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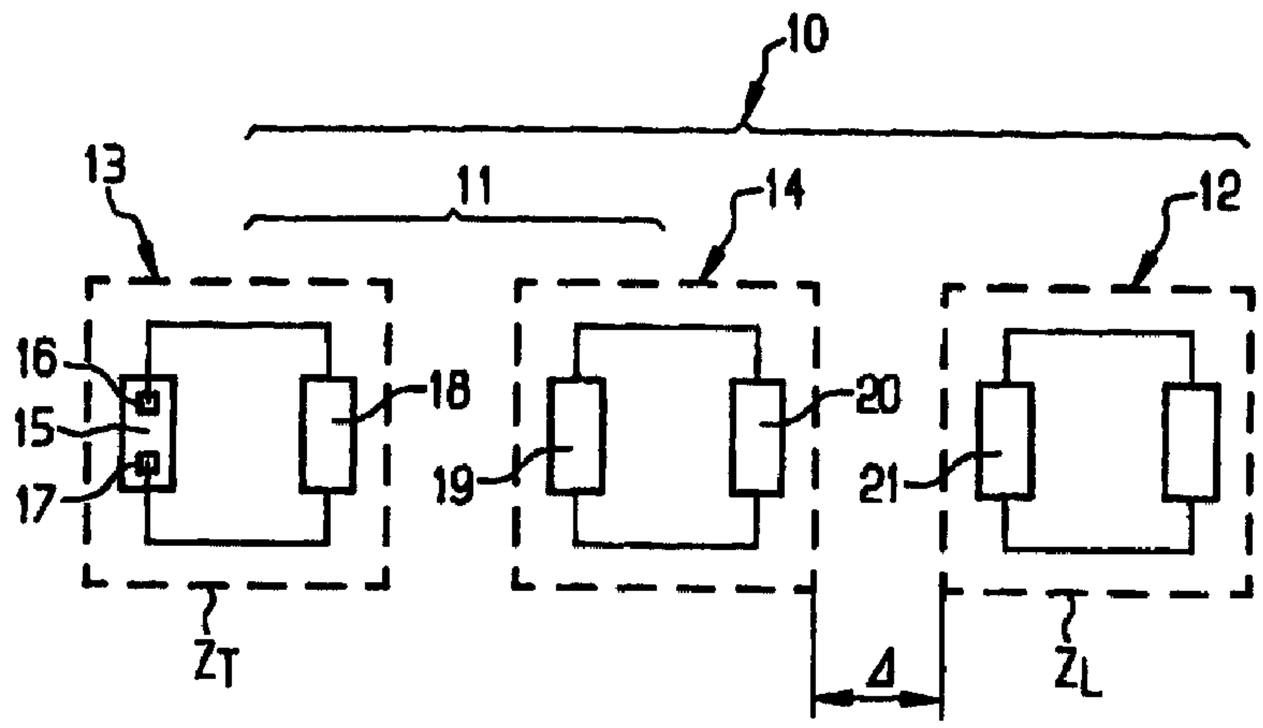
(54) **MODULE DE TRANSMISSION POUR DISPOSITIF TRANSPONDEUR, ET DISPOSITIF TRANSPONDEUR ET PROCEDE PERMETTANT DE FAIRE FONCTIONNER UN DISPOSITIF TRANSPONDEUR**

(54) **TRANSMISSION MODULE FOR A TRANSPONDER DEVICE, TRANSPONDER DEVICE AND METHOD FOR OPERATING SAID DEVICE**



(57) L'invention concerne un module de transmission (14) pour la transmission de données sans contact entre une puce (15) et un dispositif de lecture (12) comprenant un montage à bobines qui comporte un élément de couplage (19) et au moins une bobine d'antenne (20) qui sont reliés électriquement l'un avec l'autre, l'élément de couplage servant à la réalisation d'un couplage inductif avec une bobine de transpondeur (18) reliée électriquement à la puce, et la bobine d'antenne servant à la réalisation d'une liaison avec le dispositif de lecture. L'élément de couplage, qui se présente sous la forme d'une bobine de couplage (19), et la bobine d'antenne (20) sont conçus différemment en ce qui concerne leurs paramètres de bobine influant sur l'impédance de bobine.

(57) The invention relates to a transmission module (14) for contactless transmission of data between a chip (15) and a reading device (12) with a coil arrangement comprising a coupling element (19) and at least one antenna coil (20) that are electrically interconnected, wherein said coupling element is used to produce inductive coupling with a transponder coil (18) which is electrically connected to the chip, and the antenna coil is used to enable connection to the reading device. The coupling element embodied as a coupling coil (19) and the antenna coil (20) are configured differently with respect to the coil parameters affecting coil impedance.

