



(11) **EP 3 239 016 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
20.02.2019 Bulletin 2019/08

(51) Int Cl.:
B61J 3/06 ^(2006.01)

(21) Application number: **17000645.6**

(22) Date of filing: **14.04.2017**

(54) **SYSTEM FOR PUSHING OR RETAINING A TRAIN ON STEEP SLOPES**

SYSTEM ZUM SCHIEBEN ODER HALTEN EINES ZUGS AUF STEILEN GEFÄLLEN

SYSTÈME PERMETTANT DE POUSSER OU DE RETENIR UN TRAIN SUR LES PENTES RAIDES

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
ME

(30) Priority: **26.04.2016 SI 201600120**

(43) Date of publication of application:
01.11.2017 Bulletin 2017/44

(73) Proprietors:
• **Duhovnik, Joz**
1215 Medvode (SI)
• **Mozina, Janez**
4240 Radovljica (SI)

(72) Inventors:
• **Duhovnik, Joz**
1215 Medvode (SI)
• **Mozina, Janez**
4240 Radovljica (SI)

(74) Representative: **Macek, Gregor**
ITEM d.o.o.
Resljeva 16
1000 Ljubljana (SI)

(56) References cited:
CN-Y- 2 505 356 DE-A1- 3 244 017
DE-C- 467 048 US-A- 1 125 110

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Description

[0001] The object of the invention is a system and a method for pushing or retaining a train on the steep slopes of a railway line by using a haulage cable and a push/retain assist vehicle.

It is a known fact that the adhesion forces of locomotives prevent train compositions from overcoming steep slopes. This is why railways have long lines that make it possible to overcome substantial differences in altitude. Slopes, i.e. inclinations, on conventional railway lines reach up to 25 ‰, most commonly up to 17 ‰. Today, rack railways are used for slopes up to 140 ‰ for passenger railway connections, while freight traffic does not go beyond 79 ‰. It is understandable that steeper slopes require a more powerful pulling force and this is normally achieved by including two locomotives. The need for a pulling force is considerably increased on steep slopes and this is why slopes not exceeding 17 ‰ are normally used for the railway lines of passenger trains. In the case of steep slopes locomotives having a larger pulling force are used, for instance, a locomotive having a pulling force of 800 k N, which is used for slopes up to 40 ‰.

For surmounting steeper slopes a rack railway may be used. It exceeds the force for overcoming resistances and gravity by a huge rack, usually with parallel teeth in order to better overcome the load by postponing the splitting.

There are also known solutions for pulling train compositions using a steel cable for transports up to 8 km. Such solutions are frequently used in cities or local transport at an airport.

Known solutions for reducing the length of railway lines and consequently increasing the slopes are carried out by using additional locomotives or by an extra increase in friction, which is achieved by spreading rocks or steel shavings or by pushing or retaining with additional pull assist vehicles that transfer the force through a toothed profile.

[0002] All the prior used systems are limited to low-weight transport, especially to passenger trains. Yet none of the known systems has been used for the huge masses of train compositions and slopes that exceed the slopes known in conventional railway lines by more than three times.

The best-known solution of pulling and retaining with a steel cable is used in San Francisco, where the use of a steel cable is justified due to steep slopes of up to 200 ‰. The loads are relatively small since the weight of the assist vehicles and the passengers is relatively small.

In DE patent No. 3244017 a system for pulling a train over a steep slope with the assist vehicle is disclosed, wherein the train, i.e. the wagons with or without locomotive, is coupled to the assist vehicle by specially designed holding devices (22, 23) and after pulling the train and overcoming the steep slope, the train is decoupled from the assist vehicle. The system is using a pulling system with one axis which is not suitable for train com-

positions of huge masses since the weight of the assist vehicle should be equal to the weight of the locomotive. The task of the invention is a system for pushing or retaining a train that will allow a simple, rapid and reliable driving of a heavy train on a railway line with a steep slope, where differences in height of 300 to 500 m are to be overcome and the length of the railway line will not have to be extended in a spiral loop or by other shapes of curvature.

