CLAIMS:

1. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region, wherein the winding housing and the first annular structure together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly; and

a plurality of strut supports attached to the coil head assembly and for supporting and holding the coil head assembly at a predetermined distance from a first surface, wherein the plurality of strut supports extend away from the coil head assembly toward a hypothetical plane that is parallel to and on one side of the coil head assembly, and wherein the plurality of strut supports support said coil head assembly and no other coil head assembly, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

2. The superconductive magnet assembly of claim 1, wherein the predetermined distance is at least 20 centimeters.

3. The superconductive magnet assembly of claim 1, wherein the coil housing and the coil head container form an annular region therebetween and wherein the superconductive magnet assembly further comprises:

a first cooling system for cryogenically cooling the superconductive coil; and

a second cooling system separate from the first cooling system for providing a coolant to said annular region.

4. The superconductive magnet assembly of claim 3, wherein the first cooling system comprises a thermally conducting rod that thermally contacts the superconductive coil.

5. The superconductive magnet assembly of claim 3, wherein the first cooling system is for providing a cryogenic coolant to the winding housing.

6. The superconductive magnet assembly of claim 3, further comprising a plurality of coolant channels proximate to the outer electrically conducting surface of the coil head container and

wherein the second cooling system is for providing a coolant to the plurality of coolant channels for cooling the coil head container.

7. The superconductive magnet assembly of claim 3, further comprising a base plate assembly to which the plurality of strut supports are attached.

8. The superconductive magnet assembly of claim 3, wherein the first cooling system comprises a passageway within with one of said plurality of strut supports for carrying a cryogenic coolant to the superconductive coil within the first container.

9. The superconductive magnet assembly of claim 8, wherein the second cooling system comprises a channel formed within one of said plurality of strut supports for carrying a coolant to the annular region.

10. The superconductive magnet assembly of claim 3, further comprising a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form the superconducting coil subassembly circumscribing the central region.

11. The superconductive magnet assembly of claim 10, further comprising a conductor passing up through one of the plurality of strut supports and connected to the second container for applying a high voltage to the coil head container.

12. The superconductive magnet assembly of claim 10, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the dielectric region has a thickness of D and an effective dielectric strength K and wherein D is selected to be greater than V_{max}/K.

13. The superconductive magnet assembly of claim 3, wherein each strut support among the plurality of strut supports comprises a support rod and a region of thermal insulation surrounding the support rod and a dielectric region surrounding the region of thermal insulation.

14. The superconductive magnet assembly of claim 1, wherein the coil head container is torroidal.

15. A superconductive magnet assembly, comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region, wherein the winding housing and the first annular structure together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly,

wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly;

a plurality of strut supports attached to the coil head assembly and for supporting and holding the coil head assembly at a predetermined distance from a first surface, wherein the plurality of strut supports extend away from the coil head assembly toward a hypothetical plane that is parallel to and on one side of the coil, and wherein the plurality of strut supports support only said coil head assembly and no other coil head assembly; and

a vacuum chamber with the coil head container positioned and supported within the vacuum chamber by the plurality of strut supports.

16. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region;

a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form a superconducting coil subassembly circumscribing the central region; and

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly.

17. The superconductive magnet assembly of claim 16, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly and wherein said superconductive magnet assembly further comprises a plurality of strut supports attached to the coil head assembly and for holding the coil head assembly at a predetermined distance from a first surface.

18. The superconductive magnet assembly of claim 17, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

19. The superconductive magnet assembly of claim 17, wherein the predetermined distance is at least 20 centimeters.

20. The superconductive magnet assembly of claim 16, further comprising a base plate assembly to which the plurality of strut supports are attached.

21. The superconductive magnet assembly of claim 20, wherein the coil housing and the coil head container form an annular region therebetween and wherein the superconductive magnet assembly further comprises:

a first cooling system for cryogenically cooling the superconductive coil; and

a second cooling system separate from the first cooling system for providing a coolant to said annular region.

22. The superconductive magnet assembly of claim 21, wherein the first cooling system comprises a passageway within with one of said plurality of strut supports for carrying a cryogenic coolant to the superconductive coil within the first container.

