

⑫

EUROPEAN PATENT APPLICATION

⑳ Application number: **83103679.3**

⑤① Int. Cl.³: **H 01 F 37/00**

㉔ Date of filing: **15.04.83**

③① Priority: **16.04.82 IT 2158282 U**

⑦① Applicant: **SIRTEN Srl Società Italiana Reattanze Trasformatori Elettronica Nuclei, Via Pasubio 18/20, I-20093 Cernusco Sul Naviglio (Milano) (IT)**

④③ Date of publication of application: **26.10.83**
Bulletin 83/43

⑦② Inventor: **Marchegiani, Giuseppe, Via Giuseppe Garibaldi 47, I-20099 Sesto S. Giovanni Milano (IT)**

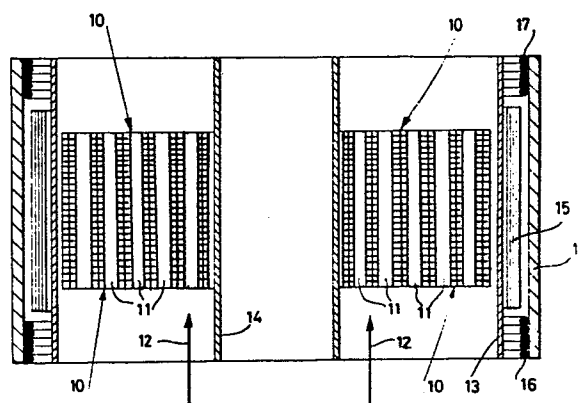
⑧④ Designated Contracting States: **AT CH DE FR GB IT LI SE**

⑦④ Representative: **Prüfer, Lutz H., Dipl.-Phys., Dipl.-Phys. Lutz H. Prüfer, Ing. G. Dragotti Willroiderstrasse 8, D-8000 München 90 (DE)**

⑤④ Inductance coll.

⑤⑦ An inductance coil of the type comprising at least one coil winding (10) of wire alternately disposed with respect to channels (11) for the passage of the cooling air, said at least one winding (10) being at least externally encompassed by an insulating cylinder (13), at least outwardly of said at least one coil winding (10) and of said insulating cylinder (13) a ferromagnetic core (15) being concentrically mounted with respect to said at least one winding (10), said core (15) extending along about the height of said at least one winding (10).

Conducting short-circuited turns (16, 17) at the ends of the winding (10) and carrying the same current as the winding (10) itself, are furthermore provided to eliminate dispersed magnetic flow.



The present invention relates to an inductance coil particularly suitable in the cases in which very small room is available and enumbering problems exist, for example in railway field, and in which at the same time it is necessary to eliminate or at least essentially limit the outwardly directed noises.

- 5 As it is known, one of the main problems about inductances is that of heating, sometimes intolerable, which the turns of coil windings undergo; it is further known that the operating temperature is a limiting factor as regards the operating conditions of the inductance, and the number of turns and the wire cross section size being the same, the current density which may pass within the winding will be as more high as
10 better is the cooling effectiveness.

Such a need has been in the past already solved by using inductance coils cooled by means of an air forced circulation.

- More specifically the solution of the problem consists in providing windings, the conducting turns of which are alternately arranged with respect to channels for the
15 cooling air parallelly circulating with respect to the coil axis.

It is further known that the inductance magnetic circuit is formed partly by a lamellar ferromagnetic body, and partly by air (air gap).

- The air part is as much more developed, the ferromagnetic part being proportionally reduced, as higher is the product of the number of turns by the current passing
20 therethrough.

The importance of the ferromagnetic part of the inductance magnetic circuit is thus evident, which must be reduced as much as possible to prevent the circulation of the cooling air from being hindered.

- To date thus of main importance was to obtain a satisfactory cooling, whereby the
25 wire winding was as a matter of fact between two insulating cylinders, without ferromagnetic part included therebetween and with the whole flow of cooling air forced to pass therebetween. As the wire layers are alternately disposed with respect to the channels for the circulation of air, the ferromagnetic part does not hinder the air flow (or as the hindrance is at a minimum in the case in which a little portion of
30 iron is placed at the cylinder ends for shielding the armatures).

According to some known assemblies, however, a ferromagnetic part is present within the coil, whereby a too high number of turns is not required, such as it would be necessary in the case of a magnetic circuit in air only.

In the specific case of the railway field, namely of the electric locomotives in which

two or more inductances have to be assembled into an extremely limited space, the problem of the magnetic flow outwardly dispersed from the coils and of the objectionable effect it has with respect to adjacent coils and other electric apparatus becomes important. In this case also due to the above stated reasons, the problem of
5 obtaining an effective cooling remains obviously important.

