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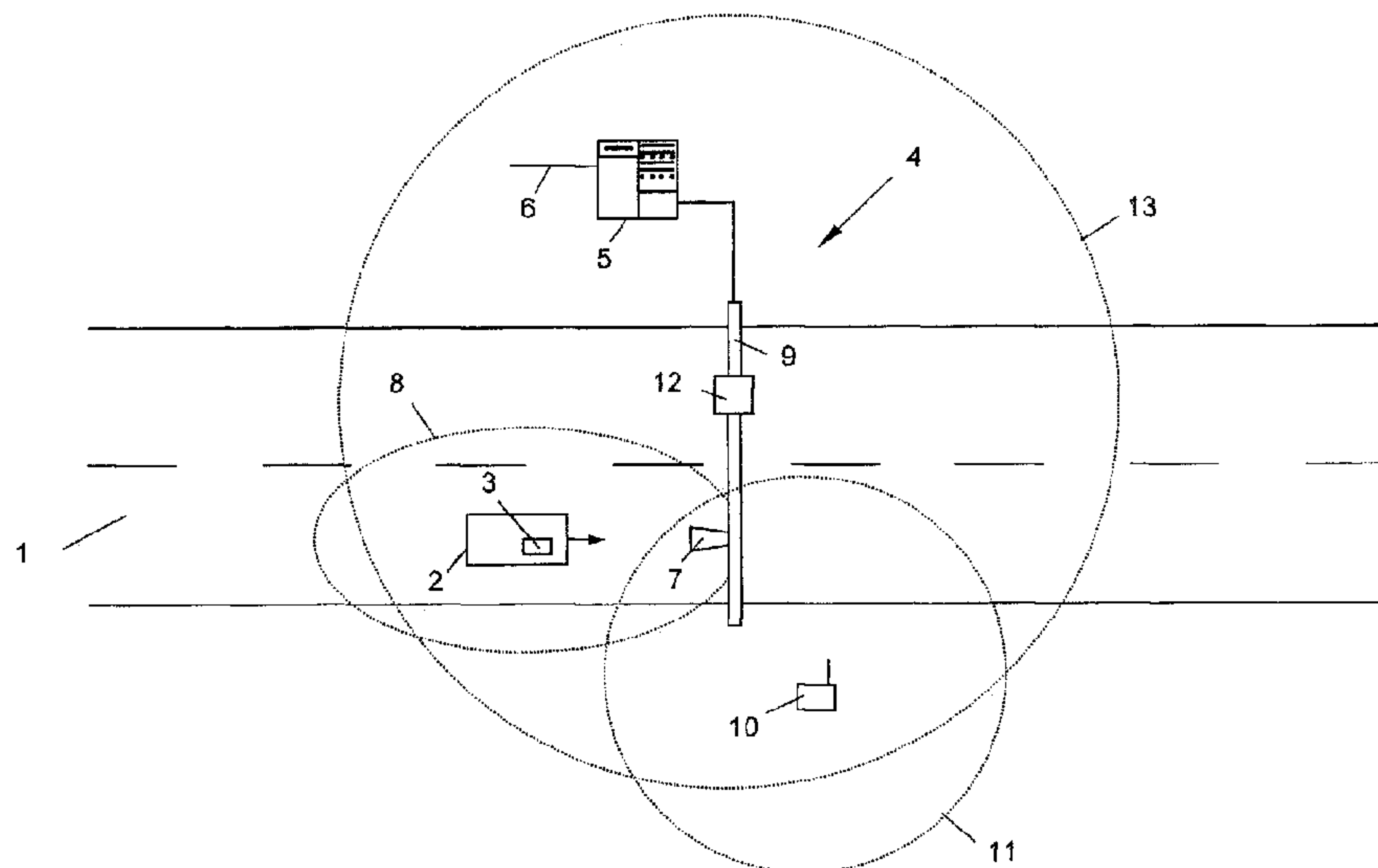
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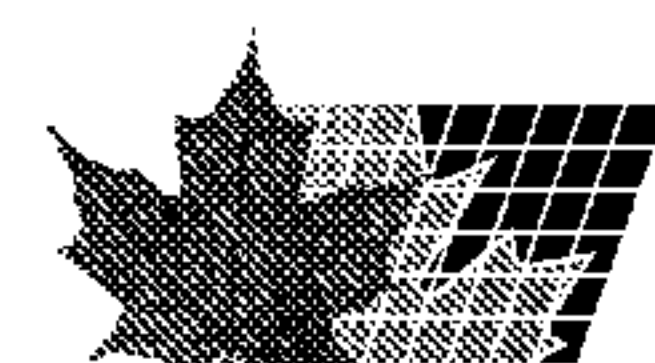
(54) Titre : BALISE POUR UN SYSTEME DE PEAGE ROUTIER

