(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 669 389 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
29.12.2021 Bulletin 2021/52

(21) Application number: **18752767.6**

(22) Date of filing: **13.08.2018**

(51) Int Cl.:
H01F 27/28 *(2006.01)* ***H01F 27/36*** *(2006.01)*
H01F 27/38 *(2006.01)* ***H01F 27/40*** *(2006.01)*
H01F 38/14 *(2006.01)*

(86) International application number:
PCT/EP2018/071901

(87) International publication number:
WO 2019/034594 (21.02.2019 Gazette 2019/08)

(54) **TOPOLOGY OF A FERRITE SHIELD FOR INDUCTIVE COILS**

TOPOLOGIE EINES FERRITSCHILDES FÜR INDUKTIVE SPULEN

TOPOLOGIE D'UN BLINDAGE EN FERRITE POUR BOBINES INDUCTIVES

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **14.08.2017 NL 2019416**

(43) Date of publication of application:
24.06.2020 Bulletin 2020/26

(73) Proprietor: **Prodrive Technologies Innovation Services B.V.**
5692 EM Son en Breugel (NL)

(72) Inventors:
- **WESSELS, Wouter Johannes Stephanus**
  5692 EM Son (NL)
- **VRIJSEN, Nilles Henricus**
  5692 EM Son (NL)
- **BRON, Ben**
  5632 JL Eindhoven (NL)
- **MEESSEN, Koen Joseph**
  5621 GP Eindhoven (NL)

(74) Representative: **AWA Benelux**
Avenue Josse Goffin 158
1082 Bruxelles (BE)

(56) References cited:
EP-A1- 3 128 524 **US-A1- 2008 116 847**
US-A1- 2014 327 391 **US-A1- 2015 022 142**
US-A1- 2015 302 984

EP 3 669 389 B1

Description

Technical field

[0001] The present invention is related to an assembly comprising an arrangement of ferrite tiles Particularly, the assembly is for contactless power transfer applications, such as in the automotive field. The present invention is equally related to an arrangement or disposition of the ferrite shield for such applications.

Background art

[0002] For inductive coils, in particular for inductive power transfer, e.g. for charging car batteries, it is known to use ferrite not only to shield the magnetic field induced by the inductive coil, but also to improve the efficiency of power transfer between a sending and a receiving coil. The ferrite guides the magnetic field generated by the sending coil along preferred paths, enabling to reduce the volume in which the magnetic field generated by the inductive coil is significant and increase the intensity of the magnetic field in the area of interest (i.e. near the receiving coil). This can improve the coupling between the coils and thereby reduce the energy losses during inductive power transfer.

[0003] One drawback of ferrite is its high mass density and cost. Using ferrite therefore tends to lead to high costs and bulky assemblies.

EP 3 128 524 A1 discloses a power transmission apparatus comprising a power transmission coil, which has a hollow formed in the centre thereof, disposed on layer of a ferrite, which layer has an opening formed therein located in the hollow of the power transmission coil.

Summary of the invention

[0004] In automotive inductive power transfer applications, it would be desirable to reduce weight, bulkiness and cost of the assemblies for inductive power transfer. However, since high power is transferred in such applications, the efficiency of the inductive power transfer must remain high. It is therefore an aim of the present invention to provide assemblies which overcome one or more of the above problems.

[0005] It is also an aim of the present invention to provide assemblies for inductive power transfer having improved power density.

[0006] According to a first aspect of the invention, there is therefore provided an assembly as set out in the appended claims.

[0007] Assemblies according to aspects described herein comprise a first inductive coil comprising one or more windings of an electric wire or cable forming one or more coil loops, and an arrangement of ferrite tiles disposed on one side (e.g., top or bottom) of the first inductive coil. According to one aspect, the coil loops are disposed in, or form a first plane. The ferrite tiles are disposed in a second plane substantially parallel to the first plane. According to a second aspect, the ferrite tiles are disposed such that they form one or more tile loops corresponding to the one or more coil loops. Tiles arranged at opposite sides of the coil are advantageously spaced apart a distance substantially equal to an internal diameter of the coil. According to another aspect, spaces between adjacent ferrite tiles are aligned locally perpendicular to an axial orientation of the electric wire. According to yet another aspect, the assembly comprises at least one second inductive coil wound about one or more of the ferrite tiles. A winding axis of the first inductive coil and a winding axis of the second inductive coil are advantageously perpendicular.

