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(54) METHOD FOR EVALUATING THE OCCUPANCY OF A TRACK SECTION AND AXEL COUNTER

(57) The invention concerns a method for evaluating the occupancy status of a track section (2) using at least one axle counter (3) with a first detection point (4a) and a second detection point (4b), which limit the track section (2). The method is characterized in the following steps:
a. acquisition of a first train pattern (8a) and a second train pattern (8b), wherein the first train pattern (8a) is a list of distance parameters (S_1 - S_5) indicating the distances (S_1 - S_5) between the axles (5a - 5f) counted at the first detection point (4a) and the second train pattern (8b) is a list of distance parameters (S'_1 - S'_4) of the distance parameters (S'_1 - S'_4) indicating the distances (S'_1 - S'_4) between the axles (5a - 5f) counted at the second detection point (4b).
b. comparing the first train pattern (8a) with the second train pattern (8b);
c. evaluating that the track section (2) is clear if there is no deviation between the patterns (8a, 8b) or a deviation is found to be based on a miscount of the axles (5a - 5f).

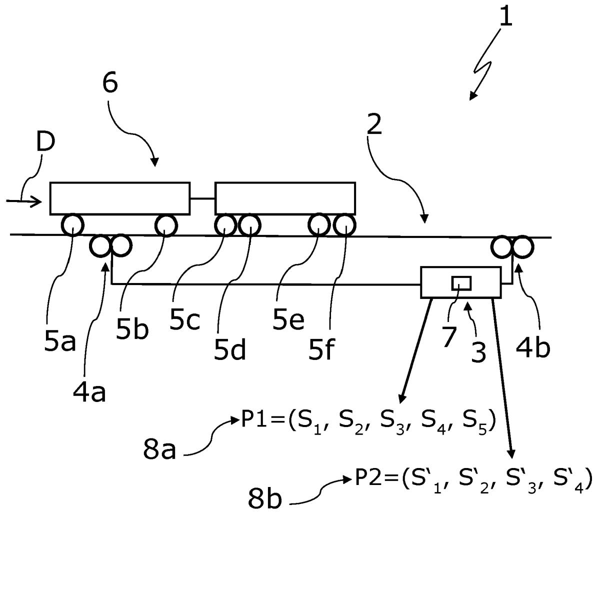

Fig. 1

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Description

Field of invention

[0001] The invention concerns a method for evaluating the occupancy of a track section using at least one axle counter with a first detection point and a second detection point, the first and second detection points limiting the track section, wherein axles of the train passing the first detection point are detected by generating in-counts and axles of the train passing the second detection point and are detected by generating out-counts. The invention further concerns an axle counter adapted to generate in-counts for axles counted in and out-counts for axles counted out and an axle counter evaluator.

Background of the invention

[0002] Methods for counting the axles of trains are known from [1].
[0003] Axle counting methods are used to determine the occupancy of the track section by a train passing the detection points.
[0004] Axle counters known from the prior art detect and count axles entering the track section and axles leaving the track section by means of sensors (detection points) that limit a track section. The axles counted by the sensors when entering a track section are compared with those when leaving the track section. A previously free track section is reported as free again when the same number of in-counted axles has also been counted out [1].
[0005] If a sensor type is used which reliability against miscounts is not high enough and if this sensor is used to compare counts of in-going and out-going axles, the doubling of sensors might compensate this reliability gap. However, this comes with an increased LCC.

Objective of the invention

[0006] It is an objective of the invention to provide a method that can determine the occupancy status of a track section with increased reliability without the use of additional hardware. It is a further objective of the present invention to provide an axle counter for carrying out the method.

Summary of the invention

[0007] These objectives are achieved by a method according to claim 1 and an axle counter according to claim 9.
[0008] The method is characterized by the following steps:

a. acquisition of a first train pattern and a second train pattern by determining for each in-count and for each out-count a distance parameter, wherein the first train pattern is a list of first distance parameters of the in-counts indicating the distances between the axles counted by the first detection point and the second train pattern is a list of second distance parameters of the out-counts indicating the distances between the axles counted by the second detection point;

b. comparing the first train pattern with the second train pattern;

c. evaluating that the track section is clear

if the first pattern complies with the second pattern or

if a deviation between the first pattern and the second pattern is detected, but is found to be based on a miscount by using the determined distance parameters.

[0009] According to the invention, the occupancy status of the track section is determined by using a pattern comparison, i.e. a comparison of lists of distance parameters, in particular of the list of distances between the axles counted by the first detection point with the list of distances between the axles counted by the second detection point, instead of a counter comparison, i.e. a comparison between the number of axles counted by the first detection point with the number of axles counted by the second detection point.
[0010] The method for evaluating the occupancy status of a track section is therefore no longer based purely on counting the passing wheels of a train. Instead, the method provides additional geometric information about the train in the form of the distances between the counted axles. The method can advantageously detect and correct errors in

counting the axles by comparing the first and second train patterns on the basis of this geometric information. This reduces the risk of a track section being incorrectly classified as "free" or "occupied". Obvious errors in axle counting can be corrected automatically. This effect can be achieved without the use of additional safety systems. In particular, the safety of the process can be increased without redundant components of the hardware or additional axle counters. In this way, an increase in complexity and additional costs of the system used for counting the axles are avoided. By detecting the train pattern, additional information about the train can also be stored and transmitted, including the length of the train carriages or the entire train and the load distribution. In some embodiments, the comparison of the train patterns is carried out continuously.

