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EP-A2- 2 644 433
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Fsg Fernsteurgerate: "Mess-und Sensortechnik Windsensor", , 30. November 2011 (2011-11-30), XP055406414, Gefunden im Internet: URL:https://www.fernsteuergeraete.de/image s/pdfs/Neu_072013/FSG-Windsensor-de_112011 .pdf [gefunden am 2017-09-13]
Thies Clima: "The world of weather data", , 30 September 2014 (2014-09-30), XP055522176, Retrieved from the Internet: URL:https://www.thiesclima.com/db/dnl/THIE S-Katalog-Wind-d-9-2014.pdf [retrieved on 2018-11-08]

Description

The invention relates to a control system and a method for controlling a contact pressing force of a collector shoe of a current collector of a railway vehicle, the collector shoe disposed on a positioning device of the current collector being brought into contact with a contact line by means of said positioning device of the current collector using the contact pressing force, a travelling speed of the railway vehicle being determined by means of a travelling speed measuring means of a measuring device of a control system of the railway vehicle, the contact pressing force being controlled as a function of the travelling speed by means of a control device of the control system, a true wind speed (vW_R) being determined relative to the railway vehicle by means of a wind measuring means of the measuring device, the contact pressing force (F_A) being controlled by means of the control device taking into account the true wind speed (vW_R), and wherein a total wind speed (vW_{ges}) is measured at the positioning device by means of the wind measuring means, the travelling speed (vF) corresponding to a relative wind speed (vW_F), the true wind speed (vW_R) being determined as the difference of the total wind speed (vW_{ges}) and the travelling speed (vF) or the relative wind speed (vW_F).

Such control systems and methods are sufficiently known and are used in railway vehicles having current collectors, in particular trains or the like. Current collectors are typically disposed on a roof of a railway vehicle and comprise a movable positioning device which can be designed as a rocker, a pantograph or a single-arm system. One or more collector shoes are disposed at an upper end of the positioning device, the collector shoes being essentially made of graphite. The positioning device is moved by means of a pneumatic or electric drive, in particular with trains, mainly pneumatic drives being used.

By means of the pneumatic drive, which can have one or more actuators, the collector shoe is pressed against a contact line or a contact wire above the railway vehicle using a contact pressing force. A contact pressing force has to be so high that the collector shoe is not separated or lifted off while the railway vehicle is in motion because this can lead to an undesirable sparkover between the contact line and the collector shoe which, in turn, promotes a rapid wear of the collector shoe or can result in an interruption of travel. Therefore, the contact pressing force of the collector shoe acting on the contact line is always controlled as a function of a travelling speed of the railway vehicle. In this context, the contact pressing force is understood to be a force which acts orthogonally to the longitudinal dimension of the contact line and which is exerted on the contact line by the collector shoe.

Railway vehicles, furthermore, also have a travelling speed measuring means for measuring a travelling speed of the railway vehicle. This travelling speed is used to control the contact pressing force by means of a control device of a control system of the railway vehicle. If the railway vehicle has a pneumatic drive of the positioning device, a pressure of an actuator acting on the positioning device, and with it a contact pressing force of the collector shoe acting on the contact line, can be controlled as a function of the travelling speed by means of a so-called proportional pressure regulator in such a manner that the contact pressing force is increased as the travelling speed increases. This prevents an undesirable detachment of the collector shoe from the contact line, even at high speeds. High speeds are understood to be travelling speeds of > 100 km/h.

However, it is disadvantageous in the known method that, as the travelling speed of the railway vehicle increases, a relative wind acts on the current collector or the collector shoe with a relative wind speed corresponding to the travelling speed and presses the collector shoe, due to aerodynamic effects, against the contact line. I.e. a contact pressing force is increased by a relative wind speed force component as the relative wind speed increases. The higher the contact pressing force of the collector shoe acting on the contact line, the higher, however, is also an abrasion of the collector shoe made of graphite and, thus, its wear. A wear of the collector shoe is increased even more substantially when a railway vehicle or a train travels through a tunnel at high speed. Newer tunnels can be many kilometers long and have a single tunnel tube for only one rail. If a train travels through such a tunnel tube at high speed, air in front of the train is compressed and flows along the train at an increased speed. A wind speed can be increased to such an extent that a total wind speed which is increased by up to 50 % occurs at a constant travelling speed in the tunnel. Collector shoes of trains which travel through long tunnels are, therefore, also subjected to an increased wear.