ABSTRACT

The invention relates to a transmission module (14) for contactless transmission of data between a chip (15) and a reading device (12) with a coil arrangement comprising a coupling element (19) and at least one antenna coil (20) that are electrically interconnected, wherein said coupling element is used to produce inductive coupling with a transponder coil (18) which is electrically connected to the chip, and the antenna coil is used to enable connection to the reading device. The coupling element embodied as a coupling coil (19) and the antenna coil (20) are configured differently with respect to the coil parameters affecting coil impedance.

Transmission module for a transponder device and also a transponder device and method of operating a transponder device

The present invention relates to a transmission module for contact-free data transmission between a chip and a reading device in accordance with Claim 1 or 2 and also to a transponder device comprising a transponder unit and a transmission module according to Claims 11, 12 or 13 and a method of operating a transponder device comprising a transponder unit and a transmission module according to Claim 16 or 17.

Transponder units, which in their simplest form comprise a chip and a transponder coil in contact with the terminal areas of the chip, are used to an increasing extent in quite different fields, wherein they uniformly serve, however, the purpose of ensuring a contact-free or wire-free communication between a reading device disposed more or less remotely from the transponder unit and the chip in order to make possible a data retrieval for the purpose of detecting data stored on the chip. Such transponder units are used, for example, in so-called contact-free chip cards, in coded labels or even for identifying animals for slaughter, in this case used as so-called injection transponders.

The different fields of application of transponder units result in some cases in transmission distances which are extremely mutually different between the respective transponder unit and the associated reading device, which distances accordingly require different operating voltages of the transponder units or of the chip comprised therein. In addition, it has hitherto been necessary to match the layout of the transponder unit to the reading device in each individual case, which, as a rule, makes an impedance matching between the transponder unit and the reading device necessary. From the above it becomes clear that even

on the basis of the two reading parameters, operating voltage and impedance, alone, a multiplicity of differently laid-out transponder units is necessary in order to ensure a reliable operation of the respective transponder unit as a function of the transmission distance and the nature of the associated reading device. These requirements are therefore an obstacle to a fundamentally desirable standardization in the layout of transponder units, which standardization would make possible an essentially cheaper production of transponder units.

The object of the present invention is therefore to make possible the design of a standardized transponder unit regardless of the transmission distance encountered in an individual case or of the respective type of reading device.

This object is achieved by a transmission module having the features of Claim 1 or 2.

According to the invention, a transmission module for the contact-free data transmission between a chip and a reading device is proposed which comprises a coil arrangement having a coupling element and at least one aerial coil which are electrically interconnected, wherein the coupling element serves to produce an inductive coupling to a transponder coil electrically connected to the chip and the aerial coil serves to produce a contact-free connection to the reading device. In this arrangement, the coupling element designed as coupling coil and the aerial coil are of different design in regard to at least one of their coil parameters which influence the coil impedance.

A transmission module which is constructed in this way and which can be combined with the transponder unit by means of inductive coupling consequently makes possible an impedance matching between the reading device and the transponder

unit. That means that, proceeding from a standardized transponder unit, matching can take place to a reading device impedance which is different from the impedance of the transponder unit in that the coupling coil is essentially identical in regard to its impedance to the impedance of the transponder unit, and the aerial coil connected electrically to the coupling coil is matched to the impedance of the reading device in regard to its impedance. Consequently, as a result of an appropriate design of the coil parameters of coupling coil and aerial coil, it is possible to combine one and the same transponder unit with reading devices differing from one another in regard to their impedance. Available as such coil parameters which influence the impedance of the respective coil in the design of the coupling element as coupling coil are, for example, the wire cross section of the coil, the length of the coil wire associated with the respective coil or even the material used to produce the coil wire.

According to the invention, a further possibility of matching a transponder unit to the particular conditions of the individual case in regard to different transmission distances is to provide, according to Claim 2, a transmission module for the contact-free data transmission between a chip and a reading device which comprises a coil arrangement having a coupling element and at least one aerial coil, wherein the coupling element serves to produce an inductive coupling to a transponder coil electrically connected to the chip and the aerial coil to produce a contact-free connection to the reading device, wherein the contact element designed as coupling coil is designed in such a way that the coupling coil serves as primary coil of a transformer formed with the associated transponder coil to induce an increased operating voltage in the chip of the transponder unit.

In the case of this achievement according to the invention, use is accordingly made of the inductive coupling between the coupling coil and the transponder coil in order to form from the coupling coil and the transponder coil a transformer with which the operating voltage in the transponder unit can be increased. Consequently, it becomes possible, proceeding from a transponder unit with a standardized layout, to span different transmission distances as a result of the fact that correspondingly differently laid-out transmission modules are used in such a way that a suitable ratio of the number of turns between the coupling coil and the transponder coil determines the transformation ratio necessary to overcome the respective transmission distance.