[0011] The distance parameters refer to parameters being characteristic for the distance between counted axles. The distance parameters are or depend from the distances between the axles detected by the detection points. From the distance parameters, the distances between the axles can be determined.

[0012] The axles counted in relate to axles entering the track section. Correspondingly, the axles counted out relate to axles leaving the track section.

Preferred embodiments of the invention

[0013] A deviation is preferably detected if the number of distance parameters of the first train pattern differs from that of the second train pattern. In addition or alternatively corresponding distance parameters of the first and second list of distance parameters can be compared.

[0014] If an axle is erroneously omitted during counting, in addition to a reduction of the number of measured distance parameters a deviation of the values of the distance parameters can be observed. In order to locate the source of the error that leads to the deviation of the train patterns, it is possible to determine at which positions the distance parameters in the first pattern and the second pattern coincide.

[0015] In an improvement of the aforementioned embodiment, the deviation is found to be based on a miscount if a sub-sequence of at least a predetermined number of distance parameters of the first train pattern complies with a sub-sequence of the second train pattern. In this variant, it is checked whether there is a consistency of a sequence of at least a predetermined number of distance values (sub-sequence) between the first and the second train pattern.

[0016] For this purpose, some distance parameters can be selected for comparison. In this way, comparatively few distance parameters can be used to quickly determine whether parts of the train are still in the track section.

[0017] In a further improvement of the aforementioned embodiment, relating to a comparison of the number of distance parameters of the first and second train pattern, the deviation is found to be based on a miscount if the distance between the first in-count and the last in-count is equal to the distance between the first out-count and the last out-count. The sum of the distance parameters of all in-counts is equal to the sum of all distance parameters of all out-counts of the patterns. In other words: The distance between the first axis counted in and the last axis counted in is the same as the distance between the first axis counted out and the last axis counted out. Both distances represent the train length.

[0018] The comparison of the distance between the first in-count and the last in-count and the distance between the first out-count and the last out-count, combined in particular with an additional comparison with a known length of the train leads to a particularly reliable conclusion about the correct way of counting during the process. This method is particularly advantageously, since miscounts of axles located between the first and the last axle of the train are less critical as long as the train length determined at the first and second detection point match.

[0019] A further embodiment of the method is characterized in that in case a deviation between the first pattern and the second pattern is detected but is found to be based on a miscount, the pattern comprising the miscount is corrected, in particular by adding the missing count and correcting the corresponding distance parameters. In this variant of the method, a logical correction of the erroneous pattern can take place in an axle counter evaluator. In particular, a missing distance parameter corresponding to an axle that was erroneously not counted is added based on the respective other train pattern, preferably automatically. The values of the other distance parameters are adjusted. This simplifies the method for a user.

[0020] In yet another variant of the method, for determining the distance parameter a time stamp is assigned to each in-count and out-count and the distance parameter is determined using the time stamps and the speed of the train at the respective point in time. The distance parameters are preferably determined by extracting the speed from the sensors of a detection point. In particular, the distance parameters are obtained as the product of the speed of the train and the differences of successive times at which the axles are counted at a detection point. In this way, the distance parameters can be easily determined. In particular, the first and second detection points are located at points where the train is moving at a constant speed in order to reliably determine the distances. In particular, sensors are located at the detection points, wherein the sensors are spaced along the track section to determine the direction of motion and the speed of the train.

[0021] Preferably, the distance parameters are the distances ($S_1, S_2, \ldots, S_n$) of neighboring axles.

[0022] In one embodiment of the method, the distance parameters are the ratios (S_1/S_2, $S_2/S_3, \ldots, S_{n-1}/Sn$) between distances of neighboring axles and distances between subsequent neighboring axles.

[0023] In other embodiments, the distance parameters may be the distance between the first and the n-th axle, the ratio of distances of the first and the n-th axle.

[0024] An axle counter comprising detection points adapted to generate in-counts for axles counted in and out-counts for axles counted out and an axle counter evaluator according to the invention is characterized in that the axle counter evaluator is adapted to generate first train patterns and second train patterns by determining for each in-count and for each out-count a distance parameter, wherein the first train patterns are sequences of the distance parameters of the in-counts and the second train patterns are sequences of the distance parameters of the out-counts. With such an axle counter, errors in counting the axles can advantageously be detected and corrected by comparing train patterns. The axle counter can be used to determine whether a track section is occupied or vacant without having to use additional devices to check the counting of the axles.

[0025] The inventive axle counter is adapted for carrying out the afore described method.

