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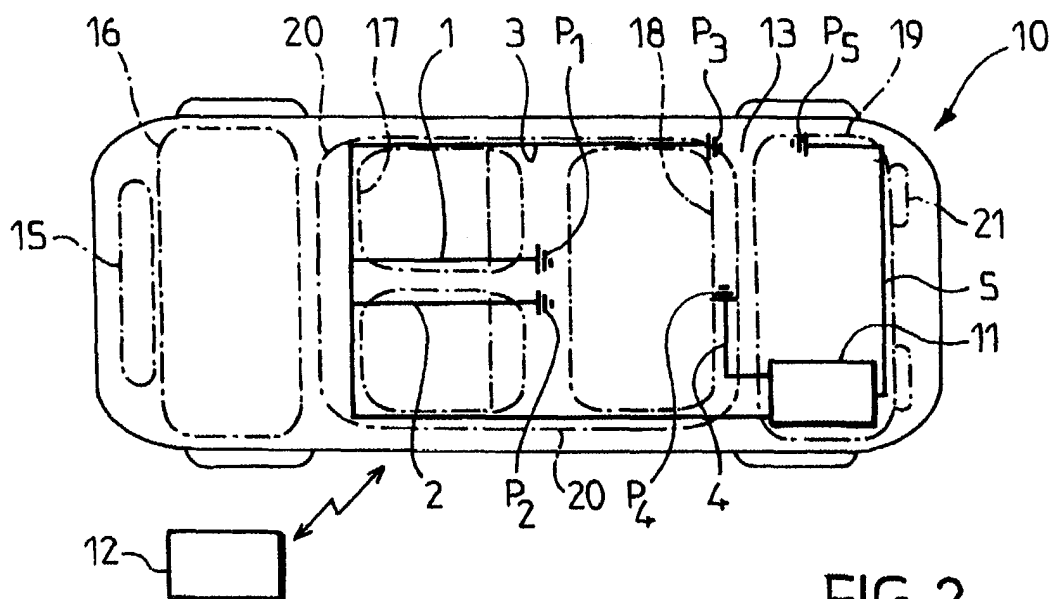
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(54) **On-board signal transmitter for implementing keyless procedure**

(57) A signal transmitter (11) communicates with a  
 portable receiver (12) for implementing a keyless entry  
 procedure. A loop antenna is connected to the signal  
 transmitter by two wire conductors (1, 2) which are twist-

ed together along a portion of their length (22) down to  
 a branching point (B<sub>2</sub>) where the two wire conductors  
 separate from one another in order to form at least a  
 portion of said loop antenna.



**FIG. 2**

**Description**Technical Field

**[0001]** The present invention relates to an on-board signal transmitter for a motor vehicle, capable of communicating with a portable receiver for implementing a keyless entry and/or keyless ignition procedure.

Background of the Invention

**[0002]** A typical configuration for keyless car systems is the use of a two way radio communication between the vehicle and an electronic key. For security reasons, the position of the electronic key has to be monitored while the communication occurs. For detecting the position of the electronic key with respect to the vehicle, i.e. the inside-outside detection and the outside zone detection, in state of the art systems, there is a proven advantage in using a low frequency communication (e.g. 20 kHz, 125 kHz, 13,56MHz). For the communication and data exchange between the car and the electronic key, a higher frequency is recommended (e.g. 315MHz, 433MHz, 868MHz, 2,45GHz) in order to benefit from a higher data rate and to save communication time, i.e. extend the battery life.

**[0003]** For the uplink (vehicle to electronic key), the state of the art system includes the use of ferrite core coil antennas placed in door handles or inside the doors. Each antenna has to be tuned and separately wired to the central unit. This is labour-intensive and costly, because a fully protected keyless system would require up to ten ferrite antennas.

**[0004]** FR2839785 discloses a vehicle comprising an on-board signal transmitter capable of communicating with a portable receiver for implementing a keyless entry and/or keyless ignition procedure. Fig. 1 shows the signal transmission system 50 of this prior art vehicle. It includes a pair of output wires 51 and 52 which are electrically connected to a pair of corresponding connection points 53 and 54 on the vehicle body 55. An antenna driver circuit 56 with a current transformer 57 generates an electrical current in the output wires 51 and 52 so as to radiate a magnetic field which can serve to communicate with an electronic key. Due to the conductivity of the metal, an electrical current  $I_{\text{body}}$  is caused to flow through the vehicle body 55 from one connection point to the other as shown in Fig. 1.

**[0005]** This prior art discloses also a loop antenna made of wire which extends around the passenger compartment of a car. However, due to the large size of the loop, the radiated magnetic field is not homogeneous throughout the passenger compartment and decreases rapidly in the middle of the loop.

Summary of the Invention

**[0006]** An object of the invention is to provide an on-board transmitter device with transmission antennas, which makes it possible to obtain a precise localisation of an electronic key while reducing the material and installation cost of the device.

**[0007]** Another object of the invention is to provide simple and cost-effective antenna systems, making it possible to attain a consistent coverage of the vehicle's interior space.

**[0008]** The invention provides also a vehicle comprising an on-board signal transmitter capable of communicating with a portable receiver for implementing a keyless entry and/or keyless ignition procedure, said signal transmitter having a loop antenna made of conductive material and arranged around at least a portion of the vehicle interior space, as seen in projection, for radiating a magnetic field, said loop antenna being connected to the signal transmitter by two wire conductors which extend from the signal transmitter, characterized in that the two wire conductors are twisted together along a portion of their length down to a branching point where the two wire conductors separate from one another in order to form at least a portion of said loop antenna.

**[0009]** This feature makes it possible to arrange a loop antenna at any position independently of the position of the transmitter by covering the distance between the transmitter output and the loop antenna with wire conductors that are twisted together. Intertwined wire conductors do not contribute substantially to the magnetic radiation of the antenna. Hence, such a configuration is substantially equivalent to a magnetic loop which closes at the branching point. Since the intertwined portion of the pair of wire conductors does not affect the radiation pattern of the loop antenna, the antenna can be placed at all appropriate locations with respect to the transmission areas to be covered, regardless of the location of the transmitter in the vehicle. Hence, the antenna system is very flexible and can be easily adapted to all types of vehicles.

