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(54) **CONTROL OF A LIFTING DEVICE OF AN INDUSTRIAL TRUCK**

STEUERUNG EINER HUBVORRICHTUNG EINES FLURFÖRDERZEUGS

COMMANDE D'UN DISPOSITIF DE LEVAGE D'UN CHARIOT DE MANUTENTION

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Description

TECHNICAL FIELD

[0001] The invention concerns in general the technical field of industrial trucks. More particularly, the invention concerns controlling of a lifting device of an industrial truck.

BACKGROUND

[0002] Industrial trucks are important devices for handling of loads e.g. in warehouses and similar. Figure 1 illustrates schematically an example of an industrial truck according to a prior art. The industrial truck may comprise a body part 110 and a lifting device 120. The body part 110 may comprise among other entities a motor for enabling a motion of the industrial truck and control devices for allowing a control of the industrial truck by an operator of the truck. The lifting device 120 may comprise a mast structure 130 along which a load tool 140 may be lifted and lowered in accordance with control operations performed by the operator of the truck. In Figure 1 the load tool 140 is so-called fork tool, but it may be selected in accordance with a type of load to be handled with the industrial truck.

[0003] A control of a lifting operation and a lowering operation of the lifting device 120 are important tasks in view of an overall operation of the industrial truck. The lifting operation is typically performed so that the motor of the industrial truck is controlled to generate a force causing the lifting of the load tool 140 along the mast 130 through increasing a pressure in one or more hydraulic cylinders of the lifting device 120. Depending on the truck type the mast 130 may also be implemented so that it may be extended in order to reach higher heights during the operation of the industrial truck. During the lifting operation so-called lift cylinder is filled in with a hydraulic agent applied in a hydraulic implementation and an amount of the hydraulic agent in a cylinder is dependent on the height of the load tool 140 of the lifting device 120. Some non-limiting examples of the hydraulic agent used by applicable cylinders may e.g. be any applicable liquid, such as oil.

[0004] Now, at some point the operator of the industrial truck generates a control operation to cause a lowering of the load tool 140. This may cause a generation of an electrical signal to an electrically actuatable valve which, in turn, causes a leakage of the hydraulic agent from the cylinder enabling the lowering of the load tool 140. In accordance with prior art solutions the controlling of the lowering valve is performed by pre-defining a control ramp, or a control curve, for the lowering valve in order to optimize a motion of the lifting device 120 during the lowering phase. Figure 2 illustrates schematically such a control ramp according to prior art wherein it is shown a control signal, i.e. a control current of the lowering valve, as a function of time. As may be derived from Figure 2 by

increasing the control current to the lowering valve the lowering motion accelerates until the lowering valve reaches its maximum operational speed set for the lowering motion and by maintaining the control current steady the lifting device 120 may be caused to lower down at a steady speed.

[0005] The solution according to prior art is a compromise and has a drawback that it does not operate optimally with different amounts of loads. For example, in some situations, especially with heavy loads, applying the control ramp as shown in Figure 1 may cause bouncing of the load during the lowering phase which is an undesired effect, and even dangerous at some instances.

[0006] Documents WO 99/16698 A1 and WO 2016/160113 A2 describe methods for controlling a lowering motion of a lifting device and lifting devices that make use of such technology. WO 99/16698 discloses the features corresponding to the preamble of claim 1.

[0007] Hence, there is a need to introduce novel approaches for handling of loads.

SUMMARY

[0008] The following presents a simplified summary in order to provide basic understanding of some aspects of various invention embodiments. The summary is not an extensive overview of the invention. It is neither intended to identify key or critical elements of the invention nor to delineate the scope of the invention. The following summary merely presents some concepts of the invention in a simplified form as a prelude to a more detailed description of exemplifying embodiments of the invention.

[0009] An object of the invention is to present a method, a control unit, an industrial truck and a computer program for controlling a lifting device. The objects of the invention are reached by a method, a control unit, an industrial truck and a computer program for controlling a lifting device as defined by the respective independent claims.