In addition to the abovementioned possibility of achieving an increased operating voltage in the transponder unit by a suitable specification of the number of turns/transformation ratio, there is also the possibility of amplifying quite generally the magnetic field of the coupling coil by means of a suitable amplification device in order thereby to achieve a correspondingly increased induction and a voltage increase, associated therewith, in the transponder unit. Such an amplification device may be formed from a voltage source which increases or generates the voltage applied to the coupling coil, that is to say, for instance, by a battery disposed in the transmission module and in contact with the coupling coil. This makes it possible to form an active transmission module which has its own voltage supply.

A further possibility for achieving an amplification effect is to provide the coupling coil with a core made of a permeable material, in particular ferrite, which core increases the magnetic field strength of the coupling coil. The amplification device described above consequently also forms an achievement which is independent of the

achievement of utilizing the coupling coil and the transponder coil to form a transformer.

In a particular embodiment of the transmission module which uses a permeable material rod as core to form an axially aligned magnetic field, the aerial coil serves simultaneously as coupling coil.

To make possible a use of the coil arrangement as transmission module and a simplified application of the coil arrangement on a transponder unit or a substrate of a transponder unit, the coil arrangement is disposed on a carrier film. The term "carrier film" is in this case not to be understood as restrictive in regard to a material choice suitable for the carrier film, that is to say, in contrast to a widespread understanding of the meaning of the term "carrier film", as used here, this term includes not only plastic materials, but also natural materials, such as, for example, cellulose or paper. Here, the term "carrier film" is solely intended to express the fact that a substrate formed as carrier film is essentially determined by its area dimension and has a thickness which is on the negligible side compared with the area dimension.

For certain application cases, for example for producing a chip card provided with such a transmission module, it is advantageous to design the coil arrangement in total as a card inlay.

If the coil arrangement is to be used in coded labels or the like, it proves advantageous if the coil arrangement is formed on an adhesive substrate.

According to Claim 11, the transponder device according to the invention is provided with a transponder unit and a transmission module, wherein the transponder unit comprises a chip having a transponder coil electrically connected to

the chip and the transmission module comprises a coupling element having an aerial coil, wherein the coupling element serves to produce an inductive coupling to the transponder coil, and the aerial coil is electrically connected to the coupling element and serves to produce a contact-free connection to a reading device, wherein, to make possible a matching between the transponder unit and the reading device, the coupling element, designed as coupling coil, and the aerial coil are of different design in regard to at least one of their parameters influencing the coil impedance. The advantages of such a transponder device provided with a transmission module have already been explained in detail at the outset.

Furthermore, according to the invention, a transponder device comprising a transponder unit and a transmission module is proposed according to Claim 12, wherein the transponder unit comprises a chip having a transponder coil electrically connected to the chip and the transmission module comprises a coupling element having an aerial coil, wherein the coupling element serves to produce an inductive coupling to the transponder coil, and the aerial coil is electrically connected to the coupling element and serves to produce a contact-free connection to a reading device, wherein the coupling element is designed as coupling coil and has a comparatively lower number of turns than the transponder coil, in such a way that the coupling coil forms a primary coil and the transponder coil a secondary coil of a transformer.

The advantages of such a transponder device provided with a transmission module in conjunction with a possible increase thereby of the operating voltage of the transponder unit have already been discussed in detail at the outset.

A further transponder device according to the invention is provided, according to Claim 13, with a transponder unit

and a transmission module, wherein the transponder unit comprises a chip having a transponder coil electrically connected to the chip and the transmission module comprises a coupling element having an aerial coil, wherein the coupling element serves to produce an inductive coupling to the transponder coil, and the aerial coil is electrically connected to the coupling element and serves to produce a contact-free connection to a reading device, wherein the coupling element is formed from a permeable material rod, in particular a ferrite core, whose end face serves as coupling surface and the aerial coil is disposed around the material rod.

In a transponder device designed in this way, because of the strongly focused axial alignment of the magnetic field generated by the permeable material rod, a particularly effective and, consequently, low-loss inductive coupling is possible between the transponder coil of the transponder unit and the aerial coil so that, regardless of the possibility described above of impedance matching or step-up transformation of the operating voltage of the transponder unit, this configuration of the transponder device already makes possible an increase in the operating voltage in the transponder unit solely as a result of the particularly low-loss coupling via the material rod.

It proves particularly advantageous that, because of the particularly low-loss inductive coupling between the aerial coil and the transponder coil via the material rod, the configuration described above of the transponder device makes possible the use of a transponder coil which is designed as a chip coil disposed on the surface of the chip. Such chip coils are also known by the term "coil on chip".

In this connection, in a special embodiment of the transponder device, the chip is disposed with its rear side

on the end face of the permeable material rod, and the chip coil disposed on the contact side of the chip opposite the rear side is disposed with its coil surface essentially congruent with the end face of the material rod. This results in an extremely miniaturized transponder device, such as is used, for example, in an injection transponder.