**[0010]** According to a specific embodiment of the invention, each said wire conductor is connected to a respective connection point on the vehicle body, said loop antenna consisting of the two wire conductors and a portion of the vehicle body which extends between both connection points. Two wire conductors, each connecting an output terminal of the transmitter to a connection point on the vehicle body, form a transmission antenna which is capable of radiating a magnetic field. Indeed, a portion of the vehicle body which extends between both connection points and the two wire conductors connected thereto constitute a circuit through which an electrical current can flow from one of the output

terminals to the other. Such a configuration, i.e. a hybrid loop made of both wire conductor and body bulk, radiates a magnetic field similar to that of a loop antenna made of wire. However, the vehicle body makes only a small contribution to the magnetic radiation of the antenna. The field strength of this transmission antenna architecture depends on the distance between the connection points, the area between both wire conductors, the length of the both wire conductors, the shape of the area between both wire conductors and the electrical current in the hybrid loop made of both wire conductors and body bulk.

**[0011]** Advantageously in that case, a capacitor is arranged between a conductor and the corresponding connection point on the vehicle body.

**[0012]** According to another embodiment of the invention, said loop antenna is entirely constituted by said wire conductors. Indeed, as a preference, the two wire conductors are two portions of a single wire in an uninterrupted circuit which is arranged in the form of a whole loop.

**[0013]** Advantageously, a portion of the two wire conductors located between said intertwined portion and said transmitter form a second loop antenna arranged around at least a portion of the vehicle interior space, as seen in projection, wherein said intertwined portion connects both loop antennas in series. In accordance with the same principle, it is possible to build a number of series-connected loop antennas with interconnections made of intertwined wires.

**[0014]** According to a further embodiment of the invention, the two wire conductors include a further intertwined portion which extends from said second loop antenna to said transmitter.

**[0015]** Advantageously, both loop antennas and both intertwined pairs are made of a single wire in an uninterrupted circuit, wherein the two wire conductors are two portions of said single wire.

**[0016]** According to specific embodiments of the invention, at least one loop is formed around the luggage compartment of the vehicle as seen in vertical projection, and/or around a centre portion of the passenger compartment of the vehicle as seen in vertical projection, and/or around a right-hand half and/or a left-hand half of the passenger compartment of the vehicle as seen in vertical projection, and/or around a front half and/or a rear half of the passenger compartment of the vehicle as seen in lateral projection, and/or around the whole passenger compartment of the vehicle as seen in longitudinal projection. These configurations provide well-defined transmission areas which are most useful for monitoring the presence or absence of the electronic key during the communication.

**[0017]** As an option different from series-connected loop antennas, it is possible to provide the parallel connection of several loops or hybrid loops at the same output terminal pair of the transmitter. In this case, there is an advantage in using different diameters for each loop cable in order to adjust the desired current relations in the parallel wire loops or hybrid loops.

**[0018]** As a preference, the wire conductors are arranged within the wiring harnesses of the vehicle. In particular, the position of the connection points on the vehicle body can be adapted to any existing wiring harness architecture. The main advantage of this embodiment is that the wire conductors which form the antennas can be fitted to the existing wiring harnesses in any car architecture. When the wire conductors are connected to the vehicle body, a closed loop wiring harness system is not required. Hence, the vehicle can be fitted with antennas for a keyless entry system without the addition of specific wiring harnesses and without any substantial modification of the existing wiring harnesses. The antennas can take advantage of typical non-closed loop architecture of the wiring harness in a car.

#### Brief description of the Drawings

**[0019]** To allow better understanding of the subject matter of the invention, several embodiments thereof depicted in the appended schematic drawings will now be described as purely illustrative and by no means exhaustive examples.

**[0020]** In the drawings:

- Figure 1 shows the signal transmission system of a prior art vehicle,
- Figure 2 is a plane view from above showing a vehicle fitted with a signal transmitter in accordance with a first embodiment of the invention,
- Figure 3 shows the transmission antennas in the vehicle of Fig. 2,
- Figure 4 shows transmission areas which can be selectively attained with the signal transmitter of Fig. 2,
- Figure 5 shows a transmitter architecture suitable for the embodiment of Fig. 2,
- Figure 6 is a view similar to Fig. 2 showing a vehicle in accordance with a second embodiment of the invention,
- Figure 7 is a perspective view showing a vehicle in accordance with a third embodiment of the invention,
- Figure 8 shows a modified embodiment of the signal transmitter,
- Figure 9 is a perspective view showing a vehicle in accordance with a fourth embodiment of the invention,
- Figure 10 is a perspective view showing a vehicle in accordance with a fifth embodiment of the invention,
- Figure 11 is a plane view from above showing a vehicle in accordance with a sixth embodiment of the invention.

**[0021]** All the figures relate to an automotive vehicle equipped with a keyless entry system. The vehicle is designated

by number 10 in Fig. 2. This system includes an on-board central control unit which is able to carry out a two-way radio communication with an electronic key 12, shown on Fig. 2, in accordance with an encrypted protocol in order to recognize the electronic key and to actuate the vehicle locks once the electronic key 12 has been recognized. The central control unit includes the antenna drivers and a logical data processing unit, such as a digital processor. For example, the communication can be triggered by actuating a door handle. In the following, the description is focused on the uplink from the on-board central unit to the electronic key 12. The other elements of the system are known by persons skilled in the art.

**[0022]** The on-board central unit includes a low frequency signal transmitter 11 (operating at e.g. 20 kHz, 125 kHz or 13,56MHz) with a number of output terminals  $O_1$ - $O_5$  connected by wire conductors 1-5 to a number of connection points  $P_1$ - $P_5$  on the vehicle body floor 13. In order to clarify the positions of the connection points, some usual components of the vehicle are shown in dot-dashed lines on Fig. 2, i.e. air intake 15, engine compartment 16, front seats 17, back seats 18, luggage compartment 19, passenger compartment 20 and rear lights 21. For example,  $P_1$  and  $P_2$  are located on both sides of the transmission tunnel in the middle of the passenger compartment 20.

**[0023]** The wire conductors 1-5 are preferably arranged in the existing wiring harnesses of the vehicle, i.e. the collection of wires and cables which supply power and/or data signals to different elements of the vehicle. For example, a wiring harness for the rear lights is generally arranged in a tunnel which runs along the bottom of the door frames. The wire conductors 1-5 are individually insulated by an insulating covering.