[0026] A first embodiment of the axle counter is characterized in that the axle counter evaluator is adapted to compare first and corresponding second train patterns, to detect deviations between the first and second pattern, and to evaluate whether a detected deviation between the first and the second pattern is based on a miscount by using the determined distance parameters. While with the axle counter systems according to the state of the art, it has to be proved that the probability of miscounts by the system is below 10^{-9}, the inventive axle counter enables a reliable track vacancy detection without the need to fulfil this requirement. Thus, a simplified and cost efficient track vacancy detection is enabled.

[0027] An improvement of this embodiment of the axle counter is characterized in that the axle counter evaluator is adapted to recognize a detected deviation as being based on a miscount, if a sub-sequence of at least a predetermined number of distance parameters of the first train pattern complies with a sub-sequence of the corresponding second train pattern. By comparing only selected distance parameters, the verification of deviations can be accelerated.

[0028] A further improvement of the aforementioned embodiment of the axle counter is characterized in that the axle counter evaluator is adapted to recognize a detected deviation as being based on a miscount if the distance between the first in-count and the last in-count is equal to the distance between the first out-count and the last out-count. The distance between the first in-count and the last in-count corresponds to the length of the train, as does the distance between the first out-count and the last out-count. Therefore, they have to be equal. This results in a particularly stable and fast check of a possible deviation of the first and second train pattern.

[0029] A preferred embodiment of the axle counter is characterized in that the axle counter evaluator is adapted to logically correct a pattern for which a deviation based on a miscount was detected. In particular, the axle counter is adapted to correct the pattern automatically, so that the axle counting procedure is accelerated. Missing distance parameters relating to axles that were erroneously not counted can be added by the axle counter.

[0030] Another preferred embodiment is characterized in that the axle counter evaluator is adapted to store the corrected pattern if applicable.

[0031] In particular, the storage takes place in an Axle Counter Evaluator (ACE). Preferably, the train patterns are stored until the train has left the track section and the track section receives the status "free". The stored pattern can also be used for later comparison with patterns of trains having the same distribution of axles to determine possible sources of error in case of deviations between train patterns.

[0032] Further advantages of the invention can be derived from the description and the drawings. Also, the above-mentioned and the still further described features can be used according to the invention individually or in any combination. The embodiments shown and described are not to be understood as a conclusive list, but rather have an exemplary character for the description of the invention.

Brief description of the drawings

[0033]

Fig. 1 schematically shows a system for evaluating the occupancy status of a track section with an axle counter.

Fig. 2 schematically shows a train with associated parameters for determining a train pattern at a first detection point.

Fig. 3 schematically shows a train with associated parameters for determining a train pattern at a second detection point.

Fig. 4 schematically shows a method for evaluating the occupancy status of the track section.

Fig. 5 shows a flow diagram with the steps for identifying and correcting a miscount.

Detailed description of the drawings

[0034] **Fig. 1** schematically shows a system **1** for evaluating the occupancy status of a track section **2** with an axle counter **3,** which has a first detection point **4a** and a second detection point **4b.** The first and second detection points 4a, 4b delimit the track section 2. The axle counter 3 is designed to count the axles **5a, 5b, 5c, 5d, 5e, 5f** of a train **6,** which passes the first detection point 4a for entering track section 2 and then the second detection point 4b for leaving the track section 2 while moving in a direction **D.** The axle counter 3 generates in-counts for axles 5a - 5f passing the first detection point 4a and out-counts for axles 5a - 5f passing the second detection point 4b. An axle counter evaluator **7** of the axle counter 3 is designed to generate a first and a second train pattern **8a, 8b** based on the detected axles. The first train pattern 8a comprises a list **P1** of distance parameters, denoted S_1, S_2, S_3, S_4, S_5 in the figure. Here, the distance parameters indicate the distances S_1 - S_5 between adjacent axles 5a - 5f determined when the train 6 passes the first detection point 4a as the train 6 enters the track section 2 (cf. Fig. 2). The second train pattern 8b comprises a list **P2** of distance parameters, denoted S'_1, S'_2, S'_3, S'_4 in the figure. Here, the distance parameters indicate the distances S'_1 - S'_4 between axles 5a - 5f determined when the train 6 passes the second detection point 4b when leaving the track section 2 (cf. Fig. 3).

[0035] In order to determine the distance parameters, the times at which the axles 5a - 5f pass the detection points 4a and 4b are stamped with time stamps (cf. Fig. 2 and Fig. 3).

[0036] **Fig. 2** schematically shows the train 6 with associated parameters for determining the train pattern 8a (see Fig. 1) at the first detection point 4a. To evaluate the distance parameters of the first list, the axle counter 3 determines the points in time t_1, t_2, t_3, t_4, t_5, t_6 at which the axles 5a - 5f pass the first detection point 4a. The speed of the train 6 at the respective points in time t_1, t_2, t_3, t_4, t_5, t_6 can be extracted by the sensor/detection point 4a, 4b. The evaluation unit 7 of the axle counter 3 determines the distance parameters S_1 - S_5, which form the first train pattern 8a in the guise of a list.

