

BRAKING RELIEF CONTROL METHOD AND DEVICE

[0001] The present application claims priority to Chinese Patent Application No.201910916326.1, titled "BRAKING RELIEF CONTROL METHOD AND DEVICE",
5 filed on September 26, 2019 with the Chinese Patent Office, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the technical field of air braking, and in particular to
10 a method and a device for controlling braking release.

BACKGROUND

[0003] With the development of air braking technology, the technology for controlling braking release of a vehicle is constantly improved.

15 [0004] Braking release is a process of weakening or eliminating braking. According to the conventional technology, a large braking release rate (that is, braking force reduced in unit time) is set for a vehicle operating in an automatic driving mode to reduce response time of the vehicle and improve control speed of the vehicle.

[0005] However, in a case that a vehicle automatically starts on a ramp, the vehicle cannot
20 generate sufficient traction force in time after obtaining a braking release command due to the large braking release rate, resulting in the vehicle rolling. Therefore, the process of starting on a ramp of the vehicle is completely controlled by a driver.

SUMMARY

25 [0006] In view of the above problems, a method and a device for controlling braking release are provided according to the present disclosure to overcome the above problems or at least partially solve the problems. The technical solutions are as follows.

[0007] A braking release control method includes:

receiving a braking release command, and obtaining a driving parameter of a vehicle;

determining whether the driving parameter meets at least one predetermined requirement, and determining a current braking release manner as a slow braking release manner base on the braking release command in a case that the driving parameter meets the at least one preset requirement; and

5 controlling, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner, where a reduction rate in the first reduction manner is lower than a predetermined rate.

[0008] In an embodiment, the receiving a braking release command and obtaining a driving parameter of a vehicle includes: receiving the braking release command and obtaining the driving parameter of the vehicle in a case that the vehicle operates in an automatic driving mode.

[0009] In an embodiment, the driving parameter includes: a road gradient and/or a driving speed.

[0010] In an embodiment, in a case that the driving parameter includes the road gradient and the driving speed, the predetermined requirement includes that the road gradient is greater than a predetermined gradient threshold or the driving speed is less than a predetermined speed threshold.

[0011] In an embodiment, the controlling, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner includes:

obtaining a value of an initial pressure of the brake cylinder in the slow braking release manner, where the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism of the vehicle at a current time instant;

determining values of pressures of the brake cylinder at multiple time instants of driving the vehicle after the current time instant based on a predetermined brake cylinder pressure reduction equation and the value of the initial pressure of the brake cylinder; and

controlling the independent brake controller to move to a position corresponding to a pressure of the brake cylinder at each of the multiple time instants of driving the vehicle after the current time instant.

[0012] In an embodiment, the predetermined brake cylinder pressure reduction equation is

expressed as:

$$P_0 = P_1 - n * T * P_m / t$$

where P_0 represents a target pressure of the brake cylinder after the current time, P_1 represents the initial pressure of the brake cylinder, n represents the number of operation periods of a braking system control program, T represents an operation period of the braking system control program, P_m represents a maximum normal pressure of the brake cylinder, t represents a predetermined time parameter for controlling a release rate, and a time interval between any two adjacent time instants after the current time instant is equal to T .

[0013] In an embodiment, the method further includes:

determining the current braking release manner as a fast braking release manner based on the braking release command in a case that a current driving state of the vehicle is not a predetermined state; and

controlling, in the fast braking release manner, a braking force of the brake mechanism of the vehicle to be reduced in a predetermined second reduction manner, where a reduction rate in the second reduction manner is greater than the reduction rate in the first reduction manner.

[0014] A device for controlling braking release includes a first obtaining unit, a first manner determination unit and a first pressure control unit. The first obtaining unit is configured to receive a braking release command and obtain a driving parameter of a vehicle. The first manner determination unit is configured to determine whether the driving parameter meets at least one predetermined requirement, and determine a current braking release manner as a slow braking release manner based on the braking release command in a case that the driving parameter meets the at least one preset requirement. The first pressure control unit is configured to control, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner, where a reduction rate in the first reduction manner is lower than a predetermined rate.

[0015] In an embodiment, the first obtaining unit is configured to receive the braking release command and obtain the driving parameter of the vehicle in a case that the vehicle operates in an automatic driving mode.

[0016] In an embodiment, the driving parameter includes a road gradient and/or a driving speed.

[0017] In an embodiment, in a case that the driving parameter includes the road gradient and the driving speed, the predetermined requirement includes that the road gradient is greater than a predetermined gradient threshold or the driving speed is less than a predetermined speed threshold.

[0018] In an embodiment, the first pressure control unit includes an initial pressure obtaining unit, a pressure determination unit and a movement control unit. The initial pressure obtaining unit is configured to obtain a value of an initial pressure of the brake cylinder in the slow braking release manner, where the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism of the vehicle at a current time instant. The pressure determination unit is configured to determine values of pressures of the brake cylinder at multiple time instants of driving the vehicle after the current time instant based on a predetermined brake cylinder pressure reduction equation and the value of the initial pressure of the brake cylinder. The movement control unit is configured to control the independent brake to move to a position corresponding to a pressure of the brake cylinder at each of the multiple time instants of driving the vehicle after the current time instant.

[0019] In an embodiment, the predetermined brake cylinder pressure reduction equation is expressed as:

$$P_0 = P_1 - n * T * P_m / t$$

where P_0 represents a target pressure of the brake cylinder after the current time, P_1 represents the initial pressure of the brake cylinder, n represents the number of operation periods of a braking system control program, T represents an operation period of the braking system control program, P_m represents a maximum normal pressure of the brake cylinder, t represents a predetermined time parameter for controlling a release rate, and a

time interval between any two adjacent time instants after the current time instant is equal to T .

