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(54) **Titre : REFROIDISSEMENT PAR JET TANGENTIEL POUR MOTEURS ELECTRIQUES**
(54) **Title: TANGENTIAL JET COOLING FOR ELECTRIC MOTORS**

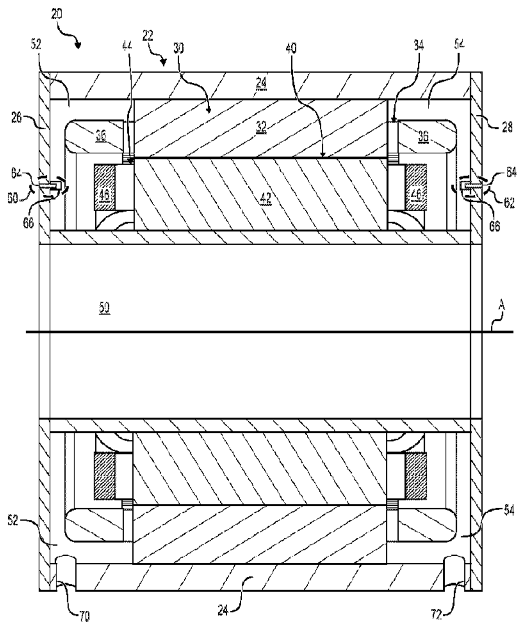

FIG. 1

(57) **Abrégé/Abstract:**
An electric machine includes a stator, a rotor configured to rotate about an axis, and a housing surrounding the rotor and the stator. The housing includes an end cap at an axial end of the electric machine. The housing encloses an end space between the rotor and the end cap. The electric machine also includes a nozzle disposed within the end space and configured to discharge a cooling fluid into the end space in a direction tangential to the rotation of the rotor. The cooling fluid may include liquid, such as oil. The electric machine may be an induction machine or a synchronous machine. The nozzle may include an inlet tube that extends through the end cap. The electric machine may include two end spaces on opposite ends of the rotor, with one or more nozzles located in each of the two end spaces.

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Abstract:

An electric machine includes a stator, a rotor configured to rotate about an axis, and a housing surrounding the rotor and the stator. The housing includes an end cap at an axial end of the electric machine. The housing encloses an end space between the rotor and the end cap. The electric machine also includes a nozzle disposed within the end space and configured to discharge a cooling fluid into the end space in a direction tangential to the rotation of the rotor. The cooling fluid may include liquid, such as oil. The electric machine may be an induction machine or a synchronous machine. The nozzle may include an inlet tube that extends through the end cap. The electric machine may include two end spaces on opposite ends of the rotor, with one or more nozzles located in each of the two end spaces.

TANGENTIAL JET COOLING FOR ELECTRIC MOTORS

FIELD

[0001] The present disclosure relates generally to cooling electric machines, such as electric motors.

BACKGROUND

[0002] Several different techniques may be used for cooling electric machines, such as electric motors or motor/generators. For example, direct jet impingement may be used to directly cool stator end windings. The cooling system is capable of removing large heat loads from the stator windings by the formation of a very thin boundary layer along the windings due to the jet impingement. Integrating this cooling system towards cooling rotor windings may be problematic at high rotational speeds as the impinging jet can bend and deviate from the intended target as it enters a rotating frame. Furthermore, maintaining temperature uniformity throughout the stator windings is only possible with a large number of jets. A large number of jets can also create problems, since jet velocity can decrease with an increase in number of jets leading to reduced heat transfer performance.

[0003] Another technique for cooling electric machines includes shaft cooling, with a cooling system integrated in a motor shaft. Shaft cooling may enable compact packaging, wherein centrifugal forces push coolant through a hollow shaft. However, it is difficult to cool components

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CLAIMS

What is claimed is:

1. An electric machine comprising:

a stator;

a rotor configured to rotate about an axis;

a housing surrounding the rotor and the stator and including an end cap at an axial end of the electric machine, the housing enclosing an end space between the rotor and the end cap; and

a nozzle disposed within the end space and configured to discharge a cooling fluid into the end space in a direction tangential to the rotation of the rotor.