The main object of the present invention is that of providing an inductance coil of extremely reduced size, maintaining an unchanged cooling effectiveness as that of the known coils, and permitting to eliminate or essentially reduce the outwardly dispersed magnetic flow.

10 This object is attained by means of an inductance coil of the type comprising at least one coil winding of wire alternately disposed with respect to channels for the cooling air flow, said winding being at least externally encompassed by an insulating cylinder, characterized in that at least externally and in position adjacent to said at least one winding a ferro-magnetic core is provided, said core being concentrically positioned
15 with respect to said at least one winding.

According to a preferred first embodiment of the inductance coil of the invention further windings are provided externally positioned with respect to the said outer insulating cylinder, said windings being short-circuited and having the purpose of reducing alternated current components by opposing the same thanks to the induced
20 currents generated in the same further windings.

According to another preferred embodiment of the present invention, coil windings are provided positioned at the ends of and within the insulating cylinder, said windings carrying the same current of the primary winding passing through said windings, but in the opposite direction so as to reduce both the a.c. components and the d.c. ones of the
25 outwardly directed flow.

According to a further embodiment of the present invention, externally of said outer ferromagnetic core, there is mounted an additional cylinder of conducting metal, fulfilling the same function of said short-circuited outer windings, and forming moreover a metallic structure for supporting and assembling the inductance coil.

30 According to another embodiment of the present invention, a second ferromagnetic core is provided, mounted internally of the insulating cylinder which internally delimittes said coil winding, said second core being adjacent and preferably in contact with said insulating cylinder, and leaving a hollow passage coaxial with the axis of said

insulating cylinder.

The present invention will be now described with reference to the accompanying drawings, to be construed in an exemplificative and not limitative sense, in which:

- fig. 1 is a diagrammatic view of the inductance coil according to the invention;
 - 5 - fig. 2 is a view similar to fig. 1 showing a different embodiment;
 - fig. 3 shows a further embodiment having a pair of inductances comprising two axially superimposed windings;
 - fig. 4 is a view similar to fig. 1 of another embodiment; and
 - fig. 5 is a cross-section view along the plan V-V of fig. 4.
- 10 Turning to the drawings in which the same reference numbers indicated equal or corresponding parts, and particularly to fig. 1, the inductance coil of the invention comprises a coil winding 10, of usual structure, the wire turns of which are alternately disposed with respect to channels 11 through which the cooling air is giuded and forced in the direction shown by arrows 12.
- 15 The coil winding 10 is encompassed by two concentric insulating cylinders 13 and 14. It should be intended that the above described elements are of strictly conventional type, so that they are not shown in greater detail.
- A cylindrical ferromagnetic core 15 is coaxially mounted with respect to the winding 10 and externally of, but in a position adjacent to, the cylinder 13, said core
- 20 substantially embracing the whole side surface of the winding 10. In this way any interference and disturbance of adjacent apparatus, in particular adjacent inductance coils, are eliminated without substantially changing the size of the inductance coil; as a matter of fact the core 15 forms a closing element for the magnetic flow linked to the winding 10, which otherwise would be outwardly dispersed.
- 25 It should be noted that the ferromagnetic core 15 may be, in a manner per se known, either in form of a cylinder of a wound band or in form of adjacent packs of lamellaplates, parallely positioned with respect to the coil axis.
- Turning now to fig. 2, it is clearly shown that besides the structure already illustrated in fig. 1 two end windings 16 and 17 are added, which are short-circuited, which in the
- 30 shown position (i.e. outside of the insulating cylinder 13) oppose themselves to the magnetic flow dispersion and more particularly to the a.c. component thereof. If in the windings 16 and 17, on the contrary the same current of the winding 10 flows, but in the opposed direction, they oppose both to the a.c. and to the d.c. components of

the externally dispersed flow, thus improving the elimination of the flow dispersed outside of the coil.

A cylinder 18 is provided concentrically and externally of the core 15.

This cylinder 18, when made of ferromagnetic material, serves to collect the possible
5 remaining flow which is dispersed outwardly notwithstanding the presence of the magnetic core 15 and, when made of a different conductor metal, it acts likewise a short-circuited closed turn and opposes to the a.c. components of the magnetic flow which might eventually escape from the magnetic core 15.

In both cases, should it be possible depending on requirements of encumbrance and
10 available room, the cylinder 18 serves also as a supporting frame of the coil and for the assembling of the same at the desired position.