[0020] In an embodiment, the device further includes a second manner determination unit and a second pressure control unit. The second manner determination unit is configured to determine the current braking release manner as a fast braking release manner based on the braking release command in a case that a current driving state of the vehicle is not a predetermined state. The second pressure control unit is configured to control, in the fast braking release manner, a braking force of the brake mechanism of the vehicle to be reduced in a predetermined second reduction manner, where a reduction rate in the second reduction manner is greater than the reduction rate in the first reduction manner.

[0021] A method and a device for controlling braking release are provided according to the present disclosure. According to the present disclosure, a braking release command is received, a driving parameter of a vehicle is obtained, and it is determined whether the driving parameter meets at least one predetermined requirement. In a case that the driving parameter meets the at least one predetermined requirement, a current braking release manner is determined as a slow braking release manner based on the braking release command. In the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle is controlled to be reduced in a predetermined first reduction manner, where a reduction rate in the first reduction manner is lower than a predetermined rate. With the present disclosure, the braking release of the vehicle can be controlled in the slow braking release manner while the vehicle operates in a certain driving state, thus the vehicle has sufficient time to generate enough traction force to overcome starting resistance in the process of braking release, thereby preventing the vehicle from rolling down and reducing impact caused by braking.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] In order to more clearly illustrate technical solutions according to the embodiments of the present disclosure or according to the conventional technology, the drawings to be used in the description of the embodiments or the conventional technology are briefly described below. Apparently, the drawings in the following descriptions show only some embodiments

of the present disclosure, and other drawings may be obtained by those skilled in the art according to the drawings without any creative work.

[0023] Figure 1 is a flow chart of a method for controlling braking release according to an embodiment of the present disclosure;

5 [0024] Figure 2 is a flow chart of a method for controlling braking release according to another embodiment of the present disclosure;

[0025] Figure 3 is a flow chart of a method for controlling braking release according to another embodiment of the present disclosure;

10 [0026] Figure 4 is a schematic structural diagram of a device for controlling braking release according to an embodiment of the present disclosure;

[0027] Figure 5 is a schematic structural diagram of a device for controlling braking release according to another embodiment of the present disclosure; and

[0028] Figure 6 is a schematic structural diagram of a device for controlling braking release according to another embodiment of the present disclosure;

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DETAILED DESCRIPTION

[0029] In order to more clearly describe the objects, technical solutions and advantages of the present disclosure, the present disclosure is described below in conjunction with the drawings and the embodiments. It should be understood that the described embodiments are
20 intend to explain the present disclosure rather than to limit the present disclosure. All other embodiments obtained by those skilled in the art based on the embodiments of the present disclosure without any creative work fall in the scope of protection of the present disclosure.

[0030] As shown in Figure 1, a method for controlling braking release is provided according to an embodiment of the present disclosure. The method may include the following steps S10
25 to S30.

[0031] In step S10, a braking release command is received, and a driving parameter of a vehicle is obtained.

[0032] In an embodiment, the vehicle in the present disclosure may be a locomotive or an engineering vehicle.

[0033] Braking release is a process of weakening or releasing braking. A braking release command is generated when braking of a vehicle is weakened or released. After receiving the braking release command, the vehicle may perform braking release in a braking release manner based on the braking release command.

5 **[0034]** It should be noted that the method according to the present disclosure may be performed while the vehicle operates in an automatic driving mode or a manual driving mode.

[0035] In an embodiment, in the step S10, the braking release command may be received and the driving parameter of the vehicle may be obtained in a case that the vehicle operates in an automatic driving mode.

10 **[0036]** In an embodiment, in the step S10, the braking release command may be received and the driving parameter of the vehicle may be obtained in a case that the vehicle operates in a manual driving mode.

[0037] Specifically, in the case that the vehicle operates in the automatic driving mode, the slow braking release manner according to the present disclosure is added to the control logic
15 of a microcomputer braking control unit in the present disclosure. Thus, in a case that the slow braking release manner according to the present disclosure is triggered in driving the vehicle, the braking release of the vehicle is to be controlled in the slow braking release manner according to the present disclosure; and in a case that the slow braking release manner according to the present disclosure is not triggered in driving the vehicle, an automatic
20 braking release of the vehicle is controlled in a braking release manner according to the conventional technology.

[0038] Specifically, a slow braking release manner switch may be arranged in the vehicle according to the present disclosure. In a case that the switch is turned on, regardless of whether the vehicle operates in the automatic driving mode or in the manual driving mode,
25 the slow braking release manner may be added in the control logic of the microcomputer braking control unit according to the present disclosure. In a case that the switch is turned off and the vehicle operates in the manual driving mode, the microcomputer braking control unit controls the braking release of the vehicle based on manual operations of the driver. In a case that the switch is turned off and the vehicle operates in the automatic driving mode, the
30 microcomputer braking control unit controls the automatic braking release of the vehicle in the braking release manner according to the conventional technology.

[0039] The driving parameter of the vehicle may indicate a driving state of the vehicle and states of devices installed in the vehicle.

[0040] In an embodiment, the driving parameter may include a road gradient and/or a driving speed.

5 **[0041]** The road gradient includes a gradient of a road on which the vehicle is driving uphill and a gradient of a road on which the vehicle is driving downhill.

[0042] The vehicle in driving may measure the road gradient using a gradient sensor, and may measure the driving speed using a speed sensor. It should be noted that the types of the sensors for measuring the road gradient and the driving speed are not limited in the present
10 disclosure.

[0043] Apparently, the driving parameter of the vehicle may further include a resistance parameter, an acceleration parameter and a fuel parameter in driving the vehicle. It should be noted that the type of the driving parameter of the vehicle is not limited in the present disclosure.

15 **[0044]** It should be further noted that, in the step S10, the sequence of receiving the braking release command and obtaining the driving parameter of the vehicle is not limited in the present disclosure. That is, the braking release command may be received first and then the driving parameter of the vehicle is obtained, or the driving parameter of the vehicle is obtained first and then the braking release command is received, or the driving parameter of
20 the vehicle is obtained and the braking release command is received at the same time.

[0045] In step S20, it is determined whether the driving parameter meets at least one predetermined requirement, and a current braking release manner is determined as a slow braking release manner based on the braking release command in a case that the driving parameter meets the at least one predetermined requirement.

