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(71) Applicant: **Westinghouse Brake and Signal Holdings Limited**
Bressenden Place
London SW1E 5BF (GB)

(72) Inventors:
- **Bamforth, Stuart Ian**
  Chippenham
  Wiltshire SN15 3BY (GB)
- **Clifton, Raymond**
  Malmesbury
  Wiltshire SN16 0NA (GB)

(74) Representative: **Newstead, Michael John et al**
Page Hargrave
Southgate
Whitefriars
Lewins Mead
Bristol BS1 2NT (GB)

(54) **Signalling system**

(57) A method for regulating the movement of a train through an area of railway fitted with trackside radio signalling equipment, the signalling equipment controlled by a control centre, comprises the steps of:
providing an interface unit on the train;
reporting the initial location of the train to the control centre;
using the control centre to select a route start location for the train, the route start location comprising a selected length of track from a reference point; and
communicating the route start location to the interface unit using the signalling equipment.

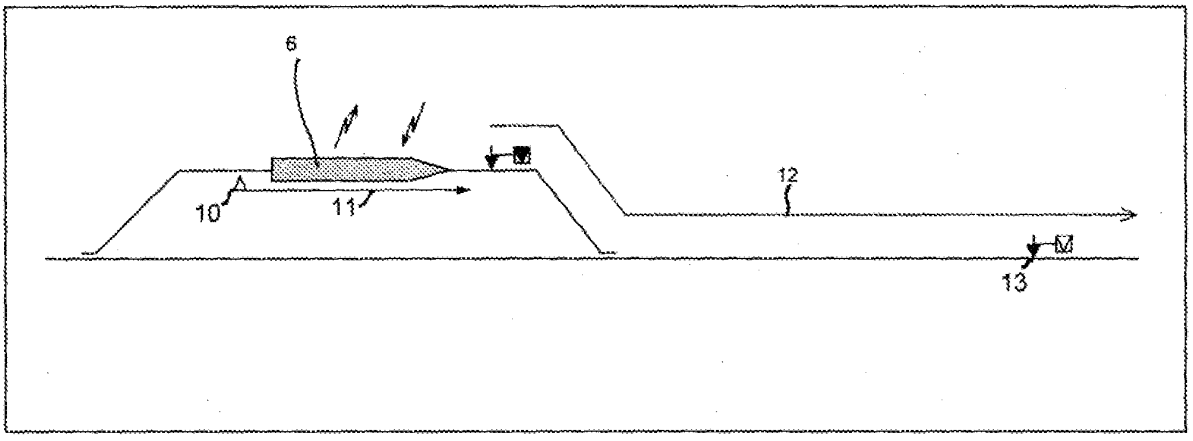

Fig. 3

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Description

[0001] The present invention concerns a method for regulating the movement of a train through an area of railway fitted with trackside radio signalling equipment, and an interface unit for use in such a method.

[0002] The invention has particular application for rail systems using a signalling system such as the European Rail Traffic Management System (ERTMS) /European Train Control System (ETCS) Level 2 or 3 internationally applied standards.

[0003] The equipment necessary to fit a train for radio-based signalling typically includes odometry, balise / transponder reading equipment and a driver's interface, together with a connection to the train braking system. In ERTMS/ETCS for example, the train-carried equipment maintains knowledge of the train location by reading track-mounted balises and by measuring the distance travelled from these reference balises using onboard odometry. The train-carried equipment periodically reports the location of the train to the trackside equipment and, assuming it is safe to do so, receives a movement authority based on this location from the trackside equipment. The train-carried equipment then monitors the movement of the train against the movement authority and enforces the authority limits by applying the train brakes if necessary. Such train-carried equipment is necessary to realise the performance benefits that are available from radio-based signalling.

[0004] The use of a radio-based signalling system, such as ERTMS/ETCS Level 2 or 3, offers many potential benefits to the railway operator. In particular, where all trains that normally operate on the railway are fitted with appropriate train-carried equipment, it is possible to remove lineside signals. However the removal of lineside signals makes the operation of any unfitted train more difficult on that part of the railway. Such unfitted trains could for example comprise works trains required for track maintenance or occasional heritage trains, hauled for example by a steam locomotive. However, other radio-based systems, such as Radio Electronic Token Block (RETB) used on some rural lines in the UK, have shown that trains may be moved safely using authorities communicated by radio with much simpler train-carried equipment used in conjunction with manual procedures.

