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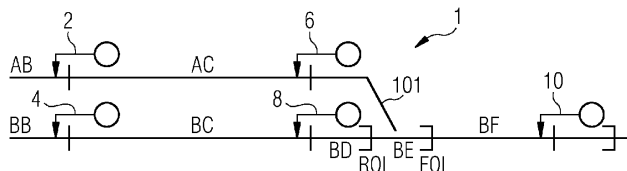
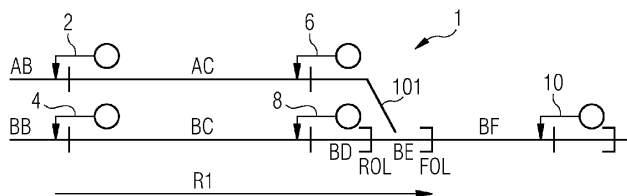
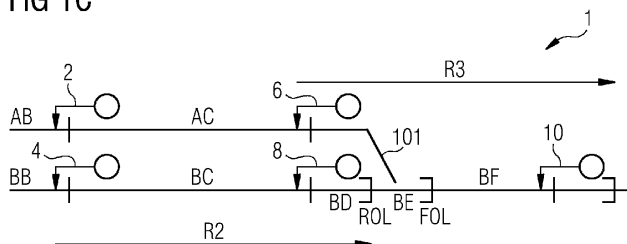
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(54) METHOD REDUCING OR RELEASING AN OVERLAP

(57) A method of stepping down between routes in a railway signalling system is described. The method involves comparing the speed of a train to a given first

threshold to determine whether a full overlap (FOL) may be released or reduced to a restricted overlap (ROL).

FIG 1A**FIG 1B****FIG 1C**

Description

[0001] The present invention relates to a method of stepping down between routes in a railway signalling system, in particular, stepping down from a main class route to a warner class route by releasing or restricting an overlap.

[0002] Railway signalling systems set routes for trains between entrance signals and destination signals along a railway line. However, should the train fail to stop at the destination signal, a safe space needs to be reserved for the train to run into in order to prevent accidents. This safe space is known as an overlap, and is reserved for the destination signal at the same time as a route up to the destination signal. A "full overlap" (FOL) for a signalling system incorporating train protection typically comprises three sections: a release distance, to provide a train driver with sufficient distance to bring a train to a halt at a Safe Supervised Stopping Point (SSSP); an Odometry Overrun Distance (OOD), to provide a flexibility to accommodate errors in the odometer on the train; and a buffer zone, provided to cater for overhang of a preceding train. A conventional signalling systems without train protection still effectively requires the three sections, although they are considered to be all included within the single concept of an overlap. Once the overlap is reserved, no other route can be set that would require the railway line the overlap covers. This reduces the risk of any collision between trains on conflicting routes. Whilst from a health and safety perspective this is clearly a necessity, from an operational perspective the reservation of full overlaps may be restrictive in busy and complex areas, such as junctions and stations. An overlap is only released once it is confirmed that the train has come to rest at the destination signal, which is typically determined by timing the occupation of the track section of the railway line immediately prior to the destination signal. Since no other route can be set until the overlap is clear, the timing of movement of trains in complex regions is effectively limited based on the number of required overlaps. It is possible to set a "restricted overlap", which is where the length of the overlap is shortened to the buffer zone. However, such a restricted overlap is only used in certain circumstances where it is safe to do so, and consequently does not have a positive impact on the operational capacity of the railway line. Stepping up from a restricted overlap (ROL) to a full overlap (FOL) is done when a train waits at a platform for another train to leave a station and cross onto the railway line in front of the platform. Stepping down from the full overlap (FOL) to the restricted overlap (ROL) is described in EP2983960B1. Here a route is configured up to a signal where an overlap is to be released, with a separate route then configured for the overlap itself. A proceed indication for the overlap route is provided by an interlocking to trackside processing equipment whenever the overlap route is available for use by an approaching train but no forward route is set from the signal. If the train receives and accepts a shortened movement authority (for only the route up to the signal, with an End of Authority, or Eoin approximately at the signal) then the overlap route can be released. This would also allow a train to exit a station and cross over onto the railway line forward of the signal, for example. However, this requires a specific route configuration in order to be used and relies on the acceptance of a modified movement authority, which may therefore not improve the operational capacity of a rail network in all circumstances, and is not possible in conventional signalling systems.