25 **[0046]** The slow braking release manner according to the present disclosure is relative to the (fast) braking release manner while the vehicle operates in the automatic operation mode according to the conventional technology.

[0047] It should be noted that according to the conventional technology, in a case that a vehicle operating in the automatic driving mode performs automatic braking in a certain
30 driving state (such as starting on a ramp), the vehicle does not have enough time to generate

traction force reaching a certain value to overcome a force that prevents the vehicle from moving forward, such as gravity, road resistance or a braking force, due to a fast braking release, resulting in a decrease in the speed of the vehicle or even rolling of the vehicle.

[0048] In a case that the driving parameter meets the predetermined requirement, it may be determined that the vehicle currently operates in a certain driving state according to the present disclosure.

[0049] The number of the predetermined requirements set for the vehicle is not limited in the present disclosure. In addition, the predetermined requirement may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

[0050] The driving state may be determined by technicians based on the braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

[0051] In an embodiment, the technicians may first determine a certain driving state, and then determine the type of the driving parameter and the predetermined requirement based on the feature of the certain driving state. For example, in a case that the driving state is a state of starting on a ramp, the gradient of the ramp may be determined as the driving parameter to be obtained, and the predetermined requirement may be determined as that the gradient of the ramp is greater than a predetermined gradient threshold according to the present disclosure.

[0052] Specifically, for a vehicle in the state of starting on a ramp, the braking release of the vehicle may be controlled in the slow braking release manner according to the present disclosure.

[0053] In step S30, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle is controlled to be reduced in a predetermined first reduction manner, where a reduction rate in the first reduction manner is lower than a predetermined rate.

[0054] It should be noted that, in the braking process of the vehicle, air enters into the brake cylinder and the pressure of the brake cylinder increases, then the pressure pushes a piston to move and acts on a brake-shoe via a brake rigging device to control the brake-shoe to press

against a wheel; and in the braking release process of the vehicle, the air in the brake cylinder is discharged and the pressure of the brake cylinder decreases, a braking release spring pushes the piston back to an original position, and the brake-shoe leaves the wheel.

[0055] The pressure of the brake cylinder is positively correlated with a braking force outputted by the brake mechanism. That is, the braking force outputted by the brake mechanism decreases with the decrease of the pressure of the brake cylinder, thus the braking is relieved; and the braking force outputted by the brake mechanism increases with the increase of the pressure of the brake cylinder, thus the vehicle is braked or the braking is strengthened.

[0056] The reduction rate in the first reduction manner is equal to a difference between pressures of the brake cylinder at two adjacent time instants in unit time. For example, the pressure of the brake cylinder in the brake mechanism at a current time instant is 1000Pa, the pressure of the brake cylinder at a next time instant is reduced to 900Pa, then the reduction rate is equal to a value obtained by dividing the difference (that is, 100Pa) of 1000Pa and 900Pa by a time interval between the two adjacent time instants.

[0057] The first reduction manner may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

[0058] The predetermined rate may be determined by the technicians according to the actual situation, which is not limited in the present disclosure.

[0059] In an embodiment, the reduction rate in the present disclosure may be changed.

[0060] Specifically, a relationship between the reduction rate and the driving parameter may be established according to the present disclosure, thus the reduction rate may change with the type or value of the driving parameter, and the vehicle may obtain a better or optimum reduction rate in the certain driving state. The establishment of the relationship and the relationship are not limited in the present disclosure.

[0061] Apparently, the reduction rate in the present disclosure may be a constant, that is, the reduction rate is a constant for a driving parameter having any type and value, thereby simplifying the control logic.

[0062] Specifically, the software code for implementing the first reduction manner may be

included in the microcomputer braking control unit of the vehicle according to the present disclosure, so that the braking release may be performed in a certain state in the slow braking release manner according to the present disclosure.

[0063] In practices, a road gradient and a driving speed may be used as the driving parameter for determining whether the vehicle is in the state of starting on a ramp. That is, the driving parameter obtained in step S10 includes a road gradient and a driving speed. In addition, a road gradient threshold and a driving speed threshold are predetermined, and the predetermined requirement is configured to include that the road gradient obtained in step S10 is greater than the predetermined road gradient threshold and the driving speed obtained in step S10 is greater than the predetermined speed threshold.

[0064] Specifically, in a case that the vehicle operates in the automatic driving mode and the driving parameter meets the predetermined requirement, it may be determined that a current driving state of the vehicle is a state of automatically starting on a ramp according to the present disclosure. Thus, after a braking release command is received, the pressure of the brake cylinder may be controlled in the slow braking release manner to be reduced in the first reduction manner according to the present disclosure. That is, the pressure of the brake cylinder is reduced at the reduction rate in the first reduction manner. Therefore, the vehicle has sufficient time to generate enough traction force to overcome starting resistance in the process of braking release, preventing the vehicle from rolling down and reducing impact caused by braking.

[0065] Alternatively, it may be determined whether the vehicle operates in the automatic driving mode and whether the driving parameter meets a predetermined requirement (corresponding to the driving state of automatically starting on a ramp) after the vehicle receives the braking release command. The sequence of determining whether the vehicle operates in the automatic driving mode and receiving the braking release command in step S10 is not limited in the present disclosure.

[0066] Apparently, in a case that the vehicle operates in the manual driving mode and the slow braking release manner switch is turned on, the braking release of the vehicle may be controlled in the slow braking release manner in the vehicle starting on a ramp, and then the vehicle completes starting on the ramp.

[0067] In the method for controlling braking release according to the embodiments, a

braking release command is received, a driving parameter of a vehicle is obtained, and it is determined whether the driving parameter meets at least one predetermined requirement. In a case that the driving parameter meets the at least one predetermined requirement, a current braking release manner is determined as a slow braking release manner based on the braking release command. In the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle is controlled to be reduced in a predetermined first reduction manner. A reduction rate in the first reduction manner is lower than a predetermined rate. With the method, the braking release of the vehicle can be controlled in the slow braking release manner while the vehicle operates in a certain driving state, thus the vehicle has sufficient time to generate enough traction force to overcome starting resistance in the process of braking release, thereby preventing the vehicle from rolling down and reducing impact caused by braking.

