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(54) **Steering control for industrial lift truck**

(57) The invention relates to a control unit (90), a method and a computer program for controlling the steered wheel (20) of an industrial truck (10), where the truck (10) is of the steer-by-wire type. The steered wheel (20) has a first and a second rotational direction, which correspond to driving forward and driving backwards. The control unit (90) is adapted to receive an indication (100) from the operator of the truck. The control unit (90) is further adapted to analyse said indication (100) and

thereafter select one of at least two measures, where the first measure (130a) is to change the selected rotational direction, and where the second measure (130b) is to change the selected rotational direction and, in connection therewith to make sure that the steered wheel (20) has been sent at a predetermined steering angle (60). The control unit (90) is further adapted to generate and send a control instruction (150a, 150b) indication the selected measure.

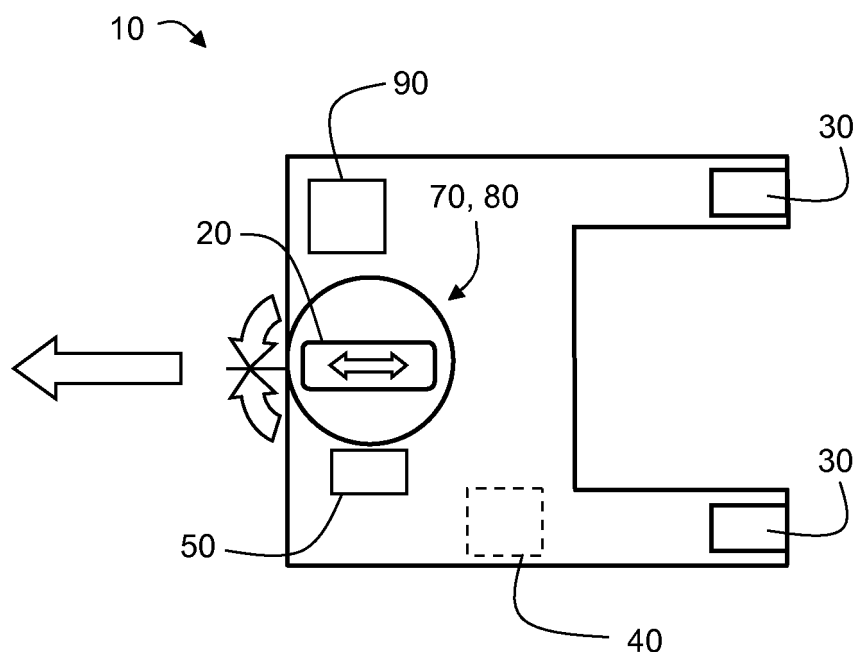


Fig 1

Description

TECHNICAL FIELD

[0001] The invention relates to a control unit and a method for controlling the steered wheel of an industrial truck, and a computer program which can cause a control unit to control the steered wheel of an industrial truck.

BACKGROUND

[0002] Freight is often transported and stored on pallets. After a truck operator has deposited a pallet in a location, by lowering the fork of the truck so that the pallet rests on the floor, the operator drives away from the pallet so that the forks are pulled out of the pallet. It is important in this operation that the truck moves straight away from the pallet, since the forks would otherwise collide with the pallet as they are being extracted. The operator must therefore drive straight back after leaving the pallet, and this means that the steered wheel of the truck must be in straight alignment.

[0003] In pillar trucks there is a physical and visible connection between the steered wheel and the pillar. There is thus no problem for the operator to set the steered wheel in straight orientation.

[0004] Certain trucks have an indicator, for example in the form of a compass rose, which shows the angle of the steered wheel(s). The indicator is however relatively inexact and the operator must still manually adjust or readjust the steered wheel(s) when the truck moves.

[0005] Document DE10204742 A1 describes a truck which is controlled with the aid of a joystick. When the joystick is released it returns to a neutral position where the truck is braked to a standstill and its steering can be centered (paragraphs 0018-0022).