[0008] Assemblies according to aspects described herein hence can ensure that the gaps (spaces) between adjacent tiles run parallel with the direction of the magnetic field and therefore the path of the magnetic field remains practically undisturbed by the tile arrangement.

[0009] Furthermore, advantageously, the area of the tiles and the area of the coil substantially fully overlap. As a result, a central area is obtained with sufficient volume that can be used for accommodating additional components. As the tiles do not substantially extend beyond the area of the coil, weight and cost can be saved.

[0010] Further advantageous aspects are described in the dependent claims.

Brief description of the figures

[0011] Aspects of the invention will now be described in more detail with reference to the appended drawings, wherein same reference numerals illustrate same features and wherein:

Figure 1 represents a partially exploded perspective view of an assembly according to aspects described herein;

Figure 2 represents an exploded perspective view of an assembly according to aspects described herein.

Description of embodiments

[0012] Referring to Fig. 1, an assembly 10 according to aspects described herein comprises an inductive coil 11, which can comprise an electric wire or cable which is wound in one or more turns forming a loop. In the configuration of Fig. 1, the loop is a single loop having an "0" configuration, even though other configurations, such as double loops (e.g. having the shape of an "8") or multiple loops are possible.

[0013] Advantageously, the coil 11 is accommodated in a housing 12 which can comprise pre-formed paths or tracks 121 accommodating the electric wire. The paths 121 may run spirally to form the turns of the electric wire or cable and thereby form the coil 11.

[0014] The housing 12 may further comprise mounts

122 for mounting ferrite tiles 14 thereon. Mounts 122 may have any suitable shape and may allow for maintaining a relative position between the coil 11 and the ferrite tiles 14. Tile support members 13, e.g. made of a resilient material, such as an elastomeric material, may be provided on mounts 122 for supporting and securing the tiles 14. Useful examples of mounts 122 and tile support members 13 are described in co-pending international application No. PCT/EP2018/071819 filed 10 August 2018.

[0015] Support members 13 and mounts 122 may ensure that tiles 14 are spaced apart from the coil 11 at any suitable distance.

[0016] According to one aspect, a plurality of ferrite tiles 14 are disposed so as to cover the coil 11. The tiles 14 are advantageously made of ferrite, in particular soft ferrite. They may be made of other magnetic (e.g. ferromagnetic or ferrimagnetic) materials. The magnetic material is advantageously used to improve magnetic coupling between the coils of the primary side and of the secondary side. Therefore, it is advantageous to choose a composition that has low losses at the power transfer frequency of interest (e.g. <500 kW/m^3 at 100 kHz, 200 mT and 25 °C). Typically, power transfer frequencies range between 50 and 100 kHz for automotive applications.

[0017] It will be convenient to note that in use, the ferrite tiles may be disposed on one side of the coil 11 only, e.g. either above, or below the coil 11. In the present disposition, a combination of rectangular tiles 141 and tiles 142 having the shape of a disc segment, e.g. a 45° segment, are advantageously used. By way of example, as shown in Fig. 1, between each 90° segment formed with tiles 142, at least one rectangular tile 141 is disposed. The tiles 14 are disposed such that they form a loop corresponding to the loop of the coil 11. The tiles 14 overlap the windings of coil 11 and advantageously provide a substantially 1/1 overlap with the area of the coil 11, i.e. the area of tiles 14 and the area of coil 11 is substantially identical.

[0018] As shown in Fig. 1, the spaces between adjacent tiles 14 are perpendicular to the local orientation (axis) of the wire of coil 11. Such a disposition ensures that the gaps (spaces) between adjacent tiles run parallel with the main direction of the magnetic field and therefore the magnetic field is not negatively affected by the tile arrangement. As a result, any number of ferrite tiles 14 may be used, as long as the spaces (gaps) between the tiles are oriented perpendicular to the coil windings. This allows to tailor the dimensions of the tiles on the basis of material properties in order to prevent breaking of tiles. This furthermore also allows to provide appropriate mounting and securing of the tiles.

[0019] Each tile advantageously comprises four edges. Two opposite edges 143 are arranged such that they are aligned with the wire of the coil 11. The other two opposite edges 144 run perpendicular to the wire of the coil. This is also advantageously the case for the segment-shaped tiles 142. The edges 144 advantageously have a length substantially corresponding to a breadth of the coil 11, i.e. the tile 14 extends continuously over a breadth of coil 11.

