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(54) Industrial truck with improved cornering control

Industriellastkraftwagen mit verbesserter Kurvenfahrtsteuerung

Camion industriel avec contrôle d'angle amélioré

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• **Bengtsson, Mats**
435 32 MÖLNLYCKE (SE)
• **Henriksson, Jim**
413 11 Göteborg (SE)

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(74) Representative: **Lind, Urban Arvid Oskar**
Awapatent AB
P.O. Box 11394
404 28 Göteborg (SE)

(73) Proprietor: **Atlet AB**
43582 Mölnlycke (SE)

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(72) Inventors:
• **Ulmestrand, Dan**
425 65 HISINGS KÄRRA (SE)

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Description

Technical Field

[0001] The present invention relates to an industrial truck, and in particular a fork lift truck, and to a method for controlling a fork lift truck.

Background of the Invention

[0002] Industrial trucks are known to drive at relatively high speed, to carry a significant weight of goods, and in some cases also in an elevated, lifted position. Consequently, the driving speed and the turning radius of the industrial truck must be controlled such that there is no tipping of the industrial truck to the laterally or longitudinally. This demanding task may be too much for the operator and, thus, e.g. in the event of driving maneuvers which are not adapted to the current lifting load and lifting height, tipping accidents may result involving severe injury or death to the operator or nearby people associated with a high level of damage to property.

[0003] To this end, much effort has been spent in providing automatic operator support systems to lower this risk, to create suitable safety precautions for reducing risks of accidents involving industrial trucks.

[0004] For example, it is known from e.g. EP 0 343 839 to limit the driving speed in dependence of inter alia the lifting load and the lifting height. Similar concepts are disclosed in e.g. US 7 165 643 and US 4 942 529. A common problem with such systems is, however, that the systems are very complex, making it difficult to adapt and calibrate the system to any certain truck, and also making the systems very costly.

[0005] Further, it is known from e.g. EP 2 172 414, EP 1 475 297 and EP 1 985 576 to reduce the travelling speed in dependence on the steering angle with less complex systems. However, in order to achieve the limiting effect when needed, and since these less complex systems have limited means to distinguish unsafe situations from safe, they often restrict the speed to an unnecessarily low level, decreasing truck productivity more than necessary.

[0006] Therefore, there is still a need for improvement within this area. In particular, there is a need for a cost-efficient safety system for industrial trucks which provides adequate safety and at the same time maintains a high productivity for the truck.

Summary of the Invention

[0007] In view of the above, a general object of the present invention is to provide an improved industrial truck, and a corresponding method for operating such an industrial truck, at least partly alleviating the above-discussed problems. This and other objects are achieved through an industrial truck and a method for controlling such an industrial truck according to the appended

claims.

[0008] According to a first aspect of the invention there is provided an industrial truck comprising:

a steering system with at least one steerable wheel, a steering control for steering the steerable wheel and a steering angle detection means for directly or indirectly detecting a steering angle of the steerable wheel; and

a traction motor system for driving said truck; wherein a permissible maximum travelling speed provided by said traction motor system is controllable in dependence of the steering angle of the steerable wheel, whereby the permissible maximum travelling speed is more limited at large steering angles than at low steering angles; characterized in that the steering system further comprises an angular velocity determination means for direct or indirect determination of an angular velocity of a steering angle alteration, and in that the permissible maximum travelling speed is further controlled in dependence of the angular velocity, so that the permissible maximum travelling speed is more limited when a high angular velocity is determined than when a low angular velocity is determined.

[0009] The present invention is based on the realization made by the present inventors that even though effective from a safety point of view, reduction of travel speed solely based on the steering angle often unnecessarily restricts the speed too much. However, by also taking the angular velocity into consideration, a much better performance and productivity can be achieved, while maintaining the same high level of safety.

[0010] Typically, the steerable wheel is turned quickly, with a high angular velocity, when going into a corner or curve. This is also a situation in which the safety risks are relatively high. By means of the present invention, a large reduction in permissible maximum travelling speed will be achieved in this situation, thereby increasing safety. However, when going out of the curve or corner, the angular velocity is normally much lower, and also the safety risks are lower. This is due to both natural behavior of typical users - a driver typically reduces speed when driving through a curve - and to other speed regulation systems, e.g. limiting the speed based on steering angle solely. By means of the present invention, a higher maximum permissible travelling speed will be obtained in this situation, which does not compromise the safety, but which significantly improves productivity. The same applies for driving through long bends and for minor driving direction corrections, where a higher permissible maximum travelling speed will be tolerated. At the same time, a high safety level is maintained during quick evasive maneuvers and the like.

[0011] If only steering angle is considered, excessive speed limitations already at very small angular deviations from straight is necessary in order to obtain an adequate

safety level. This means that the truck will unnecessarily lower its speed automatically as a result of essentially any alteration of the operator control. The truck will as a result be very slow, and productivity will be low. However, by simultaneously taking another parameter into account, the angular velocity, a more tolerable system is obtained, with maintained high security. Hereby, a quick response is obtained when entering into sharp bends and curves, whereas lower speed limitations, or no speed limitations at all, are applied when going out of curves, when entering less sharp curves, etc.

[0012] The present invention may be used for various types of trucks, such as reach trucks, stackers, order pickers, counterweight fork-lift trucks, pedestrian controlled trucks etc. It is particularly useful for rider-controlled trucks, where the operator is seated or standing in the truck during driving.

[0013] Further, the present invention can be used together with various types of steering systems. For example, the steering system may be a mechanical steering system, a hydraulic servo assisted steering system, an electrically servo assisted steering system, or a fully electronic steering ("steer by wire") system. The present invention is particularly suitable for use in connection with the latter, fully electronic steering systems, since sensors useable to determine steering angle and angular velocity are already present in such systems. A steer by wire system typically comprises a steerable wheel steerable via a steering transmitter connected to the steering control, and an electric or electro-hydraulic steering device actuated by the steering transmitter.

[0014] As used in the present application "steering angle" refers to the angle between a direction of a steerable wheel relative to a default forward and/or rearward driving direction of the industrial truck. Preferably, the steering angle is defined in relation to the default forward direction when the truck is moved in a forward direction, and in relation to the default rearward direction when moving in a rearward direction. The default forward and rearward direction normally correspond to a longitudinal length direction of the truck, and are also directed essentially perpendicular to wheel axes of non-steerable wheels.