SUMMARY OF THE INVENTION

[0006] One purpose of the present invention is to increase productivity and reduce waste when operating a fork lift truck.

[0007] The purpose is achieved by a control unit for controlling the steered wheel of an industrial truck where the truck is of the steer-by-wire type. The steered wheel has a first and a second rotational direction, which correspond to driving forward and driving backwards. The control unit is adapted to receive an indication from the operator of the truck. The control unit is further adapted to analyse said indication and thereafter select one of at least two measures, where the first measure is to change the selected direction of rotation, and where the second measure is to change the selected direction of rotation and, in connection therewith, to make sure that the steered wheel has been set at a predetermined steering angle. The control unit is further adapted to generate and send a control instruction indicating the selected measure.

[0008] The control unit can control the rotational direction of the steered wheel via a drive means which drives the steered wheel. Alternatively, the control unit can control the rotational direction of the steered wheel via drive means which drive the truck's other wheels.

[0009] Said control unit makes it possible for the truck operator to provide an indication which leads to the first measure; changing the direction between driving forward and driving backwards. Alternatively the truck operator can provide an indication which leads to the second measure; changing the direction between driving forward and driving backwards and at the same time automatically confirming the setting of the steering angle of the steered wheel. The operator can thus, by giving a single indication, switch between driving forward and driving backwards and determine the direction (the steering angle of the steered wheel). The operator thus has no need to manually, in a separate step, adjust the steering angle of the steered wheel i.e. with the aid of a separate steering mechanism such as a steering wheel or a joystick. Furthermore the control unit according to the invention makes sure that the steered wheel is set exactly at the predetermined angle, which can be difficult and/or time consuming for the operator to do.

[0010] That the control unit guarantees the steering angle of the steered wheel means that the control unit checks the steering angle of the steered wheel and when the steered wheel is not orientated to the predetermined steering angle it will effect an adjustment of the steering angle of the steered wheel.

[0011] The predetermined steering angle can involve driving straight forward or straight backwards. This is, for example, advantageous when the truck operator wishes to leave the load in confined spaces, for example on shelves in so called rack. The operator here leaves the load carefully and makes small adjustments with the steering wheel to see to it that the load is correctly placed. When the operator leaves the load he/she drives in the opposite direction, i.e. away from the load. Due to the fact that the operator has made adjustments prior to leaving the load, the truck may often start off slantingly at an angle, which may require a new compensation from the operator. This process can be time consuming and can even lead to the truck colliding with the merchandise or cargo. These problems are avoided by the control device according to the invention where the operator, through a single indication, can reverse the direction from driving forward to driving backwards in relation to the load and at the same time assure that the steered wheel has been set at a steering angle which moves the truck straight backwards.

[0012] The indication from the driver can be an indication which can affect the rotational direction of the steered wheel. An advantage of this is that the driver, when selecting the direction of drive, in this case away from the load, can also simply and intuitively affect the steering angle of the truck. A typical case has been described above, where the operator wishes to drive away from a

deposited load. Since it is often desirable to adjust the steering angle of the steered wheel in connection with changing the rotational direction of the steered wheel, it is advantageous to arrange the control unit so that said indication is an indication which can affect the rotational direction of the steered wheel.

[0013] The control unit can be adapted when analysing the indication, to compare the latest rotational direction of the steered wheel with the indicated rotational direction. The latest rotation direction means the rotational direction which the steered wheel has when the indication is received by the control unit, or the rotational direction which the steered wheel last had. Thus the control unit can be adapted to change the selected rotational direction if the latest rotational direction of the steered wheel does not agree with the indication. The control unit can comprise a processor and a memory in which inter alia the latest rotational direction of the steered wheel is stored.