[0005] It is an aim of the present invention to enable unfitted trains to operate safely within a radio-based signalling system. This aim is achieved by providing a portable unit to be carried by the unfitted trains, as well as a method of operation using the unit.

[0006] According to a first aspect of the present invention there is provided a method for regulating the movement of a train through an area of railway fitted with trackside radio signalling equipment, the signalling equipment controlled by a control centre, as set out in the accompanying claims.

[0007] According to a second aspect of the present invention, there is provided an interface unit for use in a method in accordance with the first aspect.

[0008] The unit may be used to authorise the movement of a train, which may be otherwise unfitted with the necessary train-carried equipment, through an area fitted with radio-based signalling equipment at the trackside. The unit preferably provides compatible radio-based communication with the trackside equipment, a display for displaying movement authority and other relevant information to the train driver and a keypad to allow the driver to enter certain data. The same unit can also be used for the purposes of fallback signalling if the train-carried equipment fails on a normally-fitted train.

[0009] Accordingly, the present invention provides:

i) RETB-like operation for occasional unfitted trains to be integrated with a more complex radio-based signalling system such as ERTMS/ETCS;
ii) Fallback operation for normally fitted trains in the event of train-carried equipment failure.

[0010] The invention will now be described with reference to the accompanying figures, in which:

Figure 1 shows an example of an interface unit in accordance with the present invention;

Figure 2 schematically shows a train fitted with the interface unit of Fig. 1, within a radio-based signalling system;

Figure 3 schematically shows a train arriving at the start of a route, for example a passing loop;

Figure 4 schematically shows a train entering a route; and

Figure 5 schematically shows a train arriving at the end of a route.

[0011] Referring firstly to Fig. 1, a portable signalling interface unit 1 is shown in accordance with the present invention. The unit 1 contains a radio that is compatible with the communications network for the signalling system, e.g. Global System for Mobile communications for Railways (GSM-R), and communicates with the trackside signalling system using

the protocol and message formats defined for that system (e.g. according to the ERTMS/ETCS System Requirements Specification, subset-026).

[0012] The unit 1 includes a display 2 for the presentation of information to the driver. This information could for example be a request for driver input or the display of an issued movement authority. Other information received from the trackside can also be displayed, for example text messages or emergency messages. A key pad is provided which is separated into two areas. One area 3 is similar to a GSM mobile keypad and is used for data entry by the driver. Such data could be, for example, the contact telephone number of the trackside equipment or the identity of the driver. The second keypad area 4 consists of function-specific buttons which are used by the driver as the train progresses through the radio-signalled area, including "Train in Route", "End of Route", "End of Mission" and "New RBC", whose functions will be described in more detail later. An audio output 5 is provided to attract the driver's attention to new information. The whole unit may be connected to a suitable train power supply or can operate from an internal rechargeable battery. The unit may optionally include means (not shown) to provide a voice channel to a remote location, e.g. a signaller at a control centre, but this is not essential if other means are available for the driver to communicate verbally, such as would usually be provided in a train. The unit may also include a secure Wireless Application Protocol (WAP) browser interface (not shown), as will be described later.

[0013] Fig. 2 schematically shows part of a typical ERTMS/ETCS trackside system with a train 6 carrying a unit 1 as shown in Fig. 1. Only the parts of the ERTMS/ETCS system that are relevant to the present invention are shown. A control centre 7 communicates with the train 6 via a trackside Radio Block Centre (RBC) 8 and trackside radio equipment 9. Typically the control centre 7 is manned by a signaller.

[0014] In an ERTMS/ETCS system, train-carried equipment is required to establish communication with the control centre 7 via the RBC 8 and trackside radio equipment 9, and so provide various items of train data before receiving any movement authority from the RBC 8. According to the specifications for ERTMS, the driver may enter the RBC contact information into the train-carried equipment. According to the present invention, the portable interface unit 1 is used for this purpose instead. In order to do this, the driver may obtain the contact information verbally from the signaller. The driver may also be required to enter certain 'train data', however the majority of train data can be set to default values within the portable unit. The loco identity (NID_ENGINE) for example can be unit specific.

