Claims

1. A rotor for an electric machine, wherein the rotor comprises:

a central shaft;

a rotor drum arranged radially outward of the central shaft, wherein the rotor drum comprises a hollow cylinder for carrying permanent magnets on an inner and/or outer surface of the hollow cylinder, and wherein the rotor drum is coaxial with both the central shaft and a rotational axis of the rotor;

a first cap arranged to couple the central shaft to the rotor drum to enable the rotor drum and central shaft to rotate together about the rotational axis; and

a second cap arranged to couple the central shaft to the rotor drum, and wherein the second cap is offset from the first cap along the rotational axis of the rotor;

wherein an inner portion of the cap is coupled to the central shaft at a first position along the length of the rotational axis, and an outer portion of the cap is coupled to the rotor drum at a second position along the length of the rotational axis;

wherein the first position is at a different length along the rotational axis to the second position;

wherein an outer diameter of the central shaft varies along its length; and

wherein an inner diameter of the first cap is different to an inner diameter of the second cap.

2. The rotor of claim 1, wherein the cap has a non-uniform material thickness.

3. The rotor of any preceding claim, wherein the cap has at least one spoke extending between the inner portion of the cap and the outer portion of the cap.

4. The rotor of claim 3, wherein each of the at least one spokes is adjacent to an aperture in the cap.

5. The rotor of claim 4, wherein the cap comprises a plurality of spokes and a plurality of apertures.

6. The rotor of claim 5, wherein the spokes in the cap are distributed uniformly about the rotational axis of rotor.

7. The rotor of any preceding claim, wherein an inner portion of the second cap is coupled to the central shaft at a third position along the length of the rotational axis, and an outer

portion of the second cap is coupled to the rotor drum at a fourth position along the length of the rotational axis; and

wherein the third position is at a different length along the rotational axis to the fourth position.

8. The rotor of claim 7, wherein the second position is closer to the fourth position than the third position on the rotational axis of the rotor.

9. The rotor of claim 7 or 8, wherein the distance between the first and second position on the rotational axis of the rotor is the same as the distance between the third and fourth position on the rotational axis of the rotor.

10. The rotor of any preceding claim, wherein the second position on the rotational axis of the rotor is closer to a central region of the shaft than the first position.

11. The rotor of any preceding claim, wherein an internal volume of the hollow cylinder is at least partially filed with a lightweight non-magnetic material, optionally wherein the material comprises a porous medium.

12. The rotor of any preceding claim, wherein the central shaft is hollow, optionally wherein the rotor is arranged to receive a coolant through the hollow central shaft to provide cooling to the rotor drum.

13. The rotor of any preceding claim, wherein the rotor is arranged to carry the permanent magnets on an outer surface of the hollow cylinder; and

wherein the rotor further comprises a liner arranged radially outward of the magnets to secure the magnets to the hollow cylinder.

14. The rotor of any preceding claim, wherein the rotor is arranged to carry the permanent magnets on an inner surface of the hollow cylinder, and wherein one of:

the outer portion of the cap is arranged to couple to the magnets to hold the magnets in place on the inner surface of the hollow cylinder; and

the outer portion of the cap is arranged to couple to the hollow cylinder, and wherein the cap comprises a magnet contacting portion between its inner and outer portions and arranged to contact the magnets to hold the magnets in place on the inner surface.

15. The rotor of any preceding claim, wherein an outer diameter of the hollow cylinder remains constant along the length of the rotational axis, and wherein an inner diameter of the hollow cylinder varies along the length of the rotational axis.

16. The rotor of claim 15, wherein the inner diameter is larger at one or both of the axial ends of the hollow cylinder than in a central region of the hollow cylinder along the rotational axis of the rotor.

17. The rotor of any preceding claim, wherein an inner surface of the rotor drum comprises one or more recesses for receiving the cap therein.

18. The rotor of any preceding claim, wherein the rotor comprises a plurality of permanent magnets carried by the rotor drum; and

wherein the permanent magnets are arranged in a Halbach array on the inner and/or outer surface of the hollow cylinder.

19. The rotor of any preceding claim, wherein the cap comprises at least one feature configured to be detected by a sensor to identify a rotational position of the rotor for controlling operation of a stator.

20. The rotor of any preceding claim, wherein a thickness of the material of the hollow cylinder is approximately the same as a thickness of the material of the cap.

21. An electric machine comprising:

the rotor of any preceding claim;

a stator comprising a plurality of windings arranged to interact with permanent magnets carried by the hollow cylinder of the rotor drum; and

a housing configured to house the rotor and the stator;

wherein the housing comprises at least one bearing assembly arranged to permit rotation of the rotor about its rotational axis relative to the stator and the housing.

22. The electric machine of claim 21, wherein:

the cap comprises a first cap and wherein the rotor further comprises a second cap arranged to couple the central shaft to the rotor drum;

the housing comprises two bearing assemblies: a first bearing assembly provided at a first end of the housing and central shaft, and a second bearing assembly provided at a second end of the housing and central shaft opposite to the first end; and

wherein an inner portion of the first cap is coupled to the central shaft at a location proximal to the first bearing assembly and an inner portion of the second cap is coupled to the central shaft at a location proximal to the second bearing assembly.

23. A wide gap DC electric motor comprising the rotor of any of claims 1 to 20.