[0014] The control unit can be coupled to an input device, with the aid of which the operator can provide said indication. Thus the control unit can be adapted so that a first type of actuation of the input device leads to the first measure and a second type of actuation of the input device leads to the second measure. This has the advantage that the operator can use a single input device to achieve either of the two measures. The input device is advantageously an input device for selecting the driving direction.

[0015] For example, the first type of actuation can be a temporary actuation of a resilient electric switch. The second sort of actuation can consist of the first type of actuation plus an additional actuation. The second type of actuation can for example consist of two temporary actuations of the switch in rapid sequence. In other words, the first type of actuation can be a single click, and the second type of actuation can be a double click. The control unit can be adapted to determine when the operator has made a double click actuation by measuring the time between the actuations of the switch.

[0016] The input device can consist of a push button. In this case a single push (single click) thereof can mean that the control unit will reverse the rotational direction of the steered wheel. Two pushes of the button in rapid succession (double click) can involve reversing the rotational direction of the steered wheel and assuring the setting of the steering angle of the steered wheel. Preferably the input device comprises two push buttons where a single click of the first push button provides an indication which, after analysis by the control unit, leads to the measure "drive forward" and the second push button when single clicked leaves to "drive backwards". Double clicking of the push buttons results for example in "drive straight forward" or "drive straight backwards" respectively.

[0017] The additional actuation can however take other forms. For example, if the input device is a spring-back joystick, which can be moved forward for driving forward

and backwards for driving backwards, the additional actuation can consist of the simultaneous depressing of the joystick, or the simultaneous pressing of a button on top of the joystick.

[0018] Many trucks are equipped with a drive direction selector in the form of a cradle for the operator's thumb. The cradle functions as a resilient rocker switch. By moving the cradle in one direction or the other, the operator can select "driving forward" or "driving backwards". Such a cradle is coupled to the control unit and functions as an input device. The operator can, in accordance with the invention, single click the cradle in one direction to, via the control unit, achieve driving in this direction (forward/backwards), and can double click the cradle in one direction to achieve straight driving in this direction (forward/backwards).

[0019] Should the latest rotational direction of the steered wheel agree with the rotational direction corresponding to an indication stemming from the first type of actuation, no measure is expected from the control unit. If however the indication stems from the second type of actuation, the control unit can be adapted to assure that the steered wheel is set at a predetermined steering angle. This corresponds for example to the operator driving or having driven forward and double clicking on the input device in the forward direction, whereupon the control unit sets the steered wheel so that the truck will drive straight forward. Thus the control unit can be adapted for a third measure, which is to assure that the steered wheel is set at a predetermined steering angle.

[0020] The control unit can be adapted to only provide the third measure when the truck is standing still, or when the truck has a low speed. The low speed is here meant to be for example at most 1 km/h. This will avoid the risk of the truck unintentionally changing the direction during driving as a result of unintentional operation of the input device. For this purpose, the control unit can monitor the speed of the truck, for example by monitoring the rpm of the steered wheel.

[0021] The control unit can furthermore be adapted to provide the operator with a confirmation after the rotational direction of the steered wheel has been changed and/or after the steered wheel has been set at the predetermined steering angle. The confirmation can be in the form of a sound or light signal. For example, the control unit, for this purpose, can be coupled to an indicator device and/or a sound generating means. The indicator device can comprise two driving direction indicators, for example in the form of lamps or indicators on a display. The driving direction indicators can show the current set direction of driving and blink during the time when the control device is setting the steering angle. After the steering angle has been set, the driving direction indicator will stop blinking and an auditory signal can be given. An auditory signal can also be intermittently generated during the time when the steering angle is being adjusted. Furthermore, or as an alternative, the control unit can be connected to vibratory means, which vibrates the input

device as the steering angle is being adjusted, or vibrates the input device for a short period when the setting of the steering angle has been completed.

[0022] The purpose can also be achieved by a truck which comprises the above mentioned control unit. The truck comprises then advantageously an input device for selecting the direction of driving, with the aid of which the operator can provide the indication. Furthermore, the truck can comprise driving direction indicators, sound generation means and/or vibration means for giving of the above mentioned confirmation. The invention is particularly suited to a reach truck.