[0003] According to the invention, the task is solved by a system according to claim 1. The system allows a continuous drive of a train and the related drive of an assist vehicle by coupling the assist vehicle at the rear side, whereby in the upper section the assist vehicle is automatically disconnected and the train composition drives on without stopping or braking the train composition. The invention will be described by way of drawings, in which:

Figure 1: shows the cross-section of a system according to the invention with the assist vehicle, Figure 2: shows an elevation of the system according to the invention with the assist vehicle.

The system for pushing or retaining a train on a track with a steeper slope consists of a special railroad switch 1 made of four successive parts, of which two are fixed, connected into a whole, which form a straight line for undisturbed motion of a train composition 5 of conventional dimensions for a certain speed of the train. The system makes it possible such that a curved or a straight transport line of a railway line may be transformed into a completely straight line of a railway line 2 up to the highest elevation point in that after the train composition 5 with its last wagon has completely reached the straight line of the railway line 2, a push/retain assist vehicle 3 comes from the rear side via a special railroad switch 1, and the push/retain assist vehicle 3 moving with a speed corresponding to that of the train comes into contact with the last wagon of the train composition 5 and ensures a transfer of forces up to planned values, and then the push/retain assist vehicle 3 starts pushing or retaining the train composition 5 with all the force ensured by a steel cable 4 transferred to the push/retain assist vehicle 3 by direct contact with the last wagon of the train composition 5. At optimal speed, the pulling force of the locomotive of the train composition 5 is exploited to the maximum and together with the pulling and/or retaining force of the push/retain assist vehicle 3 provides the necessary force to overcome the rolling and all other resistances and the slope component of the weight of the entire train composition 5 until reaching the highest point of the railway line, where the railway line is designed with a slope suitable for a locomotive with all its characteristics. When reaching the upper section of the railway line, the locomotive of the train composition 5 starts accelerating, while the push/retain assist vehicle 3 brakes by directly converting mechanical energy into electrical energy.

[0004] A mechanical and electronic system 6 super-

vises and controls the ascending and descending of the train composition 5. The push/retain assist vehicle 3 is fastened to the steel cable 4 in the upper position and starts accelerating in front of the train composition 5 while descending in a way that the locomotive of the descending train composition 5 reduces the speed and that the essential part of the necessary braking energy is taken over by the push/retain assist vehicle 3 which then takes over all the braking energy during descending and translates it to the force of the steel cables 4 which are connected through huge drive wheels with the engine-generator of the system 6 in such a way as to allow conversion of the mechanical energy to electrical energy. The push/retain assist vehicle 3 in the lower section then moves away from the locomotive of the train composition 5 by increasing the speed in order to reach the railway switch 1 considerably earlier and to move away from the line of the railway tracks, thus making it possible for the special railway switch 1, after the push/retain assist vehicle 3 has passed it, to assume a position, i.e. to switch the railway switch 1 into a position in which the train composition 5 can drive through the railway switch to a normal railway line and to ensure free access for a new train composition for hill climbing.

[0005] The system of the invention consists of a low-slope railway line with a train composition 5 and of a short railway line parallel thereto with a push/retain assist vehicle 3, both lines being connected by a railway switch 1. The joined line starts from the railway switch 1 along the length of the train composition 5 with a low slope and then passes to a steep slope. The route line of the push/retain assist vehicle 3 is a straight line 2 without any turns throughout the entire length. The push/retain assist vehicle 3 is fastened to the pull cable 4 between the rails of the railway line 2. On the upper section, the railway line passes from a steep slope to the line of a low slope; an engine-generator of the system 6 is arranged at this transition and has a bullwheel for the pulling cable 4.

[0006] The system for pushing or retaining a train consists of known devices and elements that are used in railroad traffic. By using all the accompanying devices and elements, the system provides for an uninterrupted drive of a train composition from takeover at the entry point at the lower section to discharge the train formation to a conventional railway network at the upper section.