[0003] It would therefore be desirable to find a way in which a restricted overlap (ROL) could be used safely in complex conventional signalling designs to improve operational capacity of a railway network without creating a risk to health and safety or relying on specific configurations of routes or changes to movement authorities.

[0004] The present invention aims to address these issues by providing a method of reducing or releasing an overlap in a railway signalling system, the railway signalling system comprising a first railway line (A) having a first signal (2) and a second signal (6), a second railway line (B) also having a first signal (4) and a second signal (8), a set of points (101) adapted to be set to enable train to cross from the first railway line (A) onto the second railway line (B) and travel towards a destination signal (10) on the second railway line (B), the method comprising the steps of: a) maintaining the first signal (2) on the first railway line (A) at a red aspect; b) setting a first route (R1) along the second railway line (B) up to the second signal (8) whilst maintaining a full overlap (FOL) at the second signal (8) that extends beyond the set of points (101); c) determining the speed of a first train (T1) as it travels along the first route (R1) and approaches the second signal (8) on the second railway line (B); d) if the speed of the first train (T1) is below a predetermined first threshold, then reducing the full overlap (FOL) to a restricted overlap (ROL) on the second railway line (B) that extends from the second signal (8) and stops short of the set of points (101), setting a second route (R2) on the second railway line (B) and setting a third route (R3) on the first railway line (A) from the second signal (6) past the set of points (101) to the destination signal (10) on the second railway line (B); or e) if the speed of the first train (T1) exceeds the predetermined first threshold, maintaining the full overlap (FOL) and maintaining both the second signal (8) on the second railway line (B) and the first signal (2) on the first railway line (A) at a red aspect.

[0005] By measuring the speed of the train, either directly or indirectly, in a preceding track section rather than relying on either specially configured routes or agreement to changes in movement authorities it is possible to step down between main class routes (M) and warner class routes (W) reliably and safely in even complex railway signalling systems.

[0006] Preferably, speed of the first train (T1) is determined using a train-borne system. The train will pass this information to the trackside system.

[0007] The train-borne system may comprise a timer, wherein the method may comprise the steps of: i) detecting a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B); ii) activating the onboard

timer if the first track-located trigger (t_1) is detected; and iii) detecting a second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B); wherein if the onboard timer expires before the second track-located trigger (t_2) is detected, the first train (T1) is travelling a speed below the pre-determined first threshold.

[0008] The track-located triggers (t_1 , t_2) may be balises, or the first track located trigger (t_1) may be an arming loop, and the second track located trigger (t_2) may be the corresponding trigger loop.

[0009] Alternatively, the train-borne system may comprise a timer, wherein the method may comprise the steps of: i) detecting a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B); ii) activating the onboard timer if the first track-located trigger (t_1) is detected; iii) detecting a second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B); and iv) determining the speed of the first train (T1) from the distance between the first track-located trigger (t_1) and the second track-located trigger (t_2) and the time taken to travel between them. In this situation, preferably the first (t_1) and second (t_2) track-located triggers are track-located magnets.

[0010] The invention will now be described by way of example only, and with reference to the accompanying drawings, in which:

Figure 1a illustrates a conventional railway signalling system layout for two railway lines;

Figure 1b illustrates a main class route (M) along the second railway line (B). A main class route is a route set from a main signal, along which the driver of a train may proceed at the main signal's aspect (either green or yellow);

Figure 1c illustrates a warner class route (W) along the first railway line (B). A warner class route (W) is one where a restricted overlap (ROL) may be set at the second signal (8) on the second railway line (B);

Figure 2 is a flow chart of a method in accordance with the embodiments of the present invention;

Figure 3 is a flow chart of a method in accordance with an embodiment of the present invention; and

Figure 4 is a flow chart of a method in accordance with another embodiment of the present invention.

