

Claims

1. Apparatus for hand tremor stabilisation comprising a rotatable flywheel assembly mountable to a hand of a user; wherein the rotatable flywheel assembly comprises i) a flywheel having a flywheel mass, **m**, and a flywheel diameter, **d**, and ii) a prime mover
5 adapted to rotate the flywheel at a rotational speed, **R**, about a flywheel rotation axis such that the rotatable flywheel assembly generates an angular momentum having a magnitude of between about 0.05 kgm²/s and about 0.30 kgm²/s.
2. The apparatus of claim 1, wherein the mass, **m**, of the flywheel is equal to or less than 2kg, preferably equal to or less than 1kg, more preferably equal to or less than 0.5kg,
10 more preferably between about 0.05kg and 0.5kg, more preferably between about 0.1kg and 0.2kg.
3. The apparatus of claim 1 or claim 2, wherein the flywheel diameter, **d**, is equal to or less than about 150mm, more preferably equal to or less than about 100mm, more preferably equal to or less than about 80mm, more preferably about 50mm.
- 15 4. The apparatus of any preceding claim, wherein the rotational speed, **R**, of the flywheel is between about 5,000 RPM and 70,000 RPM, preferably between about 10,000 RPM and 30,000 RPM, more preferably between about 15,000 RPM and about 30,000 RPM.
5. The apparatus of any preceding claim, further comprising a controller configured to control the prime mover and a sensor arranged to detect a characteristic of a movement of
20 the hand of the user when the rotatable flywheel assembly is mounted to the hand of the user, and wherein the controller is configured to control the prime mover to rotate the flywheel at a rotational speed, **R**, based on the detected characteristic.
6. The apparatus of claim 5, wherein the sensor is arranged to detect a characteristic of a hand tremor when the rotatable flywheel assembly is mounted to the hand of the user,
25 for example an amplitude, frequency, and/or acceleration of a hand tremor.
7. The apparatus of any preceding claim, further comprising a housing, and wherein the rotatable flywheel assembly further comprises a gimbal, wherein the flywheel is mounted to

the gimbal, and wherein the gimbal is pivotally mounted to the housing about a precession axis such that the flywheel can precess with respect to the housing.

8. The apparatus of claim 7, wherein the housing comprises a turntable, the gimbal being pivotally mounted to the turntable to define the precession axis, and wherein the turntable is rotatable about a pivot such that the precession axis can rotate relative to the housing.
9. The apparatus of claim 7, wherein the housing comprises a hinge seat that cooperates with a hinge member of the gimbal to pivotally mount the gimbal to the housing about a precession axis that is fixed relative to the housing.
10. The apparatus of any preceding claim, wherein the flywheel comprises a central disc portion and a circumferential skirt extending in an axial direction of the flywheel rotation axis, the circumferential skirt defining a recessed cavity.
11. The apparatus of claim 10, wherein the recessed cavity comprises at least 50% of the total mass of the flywheel, preferably at least 75% of the total mass of the flywheel.
12. Apparatus for tremor stabilisation comprising a housing that is attachable to a part of a user's body, for example a hand, and a rotatable flywheel assembly mounted to the housing, the rotatable flywheel assembly comprising a rotatable flywheel and a prime mover arranged to rotate the flywheel about a flywheel rotation axis; wherein the flywheel comprises a central disc portion and a circumferential skirt extending in an axial direction of the flywheel rotation axis, the circumferential skirt defining the recessed cavity and comprising at least 50% of the total mass of the flywheel, preferably at least 75% of the total mass of the flywheel.
13. The apparatus of claim 11 or claim 12, wherein the prime mover is at least partly nested in the recessed cavity of the flywheel.
14. The apparatus of any preceding claim, wherein the prime mover comprises an electric motor.
15. The apparatus of claim 14, wherein the electric motor comprises an electric motor having one or more of:

- an aspect ratio of a height dimension in an axial direction of the flywheel rotation axis to a width dimension perpendicular to the height dimension of about 1 or less; and/or
- a brushless electric motor; and/or
- 5 a brushless DC motor; and/or
- a DC motor comprising a diametrically-polarised permanent magnet rotor; and/or
- a DC motor comprising slotless and/or coreless windings and/or
- an axial flux configuration.
- 10 16. A method of manufacturing tremor stabilisation apparatus for attaching to a part of a user's body, for example a hand, the tremor stabilisation apparatus comprising a flywheel for generating gyroscopic forces to stabilise tremors in the user's body part, the method comprising:
- mounting the flywheel to a motor of the tremor stabilisation apparatus to provide a
- 15 rotatable flywheel assembly of the tremor stabilisation apparatus, the rotatable flywheel assembly comprising a rotating element comprising the flywheel and a rotor of the motor;
- using the motor to rotate the rotating element;
- removing material from, or adding material to, the rotating element to balance the
- 20 rotatable flywheel assembly; and
- assembling the rotatable flywheel assembly in a housing of the tremor stabilisation apparatus.
17. The method of claim 16, further comprising attaching the motor and the flywheel to a gimbal comprising a hinge member for a precession axis of the rotatable flywheel
- 25 assembly, mounting the gimbal to an accelerometer assembly via the hinge member, using

the motor to rotate the flywheel on the accelerometer assembly, and removing material from, or adding material to, the rotating element.

18. The method of claim 16 or claim 17, wherein the flywheel is made by turning a material blank on a lathe to form the flywheel, the turning comprising cutting material from the material blank from an end of the material blank opposite to a chuck of the lathe to form a profile of the flywheel, and cutting off the flywheel from the material blank without re-clamping the material blank in the lathe.

19. The method of any of claims 16 to 18, wherein material is removed from, or added to the flywheel by a non-contact process, for example ablation such as laser ablation or electron beam ablation.

20. The method of any of claims 16 to 19, wherein the flywheel comprises a circumferential face, and wherein the step of removing material from, or adding material to, the flywheel comprises removing material from or adding material to at least two planes of the circumferential surface of the flywheel.

21. The method of any of claims 16 to 20, comprising:
using the motor to rotate the flywheel at a first rotational speed,
removing material from, or adding material to, the flywheel,
then using the motor to rotate the flywheel at a second rotation speed, and
then removing material from, or adding material to, the flywheel, wherein the second rotational speed is greater than the first rotational speed.

22. Tremor stabilisation apparatus manufactured according to the method of any of claims 16 to 21.