2. The electric machine of claim 1, wherein the nozzle is further configured to discharge the cooling fluid in a same direction as the rotation of the rotor.

3. The electric machine of claim 1, wherein the nozzle includes an inlet tube that extends through the end cap for receiving the cooling fluid.

4. The electric machine of claim 1, wherein the nozzle includes an elbow bend for changing a direction of the cooling fluid prior to the cooling fluid exiting the nozzle.

5. The electric machine of claim 4, wherein the elbow bend is configured to change the direction of the fluid by 90-degrees.

6. The electric machine of claim 1, wherein the housing defines an outlet hole for the cooling fluid to drain out of the end space.

7. The electric machine of claim 6, wherein the outlet hole is located at a lowest point of the end space.

8. The electric machine of claim 1, wherein the end space extends around the stator, with the cooling fluid contacting the stator for removing heat therefrom.

9. The electric machine of claim 1, wherein the stator is located radially outwardly from the rotor; and wherein the rotor is configured to fling the cooling fluid radially outwardly into contact with the stator.

10. The electric machine of claim 1, wherein the rotor includes a rotor lamination and a plurality of rotor windings, with the end space extending between the rotor lamination and the end cap, and with the plurality of rotor windings extending into the end space.

11. The electric machine of claim 1, wherein the stator includes a stator lamination and a plurality of stator windings, with the end space extending between the stator lamination and the end cap, and with the plurality of stator windings extending into the end space.

12. The electric machine of claim 1, wherein the end cap is one of a pair of end caps, with each of the end caps disposed at opposite axial ends of the electric machine, and wherein the

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end space is one of a pair of end spaces, with each of the pair of end spaces located adjacent to corresponding ones of the pair of end caps;

wherein the nozzle is one of a pair of nozzles, with each nozzle of the pair of nozzles disposed within a corresponding one of the pair of end spaces.

13. The electric machine of claim 12, wherein each nozzle of the pair of nozzles includes a corresponding inlet tube that extends through a corresponding one of the pair of end caps for receiving the cooling fluid.

14. The electric machine of claim 1, wherein the stator includes a plurality of stator windings having stator end turns at least partially located circumferentially around the rotor, and the rotor is configured to fling the cooling fluid radially outwardly into contact with the stator end turns to remove heat therefrom.

15. The electric machine of claim 14, wherein the rotor includes a plurality of rotor windings and the stator end turns are at least partially located circumferentially around the plurality of rotor windings, and the rotor is configured to fling the cooling fluid radially outwardly from the rotor windings and into contact with the stator end turns to remove heat therefrom.