[0015] Setting of a permissible maximum travelling speed, or instantaneous speed limit, and controlling the traction motor system of the industrial truck so that the permissible maximum travelling speed is not exceeded, is per se well known in the art. For example, a controller may issue a speed limit signal, and this signal may be used in conjunction with signals related to speed and acceleration desired by the rider, or operator, to be connected to the traction motor control system so that truck speed ordinarily cannot exceed the speed represented by the instantaneous speed limit signal. The speed limit signal, representing the permissible maximum travelling speed, is determined by the controller based on input signals related to steering angle and angular velocity.

[0016] The operator ordinarily will indicate a desire for an increase or a decrease in speed by his manual posi-

tioning of a control handle, a pedal or the like. Vehicle travel may occur at any speed less than that represented by the instantaneous speed limit, or even at zero speed, if such a lesser speed is requested by the operator input signal. If a requested speed exceeds the instantaneous speed limit, the controller will hinder the speed from rising above the instantaneous speed limit. Further, if the instantaneous speed limit is lowered, the instantaneous speed limit signal may be lower than the present travel speed of the truck. In this case, the traction motor system either be operated to immediately reduce the speed of the truck to again be at or lower than the instantaneous speed limit, e.g. by braking the truck. Alternatively, the traction motor system may be controlled so that there is a reduction of tractive effort, but in no decelerating force other than that provided by motor, gearing, and tire friction, so that the truck will gradually move at a descending speed until the truck speed reaches the new instantaneous speed limit.

[0017] An alternative to limiting maximum travel speed is to modify the relationship between operator input signal and final travel speed command to the motor over the full range. However, from a productivity point of view, limiting maximum speed has proven preferable in most cases.

[0018] The steering angle detection means may be a sensor arranged to directly detect the steering angle of the steerable wheel. Such sensors are per se known, and may provide a signal in real-time indicative of the current steering angle. However, preferably the steering angle is detected indirectly, via the operator control. Here, the steering control comprises a movable control, such as a hand wheel (steering wheel), a handlebar or a joy stick. Each position of the moveable control may correspond to a specific steering angle. This may be referred to as a position regulation. Alternatively, the sensor may determine the angular velocity and the direction of movements of the moveable control, and control the steerable wheel accordingly. This may be referred to as velocity regulation. To this end, it is for example feasible to use a two channel phase delayed incremental sensor. Thus, the steering angle detection means may be a sensor arranged to indirectly detect the steering angle of the steerable wheel by detection of a moved position of the moveable control. By detecting the movement of the moveable control rather than the steerable wheel, it is possible to detect movements earlier, and thus react to changes faster. Further, in many types of steering systems, such as in a steer by wire system, such sensors are already present, and can easily be made use of also for this additional purpose. Likewise, the angular velocity determination means may also be a sensor connected directly to the steerable wheel, or to a sensor connected to the moveable control unit, for indirect determination of the angular velocity.

[0019] Preferably, the permissible maximum travelling speed is controllable in dependence of the steering angle of the steerable wheel in accordance with at least one

curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis. Preferably, there is provided a first steering angle range from zero and up to a first predetermined steering angle, in which range the industrial truck is operable at a maximum speed, a second steering angle range from a second predetermined steering angle and up to a maximal steering angle, in which range the industrial truck is operable at a reduced permissible maximum travelling speed, and a transition steering angle range between the first and second predetermined steering angles, in which range the permissible maximum travelling speed is continuously controllable in correlation with the steering angle. The curve thus has the shape of a straight line, defining a fixed permissible maximum travelling speed, corresponding to the maximum travelling speed of the truck, in the first range, and a straight line, defining a much lower fixed permissible maximum travelling speed, in the second range, and a sloped transition between these speed levels in the transition range. The first predetermined steering angle, A1, may e.g. be in the range 1-10 degrees, and preferably in the range 2-5 degrees. The first range is preferably symmetrically arranged around zero, the default forward and/or rearward travelling direction. Thus, the first range extends from -A1 to +A1. The second predetermined steering angle, A2, may e.g. be in the range 20-90 degrees, and preferably in the range 30-70 degrees. The second range thus comprises angles higher than +A2 or lower than -A2.

[0020] The additional control of the permissible maximum travelling speed in dependence of the angular velocity can be realized in various ways. In one line of embodiments, at least two such curves may be provided, wherein the choice of curve to be used for controlling the permissible maximum travelling speed is made based on the angular velocity. Thus, there may be a lower, more restrictive curve to be used when the angular velocity is high, and an upper, less restrictive curve to be used when the angular velocity is low. Determination of whether the angular velocity is high or low may be made by comparing the instantaneous angular velocity to a predetermined threshold value. The at least two curves preferably have essentially similar shapes in the transition steering angle range. It is further preferred that the curves have different first predetermined steering angles, thereby defining first steering angle ranges of different size. Thus, when low angular velocities are determined, the steering may occur within a broader range, such as from -7 to + 7 degrees, without activation of any speed restrictions, whereas when a high angular velocity is detected, the range may be much narrower, such as from -3 to + 3 degrees.

[0021] More than two curves may also be provided, such as three or four curves, and a corresponding number of threshold values related to the angular velocity may be used to determine which curve to use. There may even be an infinite amount of curves, leading to a gradual transition between an uppermost curve and a lowermost curve.

[0022] In an alternative line of embodiments, the permissible maximum travelling speed may be controllable in dependence of the steering angle of the steerable wheel in accordance with a base curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis, and wherein the permissible maximum travelling speed is further reduced and/or increased in dependence on the angular velocity. Thus, compensation for differences in angular velocity may here be used by e.g. further reducing the permissible maximum travelling speed provided by the curve with a certain factor, such as 10%, 20% or 50%, when the angular velocity exceeds a certain threshold value. Again, multiple threshold values may be used, leading to different amounts of further restrictions. Alternatively, the additional reduction may be gradual, such as the angular velocity times a certain factor. Further, instead of having the curve as an upper limit, the curve may be a lower limit, whereby the compensation is instead made to increase the speed limit when the angular velocity is low.

[0023] Preferably, a limitation of the permissible maximum travelling speed due to a determined high angular velocity is maintained at least during a predetermined minimum time period. Thus, when a high angular velocity is determined, leading to a change of curve, or a reduction of the speed by a compensating factor or the like, this new state is preferably maintained for a certain time period. This increases the safety, and also leads to a more comfortable driving experience.

[0024] The degree of additional restriction of permissible maximum travelling speed may also be made in dependence on other parameters, such as the skill and level of experience of the driver. Thus, the restrictions imposed based on angular velocity may be much higher for a less skillful and/or more inexperienced driver, whereas less severe restrictions may be used when there is a skillful and/or more experienced driver. The skillfulness and/or experience level of the driver may be identified by e.g. a personal access code provided by the driver, or by having personal and identifiable keys to the truck.