**[0024]** The wire conductors 1-5 and the corresponding connection points  $P_1$ - $P_5$  are arranged in such a manner that a number of specific areas inside the vehicle are substantially surrounded each by a hybrid loop made of a pair of the wire conductors and the portion of the body floor located between the corresponding pair of connection points. For example, as shown in Figs. 1 and 2, the front middle portion of the passenger compartment, i.e. between the front seats 17, is substantially surrounded by wire conductors 1 and 2 and the segment  $P_1$ - $P_2$  of the body floor. The same is true for the luggage compartment 19 and wire conductors 4 and 5; the right-hand side of passenger compartment 20 and wire conductors 1 and 3; the left-hand side of passenger compartment 20 and wire conductors 2 and 4. In order to transmit a signal, the transmitter 11 selects one of the above mentioned pair of wire conductors and generates an electrical current into it, so that the resulting magnetic field will have greater amplitude in the corresponding specified area than anywhere else. When a signal is transmitted to the electronic key 12 using a selected pair of wire conductors, a specific antenna identification code can be included in the signal in order to identify the corresponding transmission antenna.

**[0025]** The portions of the wire conductors 1-5 which follow the same path are twisted together, as shown with dashed lines in Fig. 3. Wire conductors 1-3 form an intertwined bundle of wire conductors 22 which extends from the transmitter 11 up to a branching point  $B_2$  where wire 2 separates from the bundle and a branching point  $B_1$  where wire 1 separates from wire 3. The additional portion of intertwined wires does not affect the magnetic field of the hybrid loop antennas.

**[0026]** Fig. 5 shows the transmitter 11 with output selection means in more details. The transmitter includes an electrical generator 30 which generates electrical current in the primary winding 32 of a current transformer 31. The electrical generator 30 can be designed as the driver circuit 56 of Fig. 1. The secondary winding 33 of transformer 31 is connectable to different pairs of the output terminals  $O_1$ - $O_5$  through a switching device 34 comprising four contact relays A-D. Tuning capacitors  $C_1$ - $C_4$  are connected between the relays A, B and D and the output terminals  $O_1$ ,  $O_3$  and  $O_5$ . A different capacitor is needed for tuning each hybrid loop if they have a different inductivity. Each contact relay has a default position denoted by 0 and an activated position denoted by 1. The relays A-D are controlled by the central unit of the system (not shown).

**[0027]** Based on this antenna architecture, it should be possible to detect the electronic key 12 in every possible situation inside and outside the vehicle 10. Possible transmission areas inside and outside the vehicle are shown in Fig. 4. Area 20 is inside the passenger compartment. Area 19 is inside the luggage compartment. Area 23 is outside the vehicle on the left-hand side. Area 24 is outside the vehicle behind the luggage compartment. Area 25 is outside the vehicle on the right-hand side.

**[0028]** To find out the current position of the electronic key 12 inside or outside the car, the hybrid loop antennas are driven sequentially as described in Table 1 with the same power level or with different levels. The process for locating the electronic key 12 is based on a measurement of the field amplitude at the electronic key reception antenna. Accordingly, every time it receives a signal, the electronic key 12 measures the field amplitude (i.e. an electric tension at the receiving antenna) and communicates that value to the on-board central unit, together with the antenna identification code as the case may be. The on-board central unit detects that the electronic key 12 is in one of the transmission areas when it receives a response to a signal which was transmitted using to the corresponding activated wires and when the corresponding field measurement condition is verified.

**[0029]** In Table 1, the factors  $k_0$  and  $k_1$  are preset levels ( $k_0=k_1$  or  $k_0<k_1$ ), which define whether the key is inside or outside the car. Such preset levels can be achieved with experimental calibration measurements. Although the status of relay D does not matter in some cases, a simpler control of the switching device is achieved by using the same control signal for switching both relays C and D together (i.e. C status=D status at all times).

**[0030]** Fig 6 shows a second embodiment 110 of the vehicle. The connection points  $P_3$  and  $P_5$  are modified to  $P'_3$  and  $P'_5$  in comparison to the first embodiment. The transmitter 111 is placed at the right-hand front corner of the vehicle compartment instead of the left-hand rear corner. The elements which are identical or analogous to those of the first embodiment are denoted by the same reference number increased by 100. The transmitter 111 is identical to the transmitter 11 of Fig. 5 and is connected to wire conductors 101-105 as shown in Fig. 5. Wire portions which follow the same path are preferably twisted or intertwined together. The transmission areas are substantially the same as in the first embodiment. The detection of the electronic key is carried out in the same manner, using the switching and detection rules shown in Table 2. Here, the default position of the contact relays A-D is selected in such a manner that the antenna wire conductors which are excited in that position are those which cover a transmission zone located on the driver's lateral side of the vehicle (area 23), so that a faster response time is obtained when the driver requests access to the car by actuating the driver door handle.

**[0031]** Fig 7 shows a third embodiment 210 of the vehicle. The doors are omitted for the sake of clarity. The elements which are identical or analogous to those of the first embodiment are denoted by the same reference number increased by 200. The transmitter 211 is placed on the left-hand side of the luggage compartment and has a circuitry similar to that shown on Fig. 5 with three output terminals to which wire conductors 201-203 are connected. Wire conductors 201 and 202 extend together along the left-hand side of the body floor 213 from the transmitter 211 up to a branching point  $B_3$  located at the bottom of the left-hand central pillar 40. This first portion of wire conductors 201 and 202 forms an intertwined wire pair 222 with a regular helical intertwining in order to minimize the magnetic radiation of this portion. From point  $B_3$ , wire 201 extends along the body floor 213, along the front side of the front door frame 44 and up the left-hand front pillar 41 up to connection point  $P_{201}$ . From point  $B_3$ , wire 202 runs along the central pillar 40 up to connection point  $P_{202}$ . Wire 203 runs along the left-hand rear pillar 42 up to connection point  $P_{203}$ . Connection points  $P_{201}$ - $P_{203}$  are located on the left-hand side of the vehicle roof 43 so that electrical current can flow from one to the other.