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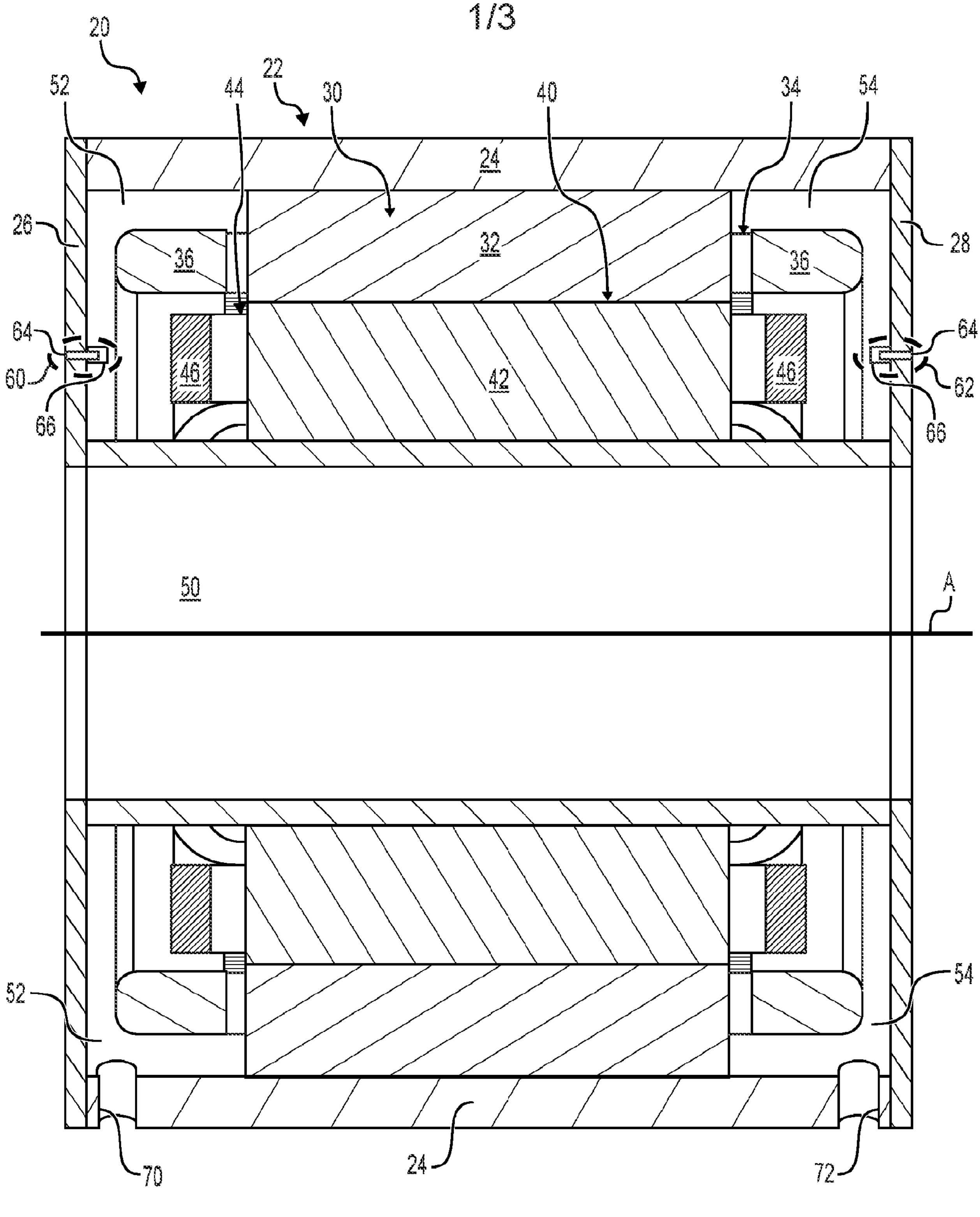
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FIG. 1