[0023] The purpose can also be achieved by a method for controlling the steered wheel of a truck. The method comprises the steps of registering an indication, analysing said indication and selecting of at least two measures, where a first measure is changing the selected rotational direction and where the second measure is to change the selected rotational direction and in connection therewith to assure that the steered wheel has been set at a predetermined steering angle. Furthermore, the method comprises the steps of generating and sending a control instruction which indicates the selected measure and carrying out of said measure period.

[0024] Finally, the purpose can be achieved by a computer readable medium comprising a program recorded thereon, which program comprises computer readable code which when it is run on a processor is disposed to cause a control unit for controlling the steered wheel of a truck to perform the process comprising the steps of registering an indication from the truck operator, to analyse said indication and select one of at least two measures, where a first measure is to change the selected rotational direction and where the second measure is to change the selected rotational direction and in connection therewith to assure that the steered wheel has been set at predetermined steering angle. Furthermore the process comprises generating and sending a control instruction which indicates the selected measured period.

DESCRIPTION OF THE DRAWINGS

[0025] An example of the invention will be illustrated in the accompanying drawings where

Figure 1 illustrates a reach truck from below,

Figure 2 shows schematically a block diagram of a control unit and sensors connected thereto, and

Figure 3 illustrates a method of controlling the steered wheel of the truck.

DESCRIPTION OF EMBODIMENTS

[0026] The reach truck 10 shown schematically in Fig. 1 comprises a steered wheel 20, which in this case also

drives the truck, and therefore the steered wheel will in the following be referred to as a drive wheel 20, and two support leg wheels 30. The truck is also provided with input means in the form of a driving direction selector 40.

The driving direction selector 40 is constructed in a normal matter as a cradle in which the thumb or finger of the operator can rest.

[0027] The truck 10 is of the steer-by-wire type, which generally means that there is no mechanical coupling between the steered wheel and a steering means such as a steering wheel. The control of the steered wheel is instead achieved with the aid of electronics, which are actuated by the operation of the steering wheel and in turn actuate the steered wheel, for example hydraulically or electrically.

[0028] An angle sensor 50 is arranged to register the steering angle 60 of the drive wheel, which can be set by a steering motor 70 which can turn the drive wheel 20 about an axis which during use extends vertically through the wheel. A drive motor 80 drives the drive wheel 20 in a first and second rotational direction about an axis which extends during use horizontally through the wheel.

[0029] The truck 10 also comprises a control unit 90, to which the driving direction selector 40, the angle sensor 50, the steering 70 motor and the drive motor 80 are connected, as it shows schematically in Fig. 2. The control unit 90, the driving direction selector 40, the angle sensor 50, the steering motor 70 and the drive motor 80 can for example communicate with each other via a controller area network (CAN).

[0030] The control unit 90 and its function will now be described with reference to the method which is described in Fig. 3 and the block diagram in Fig. 2.

[0031] A driving direction indication 100 (forward/backwards, straight forward/ backwards) generated by the truck operator with the aid of the driving director selector 40 is supplied to the control unit 90. The indication is registered in a first step 110. In the next step 120, the indication 100 is analysed and one of at least two measures is selected.

[0032] The first measure 130a is to change the direction of driving (forward/ backwards). This occurs if the driving direction indication 100 does not agree with the current or latest driving direction of the truck 10. During the analysis 120 the current or latest driving direction of the truck is thus compared to the driving direction which corresponds to the driving direction indication 100. If the driving direction indication 100 agrees with the current or latest driving direction, there will be no measure taken. According to the present example, a single click on the cradle 10 leaves to the first measure 130a.