[0037] **Fig. 3** schematically shows the train 6 with associated parameters for determining the train pattern 8b (see Fig. 1) at the second detection point 4b. The axle counter 3 (see Fig. 1) determines the points in time T_1, T_2, T_3, T_4, T_5 at which the axles 5a - 5f pass the second detection point 4b. On the basis of the times T_1 - T_5 and the speed of the train at the respective points in time, the evaluation unit 7 of the axle counter 3 determines the distance parameters S'_1 - S'_4, which form the second train pattern 8b in the guise of a list.

[0038] In the case shown in Fig. 3, the second axle 5e as seen from the front end of the train is erroneously not counted. Therefore, the distance parameter S'_1 is equal to the sum of the distance parameters S_1 and S_2 determined at the first detection point 4a. The second train pattern 8b in the form of the list (S'_1, S'_2, S'_3, S'_4) is shorter by one entry than the first train pattern 8a in the form of the list (S_1, S_2, S_3, S_4, S_5). The distance parameters S'_2, S'_3, S'_4 have the same value as the corresponding parameters S_3, S_4, S_5 determined at the first detection point 4a.

[0039] **Fig. 4** schematically shows a method **100** for evaluating the occupancy of a track section 2 by a train 6 using at least one axle counter 3 with a first detection point 4a and a second detection point 4b (see figure 1). The first and second detection points 4a, 4b delimit a track section 2. In a first step **101,** in-counts are generated for counted-in axles 5a - 5f of a train 6 passing the first detection point 4a, and out-counts are generated for counted-out axles 5a - 5f of the train 6 passing the second detection point 4b. In a second step **102,** a first train pattern 8a and a second train pattern 8b are generated by determining distance parameters S_1, S_2, S_3, S_4, S_5 between counted axles 5a - 5f at the first detection point 5a and distance parameters S'_1, S'_2, S'_3, S'_4 between counted axles 5a - 5f at the second detection point 4b. In a third step **103,** the first train pattern 8a is compared with the second train pattern 8b. In a fourth step **104,** it is checked whether the first pattern 8a matches the second pattern 8b. This check can be performed, for example, by comparing the distance parameters S_1 - S_5 and S'_1 - S'_4 at the same list positions in the first train pattern 8a and the second train pattern 8b. Alternatively or additionally, it can be verified, for example, that the distance between the first axle 5f and the last axle 5a passing the first detection point 4a is the same as the distance between the first axle 5f and the last axle 5a passing the second detection point 4b, since these distances both represent the train length.

[0040] In a fifth step **105a, 105b** if a match of the patterns 8a, 8b is determined the track section 2 is classified as free.

[0041] If a mismatch of the patterns is detected, in a first variant of the method according to the invention, in a step 105b the track section 2 is classified as occupied. In an improved variant of the method according to the invention, in the event of a mismatch, it is determined whether there is a miscount (i.e. an axles has not been counted by one of the sensors) and, if so, at which sensor. If a miscount is determined the track section 2 is classified as free. Preferably, the miscounting sensor and the position of the missing count within the pattern is identified. In particular, the incorrect pattern can be corrected by adding the missing count to the respective pattern and adapting the corresponding distance parameters S_1 - S_5 and/or S'_1 - S'_4.

[0042] If a mismatch is detected that is not based on such a miscount, the track section 2 is classified as in step **105b** of the fifth step.

[0043] If $S'_n = S_n$ for all indices n the pattern match.

[0044] If $S'_n + S_n$ a mismatch is detected.

[0045] A miscount within a mismatch can be detected by comparing the distance parameters of both patterns according to **Fig. 5.**

[0046] If a mismatch of the n-th distance parameters is detected, the n+2-th distance parameter of the first detection point 4a and the n+1-th distance parameter of the second detection point 4b are compared.

[0047] If S_{n+2} = S'_{n+1} it can be assumed that the n-th or the n+1-st axle has not been counted by the second detection point.

[0048] In the next step, it is checked if S'_n corresponds to $S_n + S_{n+1}$.

[0049] If $S_n + S_{n+1} = S'_n$ the n+1-th axle was obviously not counted.

[0050] Based on this information, it can be determined that the second pattern is incorrect.

[0051] In order to correct the second pattern, the distance parameters S'_n is replaced by the distance parameters S_n and S_{n+1} derived from the other detection point 4a, i.e. S'_n -> $(S')^*_n = S_n$ and$(S')^*_{n+1} = S_{n+1}$;. The further distance parameters (S'_{n+i} with i≥2, i.e. S'_{n+2}, S'_{n+3} ...) are controlled the same way. If they are determined to be correct, the further distance parameters are corrected by incrementing the position index of each of these distance parameters by one:

$$S'_{n+2} \text{->} (S')^*_{n+3}\ .$$

[0052] The second pattern P2 of Fig. 1 with the distance parameters S'_1 - S'_4 shown in Fig. 3 is thus corrected as follows:

$$P2\ (S'_1, S'_2, S'_3, S'_4) \text{->} P^*2\ (S_1, S_2, S'_2, S'_3, S'_4)$$

[0053] If $S_n + S_{n+1} \neq S'_n$, the track section the track section is assumed to be occupied.