**[0032]** When wire conductors 201 and 202 are selected, a transmission area is obtained which covers substantially the front half of areas 20 and 23 shown on Fig. 4, as seen in lateral projection. When wire conductors 203 and 202 are selected, a transmission area is obtained which covers substantially the rear half of areas 20 and 23 as seen in lateral projection.

**[0033]** In an embodiment alternative to that of Fig. 5, the transmitter includes electrical driving means in the form of several driver circuits connected to different pairs of output terminals. The central control unit is provided with driver circuit selection means operable in several states for selectively activating the different driver circuits. A switching device such as device 34 is not needed in that case.

**[0034]** With the transmitter type shown in Fig. 5, the antenna wire conductors are fed through a transformer 31, which prevents any short-circuited connection between the driver circuit and the vehicle body from occurring. Alternatively, it is possible to drive the antenna wire conductors directly without a transformer, as shown in the modified embodiment of Fig. 8. As shown in Fig. 8, the modified transmitter 311 includes a low frequency generator 330 (e.g. 20 kHz or 125 kHz) with two output terminals  $O_1$  and  $O_2$  which are connected to the vehicle body at connection points  $P_1$  and  $P_2$  through wire conductors 301 and 302. Number 322 represents an intertwined portion. Capacitors 47 and 48 are arranged on each wire, for example at the connection points  $P_1$  and  $P_2$ , so as to avoid the risk of a short-circuited connection for DC current between the generator and the vehicle body. While only two antenna output terminals and antenna wire conductors are shown for the sake of conciseness, it is clear that any number of output terminals can be similarly connected to the car body. Again, the corresponding output selection means can take the form of a switching device arranged between a single driver circuit and a number of output terminals or the form of a number of selectable driver circuits or other forms.

**[0035]** Fig 9 shows a fourth embodiment 410 of the vehicle. The elements which are identical or analogous to those of the first embodiment are denoted by the same reference number increased by 400. The transmitter 411 is placed on the left-hand side of the luggage compartment and has output terminals to which insulated wire conductors 401 and 402 are connected. From the transmitter outputs up to a branching point  $B_{401}$  located at the bottom of the left-hand central pillar 40, the wire conductors 401 and 402 extend together through a left-side body harness which extends longitudinally along the left-hand side of the body floor 413. This first portion of wire conductors 401 and 402 forms a twisted wire pair 422 with a regular helical intertwining in order to minimize the magnetic radiation of this portion. From point  $B_{401}$ , wire 401 has a portion 401a which extends transversally across the vehicle on the body floor 413 and a portion 401b which runs along the right-hand central pillar up to connection point  $P_{401}$ . From point  $B_{401}$ , wire 402 runs up the central pillar 40 up to connection point  $P_{402}$ . Connection points  $P_{401}$  and  $P_{402}$  are located on the underside of the vehicle top 43 at opposite sides of the vehicle body. The vehicle top 43 makes an electrical connection between both sides of the vehicle. Hence, wires 401 and 402 form a hybrid loop antenna which surrounds the passenger compartment as seen in longitudinal projection.

**[0036]** A similar hybrid loop antenna is obtained in the vehicle 510 shown on Fig. 10, where elements which are identical or analogous to those of the first embodiment are denoted by the same reference number increased by 500. Here, the intertwined wire pair 522 runs along the left-hand rear pillar 42 of the vehicle body and along the left-hand

side of the vehicle body top 43 up to branching point  $B_{501}$  which is located at the top of the left-hand central pillar 40. From point  $B_{501}$ , the insulated wire 501 has a portion 501a which extends transversally across the vehicle on the underside of the vehicle top 43 and a portion 501b which runs along the right-hand central pillar down to connection point  $P_{501}$ . From point  $B_{501}$ , insulated wire 502 runs along the central pillar 40 down to connection point  $P_{502}$ . Connection points  $P_{501}$  and  $P_{502}$  are located on the body floor 513 at opposite sides of the vehicle body. The body floor 513 makes an electrical connection between both sides of the vehicle.

**[0037]** The hybrid loop antennas of Fig. 9 and 10 can also be made at the front end or at the rear end of the passenger compartment by passing the wires along the front or rear pillars of the vehicle body instead of the centre pillars. The pair of wires 401/402 or 501/502 shown on Figs. 9 and 10 can be used as the only transmission antenna of the system, in which case only two transmitter outputs are needed. They can also be combined with other hybrid loops as shown in the preceding embodiments, in which case the transmitter will be fitted with more outputs and include output selection means, as described above.

**[0038]** The position of the central control unit with the transmitter and the positions and number of the connection points need not be the same as the illustrative embodiments shown in the figures. In fact, the path of the antenna wire conductors can be easily adapted to any desired position of the transmitter because suitable locations for connection points are available on most parts of any vehicle body and because intertwined wire pairs can be formed wherever a wire portion is not intended to radiate. In other words, the proposed antenna architecture offers great flexibility.

**[0039]** With reference to Figure 11, a sixth embodiment of the invention is now described. The same reference numbers as in Fig. 2 refer to the same vehicle elements as in the first embodiment. In vehicle 610, the transmitter 611 has two output terminals which feed two series-connected loop antennas 61 and 62 which are entirely made of insulated electrical wire. The loop antennas 61 and 62 are arranged in such a manner that their respective transmission areas substantially coincide with the passenger compartment 20 and the luggage compartment area 19, respectively. Loop antenna 61 is located on the body floor 13 at the centre of the passenger compartment 20, i.e. around the transmission tunnel and gear box. Loop antenna 62 is located on the body floor 13 around the luggage compartment area 19, as seen from above on Fig. 11. Both loops are series-connected through an intertwined wire pair 60, which does not affect the radiation pattern of each loop. An intertwined wire pair 622 is also used for connecting loop antenna 62 to the transmitter output terminals.