[0025] The steering system may further comprise an angular velocity direction determination means for direct or indirect determination of the direction of an angular velocity of a steering angle alteration, whereby it is determined whether the steering angle is increasing or decreasing, wherein the permissible maximum travelling speed is further controlled in dependence of the angular velocity direction. For example, this control may be realized so that the permissible maximum travelling speed is more limited when an increasing steering angle is determined than when a decreasing steering angle is determined.

[0026] According to another aspect of the invention, there is provided a method for controlling a permissible maximum travelling speed of an industrial truck comprising:

detecting, directly or indirectly, a steering angle of a steerable wheel;
 determining, directly or indirectly, an angular velocity of a steering angle alteration; and
 controlling the permissible maximum travelling speed in dependence of the steering angle and the angular velocity of the steerable wheel, so that the permissible maximum travelling speed is more limited at large steering angles than at low steering angles and so that the permissible maximum travelling speed is more limited when a high angular velocity is determined than when a low angular velocity is determined.

[0027] By means of this aspect of the invention, similar advantages and possible embodiments as discussed above in relation to the first aspect are obtainable.

[0028] Further embodiments and advantages of the present invention will become apparent from the following detailed description of presently preferred embodiments of the invention.

Brief description of the drawings

[0029] In the following, embodiments of the present invention will be described in detail, with reference to the accompanying, exemplifying drawings on which:

Figure 1 is a perspective view of a fork lift truck according to the present invention.

Figure 2 is a schematic view of the traction motor system and steering system of the fork lift truck in Fig. 1 according to a first embodiment.

Figure 3 is a schematic view of the traction motor system and steering system of the fork lift truck in Fig. 1 according to a second embodiment.

Figure 4 is a schematic view of the traction motor system and steering system of the fork lift truck in Fig. 1 according to a third embodiment.

Figure 5 is a diagram illustrating curves useable to control the permissible maximum speed.

Detailed description of preferred embodiments

[0030] Referring now to Fig. 1, there is shown a perspective view of an industrial fork lift truck 1. The fork lift truck 1 comprises a frame 11, to which are mounted a mast 2, and in the exemplary embodiment a telescoping mast, for lifting of forks 3, an operator control station comprising an operator control 4, two non-steerable wheels 5, and a drive wheel (not visible in fig 1). By means of a lifting system, the forks carried by the mast can be moved in height between a lowered position and desired raised positions.

[0031] Even though Fig. 1 illustrates a specific example of a fork lift truck, it is to be acknowledged by the skilled reader that the steering system as will be discussed in the following may also be used on many other types of

fork lift trucks.

[0032] Referring now to Fig. 2, a schematic block diagram of one embodiment of the steering system and traction motor system of the lift truck 1 in Fig 1 is illustrated.

[0033] The steering system is here a so-called steer by wire system. However, many other types of steering systems may be used. The steering system comprises a manually operable moveable steering control 41, such as a hand wheel/steering wheel, a handlebar or a joy stick. In the illustrative example a hand wheel is used. The hand wheel is connected to a rotatable shaft 42. The rotation of the rotatable shaft is registered by a steering transmitter 43, which forwards steering signals to a steering controller 44. The steering controller controls a steering device 45, such as an electric or electro-hydraulic actuator or the like. Thus, turning of the hand wheel is translated to electrical signals, which are transmitted to the steering device, which in turn performs corresponding steering of the steerable wheel 6, connected to the truck by a rotatable connection 48.

[0034] Further, the steering system comprises a steering angle detector 46 and an angular velocity detector 47. These detectors may be separate units, as in the illustrative example. However, these detectors may also be arranged as a single detector, detecting both the steering angle and the angular velocity. Further, the detectors may be an integrated part of the steering transmitter 43.

[0035] Thus, in the illustrative example of Fig. 2, the determination of steering angle and angular velocity is made indirectly, based on the movement of the steering control.

[0036] Alternatively, one or both of the steering angle detector 46 and the angular velocity detector 47 may be connected directly to the steerable wheel, as illustrated in Fig. 3.

[0037] According to still another alternative, the sensor 46' is a sensor sensing both the angular velocity and the direction of the rotation of the steering control. The sensor may e.g. be realized as an incremental sensor. Further, the sensor in this embodiment forwards its signals to the steering controller, which in turn forwards signals to the speed controller. Generally, the steering controller and the speed controller may be considered part of an overall steer system, which controls both the traction motor and the steering device. The signals from the steering angle detector 46 and the angular velocity detector 47 are forwarded to a speed controller 52. The speed controller also receives input signals from a foot operated control 51, such as a pedal. However, hand operated controls, such as handles and the like, are also feasible. Based on these input signals, the speed controller 52 controls a traction motor for driving the truck.

[0038] The speed controller controls the traction motor in accordance with the signals received by the speed control 51, but also restricts the speed to a permissible maximum travelling speed, which is determined based on the steering angle and the angular velocity. The permissible maximum travelling speed is set so that it is more

limited at large steering angles than at low steering angles and so that it is more limited when a high angular velocity is determined than when a low angular velocity is determined.

[0039] The permissible maximum travelling speed may be controllable in dependence of the steering angle of the steerable wheel in accordance with one or more curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis. Such curves are illustrated in Fig. 5. In this example, two curves, a lower curve and an upper curve, are illustrated.

[0040] The lower curve forms a first steering angle range "1" from zero and up to a first predetermined steering angle, here about 3 degrees, in which range the industrial truck is operable at a maximum speed, such as 14 km/h. A second steering angle range "2" is formed from a second predetermined steering angle, here about 35 degrees, and up to a maximal steering angle. In this range the industrial truck is operable at a reduced permissible maximum travelling speed, such as 6 km/h. A transition steering angle range "T" is formed between the first and second predetermined steering angles, in which range the permissible maximum travelling speed is continuously controllable in correlation with the steering angle. Preferably, the permissible maximum travelling speed decreases rapidly from the first steering angle range "1", and then flattens out towards the second steering angle range "2".

[0041] The upper curve has a form similar to the lower curve. However, in the upper curve, the first steering angle range "1" is broader, extending e.g. to about 7 degrees. Further, both in the transition range and the second range, the speed corresponding to each steering angle may be higher than in the lower curve. Still further, at a third predetermined steering angle "3", such as e.g. about 60 degrees, the upper curve may be lowered down to the lower curve.