[0010] According to the invention, there is provided a method for controlling a lowering motion of a lifting device of an industrial truck, the method, performed by a control unit of the industrial truck, comprises:

determining a weight of a load dependent control ramp, wherein the weight of the load dependent control ramp defines values of a control signal as a function of time to cause the lifting device to reach its maximum lowering speed, the weight of the load dependent control ramp is determined by:

selecting the load dependent control ramp among a plurality of the weight of the load dependent control ramps; or
generating the load dependent control ramp by scaling a reference control ramp in accordance with the weight of the load; and

generating at least one control signal to at least one valve controlling at least in part the lowering motion of the lifting device, the at least one control signal carrying data corresponding to a weight of a load dependent control ramp.

[0011] The method may further comprise: determining a weight of a load carried by the lifting device. For example, a determination of the weight of the load may be performed by one of: obtaining measurement data from at least one sensor configured to measure the weight of the load; obtaining data representing the weight of the load from data storage; obtaining a parameter from a lift motor being dependent of the weight of the load. The determination of the weight may be performed in response to a detection of a control signal causing an initiation of the lowering motion of the lifting device.

[0012] The control ramp dedicated to the load having a weight in a first range may be defined to allow reaching of a maximum speed of the lowering motion faster than the control ramp dedicated to the load having a weight in a second range. For example, the weight in the first range may be less than the weight in the second range.

[0013] According to the invention, there is provided a control unit of an industrial truck for controlling a lowering motion of a lifting device of an industrial truck, the control unit is configured to:

determine a weight of a load dependent control ramp, wherein the weight of the load dependent control ramp defines values of a control signal as a function of time to cause the lifting device to reach its maximum lowering speed, the weight of the load dependent control ramp is determined by:

selecting the load dependent control ramp among a plurality of the weight of the load dependent control ramps; or
generating the load dependent control ramp by scaling a reference control ramp in accordance with the weight of the load; and

generate at least one control signal to at least one valve controlling at least in part the lowering motion of the lifting device, the at least one control signal carrying data corresponding to a weight of a load dependent control ramp.

[0014] The control unit may further be configured to: determine a weight of a load carried by the lifting device. For example, the control unit may be configured to perform a determination of the weight of the load by one of: obtaining measurement data from at least one sensor configured to measure the weight of the load; obtaining data representing the weight of the load from data storage; obtaining a parameter from a lift motor being dependent of the weight of the load. The control unit may be configured to perform the determination of the weight in

response to a detection of a control signal causing an initiation of the lowering motion of the lifting device.

[0015] The control unit may be configured to define the control ramp dedicated to the load having a weight in a first range to allow reaching of a maximum speed of the lowering motion faster than the control ramp dedicated to the load having a weight in a second range. For example, the weight in the first range may be less than the weight in the second range.

[0016] According to third aspect, an industrial truck is provided, the industrial truck comprising: a lifting device; at least one valve controlling at least in part a lowering motion of the lifting device; and a control unit according to the second aspect as defined above.

[0017] According to a fourth aspect, a computer program is provided, the computer program comprising computer readable program code configured to cause performing of the method according to the first aspect as defined above when said program code is run on one or more computing apparatuses.

[0018] The expression "a number of" refers herein to any positive integer starting from one, e.g. to one, two, or three.

[0019] The expression "a plurality of" refers herein to any positive integer starting from two, e.g. to two, three, or four.

[0020] Various exemplifying and non-limiting embodiments of the invention both as to constructions and to methods of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific exemplifying and non-limiting embodiments when read in connection with the accompanying drawings.

[0021] The verbs "to comprise" and "to include" are used in this document as open limitations that neither exclude nor require the existence of unrecited features. The features recited in dependent claims are mutually freely combinable unless otherwise explicitly stated. Furthermore, it is to be understood that the use of "a" or "an", i.e. a singular form, throughout this document does not exclude a plurality.

BRIEF DESCRIPTION OF FIGURES

[0022] The embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings.

Figure 1 illustrates schematically an industrial truck according to prior art.

Figure 2 illustrates schematically a control ramp of a lowering valve according to prior art.

Figure 3 illustrates schematically a lifting device according to an example.

Figure 4 illustrates schematically a method accord-

ing to an example.

Figure 5 illustrates schematically data structure applicable in a method according to an example.

Figure 6 illustrates schematically selectable control ramps according to an example.

Figure 7 illustrates schematically a control unit according to an example.