[0054] After checking the n-th distance parameter of one of the two train patterns and, if necessary, correcting the n-th distance parameter according to the procedure described above, the (n+1)-th distance parameter following the n-th distance parameter in this train pattern is verified according to the procedure described above and, if necessary, corrected. By successively checking all the distance parameters of one of the train patterns according to the above-described procedure, mismatches between the train patterns are eliminated so that matching train patterns are obtained.

List of reference signs

[0055]

1	System for evaluating occupancy of a track section
2	track section
3	axle counter
4a, 4b	detection points
5a - 5f	axles
6	train
7	axle counter evaluator
8a	first train pattern (list P1 of distance parameters of the first train pattern)
8b	second train pattern (list P2 of distance parameters of the second train pattern)
D	direction of movement of the train

List of cited documents

[0056]

[01] https://en.wikipedia.org/wiki/Axle_counter

Claims

1. Method (100) for evaluating occupancy of a **track section** (2) using at least one **axle counter** (3) with a **first detection point** (4a) and a **second detection point** (4b), the first and second detection points (4a, 4b) limiting the track section (2), wherein **axles** (5a - 5f) of a **train** (6) passing the first detection point (4a) are detected by generating **in-counts** and **axles** (5a - 5f) of the **train** (6) passing the second detection point (4b) and are detected by generating **out-counts;**
characterized in
that the method (100) comprises the following method steps:

   a. acquisition of a **first train pattern** (8a) and a **second train pattern** (8b) by determining for each in-count and for each out-count a distance parameter (S_1 - S_5, S'_1 - S'_4), wherein the first train pattern (8a) is a list (P1) of first **distance parameters** (S_1 - S_5) of the in-counts indicating the distances (S_1 - S_5) between the axles (5a - 5f) counted by the first detection point (4a) and the second train pattern (8b) is a list (P2) of second distance parameters (S'_1 - S'_4) of the out-counts indicating the distances (S'_1 - S'_4) between the axles (5a - 5f) counted by the second detection point (4b);
   b. comparing the first train pattern (8a) with the second train pattern (8b);
   c. evaluating that the track section (2) is clear
   if the first pattern (8a) complies with the second pattern (8b) or
   if a **deviation** between the first pattern (8a) and the second pattern (8b) is detected, but is found to be based on a **miscount** by using the determined distance parameters (S_1 - S_5, S'_1 - S'_4).

2. Method according to claim 1 **characterized in that** a deviation is detected if the number of distance parameters (S_1 - S_5, S'_1- S'_4) of the first train pattern (8a) differs from that of the second train pattern (8b).

3. Method according to claim 2, **characterized in that** the deviation is found to be based on a miscount if a sub-sequence of at least a predetermined number of distance parameters (S_1 - S_5) of the first train pattern (8a) complies with a sub-sequence of the second train pattern (8b).

4. Method according to claim 2, **characterized in that** the deviation is found to be based on a miscount if the distance between the first in-count and the last in-count is equal to the distance between the first out-count and the last out-count.

5. Method according to any one of the preceding claims, **characterized in that** in case a deviation between the first pattern (8a) and the second pattern (8b) is detected but is found to be based on a miscount, the pattern (8b) comprising the miscount is corrected, in particular by adding the missing count (S2) and correcting the corresponding distance parameters (S'_1-S'_4).

6. Method according to any one of the preceding claims, **characterized in that** for determining the distance parameter a time stamp is assigned to each in-count and out-count and the distance parameter (S_1 - S_5, S'_1 - S'_4) is determined using the time stamps and the speed of the train at the respective point in time (t_1 - t_6,T_1 - T_5).

7. Method according to any one of the claims 1 to 6, **characterized in that** the distance parameters are the distances (S_1, S_2,..., S_n) of neighboring axles.

8. Method according to any one of the claims 1 to 6, **characterized in that** the distance parameters are the ratios (S_1/S_2, S_2/S_3,..., S_{n-1}/S_n) between distances (S_1 - S_5) of neighboring axles (5a - 5f) and distances between subsequent neighboring axles (5a - 5f).

9. Axle counter (3) comprising detection points (4a, 4b) adapted to generate in-counts for axles (5a - 5f) counted in and out-counts for axles (5a - 5f) counted out and an axle counter evaluator (7),
characterized in
that the axle counter evaluator (7) is adapted to generate first train patterns (8a) and second train patterns (8b) by determining for each in-count and for each out-count a distance parameter (S_1 - S_5, S'_1 - S'_4), wherein the first train patterns (8a) are sequences of the distance parameters (S_1 - S_5) of the in-counts and the second train patterns (8b) are sequences of the distance parameters (S'_1 - S'_4) of the out-counts.

10. Axle counter according to claim 9 **characterized in**

that the axle counter evaluator (7) is adapted
to compare first and corresponding second train patterns (8a, 8b),
to detect deviations between the first and second pattern (8a, 8b), and
to evaluate whether a detected deviation between the first and the second pattern (8a, 8b) is based on a miscount by using the determined distance parameters (S_1 - S_5, S'_1 - S'_4).

11. Axle counter according to claim 10, **characterized in that** the axle counter evaluator (7) is adapted to recognize a detected deviation as being based on a miscount, if a sub-sequence of at least a predetermined number of distance parameters (S_1 - S_5, S'_1 - S'_4) of the first train pattern (8a) complies with a sub-sequence of the corresponding second train pattern (8b).