[0042] In this example, the permissible maximum travelling speed may follow either of the upper curve and the lower curve, in dependence of the steering angle. Whether to use the upper curve or the lower curve is determined in dependence of whether the angular velocity exceeds a predetermined threshold value or not. Thus, at an angular velocity being below said threshold value, the upper curve is followed. If the angular velocity exceeds the threshold value, the controller switches to the lower curve instead. Both steering angle and angular velocity are monitored continuously. However, after a switch to the lower curve, the control preferably maintains this more restricted control for a certain time period before switching back.

[0043] As has already been discussed in the foregoing, alternative ways of controlling the permissible maximum travelling speed in dependence of the angular velocity are feasible. For example, more than two curves may be provided, such as three or four curves, and a corresponding number of threshold values related to the angular

velocity may be used to determine which curve to use. There may even be an infinite amount of curves, leading to a gradual transition between an uppermost curve and a lowermost curve. Further, the permissible maximum travelling speed may be controllable in dependence of the steering angle of the steerable wheel in accordance with a base curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis, and wherein the permissible maximum travelling speed is further reduced and/or increased in dependence on the angular velocity. Thus, it is e.g. possible to use the upper curve as the base curve, and then further reduce the permissible maximum travelling speed in dependence of the angular velocity, or to use the lower curve as the base curve, and then further increase the permissible maximum travelling speed in dependence of the angular velocity.

[0044] The person skilled in the art realizes that the present invention is not limited to the preferred embodiments. For example alternative ways of setting the permissible maximum travelling speed based on the steering angle and the angular velocity are feasible. Further, the sensors for determining steering angle and angular velocity may be arranged at various positions, and may also be integrated with each other or with other components in the truck. Still further, the threshold value(s) for the angular velocity may be adjustable, and may e.g. be set differently for different users, depending on skills and/or experience level. Such and other obvious modifications must be considered to be within the scope of the present invention, as it is defined by the appended claims. It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting to the claim. The word "comprising" does not exclude the presence of other elements or steps than those listed in the claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. Further, a single unit may perform the functions of several means recited in the claims.

Claims

1. An industrial truck (1) comprising:

a steering system with at least one steerable wheel, a steering control (41) for steering the steerable wheel (6) and a steering angle detection means (43) for directly or indirectly detecting a steering angle of the steerable wheel (6), and a traction motor system (53) for driving said truck (1),
wherein a permissible maximum travelling speed provided by said traction motor system

- (53) is controllable in dependence of the steering angle of the steerable wheel (6), whereby the permissible maximum travelling speed is more limited at large steering angles than at low steering angles;
characterized in that the steering system further comprises an angular velocity determination means (47) for direct or indirect determination of an angular velocity of a steering angle alteration, and **in that** the permissible maximum travelling speed is further controlled in dependence of the angular velocity, so that the permissible maximum travelling speed is more limited when a high angular velocity is determined than when a low angular velocity is determined.
2. The industrial truck (1) of claim 1, wherein the steering angle detection means (43) is a sensor arranged to directly detect the steering angle of the steerable wheel (6).
 3. The industrial truck (1) of claim 1, wherein the steering control (41) comprises a movable control, such as a hand wheel, handlebar or a joy stick, and wherein the steering angle detection means (43) is a sensor arranged to indirectly detect the steering angle of the steerable wheel (6) by detection of a moved position of the moveable control.
 4. The industrial truck (1) of any one of the preceding claims, wherein the steering control (41) comprises a movable control, such as a hand wheel, a handlebar or a joy stick, and wherein the angular velocity determination means (47) is a sensor for indirect determination of the angular velocity of a steering angle alteration by detection of the moving speed of the moveable control.
 5. The industrial truck (1) of any one of the preceding claims, wherein the permissible maximum travelling speed is controlled by providing input signals related to steering angle and angular velocity to a controller (52), and generating a speed limit signal in said controller (52) in dependence of these input signals, said speed limit signal being supplied to said traction motor system (53) to limit the speed of the truck (1).
 6. The industrial truck (1) of any one of the preceding claims, wherein the permissible maximum travelling speed is controllable in dependence of the steering angle of the steerable wheel (6) in accordance with a curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis, and wherein at least two such curves are provided, the choice of curve to be used for controlling the permissible maximum travelling speed being made based on the angular velocity.
 7. The industrial truck (1) of any one of the preceding claims, wherein the permissible maximum travelling speed is controllable in dependence of the steering angle of the steerable wheel (6), so that in a first steering angle range from zero and up to a first predetermined steering angle, the industrial truck (1) is operable at a maximum speed, in a second steering angle range from second predetermined steering angle and up to a maximal steering angle, the industrial truck (1) is operable at a reduced permissible maximum travelling speed, and in a transition steering angle range between said first and second predetermined steering angles, the permissible maximum travelling speed is continuously controllable in correlation with the steering angle.
 8. The industrial truck (1) of claim 6 and 7, wherein the at least two curves have essentially similar shapes in the transition steering angle range.
 9. The industrial truck (1) of claim 6 and 7 or claim 8, wherein the curves have different first predetermined steering angles, thereby defining first steering angle ranges of different size.
 10. The industrial truck (1) of any one of the preceding claims as dependent on claim 6, wherein at least one threshold value for the angular velocity is provided, wherein the choice of curve to be used is made in dependence of whether the determined angular velocity is above or below said at least one threshold value.
 11. The industrial truck (1) of any one of the claims 1-5 and 7, wherein the permissible maximum travelling speed is controllable in dependence of the steering angle of the steerable wheel (6) in accordance with a base curve defining a relationship between the permissible maximum travelling speed on one axis and the steering angle on another axis, and wherein the permissible maximum travelling speed is further reduced and/or increased in dependence on the angular velocity.
 12. The industrial truck (1) of any one of the preceding claims, wherein the steerable wheel (6) is steerable via a steering transmitter (43) connected to the steering control (44), and an electric or electro-hydraulic steering device (45) actuated by the steering transmitter (43).
 13. The industrial truck (1) of any one of the preceding claims, wherein a limitation of the permissible maximum travelling speed due to a determined high angular velocity is maintained at least during a predetermined minimum time period.
 14. The industrial truck (1) of any one of the preceding

claims, wherein the steering system further comprises an angular velocity direction determination means for direct or indirect determination of the direction of an angular velocity of a steering angle alteration, whereby it is determined whether the steering angle is increasing or decreasing, wherein the permissible maximum travelling speed is further controlled in dependence of the angular velocity direction.

15. A method for controlling a permissible maximum travelling speed of an industrial truck (1) comprising:

detecting, directly or indirectly, a steering angle of a steerable wheel (6);

characterized by determining, directly or indirectly, an angular velocity of a steering angle alteration; and

controlling the permissible maximum travelling speed in dependence of the steering angle and the angular velocity of the steerable wheel (6), so that the permissible maximum travelling speed is more limited at large steering angles than at low steering angles and so that the permissible maximum travelling speed is more limited when a high angular velocity is determined than when a low angular velocity is determined.