[0011] Figure 1a illustrates a conventional railway signalling system layout for two railway lines. Conventional United Kingdom practice is used for the nomenclature of the signals, railway lines and points, and is used throughout this description and in the accompanying drawings. The railway signalling system 1 comprises a first railway line (A) having a first signal (2) and a second signal (6), a second railway line (B) also having a first signal (4) and a second signal (8). A set of points (101) is adapted to be set to enable train to cross from the first railway line (A) onto the second railway line (B). A destination signal (10) is also provided on the second railway line (B), up to which trains from each of the first (A) and second (B) can approach. Each region of a railway line (A, B) is divided into track sections or blocks, based upon the signals. These are as follows:

Table 1: Track sections in Figure 1a

Line	Section	Location
A	AB	Up to the first signal (2)
	AC	Between the first signal (2) and the second signal (6)
B	BB	Up to the first signal (4)
	BC	Between the first signal (4) and the second signal (8)
	BD	Between the second signal (8) and a reduced overlap (ROL) for the second signal (8)
	BE	Between the reduced overlap (ROL) and the full overlap (FOL) for the second signal (8)
	BF	Between the full overlap (FOL) for the second signal (8) and the destination signal (10)

[0012] Figure 1b illustrates a first route along the second railway line (B). This first route (R1) and is set from a main signal, along which the driver of a train may proceed at the main signal's aspect (either green or yellow). In Figure 1b, the first route (R1) is set up to the second signal (8) on the second railway line (B). A full overlap (FOL) is set at the second signal (8), and is protected from a train exceeding the safe overrun distance using TPWS (Train Protection and Warning System) loops or ETCS (European Train Control System) balises on the approach to the second signal (8), such as an Over Speed Sensor (OSS), or at the second signal (8), such as a Train Stop Sensor (TSS). The full overlap (FOL) requires that the track sections BD and BE are clear, and that the set of points (101) are set to normal. In this configuration, a route from the second signal (6) on the first railway line (A) to the destination signal (10) on the second railway line (B) cannot be set. However, a route from the second signal (8) on the second railway line (B) to the destination signal (10) on the second railway line (B) can be set over the top of the full overlap (FOL) as it is safe to do so.

[0013] Figure 1c illustrates a second route along the first railway line (B). This second route (R1) is one where a restricted overlap (ROL) may be set at the second signal (8) on the second railway line (B). This is due to the first route (R1) being set on the first railway line (A) up to the destination signal (10) on the second railway line (B). However, since the restricted overlap (ROL) length is not sufficient to stop a train overrunning the second signal (8) on the second railway line (B), the first signal (4) on the second railway line (B) must be held at a red aspect until the track section BB is occupied for a sufficient time to confirm that the approach speed of the train is slow enough to be able to stop within the reduced overlap (ROL) length at the second signal (8) on the second railway line (B). If this is the case, a third route (R1) can be set from the second signal (6) on the first railway line (A) past the set of points (101) to the destination signal (10) on the second railway line (B).

[0014] In order to improve the operational capacity of the railway network, the embodiments of the present invention enable the release of a full overlap (FOL) on one railway line to allow the setting of another route crossing onto the railway line from a second railway line that would ordinarily not be possible. Figure 2 is a flow chart of a method in accordance with the embodiments of the present invention. As an example, the signalling system configuration shown in Figures 1a, 1b and 1c is used to illustrate how an embodiment of the present invention functions. However, it should be borne in mind that the embodiments of the present invention may be applied to any situation where an overlap requires release, such as when entering and exiting a station and crossing onto and across sections of track (such as between main and relief lines).

[0015] The method 200 begins, at step 202, with maintaining the first signal (2) on the first railway line (A) at a red aspect. This prevents any trains from moving from the track section AB into the track section AC and approaching the second signal (6) on the first railway line (A), since no overlap has been set. At step 204, a first route is set along the second railway line (B) up to the second signal (8) whilst maintaining a full overlap (FOL) at the second signal (8) that extends beyond the set of points (101). This is possible as no overlap is set for the second signal (6) on the first railway line (A) as the previous signal shows a red aspect. Next, at step 206, the speed of a first train (T1) is determined as it travels the first route (R1) and approaches the second signal (8) on the second railway line (B). Determining the speed of the first train (T1) as it travels along the track section BC reveals whether or not the first train (T1) can stop safely within the full overlap (FOL). At step 208, if the speed of the first train (T1) is determined to be below a predetermined first threshold, then the full overlap (FOL) is reduced to a restricted overlap (ROL) on the second railway line (B) that extends from the second signal (8) and stops short of the set of points (101) and a second route (R2) is set on the second railway line (B) at step 212 up to the second signal (8) pm the second railway line (B). If the speed of the train (T1) is low enough, then the full overlap (FOL) may be released completely. Then, at step 214, a third route (R3) is set, this time on the first railway line (A), which may be from the first signal (2) to the second signal (6), the second signal (6) past the set of points (101) to the destination signal (10) on the second railway line (B) or both. However, if at step 208, the speed of the first train (T1) is determined to exceed the predetermined first threshold, then at step 212 the full overlap (FOL) is maintained, as are both the second signal (8) on the second railway line (B) and the first signal (2) on the first railway line (A) at a red aspect.