Finally, the fig. 3 shows an embodiment similar to that of fig. 2, from which it differs only because two coil windings 10 are provided, instead of one, thus giving place to two superimposed inductances.

15 Moreover at the ends of the coil, ferromagnetic cores 19 are provided sized so that the air circulation is not hindered, said cores obviously acting to prevent the dispersed flow through the coil ends from passing.

Referring now to figures 4 and 5, an embodiment substantially similar to that of fig. 2 is shown, with the exception that in addition to the ferromagnetic core 15 (not shown
20 in the figures and similar to that of fig. 1) which encircles the outer insulating cylinder 13, a further ferromagnetic core 115 is provided in form of lamellar packs fastened at the adjacent surface of the inner insulating cylinder 14.

The ferromagnetic core 115 obviously can also be in form of a continuous wound element, having the function of collecting and guiding the lines of force of the
25 magnetic field due to the reasons well known in the art.

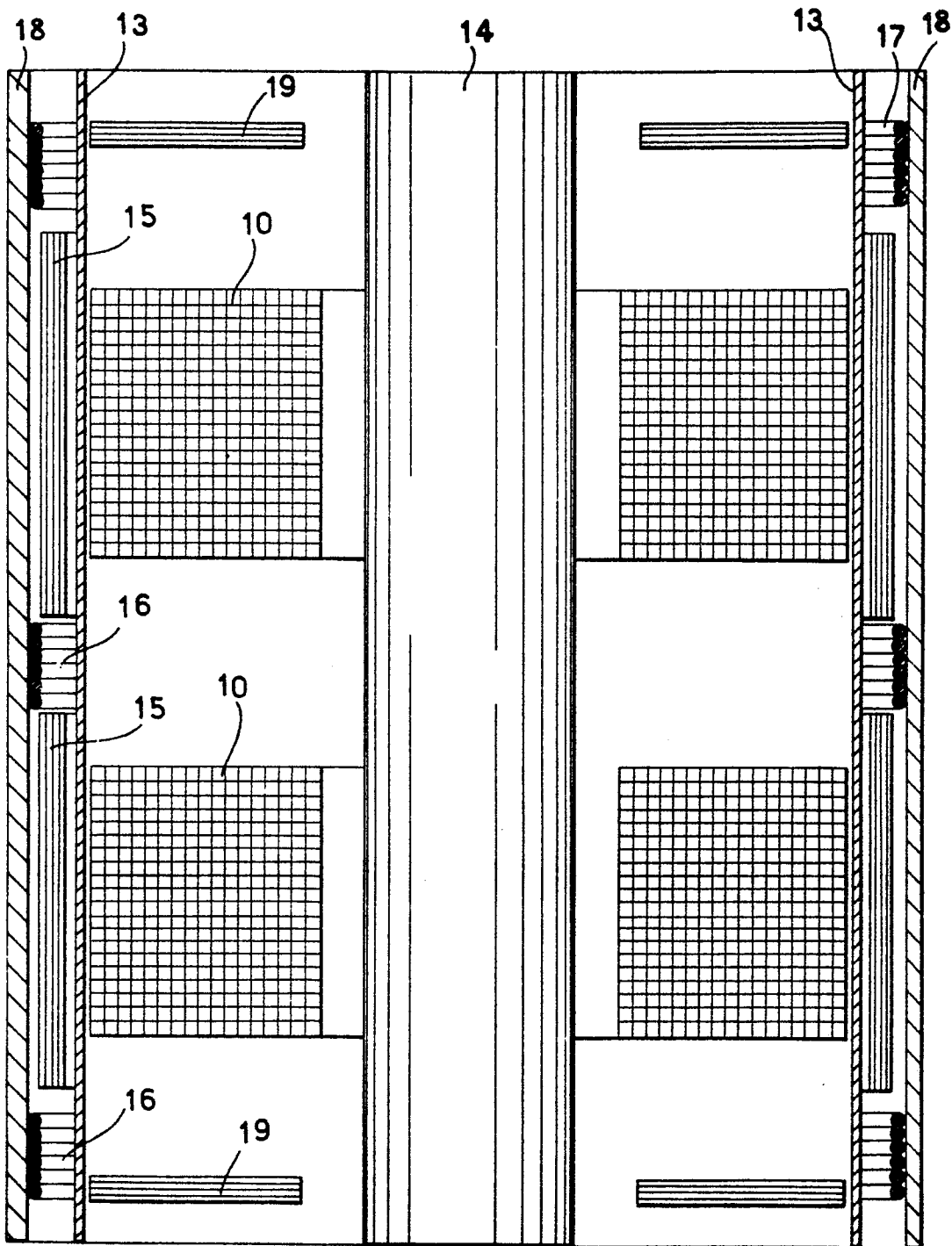
In this case the coil windings 16 and 17 of fig. 2 may also be provided.