23. The superconductive magnet assembly of claim 22, further comprising a plurality of coolant channels proximate to the electrically conductive outer surface of the coil head container for carrying the coolant to cool the coil head container.

24. The superconductive magnet assembly of claim 16, wherein the dielectric region comprises a material selected from the group consisting of ceramic, polymer, and glass.

25. The superconductive magnet assembly of claim 16, wherein the dielectric region comprises a vacuum separating the coil head container from the first annular structure.

26. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region;

a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure is made of an electrically conductive material and said second enclosed inside region completely contains the superconductive coil subassembly, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly; and

a plurality of strut supports attached to the coil head assembly and for supporting and holding the coil head assembly at a predetermined distance from a first surface.

27. The superconductive magnet assembly of claim 26, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is

characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

28. The superconductive magnet assembly of claim 26, wherein the predetermined distance is at least 20 centimeters.

29. A plasma system comprising:

a superconductive magnet assembly which during operation is in proximity to a plasma within the plasma system;

a cryogenic cooling system for cryogenically cooling the superconductive magnet assembly;

a pumping system for supplying and circulating a dielectric coolant to the superconductive magnet assembly; and

a high voltage power supply for supplying a high voltage to the superconductive magnet assembly,

wherein the superconductive magnet assembly comprises:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings of the superconductive material arranged along the length of the first conduit structure, said winding housing having an outer surface;

a layer of thermal insulation material encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region, wherein the winding housing and the first annular structure together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly, wherein the coil housing and the coil head container form an annular region therebetween;

a first cooling system for cryogenically cooling the superconductive coil; and

a second cooling system separate from the first cooling system comprising a plurality of coolant channels proximate to the electrically conductive outer surface of the coil head container, said second cooling system for providing a coolant to said plurality of coolant channels to cool said coil head container,

wherein during operation cryogenic cooling system supplies a cryogenic coolant to the first cooling system, the second pump supplies the dielectric coolant to the second cooling system, and the high voltage power supply supplies the high voltage to the coil head container.

30. The plasma system of claim 29, further comprising a layer of dielectric material encasing the first annular structure to form a second annular structure that circumscribes the central region,

wherein the winding housing and the first and second annular structures together form the superconducting coil subassembly circumscribing the central region.

31. The plasma system of claim 30, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly and wherein said superconductive magnet assembly further comprises a plurality of strut supports attached to the coil head assembly and for holding the coil head assembly at a predetermined distance from a first surface.

32. The plasma system of claim 30, wherein the plurality of strut supports support only said coil head assembly and no other coil head assembly.

33. The plasma system of claim 31, wherein the predetermined distance is at least 20 centimeters.

34. The plasma system of claim 31, further comprising a vacuum chamber with the coil head container positioned and supported within the vacuum chamber by the plurality of strut supports.

CLAIMS:

1. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region, wherein the winding housing and the first annular structure together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly; and

a plurality of strut supports attached to the coil head assembly and for supporting and holding the coil head assembly at a predetermined distance from a first surface, wherein the plurality of strut supports extend away from the coil head assembly toward a hypothetical plane that is parallel to and on one side of the coil head assembly, and wherein the plurality of strut supports support said coil head assembly and no other coil head assembly, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

2. The superconductive magnet assembly of claim 1, wherein the predetermined distance is at least 20 centimeters.

3. The superconductive magnet assembly of claim 1, wherein the coil housing and the coil head container form an annular region therebetween and wherein the superconductive magnet assembly further comprises:

a first cooling system for cryogenically cooling the superconductive coil; and

a second cooling system separate from the first cooling system for providing a coolant to said annular region.

4. The superconductive magnet assembly of claim 3, wherein the first cooling system comprises a thermally conducting rod that thermally contacts the superconductive coil.

5. The superconductive magnet assembly of claim 3, wherein the first cooling system is for providing a cryogenic coolant to the winding housing.

6. The superconductive magnet assembly of claim 3, further comprising a plurality of coolant channels proximate to the outer electrically conducting surface of the coil head container and wherein the second cooling system is for providing a coolant to the plurality of coolant channels for cooling the coil head container.

7. The superconductive magnet assembly of claim 3, further comprising a base plate assembly to which the plurality of strut supports are attached.