From EP 2 644 433 A2 a current collector on a vehicle is known by means of which a collector shoe is brought into contact with a contact line. A contact pressing force of the collector shoe acting on the contact line is, in particular, to be controlled by means of a control unit and sensors. So-called sensor means can comprise a speed sensor for measuring a travelling speed, a wind sensor for measuring a wind speed and other sensors. By means of the sensor for measuring the wind speed, a crosswind and a headwind are to be measured because a position of the contact line can be influenced thereby.

From DE 196 43 284 A1 is also known a current collector or a method for controlling a contact pressing force, the current collector having a control by means of which a fluctuation of the contact pressing force is to be reduced. For this purpose, a piezoelectronic sensor or an acceleration sensor is provided at the contact strip by means of which the fluctuation of the contact pressing force is to be detected.

DE 10 2013 201 494 A1 relates to a system for diagnosing an operating state of a railway vehicle, wherein measured values of railway vehicles may be brought together in a central control center, be processed using data technology and be stored. Inter alia, also measured values related to the weather can be recorded by a railway vehicle. DE1084960 relates to a means for measuring absolute velocities. The invention relates to a means for measuring the magnitude and the direction of the true velocity of a watercraft or aircraft or of the components of the true velocity parallel and perpendicular to the longitudinal axis of a vehicle.

The object of the invention is therefore to propose a method for controlling a contact pressing force of a collector shoe, and a control system for a current collector which extends a service life of a collector shoe.

This object is attained by a method having the features of claim 1 and by a control system having the features of claim 10.

In the method according to the invention for controlling a contact pressing force (F_A) of a collector shoe of a current collector of a railway vehicle, the collector shoe disposed on a positioning device of the current collector is brought into contact with a contact line by means of said positioning device of the current collector using the contact pressing force (F_A), a travelling speed (vF) of the railway vehicle being determined by means of a travelling speed measuring means of a measuring device of a control system of the railway vehicle, the contact pressing force (F_A) being controlled as a function of the travelling speed (vF) by means of a control device of the control system, a true wind speed (vW_R) being determined relative to the railway vehicle by means of a wind measuring means of the measuring device, the contact pressing force (F_A) being controlled by means of the control device taking into account the true wind speed (vW_R), a total wind speed (vW_{ges}) being measured at the positioning device by means of the wind measuring means, the travelling speed (vF) corresponding to a relative wind speed (vW_F), the true wind speed (vW_R) being determined as the difference of the total wind speed (vW_{ges}) and the travelling speed (vF) or the relative wind speed (vW_F).

In the method according to the invention, the wind measuring means is used in order to measure the real wind speed (vW_R). The true wind speed (vW_R) results from the wind conditions prevailing at the location of the railway vehicle or directly at the current collector, independently of a relative wind speed (vW_F). Since the contact pressing force (F_A) is already controlled as a function of the travelling speed (vF) by means of the control device, it is possible to correct the contact pressing force (F_A) by additionally measuring the true wind speed (vW_R). If a railway vehicle travels, for example, through a tunnel, the contact pressing force (F_A) would substantially increase in an undesirable manner due to the aerodynamic effects. This increase results from the true wind speed (vW_R) which is also substantially increased in the tunnel and which is added to the relative wind speed (vW_F). The control device in this case prevents an excessive increase of the contact pressing force (F_A) by adapting it to the true wind speed (vW_R), whereby an increased wear of the collector shoe can be avoided. At the same time, the contact pressing force (F_A) is always so high that it is adapted to the travelling speed (vF) of the vehicle.

According to the invention, a total wind speed (vW_{ges}) is measured at the positioning device by means of the wind measuring means. In this case, for example a simple pitot tube can be used as wind measuring means if the travelling speed (vF) or the relative wind speed (vW_F) is already known. In this case, the wind measuring device is particularly easily designable. The wind measuring means can also be disposed directly at the positioning device, in particular adjacent to the collector shoe to determine the actual wind conditions or flow conditions at the collector shoe. In this case, the contact pressing force (F_A) can be controlled even more precisely.

In this case, the contact pressing force (F_A) can always be controlled proportionally to the travelling speed (vF). Thus, it can be ensured that the contact pressing force (F_A) is also increased as the travelling speed (vF) increases and vice versa. The control system can therefore, for example, comprise a known proportional pressure regulator which controls a pressure for a pneumatic actuator. Thus, the method for controlling a contact pressing force (F_A) can also be carried out by means of the control device by retrofitting proportional pressure regulators.