It is an important feature of the invention the fact that the core 115 extends from the insulating cylinder 14 towards the center, but leaving free passage along the axis of the coil either because the latter becomes lighter and because the costs are reduced,
30 and finally because the efficiency of the coil itself is improved lower is the distance between core and winding the more effective is action of the ferromagnetic component . It is finally meant that some of the above described components can be substituted for by other components having an identical function and which accordingly are intended to be included in the scope of present invention.

CLAIMS

- 1) An inductance coil of the type comprising at least one conducting coil winding alternately positioned with respect to channels for the passage of the cooling air, said at least one winding being at least externally encompassed by an insulating cylinder, characterized in that at least outwardly of said at least one coil winding and of said
5 insulating cylinder a ferromagnetic core is concentrically mounted with respect to said at least one winding, said core extending for about the height of said at least one winding.
- 2) An inductance coil according to claim 1, characterized in that at the ends of said at least one winding, wire turns are provided mounted outside of said outer insulating
10 cylinder, said turns carrying the same current passing through said at least one winding, but in the opposite direction.
- 3) An inductance coil according to the claim 1, characterized in that at the ends, of said at least one winding, conductor turns are provided, said turns being mounted outside of said insulating cylinder and being short-circuited.
- 15 4) An inductance coil according to claim 1, characterized in that externally of said ferromagnetic core a cylinder made of conductor metal is provided.
- 5) An inductance coil according to claim 4, characterized in that said outer cylinder is also made of ferromagnetic material.
- 6) An inductance coil according to claim 1, wherein said at least one winding is
20 delimited by an inner insulating cylinder, characterized in that a ferromagnetic core is provided at a position adjacent to said inner insulating cylinder, said core leaving a free passage along the axis of the coil.
- 7) An inductance coil according to claims 1 and 6, characterized in that said ferromagnetic cores are in form of a hollow cylinder by winding a ferromagnetic strip.
- 25 8) An inductance coil according to claims 1 and 6, characterized in that said ferromagnetic cores are in form of packs of metal sheet plates parallelly oriented in respect with the coil axis.

Figure 1 is a schematic cross-sectional view of a multi-layered structure, possibly a semiconductor device or a composite material. The structure is divided into two main sections by a central vertical line. The left section shows a central core (10) with vertical layers (11) and a bottom layer (12). The right section shows a similar core (10) with vertical layers (11) and a bottom layer (12), but with an additional layer (13) on the right side. The entire structure is enclosed in a frame (14) with a top layer (15) and a bottom layer (16). The right side of the frame is labeled 17 and 18.