In the method according to the invention of operating a transponder device having a transponder unit comprising a chip and a transponder coil and having a transmission module comprising a coupling coil and an aerial coil electrically connected to the coupling coil, the impedance of the aerial coil matched to a reading device communicating with the transponder unit is converted by means of the transmission module into an impedance of the coupling coil matched to the impedance of the transponder unit.

A further method according to the invention of operating a transponder device having a transponder unit comprising a chip and a transponder coil and having a transmission module comprising a coupling coil and an aerial coil electrically connected to the coupling coil consists in using the coupling coil of the transmission module together with the transponder coil as a transformer which increases the operating voltage in the transponder unit.

Preferred embodiments of the transmission modules according to the invention and also embodiments of transponder devices provided with such transmission modules are explained in greater detail below with respect to the drawings, possible operating modes of such transponder devices being explained.

In the drawings:

Figure 1 shows a diagrammatic view of a data transmission arrangement comprising a transponder device and a reading device;

Figure 2 shows a detail view of the transponder device shown diagrammatically in Figure 1;

Figure 3 shows a sectional view of a chip card constructed in layer technique and provided with a transponder device;

Figure 4 shows a plan view of the transponder device disposed in the chip card shown in Figure 3;

Figure 5 shows a further exemplary embodiment of a transponder device.

Figure 1 shows a data transmission arrangement 10 comprising a transponder device 11 and a reading device 12. The transponder device 11 comprises a transponder unit 13 and a transmission module 14. In the diagrammatic view chosen in Figure 1, the transponder unit 13 comprises a chip 15 and a transponder coil 18 electrically connected to the terminal areas 16, 17 of the chip 15.

The transmission module 14 comprises in the present case a coupling element, designed here as coupling coil 19, and an aerial coil 20 electrically connected to the coupling coil.

The transmission module 14 basically serves to receive the electromagnetic broadcasting power emitted by a broadcasting coil 21 of the reading device 12 via the aerial coil 20 and to transmit it inductively by means of the coupling coil 19 to the transponder coil 18 of the transponder unit 13. In this connection, the coupling coil 19 essentially has the purpose of focusing the electromagnetic field on the transponder coil 18 in order

to achieve as effective an inductive coupling as possible between the coupling coil 19 and the transponder coil 18.

A further function of the transmission module 14 is to effect an increase in the operating voltage of the chip 15 by means of a suitable interaction with the transponder coil 18 in order to make possible an increased transmission distance Δ between the transponder device 11 and the reading device 12.

In addition, the transmission module 14 makes possible a matching of the impedance Z_T of the transponder unit 13 to the impedance Z_L of the reading device 12 as a result of the fact that the coupling coil 19 and the aerial coil 20 are essentially identical in their impedance values to the transponder unit 13 or the reading device 12, respectively, or are matched thereto.

Figure 2 shows, for the purpose of a more detailed explanation of the modes of operation, referred to above, of the transmission module 14, a more detailed view of the transponder device 11 with the transponder unit 13 comprising the chip 15 and the transponder coil 18 and the transmission module 14 comprising the coupling coil 19 and the aerial coil 20.

In the present case, the aerial coil 20 comprises a number of turns n = 8 and the coupling coil 19 comprises a number of turns n = 10. The coupling coil 19 and the aerial coil 20 are connected via electrical conductors 22, 23. Because of the different winding lengths of the coils in conjunction with the number of turns, given otherwise identical coil parameters which influence the coil impedance of the coupling coil 19 and the aerial coil 20, the coupling coil 19 has, in the present case, a lower impedance than the aerial coil 20. Accordingly, the design of the transmission module 14 shown in Figure 2 can be

designed, for example, so that the coupling coil 19 is matched to the relatively low impedance of the transponder unit 13 and the aerial coil 20 is matched to the relatively high impedance of a reading device, which is not shown in greater detail here, so that it becomes possible by means of the transmission module 14 to connect a high-resistance reading device to a low-resistance transponder unit without the transponder unit itself, that is to say the transponder coil 18, having to be matched directly in terms of impedance for this purpose.

In the embodiment of the transmission module 14 shown in Figure 2, in addition, an interaction of the coupling coil 19 provided with a relatively low number of turns n = 10 with the transponder coil 18 comprising a relatively high number of turns n = 20 produces a transformer effect via the inductive coupling indicated here by a diagrammatic field line pattern 24 in such a way that the coupling coil 19 and the transponder coil 18 act as primary coil and secondary coil, respectively, of a transformer 25, with the consequence that a comparatively increased voltage is induced in the transponder coil 18, as a result of which a correspondingly increased operating voltage is available for the chip 15.

