CLAIMS:

1. Propulsion system assembly comprising:

a driveshaft rotatably mounted to a casing about a drive axis, the driveshaft comprising a first shaft end and an opposite facing second shaft end;

a plurality of electric motor modules in axially stacked relationship with one another with respect to the drive axis to define an electric motor module stack, said plurality being an integer greater than unity, each electric motor module being configured for transmitting a torque to the driveshaft when coupled thereto independently of at least one other said electric motor module;

each electric motor module comprising a controllable clutch arrangement for selectively coupling and decoupling the respective electric motor module with respect to the driveshaft to respectively enable and disable transmission of torque between the respective electric motor module and the driveshaft.

2. The propulsion system assembly according to claim 1, wherein each said electric motor module comprises:

a stator element;

a rotor element rotatably mounted with respect to the stator element, and configured for being reversibly coupled to the drive shaft via the respective clutch arrangement.

3. The propulsion system assembly according to claim 1 or claim 2, wherein each electric motor module has a depth dimension parallel to the drive axis and a width dimension orthogonal to the drive axis, wherein said width dimension is greater than said depth dimension.

4. The propulsion system assembly according to claim 3, wherein a ratio of said width dimension to said depth dimension is between 5 and 20.

5. The propulsion system assembly according to claim 3, wherein a ratio of said width dimension to said depth dimension is greater than 10.

6. The propulsion system assembly according to any one of claims 1 to 5, wherein each said electrical motor module is design to generate the same torque under the same operating conditions as one another.

7. The propulsion system assembly according to any one of claims 1 to 6, wherein each said electrical motor module is design to generate a module design shaft power of 40kW or more than 40kW.

8. The propulsion system assembly according to any one of claims 1 to 7, wherein said propulsion system assembly is configured to provide a design shaft power using all said electric motor modules, wherein said design shaft power is greater than a required shaft power by a shaft power safety margin, wherein said shaft power safety margin is not less than a module design shaft power of at least one said electric motor module.

9. The propulsion system assembly according to any one of claims 1 to 8, wherein for each electric motor module, the respective clutch arrangement comprises an electromechanical clutch independently actuable with respect to the other said clutch arrangements.

10. The propulsion system assembly according to any one of claims 2 to 8, wherein for each electric motor module, the respective clutch arrangement comprises:

- a clutch rotor and a field coil concentrically provided on the rotor element, and
- an armature affixed to the driveshaft,

wherein responsive to actuation of the respective clutch arrangement the clutch rotor frictionally abuts the armature driveshaft to enable transmission of said torque between the respective electric motor module and the driveshaft.

11. The propulsion system assembly according to any one of claims 1 to 10, wherein for each electric motor module, the respective clutch arrangement is actuable responsive to one or more of electric, electronic or digital signals.

12. The propulsion system assembly according to any one of claims 1 to 11, wherein for each electric motor module, the respective clutch arrangement is actuable responsive to the clutch arrangement being subjected to a rotational resistance from the respective electric motor module greater than a predetermined threshold.

13. The propulsion system assembly according to any one of claims 1 to 12, further comprising a first rotor element for aerodynamically generating a first thrust responsive to being turned about said drive axis by the propulsion system assembly.

14. The propulsion system assembly according to claim 13, wherein said first rotor element is affixed to said first shaft end.

15. The propulsion system assembly according to claim 13 or claim 14, wherein said first rotor element comprises any one of a propeller, ducted fan, unducted fan.

16. The propulsion system assembly according to any one of claims 1 to 12, further comprising a second rotor element for aerodynamically generating a second thrust responsive to being turned about said drive axis by the propulsion system assembly.

17. The propulsion system assembly according to claim 16, wherein said second rotor element is affixed to said second shaft end.

18. The propulsion system assembly according to claim 16 or claim 17, wherein said second rotor element comprises any one of a propeller, ducted fan, unducted fan.

19. The propulsion system assembly according to any one of claims 1 to 18, the casing comprising a first casing bracket affixed to a first said electric motor module that is closest to said first shaft end, and a second casing bracket affixed to a second said electric motor module that is closest to said second shaft end, said first casing bracket comprising a first bearing arrangement and said second casing bracket comprising a second bearing arrangement, the driveshaft being rotatably mounted with respect to said first bearing arrangement and said second bearing arrangement.

20. The propulsion system assembly according to any one of claims 1 to 19, wherein in said axially stacked relationship, each pair of axially adjacent said electric motor modules are fixedly connected to one another.

21. The propulsion system assembly according to any one of claims 1 to 20, wherein said electric motor modules are connected to the casing in fixed spatial relationship in said axially stacked relationship.

22. The propulsion system assembly according to any one of claims 1 to 21, wherein said casing comprises a plurality of spacer elements interconnecting each pair of axially adjacent electric motor modules in fixed spatial relationship in said axially stacked relationship.