Patentansprüche

1. Flurförderzeug (1), umfassend:

ein Lenksystem mit mindestens einem lenkbaren Rad, einer Lenksteuerung (41) zum Lenken des lenkbaren Rades (6) und einem Lenkwinkel-Erfassungsmittel (43) zum direkten oder indirekten Erfassen eines Lenkwinkels des lenkbaren Rades (6) und

ein Fahrmotorsystem (53) zum Antreiben des Flurförderzeugs (1);

wobei eine zulässige maximale Fortbewegungsgeschwindigkeit, die durch das Fahrmotorsystem (53) bereitgestellt wird, in Abhängigkeit von dem Lenkwinkel des lenkbaren Rades (6) steuerbar ist, wodurch die zulässige maximale Fortbewegungsgeschwindigkeit bei großen Lenkwinkeln stärker begrenzt ist als bei kleinen Lenkwinkeln;

dadurch gekennzeichnet, dass das Lenksystem ferner ein Winkelgeschwindigkeits-Bestimmungsmittel (47) zur direkten oder indirekten Bestimmung einer Winkelgeschwindigkeit einer Lenkwinkeländerung umfasst und dass die zulässige maximale Fortbewegungsgeschwindigkeit ferner derart in Abhängigkeit von der Winkelgeschwindigkeit gesteuert wird, dass die zulässige maximale Fortbewegungsgeschwindigkeit, wenn eine hohe Winkelgeschwindigkeit be-

stimmt wird, stärker begrenzt ist, als wenn eine niedrige Winkelgeschwindigkeit bestimmt wird.

2. Flurförderzeug (1) nach Anspruch 1, wobei das Lenkwinkel-Erfassungsmittel (43) ein Sensor ist, der so eingerichtet ist, dass er den Lenkwinkel des lenkbaren Rades (6) direkt erfasst.

3. Flurförderzeug (1) nach Anspruch 1, wobei die Lenksteuerung (41) eine bewegliche Steuerung, z.B. ein Handrad, eine Lenkstange oder einen Joystick umfasst und wobei das Lenkwinkel-Erfassungsmittel (43) ein Sensor ist, der so eingerichtet ist, dass er den Lenkwinkel des lenkbaren Rades (6) indirekt durch Erfassen einer Bewegungsposition der beweglichen Steuerung erfasst.

4. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei die Lenksteuerung (41) eine bewegliche Steuerung, z.B. ein Handrad, eine Lenkstange oder einen Joystick umfasst und wobei das Winkelgeschwindigkeits-Bestimmungsmittel (47) ein Sensor zur indirekten Bestimmung der Winkelgeschwindigkeit einer Lenkwinkeländerung durch Erfassen der Bewegungsgeschwindigkeit der beweglichen Steuerung ist.

5. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei die zulässige maximale Fortbewegungsgeschwindigkeit dadurch gesteuert wird, dass einer Steuerung (52) Eingabesignale bereitgestellt werden, die auf den Lenkwinkel und die Winkelgeschwindigkeit bezogen sind, und dass in der Steuerung (52) in Abhängigkeit von diesen Eingabesignalen ein Geschwindigkeitsbegrenzungssignal erzeugt wird, wobei das Geschwindigkeitsbegrenzungssignal dem Fahrmotorsystem (53) zugeführt wird, um die Geschwindigkeit des Flurförderzeugs (1) zu begrenzen.

6. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei die zulässige maximale Fortbewegungsgeschwindigkeit in Abhängigkeit von dem Lenkwinkel des steuerbaren Rades (6) gemäß einer Kurve steuerbar ist, die eine Beziehung zwischen der zulässigen maximalen Fortbewegungsgeschwindigkeit auf einer Achse und dem Lenkwinkel auf einer anderen Achse definiert, und wobei mindestens zwei solcher Kurven bereitgestellt werden, wobei die Wahl der Kurve, die zum Steuern der zulässigen maximalen Fortbewegungsgeschwindigkeit zu verwenden ist, auf der Grundlage der Winkelgeschwindigkeit getroffen wird.

7. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei die zulässige maximale Fortbewegungsgeschwindigkeit in Abhängigkeit von dem Lenkwinkel des steuerbaren Rades (6) so steuerbar

ist, dass in einem ersten Lenkwinkelbereich von Null bis zu einem ersten vorgegebenen Lenkwinkel das Flurförderzeug (1) mit einer maximalen Geschwindigkeit zu betreiben ist, in einem zweiten Lenkwinkelbereich von einem zweiten vorgegebenen Lenkwinkel bis zu einem maximalen Lenkwinkel das Flurförderzeug (1) mit einer verringerten zulässigen maximalen Fortbewegungsgeschwindigkeit zu betreiben ist und in einem Übergangs-Lenkwinkelbereich zwischen dem ersten und zweiten vorgegebenen Lenkwinkel die zulässige maximale Fortbewegungsgeschwindigkeit in Korrelation mit dem Lenkwinkel kontinuierlich steuerbar ist.

8. Flurförderzeug (1) nach Anspruch 6 und 7, wobei die mindestens zwei Kurven in dem Übergangs-Lenkwinkelbereich im Wesentlichen ähnliche Formen aufweisen.
9. Flurförderzeug (1) nach Anspruch 6 und 7 oder Anspruch 8, wobei die Kurven unterschiedliche erste vorgegebene Lenkwinkel aufweisen, wodurch erste Lenkwinkelbereiche unterschiedlicher Größe definiert werden.
10. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, soweit sie von Anspruch 6 abhängen, wobei mindestens ein Schwellenwert für die Winkelgeschwindigkeit bereitgestellt wird, wobei die Wahl der zu verwendenden Kurve in Abhängigkeit davon getroffen wird, ob die bestimmte Winkelgeschwindigkeit über oder unter dem mindestens einen Schwellenwert liegt.
11. Flurförderzeug (1) nach einem der Ansprüche 1 bis 5 und 7, wobei die zulässige maximale Fortbewegungsgeschwindigkeit in Abhängigkeit von dem Lenkwinkel des lenkbaren Rades (6) gemäß einer Basiskurve steuerbar ist, die eine Beziehung zwischen der zulässigen maximalen Fortbewegungsgeschwindigkeit auf einer Achse und dem Lenkwinkel auf einer anderen Achse definiert, und wobei die zulässige maximale Fortbewegungsgeschwindigkeit ferner in Abhängigkeit von der Winkelgeschwindigkeit verringert oder erhöht wird.
12. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei das lenkbare Rad (6) über einen Lenksender (43), der mit der Lenksteuerung (44) verbunden ist, und eine elektrische oder elektrohydraulische Lenkvorrichtung (45) lenkbar ist, die durch den Lenksender (43) betätigt wird.
13. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei eine Begrenzung der zulässigen maximalen Fortbewegungsgeschwindigkeit aufgrund einer bestimmten hohen Winkelgeschwindigkeit mindestens während einer vorgegebenen mini-

malen Zeitperiode beibehalten wird.