[0015] The operation of the portable interface unit will now be further described by way of example with reference to a procedure for moving an unfitted train along a route through an ERTMS Level 2 area, including reference to Figs. 3 to 5. Initially, set-up data such as driver identity, other train information, RBC contact details are entered by the driver to the unit. The unit then contacts the RBC which may respond by accepting the communication session with the train and indicating that any train movement is the responsibility of the driver (known as Staff Responsible authority in ERTMS). The identity of the train can be passed to the control centre to inform the signaller. A location for the train is determined at the entry to a route through verbal communication between the driver and the signaller.

[0016] A procedure in accordance with the present invention is given in detail in the following table, in which the functionality is divided into that performed on the train 6, by the RBC 8 and at the control centre 7. The term "On Sight" used in the table relates to one of the driving modes for a train operating within an ERTMS system. It is granted by the trackside which provides an authority to move for a defined distance, normally to the end of a route. The speed of the train is restricted to a defined value and the driver is required to observe and stop the train short of any obstruction on the track.

#	Control Centre	RBC	Train	Comments
1.			Driver enters driver identity and RBC contact details into unit	Other train data may be entered if necessary
2.			Unit contacts RBC	Train location is reported as 'unknown'
3.		RBC accepts the new train and may issue Staff Responsible authorisation		The Driver might move the train, if it is not already at the start of a route
4.		RBC reports the train ID to control centre		
5.	Identity of train displayed to signaller			

(continued)

#	Control Centre	RBC	Train	Comments
6.			Driver contacts control centre by voice radio to report the location of the train	The location could, for example, be identified by a signal or trackside marker identity
7.	Signalman enters given location for train			The location could, for example, be selected from a predefined list of signal/marker identities
8.	Control centre sends a location message via the RBC using a general purpose packet (ETCS packet 44)			The message specifies a balise group 10 located behind the train which can be used by the portable unit as the last reported balise group and a fixed distance 11 from that balise group 10 defined for the location selected by the signaller (see Fig. 3)
9.		RBC forwards location packet to train		
10.			Unit receives the location packet and, following acknowledgement from the driver, reports the location back to RBC as valid (using the last reported balise group and offset distance specified)	The initial location may be presented to the driver as an associated text message and require the driver's acknowledgement.
11.		RBC forwards location of train to control centre		
12.	Signaller checks train location display and sets On Sight route 12 for train to next loop or end of route			Route setting and locking uses conventional interlocking logic
13.		RBC issues an On Sight movement authority to the train		The movement authority includes the last reported balise group 10 and a movement authority length 16 to the End of Authority (EoA)
14.			Unit displays On Sight movement authority to driver allowing driver to drive train along the first route	

(continued)

#	Control Centre	RBC	Train	Comments
15.			Once the train is clear of loop/junction, the driver presses 'Train In Route' button on portable unit	'Loop Clear' can be indicated using a trackside marker 13 if required (see Fig. 4)
16.			Unit reports new location to RBC	The new location can be reported using the same last reported balise group 10 with a fixed distance 14 calculated by adding a defined distance 17 to the previous location offset 11.
17.		RBC forwards new train location to control centre		
18.	Control centre displays train in route.			The train is also detected in the route by the interlocking (or indicated by the RBC) allowing loop entry/junction to be released
19.			Train continues along the route	Driver responsible for train speed control
20.			Train arrives at next loop or end of the route and stops	
21.			Driver presses 'End of Route' button on unit	
22.			Unit reports 'end' location to RBC	The 'end' location is reported using the same last reported balise group 10 with a fixed distance 15 subtracted from the movement authority length 16 (see Fig. 5)
23.		RBC forwards new train location to control centre		
24.	Control centre displays train at end of route (e.g. in loop)			
25.	Signalman selects 'Accept Location' for train			This acceptance could involve verbal confirmation if required
26.	Control centre sends an updated location message to RBC using packet 44			The new packet 44 message defines a new last reported balise group and distance offset

(continued)