Figure 3 shows a transmission module 26 in an embodiment as a card inlay in a chip card 27 formed in layer technique.

In addition to the transmission module 26, the further layers are formed from a chip inlay 28 having a chip 29 accommodated therein, a transponder coil inlay 30 having a transponder coil 31 embedded therein and in contact with the chip 29 and two outer top layers 32 and 33 disposed in each case on the chip inlay 28 or the transmission module 26. The chip inlay 28 and the transponder coil inlay 30 form, in the present case, a transponder device 49.

Figure 4 shows the transmission module 26 in a plan view, with a coupling coil 34 and an aerial coil 35 which are interconnected via conductors 36, 37 and are disposed here on a common carrier layer 38 designed as thin-film substrate, which carrier layer may be composed in the present case of a polyimide film.

Both the transponder coil 31 and the coupling coil 34, and the aerial coil 35 may be formed as wire coils and also as coils produced in another way.

Figure 5 shows a transponder device 39 comprising a transponder unit 40, which is formed from a chip 41 and a transponder coil 43 disposed directly on the contact surface 42 provided with terminal areas. In specialist language, such coil arrangements are also described by the term "coil on chip" and can be produced in an etching or shearing process.

The transponder device 39 comprises a transmission module 44 which is composed of a short-circuited aerial coil 46 disposed around a ferrite core 45. As a departure from the transmission modules 14 and 26 shown in Figures 2 and 4, the electromagnetic field picked up by the aerial coil 46 is focused in the case of the transmission module 44 on the transponder coil 43 not by means of a coupling coil, but by means of the ferrite core 45 which strongly focuses the magnetic field and aligns it axially.

As shown in Figure 5, the transponder device 39 makes possible a construction in which the chip 41 can be positioned by means of its rear side 47 directly on an end face 48 of the ferrite core 45. To achieve as effective an inductive coupling as possible between the ferrite core 45 and the transponder coil 43, the chip 41 is disposed on the end face 48 of the ferrite core 45 in such a way that the end face 48 from which the magnetic field is essentially

emitted and the transponder coil 43 are in a congruent position.

The transponder device shown in Figure 5 is particularly suitable for use as a so-called injection transponder in which the transponder device 39 is disposed in a hermetically sealed manner in an injection container which is formed, for example, from glass and which can be used, for example, when subcutaneously injected as transponder for identifying animals to be slaughtered.

1. Transmission module (14, 26) for the contact-free data transmission between a chip (15, 29) of a transponder unit (49) and a reading device (12) having a coil arrangement which comprises a coupling coil (19, 34) and at least one aerial coil (20, 35) which are electrically interconnected, wherein the coupling coil serves to produce an inductive coupling (24) to a transponder coil (18, 31) electrically connected to the chip and the aerial coil serves to produce a connection to the reading device, and the coupling coil (19, 34) and the aerial coil (20, 35) are of different design in regard to their coil parameters influencing the coil impedance, characterized in that the coupling coil (19, 34) and the aerial coil (20, 35) are disposed on a common carrier layer (38), in such a way that the coil arrangement, together with the carrier layer, forms a unit which can be used independently of the transponder unit.

2. Transmission module according to Claim 1, characterized in that the coil arrangement (34, 35) on the carrier layer (38) forms a card inlay (30) of a chip card constructed in layer technique.

3. Transmission module according to Claim 1 or 2, characterized in that the carrier layer (38) is designed as carrier film.

4. Transmission module according to one or more of the preceding claims, characterized in that the carrier layer is designed as adhesive substrate.

5. Transmission module (44) for the contact-free data transmission between a chip (41) of a transponder unit (40) and a reading device having a coil

arrangement which comprises a coupling element (45) and at least one aerial coil (20, 35, 46), wherein the coupling element serves to produce an inductive coupling to a transponder coil (43) electrically connected to the chip and the aerial coil serves to produce a connection to the reading device, characterized in that the coupling element is designed as a permeable material rod which is surrounded by the aerial coil in such a way that the material rod serves as substrate for the aerial coil and the material rod, together with the aerial coil, forms a unit which can be used independently of the transponder unit.

6. Transponder device (39) comprising a transponder unit (40) and a transmission module (44), wherein the transponder unit comprises a chip (41) with a transponder coil (43) electrically connected to the chip and the transmission module comprises a coupling element (45) having an aerial coil (46), wherein the coupling element serves to produce an inductive coupling to the transponder coil, and the aerial coil serves to produce a contact-free connection to a reading device (12), characterized in that the coupling element is formed from a permeable material rod (45) whose end face (48) serves as coupling surface, and the aerial coil (46) is disposed around the material rod (45).

7. Transponder device according to Claim 6, characterized in that the transponder coil is designed as a "coil-on-chip" chip coil (43) disposed on the surface (42) of the chip (41).