Claims

1. A system for pushing or retaining a train on steep slopes of a railway line, the system comprising a haulage cable and an assist-vehicle, **characterized in that** the system is formed of a railway line of a low slope, i.e. with an inclination up to 25 %, for a train composition (5) and of a railway line for a push/retain assist vehicle (3), wherein said railway line is parallel to the railway line of the low slope, both said railway

lines are connected by a railway switch (1) and form one strait joined railway line; the joined railway line starts from the railway switch (1) with a low slope, and then passes to a steep slope, i.e. with an inclination that exceeds the slopes known in conventional railway lines by more than three times, on its upper section, said joined railway line passes at a transition from the steep slope to a joined railway line of a low slope, wherein the route of the push/retain assist vehicle (3) is a straight railway line (2) throughout its entire length; the push/retain assist vehicle (3) is fastened to a pull cable (4); the system further comprising an engine-generator (6) that is arranged at the transition and has a bullwheel for the pulling cable (4), and regulators.

2. A method for a system according to claim 1 for pushing or retaining a train on steep slopes of a railway line by using a haulage cable and an assist-vehicle, **characterized in that**, after the train composition (5) with its last wagon in hill climbing has completely passed the railroad switch (1) and reached the straight joined railway line, a push/retain assist vehicle (3) moving with a speed corresponding to a speed of the train composition (5) comes via the railroad switch (1) in contact with the last wagon of the train composition (5), and then the push/retain assist vehicle (3) starts pushing with all the force ensured by the cable (4) transferred to the push/retain assist vehicle (3) by direct contact of the push/retain assist vehicle (3) with the last wagon of the train composition (5), such that the pulling force of the locomotive of the train composition (5) is exploited to the maximum and together with the pulling force of the push/retain assist vehicle (3) provides the necessary force to overcome the rolling resistance and all other resistances and the slope component of the weight of the entire train composition (5) until reaching the upper section of the joined railway line, and when reaching the upper section of the joined railway line, the train composition (5) starts accelerating, while the push/retain assist vehicle (3) stops, wherein when the train composition (5) is descending the push/retain assist vehicle (3) starts accelerating in front of the train composition (5) to come in contact with the locomotive thus the essential part of the necessary braking energy is taken over by the push/retain assist vehicle (3) which translates said braking energy during descending to the force of the pull cables (4) which are connected through bullwheel with the engine-generator (6) of the system in such a way as to enable conversion of the mechanical energy to electrical energy.
3. A method for a system according to claim 1 for pushing or retaining a train on steep slopes of a railway line by using a haulage cable and a push/retain assist vehicle, **characterized in that** when the train com-

position (5) is descending on the joined railway line of the steep slope, the push/retain assist vehicle (3) in the lower section of the joined railway line moves away from the train composition (5) by increasing the speed with regard to the speed of the train composition (5) in order to reach the railway switch (1) earlier and to move away from the joined railway line, thus making it possible for the railway switch (1), after the push/retain assist vehicle (3) has passed it, to switch into position in which the train composition can drive through the railway switch (1) to the railway line and to ensure free access for a new train composition for hill climbing.

Patentansprüche

1. System zum Schieben oder Halten eines Zuges auf steilen Gefällen einer Eisenbahnstrecke, wobei das System ein Zugseil und ein Hilfsfahrzeug umfasst, **dadurch gekennzeichnet, dass** das System aus einer Schienenstrecke mit niedrigem Gefälle, d. h. mit einer Neigung bis zu 25‰, für eine Zuggarnitur (5) und aus einer Eisenbahnstrecke für ein Schub-/Halte-Hilfsfahrzeug (3) besteht, wobei die Eisenbahnstrecke parallel zur Schienenstrecke mit dem niedrigen Gefälle verläuft, wobei die beiden Schienenstrecken über eine Weiche (1) verbunden sind und eine gerade verbundene Bahnschiene bilden; die verbundene Bahnschiene beginnt an der Weiche (1) mit dem geringen Gefälle und geht dann in ein steiles Gefälle über, d. h. mit einer Neigung, die die bei herkömmlichen Eisenbahnstrecken bekannten Gefälle um mehr als das Dreifache übersteigt, an ihrem oberen Abschnitt geht die verbundene Eisenbahnstrecke an einem Übergang von steilen Gefälle in eine verbundene Eisenbahnstrecke mit geringem Gefälle über, wobei der Weg des Schub-/Halte-Hilfsfahrzeugs (3) über seine gesamte Länge eine gerade Bahnstrecke (2) ist; das Zug-/Halte-Hilfsfahrzeug (3) ist an einem Zugseil (4) befestigt; das System umfasst weiterhin einen Motorgenerator (6), der am Übergang angeordnet ist und eine Seilbremse für das Zugseil (4) aufweist, sowie Reglern.
2. Verfahren für das System nach Anspruch 1 zum Schieben oder Halten eines Zuges auf steilen Gefällen einer Eisenbahnstrecke unter Verwendung eines Zugseils und eines Hilfsfahrzeugs, **dadurch gekennzeichnet, dass**, nachdem die Zuggarnitur (5) mit ihrem letzten Waggon beim Bergauffahren die Weiche (1) vollständig passiert hat und die gerade verbundene Eisenbahnstrecke erreicht hat, ein Schub-/Halte-Hilfsfahrzeug (3), das sich mit einer Geschwindigkeit, die der Geschwindigkeit der Zuggarnitur (5) entspricht, bewegt, über die Weiche (1) in Kontakt mit dem letzten Waggon der Zuggarnitur