[0016] The speed of the train (T1) is determined using a train-borne system. This may be based on existing technology utilised inside a train cab, or utilise additional apparatus provided specifically to determine train speed. Train speed is typically measured using a combination of speed sensors, rotation sensors and diagnostic systems. For example, a traditional speed measurement technique is the use of eddy currents, where a pole moves past a sensor, which then measures variation in distance based on an electromagnetic field. Other techniques include Hall effect sensors and variable reluctance sensors. Each of these techniques works by determining the rotational speed of the train wheels and thereby the linear speed of the train. These sensors may therefore be present on the train (T1) already, or may be retrofitted to the train (T1). In addition to the speed sensors, the train-borne system may alternatively comprise an onboard timer, which is used to time the occupation of specific track sections. An onboard map is also available, along with positional data from either GPS (ground positioning system) or GNSS (global navigation satellite system) then enables the speed of the train to be determined from the time measured by the timer and the location of the train (T1). Figure 3 is a flow chart of a method in accordance with an embodiment of the present invention. The method steps illustrated in Figure 3 are carried out following step 206 and prior to step 208 of the method in accordance with the embodiments of the present invention illustrated in Figure 2. In this embodiment, the speed of the first train (T1) is compared indirectly with a pre-determined first threshold. Initially, at step 300, a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B) is detected. This may be done using any suitable technology available on the track and train in question, based upon, for example, whether the train utilises ETCS (European Train Control System), TPWS (Train Protection and Warning System) or AWS (Automatic Warning System). At step 302, the onboard timer is activated if the first track-located trigger (t_1) is detected. This begins the timing of the occupation of a track section that has the first track-located trigger (t_1) at its entrance and a second track-located trigger (t_2) at its exit. At step 304, the second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B) is detected. At this point one of two actions will have occurred: at step 306, if the onboard timer has already expired before the second track-located trigger (t_2) has been reached, it is determined that the first train (T1) is travelling a speed below the pre-determined first threshold. However, if, as indicated at step 308, the onboard timer is still running when the second track-located trigger (t_2) is reached, and has not expired, then the first train (T1) is determined to be travelling at too high a speed to stop without the provision of a full overlap (FOL) and therefore the full overlap is not released or restricted, as in step 208b. The time value

that the onboard value is set to is determined by the identity of the first track-located trigger (t_1), and represents a pre-determined first threshold time that is directly calculated from a pre-determined speed. A database or map of locations and corresponding times may be used to identify the time value the onboard timer is set to at the point the first track-located trigger (t_1) is detected. This may be done using the existing GPS (Global Positioning System) or GSM-R (Global System for Mobile Communications - Railway) capability onboard the first train (T1), for example, in a cab radio. The database or map may be stored locally on the first train (T1) to remove any time lag due to communications between the first train (T1) and a central or remote server. The database entries or map may be loaded into memory storage on the first train (T1) when the driver provides their credentials and route information to the onboard systems before starting a journey. In an ETCS signalling system, the track-located triggers (t_1 , t_2) are balises. In an TPWS signalling system, the first track located trigger (t_1) is an arming loop, and the second track located trigger (t_2) is the corresponding trigger loop.