**[0040]** More precisely, intertwined wire pair 622 extends from the transmitter output terminals to a first branching point  $B_{601}$  where two wire portions 603 and 604 separate from one another. Wire portions 603 and 604 extend along the sides of the luggage compartment 19 in mutually opposite directions down to meeting point  $B_{603}$  which is located in the middle of the vehicle at the front side of the luggage compartment. From points  $B_{601}$  to  $B_{603}$ , wire portions 603 and 604 form loop antenna 62. At point  $B_{603}$ , wire portions 603 and 604 join to form an intertwined wire pair 622 which extends longitudinally along the body floor 13 down to a second branching point  $B_{602}$  where two wire portions 601 and 602 separate from one another. From point  $B_{602}$ , wire portions 601 and 602 extend along opposite lateral sides of the transmission tunnel and are connected to one another at the front end of the passenger compartment so as to constitute loop antenna 61.

**[0041]** Both loop antennas and both intertwined wire pairs can be made with a single uninterrupted wire. They can also be made of a number of shorter wire portions which are series-connected with appropriate connectors, in order to simplify the installation of the antenna assembly. As a preference, the corresponding wire or wire portions are placed in the wiring harnesses of the vehicle. Alternatively, they can be connected through one or more standard connectors between different on-board system modules of the vehicle.

**[0042]** Transmitter 611 includes an antenna driver circuit, which can be similar to that shown on Fig. 1, i.e. with an electrical current transformer for impedance matching.

**[0043]** More than two series-connected loop antennas can be formed similarly. In this embodiment, a very simple and cost-effective antenna assembly is obtained, which provides a number of well-defined transmission areas, because the intertwined wire portions do not affect the radiation pattern of the loop antennas, while making it possible to use a simple driver circuit with two output terminals.

**[0044]** The invention is also applicable to keyless ignition systems.

**[0045]** Although the invention has been described in conjunction with a number of particular embodiments, it is quite obvious that it is not in any way restricted thereto and that it encompasses all technical equivalents of the described means and combinations thereof if these fall within the scope of the claimed invention.

Table 1:

| detection logic for localising the electronic key in the embodiment of Fig. 2 |                 |                                |                                |
|-------------------------------------------------------------------------------|-----------------|--------------------------------|--------------------------------|
| Transmission area (see Fig. 4)                                                | Activated Wires | Condition on Field Measurement | Status of Relays (see Fig. 5)  |
| 20                                                                            | 1 and 2         | Field Strength > $k_1$         | A=0, B=1<br>C=0, D=0           |
| 19                                                                            | 4 and 5         | Field Strength > $k_1$         | A=1, B=0 or 1<br>C=1, D=0 or 1 |
| 23                                                                            | 2 and 4         | Field Strength < $k_0$         | A=0, B=1<br>C=1, D=1           |
| 24                                                                            | 4 and 5         | Field Strength < $k_0$         | A=1, B=0 or 1<br>C=1, D=0 or 1 |
| 25                                                                            | 1 and 3         | Field Strength < $k_0$         | A=0, B=0<br>C=0, D=0 or 1      |

Table 2:

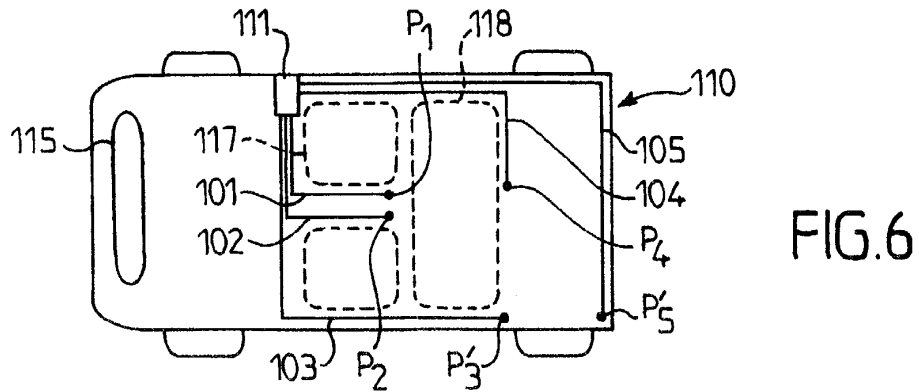
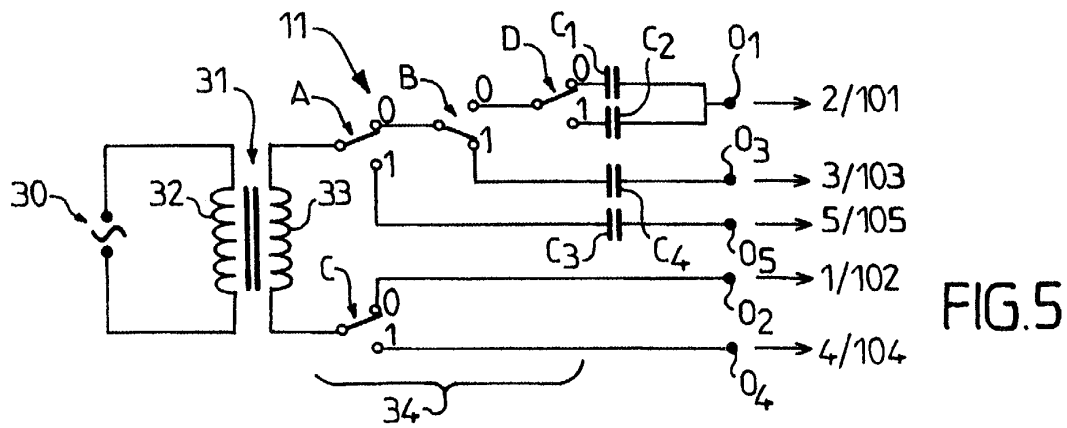
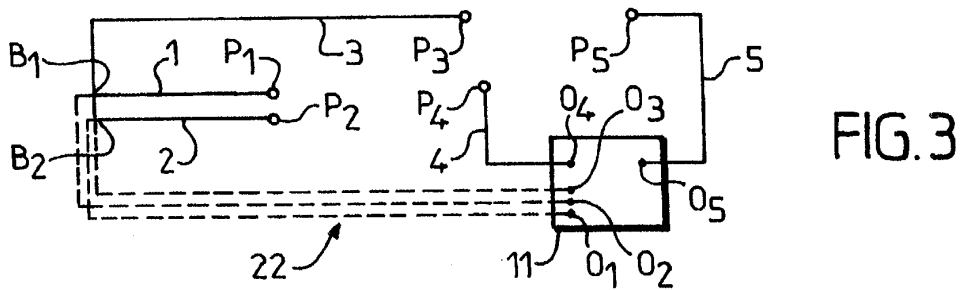
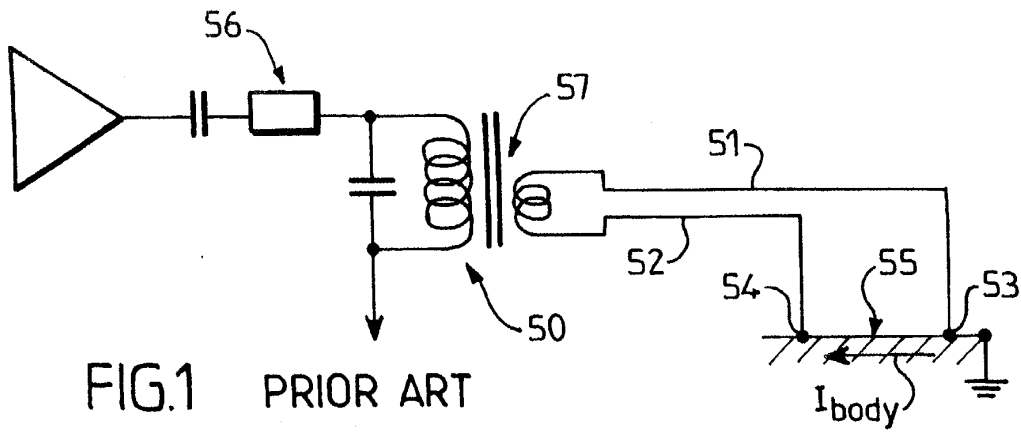
| detection logic for localising the electronic key in the embodiment of Fig. 6 |                 |                                |                                 |
|-------------------------------------------------------------------------------|-----------------|--------------------------------|---------------------------------|
| Transmission area (see Fig. 4)                                                | Activated Wires | Condition on Field Measurement | Status of Relays (see Fig. 5)   |
| 20                                                                            | 101 and 102     | Field Strength > $k_1$         | A=0, B=1<br>C=0, D=0            |
| 19                                                                            | 104 and 105     | Field Strength > $k_1$         | A=1, B=0 or 1<br>C=1, D=0 or 1  |
| 23                                                                            | 102 and 103     | Field Strength < $k_0$         | A=0, B=0<br>C=0, D=0 or 1       |
| 24                                                                            | 104 and 105     | Field Strength < $k_0$         | A= 1, B=0 or 1<br>C=1, D=0 or 1 |
| 25                                                                            | 101 and 104     | Field Strength < $k_0$         | A=0, B=1<br>C=1, D=1            |