According to the invention, the travelling speed (vF) corresponds to a relative wind speed (vW_F), the true wind speed (vW_R) being determined as the difference of a total wind speed (vW_{ges}) and the travelling speed (vF) or the relative wind speed (vW_F). In this case, the true wind speed (vW_R) not even has to be measured directly, but it can be calculated by the control device from measurements of other quantities. Since the relative wind speed (vW_F) is equal to the travelling speed (vF) or their negative or inverse value is correspondingly $-vW_F = vF$, the relative wind speed (vW_F) can simply be determined by measuring the travelling speed (vF). The travelling speed (vF) is regularly measured at every railway vehicle, for example at a wheel of a railway vehicle, such that the control device can easily process this then known quantity. Regardless of an anyway existing measurement of the travelling speed (vF), the relative wind speed (vW_F) can be measured again separately by means of the wind measuring means. A true wind speed (vW_R) can then be determined particularly easily for example by means of a Prandtl tube.

A relative wind speed force component (F_{WFY}) can be determined as a function of the travelling speed (vF) or a relative wind speed (vW_F) and/or a true wind speed force component (F_{WRY}) can be determined as a function of the true wind speed (vW_R) by means of the control device. The relative wind speed (vW_F) and the true wind speed (vW_R) act on the collector shoe in the opposite direction to the direction of movement of the collector shoe relative to the contact line. In this case, the true wind speed (vW_R) can also be a component of a wind acting laterally on the railway vehicle. Due to aerodynamic effects at the collector shoe, the relative wind speed force component (F_{WFY}) and/or the true wind speed force component (F_{WRY}) which each acts orthogonally to the contact line result(s). These quantities can be determined by the control device as a function of the respective wind speeds. Thus, it is possible that the control device adapts the contact pressing force (F_A) as a function of the aforementioned force components in order to reduce a wear of the collector shoe.

The contact pressing force (F_A) can be the sum of the negative true wind speed force component (F_{WRY}) and the travelling speed force component (F_{AvK}), the travelling speed force component (F_{AvK}) being able to be controlled by means of the control device. As a consequence, only the force component (F_{AvK}) provided for the respective speed of the railway vehicle and the true wind speed force component (F_{WRY}) can be taken into account when controlling the contact pressing force (F_A). In this case, the relative wind speed force component (F_{WFY}) can be ignored. Substantially reducing a wear of the collector shoe and improving a contact quality already becomes possible only by taking into account the true wind speed (vW_R).

A service life can be extended even further if the contact pressing force (F_A) is the sum of the relative wind speed force component (F_{WFY}), the negative true wind speed force component (F_{WRY}) and the travelling speed force component (F_{AvK}), the travelling speed force component (F_{AvK}) being controllable by means of the control device. On the whole, in this case, the contact pressing force (F_A) can be adapted to all the aerodynamic forces influencing the contact pressing force.

The relative wind speed force component (F_{WFY}) and the travelling speed force component (F_{AvK}) can be determined by means of the control device taking into account a height of the collector shoe. A height of the collector shoe basically depends on its wear such that a new collector shoe typically is always higher than a collector shoe which has already been in use for some time since, in this case, the height has already been reduced by abrasion. However, the height of the collector shoe also affects the aerodynamic behavior of the collector shoe and, thus, in particular the contact pressing force (F_A) influenced by wind speeds. The control device can now, due to the known height of the collector shoe, determine or calculate the relative wind speed force component (F_{WFY}) and the travelling speed force component (F_{AvK}). In this case, the height of the collector shoe may be measured at regular intervals by means of a height measuring means in order to be able to control the contact pressing force (F_A) even more precisely.

A function of values of the true wind speed (vW_R) and values of the true wind speed force component (F_{WRY}) can be stored by means of a storage means of the control device. According to this, the control device can comprise means for data processing with the storage means. In this case, the function stored in the storage means enables an assignment of the true wind speed (vW_R) determined by means of the wind measuring means to a value of the true wind speed force component (F_{WRY}). This simplifies the control of the contact pressing force (F_A) even further.

Moreover, a calibration of the function can be carried out by measuring the contact pressing force (F_A) and a total wind speed (vW_{ges}). The contact pressing force (F_A) of the collector shoe acting on the contact line can, for example, be determined by means of force sensors which are disposed at or close to the collector shoe. Thus, the actual contact pressing force can be determined as a function of the total wind speed (vW_{ges}), in this case, the function being able to be adapted in each case in such a manner that the control device always sets the desired contact pressing force (F_A) which is adapted to the travelling speed (vF). Due to the calibration, it is possible to apply the method to any type and model of railway vehicles or current collectors since, in this case, the flow conditions at the railway vehicles, which are different in each case, can be taken into account.

