CLAIMS:

1. A high temperature superconducting, HTS, field coil, the HTS field coil comprising:

a plurality of turns comprising HTS material and metallic stabilizer;

a partially insulating layer separating the turns, such that current can be shared between turns via the partially insulating layer;

the partially insulating layer comprising:

an electrically conducting layer coated on one side with a first insulating layer and on the other side with a second insulating layer;

each insulating layer having one or more windows through which electrical contact can be made between the turns and the electrically conducting layer;

wherein the windows in the first insulating layer are offset in the plane of the electrically conducting strip from the windows in the second insulating layer.

2. An HTS field coil according to any preceding claim, wherein the electrically conducting layer is a continuous electrically conducting strip.

3. An HTS field coil according to claim 1, wherein the electrically conducting layer comprises a plurality of regions, each region electrically connecting a respective first window in the first insulating layer to a respective second window in the second insulating layer, and each region being electrically insulated in the plane of the electrically conducting layer from the other regions.

4. An HTS field coil according to claim 3, wherein each region comprises a track between the first and second window, a length of the track between the first and second window being at least twice a width of the track measured perpendicular to the length.

5. An HTS field coil according to claim 4, wherein each track is non-linear.

6. An HTS field coil according to any preceding claim, wherein the windows in the second layer are each a part of a respective via extending through the first insulating layer, the second insulating layer, and the electrically conductive layer, the partially

insulating layer further comprising an insulating cap on each via at the end proximate to the first insulating layer.

7. An HTS field coil according to any preceding claim, wherein the offset distance between each window on one layer and the closest window on the other layer is greater than a thickness of the electrically conducting layer, and/or wherein the offset distance between each window on one layer and the closest window on the other layer is less than 1/5 of the length of a turn of the HTS field coil, more preferably less than 1/10, more preferably less than 1/50.

8. An HTS field coil according to any preceding claim, wherein each insulating layer comprises a plurality of windows offset along a length of the partially insulating layer.

9. An HTS field coil according to claim 8, wherein the windows on each insulating layer are regularly spaced with a spacing that is the same for both insulating layers, and wherein each window has the same area, and/or wherein the windows on one insulating layer are offset from those in the opposing insulating layer such that each window on one insulating layer is equidistant from the two closest windows of the opposing insulating layer.

10. An HTS field coil according to claim 8 or 9, wherein the insulating layers are formed by:

helically wrapping an insulating tape around the electrically conducting layer; or

helically wrapping an insulating tape around the turns;

such that gaps in the helical winding form the windows.

11. An HTS field coil according to any of claims 1 to 7, wherein each insulating layer comprises a single window extending along the length of the insulating layer, and the window on one insulating layer is offset along a width of the partially insulating layer from the window in the other insulating layer.

12. An HTS field coil according to claim 11, wherein the electrically conducting layer is bent such that the portion of the electrically conducting layer exposed by each window lies in the plane of the respective insulating layer.

13. An HTS field coil according to any preceding claim, wherein each insulating layer extends beyond the electrically conducting layer on at least one side.

14. An HTS field coil according to any preceding claim, wherein:

the partially insulating layer comprises electrically conducting inserts in the or each window;

each window is plated with an electrically conducting material; and/or

the electrically conducting layer comprises electrically conducting protrusions which extend into the or each window;

and wherein:

the electrically conducting inserts or protrusions fill the respective window; or

the electrically conducting inserts or protrusions fill only a portion of the respective window, and electrical contact between the electrically conducting layer and the turns through the window is only via the electrically conducting inserts.

15. An HTS field coil according to any preceding claim, wherein the partially insulating layer comprises electrically conducting connection strips located outside the insulating layers and electrically connected to the electrically conducting strip via the windows, wherein the electrically conducting connection strips are electrically connected to the adjacent turns.

16. An HTS field coil according to any preceding claim, wherein the partially insulating layer comprises a plurality of sections connected by butt joints.

17. A method of manufacturing an HTS field coil, the method comprising:

providing an HTS cable, the HTS cable comprising HTS material and metallic stabiliser;

providing a partially insulating layer, the partially insulating layer comprising:

an electrically conducting layer coated on one side with a first insulating layer and on the other side with a second insulating layer;

each insulating layer having one or more windows through which electrical contact can be made between the turns and the electrically conducting layer;

wherein the windows in the first insulating layer are offset in the plane of the electrically conducting layer from the windows in the second insulating layer;

assembling the HTS cable and the partially insulating layer together to form an HTS field coil, such that current can be shared between turns of the HTS cable via the partially insulating layer.

18. A method according to claim 17, wherein providing the partially insulating layer comprises separately providing each of the electrically conducting layer and, insulating layers, and forming the partially insulating layer during winding of the HTS coil.

19. A method according to claim 18, wherein forming the partially insulating layer during winding of the coil comprises attaching the insulating layers to the electrically conducting layer with epoxy and curing the epoxy by the use of heated pressure rollers immediately before winding the partially insulating layer into the coil.

20. A method according to claim 17, wherein providing the partially insulating layer comprises:

bonding the insulating layers to the electrically conducting layer by adhesive;

etching the insulating layers to form the windows.

21. A method according to any of claims 17 to 20, wherein providing the partially insulating layer comprises:

providing a first insulating layer;

coating a surface of the first insulating layer with the electrically conductive layer;

attaching a second insulating layer to the electrically conducting layer;

drilling the windows in the first and second insulating layer.

22. A method according to any of claims 17 to 21, and comprising solder potting the HTS field coil.

23. A method according to claim 22, wherein at least one of the partially insulating layers has an overhang which extends beyond the electrically conducting layer on at least one side, and comprising, following the step of solder potting, machining that side of the HTS coil to a level such that at least a portion of the overhang is removed.

24. A method according to any of claims 22 to 23, and comprising, prior to solder potting, applying a removable mask to one side of the HTS coil, and removing the mask following solder potting.

25. A tokamak fusion reactor comprising an HTS field coil according to any one of claims 1 to 16, wherein the HTS field coil is one of a toroidal field coil or a poloidal field coil.

26. A proton beam therapy, PBT, device comprising an HTS field coil according to any one of claims 1 to 16, wherein the HTS field coil is one of:

a field coil of an accelerator of the PBT device;

a dipole or quadrupole magnet of a proton beam steering system of the PBT device.