DESCRIPTION OF THE EXEMPLIFYING EMBODIMENTS

[0023] The specific examples provided in the description given below should not be construed as limiting the scope and/or the applicability of the appended claims. Lists and groups of examples provided in the description given below are not exhaustive unless otherwise explicitly stated.

[0024] Figure 3 illustrates schematically an example of a lifting device 120 of an industrial truck for describing at least some aspects relating to a lowering of a load tool 140. The industrial truck may e.g. be an electrically operated or using gasoline as fuel. A non-limiting example of the industrial truck may be so-called counterweight truck. In Figure 3 corresponding reference numbers are used with Figure 1 illustrating an industrial truck according to prior art. As mentioned, Figure 3 illustrates schematically the lifting device 120 of the industrial truck so as to allow describing at least some aspects according to an example. The lifting device 120 comprises a mast 130 and a load tool 140 as well as one or more hydraulic cylinders 220 coupled e.g. between an entity of the load tool 140 and a base of the industrial truck so as to allow a motion of the load tool 140 along the mast 130 under control of the one or more hydraulic cylinders 220. Generally speaking, the coupling of the one or more cylinders is arranged so that the fixing points at different ends of a cylinder are selected so that they allow the motion of the entities with respect to each other so that the load tool 140 may be moved upwards and downwards. More specifically, in response to a detection of a control operation of the operator indicating an upward movement of the load tool 140 an increase of a pressure of the hydraulic agent in the hydraulic cylinders 220 is generated to cause the movement upwards. Still further, the lifting device 120 of the industrial truck comprises further a controllable valve 230 to enable decreasing the pressure in the hydraulic cylinders 220. The decrease of the pressure may e.g. be achieved by leaking the hydraulic agent, such an applicable liquid like oil, out from the respective hydraulic cylinders 220. Depending on the type of cylinders 220 the hydraulic agent may be released to a container, such as a tank, to be re-used during upward movement of the load tool 140 by controlling the controllable valve 230, or valves 230, with electrical control signal. For sake of completeness, the location of the controllable valve

230 may be dependent on a type of the cylinder 220, and it may e.g. reside at the body part 110 of the industrial truck with the container.

[0025] The lifting device 120 as described may further comprise a control unit 210 which may be configured to generate the control signal to control the controllable valve 230. The control unit 210 may also be configured to receive input from a number of sources of the industrial truck, such as from the lifting device 120 itself and/or from other entities. As a non-limiting example of sources of input to the control unit 210 one or more sensors 240 operatively mounted to the industrial truck as well as a lift motor controlling the at least one cylinder may be mentioned. For example, the control unit 210 may be configured to receive data from a number of sensors by means of which it may evaluate a weight of the load the lifting device 120 carries at least during a lowering motion. Another non-limiting example of the source of input may be one or more controller devices operable by the operator of the industrial truck, such as an input device for controlling the lifting device 120. For sake of completeness it is worthwhile to mention that the control unit 210 may be a master control unit of the industrial truck or it may be a sub-controller to the master control unit wherein the sub-controller may operate as a slave to the master controller of the industrial truck.

[0026] Next, some further aspects are described by referring to Figure 4 illustrating schematically an example of a method for controlling an operation of an industrial truck especially when lowering the load tool 140 of the lifting device 210. In accordance to the example of Figure 4 a control unit 210 of the industrial truck may be configured to determine 410 at least a value representing a weight of a load carried by the lifting device 120 either directly or indirectly. The determination 410 of the weight may e.g. be performed on a basis of data received from a sensor 240 wherein a type of sensor 240 is such that it may generate measurement data representing a weight of the load either directly or indirectly. Some non-limiting examples of applicable sensors 240 may be a pressure sensor, a strain gauge, a parameter obtainable from a lift motor which is dependent of the weight of the load, such as a value representing a torque or a force of the lift motor, like a control current of the motor. In some other examples, the control unit 210 may receive data representing the weight from other sources, such as from data storage implemented e.g. as a database accessible by the control unit 210. For example, the control unit 210 may be configured to identify the load e.g. with a reader device mounted in the industrial truck and inquiry the data representing the weight from the database with the identifier. In accordance with some examples the control unit 210 may e.g. generate a detection that the lifting device 120 carries a load based on the data representing weight, or through other kind of detection, or that the lifting device 120 does not carry any weight.