(54) Title: BEACON FOR A ROAD TOLL SYSTEM



(57) Abrégé/Abstract:

Beacon (4) with a transceiver (5) for radio communication with vehicle OBUs (3) of a road toll system, wherein the transceiver (5) has a directional antenna (7) and is configured to communicate wirelessly with OBUs (3) on a selected channel directed via the directional antenna (7), wherein the transceiver (5) is additionally equipped with an omnidirectional antenna (12) and is configured to transmit, before the beginning of a directional radio communication (8), by means of the omnidirectional antenna (12) a channel reservation message (RTS) and/or to check, before the beginning of a directional radio communication (8), by means of the omnidirectional antenna (12) whether the selected channel is free (LBT).



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5 configured to communicate wirelessly with OBUs (3) on a selected channel directed via the directional antenna (7), wherein the transceiver (5) is additionally equipped with an omnidirectional antenna (12) and is configured to transmit, before the beginning of a directional radio communication (8), by means of the omnidirectional antenna (12) a channel reservation message (RTS) and/or to check, before the
10 beginning of a directional radio communication (8), by means of the omnidirectional antenna (12) whether the selected channel is free (LBT).

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Beacon for a Road Toll System

The present invention relates to a beacon with a transceiver for radio communication with vehicle OBUs of a road toll system, wherein the transceiver has a directional antenna and is configured to communicate wirelessly and directionally with OBUs on
5 a selected channel via the directional antenna.

Radio beacons with directional antennas, so-called directional beacons, are used to enable on the one hand a high power to be emitted and on the other hand the position of an OBU (onboard unit) to be located on the coverage range of the directional antenna. However, the use of a directional antenna leads to the problem
10 that other transceivers active on the same channel are difficult to hear or cannot be heard at all outside the radio field of the directional antenna, and this can lead to a disturbance in the radio communication between the beacon and the OBU that is known as a "hidden node" problem.

Various methods for solving the hidden node problem are known such as CSMA/CA
15 (carrier sense multiple access/collision avoidance) with the listen before talk (LBT) principle, as well as the RTS/CTS extension thereof with the exchange of a channel reservation message (request to send, RTS) and a reservation acknowledgement message (clear to send, CTS). The aim of the invention is to provide solutions to enable these known mechanisms to be used for road toll systems with directional
20 beacons.

This aim is achieved with a beacon of the aforementioned type that is distinguished according to some embodiments of the invention in that the transceiver is additionally equipped with an omnidirectional antenna and is configured to transmit, before the beginning of a directional radio communication, by means of the omnidirectional
25 antenna a channel reservation message and/or to check, before the beginning of a directional radio communication, by means of the omnidirectional antenna whether the selected channel is free.

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Some embodiments of the invention provide a new type of radio beacon for a road toll system, which has a directional antenna to allow toll transactions with OBUs to be conducted in a restricted area with a high power density and with locating function and also an omnidirectional antenna for implementation of a CSMA/CA or
5 RTS/CTS-CSMA/CA function in order to substantially exclude a disturbance of the directional communication as a result of hidden nodes.

In accordance with an aspect of the invention, there is provided a beacon with a transceiver for radio communication with vehicle OBUs of a road toll system, wherein the transceiver has a directional antenna and is configured to communicate wirelessly
10 and directionally with OBUs on a selected channel via the directional antenna, wherein the transceiver is additionally equipped with an omnidirectional antenna and is configured to transmit, before the beginning of a directional radio communication, by means of the omnidirectional antenna a channel reservation message and/or to check, before the beginning of a directional radio communication, by means of the
15 omnidirectional antenna whether the selected channel is free.

According to one embodiment of the invention the transceiver is configured in order to first check whether the selected channel is free and then to transmit the channel reservation message, which results in a particularly low susceptibility to interference.

The directional radio communication in some embodiments occurs according to the
20 DSRC (dedicated short-range communication) or WAVE (wireless access in a vehicle environment) standard.

In some embodiments the beacon has a support mounted over a road, on which the directional antenna and the omnidirectional antenna are mounted.