[0020] A central area 15 is completely enclosed by the coil 11. Advantageously, central area 15 is also fully enclosed by the loop of tiles 14. That is, tiles arranged at opposite sides of the coil 11 are spaced apart over a distance substantially equal to, or slightly smaller than an internal diameter of coil 11. The central area advantageously accommodates electronic circuitry, e.g. driving circuitry for the coil 11. Useful examples of electric circuitry that can be accommodated in central area 15 are: inverter circuitry and rectifier circuitry

[0021] Referring to Fig. 2, in order to shield the electronic circuitry arranged in central area 15, a shielding layer 16 of an electrically conductive material can be arranged between the central area on the one hand and the coil 11 and ferrite tiles 14 on the other hand. Layer 16 may advantageously be made of a thermally conductive material in order to form a thermal path with low thermal resistance to facilitate heat spreading. Advantageously, layer 16 overlaps at least partially with the ferrite tiles 14, at a side opposite the coil 11. Within central area 15, layer 16 advantageously forms a bulge 161. Bulge 161 advantageously increases a space in central area 15. Additionally, bulge 161 advantageously protrudes in a direction of the coil 11 which may facilitate heat transfer to the environment from a side 101. This is particularly useful where assembly 20 is a ground assembly of an automotive inductive power transfer system and the assembly 20 rests with side 102 on ground level. In such a case, side 101 will form the top side.

[0022] It will be convenient to note that the assembly 20 of Fig. 2 is inversed with respect to the assembly 10 of Fig. 1, i.e. in Fig. 2 the tiles 14 are located underneath the coil 11. Additionally, electronic circuitry in central area 15 would be located underneath layer 16 (e.g., underneath bulge 161).

[0023] A conductive loop 17 may be provided at a periphery of layer 16. Conductive loop 17 advantageously has a higher conductivity than layer 16. By way of example, layer 16 may be made of aluminium and conductive loop 17 may be formed of copper. A relatively high conductivity for loop 17 advantageously decreases power dissipation within the housing 12. The conductive loop 17 may comprise a wire arranged in a single turn or a plurality of turns and may or may not be constrained to a single plane. Conductive loop 17 may be terminated by a fixed or variable impedance, which can be resistive, capacitive, or inductive, or any suitable combination thereof. By way of example, conductive loop 17 can be made of (separately insulated) stranded copper wire, solid copper plate or any other material with a relatively low AC resistance.

[0024] The central area 15 may additionally or alternatively be covered with a layer 18 made of a material having a relative magnetic permeability μ_r > 10. The material of layer 18 advantageously has a low electrical conductivity σ << 1000 S/m, e.g. ferrite material ($\sigma \approx 1 \cdot 10^{-5}$ S/m). The ferrite can be either flexible or solid and may be relatively thin due to the low magnetic flux density in this location. Layer 18 advantageously has a thickness which is less than or equal to half the thickness of the tiles 14, advantageously less than or equal to 0.2 times the thickness of tiles 14. The layer 18 is advantageously applied to shield the layer 16 which reduces the power dissipation due to eddy currents that are induced by the coil. Layer 18 advantageously has some overlap with the tiles 14.

[0025] Assemblies as in Fig. 1 and Fig. 2 are advantageously used for inductive power transfer in automotive applications. By way of example, the assembly of Fig. 1 can be mounted underneath a vehicle to form a vehicle unit for inductive power transfer with coil 11 being the power transfer coil. The assembly of Fig. 2 can be installed on ground for power transmission to the assembly of Fig. 1.

[0026] Referring back to Fig. 1, a second type of coil 19 is provided in addition to coil 11. Four such coils 19 are provided in Fig. 1, at 90° distance from one another, and more or less coils 19 may be provided as desired. For example, only two or three coils 19 may be provided, at least two of which may have perpendicular axes. Each coil 19 is wound about a tile 14, in particular a rectangular tile 141. The coils 19 are wound about a plurality of tiles 14. As shown in more detail in Fig. 2, the second type coil 19 may comprise two opposite coils 191 and another two opposite coils 192, each one arranged in a different quadrant of the loop formed by tiles 14. Coils 191 have a winding axis 193 which is perpendicular to winding axis 194 of the coils 192. The winding axes 193, 194 of the second type coils 19 are perpendicular to the winding axis 111 of the (inductive power transfer) coil 11.

[0027] Coils 19 may be used for inducing/sensing additional magnetic fields distinct from the magnetic field induced by coil 11, e.g. for position sensing. By spatially separating the different coils 19, less coils are required and/or a better accuracy can be obtained for such purposes. Typically, the coils 19 are wound perpendicular to the main direction of the magnetic field generated by power transfer coil 11. This leads to an improved decoupling of the magnetic fields of coils 11 and 19, with improves signal to noise ratio and reduced coupling of higher harmonics. As a result less stringent insulation requirements for coil 19 are needed.