[0027] Furthermore, the at least one sensor 240, and the operation with the control unit 210, may advanta-

geously be arranged so that the determination of the weight may be performed with an accuracy serving over-all targets of the example as is described in the description herein. In the determination of the weight of the load a weight of at least some entities of the lifting device 120 may be taken into account, e.g. by utilizing information from other sensors from which it is possible to determine the parts of the lifting device 120 causing weight in the measurement, and which may then be filtered out in order to know the weight of the load.

[0028] In response to the determination 410 of the value representing the weight of the load the control unit 210 may be arranged to determine 420 a control ramp for controlling the valve 230. The determination 420 of the control ramp may be performed by selecting the load dependent control ramp among a plurality of control ramps, or control curves, selectable by the control unit 210. For example, the plurality of the control ramps may be predefined and stored in a memory accessible by the control unit 210. The memory may be internal or external to the control unit 210. In other words, a processing entity of the control unit 210 may be arranged to inquire the control ramp to be applied to from the memory. The determination 420 of the control ramp may be performed by using a value representing a weight of the load, or any other value derivable from the weight, and compare it with a number of comparison values. Figure 5 illustrates schematically a non-limiting example of a data structure defining comparison values and control ramps corresponding to the comparison values. The control ramps may e.g. be defined so that a control ramp A shall be applied to loads below a weight W1, a control ramp B shall be applied to loads between weights W1 and W2, and a control ramp C shall be applied to loads above a weight W2 wherein W1 and W2 shall be understood as comparison values and the control ramp A, B, and C as corresponding control ramps selectable in accordance with the definitions shown in Figure 5. In some examples, a control ramp for a determined weight of the load may be generated by interpolating it from pre-defined control ramps to achieve stepless transition between pre-defined control ramps. As a non-limiting example, if it is determined that the weight of the load is between the comparison values W1 and W2, the ramp B is selected. By performing the described operation, the control unit 210 may retrieve the respective ramp from the memory. The control ramp defines values of the control signal of the valve 230 in accordance with time, for example. In case the valve may be controlled with an electrical signal, the control ramp comprises values of an electrical signals, such as a control current values, as a function of time to be provided by the control unit 210 to the valve 230 in order to control an operation of the hydraulic cylinder 220 as described. In other words, in response to the receipt of the selected control ramp the control unit 210 may be configured to generate 430 a control signal in accordance with the values of the selected control ramp to the valve 230 so as to control the lowering motion

of the lifting device 120. For sake of clarity it is worthwhile to mention that the generated control signal is defined as values corresponding to a parameter used for controlling the valve 230 in question. As a non-limiting example, a typical alternative to the control current may be a control voltage.

[0029] In the description of some aspects of the invention it is mainly indicated that the weight of the load is a primary criterion in the selection of the control ramp to the valve 230. In some other examples, there may be applied further data in the selection together with the weight of the load information. For example, in some implementation the control unit 210 may receive a data value representing a height of the load at an instant of time and it may be used, together with the weight of the load information, in the selection of the control ramp. In this kind of approach the data structure may be defined as two-dimensional so that a certain control ramp is selected if both a first criteria defined for the weight of the load and a second criteria defined for the height of the load corresponding to the respective control ramp are fulfilled to. Moreover, in this kind of implementation wherein at least one of the criteria is constantly changing during a motion of the lifting device 120, the control ramp may also be reselected during the motion.

[0030] Moreover, in the above give description it is indicated that the control ramps may be predefined in advance and stored in the memory for selection. Alternatively or in addition, the determination 420 of the control ramp may be performed so that a so-called reference control ramp is stored in a memory accessible by the control unit 210, which may be mathematically modified at least in accordance with the weight of the load in response to a receipt of at least the weight information. This kind of scaling approach may also generate a plurality of control ramps for each need and, hence, the determination 420 of the control ramp may be performed. Naturally, the control unit 210 may be configured to apply a pre-defined mathematical formula for scaling the control ramp e.g. in a stepless manner.

[0031] The implementation of the method may be initiated in response to a detection of a predefined event. The predefined event may e.g. relate to a controlling of the industrial truck by the operator of the truck. For example, it may be detected that the operator provides an instruction through a user interface to cause a lowering of the load tool 140, or the lifting device 120, in general and the lowering instruction triggers an application of the method by the control unit 210 and the determination of the load may be initiated in a manner as described.