[0068] Based on steps shown in Figure 1, a method for controlling braking release is provided according to another embodiment. In the method, in a case that the driving parameter includes the road gradient and the driving speed, the predetermined requirement may include that the road gradient is greater than a predetermined gradient threshold or the driving speed is less than a predetermined speed threshold.

[0069] It should be noted that in a case that the vehicle operates on a road having a gradient greater than a certain value, if the braking is relieved quickly by the vehicle, the vehicle does not have sufficient time to generate enough traction force, resulting in the vehicle rolling down (for example, while the vehicle is in the state of starting on a ramp, a state of driving uphill, or a state of driving downhill). Moreover, the vehicle may be damaged due to the impact force caused by the braking release at a large rate.

[0070] It should be noted that in a case that the vehicle operates at a driving speed less than the predetermined speed threshold, if the braking is relieved quickly by the vehicle, the vehicle does not have sufficient time to generate enough traction force, resulting in the vehicle rolling down (for example, while the vehicle is in the state of starting on a ramp or a state of driving uphill). In a case that the vehicle operates in a low constant speed driving state (a driving state in the automatic driving mode), adverse effects, such as large impact force due to braking release and a large constant speed error, may be caused by the large braking release rate.

[0071] Specifically, the slow braking release manner may be included in the automatic driving mode of the vehicle according to the present disclosure. In a case that the vehicle operates in the automatic driving mode, if the road gradient or the driving speed meets the predetermined requirement, the braking release of the vehicle may be controlled in the slow braking release manner according to the present disclosure; and if the road gradient and the driving speed do not meet the predetermined requirement, the automatic braking release of the vehicle may be controlled based on a fast braking release manner according to the conventional technology.

[0072] Specifically, the slow braking release manner may be included in the manual driving mode of the vehicle according to the present disclosure. In a case that the slow braking release manner switch is turned on, if the road gradient or the driving speed meets the predetermined requirement, the braking release of the vehicle may be controlled in the slow braking release manner; and if the road gradient and the driving speed do not meet the predetermined requirement, the braking release of the vehicle is controlled based on manual operations by the driver.

[0073] The predetermined gradient threshold and the predetermined speed threshold may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which are not limited in the present disclosure.

[0074] In the method for controlling braking release according to the embodiments, the braking release of the vehicle is controlled in the slow braking release manner in a case that the vehicle operates on a road having a gradient greater than the predetermined gradient threshold or the vehicle operates at a driving speed less than the predetermined speed threshold, preventing the vehicle in driving from rolling and being impacted by a large impact force caused by braking, and reducing the adverse effects due to the speed error.

[0075] Based on the steps shown in Figure 1, a method for controlling braking release is provided according to another embodiment. As shown in Figure 2, the step S30 may include the following sub steps S31 to S33.

[0076] In sub step S31, a value of an initial pressure of the brake cylinder is obtained in the slow braking release manner, where the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism of the vehicle at a current

time instant.

[0077] The independent brake controller controls the pressure of the brake cylinder by using an independent control valve to control the braking and the braking release of the vehicle, which is independent of the braking and the braking release of other parts of the vehicle.

5 [0078] In sub step S32, values of pressures of the brake cylinder at multiple time instants of driving the vehicle after the current time instant are determined based on a predetermined brake cylinder pressure reduction equation and the value of the initial pressure of the brake cylinder.

10 [0079] The brake cylinder pressure reduction equation may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

[0080] In sub step S33, the independent brake controller is controlled to move to a position corresponding to a pressure of the brake cylinder at each of the multiple time instants of driving the vehicle after the current time instant.

15 [0081] In an embodiment, the predetermined brake cylinder pressure reduction equation is expressed as:

$$P_0 = P_1 - n * T * P_m / t$$

where P_0 represents a target pressure of the brake cylinder after the current time, P_1 represents the initial pressure of the brake cylinder, n represents the number of operation
20 periods of a braking system control program, T represents an operation period of the braking system control program, P_m represents a maximum normal pressure of the brake cylinder, t represents a predetermined time parameter for controlling a release rate, and a time interval between any two adjacent time instants after the current time instant is equal to T .

25 [0082] In the present disclosure, the braking release rate P_m / t of the vehicle is changed by changing t . t may be determined by technicians based on braking-related standards

and requirements, braking performance of vehicles, actual braking requirements, and the like. The technicians may configure t to range from 15 seconds to 20 seconds. It should be noted that the value of t is not limited in the present disclosure.

[0083] It should be noted that in the conventional braking release manner, that is, in the fast braking release manner, the technicians may control the pressure of the brake cylinder based on the brake cylinder pressure reduction equation. Specifically, the technicians may configure t to range from 2 seconds to 4 seconds.

[0084] With the slow braking release manner based on the brake cylinder pressure reduction equation, each time the braking system control program is executed, the pressure of the brake cylinder of the vehicle is reduced by $T * P_m / t$. The pressure of the brake cylinder of the vehicle is reduced by P_m / t per second. The reduction rate is a constant (that is, the reduction rate is a constant for a driving parameter having any type and value, thereby simplifying the control logic). For example, if P_m is equal to 300kN and t is equal to 15s, the reduction rate based on the brake cylinder pressure reduction equation is equal to 20kN/s.

[0085] T is determined based on the computing performance of the braking system control program, which is not limited in the present disclosure.

[0086] According to the method for controlling braking release according to the embodiments, the slow braking release manner is performed based on the predetermined brake cylinder pressure reduction equation, and the reduction rate in the first reduction manner is a constant, thereby simplifying the control logic in performing the slow braking release manner.

[0087] Based on the steps shown in Figure 1, a method for controlling braking release is provided according to another embodiment. As shown in Figure 3, the method further includes the following steps S41 and S42.