#	Control Centre	RBC	Train	Comments
27.		RBC forwards location packet to train		
28.			Unit receives location packet and, after driver acknowledgement, reports the new location to RBC	This 'new' location is effectively the same as reported previously but with a new last reported balise group 10' and offset 11'.
29.		RBC forwards new location of train to control centre		
30.	Signaller sets new On Sight route for train to next loop or end of route			
31.		RBC issues new On Sight movement authority to train		The On Sight movement authority includes the new last reported balise group and the distance to the EoA
32.			Unit displays On Sight movement authority to driver allowing driver to drive train along the next route	
33.			Once train clear of loop, the driver presses 'Train In Route' button	
34.			Unit reports new location to RBC	Using the new last reported balise group with a fixed distance added to previous location offset
35.		RBC forwards new train location to control centre		
36.	Control centre displays train in route			The train is also detected in the route by the interlocking (or indicated by the RBC) allowing previous route to release
37.	*Process repeats from 19 above*			

[0017] When the train has reached a terminal station, or reaches the end of the fitted area and receives authority from an alternative signalling system, then the driver presses an 'End of Mission' button on the portable unit which causes the communication session with the RBC to be terminated.

[0018] The same functionality and procedure can be used by either an unfitted train or by a train with failed onboard equipment in which case the procedure may start at any location within the fitted area. The procedure can also be used for any journey on a route by route basis, not only between passing loops. If a timeout of the movement authority is used by the RBC then the portable unit can simply repeat the last location information again in order to request a new movement

authority before the timeout expires. Because the RBC is transmitting standard messages to the portable unit, other information can also be received and displayed to the driver as necessary, for example emergency stop commands and text messages.

[0019] The above process is described using fixed distance offsets for reporting the train in a route. It would be possible however for the RBC to, optionally, send a variable distance with the initial location depending on the route to be entered by the train. This variable distance allows for variation in clearing junctions and crossings for more complex railway layouts. Further specific location information could also be transmitted from the trackside as the train is detected moving through a route.

[0020] If there is an RBC-RBC boundary within the fitted area between a "handing-over" RBC and an "accepting" RBC then this can also be handled by the unit. The location of the boundary and the accepting RBC contact details are identified by the handing over RBC in the movement authority sent to the unit. The identity of the border balise can be identified from linking information also sent with the movement authority by the handing-over RBC. The physical location of the border can be identified for the driver by another trackside marker, although the actual location of the train when it performs the transition from one RBC to another is not important, so long as the train is in the correct route. When the transition is required, the driver presses the 'New RBC' button on the unit. The unit then reports a location to the handing over RBC relative to the border balise such that the train is within the accepting RBC area and the rear of the train is reported clear of the boundary. This causes the handing-over RBC to terminate communications with the unit and allows the unit to establish communications with the accepting RBC.

[0021] If, at any time, a timeout of communications occurs or an RBC-RBC handover fails, then the driver can be allowed to continue to the end of the given movement authority where the start process is repeated.

[0022] Various alternatives will be apparent to those skilled in the art, within the scope of the claims.

[0023] For example, it would be possible to provide power for the unit by utilising a plug-coupled interface to the train. It would also be possible to provide connection to other circuits available on the train. Such a connection may be useful where a standard interface could be provided, for example for fallback operation when a failure occurs in fitted train-carried equipment. Depending on the interface and on the failure of fitted equipment, it may be possible to provide connection to odometry, balise reader information and train brake control circuits. In such cases, the functionality of the unit would be enhanced to make use of the available interfaces and could provide operation that more closely resembles normal ETCS train-carried operation.

[0024] The procedure described in the table above includes the use of verbal communication with the signaller. It is often the case that a separate voice communication system is provided for this purpose on board all trains, in addition to any data radio system. It is possible however to include a voice input capability into the unit if required. Voice communication would then be possible directly using the GSM-R radio network.

[0025] It is possible to incorporate input from a Global Positioning by Satellite (GPS) receiver. Using GPS information, the portable unit would be able to identify the location of the train automatically. This location and the concept of 'virtual balises' could be used directly, or the information could be incorporated into the procedure for verifying the train location by the signaller. Once the location of the train has been established, the movement of the train and its progress along the route may be monitored and accurately reported to the RBC, as is conventional for ETCS, without requiring input from the driver. Even without the interpretation of the absolute GPS location data, the train-carried unit can incrementally determine approximate distance travelled from the initial given location using geometrical separation of coordinates. This estimated distance travelled can additionally be used by the portable unit to provide movement authority overrun protection either through a warning to the driver or by direct control of the brakes if available.