[0032] The described method provides a way to apply an optimal control ramp to the lowering motion of the lifting device 120 in accordance with the weight of the load carried with the lifting device 120 of the industrial truck. In other words, a load weight dependent control ramp, or control curve, may be used for controlling the valve 230. Figure 6 illustrates schematically two possible

load weight dependent control ramps for controlling the valve 230 in a lowering motion which may either be selectable or scalable from the reference control ramp at least in accordance with the weight of the load information. As indicated in Figure 6 one of the control ramps may be defined for a situation that the lifting device 120 does not carry any load whereas the other control ramp may be defined for a situation that a load is carried by the lifting device 120. As mentioned, the respective control ramps define values of a control signal, i.e. a control current (mA), to the lowering valve 230 as a function of time (ms). As may be seen from Figure 6 in advantageous examples the control ramps are defined so that with a smaller load the maximum lowering speed is reached faster than in a situation that the lifting device 120 carries load. In this manner, it is possible to mitigate the drawbacks of the prior art solutions, such as mitigating a bouncing effect especially with heavy loads, but also to increase an operation of the industrial truck with low weights since the lowering operation may be finalized faster. As already discussed, it is possible to define more than two control curves for determination and it may be advantageous especially in situations where the industrial truck operates in environment where weights of the possible loads varies a lot.

[0033] The industrial truck may comprise a control unit 210 for performing a method according to at least some examples. Figure 7 illustrates schematically as a block diagram an example of the control unit 210 applicable in the industrial truck. The block diagram of Figure 7 depicts some components of an apparatus that may be employed to implement the control unit 210. The apparatus comprises a processor 710 and a memory 720. The memory 720 may store data and computer program code 725, such as the control ramps to be applied by the processor 710 in the manner as described. The apparatus may further comprise communication means 730 for wired or wireless communication with other apparatuses, such as with the lifting device 120 and sensors 240, and other entities of the industrial truck, such as I/O components providing e.g. a user interface with the user of the industrial truck. The components of the apparatus may be communicatively connected to each other via a bus 740 that enables transfer of data and control information between the components.

[0034] The memory 720 and a portion of the computer program code 725 stored therein may be further arranged, with the processor 710, to cause the apparatus, i.e. the control unit 210, to perform a method as described herein. The processor 710 may be configured to read from and write to the memory 720. Although the processor 710 is depicted as a respective single component, it may be implemented as respective one or more separate processing components. Similarly, although the memory 720 is depicted as a respective single component, it may be implemented as respective one or more separate components, some or all of which may be integrated/removable and/or may provide permanent / semi-perma-

nent/ dynamic/cached storage.

[0035] The computer program code 725 may comprise computer-executable instructions that implement functions that correspond to steps of the method as described when loaded into the processor 710. As an example, the computer program code 725 may include a computer program consisting of one or more sequences of one or more instructions. The processor 710 is able to load and execute the computer program by reading the one or more sequences of one or more instructions included therein from the memory 720. The one or more sequences of one or more instructions may be configured to, when executed by the processor 710, cause the apparatus to perform the method according to an example. Hence, the apparatus may comprise at least one processor 710 and at least one memory 720 including the computer program code 725 for one or more programs, the at least one memory 720 and the computer program code 725 configured to, with the at least one processor 710, cause the apparatus to perform the method as described.

[0036] The computer program code 725 may be provided e.g. a computer program product comprising at least one computer-readable non-transitory medium having the computer program code 725 stored thereon, which computer program code 725, when executed by the processor 710 causes the apparatus to perform the method. The computer-readable non-transitory medium may comprise a memory device or a record medium such as a CD-ROM, a DVD, a Blu-ray disc or another article of manufacture that tangibly embodies the computer program. As another example, the computer program may be provided as a signal configured to reliably transfer the computer program.

[0037] Still further, the computer program code 725 may comprise a proprietary application, such as computer program code for controlling the lowering motion of the lifting device 120. The proprietary application may be a client application of a service whose server application is running on a server apparatus of the system e.g. in a situation where the industrial truck is at least in part controlled externally to the industrial truck. The proprietary application may e.g. detect aspects representing a status of the lifting device 120 as well as generate control operations accordingly, for example.

[0038] Any of the programmed functions mentioned may also be performed in firmware or hardware adapted to or programmed to perform the necessary tasks.