[0088] In step S41, a current braking release manner is determined as a fast braking release manner based on the braking release command in a case that a current driving state of the

vehicle is not a predetermined state.

[0089] The driving state of the vehicle may be indicated by the driving parameter obtained in step S10. For example, the driving state of the vehicle includes a driving speed and a road gradient.

5 **[0090]** The predetermined state may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like. For example, the predetermined state may be a state of driving on a road having a gradient greater than a certain gradient or a state of driving at a driving speed lower than a certain speed, which is not limited in the present disclosure.

10 **[0091]** Specifically, in a case that the vehicle operates in the automatic driving mode and the driving parameter does not meet the predetermined requirement, it may be determined that the current driving state of the vehicle is not the predetermined state according to the present disclosure.

15 **[0092]** It should be noted that the automatic braking release of the vehicle is controlled in the fast braking release manner according to the conventional technology, and the fast braking release manner is relative to the slow braking release manner in the present disclosure.

[0093] In step S42, in the fast braking release manner, a braking force of the brake mechanism of the vehicle is controlled to be reduced in a predetermined second reduction manner. A reduction rate in the second reduction manner is greater than the reduction rate in
20 the first reduction manner.

[0094] The reduction rate in the second reduction manner is determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

25 **[0095]** With the method for controlling braking release according to the embodiments, the automatic braking release of the vehicle is controlled in the fast braking release manner in a case that the vehicle operates in a driving state in which it is unnecessary to control the braking release of the vehicle in the slow braking release manner, thereby reducing the adjustment time of the braking control system and improving the control speed of the braking control system.

30 **[0096]** Corresponding to the steps shown in Figure 1, as shown in Figure 4, a device for

controlling braking release is provided according to an embodiment of the present disclosure. The device includes a first obtaining unit 100, a first manner determination unit 200 and a first pressure control unit 300.

5 [0097] The first obtaining unit 100 is configured to receive a braking release command and obtain a driving parameter of a vehicle.

[0098] In an embodiment, the vehicle in the present disclosure may be a locomotive or an engineering vehicle.

10 [0099] Braking release is a process of weakening or releasing braking. A braking release command is generated when braking of the vehicle is weakened or released. After receiving the braking release command, the vehicle may perform braking release in a braking release manner based on the braking release command.

[0100] It should be noted that the method according to the present disclosure may be performed while the vehicle operates in an automatic driving mode or a manual driving mode.

15 [0101] In an embodiment, the first obtaining unit 100 may be configured to receive the braking release command and obtain the driving parameter of the vehicle in a case that the vehicle operates in an automatic driving mode.

[0102] In an embodiment, the first obtaining unit 100 may be further configured to receive the braking release command and obtain the driving parameter of the vehicle in a case that the vehicle operates in a manual driving mode.

20 [0103] Specifically, in the case that the vehicle operates in the automatic driving mode, the slow braking release manner according to the present disclosure is added to the control logic of a microcomputer braking control unit in the present disclosure. Thus, in a case that the slow braking release manner according to the present disclosure is triggered in driving the vehicle, the braking release of the vehicle is controlled in the slow braking release manner according to the present disclosure; and in a case that the slow braking release manner according to the present disclosure is not triggered in driving the vehicle, an automatic braking release of the vehicle is controlled in a braking release manner according to the conventional technology.

25 [0104] Specifically, a slow braking release manner switch may be arranged in the vehicle according to the present disclosure. In a case that the switch is turned on, regardless of

whether the vehicle operates in the automatic driving mode or in the manual driving mode, the slow braking release manner may be added in the control logic of the microcomputer braking control unit according to the present disclosure. In a case that the switch is turned off and the vehicle operates in the manual driving mode, the microcomputer braking control unit controls the braking release of the vehicle based on manual operations of the driver. In a case that the switch is turned off and the vehicle operates in the automatic driving mode, the microcomputer braking control unit controls the automatic braking release of the vehicle in the braking release manner according to the conventional technology.

[0105] The driving parameter of the vehicle may indicate a driving state of the vehicle and states of devices installed in the vehicle.

[0106] In an embodiment, the driving parameter may include a road gradient and/or a driving speed.

[0107] The road gradient includes a gradient of a road on which the vehicle is driving uphill and a gradient of a road on which the vehicle is driving downhill.

[0108] The vehicle in driving may measure the road gradient using a gradient sensor, and may measure the driving speed using a speed sensor. It should be noted that the types of the sensors for measuring the road gradient and the driving speed are not limited in the present disclosure.

[0109] Apparently, the driving parameter of the vehicle may further include a resistance parameter, an acceleration parameter and a fuel parameter in driving the vehicle. It should be noted that the type of the driving parameter of the vehicle is not limited in the present disclosure.

[0110] It should be further noted that, the sequence of receiving the braking release command and obtaining the driving parameter of the vehicle is not limited in the present disclosure. That is, the braking release command may be received first and then the driving parameter of the vehicle is obtained, or the driving parameter of the vehicle is obtained first and then the braking release command is received, or the driving parameter of the vehicle is obtained and the braking release command is received at the same time.

[0111] The first manner determination unit 200 is configured to determine whether the driving parameter meets at least one predetermined requirement, and determine a current

braking release manner as a slow braking release manner based on the braking release command in a case that the driving parameter meets the at least one predetermined requirement.

5 [0112] The slow braking release manner according to the present disclosure is relative to the (fast) braking release manner while the vehicle operates in the automatic operation mode according to the conventional technology.

10 [0113] It should be noted that according to the conventional technology, in a case that a vehicle operating in the automatic driving mode performs automatic braking in a certain driving state (such as starting on a ramp), the vehicle does not have enough time to generate traction force reaching a certain value to overcome a force that prevents the vehicle from moving forward, such as gravity, road resistance or a braking force, due to a fast braking release, resulting in a decrease in the speed of the vehicle or even rolling of the vehicle.