Fig. 3

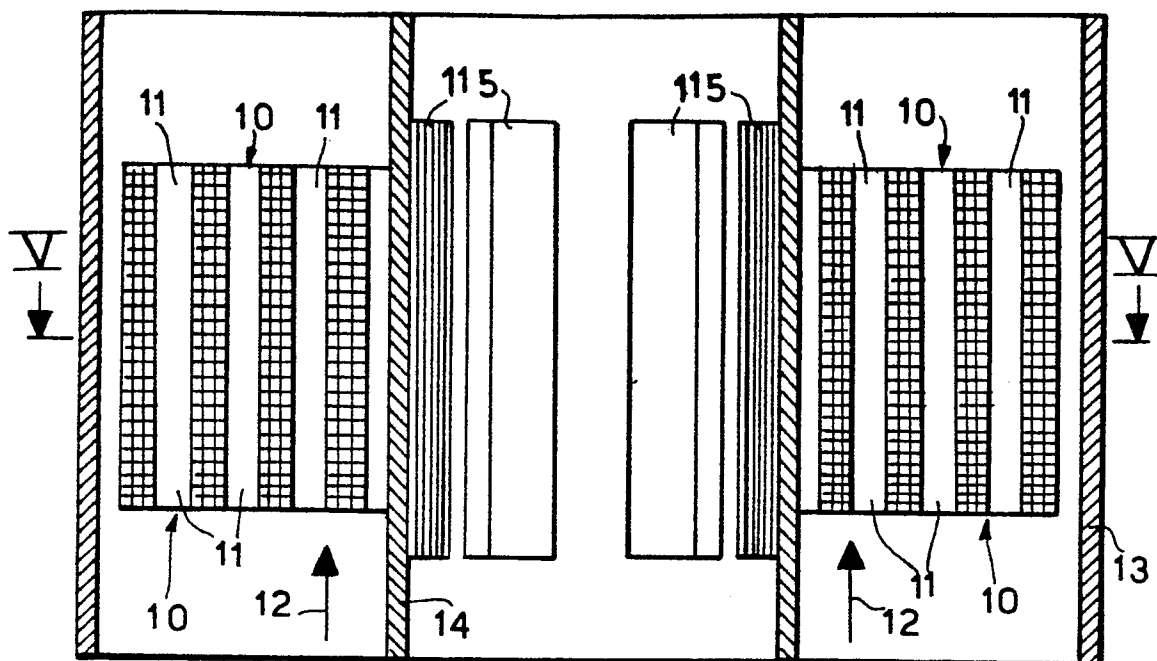


Fig. 4

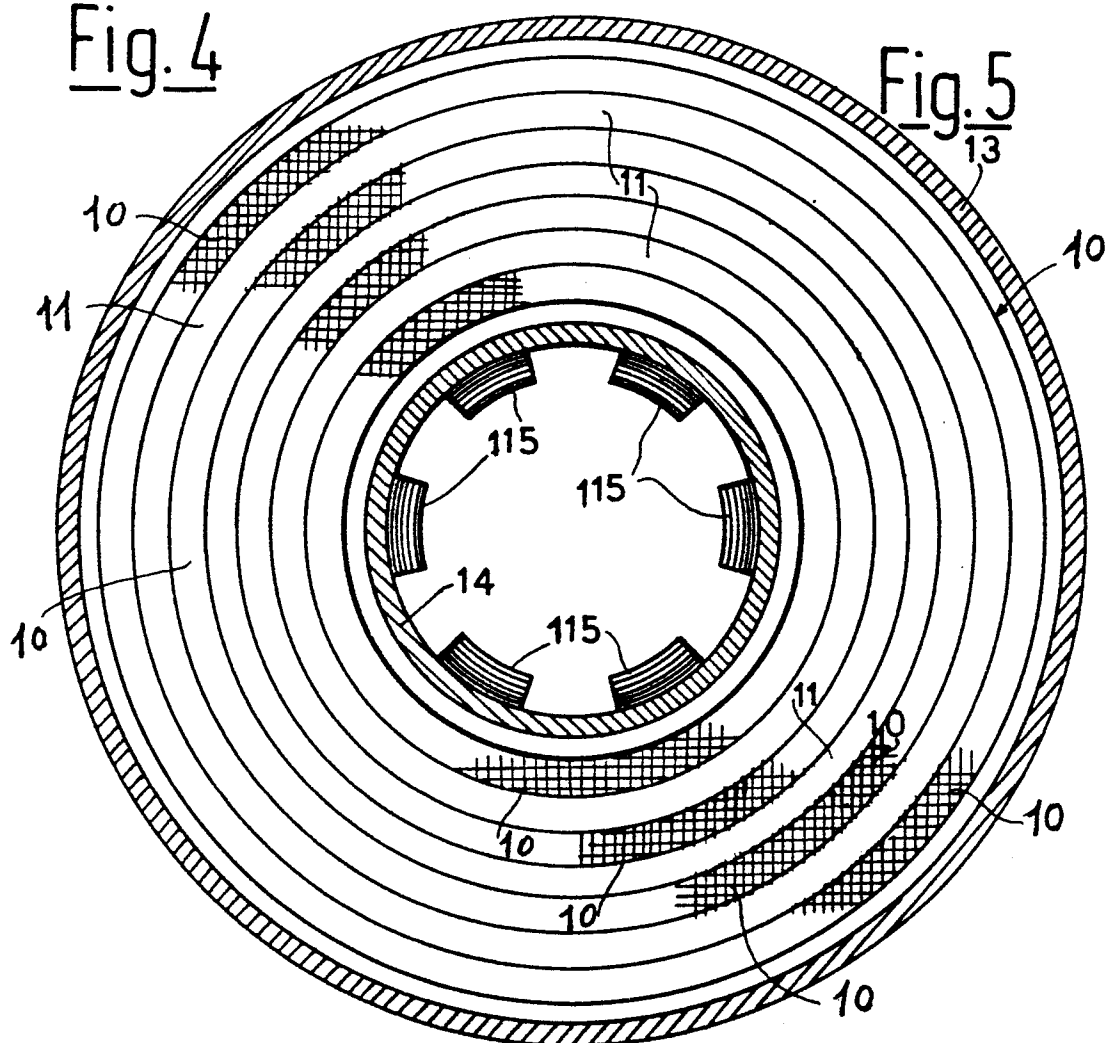


Fig. 5