A height of the collector shoe can be continuously measured by means of a height measuring means of the measuring device, the contact pressing force being controlled by means of the control device taking into account the height. In this case, the height measuring means can, for example, be a camera which captures the collector shoe or a sensor which is mounted at or within the collector shoe. It is essential that the height of the collector shoe can be measured continuously during an operation so that the contact pressing force (F_A) can always be adapted to a height of the collector shoe, which due to abrasion of the collector shoe constantly changes, by means of the control device. In this case, in addition to controlling the contact pressing force (F_A), also a lowering of the collector shoe can be initiated by means of the height measuring means if the collector shoe is below a minimum height in order to prevent a damage to the contact line.

In the control system according to the invention for a current collector for railway vehicles, the current collector has a movable positioning device and at least one collector shoe disposed on said positioning device, the collector shoe being able to be brought into contact with a contact line by means of the positioning device using a contact pressing force (F_A), the control system comprising a measuring device and a control device, the measuring device having a travelling speed measuring means for determining a travelling speed (vF) of a railway vehicle, the contact pressing force (F_A) being controllable as a function of the travelling speed (vF) by means of the control device, the measuring device having a wind measuring means for determining a true wind speed (vW_R) relative to the railway vehicle, the contact pressing force (F_A) being controllable by means of the control device taking into account the true wind speed (vW_R), wherein a total wind speed (vW_{ges}) is measurable at the positioning device by means of the wind measuring means, the travelling speed (vF) corresponding to a relative wind speed (vW_F), the true wind speed (vW_R) being determinable as the difference of the total wind speed (vW_{ges}) and the travelling speed (vF) or the relative wind speed (vW_F). With regard to the advantages of the control system according to the invention, reference is made to the description of advantages of the method according to the invention.

The wind measuring means can be a Venturi tube, a pitot tube, a Prandtl tube or an anemometer, in particular an ultrasonic anemometer, a thermoelectric anemometer, a thermo-optic anemometer or a plate anemometer. In this case, it is essential that the wind measuring means can be designed for measuring the true wind speed (vW_R) or a total wind speed (vW_{ges}). Advantageously, the wind measuring means can be disposed on a roof of the railway vehicle close to the current collector or directly at the positioning device adjacent to the collector shoe.

The wind measuring means can have a fiber-optic sensor for air speed measurement. In this case, the fiber-optic sensor can form a thermo-optic anemometer. In this case, it is particularly advantageous that the fiber-optic sensor cannot be influenced by electromagnetic fields as they are regularly present at current collectors. The fiber-optic sensor can therefore also be disposed in an adjacent manner to the collector shoe without the measurement result being falsified by currents flowing across the collector shoe or by, for example, a sparkover. In addition, the sensor cannot become unusable for operation due to dirt accumulation as it is the case with a pitot tube.

The measuring device can have a height measuring means by means of which a height of the collector shoe is measurable, the height measuring means being able to have a fiber-optic sensor which can be disposed inside the collector shoe. In this case, the fiber-optic sensor for measuring the height of the collector shoe also cannot be influenced by electromagnetic fields. Moreover, adapting the contact pressing force (F_A) to the actual height of the collector shoe becomes possible with the height measuring means. If the fiber-optic sensor is disposed inside the collector shoe, the fiber-optic sensor is also protected from external influences which can falsify the measurement result.

In this case, a unidirectional fiber bundle can be disposed in a vertical drill hole in the collector shoe, the fiber bundle being able to fill the drill hole completely. The fiber-optic sensor is then formed in the drill hole by the fiber bundle. The drill hole can be a blind hole or a through hole in the collector shoe. When the collector shoe is abraded due to contact with the contact line, the fiber bundle is also abraded, a length of the fiber bundle being shortened thereby. This change in length of the fiber bundle can be detected and, thereof, a height of the collector shoe is obtained. A plurality of fiber bundles which are disposed at a distance from one another can be disposed in the collector shoe. Since the fiber bundle is only inserted into the vertical drill hole, the fiber-optic sensor is easy to mount. Moreover, according to requirements, the fiber bundle may be fixed or poured in the hole by means of an adhesive material.

Furthermore, the travelling speed measuring means can be realized independently of the wind measuring means. In this case, the travelling speed measuring means can be the travelling speed measuring means which is anyway formed at a railway vehicle for determining and displaying a travelling speed, for example for a vehicle driver. In this case, it is possible to dispense with an additional formation of a travelling speed measuring means. At the same time, a relative wind speed (vW_F) can be measured by means of a wind measuring means to obtain an even more precise measurement result.

Alternatively, the wind measuring means can realize the travelling speed measuring means. In this case, a travelling speed (vF) is measured only by means of the wind measuring means. In this case, the control system can be realized independently of a possibly already present travelling speed measuring means of a railway vehicle, whereby the control system can be used more universally on railway vehicles.