8. Transponder device according to Claim 6 or 7, characterized in that the chip (41) is disposed

with its rear side (47) on the end face (48) of the permeable material rod (45) and the chip coil (43) disposed on the contact surface (42) of the chip (41) opposite the rear side (47) is disposed with its coil surface essentially congruent with the end face (48) of the material rod (45).

FIG 1

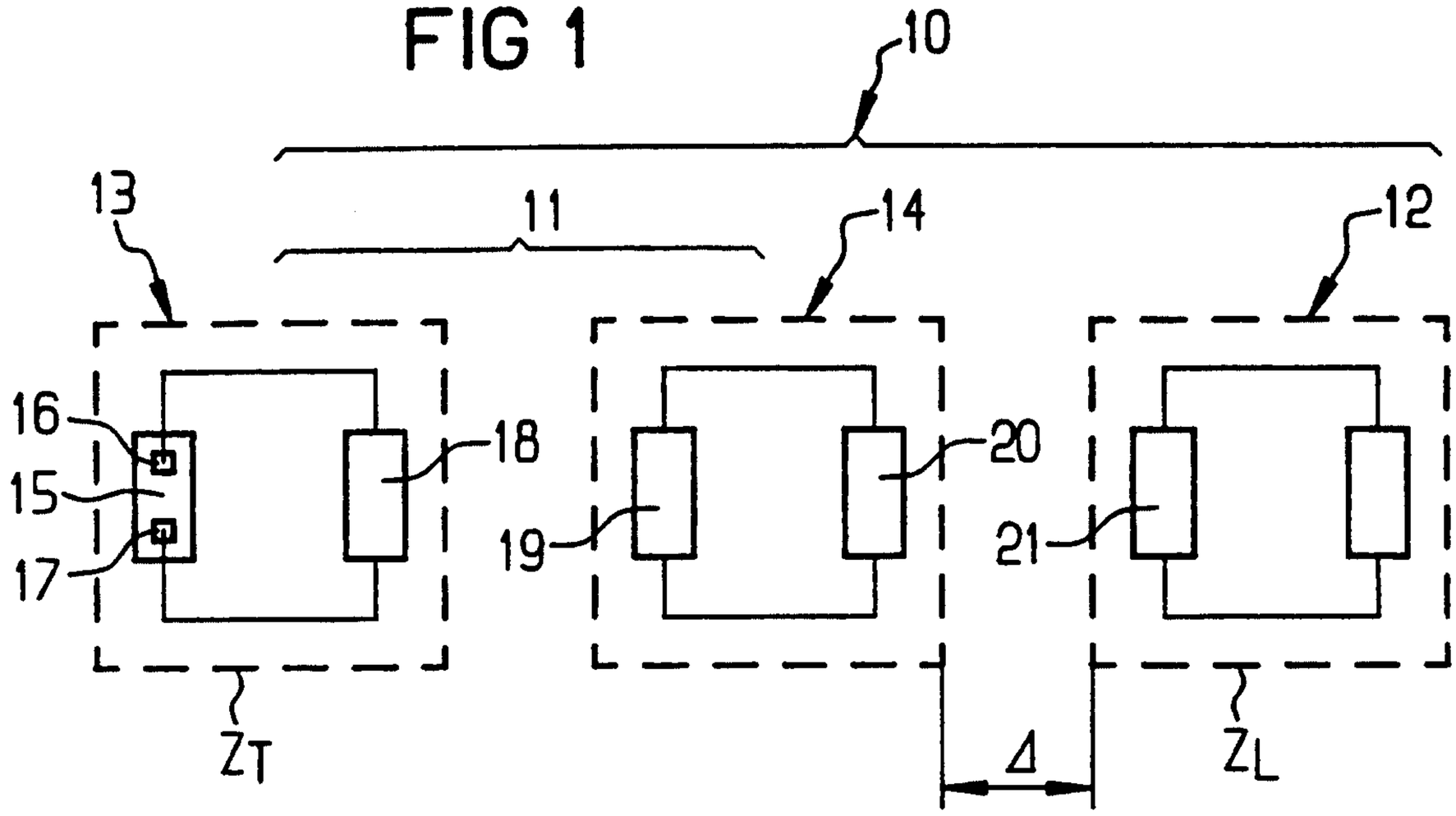

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FIG 2

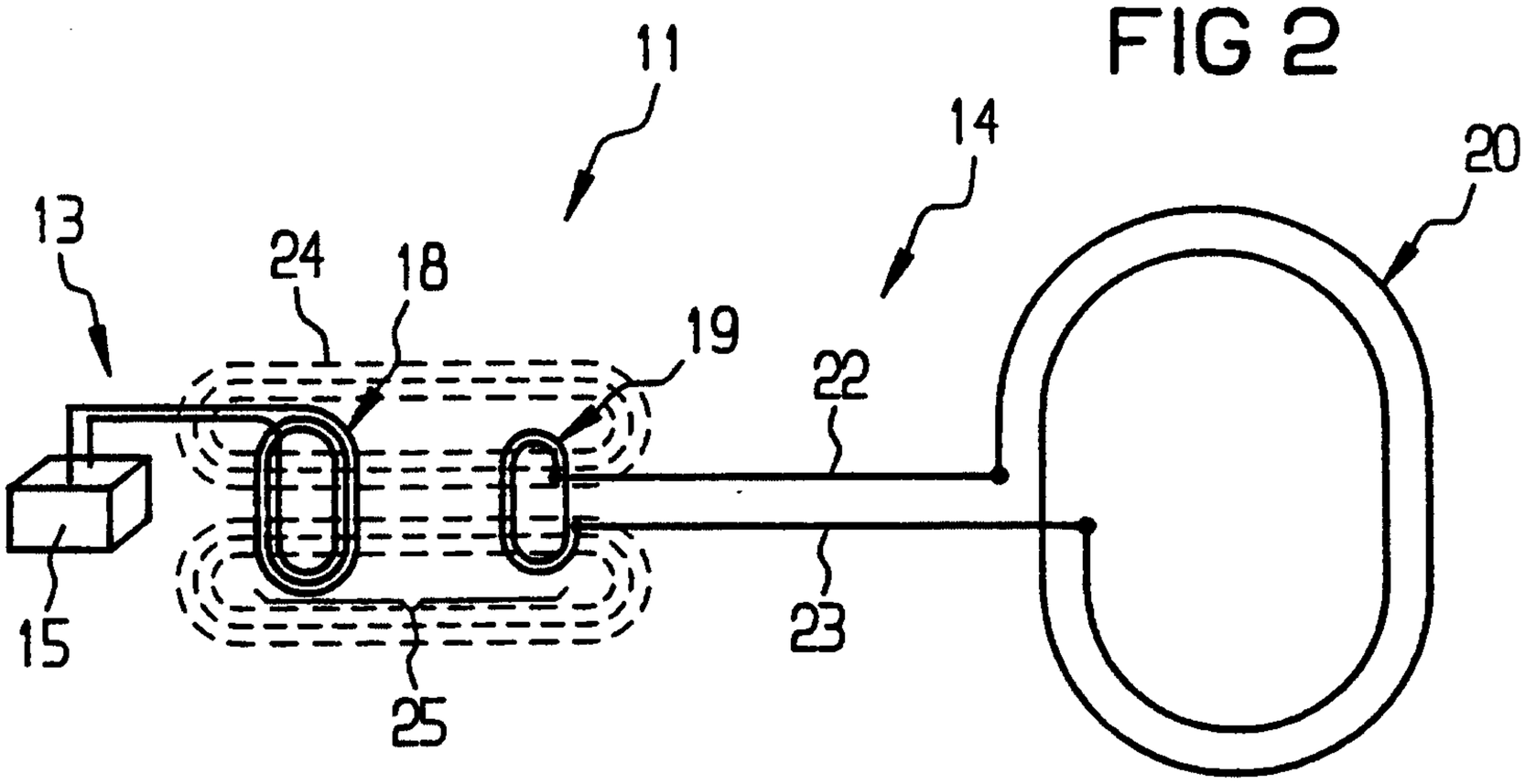
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FIG 3