[0033] The second possible measure 130b is to reverse the driving direction (forward/ backwards) and to set the drive wheel 20 parallel to the supporting leg wheels 30. The second measure corresponds thus to the first measure plus an additional measure. According to the present example, a double click on the driving direction selector 40 can lead to the second measure 130b.

An example is that the driver has transported on the fork (not shown on the truck) running parallel to and above the supporting leg wheels 30, a load on a pallet to a predetermined location. The operator, before the fork has been lowered has been forced to steer the truck laterally to correctly adjust the position of the pallet. When the driver thereafter wishes to change the driving direction and at the same time set the drive wheel at an angle for driving in a direction straight away from the pallet, so that the forks of the truck can be extracted from the pallet without touching the pallet, the driver double clicks on the driving direction selector 40 in the direction away from the pallet. The control unit 10 then selects the second measure 130b, and the direction of driving can be changed and the drive wheel 20 will be set parallel to the supporting leg wheels 30.

[0034] In the subsequent step 140, a control instruction 150a, 150b, which indicates the selected measure, is generated and sent. The control instruction 150a, 150b is sent via CAN from the control unit 10 to the unit in question, in this case to the steering motor 70 and the drive motor 80.

[0035] The method comprises a last step 160 where the selected measure is carried out. In the example above, this corresponds to the steering motor 70 turning the drive wheel 20 to an angle which involves driving in the longitudinal direction of the forks (the angle illustrated in Fig. 1) and preparing the drive motor 80 upon acceleration by the operator to drive the drive wheel in a direction which involves driving away from the load (the direction illustrated by the left hand arrow in Fig. 1). Thus the drive wheel can be set parallel to the supporting leg wheels 30 before the truck 10 moves forward or backwards.

[0036] Should the driver double click on the driving direction selector 40 in the current driving direction (forward/backwards), the control unit 90 can be adapted to select the third measure which means setting the drive wheel parallel to the supporting leg wheels. In connection with the minor adjustments which the operator makes when placing a load, the operator can, in addition to adjusting the steering angle 60 can also alternately back or drive forward. When the load has been placed correctly, it is practical for the operator to simply be able to set the drive wheel straight so that the forks can pass out from under the pallet regardless of the latest rotational direction of the drive wheel. In other words, when the driver double clicks on the driving direction selector 40 in a direction away from the load, the control unit 10 can be adapted to assure that the steering angle 60 of the drive wheel 20 is for driving straight back from the load, regardless of the latest/current rotational direction of the drive wheel 20. This function can be deactivated during driving.

[0037] The control unit 90 can, with the aid of the angle sensor 50, monitor the steering angle 60 of the drive wheel 20. The angle sensor 50 can be coupled to the drive wheel 20 or to the steering motor 70. When the

control unit 90 is to make sure that the drive wheel 20 has been set at a desired steering angle 60, the control unit 90 can register in a first step the current steering angle 60, in a second step adjust the steering angle 60 with the aid of the steering motor 70 by sending the corresponding control instruction 150b to the steering motor 70, and the steering angle 60 can be continuously monitored by the angle sensor 50. In a last step, when the angle sensor 50 signals the desired steering angle 60, the control unit 90 can stop the movement of the steering motor 70. If the control unit, in a first step has already discovered that the drive wheel is at a desired angle, the setting process is terminated.

[0038] The control unit 90 can also control the rotational direction of the drive wheel 20. This takes place by giving the drive motor 80 a control instruction 150a from the control unit 90. Said control instruction 150a contains information concerning which direction the drive wheel 20 is to rotate in, and the desire of the rotational speed.

[0039] For the purpose of assuring that the truck 10 moves in the desired direction, the control instruction 150a can be sent to the drive motor 80 first after the control unit 90 has made sure that the drive wheel 20 has been set at a desired steering angle 60.