15 [0114] In a case that the driving parameter meets the predetermined requirement, it may be determined that the vehicle currently operates in a certain driving state according to the present disclosure.

20 [0115] The number of the predetermined requirements set for the vehicle is not limited in the present disclosure. In addition, the predetermined requirement may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

[0116] The certain driving state may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

25 [0117] In an embodiment, the technicians may first determine a certain driving state, and then determine the type of the driving parameter and the predetermined requirement based on the feature of the certain driving state.

[0118] Specifically, for a vehicle in the state of starting on a ramp, the braking release of the vehicle may be controlled in the slow braking release manner according to the present disclosure.

30 [0119] The first pressure control unit 300 is configured to control, in the slow braking

release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner. A reduction rate in the first reduction manner is lower than a predetermined rate.

5 [0120] It should be noted that, in the braking process of the vehicle, air enters into the brake cylinder and the pressure of the brake cylinder increases, then the pressure pushes a piston to move and then acts on a brake-shoe via a brake rigging device to make the brake-shoe to press against a wheel; and in the braking release of the vehicle, the air in the brake cylinder is discharged and the pressure of the brake cylinder decreases, a braking release spring pushes the piston back to an original position, and the brake-shoe leaves the wheel.

10 [0121] The pressure of the brake cylinder is positively correlated with a braking force outputted by the brake mechanism. That is, the braking force outputted by the brake mechanism decreases with the decrease of the pressure of the brake cylinder, thus the braking is relieved; and the braking force outputted by the brake mechanism increases with the increase of the pressure of the brake cylinder, thus the vehicle is braked or the braking is strengthened.

15 [0122] The reduction rate in the first reduction manner is equal to a difference between pressures of the brake cylinder at two adjacent time instants in unit time.

[0123] The first reduction manner may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

20 [0124] The predetermined rate may be determined by the technicians according to the actual situation, which is not limited in the present disclosure.

[0125] In an embodiment, the reduction rate in the present disclosure may be changed.

25 [0126] Specifically, a relationship between the reduction rate and the driving parameter is established according to the present disclosure, thus the reduction rate may change with the type or value of the driving parameter, and the vehicle may obtain a better or optimum reduction rate in the certain driving state. The establishment of the relationship and the relationship are not limited in the present disclosure.

30 [0127] Apparently, the reduction rate in the present disclosure may be a constant, that is, the reduction rate is a constant for a driving parameter having any type and value, thereby

simplifying the control logic.

[0128] Specifically, the software code for implementing the first reduction manner may be included in the microcomputer braking control unit of the vehicle according to the present disclosure, so that the braking release may be performed in a certain state in the slow braking release manner according to the present disclosure.

[0129] In practices, a road gradient and a driving speed may be used as the driving parameter for determining whether the vehicle is in the state of starting on a ramp. That is, the driving parameter obtained by the first obtaining unit 100 includes a road gradient and a driving speed. In addition, a road gradient threshold and a driving speed threshold are predetermined, and the predetermined requirement is configured to include that the road gradient obtained by the first obtaining unit 100 is greater than the predetermined road gradient threshold and the driving speed obtained by the first obtaining unit 100 is greater than the predetermined speed threshold.

[0130] Specifically, in a case that the vehicle operates in the automatic driving mode and the driving parameter meets the predetermined requirement, it may be determined that a current driving state of the vehicle is a state of automatically starting on a ramp according to the present disclosure. Thus, after a braking release command is received, the pressure of the brake cylinder is controlled in the slow braking release manner to be reduced in the first reduction manner according to the present disclosure. That is, the pressure of the brake cylinder is reduced at the reduction rate in the first reduction manner, thus the vehicle has sufficient time to generate enough traction force to overcome starting resistance in the process of braking release, preventing the vehicle from rolling down and reducing impact caused by braking.

[0131] Alternatively, it may be determined whether the vehicle operates in the automatic driving mode and whether the driving parameter meets the predetermined requirement (corresponding to the driving state of automatically starting on a ramp) after the vehicle receives the braking release command. The sequence of determining whether the vehicle operates in the automatic driving mode and obtaining two commands by the first obtaining unit 100 is not limited in the present disclosure.

[0132] Apparently, in a case that the vehicle operates in the manual driving mode and the slow braking release manner switch is turned on, the braking release of the vehicle may be

controlled in the slow braking release manner in the vehicle starting on a ramp, and then the vehicle completes starting on the ramp.

[0133] In the device for controlling braking release according to the embodiments, a braking release command is received, a driving parameter of a vehicle is obtained, and it is determined whether the driving parameter meets at least one predetermined requirement. In a case that the driving parameter meets the at least one predetermined requirement, a current braking release manner is determined as a slow braking release manner based on the braking release command. In the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle is controlled to be reduced in a predetermined first reduction manner. A reduction rate in the first reduction manner is lower than a predetermined rate. With the device, the braking release of the vehicle can be controlled in the slow braking release manner while the vehicle operates in a certain driving state, thus the vehicle has sufficient time to generate enough traction force to overcome starting resistance in the process of braking release, thereby preventing the vehicle from rolling down and reducing impact caused by braking.

[0134] Based on the device shown in Figure 4, a device for controlling braking release is provided according to another embodiment. In the device, in a case that the driving parameter includes the road gradient and the driving speed, the predetermined requirement may include that the road gradient is greater than a predetermined gradient threshold or the driving speed is less than a predetermined speed threshold.

[0135] It should be noted that in a case that the vehicle operates on a road having a gradient greater than a certain value, if the braking is relieved quickly by the vehicle, the vehicle does not have sufficient time to generate enough traction force, resulting in the vehicle rolling down. Moreover, the vehicle may be damaged due to the impact force caused by the braking release at a large rate.

[0136] It should be noted that in a case that the vehicle operates at a driving speed less than the predetermined speed threshold, if the braking is relieved quickly by the vehicle, the vehicle does not have sufficient time to generate enough traction force, resulting in the vehicle rolling down. In a case that the vehicle operates in a low constant speed driving state (a driving state in the automatic driving mode), adverse effects, such as large impact force due to braking release and a large constant speed error, may be caused by the large braking release

rate.

