: 0% to 0.400%,

Ni: 0% to 5.0%,

Cu: 0% to 5.0%,

Ca: 0% to 0.010%,

Mg: 0% to 0.0100%,

a rare earth element (REM): 0% to 0.010%,

B: 0% to 0.0050%,

Ti: 0.0030% or less,

O: 0.0200% or less, and

a remainder consisting of Fe and impurities, and

wherein a value of an expression (2) below for the non-oriented electrical steel sheet that is used for the core of the stator is lower than a value of the expression (2) for the non-oriented electrical steel sheet that is used for the core of the rotor,

Expression (2): $9.9 + 12.4 \times \text{Si (mass\%)} + 6.6 \times \text{Mn (mass\%)} + 10.0 \times \text{Al (mass\%)}$.

9. A method of manufacturing a non-oriented electrical steel sheet for a

stator and a non-oriented electrical steel sheet for a rotor of the rotating electrical machine according to claim 1, wherein when a non-oriented electrical steel sheet in which a chemical composition includes, by mass%,

C: 0.0100% or less,

Si: 2.6% or more and 4.5% or less,

Mn: 0.1% or more and 3.0% or less,

P: 0.15% or less,

S: 0.0030% or less,

N: 0.0040% or less,

Al: 0.1% or more and 2.0% or less,

one or more selected from Sn and Sb: 0% to 0.200%,

Cr: 0% to 0.400%,

Ni: 0% to 5.0%,

Cu: 0% to 5.0%,

Ca: 0% to 0.010%,

Mg: 0% to 0.0100%,

a rare earth element (REM): 0% to 0.010%,

B: 0% to 0.0050%,

Ti: 0.0030% or less,

O: 0.0200% or less, and

a remainder consisting of Fe and impurities is manufactured by a process that include steelmaking, hot rolling, hot-rolled sheet annealing, pickling, cold rolling, and final annealing, two types of annealing temperatures for the final annealing are set and a final annealing temperature of the non-oriented electrical steel sheet for the rotor is set to a temperature in a range of 600°C to 900°C, which is lower than a final

annealing temperature of the non-oriented electrical steel sheet for the stator, so that at least one of an expression (1) of A > B and an expression (3) of A1 > B1 is satisfied,

wherein a value of an expression (2) below for the non-oriented electrical steel sheet that is used for the stator is lower than a value of the expression (2) for the non-oriented electrical steel sheet that is used for the rotor,

Expression (2): 9.9 + 12.4 × Si (mass%) + 6.6 × Mn (mass%) + 10.0 × Al (mass%).

10. The method of manufacturing a non-oriented electrical steel sheet for a stator and a non-oriented electrical steel sheet for a rotor of the rotating electrical machine according to claim 9, wherein the expression (1) of condition 1 is A > 1.003×B and the expression (3) of condition 2 is A1 > 1.005×B1.

11. The method of manufacturing a non-oriented electrical steel sheet for a stator and a non-oriented electrical steel sheet for the rotor of a rotating electrical machine according to claim 9 or 10, wherein the expression (1) is satisfied.

12. The method of manufacturing a non-oriented electrical steel sheet for a stator and a non-oriented electrical steel sheet for a rotor of the rotating electrical machine according to claim 9 or 10, wherein the expression (3) is satisfied.

13. The method of manufacturing a non-oriented electrical steel sheet for a stator and a non-oriented electrical steel sheet for the rotor of a rotating electrical machine according to any one of claims 9 to 12, wherein the chemical composition of the non-oriented electrical steel sheet includes P: less than 0.03% by mass%.

14. The method of manufacturing a non-oriented electrical steel sheet for a stator and a non-oriented electrical steel sheet for a rotor of the rotating electrical machine according to any one of claims 9 to 13, wherein the chemical composition of the non-oriented electrical steel sheet includes Cr: 0.001% to 0.400% by mass%.