[0026] The unit may be used in conjunction with the management of possessions. The unit can be used at the trackside, on a train, or in a road vehicle to provide communication with the control centre for the granting and releasing of possessions. The unit would for example allow a person at the trackside to interact safely with a central database for the purposes of providing protection for work being carried out on the track, i.e. to prevent trains from being signalled onto that part of the track. Typically the unit might provide a secure Wireless Application Protocol (WAP) browser interface to allow the possession controller to enter location and other possession data. Similarly the WAP browser interface can be used to release the possession at the end of track working. The possession management may be conducted in conjunction with verbal procedures. Including a voice input to the unit may therefore be appropriate. The inclusion of a GPS receiver can also be envisaged which provides accurate confirmation of the location of a possession.

[0027] The invention is described in terms of its use and operation within an ERTMS/ETCS Level 2 radio based signalling system, however the same principles can be applied to operation within other radio based systems.

Claims

1. A method for regulating the movement of a train through an area of railway fitted with trackside radio signalling equipment, the signalling equipment being controlled by a control centre, comprising the steps of:

providing an interface unit on the train;
reporting the initial location of the train to the control centre;
using the control centre to select a route start location for the train, the route start location comprising a selected length of track from a reference point; and
communicating the route start location to the interface unit using the signalling equipment.

2. A method according to claim 1, wherein the initial location of the train is determined using a GPS system.

3. A method according to either of claims 1 and 2, comprising the steps of:

after the route start location has been communicated to the interface unit, confirming that the train is at the correct route start location by a driver of the train; and using the unit to send the confirmation to the control centre via the signalling equipment.

4. A method according to claim 3, wherein after the confirmation has been received by the control centre, a route is set for the train, and a movement authority of selected track length for the train to proceed along that route is communicated to the unit by the signalling equipment.

5. A method according to any preceding claim, wherein after the train has travelled a selected distance from the route start location, and so is fully within the route, the unit is used to communicate this information to the control centre.

6. A method according to claim 5, wherein the selected distance is indicated to a driver of the train by a trackside marker.

7. A method according to either of claims 5 and 6, wherein the distance is fixed and set relative to the reference point.

8. A method according to either of claims 5 and 6, wherein the distance is variable and specified by the trackside equipment.

9. A method according to claim 5, wherein the distance is determined using odometry.

10. A method according to claim 5, wherein the distance is determined using a GPS system.

11. A method according to any preceding claim, wherein the unit is used to communicate to the control centre that the train is at or approaching the end of the route.

12. A method according to claim 11, when dependent on claim 4, wherein the position of the train at the end of the route is determined by subtracting a selected length from the movement authority length.

13. A method according to either of claims 11 and 12, wherein, if required, the control centre selects a new route start location for the train, the new route start location comprising a selected length of track from a second reference point; and communicates the route start location to the interface unit using the signalling equipment.

14. A method according to any preceding claim, wherein a GPS system is used to monitor the location of the train.

15. A method according to any preceding claim, wherein the trackside signalling system operates in accordance with the specifications of the European Rail Traffic Management System and / or the European Train Control System.

16. A method according to any preceding claim, wherein the or each reference point comprises a balise group.

17. An interface unit for use in the method according to any preceding claim, the unit comprising means for communicating with a remotely-located control centre via trackside radio signalling equipment.

18. A unit according to claim 17, comprising means for receiving text messages.

19. A unit according to either of claims 17 and 18, comprising a Wireless Application Protocol browser interface.

20. A unit according to any of claims 17 to 19, comprising means for transmitting a voice channel to a remote location.

21. A unit according to any of claims 17 to 20, comprising a GPS receiver.

22. A unit according to any of claims 17 to 21, comprising a keypad.

23. A unit according to claim 22, comprising a dedicated key for enabling a driver of the train to input that the train is in a route.

24. A unit according to either of claims 22 and 23, comprising a dedicated key for enabling a driver of the train to input that the train is at the end of a route.