(5) kommt, woraufhin das Schub-/Halte-Hilfsfahrzeug (3) mit der gesamten, durch das Seil (4) gewährleisteten Kraft das Schub-/Halte-Hilfsfahrzeug (3) durch direkten Kontakt des Schub-/Halte-Hilfsfahrzeugs (3) mit dem letzten Waggon der Zuggarnitur (5) anschiebt, so dass die Zugkraft der Lokomotive der Zuggarnitur (5) maximal ausgenutzt wird und zusammen mit der Zugkraft des Schub-/Halte-Hilfsfahrzeugs (3) die notwendige Kraft zur Überwindung des Rollwiderstandes und aller anderen Widerstände und des Steigungsanteils des Gewichts der gesamten Zuggarnitur (5), bis zum Erreichen des oberen Abschnitts der verbundenen Eisenbahnstrecke zur Verfügung stellt, und beim Erreichen des oberen Abschnitts der verbundenen Eisenbahnstrecke die Zugzusammensetzung (5) zu beschleunigen beginnt, während das Schub-/Halte-Hilfsfahrzeug (3) stoppt, wobei, wenn die Zuggarnitur (5) hinabfährt, das Schub-/Halte-Hilfsfahrzeug (3) vor der Zuggarnitur (5) beschleunigt, um mit der Lokomotive in Kontakt zu kommen, so dass der wesentliche Teil der notwendigen Bremsenergie von dem Schub-/Halte-Hilfsfahrzeug (3) übernommen wird, welche die Bremsenergie während der Abfahrt auf die Kraft der Zugseile (4) überträgt, die durch das Bremsseil mit dem Motorgenerator (6) des Systems derart verbunden sind, dass eine Umwandlung der mechanischen Energie in elektrische Energie ermöglicht wird.

3. Verfahren für das System nach Anspruch 1 zum Schieben oder Halten eines Zuges auf steilen Gefällen einer Eisenbahnstrecke unter Verwendung eines Zugseils und eines Hilfsfahrzeugs, **dadurch gekennzeichnet, dass**, nachdem die Zuggarnitur (5) auf der verbundenen Eisenbahnstrecke mit starkem Gefälle herabfährt, sich das Schub-/Halte-Hilfsfahrzeug (3) im unteren Abschnitt der verbundenen Eisenbahnstrecke von der Zuggarnitur wegbewegt, sodass es die Geschwindigkeit in Bezug auf die Geschwindigkeit der Zuggarnitur (5) beschleunigt, um die Weiche (1) eher zu erreichen und sich von der verbundenen Eisenbahnstrecke weg zu bewegen, so dass die Weiche (1), nachdem das Schub-/Halte-Hilfsfahrzeug (3) sie passiert hat, in eine Position umschalten kann, in der die Zuggarnitur die Weiche (1) bis zur Eisenbahnstrecke durchfahren kann und den freien Zugang für eine andere Zuggarnitur für eine Berganfahrt gewährleistet.