[0039] Some aspects of the present invention may refer to an industrial truck implementing the method as described utilizing at least a control unit 210 in the manner as described.

[0040] For sake of completeness it is worthwhile to mention that at least some aspects of the non-limiting examples covered in the foregoing description are described in an environment wherein the valve operates so that the more control current is provided to the valve the more open it is and, as a result, the faster the pressure in

the hydraulic cylinder decreases. However, in some examples the valve may operate vice versa i.e. the less current is provided, the more open the valve is. Hence, the method may be adjusted accordingly to meet the type of the valve applied to the implementation.

[0041] Further, some aspects relating to the present invention are mainly described in the foregoing description with an industrial truck comprising hydraulic cylinders. However, the principle of the present invention is also applicable with other types of cylinders, such as pneumatic cylinders.

[0042] The specific examples provided in the description given above should not be construed as limiting the applicability and/or the interpretation of the appended claims. Lists and groups of examples provided in the description given above are not exhaustive unless otherwise explicitly stated.

Claims

1. A method for controlling a lowering motion of a lifting device (120) of an industrial truck, **characterized in that** the method, performed by a control unit (210) of the industrial truck, comprises:

determining (420) a weight of a load dependent control ramp, wherein the weight of the load dependent control ramp defines values of a control signal as a function of time to cause the lifting device (120) to reach its maximum lowering speed, the weight of the load dependent control ramp is determined (420) by:

selecting the load dependent control ramp among a plurality of the weight of the load dependent control ramps; or
generating the load dependent control ramp by scaling a reference control ramp in accordance with the weight of the load; and

generating (430) at least one control signal to at least one valve (230) controlling at least in part the lowering motion of the lifting device (120), the at least one control signal carrying data corresponding to the weight of the load dependent control ramp.

2. The method of claim 1, the method further comprising:
determining (410) a weight of a load carried by the lifting device (120).
3. The method of claim 2, wherein a determination of the weight of the load is performed by one of: obtaining measurement data from at least one sensor (240) configured to measure the weight of the load; obtaining data representing the weight of the load from data

storage; obtaining a parameter from a lift motor being dependent of the weight of the load.

4. The method of claim 2 or claim 3, wherein the determination of the weight is performed in response to a detection of a control signal causing an initiation of the lowering motion of the lifting device (120).
5. The method of any of preceding claims, wherein the control ramp dedicated to the load having a weight in a first range is defined to allow reaching of a maximum speed of the lowering motion faster than the control ramp dedicated to the load having a weight in a second range.
6. The method of claim 5, wherein the weight in the first range is less than the weight in the second range.
7. A control unit (210) of an industrial truck for controlling a lowering motion of a lifting device (120) of an industrial truck, **characterized in that** the control unit (210) is configured to:

determine (420) a weight of a load dependent control ramp, wherein the weight of the load dependent control ramp defines values of a control signal as a function of time to cause the lifting device (120) to reach its maximum lowering speed, the weight of the load dependent control ramp is determined (420) by:

selecting the load dependent control ramp among a plurality of the weight of the load dependent control ramps; or
generating the load dependent control ramp by scaling a reference control ramp in accordance with the weight of the load; and

generate (430) at least one control signal to at least one valve (230) controlling at least in part the lowering motion of the lifting device (120), the at least one control signal carrying data corresponding to a weight of a load dependent control ramp.

8. The control unit (210) of claim 7, the control unit (210) further configured to:
determine (410) a weight of a load carried by the lifting device (120).
9. The control unit (210) of claim 8, wherein the control unit (210) is configured to perform a determination of the weight of the load by one of: obtaining measurement data from at least one sensor (240) configured to measure the weight of the load; obtaining data representing the weight of the load from data storage; obtaining a parameter from a lift motor being dependent of the weight of the load.