14. Flurförderzeug (1) nach einem der vorhergehenden Ansprüche, wobei das Lenksystem ferner ein Winkelgeschwindigkeitsrichtungs-Bestimmungsmittel zum direkten oder indirekten Bestimmen der Richtung einer Winkelgeschwindigkeit einer Lenkwinkeländerung umfasst, wodurch bestimmt wird, ob der Lenkwinkel größer oder kleiner wird, wobei die zulässige maximale Fortbewegungsgeschwindigkeit ferner in Abhängigkeit von der Winkelgeschwindigkeitsrichtung gesteuert wird.
15. Verfahren zum Steuern einer zulässigen maximalen Fortbewegungsgeschwindigkeit eines Flurförderzeugs (1), umfassend:

direktes oder indirektes Erfassen eines Lenkwinkels eines lenkbaren Rades (6);

gekennzeichnet durch

direktes oder indirektes Bestimmen einer Winkelgeschwindigkeit einer Lenkwinkeländerung und

Steuern der zulässigen maximalen Fortbewegungsgeschwindigkeit in Abhängigkeit von dem Lenkwinkel und der Winkelgeschwindigkeit des lenkbaren Rades (6), so dass die zulässige maximale Fortbewegungsgeschwindigkeit bei großen Lenkwinkeln stärker begrenzt ist als bei kleinen Lenkwinkeln und die zulässige maximale Fortbewegungsgeschwindigkeit, wenn eine hohe Winkelgeschwindigkeit bestimmt wird, stärker begrenzt ist, als wenn eine niedrige Winkelgeschwindigkeit bestimmt wird.

Revendications

1. Véhicule industriel (1) comprenant :

un système de direction comportant au moins une roue directrice, une commande de direction (41) permettant de diriger la roue directrice (6) et un moyen de détection d'angle de braquage (43) permettant de détecter directement ou indirectement un angle de braquage de la roue directrice (6) ; et

un système moteur de traction (53) permettant de mouvoir ledit véhicule (1) ;

dans lequel la vitesse de déplacement maximale admissible fournie par ledit système moteur de traction (53) peut être régulée en fonction de l'angle de braquage de la roue directrice (6), la vitesse de déplacement maximale admissible étant davantage limitée à de grands angles de braquage qu'à de faibles angles de braquage ;
caractérisé en ce que le système de direction comprend en outre un moyen de détermination

- de la vitesse angulaire (47) permettant une détermination directe ou indirecte de la vitesse angulaire d'une modification d'angle de braquage, **et en ce que** la vitesse de déplacement maximale admissible est en outre régulée en fonction de la vitesse angulaire, si bien que la vitesse de déplacement maximale admissible est davantage limitée en cas de détermination d'une vitesse angulaire élevée qu'en cas de détermination d'une faible vitesse angulaire.
2. Véhicule industriel (1) selon la revendication 1, dans lequel le moyen de détection d'angle de braquage (43) est un capteur agencé pour détecter directement l'angle de braquage de la roue directrice (6).
 3. Véhicule industriel (1) selon la revendication 1, dans lequel la commande de direction (41) comprend une commande actionnable, telle qu'un volant, un guidon ou une manette, et dans lequel le moyen de détection d'angle de braquage (43) est un capteur agencé pour détecter indirectement l'angle de braquage de la roue directrice (6) en détectant un déplacement de position de la commande actionnable.
 4. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel la commande de direction (41) comprend une commande actionnable, telle qu'un volant, un guidon ou une manette, et dans lequel le moyen de détermination de la vitesse angulaire (47) est un capteur permettant la détermination indirecte de la vitesse angulaire d'une modification d'angle de braquage en détectant la vitesse d'actionnement de la commande actionnable.
 5. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel la vitesse de déplacement maximale admissible est régulée en fournissant des signaux d'entrée en lien avec l'angle de braquage et la vitesse angulaire à un régulateur (52), et en générant un signal de limite de vitesse dans ledit régulateur (52) en fonction de ces signaux d'entrée, ledit signal de limite de vitesse étant fourni audit système moteur de traction (53) afin de limiter la vitesse du véhicule (1).
 6. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel la vitesse de déplacement maximale admissible peut être régulée en fonction de l'angle de braquage de la roue directrice (6) conformément à une courbe définissant une relation entre la vitesse de déplacement maximale admissible sur un axe et l'angle de braquage sur un autre axe, et dans lequel il est prévu au moins deux courbes de ce type, le choix de la courbe à utiliser pour réguler la vitesse de déplacement maximale admissible se faisant en fonction de la vitesse angulaire.
 7. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel la vitesse de déplacement maximale admissible peut être régulée en fonction de l'angle de braquage de la roue directrice (6), si bien que dans une première plage d'angle de braquage allant de zéro jusqu'à un premier angle de braquage prédéterminé, le véhicule industriel (1) fonctionne à une vitesse maximale, dans une seconde plage d'angle de braquage allant d'un second angle de braquage prédéterminé jusqu'à un angle de braquage maximal, le véhicule industriel (1) fonctionne à vitesse de déplacement maximale admissible réduite, et dans une plage d'angle de braquage de transition entre lesdits premier et second angles de braquage prédéterminés, la vitesse de déplacement maximale admissible peut être régulée en continu en corrélation avec l'angle de braquage.
 8. Véhicule industriel (1) selon la revendication 6 et 7, dans lequel les au moins deux courbes présentent des formes essentiellement similaires dans la plage d'angle de braquage de transition.
 9. Véhicule industriel (1) selon les revendications 6 et 7 ou la revendication 8, dans lequel les courbes présentent des premiers angles de braquage prédéterminés différents, définissant ainsi des plages de premier angle de braquage de différentes tailles.
 10. Véhicule industriel (1) selon l'une quelconque des revendications précédentes dans la mesure où elle dépend de la revendication 6, dans lequel il est prévu au moins une valeur seuil relative à la vitesse angulaire, le choix de la courbe à utiliser se faisant en fonction du fait que la vitesse angulaire déterminée est supérieure ou inférieure à ladite au moins une valeur seuil.
 11. Véhicule industriel (1) selon l'une quelconque des revendications 1 à 5 et 7, dans lequel la vitesse de déplacement maximale admissible peut être régulée en fonction de l'angle de braquage de la roue directrice (6) conformément à une courbe de base définissant une relation entre la vitesse de déplacement maximale admissible sur un axe et l'angle de braquage sur un autre axe, et dans lequel la vitesse de déplacement maximale admissible est encore réduite et/ou élevée en fonction de la vitesse angulaire.
 12. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel la roue directrice (6) peut être orientée par le biais d'un transmetteur de direction (43) relié à la commande de direction (44) et d'un dispositif de direction électrique ou électro-hydraulique (45) actionné par le transmet-

teur de direction (43).

13. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel une limitation de la vitesse de déplacement maximale admissible due à la détermination d'une vitesse angulaire élevée est maintenue au moins pendant une période de temps minimale prédéterminée. 5
14. Véhicule industriel (1) selon l'une quelconque des revendications précédentes, dans lequel le système de direction comprend en outre un moyen de détermination du sens de la vitesse angulaire permettant la détermination directe ou indirecte du sens de la vitesse angulaire d'une modification d'angle de braquage, moyennant quoi il est déterminé si l'angle de braquage augmente ou diminue, la vitesse de déplacement maximale admissible étant en outre réglée en fonction du sens de la vitesse angulaire. 10 15 20
15. Procédé de régulation de la vitesse de déplacement maximale admissible d'un véhicule industriel (1) comprenant :
- la détection, directe ou indirecte, de l'angle de braquage d'une roue directrice (6) ; 25
- caractérisé par**
- la détermination, directe ou indirecte, de la vitesse angulaire d'une modification d'un angle de braquage ; et 30
- la régulation de la vitesse de déplacement maximale admissible en fonction de l'angle de braquage et de la vitesse angulaire de la roue directrice (6), si bien que la vitesse de déplacement maximale admissible est davantage limitée à de grands angles de braquage qu'à de faibles angles de braquage et si bien que la vitesse de déplacement maximale admissible est davantage limitée en cas de détermination d'une vitesse angulaire élevée qu'en cas de détermination d'une faible vitesse angulaire. 35 40 45 50 55