23. The propulsion system assembly according to any one of claims 1 to 22, further comprising a housing member for enclosing therein at least said casing and said plurality of electric motor modules.

24. The propulsion system assembly according to claim 23, wherein said housing member is configured for pivoting about a pivot axis different from the drive axis.

25. The propulsion system assembly according to claim 24, wherein said pivot axis is orthogonal to the drive axis.

26. The propulsion system assembly according to any one of claims 1 to 25, further comprising a control system for controlling operation of each said electric motor module.

27. The propulsion system assembly according to claim 26, wherein said control system comprises a motor controller for each said electric motor module, each respective motor controller being configured for operating the respective said clutch arrangement, wherein to cause the respective said clutch arrangement to selectively couple and decouple the respective said electric motor module with respect to the driveshaft.

28. The propulsion system according to claim 27, wherein each said motor controller is configured for operating the respective said clutch arrangement to decouple the respective said electric motor module with respect to the driveshaft responsive to a detectable fault being detected in the respective said electric motor module.

29. The propulsion system according to claim 28, wherein said detectable fault comprises a significant reduction in the shaft power generated by the respective said electric motor module as compared with an expected shaft power level.

30. The propulsion system according to claim 28 or claim 29, comprising a detector for detecting said detectable fault, said detector being operatively connected to the control system.

31. The propulsion system according to claim 30, wherein said detector comprises at least one of Hall effect Sensors, Encoders, Resolvers.

32. The propulsion system according to any one of claims 27 to 31, wherein each said motor controller is configured for operating independently of at least one other said motor controller.

33. The propulsion system according to any one of claims 27 to 32, wherein said control system comprises a master controller for controlling operation of the plurality of said motor controllers corresponding to said plurality of electric motor modules.

34. An air vehicle comprising at least one propulsion system assembly as defined in any one of claims 1 to 33.

35. The air vehicle according to claim 34, wherein the air vehicle is a VTOL type air vehicle.

36. The air vehicle according to claim 34 or claim 35, wherein the air vehicle is a manned air vehicle.

37. The air vehicle according to claim 34 or claim 35, wherein the air vehicle is an unmanned air vehicle (UAV).

38. The air vehicle according to any one of claims 34 to 37, each said propulsion system assembly configured for selectively providing vertical thrust for vectored thrust flight and for selectively changing the thrust vector to provide horizontal thrust for aerodynamic flight.

39. The air vehicle according to claim 38, wherein at least one said propulsion system assembly is reversibly tiltable between a horizontal angular disposition for providing horizontal thrust and a vertical angular disposition for providing vertical thrust.

40. The air vehicle according to any one of claims 34 to 39, comprising three said propulsion system assemblies.

41. The air vehicle according to claim 34, wherein said three propulsion system assemblies are in triangular configuration when viewed in plan view.

42. Method for operating an air vehicle, comprising

(a) providing a shaft power requirement for driving a desired rotor at desired operating conditions;

(b) providing a propulsion system assembly as defined in any one of claims 1 to 33, wherein each said electric motor module is designed to provide a module shaft power output at said desired operating conditions, wherein said integer is chosen such that a shaft power output of the stack, defined as a product of said integer and said module shaft power output, matches or exceeds said shaft power requirement.

43. Method according to claim 42, comprising modifying said shaft power requirement and correspondingly modifying said integer by increasing or decreasing said plurality of said electric motor modules such that a modified product of said modified integer and said module shaft power output matches or exceeds said modified shaft power requirement.

44. Method according to claim 42 or claim 43, comprising adding additional said electric motor modules to said electric motor module stack to thereby increase said shaft power output of the thus modified propulsion system assembly as compared with the unmodified said propulsion system assembly.

45. Method according to claim 42 or claim 43, comprising removing at least one said electric motor modules from said electric motor module stack to thereby decrease said shaft power output of the thus modified propulsion system assembly as compared with the unmodified said propulsion system assembly.

46. Method according to any one of claims 42 to 45, comprising monitoring operation of each said electric motor module and operating the respective said clutch arrangement thereof to decouple the respective said electric motor module from the driveshaft responsive to a detectable fault being detected in operation of the respective said electric motor module.

47. Method according to any one of claims 42 to 46, wherein said shaft power requirement is determined for vectored thrust flight, and further comprising operating the propulsion system assembly in aerodynamic flight with a reduced number of electric motor modules coupled to the driveshaft, said reduced number being at least one less than said integer.

48. Method according to claim 47, wherein each said electric motor module of said reduced number of electric motor modules operates at maximum efficiency during said aerodynamic flight.

49. Method according to claim 47 or claim 48 wherein a ratio of said integer to said reduced number is between 5 and 10.

50. An electric motor module, comprising

a stator element;

a rotor element rotatably mounted with respect to the stator element,

a controllable clutch arrangement for selectively coupling and decoupling the electric motor module with respect to a driveshaft to respectively enable and disable transmission of torque between the electric motor module and the driveshaft.