[0137] Specifically, the slow braking release manner may be included in the automatic driving mode of the vehicle according to the present disclosure. In a case that the vehicle operates in the automatic driving mode, if the road gradient or the driving speed meets the predetermined requirement, the braking release of the vehicle may be controlled in the slow braking release manner according to the present disclosure; and if the road gradient and the driving speed do not meet the predetermined requirement, the automatic braking release of the vehicle may be controlled in a fast braking release manner according to the conventional technology.

[0138] Specifically, the slow braking release manner may be included in the manual driving mode of the vehicle according to the present disclosure. In a case that the slow braking release manner switch is turned on, if the road gradient or the driving speed meets the predetermined requirement, the braking release of the vehicle may be controlled in the slow braking release manner; and if the road gradient and the driving speed do not meet the predetermined requirement, the braking release of the vehicle is controlled based on manual operations by the driver.

[0139] The predetermined gradient threshold and the predetermined speed threshold may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which are not limited in the present disclosure.

[0140] In the device for controlling braking release according to the embodiments, the braking release of the vehicle is controlled in the slow braking release manner in a case that the vehicle operates on a road having a gradient greater than the predetermined gradient threshold or the vehicle operates at a driving speed less than the predetermined speed threshold, preventing the vehicle in driving from rolling and being impacted by a large impact force caused by braking, and reducing the adverse effects due to the speed error.

[0141] Based on the device shown in Figure 4, a device for controlling braking release is provided according to another embodiment. As shown in Figure 5, the first pressure control unit 300 may include an initial pressure obtaining unit 301, a pressure determination unit 302 and a movement control unit 303.

[0142] The initial pressure obtaining unit 301 is configured to obtain a value of an initial pressure of the brake cylinder in the slow braking release manner, where the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism of the vehicle at a current time instant.

5 [0143] The independent brake controller controls the pressure of the brake cylinder by using an independent control valve to control the braking and the braking release of the vehicle, which is independent of the braking and the braking release of other parts of the vehicle.

[0144] The pressure determination unit 302 is configured to determine values of pressures of the brake cylinder at multiple time instants of driving the vehicle after the current time instant
10 based on a predetermined brake cylinder pressure reduction equation and the value of the initial pressure of the brake cylinder.

[0145] The brake cylinder pressure reduction equation may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

15 [0146] The movement control unit 303 is configured to control the independent brake to move to a position corresponding to a pressure of the brake cylinder at each of the multiple time instants of driving the vehicle after the current time instant.

[0147] In an embodiment, the predetermined brake cylinder pressure reduction equation is expressed as:

20
$$P_0 = P_1 - n * T * P_m / t$$

where P_0 represents a target pressure of the brake cylinder after the current time, P_1 represents the initial pressure of the brake cylinder, n represents the number of operation periods of a braking system control program, T represents an operation period of the braking system control program, P_m represents a maximum normal pressure of the brake
25 cylinder, t represents a predetermined time parameter for controlling a release rate, and a time interval between any two adjacent time instants after the current time instant is equal to T .

[0148] In the present disclosure, the braking release rate P_m / t of the vehicle is changed by changing t . t may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like. The technicians may configure t to range from 15 seconds to 20 seconds. It should be noted
5 that the value of t is not limited in the present disclosure.

[0149] It should be noted that in the conventional braking release manner, that is, in the fast braking release manner, the technicians may control the pressure of the brake cylinder based on the brake cylinder pressure reduction equation. Specifically, the technicians may configure t to range from 2 seconds to 4 seconds.

10 [0150] With the slow braking release manner based on the brake cylinder pressure reduction equation, each time the braking system control program is executed, the pressure of the brake cylinder of the vehicle is reduced by $T * P_m / t$. The pressure of the brake cylinder of the vehicle is reduced by P_m / t per second, and the reduction rate is a constant (that is, the reduction rate is a constant for a driving parameter having any type and value, thereby
15 simplifying the control logic).

[0151] T is determined based on the computing performance of the braking system control program, which is not limited in the present disclosure.

20 [0152] According to the device for controlling braking release according to the embodiments, the slow braking release manner is performed based on the predetermined brake cylinder pressure reduction equation, and the reduction rate in the first reduction manner is a constant, thereby simplifying the control logic in performing the slow braking release manner.

25 [0153] Based on the device shown in Figure 4, a device for controlling braking release is provided according to another embodiment. As shown in Figure 6, the device further includes a second manner determination unit 401 and a second pressure control unit 402.

[0154] The second manner determination unit 401 is configured to determine a current

braking release manner as a fast braking release manner based on the braking release command in a case that a current driving state of the vehicle is not a predetermined state.

5 [0155] The driving state of the vehicle may be indicated by the driving parameter obtained by the first acquisition unit 100. For example, the driving state of the vehicle includes a driving speed and a road gradient.

[0156] The predetermined state may be determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

10 [0157] Specifically, in a case that the vehicle operates in the automatic driving mode and the driving parameter does not meet the predetermined requirement, it may be determined that the current driving state of the vehicle is not the predetermined state according to the present disclosure.

15 [0158] It should be noted that the automatic braking release of the vehicle is controlled in the fast braking release manner according to the conventional technology, and the fast braking release manner is relative to the slow braking release manner in the present disclosure.

[0159] The second pressure control unit 402 is configured to control, in the fast braking release manner, a braking force of the brake mechanism of the vehicle to be reduced in a predetermined second reduction manner. A reduction rate in the second reduction manner is greater than the reduction rate in the first reduction manner.

20 [0160] The reduction rate in the second reduction manner is determined by technicians based on braking-related standards and requirements, braking performance of vehicles, actual braking requirements, and the like, which is not limited in the present disclosure.

25 [0161] With the device for controlling braking release according to the embodiments, the automatic braking release of the vehicle is controlled in the fast braking release manner in a case that the vehicle operates in a driving state in which it is unnecessary to control the braking release of the vehicle in the slow braking release manner, thereby reducing the adjustment time of the braking control system and improving the control speed of the braking control system.