[0040] According to the above described example, the respective units communicate via CAN. However, the steering motor 70 and the drive motor 80 can be controlled directly from the control unit 90. The control instruction 150a, 150b corresponding to drive voltages which cause the steering- and drive motors 70, 80 to rotate in agreement with the size and polarity of the drive voltages. In a corresponding manner, the driving direction selector 40 and the angle sensor 50 can be connected in a conventional manner directly electrically to the input of the control unit 90.

[0041] The control unit 90 comprises a memory and a processor which can execute a computer program, whereby the control unit 90 can be caused to perform the above described process.

Claims

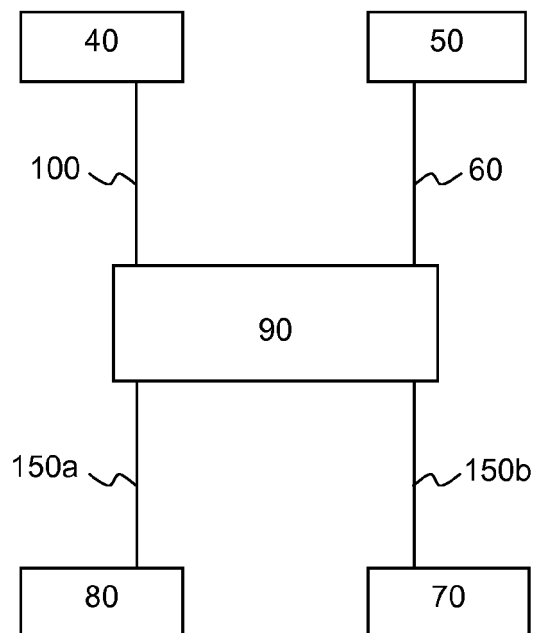
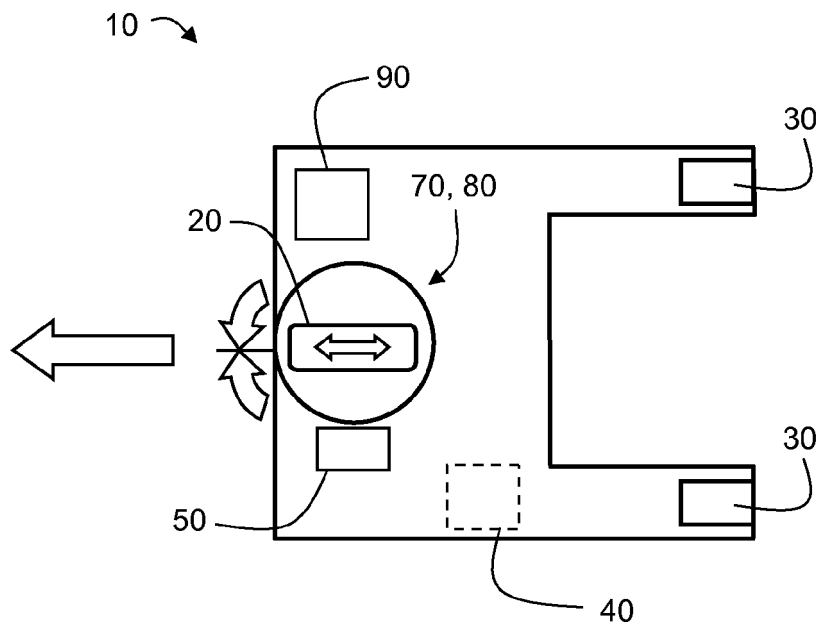
1. Control unit (90) for controlling the steered wheel (20) of an industrial truck (10), said steered wheel (20) having a first and a second rotational direction, said control unit (90) being adapted to receive an indication (100) from the operator of the truck, where the truck is of the steer-by-wire type, **characterized in that**

- the control unit (90) is adapted to analyse said indication (100) and thereafter select one of at least two measures,

- where a first measure (130a) is to change the selected rotational direction, and
- where a second measure (130b) is to