[0028] The second coils 19 are connected to circuitry 195 designed for either providing power to the coils to emit a magnetic field, or to sense a magnetic field. The circuitry 195 is advantageously arranged in the central area 15, and advantageously comprises an analog front-end connecting the second coils to a digital processing unit. The emitted or sensed magnetic field is advantageously a low frequent magnetic field, such as in the range between 3 kHz and 300 kHz, in particular between 75 kHz and 225 kHz. Advantageously, the second coils 19 are formed as a resonant tank, hence including a capacitor which can be comprised in the circuitry to which the second coils are connected. The resonant tank advantageously has a resonance at a frequency different than the frequency of the coil 11 for efficiently receiving or transmitting signals used.

[0029] The coils 19, when used in transmit (power emission) mode are advantageously powered sequentially to create a pulsed magnetic field. Alternatively, each of the coils 19 is powered with a different frequency so as to avoid interference between the coils 19. In the latter case, the coils 19 can be powered simultaneously. A square wave is advantageously used to power the coils. A coding scheme can be used to identify which one of the coils 19 is active. Typically, in an inductive power transfer system, one side of the system, e.g. the ground unit, comprises a plurality of second coils 19 as transmitting coils and the other side, e.g. the mobile (vehicle) unit, comprises a plurality of second coils 19 as receiving coils, configured to sense the magnetic field emitted by the second coils 19 of the opposite side.

[0030] In use, the receiving coils sense the magnetic field emitted by the transmitting coils. The properties, such as magnitude and phase, of the sensed magnetic field pulses can be used to obtain the position of the power transmitting side of the power transfer system with respect to the power receiving side of the system, or vice versa. This position information is relevant to enable efficient power transfer.

Claims

1. Assembly (10, 20), comprising:

   a first inductive coil (11) comprising one or more windings of an electric wire forming one or more coil loops defining a plane,
   an arrangement of ferrite tiles (14) disposed on one side of the first inductive coil substantially parallel to the plane,

      wherein the ferrite tiles are disposed such that they form one or more tile loops corresponding to the one or more coil loops and such that spaces between adjacent ones of the ferrite tiles are aligned locally perpendicular to the electric wire,
      characterised in that the assembly comprises at least one second inductive coil (19) wound about one or more of the ferrite tiles (14) such that a winding axis (111) of the first inductive coil (11) and a winding axis (193, 194) of the second inductive coil are perpendicular.

2. Assembly of claim 1, wherein the ferrite tiles (14) are continuous in a direction locally perpendicular to the electric wire and over a length corresponding to a breadth of the inductive coil (11).

3. Assembly of claim 1 or 2, wherein an area of extension of the ferrite tiles (14) and an area of extension of the first inductive coil (11) are substantially identical.

4. Assembly of any one of the claims 1 to 3, wherein at least one of the one or more coil loops and corresponding tile loop enclose a central area (15) free from covering by the ferrite tiles (14), preferably further comprising one or more driving circuits for the inductive coil arranged in the central area (15), more preferably further comprising a thermally conductive layer (16) covering the central area (15) and the respective coil loop and tile loop, even more preferably wherein the thermally conductive layer (16) is electrically conductive.

5. Assembly of claim 4, comprising a ferrite comprising layer covering the central area (15), wherein the ferrite comprising layer at least partially overlaps the ferrite tiles, preferably wherein the ferrite comprising layer is formed as a continuous sheet.

6. Assembly of claim 5, wherein the ferrite comprising layer has a thickness at least 20% smaller than a thickness of the ferrite tiles.

7. Assembly of any one of the preceding claims, wherein the at least one second inductive coil (19) is configured for generating and/or sensing an additional magnetic field distinct from a magnetic field induced by the first inductive coil (11).

8. Assembly of claim 7, wherein the at least one second inductive coil (19) is a positioning coil configured for inducing or sensing the additional magnetic field for position sensing.

9. Assembly of any one of the preceding claims, wherein the at least one second inductive coil (19) forms a resonant tank.

10. Assembly of any one of the preceding claims, comprising circuitry (195) coupled to the at least one second coil (19) and configured to form a or the resonant tank.

11. Assembly of any one of the preceding claims, comprising a plurality of the second inductive coil (19), each of the plurality of the second inductive coil being located in a different quadrant of the respective coil loop.

