SUMMARY ~~OF THE INVENTION~~

It would be advantageous to have improved inductor coil.

The object of the present invention is solved with the subject matter of the independent claims, wherein further embodiments are incorporated in the dependent claims. It should be noted that the following described aspects and examples of the invention apply also to the inductor coils and to the methods of forming inductor coils.

In a first aspect, there is provided an inductor coil, comprising:

- a first component;
- a second component; and
- a length of conductor.

The first component is located adjacent to the second component. A core is formed from the first component and the second component. The core is located along a first portion of a central axis and a second portion of the central axis. Along a third portion of the central axis the first component is spaced from the second component to form a gap in the core. The third portion of the central axis is between the first portion of the central axis and the second portion of the central axis. A first part of the length of conductor is located around the first portion of the central axis, located around the second portion of the central axis, and located around the third portion of the central axis to form a plurality of turns of conductor around the core and the gap in the core. At least one section of the first part of the length of conductor is compressed in the direction of the central axis.

In this manner, the coil with a compressed conductor can achieve lower or equal DCR than existing coils, but at the same time the AC losses rather than being 5-20 times the DC losses now only 1-3 times the DC losses.

In an example, a second part and a third part of the length of conductor at the ends of the length of conductor form part of connection terminals of the inductor coil.

In an example, the whole of the first part of the length of the conductor is compressed.

In an example, the conductor comprises a Litz wire.

In a third aspect, there is provided an inductor coil, comprising:

- a first component;
- a second component; and
- a length of conductor.

The first component is located adjacent to the second component. A core is formed from the first component and the second component. The core is located along a first portion of a central axis and a second portion of the central axis. Along a third portion of the central axis the first component is spaced from the second component to form a gap in the core. The third portion of the central axis is between the first portion of the central axis and the second portion of the central axis. A first part of the length of conductor is located around the first portion of the central axis, located around the second portion of the central axis, and located around the third portion of the central axis to form a plurality of turns of conductor around the core and the gap in the core. Each turn of conductor of the plurality of turns of conductor has an inner part of the conductor spaced at least one distance from the central axis in a direction perpendicular to the central axis. The inner part of the conductor of two or more turns of the conductor located around the first portion of the central axis and/or located around the second portion of the central axis ~~is/~~are spaced from the central axis by at least one first distance. The inner part of the conductor of one or more turns of the conductor located around the third portion of the central axis is spaced from the central axis by at least one second distance greater than the at least one first distance.

In other words, the turns of the conductor at the position of the gap in the core are spaced further from axis of the inductor coil than the other turns around the core. This can be through either displacement of the turns sideways, or deformation of the inner part of the conductor turns facing the axis of the inductor coil. In this manner, the inductor coil does not lead to induced eddy currents that would otherwise be caused by conductive material being present in these fringing fields. This avoids temperature hotspots, maximises the available cross-sectional area of conductor, and maximises the thermal performance of the coil.

In an example, a second part and a third part of the length of conductor at the ends of the length of conductor form part of connection terminals of the inductor coil.

Inductor coil according to any of claims 31-40, wherein adjacent turns of the plurality of turns of conductor are bonded to each other.

This for example, facilitates prior compression of the first part of the length of conductor before it is located around the core gap in the core of the inductor coil, parts of the conductor turns may not then be under compression between the base portions of the first component and second component, but remain in a compressed tight arrangement.

In a fourth aspect, there is provided an inductor coil, comprising:

- a first component;
- a second component; and
- a length of conductor (18).

The first component is located adjacent to the second component. A core is formed from the second component. The core is located along a first portion of a central axis. Along a second portion of the central axis the first component is spaced from the second component to form a gap in the core. The second portion of the central axis is between the first portion of the central axis and the first component. A first part of the length of conductor is located around the first portion of the central axis, and located around the second portion of the central axis to form a plurality of turns of conductor around the core and the gap in the core. Each turn of conductor of the plurality of turns of conductor has an inner part of the conductor spaced at least one distance from the central axis in a direction perpendicular to the central axis. The inner part of the conductor of two or more turns of the conductor located around the first portion of the central axis ~~is~~ are spaced from the central axis by at least one first distance. The inner part of the conductor of one or more turns of the conductor located around the second portion of the central axis is spaced from the central axis by at least one second distance greater than the at least one first distance.

In other words, the turns of the conductor at the position of the gap in the core are spaced further from axis of the inductor coil than the other turns around the core. This can be through either displacement of the turns sideways, or deformation of the inner part of the conductor turns facing the axis of the inductor coil. In this manner, the inductor coil does not lead to induced eddy currents that would otherwise be caused by conductive material being

In an example, the spacer comprises a non-conductive material.

In an example, the spacer comprises a central hole configured to be located around the central axis.

In an example, the first component comprises a ferrite material.

In an example, the second component comprises a ferrite material.

In an example, the conductor comprises a multi-strand wire.

In an example, the conductor comprises a Litz wire.

In a seventh aspect, there is provided a method of forming an inductor coil, comprising:

- locating a first component adjacent to the second component, wherein a core is formed from the first component and the second component, wherein the core is located along a first portion of a central axis and a second portion of the central axis, wherein along a third portion of the central axis the first component is spaced from the second component to form a gap in the core, and wherein the third portion of the central axis is between the first portion of the central axis and the second portion of the central axis;
- locating a first part of the length of conductor around the first portion of the central axis, around the second portion of the central axis, and around the third portion of the central axis to form a plurality of turns of conductor around the core and the gap in the core; and
- locating the first part of the length of conductor such that each turn of conductor of the plurality of turns of conductor has an inner part of the conductor spaced at least one distance from the central axis in a direction perpendicular to the central axis. The inner part of the conductor of two or more turns of the conductor located around the first portion of the central axis and/or located around the second portion of the central axis ~~is/~~are spaced from the central axis by at least one first distance. The inner part of the conductor of one or more turns of the conductor located around the third portion of the central axis is spaced from the central axis by at least one second distance greater than the at least one first distance.

portion of the central axis ~~is~~ are spaced from the central axis by at least one first distance. The inner part of the conductor of one or more turns of the conductor located around the second portion of the central axis is spaced from the central axis by at least one second distance greater than the at least one first distance.

In other words, the turns of the conductor at the position of the gap in the core are spaced further from axis of the inductor coil than the other turns around the core. This can be through either displacement of the turns sideways, or deformation of the inner part of the conductor turns facing the axis of the inductor coil. In this manner, the inductor coil does not lead to induced eddy currents that would otherwise be caused by conductive material being present in these fringing fields. This avoids temperature hotspots, maximises the available cross-sectional area of conductor, and maximises the thermal performance of the coil.

In an example, a second part and a third part of the length of conductor at the ends of the length of conductor form part of connection terminals of the inductor coil.

In an example, the whole of the first part of the length of the conductor is compressed.

In an example, the method comprises locating a spacer in the gap in the core to form a gap around the core. An outer surface of a portion of the spacer is located a distance from the central axis that is greater than a distance from the central axis of an outer surface of the second component that forms the core.

In other words, the spacer is positioned in the gap in the core, and is wider than the diameter of the core, and when the first part of the length of conductor is located around the core and gap in the core, the spacer forms a space around the outer extent of the gap in the core, by either in effect pushing conductor turns sideways, and/or deforming the inner part of each conductor turn at the location of the gap in the core.

In an example, a dimension of the portion of the spacer adjacent to the outer surface of the second component in the direction of the central axis is greater than a dimension of the gap in the core in the direction of the central axis.