8. The superconductive magnet assembly of claim 3, wherein the first cooling system comprises a passageway within with one of said plurality of strut supports for carrying a cryogenic coolant to the superconductive coil within the first container.

9. The superconductive magnet assembly of claim 8, wherein the second cooling system comprises a channel formed within one of said plurality of strut supports for carrying a coolant to the annular region.

10. The superconductive magnet assembly of claim 3, further comprising a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form the superconducting coil subassembly circumscribing the central region.

11. The superconductive magnet assembly of claim 10, further comprising a conductor passing up through one of the plurality of strut supports and connected to the second container for applying a high voltage to the coil head container.

12. The superconductive magnet assembly of claim 10, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the dielectric region has a thickness of D and an effective dielectric strength K and wherein D is selected to be greater than V_{max}/K.

13. The superconductive magnet assembly of claim 3, wherein each strut support among the plurality of strut supports comprises a support rod and a region of thermal insulation surrounding the support rod and a dielectric region surrounding the region of thermal insulation.

14. The superconductive magnet assembly of claim 1, wherein the coil head container is torroidal.

15. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings

wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region;

a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form a superconducting coil subassembly circumscribing the central region; and

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure has an electrically conductive outer surface and said second enclosed inside region completely contains the superconductive coil subassembly.

16. The superconductive magnet assembly of claim 15, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly and wherein said superconductive magnet assembly further comprises a plurality of strut supports attached to the coil head assembly and for holding the coil head assembly at a predetermined distance from a first surface.

17. The superconductive magnet assembly of claim 16, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

18. The superconductive magnet assembly of claim 16, wherein the predetermined distance is at least 20 centimeters.

19. The superconductive magnet assembly of claim 15, further comprising a base plate assembly to which the plurality of strut supports are attached.

20. The superconductive magnet assembly of claim 19, wherein the coil housing and the coil head container form an annular region therebetween and wherein the superconductive magnet assembly further comprises:

a first cooling system for cryogenically cooling the superconductive coil; and

a second cooling system separate from the first cooling system for providing a coolant to said annular region.

21. The superconductive magnet assembly of claim 20, wherein the first cooling system comprises a passageway within with one of said plurality of strut supports for carrying a cryogenic coolant to the superconductive coil within the first container.

22. The superconductive magnet assembly of claim 21, further comprising a plurality of coolant channels proximate to the electrically conductive outer surface of the coil head container for carrying the coolant to cool the coil head container.

23. The superconductive magnet assembly of claim 15, wherein the dielectric region comprises a material selected from the group consisting of ceramic, polymer, and glass.

24. The superconductive magnet assembly of claim 15, wherein the dielectric region comprises a vacuum separating the coil head container from the first annular structure.

25. A superconductive magnet assembly comprising:

a superconductive coil having one or more windings of superconductive material;

a winding housing formed by a first conduit structure circumscribing a central region and closing on itself to form a first enclosed inside region within the first conduit structure, said first enclosed inside region containing the superconductive coil with the one or more windings wound around the central region, said winding housing having an outer surface;

a region of thermal insulation encasing the outer surface of the winding housing to form a first annular structure that circumscribes the central region;

a dielectric region encasing the first annular structure to form a second annular structure that circumscribes the central region, wherein the winding housing and the first and second annular structures together form a superconducting coil subassembly circumscribing the central region;

a coil head container formed by a second conduit structure circumscribing the central region and closing on itself to form a second enclosed inside region within the coil head container, wherein said second conduit structure is made of an electrically conductive material and said second enclosed inside region completely contains the superconductive coil subassembly, wherein the coil head container and the superconductive coil subassembly within the coil head container form a coil head assembly; and

a plurality of strut supports attached to the coil head assembly and for supporting and holding the coil head assembly at a predetermined distance from a first surface.

26. The superconductive magnet assembly of claim 25, wherein during use a high voltage V_{max} is applied to the coil head container, wherein the predetermined distance is D and is characterized by an effective dielectric strength K, and wherein D is selected to be greater than V_{max}/K.

27. The superconductive magnet assembly of claim 25, wherein the predetermined distance is at least 20 centimeters.