If a wind measuring means is used, it may be used for determining a true wind speed (vW_R) at a current collector of a railway vehicle. This makes it possible in the first place to use the true wind speed (vW_R) for precisely controlling a contact pressing force (F_A) of a collector shoe of the current collector of the railway vehicle with the above described advantages.

Further advantageous embodiments of the control system are provided by the dependent claims referring back to method claim 1.

Below, preferred embodiments of the invention are explained in more detail with reference to the accompanying drawings.

Fig. 1 shows a schematic representation of a current collector;

Fig. 2 shows a schematic representation of a collector shoe with relative velocities;

Fig. 3 shows a schematic representation of the collector shoe with relative forces;

Fig. 4 shows a schematic representation of a control system;

Fig. 5 shows a representation of a fiber-optic sensor.

Fig. 1 shows a current collector 10 on a roof 11 of a railway vehicle (not shown in more detail) having a positioning device 13 realized as pantograph 12. At pantograph 12, two collector shoes 14 are disposed at a rocker 15 transversely to a contact line 16. The railway vehicle moves with a travelling speed vF relative to contact line 16, the railway vehicle being flowed against with a total wind speed vW_{ges} parallel to contact line 16. Collector shoes 14 are pressed transversely or orthogonally to contact line 16 against it using a contact pressing force F_A. Contact pressing force F_A is controlled by means of a control device (not shown).

Fig. 2 shows a schematic representation of collector shoe 14 at contact line 16 with vectors drawn at a vertical axis 17 of collector shoe 14. A total wind speed vW_{ges} is composed of a relative wind speed vW_F and a true wind speed vW_R. In this case, relative wind speed vW_F is equal to a travelling speed vF and acts in the opposite direction of travelling speed vF. Therefore, true wind speed vW_R corresponds to the proportion of a wind which acts on the current collector or collector shoe 14, regardless of a travelling speed vF. This wind can also be negative, i.e. act with the travelling direction of the railway vehicle and, thus, reduce relative wind speed vW_F or total wind speed vW_{ges}.

Fig. 3 shows collector shoe 14 and contact line 16 with a collector shoe 14 during a travelling operation of the railway vehicle and with, in this case, acting force vectors. From travelling speed vF results a relative wind speed force F_{WF} which, due to the aerodynamic effects at the positioning device or collector shoe 14, acts transversely on collector shoe 14. Relative wind speed force F_{WF} is divided into relative wind speed force components F_{WFY} and F_{WFX}. True wind speed vW_R also causes a true wind speed force F_{WR} having true wind speed force components F_{WRY} and F_{WRX}. Relative wind speed force component vW_{FY} and true wind speed force component F_{WRY} act orthogonally to contact line 16 on collector shoe 14 and press it together with a speed-dependent contact pressing force F_{AV} against contact line 16. In this case, speed-dependent contact pressing force F_{AV} is generated by a positioning device with a proportional pressure regulator as a function of a current travelling speed vF and is increased in a proportional ratio as the travelling speed vF increases. From this results increased contact pressing force F_{AE} which, due to true wind speed force component F_{WRY}, is higher than actually required, which, in turn, leads to an increased wear and, thus, a shortened service life of collector shoe 14. The control device (not shown) therefore determines true wind speed vW_R and true wind speed force component F_{WRY} which results therefrom, true wind speed force component F_{WRY} basically being subtracted from increased contact pressing force F_{AE} by means of the control device. However, this can also already be carried out during the determination of the wind speed. It is essential that contact pressing force F_A is corrected by the influence of true wind speed force components F_{WRY}. Consequently, contact pressing force F_A is so high that at least a contact pressing force required for the respective travelling speed vF is applied and not exceeded.

Fig. 4 shows a schematic structure of a control system 18 having a control device 19 and a drive 20 of a positioning device (not shown in more detail). A wind measuring means 21, a travelling speed measuring means 22 and a height measuring means 23 supply control device 19 with operating parameters, control device 19 exerting a contact pressing force formed as a function of the operating parameters on a collector shoe (not shown) via drive 20.

Fig. 5 shows a schematic representation of a fiber-optic sensor 24 for air speed measurement. Fiber-optic sensor 24 comprises a U-shaped profile cover 25 and a unidirectional fiber bundle 26 having a sensor end 27. A change in temperature at sensor end 27 can optically change a coating (not shown in more detail) of sensor end 27 such that this change of the coating, in turn, can be detected via fiber bundle 26 by means of an evaluation device (not shown in more detail). Profile cover 25 serves to protect sensor end 27 from detrimental environmental influences.