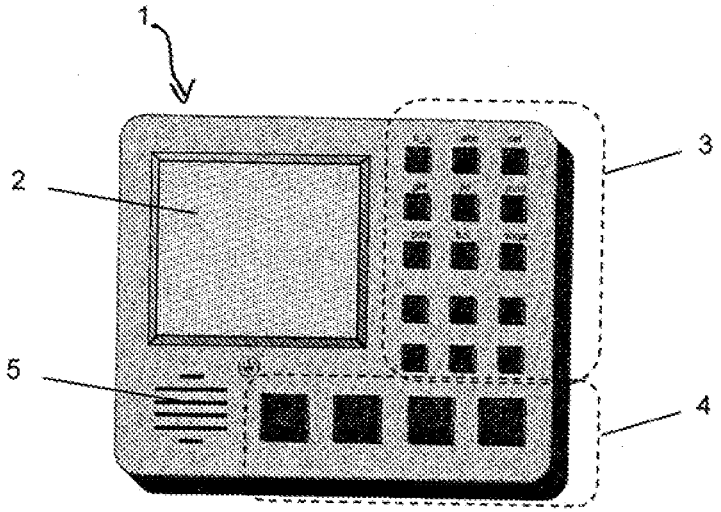
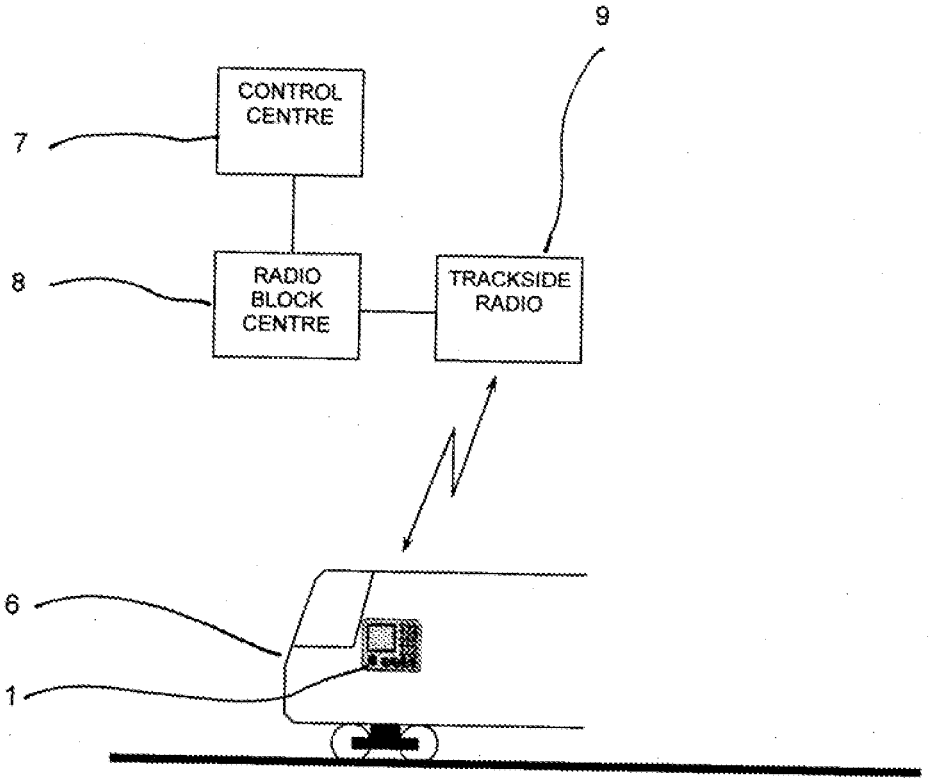

1
2
3
4
5

Fig. 1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7
8
RADIO BLOCK CENTRE
TRACKSIDE RADIO
6
1