[0017] Figure 4 is a flow chart of a method in accordance with another embodiment of the present invention. This illustrates the methodology used in an AWS signalling system, such as in the United Kingdom. In this example, the first (t_1) and second (t_2) track-located triggers are magnets, which are placed at a known distance from the second signal (8) on the second railway line (B). The method steps illustrated in Figure 4 are carried out following step 206 and prior to step 208 of the method in accordance with the embodiments of the present invention illustrated in Figure 2. At step 400, a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B) is detected. At step 402, the onboard timer is activated if the first track-located trigger (t_1) is detected. This begins the timing of the occupation of a track section that has the first track-located trigger (t_1) at its entrance and a second track-located trigger (t_2) at its exit. At step 404, the second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B) is detected. The magnets forming the first (t_1) and second (t_2) track-located triggers are placed a set distance apart. As the wheels of the train pass through the magnetic fields created by the magnets and cause perturbations, these perturbations can be measured onboard the train, along with the time between each pair of detected perturbations (two per each wheel as it passes through the magnetic fields). At step 406, the time between perturbations and the distance between the magnets is used to calculate the speed of the first train (T1):

$$s = d/t \quad (\text{Equation 1})$$

where s is the speed of the first train (T1), d is the distance between the magnets and t is the time the wheel spends traversing the distance between the magnets. The distance between the magnets is small enough to be able to ignore any effects of acceleration or deceleration on the measurement of the speed of the first train (T1). The speed is then compared directly to the pre-determined first threshold in order to determine whether the full overlap (FOL) can be released or restricted.

[0018] The first threshold against which the speed of the train (T1) is compared to is a speed that corresponds to the length of certain distances associated with a signal in which the train could come to a halt safely. For example, for removal of the full overlap (FOL) the pre-determined first threshold is a speed corresponding to the length of the restricted overlap associated with the second signal (8) on the second railway line (B) from which the train (T1) can safely come to a halt within the length of the restricted overlap. For the stepping down from the full overlap (FOL) to the restricted overlap (ROL), then the pre-determined first threshold is a speed corresponding to the length of a buffer zone and safe supervised stopping point (SSSP) associated with the second signal (8) on the second railway line (B) from which the train (T1) can safely come to a halt within the length of the restricted overlap and safe supervised stopping point. If the speed of the first train (T1) is below a pre-determined second threshold, where the pre-determined second threshold is a low enough speed, the full overlap (FOL) can be released completely. The pre-determined second threshold is a lower speed than the pre-determined first threshold.

[0019] The length of the restricted overlap (ROL) may also be determined by the speed of an approaching train (T1). For example, if an approaching train (T1) travels at a speed of 50km/h, then a restricted overlap (ROL) having a first length ROL_1 is set. However, if an approaching train is travelling at a speed of 25km/h, then a restricted overlap (ROL) having a second length ROL_2 is set, where ROL_2 is shorter than ROL_1 . It is possible therefore that by varying the speed of a train (T1) as it approaches a signal to vary the length of the restricted overlap (ROL) according to the speed of the train. Therefore, the length of the restricted overlap (ROL) may be static (set until the train (T1) reaches a specific signal) or dynamic.

[0020] The above-described embodiments are exemplary only, and other possibilities and alternatives within the scope of the invention will be apparent to those skilled in the art.

Claims

1. A method of reducing or releasing an overlap in a railway signalling system, the railway signalling system comprising a first railway line (A) having a first signal (2) and a second signal (6), a second railway line (B) also having a first signal (4)

and a second signal (8), a set of points (101) adapted to be set to enable train to cross from the first railway line (A) onto the second railway line (B) and travel towards a destination signal (10) on the second railway line (B), the method comprising the steps of:

- 5 a) maintaining the first signal (2) on the first railway line (A) at a red aspect;
b) setting a first route (R1) along the second railway line (B) up to the second signal (8) whilst maintaining a full overlap (FOL) at the second signal (8) that extends beyond the set of points (101);
c) determining the speed of a first train (T1) as it travels along the first route (R1) and approaches the second signal (8) on the second railway line (B);
10 d) if the speed of the first train (T1) is below a predetermined first threshold, then reducing the full overlap (FOL) to a restricted overlap (ROL) on the second railway line (B) that extends from the second signal (8) and stops short of the set of points (101), setting a second route (R2) on the second railway line (B) and setting a third route (R3) on the first railway line (A) from the second signal (6) past the set of points (101) to the destination signal (10) on the second railway line (B);
15 or
e) if the speed of the first train (T1) exceeds the predetermined first threshold, maintaining the full overlap (FOL) and maintaining both the second signal (8) on the second railway line (B) and the first signal (2) on the first railway line (A) at a red aspect.