30 [0162] The terms such as "first", "second", "third", "fourth" and the like (if any) in the description, claims and drawings are only used to distinguish similar objects, rather than

describe a particular or chronological order. It should be understood that data used in the above way may be exchanged in an appropriate case, such that the embodiments of the present disclosure described here can be implemented in an order different from the order shown or described here. In addition, the terms such as "include", "comprise" or any other
5 variants thereof are intended to be non-exclusive. For example, a process, method, system, product or device including a series of steps or elements includes not only the steps or elements but also other steps or elements that are not enumerated, or include other steps or elements inherent for the process, method, system, product or device.

[0163] In addition, technical solutions in the various embodiments may be combined with
10 each other, and the combined technical solution is required to be implemented by those skilled in the art. If the combined technical solution is contradictory or cannot be implemented, it is determined that the combined technical solution does not exist and is not within the protection scope of the present disclosure.

[0164] The above description shows only the preferred embodiment of the present
15 disclosure, and is not intended to limit the protection scope of the present disclosure. Any equivalent structure or equivalent process modification made by using the description and the drawings of the present disclosure, no matter whether it is directly or indirectly used in any other related technical field, should be included in the protection scope of the present disclosure.

CLAIMS

1. A method for controlling braking release, comprising:

receiving a braking release command, and obtaining a driving parameter of a vehicle;

5 determining whether the driving parameter meets at least one predetermined requirement, and determining a current braking release manner as a slow braking release manner based on the braking release command in a case that the driving parameter meets the at least one predetermined requirement; and

controlling, in the slow braking release manner, a pressure of a brake cylinder in a brake
10 mechanism of the vehicle to be reduced in a predetermined first reduction manner, wherein a reduction rate in the first reduction manner is lower than a predetermined rate.

2. The method according to claim 1, wherein the receiving a braking release command and obtaining a driving parameter of a vehicle comprises:

receiving the braking release command and obtaining the driving parameter of the
15 vehicle in a case that the vehicle operates in an automatic driving mode.

3. The method according to claim 1, wherein the driving parameter comprises a road gradient and/or a driving speed.

4. The method according to claim 3, wherein in a case that the driving parameter
comprises the road gradient and the driving speed, the predetermined requirement comprises
20 that the road gradient is greater than a predetermined gradient threshold or the driving speed is less than a predetermined speed threshold.

5. The method according to any one of claims 1 to 4, wherein the controlling, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner comprises:

25 obtaining a value of an initial pressure of the brake cylinder in the slow braking release manner, wherein the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism of the vehicle at a current time instant;

determining values of pressures of the brake cylinder at a plurality of time instants of driving the vehicle after the current time instant based on a predetermined brake cylinder

pressure reduction equation and the value of the initial pressure of the brake cylinder; and

controlling the independent brake controller to move to a position corresponding to a pressure of the brake cylinder at each of the plurality of time instants of driving the vehicle after the current time instant.

- 5 6. The method according to claim 5, wherein the predetermined brake cylinder pressure reduction equation is expressed as:

$$P_0 = P_1 - n * T * P_m / t$$

where P_0 represents a target pressure of the brake cylinder after the current time, P_1 represents the initial pressure of the brake cylinder, n represents the number of operation
10 periods of a braking system control program, T represents an operation period of the braking system control program, P_m represents a maximum normal pressure of the brake cylinder, t represents a predetermined time parameter for controlling a release rate, and a time interval between any two adjacent time instants after the current time instant is equal to T .

- 15 7. The method according to claim 1, further comprising:

determining the current braking release manner as a fast braking release manner based on the braking release command in a case that a current driving state of the vehicle is not a predetermined state; and

controlling, in the fast braking release manner, a braking force of the brake mechanism
20 of the vehicle to be reduced in a predetermined second reduction manner, wherein a reduction rate in the second reduction manner is greater than the reduction rate in the first reduction manner.

8. A device for controlling braking release, comprising a first obtaining unit, a first manner determination unit, and a first pressure control unit, wherein

- 25 the first obtaining unit is configured to receive a braking release command and obtain an driving parameter of a vehicle,

the first manner determination unit is configured to determine whether the driving parameter meets at least one predetermined requirement and determine a current braking release manner as a slow braking release manner based on the braking release command in a case that the driving parameter meets the at least one preset requirement, and

5 the first pressure control unit is configured to control, in the slow braking release manner, a pressure of a brake cylinder in a brake mechanism of the vehicle to be reduced in a predetermined first reduction manner, wherein a reduction rate in the first reduction manner is lower than a predetermined rate.

9. The device according to claim 8, wherein the first pressure control unit comprises an
10 initial pressure obtaining unit, a pressure determination unit, and a movement control unit, wherein

the initial pressure obtaining unit is configured to obtain a value of an initial pressure of the brake cylinder in the slow braking release manner, wherein the initial pressure of the brake cylinder corresponds to a position of an independent brake controller in the brake mechanism
15 of the vehicle at a current time instant,

the pressure determination unit is configured to determine values of pressures of the brake cylinder at a plurality of time instants of driving the vehicle after the current time instant based on a predetermined brake cylinder pressure reduction equation and the value of the initial pressure of the brake cylinder, and

20 the movement control unit is configured to control the independent brake controller to move to a position corresponding to a pressure of the brake cylinder at each of the plurality of time instants of driving the vehicle after the current time instant.

10. The device according to claim 8, further comprising a second manner determination unit and a second pressure control unit, wherein

25 the second manner determination unit is configured to determine the current braking release manner as a fast braking release manner based on the braking release command in a case that a current driving state of the vehicle is not a predetermined state, and

the second pressure control unit is configured to control, in the fast braking release manner, a braking force of the brake mechanism of the vehicle to be reduced in a
30 predetermined second reduction manner, wherein a reduction rate in the second reduction

manner is greater than the reduction rate in the first reduction manner.