- change the selected rotational direction and, in connection therewith, to make sure that the steered wheel (20) has been set at a predetermined steering angle (60),
5
- said control unit (90) further being adapted to generate and send a control instruction (150a, 150b) which indicates the selected measure.
2. Control unit according to claim 1, wherein said steering angle (60) involves driving straight forward or straight backwards. 10
3. Control unit according to one of the proceeding claims 1-2, wherein said indication (100) is an indication which can affect the rotational direction of the steered wheel (20). 15
4. Control unit according to claim 2, wherein the control unit (90) is adapted, upon analysis of the indication (100), to compare the latest rotational direction of the steered wheel (20) with a rotational direction which the indication involves. 20
5. Control unit according to one of the proceeding claims 1-4, wherein the control unit (90) is coupled to input means (40), with the aid of which the operator can provide said indication (100), and the control unit is arranged so that a first type of actuation of the input means leads to the first measure (130a) and a second type of actuation of the input means leads to the second measure (130b). 25 30
6. Control unit according to one of the proceeding claims 1-5, wherein 35
- a third measure which the control unit (90) is adapted to select is to make sure that the steered wheel (20) is set at a predetermined steering angle (60). 40
7. Industrial truck comprising the control unit (90) according to one of the proceeding claims 1-6.
8. Truck according to claim 7, further comprising input means (40) for selecting the driving direction, with the aid of which the operator can provide the indication (100). 45
9. Method for controlling the steered wheel (20) of an industrial truck, comprising the steps of 50
- registering (110) an indication (100),
- analysing (120) said indication (100) and selecting of one of at least two measures, 55
- where a first measure (130a) is to change the selected rotational direction, and

- where a second measure (130b) is to change the selected rotational direction and in connection therewith to make sure that the steered wheel (20) has been set at a predetermined steering angle (60),
- generating and sending (140) a control instruction (150a, 150b) which indicates the selected measure (130a, 130b), and
- carrying out (160) said measure.
10. Computer readable medium comprising a program stored thereon, which program comprises computer readable code which, when it is run in a processor, is disposed to cause a control unit (90) for controlling the steered wheel (20) of an industrial truck to perform the process comprising the steps of
- registering (110) an indication (100) from the operator of the truck,
- analysing (120) said indication (100) and selecting of one of at least two measures,
- where a first measure (130a) is to change the selected rotational direction, and
• where a second measure (130b) is to change the selected rotational direction and in connection therewith to make sure that the steered wheel (20) has been set at a predetermined steering angle (60),
- generating and sending (140) a control instruction (150a, 150b) which indicates the selected measure (130a, 130b).



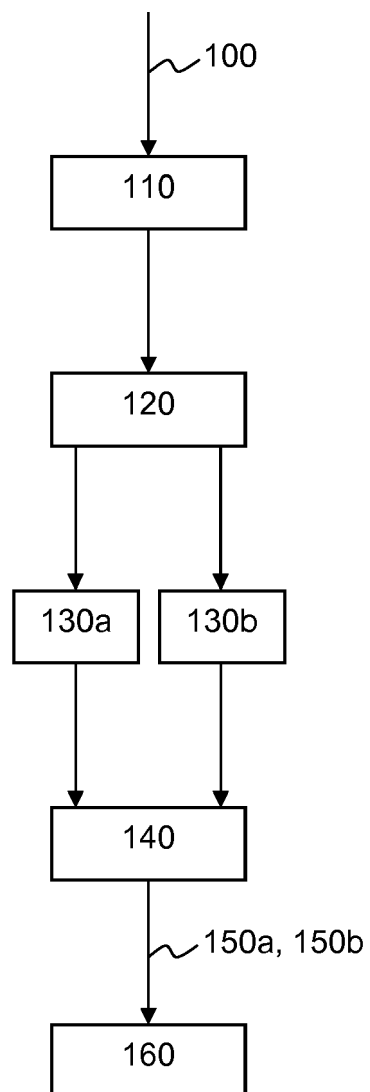


Fig 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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