Patentkrav

1. Fremgangsmåde til regulering af en kontakttrykkraft (F_A) for et slæbestykke (kollektorsko) (14) for en strømkollektor (10) til et skinnekøretøj, hvorved, ved hjælp af et positioneringsapparat (13) på strømkollektoren, det derpå arrangerede slæbestykke med kontakttrykkraften (F_A) bringes til anlæg mod en køreledning (16), ved hjælp af en køremåleindretning (22) i et måleapparat for et reguleringssystem (18) i skinnekøretøjet, der bestemmes en kørehastighed (vF) for skinnekøretøjet, hvorved, ved hjælp af et reguleringsapparat (19) i reguleringssystemet, kontakttrykkraften (F_A) reguleres i afhængighed af kørehastigheden (vF), hvorved, ved hjælp af en vindmåleindretning (21) i måleapparatet, en sand-vindhastighed (vW_R) i forhold til skinnekøretøjet bestemmes, hvorved, ved hjælp af reguleringsapparatet, kontakttrykkraften (F_A) reguleres under hensyntagen til sand-vindhastigheden (vW_R),

kendetegnet ved, at

der ved hjælp af vindmåleindretningen måles en total-vindhastighed (vW_{ges}) på positioneringsapparatet (13), hvorved kørehastigheden (vF) svarer til en kørevindhastighed (vW_F), hvorved sand-vindhastighed (vW_R) bestemmes som differencen mellem total-vindhastigheden (vW_{ges}) og kørehastigheden (vF) eller kørevindhastigheden (vW_F) bestemmes.

2. Fremgangsmåde ifølge krav 1,

kendetegnet ved, at kontakttrykkraften (F_A) reguleres proportionalt med kørehastigheden (vF).

3. Fremgangsmåde ifølge krav 1 eller 2,

kendetegnet ved, at

en kørehastigheds-kraftkomponent (F_{WFY}) i afhængighed af kørehastigheden (vF) eller en kørevindhastighed (vW_F) og/eller en sand-vindhastighed-kraftkomponent (F_{WRY}) i afhængighed af den sande vindhastighed (vW_R) bestemmes ved hjælp af reguleringsapparatet (19).

4. Fremgangsmåde ifølge krav 3,

kendetegnet ved, at kontakttrykkraften (F_A) er summen af den negative sand-vindhastigheds-kraftkomponent (F_{WRY}) og kørehastigheds-kraftkomponenten (F_{AVK}), hvorved kørehastigheds-kraftkomponenten (F_{AVK}) reguleres ved hjælp af reguleringsapparatet (19).

5. Fremgangsmåde ifølge krav 3,
kendetegnet ved, at kontakttrykkraften (F_A) er summen af kørevindhastigheds-kraftkomponenten (F_{WFY}), den negative sand-vindhastigheds-kraftkomponent (F_{WRY}) og kørehastigheds-kraftkomponenten (F_{AWK}), hvorved kørehastigheds-kraftkomponenten (F_{AWK}) reguleres ved hjælp af reguleringsapparatet (19).

6. Fremgangsmåde ifølge et af kravene 3 til 5,
kendetegnet ved, at kørevindhastigheds-kraftkomponenterne (F_{WFY}) og kørehastigheds-kraftkomponenten (F_{AWK}) under hensyntagen til en højde af slæbestykket bestemmes ved hjælp af reguleringsapparatet (19).

7. Fremgangsmåde ifølge et af kravene 3 til 6,
kendetegnet ved, at der ved hjælp af en lagringsindretning i reguleringsapparatet (19) lagres en funktion af værdier af sand-vindhastigheden (vW_R) og værdier af sand-værdi-vindhastighedskomponenten (F_{WRY}).

8. Fremgangsmåde ifølge krav 7,
kendetegnet ved, at en kalibrering af funktionen sker ved hjælp af en måling af kontakttrykkraften (F_A) og en total-vindhastighed (vW_{ges}).

9. Fremgangsmåde ifølge et af de foregående krav,
kendetegnet ved, at, ved hjælp af en højdemåleindretning (23) i måleapparatet, en højde af slæbestykket (14) fortløbende måles, hvorved reguleringsapparatet (19) regulerer kontakttrykkraften (F_A) under hensyntagen til højden.