12. Axle counter according to claim 10, **characterized in that** the axle counter evaluator (7) is adapted to recognize a detected deviation as being based on a miscount if the distance between the first in-count and the last in-count is equal to the distance between the first out-count and the last out-count.

13. Axle counter according to any one of the claims 10 to 12, **characterized in that** the axle counter evaluator (7) is adapted to logically correct a pattern (8a, 8b) for which a deviation based on a miscount was detected.

14. Axle counter according to any one of the claims 10 to 13, **characterized in that** the axle counter evaluator is adapted to store the corrected pattern (8a, 8b) if applicable.

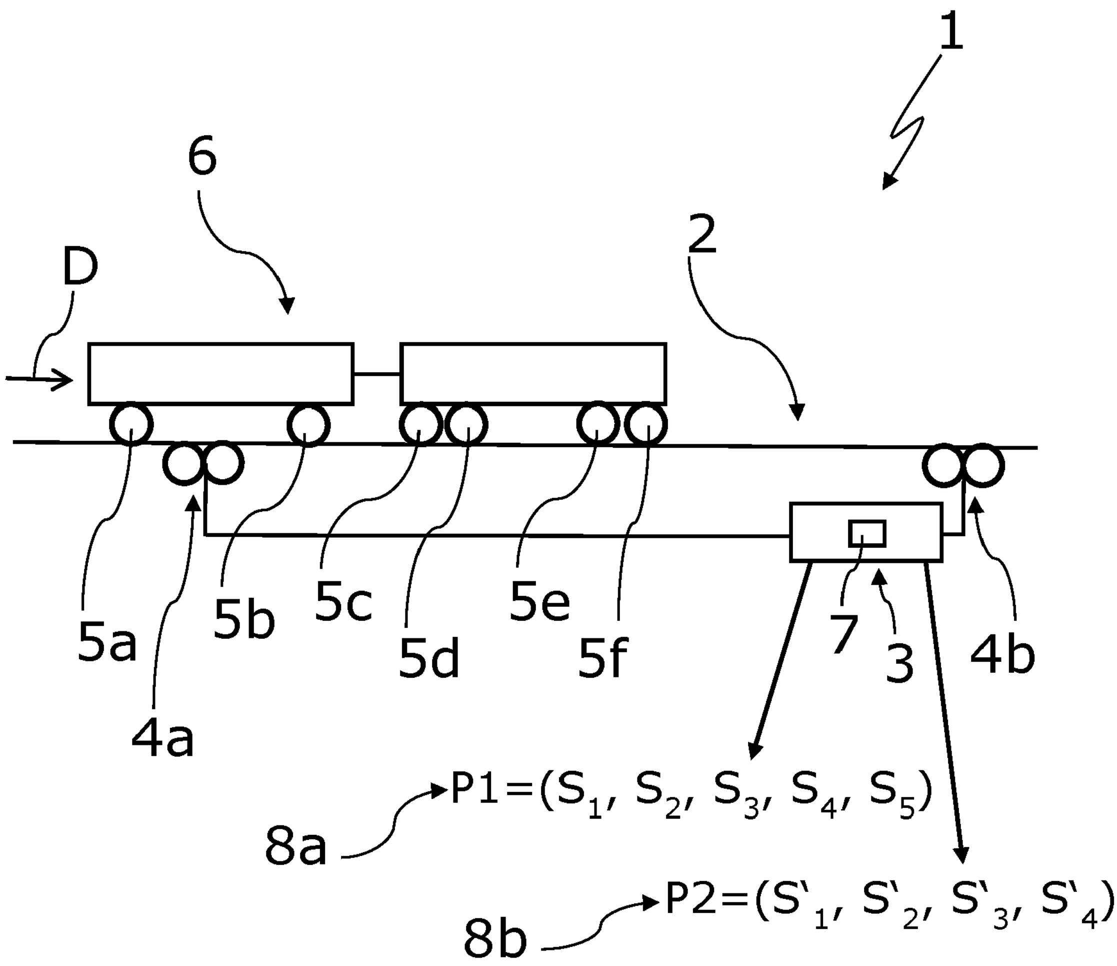

Fig. 1

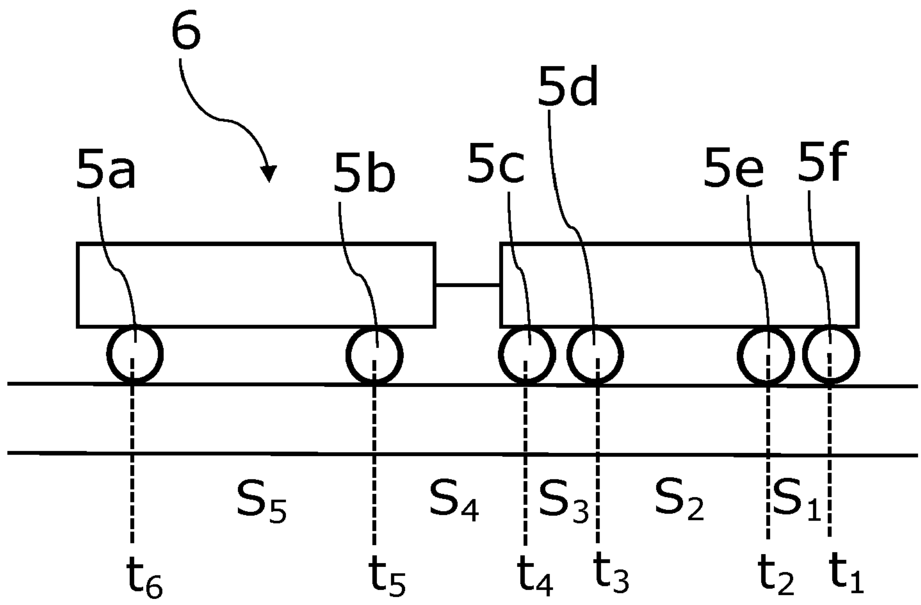
6
5a
5b
5c
5d
5e
5f
S_5 S_4 S_3 S_2 S_1
t_6 t_5 t_4 t_3 t_2 t_1

Fig. 2

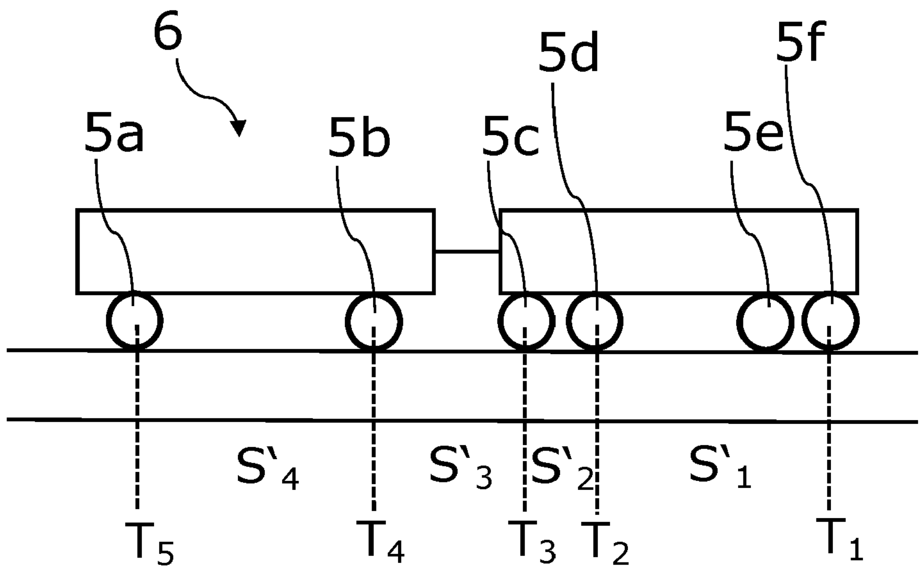
6
5a
5b
5c
5d
5e
5f
$S`_4$ $S`_3$ $S`_2$ $S`_1$
T_5 T_4 T_3 T_2 T_1