The invention is explained in more detail below on the basis of an exemplary
25 embodiment with reference to the attached drawings, wherein the single figure 1 thereof is a block diagram showing a section of a road toll system with a beacon of an embodiment of the invention in plan view.

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Figure 1 shows, in sections, a road 1, on which vehicles 2 with OBUs 3 move that can communicate wirelessly with road-side beacons 4 of a road toll system (not further shown). The exemplary beacon 4 comprises a transceiver 5, which connects to a central unit (not shown) of the road toll system via a data line 6, and can also
5 communicate via a directional antenna 7 with an OBU 3 in the radio coverage area (radio field) 8 of the antenna 7. The radio communication between the transceiver 5 or its directional antenna 7 and the OBU 3 preferably occurs according to the DSRC or WAVE standard in a manner known to the person skilled in the art.

The directional antenna 7 is mounted on a support 9 directly above the road 1, for
10 example, and can supply the radio field 8 with high power because of its directional characteristic. Moreover, because of the directional characteristic an OBU 3 can be located on or in the region of the radio field 8.

The transceiver part of the OBU 3 usually also has a directional characteristic, e.g. directed forwards and upwards through the windscreen of the vehicle 2 to be able to
15 conduct a directional radio communication of high power density with the antenna 7.

Another transceiver device with e.g. an omnidirectional transceiver range 11, e.g. a WLAN or WAVE client or node, located in the vicinity of the beacon 4 is given the reference 10. If the transceiver 10 uses the same radio channel as the beacon 4 and/or the OBU 3, the radio communication of the beacon 4 with the OBU 3 could
20 interfere in certain local and temporal constellations of the transceiver 11 without the beacon 4 or the OBU 3 being able to recognise this, for example (hidden node problem).

To prevent this, the transceiver 5 of the beacon 4 is equipped with an additional omnidirectional antenna 12, the radio coverage range (radio field) of which is entered
25 in an exemplary manner at 13 and comprises both the OBU 3 and the transceiver 10. The omnidirectional antenna 12 can be mounted, for example, on the same support 9 above the road 1 as the antenna 7.

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Via the omnidirectional antenna 12 the transceiver 5 can now conduct a listen before talk function (LBT) corresponding to the CSMA/CA process, i.e. can - before the beginning of a directional radio communication via the antenna 7 with the OBU 3 - "listen omnidirectionally" in the channel selected for the directional radio

- 5 communication to check whether the channel is free. Alternatively or additionally hereto, the transceiver 5 can conduct an RTS/CTS function corresponding to the RTS/CTS-CSMA/CA process via the omnidirectional antenna 12, i.e. omnidirectionally transmit a channel reservation message RTS (request to send) in the channel selected for the directional radio communication with the OBU 3. The
- 10 OBU 3 can answer with a channel reservation acknowledgement CTS (clear to send), for example, and other transceiver devices such as the transceiver device 10 can listen to one or both of the messages RTS, CTS and hold back from own transmissions during the estimated transmission time, as known to the person skilled in the art.

- 15 The LBT and RTS functions can also be conducted in succession, i.e. the transceiver 5 checks whether the selected channel is free (LBT) in a first step, and then transmits the channel reservation message RTS in a second step.

- After checking whether the channel is free (LBT), or after receiving the channel reservation confirmation CTS, either the entire radio communication of the
- 20 transceiver 5 with the OBU 3 can be conducted via the directional antenna 7 or the transceiver 5 transmits via the omnidirectional antenna 12 and receives via the directional antenna 7.

- In the present description the term "omnidirectional" is understood to be any desired omnidirectional characteristic that does not necessarily have to be a circular or
- 25 spherical omnidirectional characteristic. In the present description the term "directional" is understood to be a directional characteristic that is not necessarily unidirectional, i.e. has only a single propagation lobe, but could also have multiple propagation lobes, e.g. principal and secondary lobes, front and rear lobes etc.

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Consequently, the invention is not restricted to the represented embodiments, but covers all variants and modifications that fall within the framework of the attached claims.