10. Reguleringssystem for en strømaftager (10) til skinnekøretøjer, hvorved strømaftageren omfatter en bevægelig positioneringsindretning (13) og i det mindste et derpå arrangeret slæbestykke (kollektorsko) (14), hvorved, ved hjælp af positioneringsapparatet, slæbestykket med en kontakttrykkraft (F_A) kan

bringes til anlæg mod en køreledning (16), hvorved reguleringssystemet omfatter et måleapparat og et reguleringsapparat (19), hvorved måleapparatet omfatter en fartmåleindretning (22) til bestemmelse af en kørehastighed (vF) for et skinnekøretøj, hvorved, ved hjælp af reguleringsapparatet, kontakttrykkraften (F_A) kan reguleres i afhængighed af kørehastigheden (vF), hvorved måleapparatet omfatter en vindmåleindretning (21) til bestemmelse af en sand-vindhastighed (vW_R) i forhold til skinnekøretøjet, hvorved, ved hjælp af reguleringsapparatet, kontakttrykkraften (F_A) kan reguleres under hensyntagen til sand-vindhastigheden (vW_R),

kendetegnet ved, at, ved hjælp af vindmåleindretningen, en total-vindhastighed (vW_{ges}) på positioneringsapparatet (13) kan måles, hvorved kørehastigheden (vF) svarer til en kørevindhastighed (vW_F), hvorved sand-vindhastigheden (vW_R) kan bestemmes som differencen mellem total-vindhastighed (vW_{ges}) og kørehastigheden (vF) eller kørevindhastigheden (vW_F).

11. Reguleringssystem ifølge krav 10,

kendetegnet ved, at vindmåleindretningen (21) er et Venturi-rør, et Pitot-rør, et Prandtl-rør eller et anemometer, navnlig et ultralyds-anemometer, et termoelektrisk anemometer, termooptisk anemometer, plade-anemometer.

12. Reguleringssystem ifølge krav 10 eller 11,

kendetegnet ved, at vindmåleindretningen (21) omfatter en fiberoptisk sensor (24) til lufthastighedsmåling.

13. Reguleringssystem ifølge et af kravene 10 til 12,

kendetegnet ved, at måleapparatet omfatter en højdemåleindretning (23), ved hjælp af hvilken en højde af slæbestykket (14) kan måles, hvorved højdemåleindretningen omfatter en fiberoptisk sensor, som er arrangeret inden i kollektorskoen.

14. Reguleringssystem ifølge krav 13,

kendetegnet ved, at et unidirektionalt fiberbundt er arrangeret i en vertikal boring i slæbestykket (14), hvorved fiberbundtet helt udfylder boringen.

15. Reguleringssystem ifølge et af kravene 10 til 14,
kendetegnet ved, at kørehastigheds-måleindretningen (22) er dannet som uafhængig af vindmåleindretningen (21).

16. Reguleringssystem ifølge et af kravene 10 til 14,
kendetegnet ved, at vindmåleindretningen (21) danner kørehastigheds-måleindretningen (22).