Fig. 2

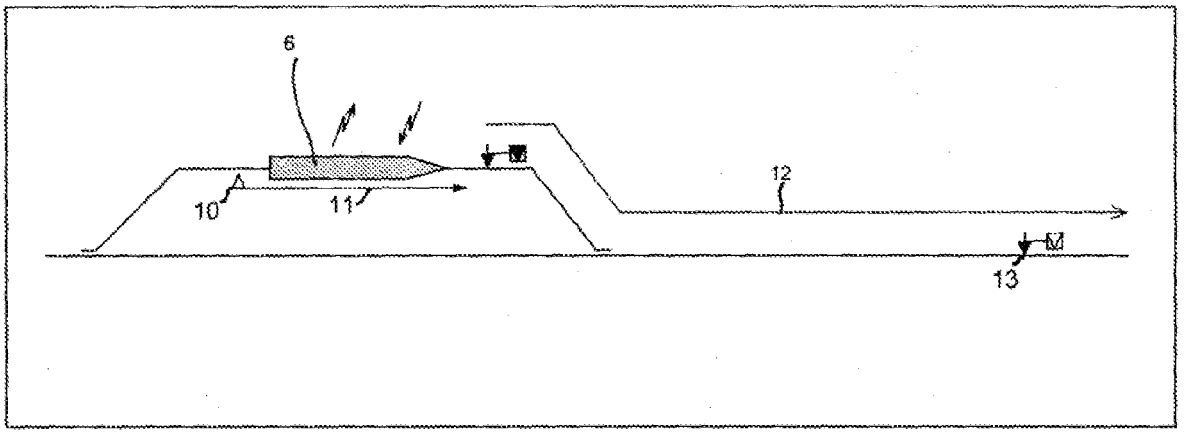

Fig. 3

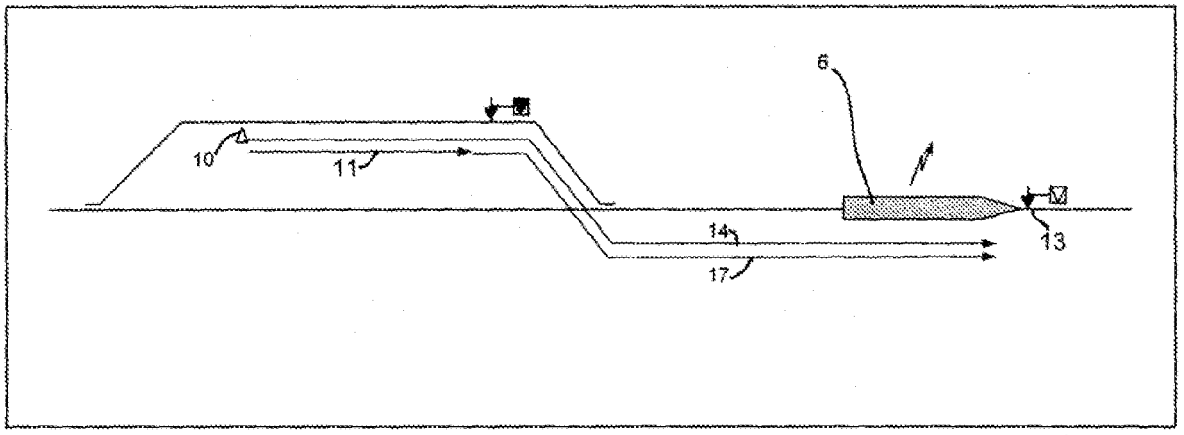

Fig. 4

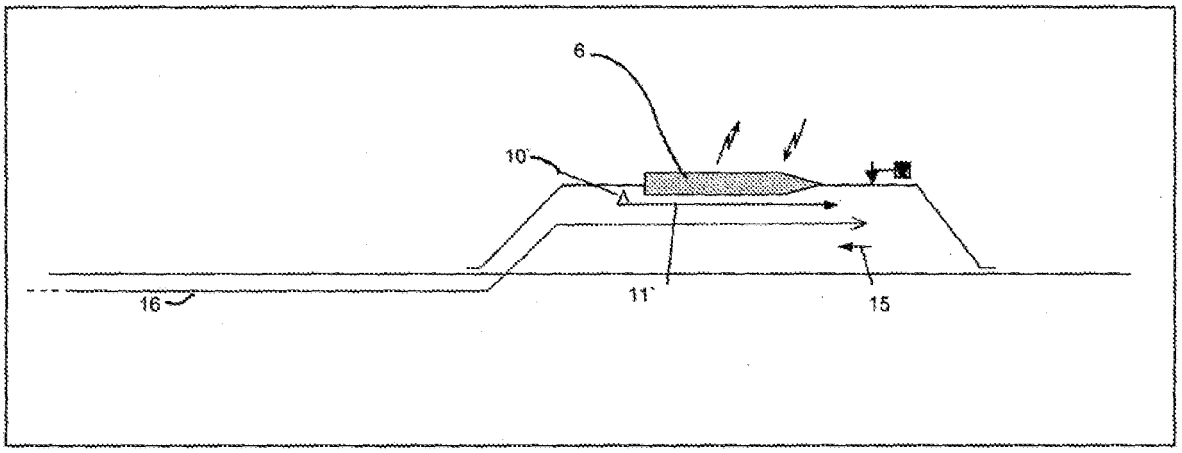

Fig. 5