Revendications

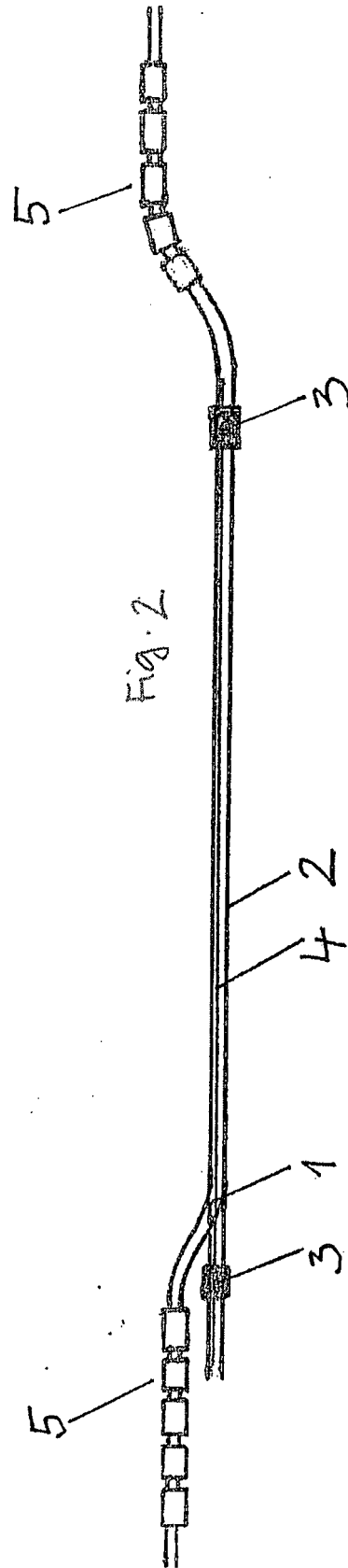
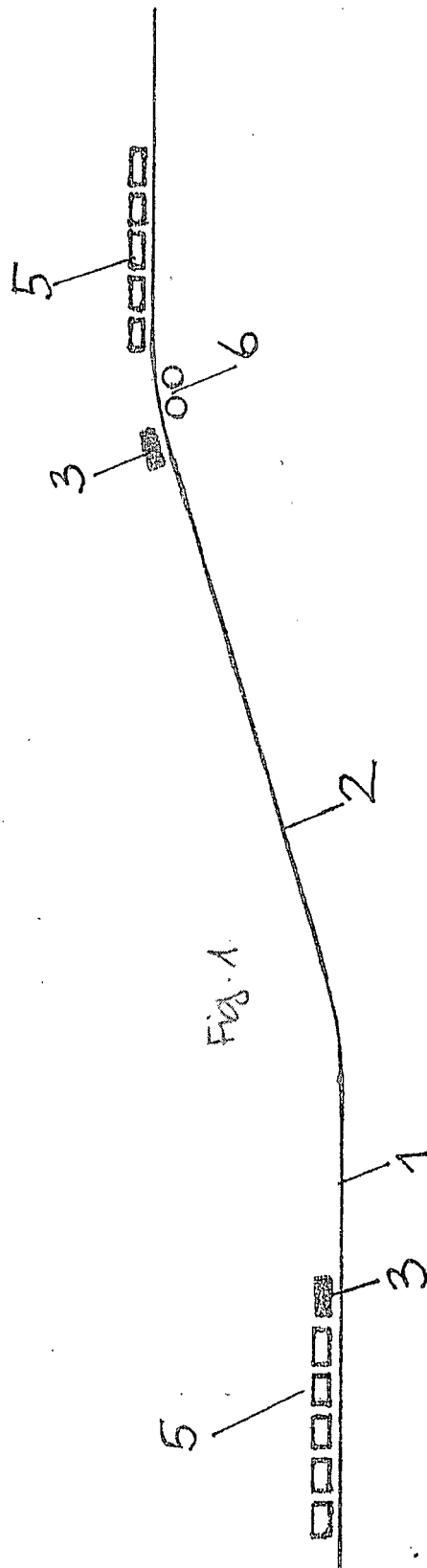
1. Système permettant de pousser ou de retenir un train sur des pentes raides d'une ligne de chemin de fer, le système comprenant un câble de traction et un véhicule d'assistance, **caractérisé en ce que** le système est formé d'une ligne de chemin de fer de