FRONT NOZZLE

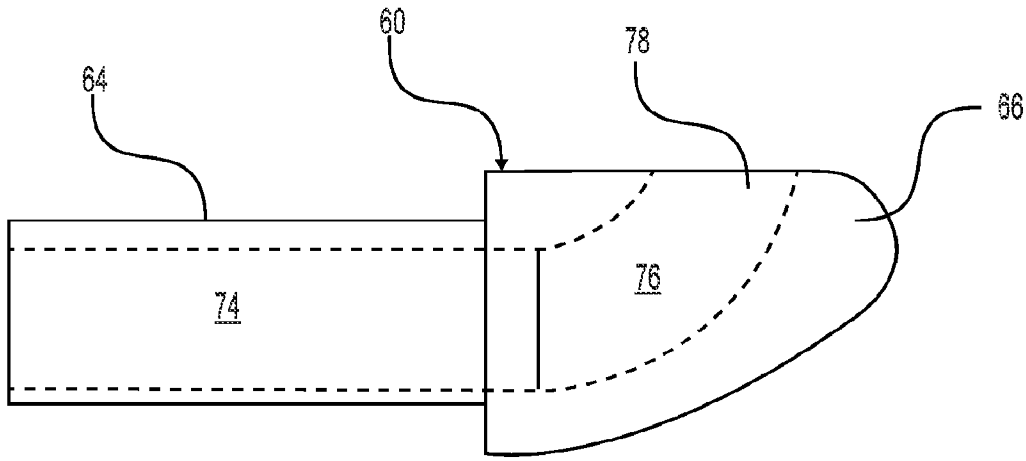

FIG. 2

REAR NOZZLE

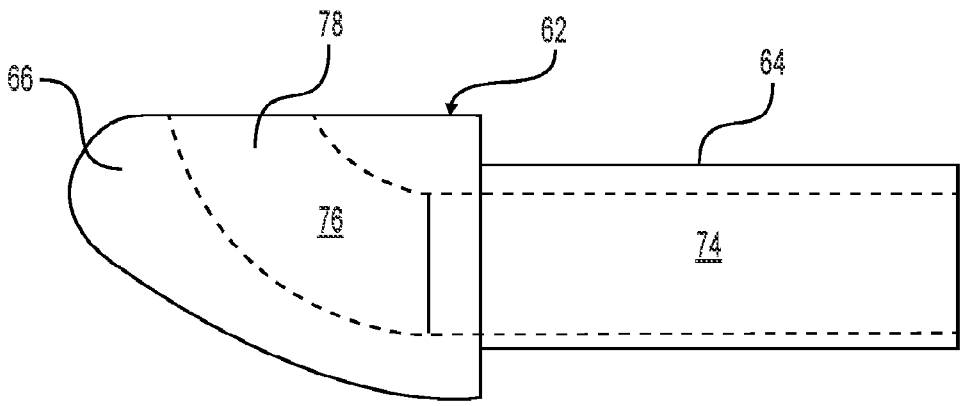

FIG. 3