12. Assembly of any one of the preceding claims, wherein at least one of the tile loops consists of a combination of rectangular tiles (141) and tiles shaped as a disc segment (142).

13. Assembly of any one of the preceding claims, wherein the first inductive coil (11) is a coil for inductive transfer of electrical energy.

14. Ground assembly (20) for inductive power transfer to a vehicle, comprising the assembly of claim 10.

15. Vehicle assembly (10) for receiving electrical energy transferred by inductive power transfer, comprising the assembly of claim 13.

Patentansprüche

1. Anordnung (10, 20), umfassend:

eine erste induktive Spule (11), umfassend eine oder mehrere Wicklungen eines elektrischen Drahts, die eine oder mehrere Spulenschleifen bildet, die eine Ebene definieren,
eine Anordnung von Ferritfliesen (14), die auf einer Seite der ersten induktiven Spule angeordnet ist, im Wesentlichen parallel zur Ebene, wobei die Ferritfliesen derart angeordnet sind, dass sie eine oder mehrere Fliesenschleifen bilden, die der einen oder mehreren Spulenschleifen entsprechen, und derart, dass Zwischenräume zwischen Benachbarten der Ferritfliesen lokal senkrecht zum elektrischen Draht ausgefluchtet sind,
dadurch gekennzeichnet, dass die Anordnung mindestens eine zweite induktive Spule (19) umfasst, die um eine oder mehrere der Ferritfliesen (14) gewickelt ist, so dass eine Wicklungsachse (111) der ersten induktiven Spule (11) und eine Wickelungsachse (193, 194) der zweiten induktiven Spule senkrecht sind.

2. Anordnung nach Anspruch 1, wobei die Ferritfliesen (14) kontinuierlich in einer Richtung, die lokal senkrecht zum elektrischen Draht ist, und über eine Länge, die einer Breite der induktiven Spule (11) entspricht, sind.

3. Anordnung nach Anspruch 1 oder 2, wobei ein Ausdehnungsbereich der Ferritfliesen (14) und ein Ausdehnungsbereich der ersten induktiven Spule (11) im Wesentlichen identisch sind.

4. Anordnung nach irgendeinem der Ansprüche 1 bis 3, wobei mindestens eine der einen oder mehreren Spulenschleifen und entsprechenden Fliesenschleife einen zentralen Bereich (15) einschließen, der frei von Abdeckung durch die Ferritfliesen (14) ist, vorzugsweise weiter umfassend einen oder mehrere Antriebsschaltkreise für die induktive Spule, die im zentralen Bereich (15) angeordnet sind, insbesondere weiter umfassend eine thermisch leitende

Schicht (16), die den zentralen Bereich (15) und die entsprechende Spulenschleife und Fliesenschleife abdeckt, noch bevorzugter, wobei die thermisch leitende Schicht (16) elektrisch leitend ist.

5. Anordnung nach Anspruch 4, umfassend eine Ferrit-umfassende Schicht, die den zentralen Bereich (15) abdeckt, wobei die Ferrit-umfassende Schicht mindestens teilweise die Ferritfliesen überlappt, vorzugsweise wobei die Ferrit-umfassende Schicht als eine kontinuierliche Bahn gebildet ist.

6. Anordnung nach Anspruch 5, wobei die Ferrit-umfassende Schicht eine Dicke aufweist, die mindestens 20 % kleiner als eine Dicke der Ferritfliesen ist.

7. Anordnung nach irgendeinem der vorhergehenden Ansprüche, wobei die mindestens eine zweite induktive Spule (19) konfiguriert ist, um ein zusätzliches magnetisches Feld verschieden von einem magnetischem Feld, das von der ersten induktiven Spule (11) induziert wird, zu erzeugen und/oder abzutasten.

8. Anordnung nach Anspruch 7, wobei die mindestens eine zweite induktive Spule (19) eine Positionierspule ist, die konfiguriert ist, um das zusätzliche magnetische Feld für die Positionserfassung zu induzieren oder abzutasten.

9. Anordnung nach irgendeinem der vorhergehenden Ansprüche, wobei die mindestens eine zweite induktive Spule (19) einen Resonanztank bildet.

10. Anordnung nach irgendeinem der vorhergehenden Ansprüche, umfassend einen Schaltkreis (195), der mit der mindestens einen zweiten Spule (19) gekoppelt und konfiguriert ist, um einen oder den Resonanztank zu bilden.