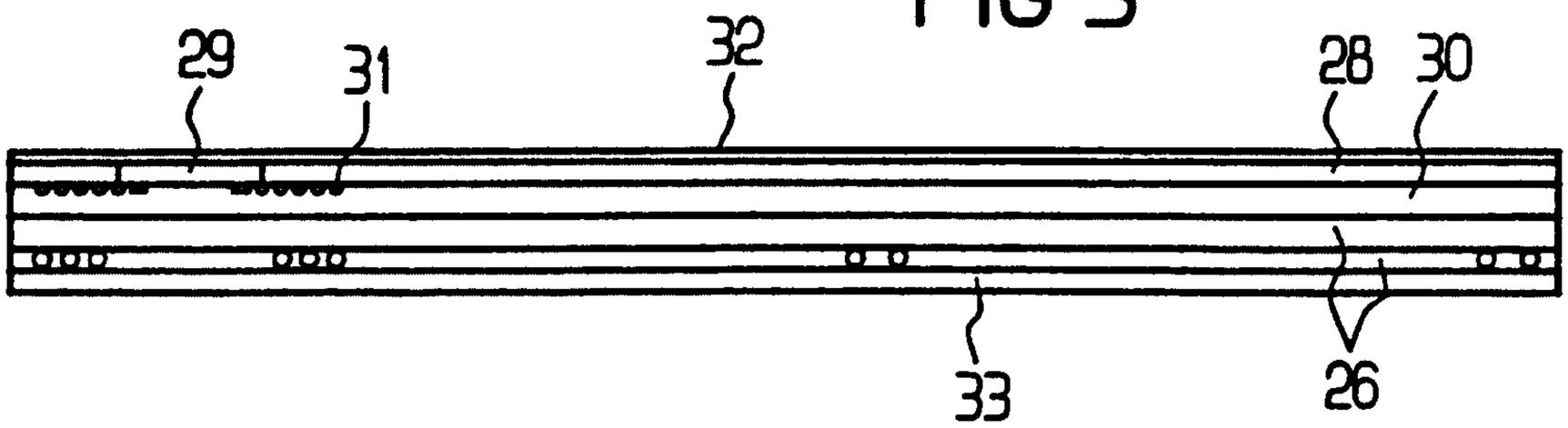

FIG 4

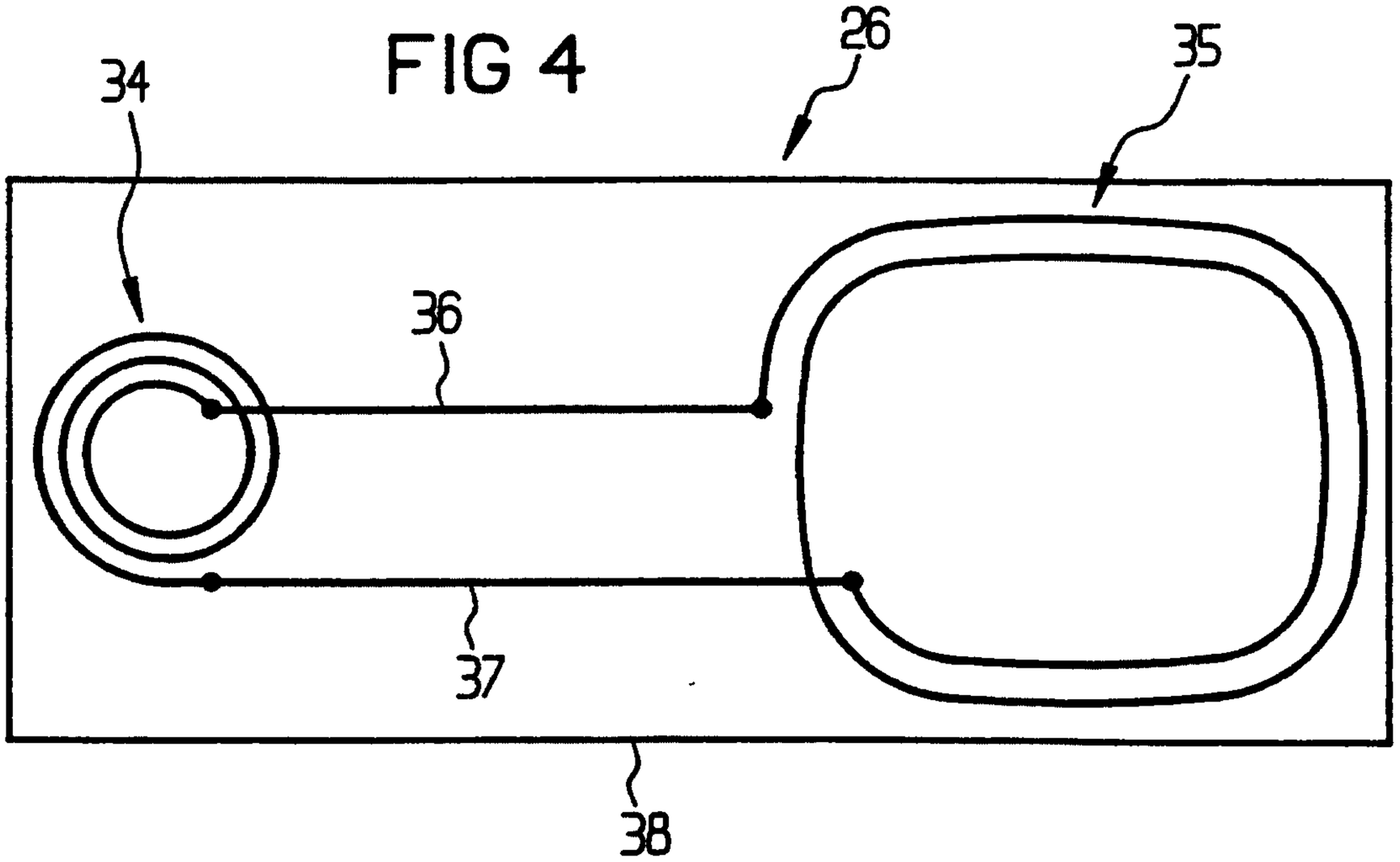

FIG 5