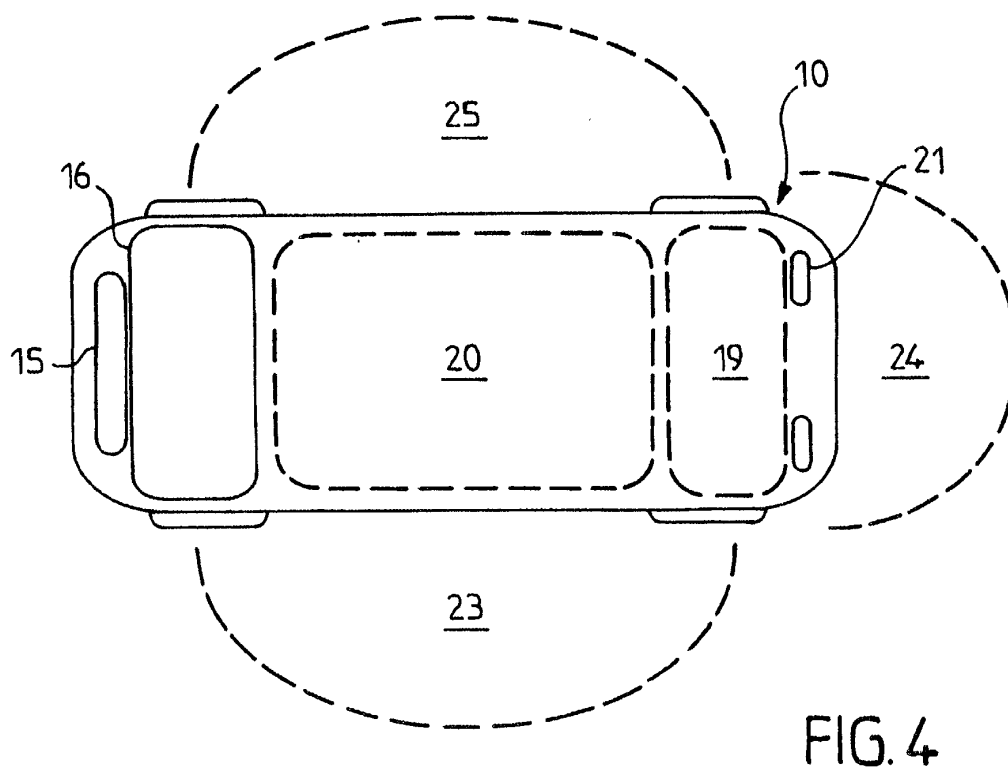
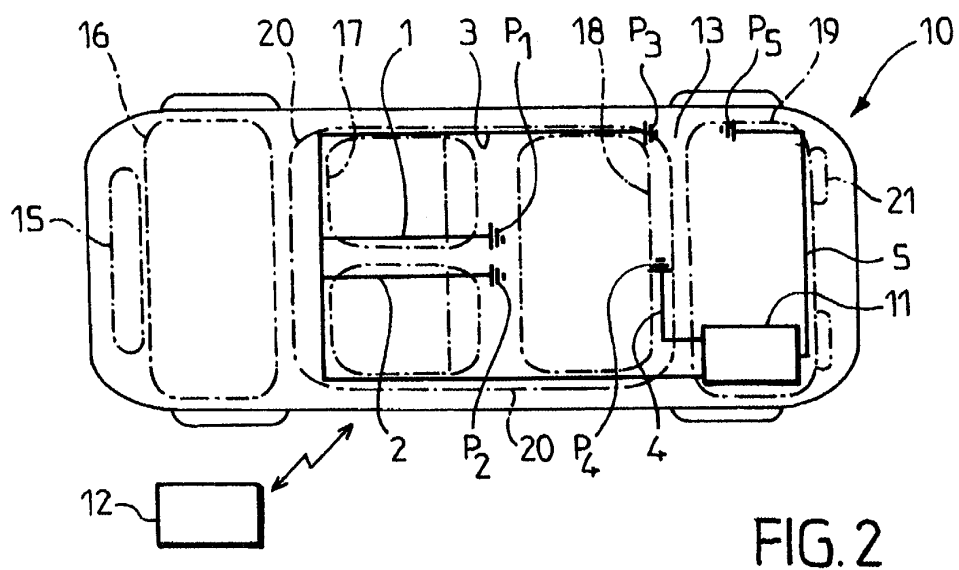
## Claims