11. Anordnung nach irgendeinem der vorhergehenden Ansprüche, umfassend eine Vielzahl der zweiten induktiven Spule (19), wobei sich jede der Vielzahl der zweiten induktiven Spule in einem verschiedenen Quadranten der entsprechenden Spulenschleife befindet.

12. Anordnung nach irgendeinem der vorhergehenden Ansprüche, wobei mindestens eine der Fliesenschleifen aus einer Kombination von rechtwinkligen Fliesen (141) und Fliesen, die wie ein Scheibensegment (142) geformt sind, besteht.

13. Anordnung nach irgendeinem der vorhergehenden Ansprüche, wobei die erste induktive Spule (11) eine Spule für induktive Übertragung von elektrischer Energie ist.

14. Bodenanordnung (20) zur induktiven Leistungsübertragung an ein Fahrzeug, umfassend die Anordnung nach Anspruch 10.

15. Fahrzeuganordnung (10) zum Aufnahme von elektrischer Energie, übertragen durch induktive Leistungsübertragung, umfassend die Anordnung nach Anspruch 13.

Revendications

1. Ensemble (10, 20) comprenant :

> une première bobine inductive (11) comprenant un ou plusieurs enroulements d'un fil électrique formant une ou plusieurs boucles de bobine définissant un plan,
> un agencement de carreaux de ferrite (14) disposé d'un côté de la première bobine inductive sensiblement parallèlement au plan,
> dans lequel les carreaux de ferrite sont disposés de sorte qu'ils forment une ou plusieurs boucles de carreau correspondant aux une ou plusieurs boucles de bobine et de sorte que des espaces entre les carreaux adjacents des carreaux de ferrite sont alignés localement perpendiculairement au fil électrique,
> **caractérisé en ce que** l'ensemble comprend au moins une seconde bobine inductive (19) enroulée autour d'un ou de plusieurs carreaux de ferrite (14) de sorte qu'un axe d'enroulement (111) de la première bobine inductive (11) et un axe d'enroulement (193, 194) de la seconde bobine inductive sont perpendiculaires.

2. Ensemble selon la revendication 1, dans lequel les carreaux de ferrite (14) sont continus dans une direction localement perpendiculaire au fil électrique et sur une longueur correspondant à une largeur de la bobine inductive (11) .

3. Ensemble selon la revendication 1 ou 2, dans lequel une zone d'extension des carreaux de ferrite (14) et une zone d'extension de la première bobine inductive (11) sont sensiblement identiques.

4. Ensemble selon l'une quelconque des revendications 1 à 3, dans lequel au moins l'une des une ou plusieurs boucles de bobine et une boucle de carreau correspondante entourent une zone centrale (15) dépourvue de recouvrement par les carreaux de ferrite (14), comprenant de préférence en outre un ou plusieurs circuits d'entraînement pour la bobine inductive agencée dans la zone centrale (15), comprenant en outre encore de préférence une couche thermiquement conductrice (16) recouvrant la zone centrale (15) et la boucle de bobine respective et la boucle de carreau, même encore de préférence, dans lequel la couche thermiquement conductrice (16) est électriquement conductrice.

5. Ensemble selon la revendication 4, comprenant une couche comprenant du ferrite recouvrant la zone centrale (15), dans lequel la couche comprenant du ferrite recouvre au moins partiellement les carreaux de ferrite, de préférence dans lequel la couche comprenant du ferrite est formée en tant que feuille continue.

6. Ensemble selon la revendication 5, dans lequel la couche comprenant du ferrite a une épaisseur au moins 20% inférieure à une épaisseur des carreaux de ferrite.

7. Ensemble selon l'une quelconque des revendications précédentes, dans lequel la au moins une seconde bobine inductive (19) est configurée pour générer et/ou détecter un champ magnétique additionnel distinct d'un champ magnétique induit par la première bobine inductive (11).

8. Ensemble selon la revendication 7, dans lequel la au moins une seconde bobine inductive (19) est une bobine de positionnement configurée pour induire ou détecter le champ magnétique additionnel pour détecter la position.

9. Ensemble selon l'une quelconque des revendications précédentes, dans lequel la au moins une seconde bobine inductive (19) forme un convertisseur résonnant.

10. Ensemble selon l'une quelconque des revendications précédentes, comprenant des circuits (195) couplés à la au moins une seconde bobine (19) et configurés pour former un ou le convertisseur résonnant.