- 20 2. Method as claimed in claim 1, wherein the speed of the first train (T1) is determined using a train-borne system.
3. Method as claimed in claim 2, wherein the train-borne system is a speed sensor.
4. Method as claimed in claim 2, wherein the train-borne system comprises a timer, and wherein the method comprises
25 the steps of:

- i) detecting a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B);
ii) activating the onboard timer if the first track-located trigger (t_1) is detected; and
30 iii) detecting a second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B);

wherein if the onboard timer expires before the second track-located trigger (t_2) is detected, the first train (T1) is travelling a speed below the pre-determined first threshold.

- 35 5. Method as claimed in claim 4, wherein the track-located triggers (t_1 , t_2) are balises.
6. Method as claimed in claim 4, wherein the first track located trigger (t_1) is an arming loop, and the second track located trigger (t_2) is the corresponding trigger loop.
- 40 7. Method as claimed in claim 2, wherein the train-borne system comprises a timer, and wherein the method comprises the steps of:

- i) detecting a first track-located trigger (t_1) positioned prior to the second signal (8) on the second railway line (B);
ii) activating the onboard timer if the first track-located trigger (t_1) is detected;
45 iii) detecting a second track-located trigger (t_2) positioned between the first track located trigger (t_1) and the second signal (8) on the second railway line (B); and
iv) determining the speed of the first train (T1) from the distance between the first track-located trigger (t_1) and the second track-located trigger (t_2) and the time taken to travel between them.

- 50 8. Method as claimed in claim 6, wherein the first (t_1) and second (t_2) track-located triggers are track-located magnets.
9. Method as claimed as in any preceding claim, wherein when the speed of the first train (T1) is below a pre-determined second threshold, the full overlap (FOL) can be released completely.
- 55 10. Method as claimed in claim 9, wherein the pre-determined second threshold is a lower speed than the pre-determined first threshold.

11. Method as claimed in any preceding claim, further comprising the steps of:

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varying the speed of the first train (T1) as it approaches the second signal (8) on the second railway line (B); and varying the length of a corresponding restricted overlap (ROL) in response to the speed of the first train (T1); wherein the length of the restricted overlap (ROL) is proportional to the speed of the first train (T1).