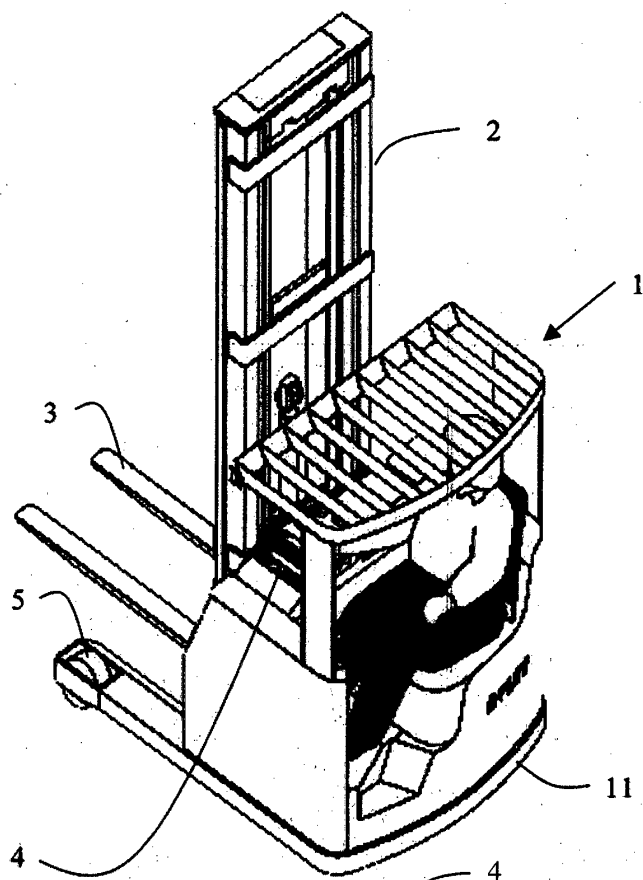


Fig. 1

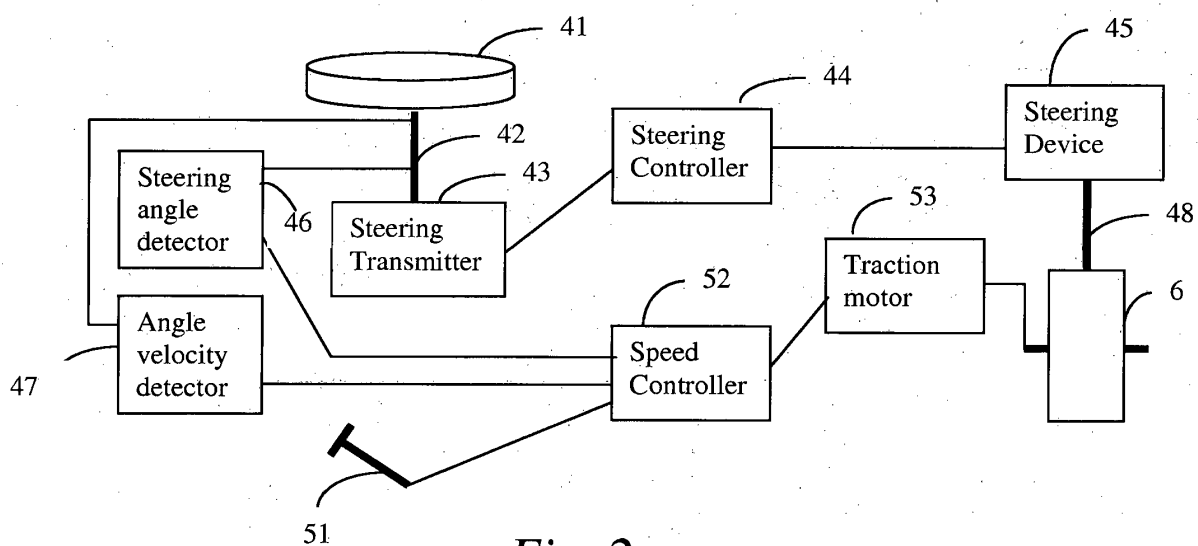
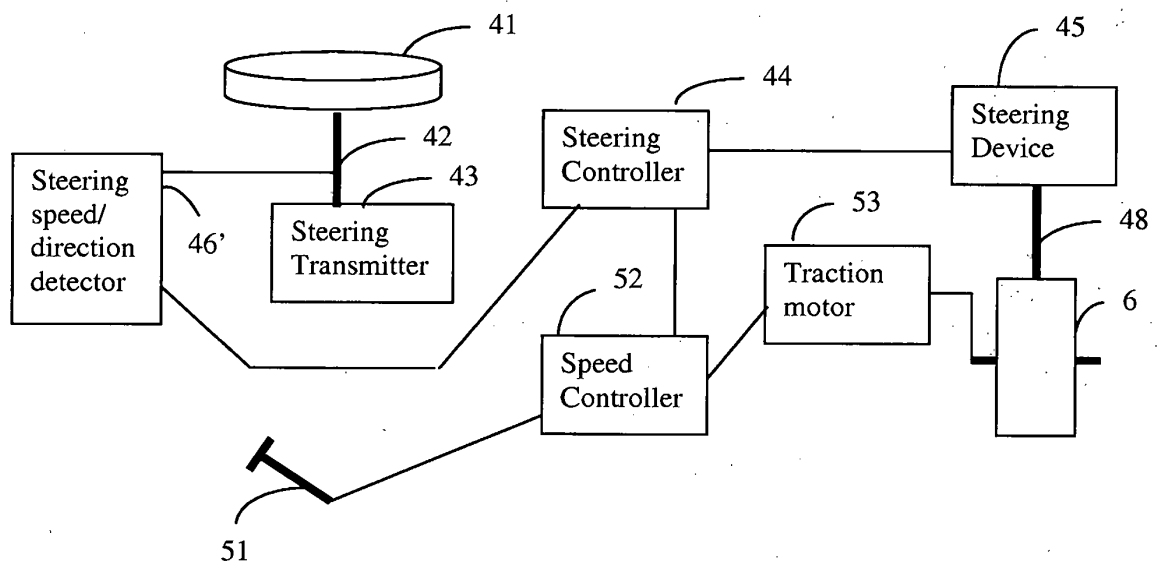
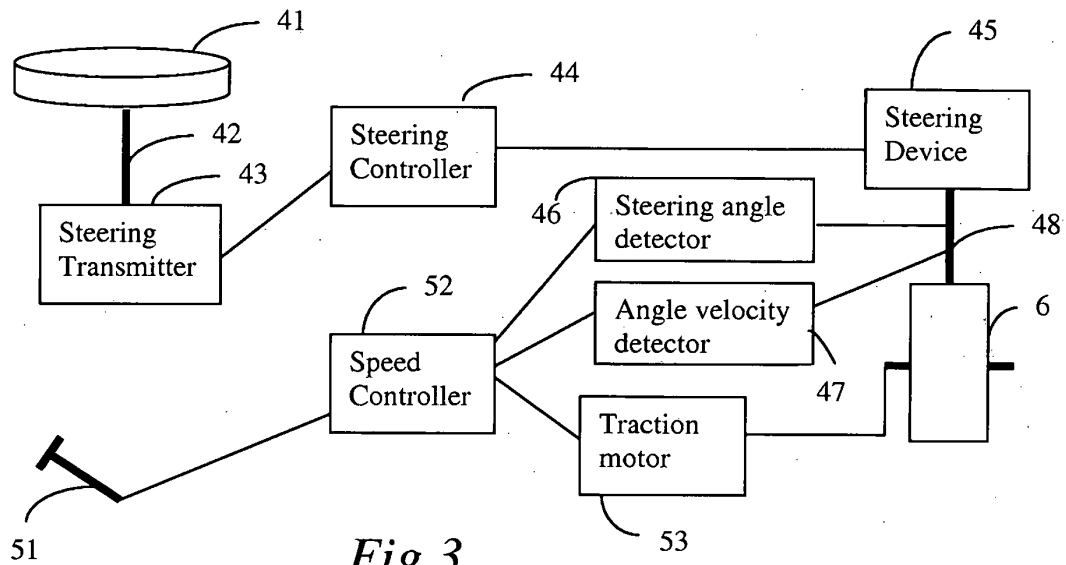
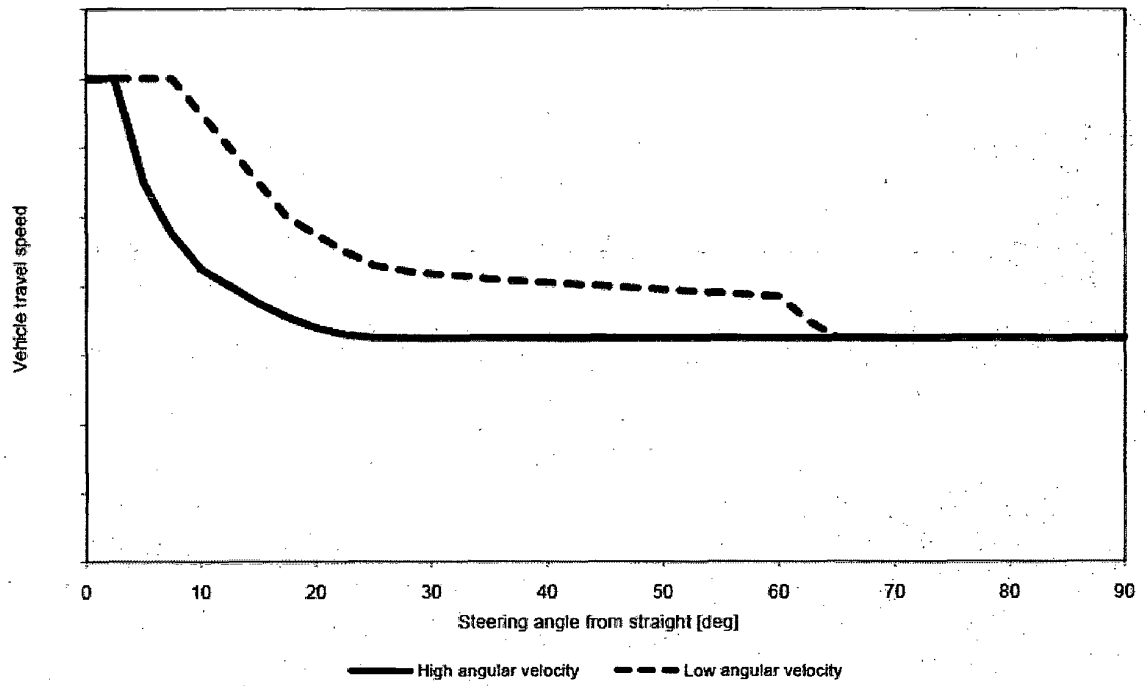


Fig. 2





1	T	2	3
1	T	2	

Fig 5

REFERENCES CITED IN THE DESCRIPTION

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