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CLAIMS:

1. A beacon with a transceiver for radio communication with vehicle on-board units (OBUs) of a road toll system, wherein the transceiver has a directional antenna and is configured to communicate wirelessly and directionally with OBUs on a selected channel via the directional antenna, wherein the transceiver is additionally equipped with an omnidirectional antenna and is configured to transmit, before the beginning of a directional radio communication, by means of the omnidirectional antenna a channel reservation message and/or to check, before the beginning of a directional radio communication, by means of the omnidirectional antenna whether the selected channel is free.
2. The beacon according to claim 1, wherein the transceiver is configured to first check whether the selected channel is free and then to transmit the channel reservation message.
3. The beacon according to claim 1 or 2, wherein the directional radio communication occurs according to a dedicated short-range communication (DSRC) or wireless access in a vehicle environment (WAVE) standard.
4. The beacon according to any one of claims 1 to 3, further comprising a support mounted over a road, on which the directional antenna and the omnidirectional antenna are mounted.

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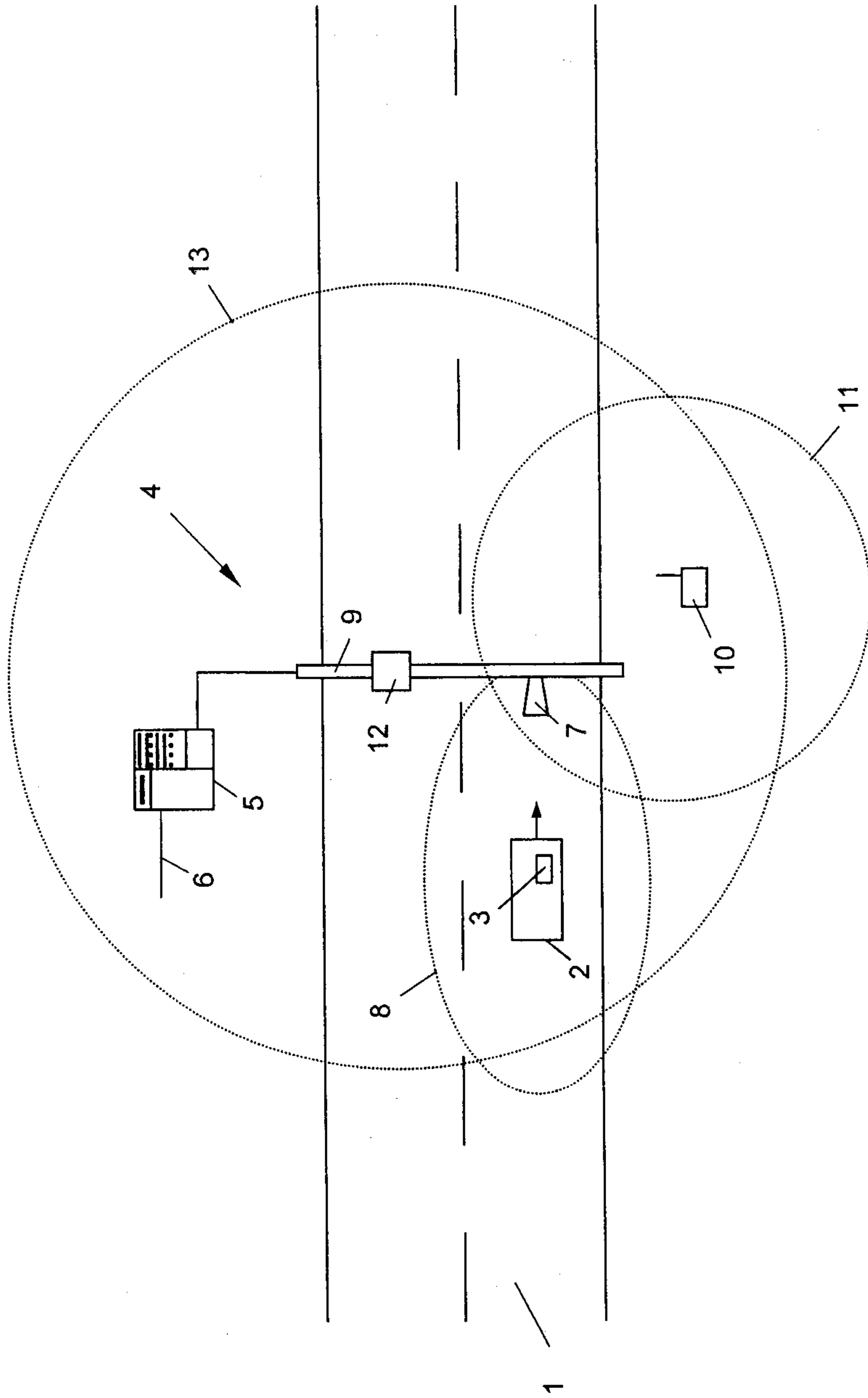


Fig. 1