faible pente, c'est-à-dire avec une inclinaison allant jusqu'à 25 %, pour une composition de train (5) et d'une ligne de chemin de fer pour un véhicule d'assistance de poussée/retenue (3), ladite ligne de chemin de fer étant parallèle à la ligne de chemin de fer de faible pente, lesdites lignes de chemin de fer étant reliées entre elles par un aiguillage (1) et formant une ligne de chemin de fer reliée droite ; la ligne de chemin de fer reliée commence à partir de l'aiguillage (1) par une faible pente, puis passe à une pente raide, c'est-à-dire à une inclinaison qui dépasse de plus de trois fois les pentes connues dans les lignes de chemin de fer classiques, sur sa section supérieure, ladite ligne de chemin de fer reliée passe au niveau d'une transition de la pente raide à une ligne de chemin de fer reliée de faible pente, la ligne du véhicule d'assistance de poussée/retenue (3) étant une ligne de chemin de fer droite (2) sur toute sa longueur ; le véhicule d'assistance de poussée/retenue (3) est fixé à un câble de traction (4) ; le système comprenant en outre un moteur-générateur (6) qui est disposé au niveau de la transition et comporte une roue motrice pour le câble de traction (4), et des régulateurs.

2. Procédé pour un système selon la revendication 1 permettant de pousser ou de retenir un train sur les pentes raides d'une ligne de chemin de fer à l'aide d'un câble de traction et d'un véhicule d'assistance, **caractérisé en ce que**, après que la composition de train (5) ayant son dernier wagon en position de montée a complètement passé l'aiguillage (1) et a atteint la ligne de chemin de fer reliée droite, un véhicule d'assistance de poussée/retenue (3) se déplaçant à une vitesse correspondant à la vitesse de la composition de train (5) arrive via l'aiguillage (1) à entrer en contact avec le dernier wagon de la composition de train (5), puis le véhicule d'assistance de poussée/retenue (3) commence à pousser avec l'ensemble de la force fournie par le câble (4) transférée au véhicule d'assistance de poussée/retenue (3) par contact direct du véhicule d'assistance de poussée/retenue (3) avec le dernier wagon de la composition de train (5), de telle sorte que la force de traction de la locomotive de la composition de train (5) soit exploitée au maximum et fournisse conjointement avec la force de traction du véhicule d'assistance de poussée/retenue (3) la force nécessaire pour surmonter la résistance au roulement et toutes les autres résistances ainsi que la composante de pente du poids de la composition de train entière (5) jusqu'à atteindre la section supérieure de la ligne de chemin de fer reliée, et lorsqu'elle atteint la section supérieure de la ligne de chemin de fer reliée, la composition de train (5) commence à accélérer, tandis que le véhicule d'assistance de poussée/retenue (3) s'arrête, lorsque la composition de train (5) descend, le véhicule d'assistance de poussée/retenue

(3) commence à accélérer à l'avant de la composition de train (5) pour venir en contact avec la locomotive, la partie essentielle de l'énergie de freinage nécessaire étant absorbée par le véhicule d'assistance de poussée/retenue (3) qui transmet ladite énergie de freinage pendant la descente à la force des câbles de traction (4) qui sont reliés par l'intermédiaire d'une roue motrice au moteur-générateur (6) du système de manière à permettre la conversion de l'énergie mécanique en énergie électrique.

3. Procédé pour un système selon la revendication 1 permettant de pousser ou de retenir un train sur des pentes raides de ligne de chemin de fer à l'aide d'un câble de traction et d'un véhicule d'assistance de poussée/retenue, **caractérisé en ce que**, lorsque la composition de train (5) descendant sur la ligne de chemin de fer reliée de la pente raide, le véhicule d'assistance de poussée/retenue (3) se déplace, dans la section inférieure de la ligne de chemin de fer reliée, dans le sens opposé à la composition de train (5) en augmentant la vitesse par rapport à la vitesse de la composition de train (5) pour atteindre l'aiguillage (1) plus tôt et s'éloigner de la ligne de chemin de fer reliée, ce qui permet à l'aiguillage (1), après que le véhicule d'assistance de poussée/retenue (3) a traversé celui-ci, de passer dans une position dans laquelle la composition de train peut être entraînée à travers l'aiguillage (1) vers la ligne de chemin de fer et garantir un accès libre à une nouvelle composition de train pour monter la côte.



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 3244017 A [0002]