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FIG 1A

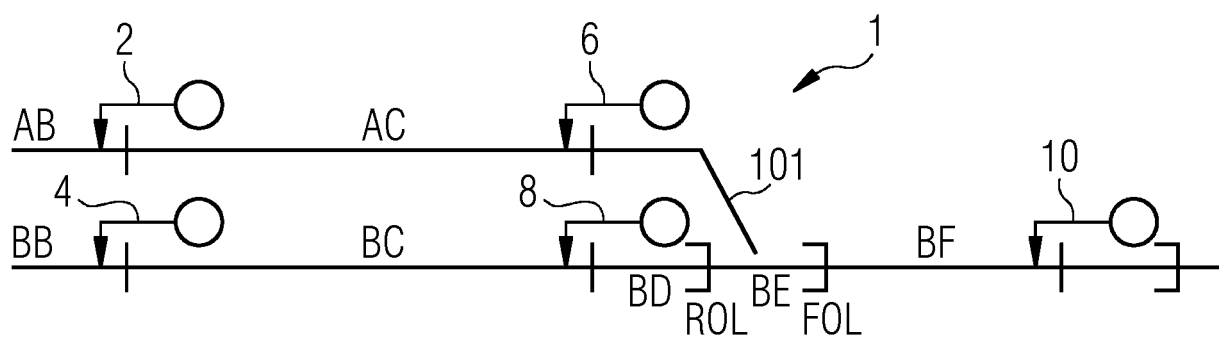


FIG 1B

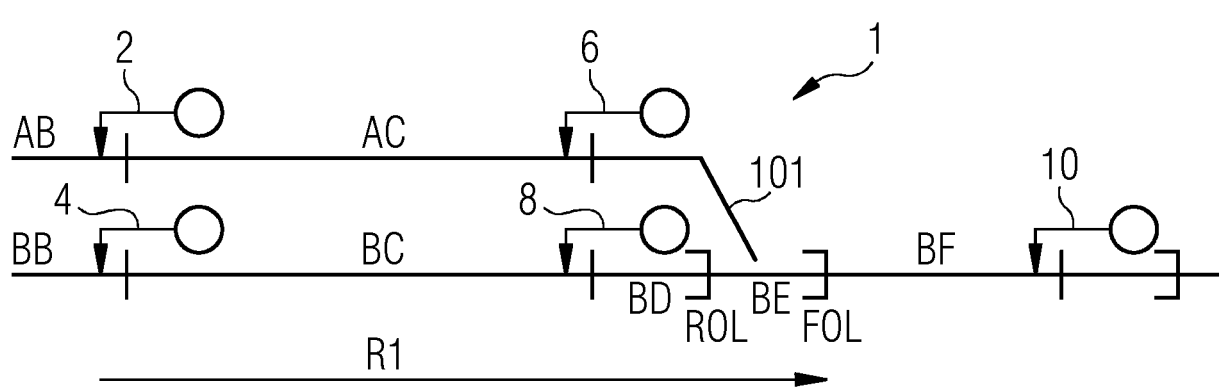


FIG 1C

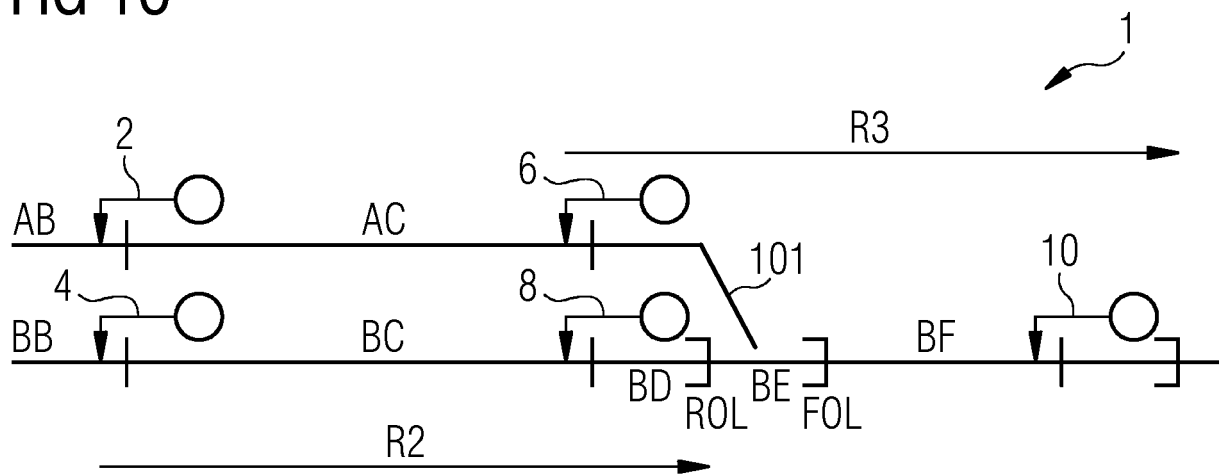


FIG 2

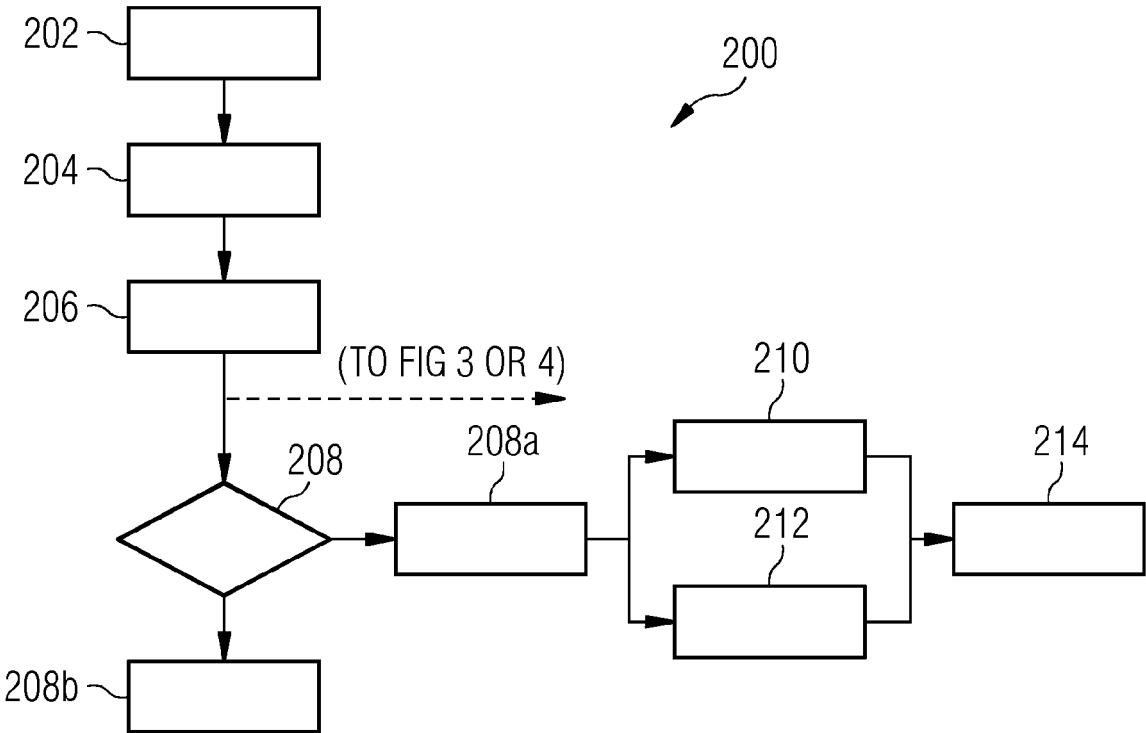


FIG 3

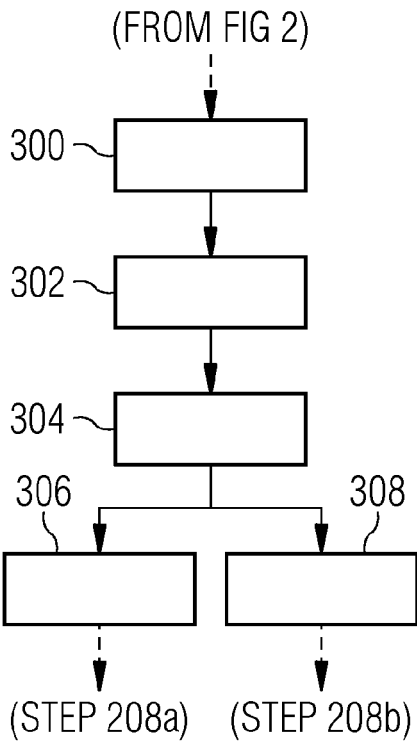
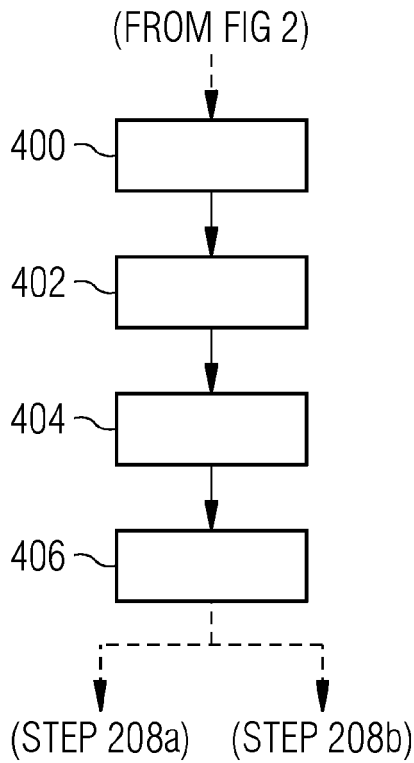


FIG 4





EUROPEAN SEARCH REPORT

Application Number

EP 24 18 9071

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 983 960 B1 (SIEMENS MOBILITY LTD [GB]) 24 February 2021 (2021-02-24) * figures 1-6 * * paragraphs [0008] - [0014] * * paragraphs [0022] - [0028] * -----	1-11	INV. B61L27/20 B61L27/40 B61L25/02
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Place of search Munich		Date of completion of the search 13 December 2024	Examiner Robinson, Victoria
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