Fig. 3

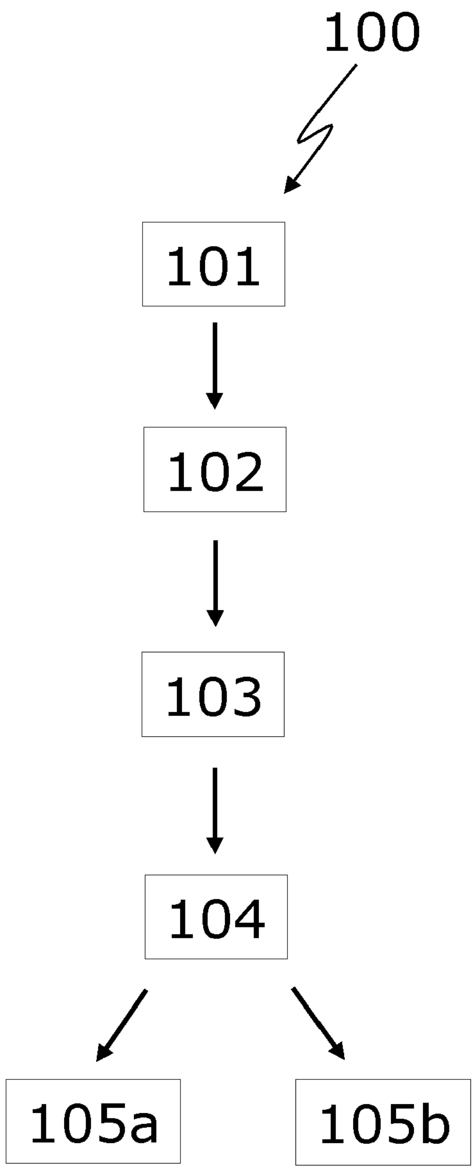

Fig. 4

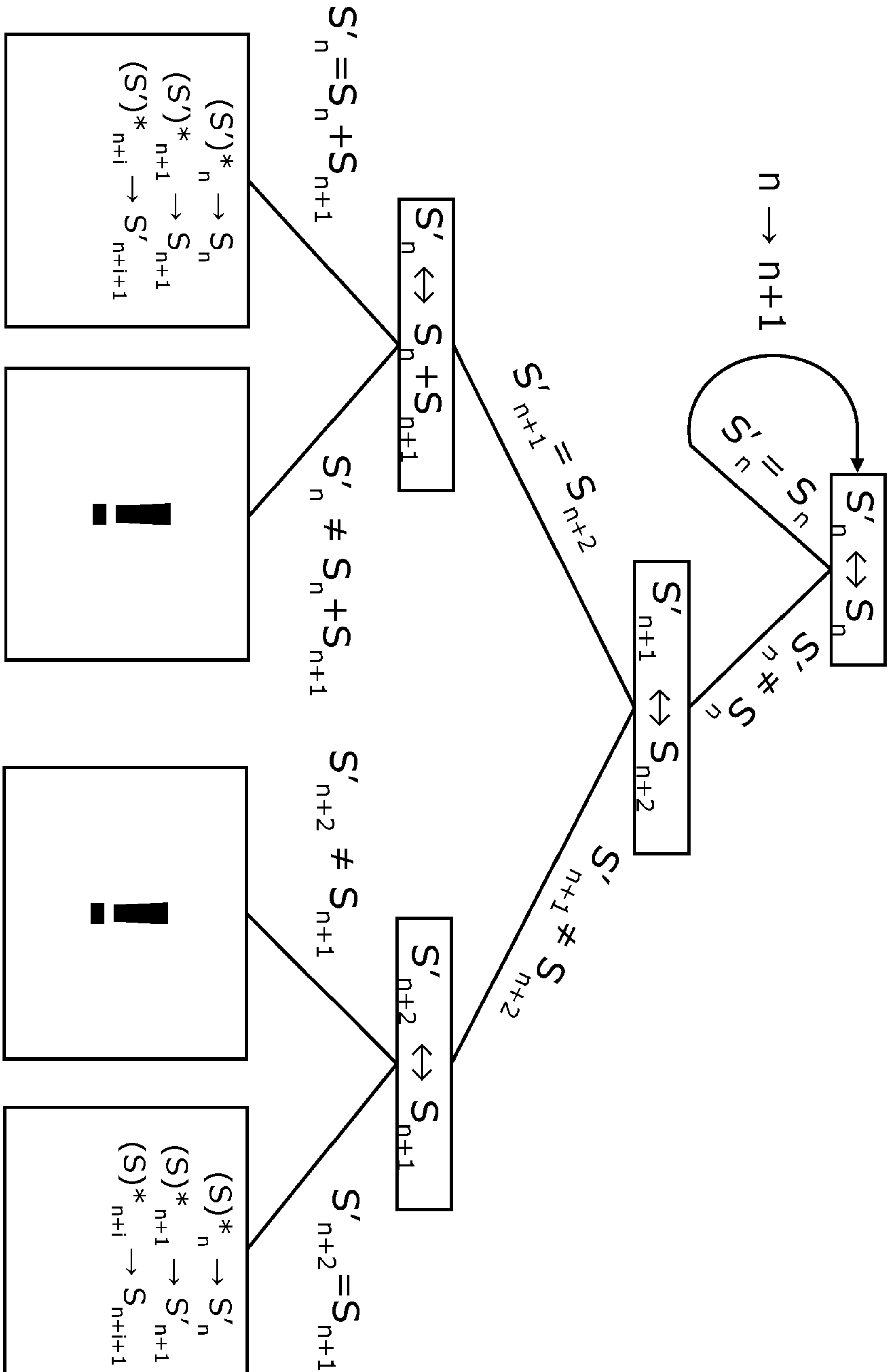
n → n+1
S'n ⇔ Sn
S'n = Sn
S'n ≠ Sn
S'n+1 ⇔ Sn+2
S'n+1 = Sn+2
S'n+1 ≠ Sn+2
S'n ⇔ Sn+Sn+1
S'n=Sn+Sn+1
S'n ≠ Sn+Sn+1
(S')*n → Sn
(S')*n+1 → Sn+1
(S')*n+i → S'n+i+1
!
S'n+2 ⇔ Sn+1
S'n+2 ≠ Sn+1
S'n+2=Sn+1
(S)*n → S'n
(S)*n+1 → S'n+1
(S)*n+i → Sn+i+1
!

Fig. 5

EUROPEAN SEARCH REPORT

Application Number
EP 22 20 3327

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 32 01 293 A1 (STANDARD ELEKTRIK LORENZ AG [DE]) 11 August 1983 (1983-08-11) * figures 1 and 2; page 5, line 23 - page 6, line 9; page 7, lines 5 - 18; page 8, lines 3 - 20; page 10, lines 7 - 19; and page 12, lines 1 - 25 * -----	1-14	INV. B61L1/16

TECHNICAL FIELDS SEARCHED (IPC)

B61L

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	20 March 2023	Plützer, Stefan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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The members are as contained in the European Patent Office EDP file on
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20-03-2023

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