- Vehicle (10, 110, 210, 410, 510, 610) comprising an on-board signal transmitter (11, 111, 211, 311, 411, 511, 611) capable of communicating with a portable receiver (12) for implementing a keyless entry and/or keyless ignition procedure, said signal transmitter having a loop antenna made of conductive material and arranged around at least a portion of the vehicle interior space (19, 20), as seen in projection, for radiating a magnetic field, said loop antenna being connected to the signal transmitter by two wire conductors which extend from the signal transmitter, **characterized in that** the two wire conductors (1, 2; 101, 102; 201, 202; 301, 302; 401, 402; 501, 502; 601, 602) are twisted together along a portion of their length (22, 222, 322, 422, 522, 60) down to a branching point ( $B_2$ ,  $B_3$ ,  $B_{401}$ ,  $B_{501}$ ,  $B_{602}$ ) where the two wire conductors separate from one another in order to form at least a portion of said loop antenna.
- Vehicle as claimed in claim 1, **characterized in that** each said wire conductor (1, 2; 101, 102; 201, 202; 301, 302; 401, 402; 501, 502) is connected to a respective connection point ( $P_1$ ,  $P_{201}$ ,  $P_{202}$ ,  $P_{401}$ ,  $P_{402}$ ,  $P_{501}$ ,  $P_{502}$ ) on the vehicle body (13, 43, 513), said loop antenna consisting of the two wire conductors and a portion of the vehicle body which extends between both connection points.
- Vehicle as claimed in claim 2, **characterized in that** a capacitor (47, 48) is arranged between a conductor (301,

302) and the corresponding connection point ( $P_1$ ,  $P_2$ ) on the vehicle body.

4. Vehicle as claimed in claim 1, **characterized in that** said loop antenna (61) is entirely constituted by said wire conductors (601, 602).
5. Vehicle as claimed in claim 4, **characterized in that** the two wire conductors (601, 602) are two portions of a single wire in an uninterrupted circuit which is arranged in the form of a whole loop (61).
6. Vehicle as claimed in any one of claims 1 to 5, **characterized in that** a portion (603, 604) of the two wire conductors located between the intertwined portion (60) and said transmitter (611) form a second loop antenna (62) arranged around at least a portion of the vehicle interior space, as seen in projection, wherein said intertwined portion connects both loop antennas (61, 62) in series.
7. Vehicle as claimed in claim 6, **characterized in that** the two wire conductors include a further intertwined portion (622) which extends between said second loop antenna (62) and said transmitter (611).
8. Vehicle as claimed in claim 7, **characterized in that** both loop antennas (61, 62) and both intertwined pairs (60, 622) are made of a single wire in an uninterrupted circuit, wherein the two wire conductors are two portions of said single wire.
9. Vehicle as claimed in any one of claims 1 to 8, **characterized in that** at least one loop is formed around the luggage compartment (19) of the vehicle, as seen in vertical projection.
10. Vehicle as claimed in any one of claims 1 to 9, **characterized in that** at least one loop is formed around a centre portion of the passenger compartment (20) of the vehicle, as seen in vertical projection.
11. Vehicle as claimed in any one of claims 1 to 10, **characterized in that** at least one loop is formed around a right-hand half and/or a left-hand half of the passenger compartment (20) of the vehicle, as seen in vertical projection.
12. Vehicle as claimed in any one of claims 1 to 11, **characterized in that** at least one loop is formed around a front half and/or a rear half of the passenger compartment (20) of the vehicle, as seen in lateral projection.
13. Vehicle as claimed in any one of claims 1 to 12, **characterized in that** at least one loop is formed around the passenger compartment (20) of the vehicle, as seen in longitudinal projection.
14. Vehicle as claimed in any one of claims 1 to 13, **characterized in that** the wire conductors (1-5, 101-105; 201-203, 301-302, 401-402, 501-502, 601-604) are arranged within the wiring harnesses of the vehicle.