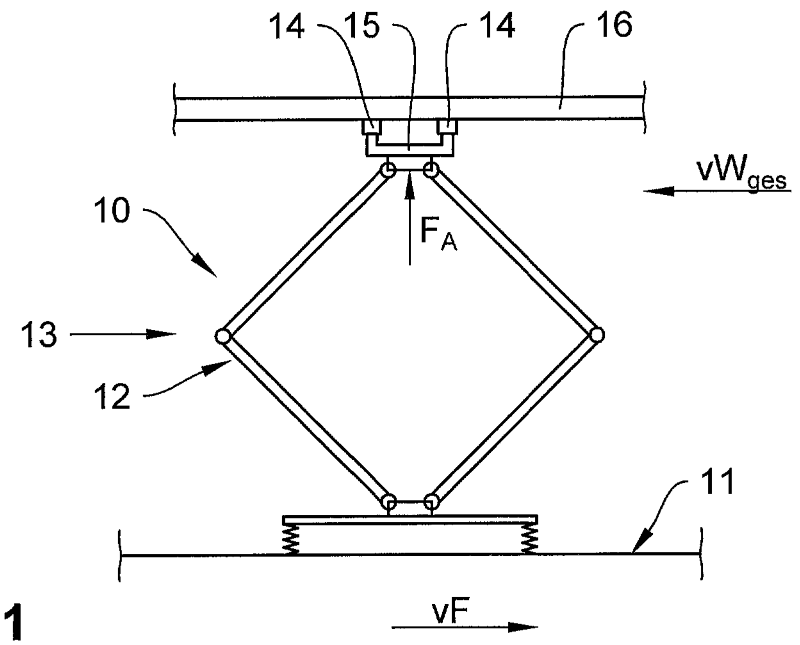

Fig. 1

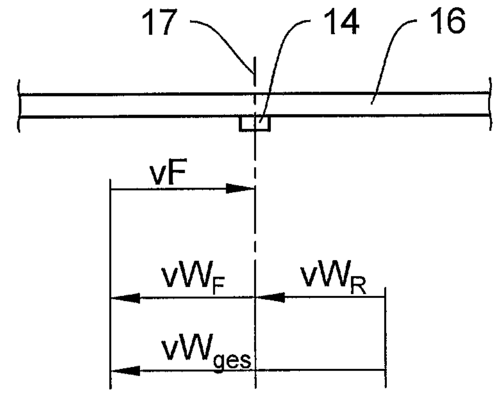

Fig. 2

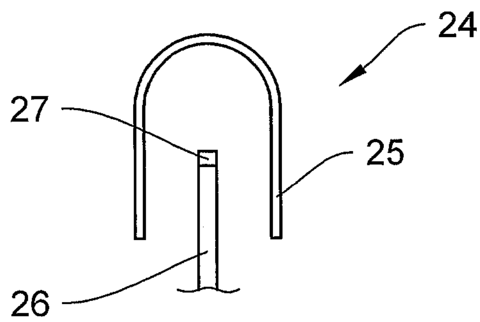

Fig. 5

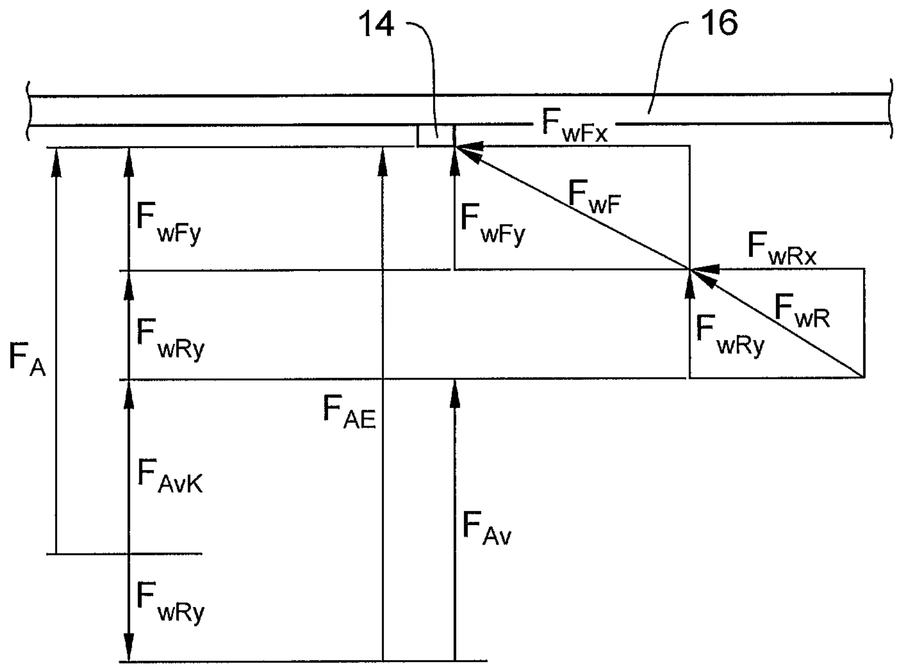
14
16
F_{wFx}
F_{wF}
F_{wFy}
F_{wFy}
F_{wRx}
F_{wR}
F_{wRy}
F_{wRy}
F_A
F_{AE}
F_{AvK}
F_{Av}
F_{wRy}

Fig. 3

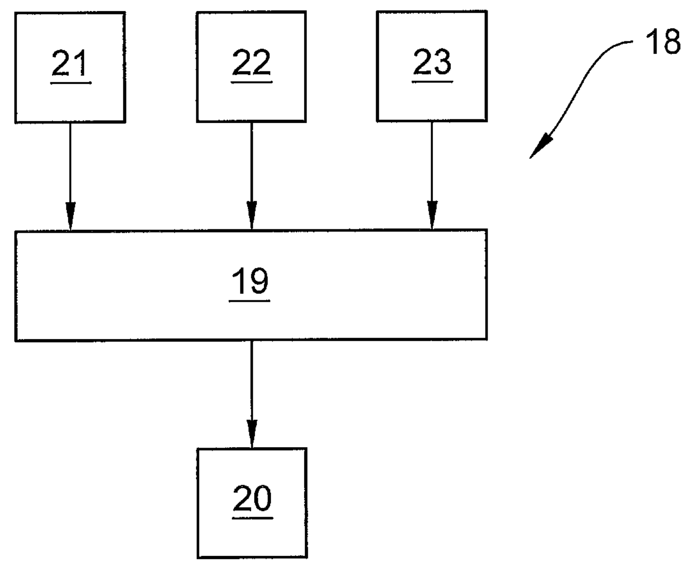
21
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Fig. 4