15. A method of manufacturing a stator and a rotor of the rotating electrical

machine according to claim 1, comprising:

manufacturing a non-oriented electrical steel sheet in which a chemical composition includes, by mass%,

C: 0.0100% or less,

Si: 2.6% or more and 4.5% or less,

Mn: 0.1% or more and 3.0% or less,

P: 0.15% or less,

S: 0.0030% or less,

N: 0.0040% or less,

Al: 0.1% or more and 2.0% or less,

one or more selected from Sn and Sb: 0% to 0.200%,

Cr: 0% to 0.400%,

Ni: 0% to 5.0%,

Cu: 0% to 5.0%,

Ca: 0% to 0.010%,

Mg: 0% to 0.0100%,

a rare earth element (REM): 0% to 0.010%,

B: 0% to 0.0050%,

Ti: 0.0030% or less,

O: 0.0200% or less, and

a remainder consisting of Fe and impurities, by a process that include steelmaking, hot rolling, hot-rolled sheet annealing, pickling, cold rolling, and final annealing;

punching out a material that is used for a stator and a material that is used for a rotor from the obtained non-oriented electrical steel sheet and stacking the materials;

and

performing stress relief annealing only on the stator such that at least one of an expression (1) of A > B and an expression (3) of A1 > B1 is satisfied,

wherein a value of an expression (2) below for the material that is used for the stator is lower than a value of the expression (2) for the material that is used for the rotor,

Expression (2): 9.9 + 12.4 × Si (mass%) + 6.6 × Mn (mass%) + 10.0 × Al (mass%).

16. The method of manufacturing a stator and a rotor of the rotating electrical machine according to claim 15, wherein the expression (1) of condition 1 is A > 1.003×B and the expression (3) of condition 2 is A1 > 1.005×B1.

17. The method of manufacturing a stator and a rotor according to claim 15 or 16, wherein the expression (1) is satisfied.

18. The method of manufacturing a stator and a rotor according to claim 15 or 16, wherein the expression (3) is satisfied.

19. The method of manufacturing a stator and a rotor of a rotating electrical machine according to any one of claims 15 to 18, wherein the chemical composition of the non-oriented electrical steel sheet includes P: less than 0.03% by mass%.

20. The method of manufacturing a stator and a rotor of a rotating electrical machine according to any one of claims 15 to 19, wherein the chemical composition of the non-oriented electrical steel sheet includes Cr: 0.001% to 0.400% by mass%.

21. A non-oriented electrical steel sheet set that is used for a core material of a rotating electrical machine, wherein at least one of

Condition 1: a thermal conductivity A of a non-oriented electrical steel sheet for a stator is in a range of 12 to 35 W/(m·K), a thermal conductivity B of a non-oriented electrical steel sheet for a rotor is in a range of 10 to 33 W/(m·K), and both the

thermal conductivities have a relationship of an expression (1) of A > B, and

Condition 2: a thermal diffusivity A1 of the non-oriented electrical steel sheet for the stator is in a range of 3.0×10^{-6} to 9.0×10^{-6} $m^2/sW/(m \cdot K)$, a thermal diffusivity B1 of the non-oriented electrical steel sheet for rotor is in a range of 2.5×10^{-6} to 8.5×10^{-6} $m^2/sW/(m \cdot K)$, and both the thermal diffusivities have a relationship of an expression (3) of A1 > B1

is satisfied,

wherein a chemical composition of each of the non-oriented electrical steel sheets that are used for the stator and the rotor includes, by mass%,

C: 0.0100% or less,

Si: 2.6% or more and 4.5% or less,

Mn: 0.1% or more and 3.0% or less,

P: 0.15% or less,

S: 0.0030% or less,

N: 0.0040% or less,

Al: 0.1% or more and 2.0% or less,

one or more selected from Sn and Sb: 0% to 0.200%,

Cr: 0% to 0.400%,

Ni: 0% to 5.0%,

Cu: 0% to 5.0%,

Ca: 0% to 0.010%,

Mg: 0% to 0.0100%,

a rare earth element (REM): 0% to 0.010%,

B: 0% to 0.0050%,

Ti: 0.0030% or less,

O: 0.0200% or less, and

a remainder consisting of Fe and impurities, and

wherein a value of an expression (2) below for the non-oriented electrical steel sheet that is used for the core of the stator is lower than a value of the expression (2) for the non-oriented electrical steel sheet that is used for the core of the rotor,

Expression (2): 9.9 + 12.4 × Si (mass%) + 6.6 × Mn (mass%) + 10.0 × Al (mass%).

22. The non-oriented electrical steel sheet set that is used for a core material of a rotating electrical machine according to claim 21, wherein the expression (1) of condition 1 is $A > 1.003 \times B$ and the expression (3) of condition 2 is $A1 > 1.005 \times B1$.

23. The non-oriented electrical steel sheet set according to claim 21 or 22, wherein the condition 1 is satisfied.

24. The non-oriented electrical steel sheet set according to claim 21 or 22, wherein the condition 2 is satisfied.