11. Ensemble selon l'une quelconque des revendications précédentes, comprenant une pluralité de secondes bobines inductives (19), chacune de la pluralité de secondes bobines inductives étant positionnée dans un quadrant différent de la boucle de bobine respective.

12. Ensemble selon l'une quelconque des revendications précédentes, dans lequel au moins l'une des boucles de carreau se compose d'une combinaison de carreaux rectangulaires (141) et de carreaux formés comme un segment de disque (142).

13. Ensemble selon l'une quelconque des revendications précédentes, dans lequel la première bobine inductive (11) est une bobine pour le transfert inductif d'énergie électrique.

14. Ensemble de terre (20) pour le transfert d'énergie inductive à un véhicule, comprenant l'ensemble selon la revendication 10.

15. Ensemble de véhicule (10) pour recevoir l'énergie électrique transférée par transfert d'énergie inductive comprenant l'ensemble selon la revendication 13.

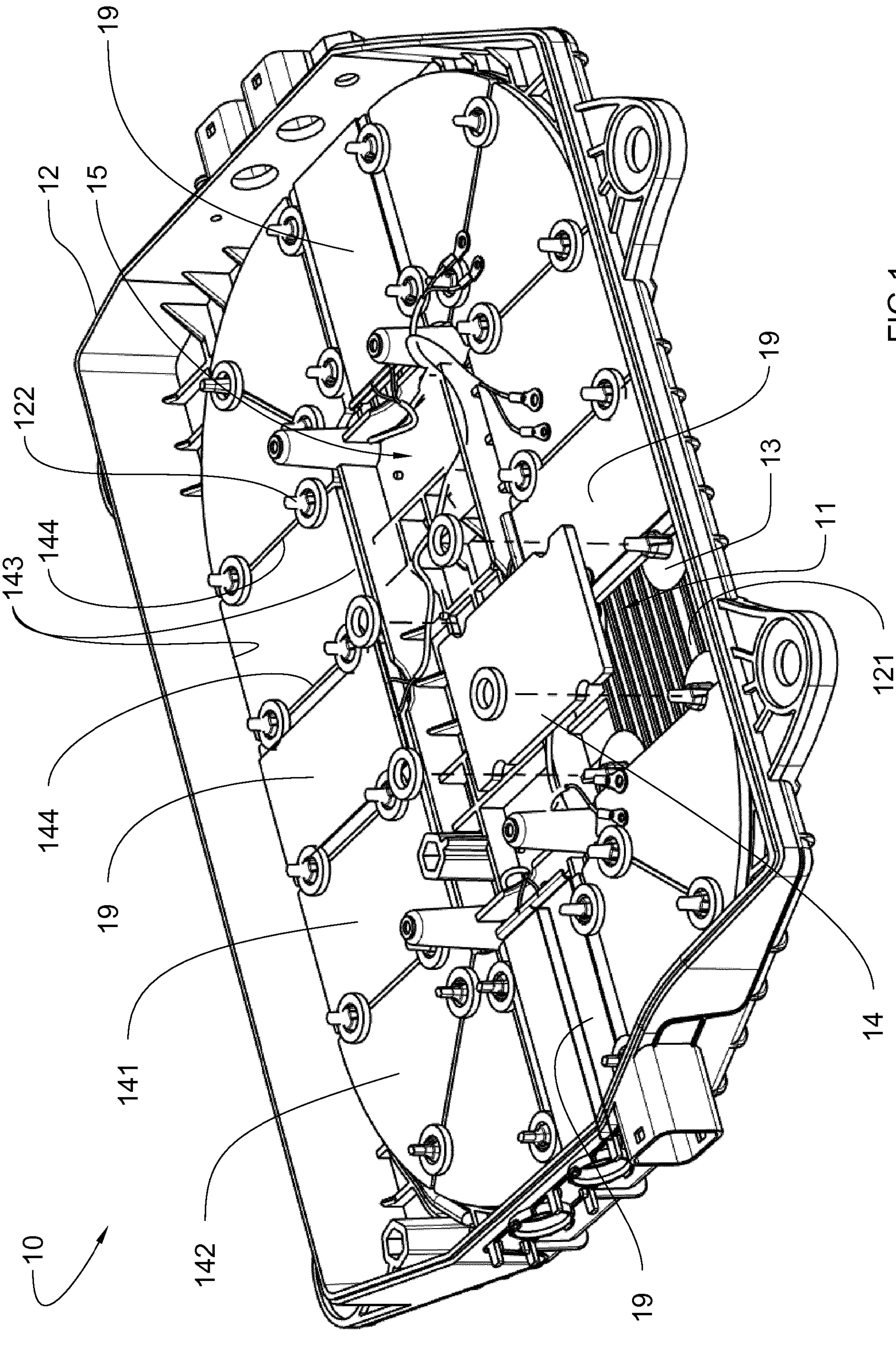

FIG 1

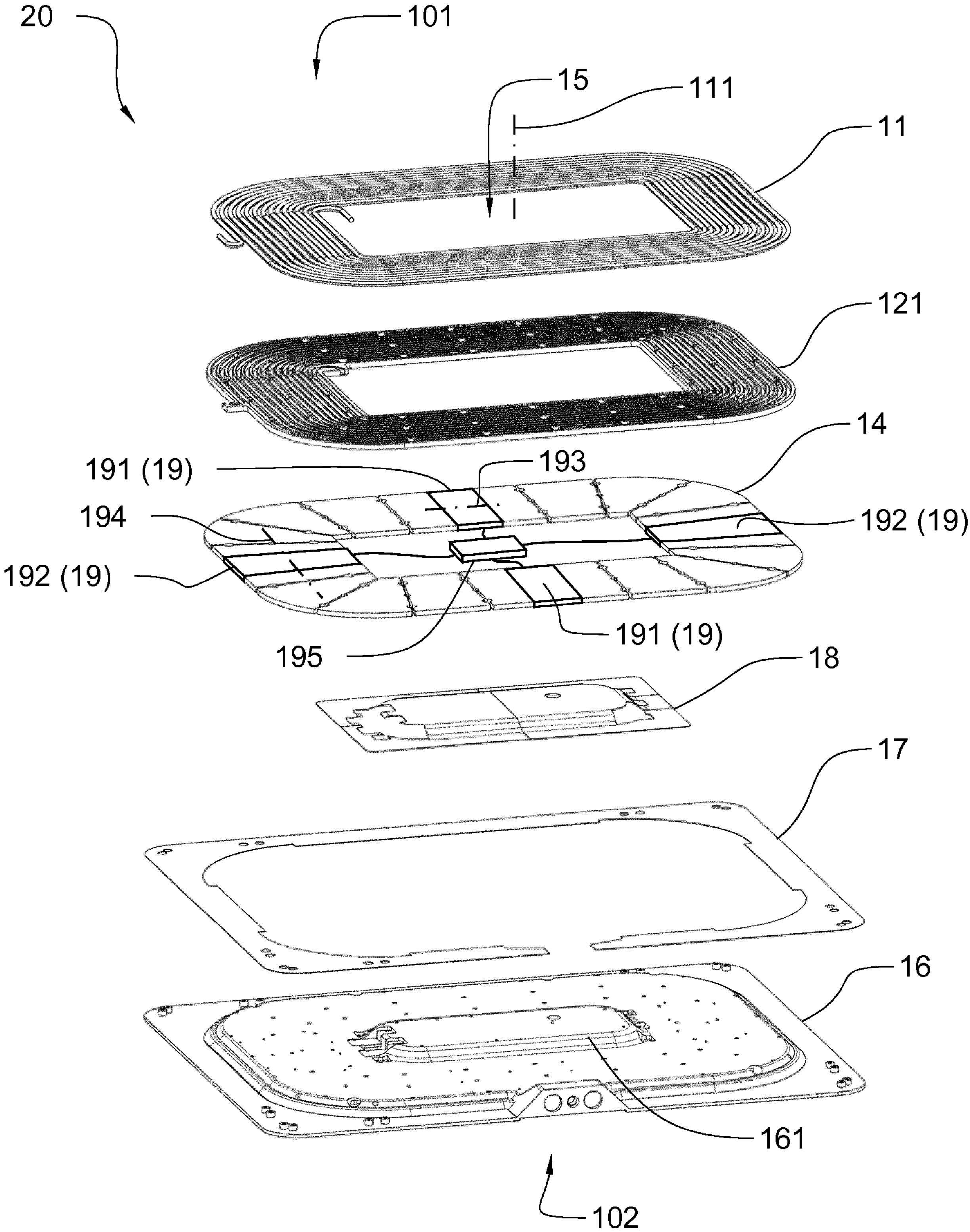
20
101
15
111
11
121
14
191 (19)
193
194
192 (19)
192 (19)
191 (19)
195
18
17
16
161
102

FIG 2

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- EP 3128524 A1 **[0003]**
- EP 2018071819 W **[0014]**