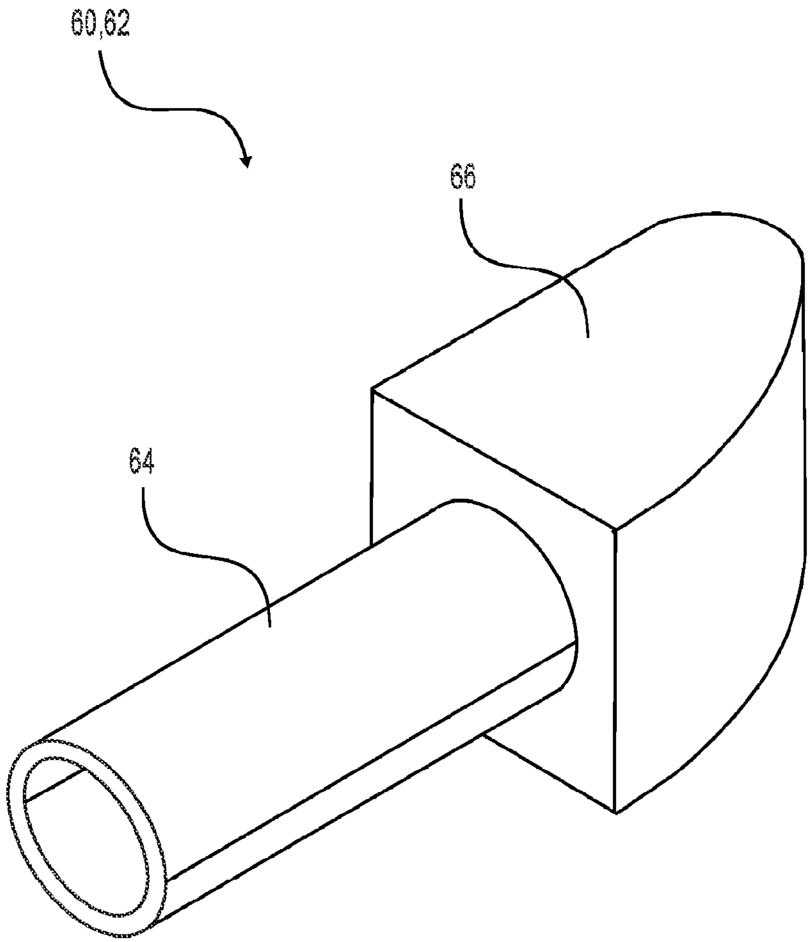

FIG. 4

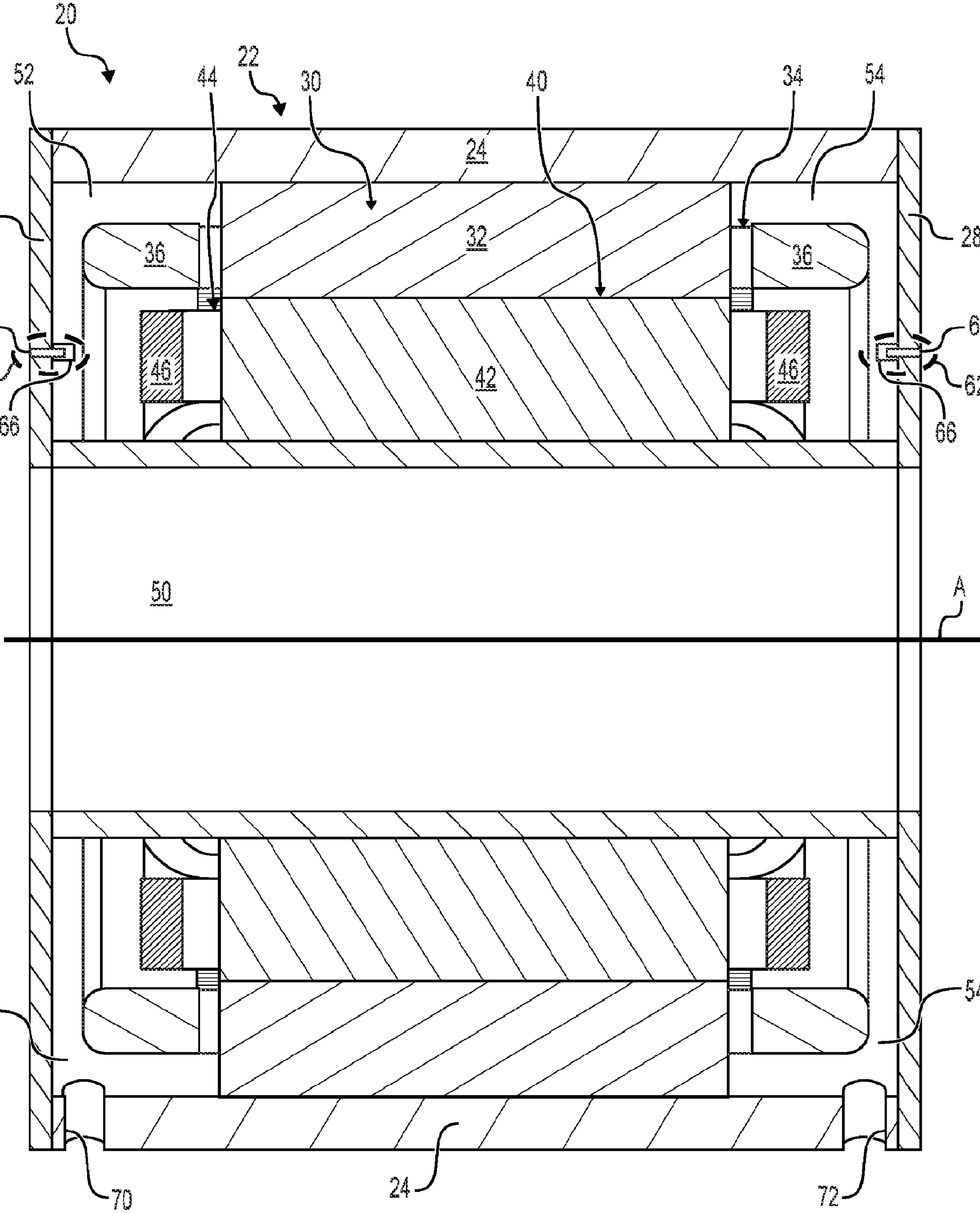

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FIG. 1