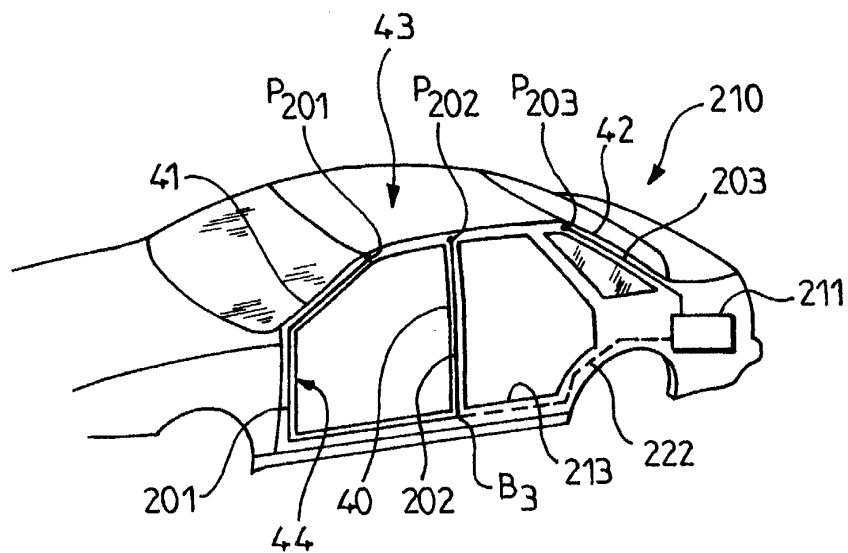


FIG. 7

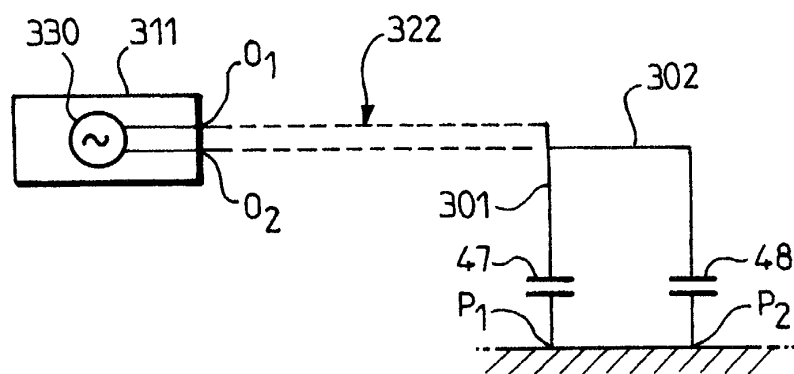


FIG.8

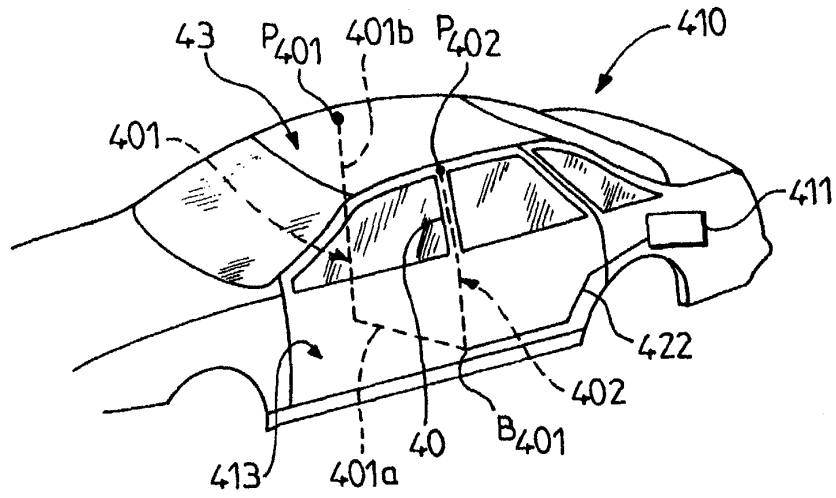


FIG. 9

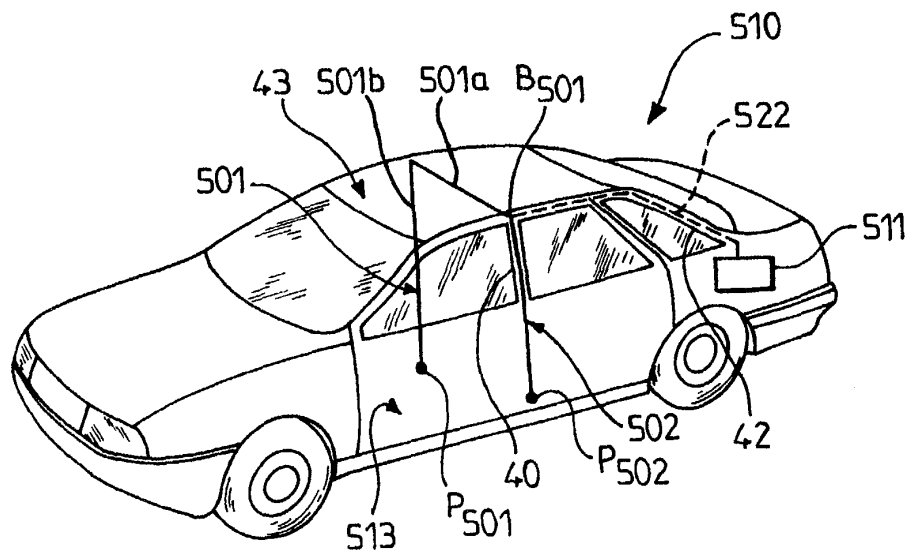


FIG. 10

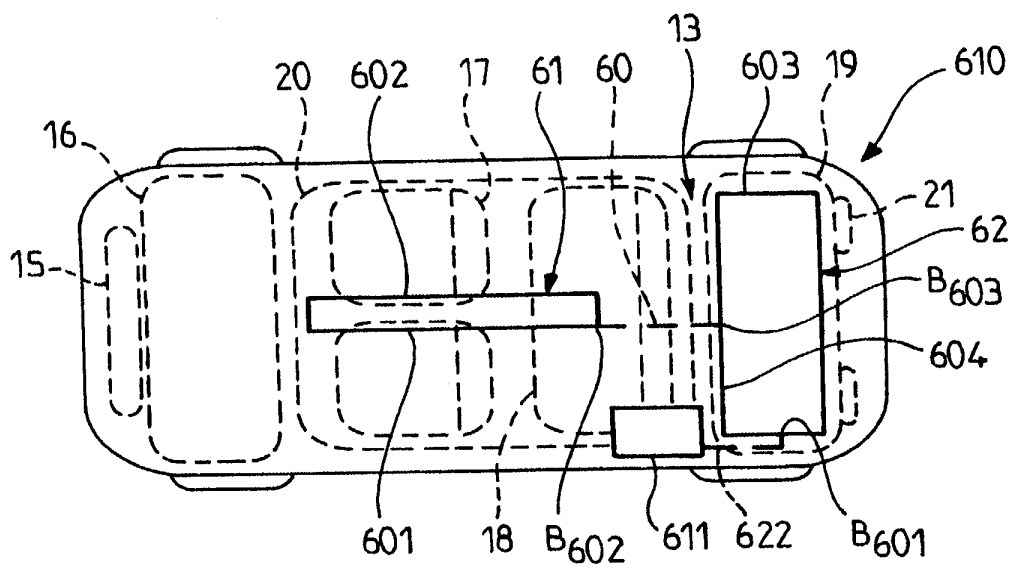


FIG.11



European Patent  
Office

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Application Number  
EP 04 07 7304

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The members are as contained in the European Patent Office EDP file on  
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16-12-2004

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