10. The control unit (210) of claim 8 or claim 9, wherein the control unit (210) is configured to perform the determination of the weight in response to a detection of a control signal causing an initiation of the lowering motion of the lifting device (120). 5
11. The control unit (210) of any of preceding claims 7 to 10, wherein the control unit (210) is configured to define the control ramp dedicated to the load having a weight in a first range to allow reaching of a maximum speed of the lowering motion faster than the control ramp dedicated to the load having a weight in a second range. 10
12. The control unit (210) of claim 11, wherein the weight in the first range is less than the weight in the second range. 15
13. An industrial truck, the industrial truck comprising: 20
- a lifting device (120),
at least one valve (230) controlling at least in part a lowering motion of the lifting device (120), and
a control unit (210) according to any of claims 8 to 14. 25
14. A computer program comprising computer readable program code configured to cause performing of the method according to any of claims 1 to 6 when said program code is run on a control unit (210) according to any of claims 7 to 30

Patentansprüche

1. Verfahren zum Steuern einer Absenkbewegung einer Hebevorrichtung (120) eines Flurförderzeugs, **dadurch gekennzeichnet, dass** das von einer Steuereinheit (210) des Flurförderzeugs ausgeführte Verfahren Folgendes umfasst:
Bestimmen (420) eines Gewichts einer lastabhängigen Steuerrampe, wobei das Gewicht der lastabhängigen Steuerrampe Werte eines Steuersignals als Funktion der Zeit definiert, um zu bewirken, dass die Hebevorrichtung (120) ihre maximale Absenkgeschwindigkeit erreicht, wobei das Gewicht der lastabhängigen Steuerrampe bestimmt (420) wird durch:

Auswählen der lastabhängigen Steuerrampe aus einer Vielzahl von Gewichten der lastabhängigen Steuerrampen; oder
Erzeugen der lastabhängigen Steuerrampe durch Skalieren einer Referenz-Steuerrampe entsprechend dem Gewicht der Last; und
Erzeugen (430) mindestens eines Steuersignals an mindestens ein Ventil (230), das die Absenkbewegung der Hebevorrichtung (120) 35

mindestens teilweise steuert, wobei das mindestens eine Steuersignal Daten enthält, die dem Gewicht der lastabhängigen Steuerrampe entsprechen.

2. Verfahren nach Anspruch 1, das Verfahren ferner umfassend:
Bestimmen (410) eines Gewichts einer von der Hebevorrichtung (120) getragenen Last. 40
3. Verfahren nach Anspruch 2, wobei eine Bestimmung des Gewichts der Ladung auf eine der folgenden Weisen durchgeführt wird: Erhalten von Messdaten von mindestens einem Sensor (240), der konfiguriert ist, um das Gewicht der Last zu messen; Erhalten von Daten, die das Gewicht der Last darstellen, aus einem Datenspeicher; Erhalten eines vom Gewicht der Last abhängigen Parameters von einem Hubmotor. 45
4. Verfahren nach Anspruch 2 oder Anspruch 3, wobei die Bestimmung des Gewichts als Reaktion auf die Erfassung eines Steuersignals erfolgt, das eine Einleitung der Absenkbewegung der Hebevorrichtung (120) bewirkt. 50
5. Verfahren nach einem der vorstehenden Ansprüche, wobei die für die Last mit einem Gewicht in einem ersten Bereich vorgesehene Steuerrampe so definiert ist, dass eine maximale Geschwindigkeit der Absenkbewegung schneller erreicht werden kann als mit der für die Last mit einem Gewicht in einem zweiten Bereich vorgesehenen Steuerrampe. 55
6. Verfahren nach Anspruch 5, wobei das Gewicht im ersten Bereich geringer ist als das Gewicht im zweiten Bereich.
7. Steuereinheit (210) eines Flurförderzeugs zum Steuern einer Absenkbewegung einer Hebevorrichtung (120) eines Flurförderzeugs, **dadurch gekennzeichnet, dass** die Steuereinheit (210) konfiguriert ist, um:
ein Gewicht einer lastabhängigen Steuerrampe zu bestimmen (420), wobei das Gewicht der lastabhängigen Steuerrampe Werte eines Steuersignals als Funktion der Zeit definiert, um zu bewirken, dass die Hebevorrichtung (120) ihre maximale Absenkgeschwindigkeit erreicht, wobei das Gewicht der lastabhängigen Steuerrampe bestimmt (420) wird durch:

Auswählen der lastabhängigen Steuerrampe aus einer Vielzahl von Gewichten der lastabhängigen Steuerrampen; oder
Erzeugen der lastabhängigen Steuerrampe durch Skalieren einer Referenz-Steuerrampe entsprechend dem Gewicht der Last; und

Erzeugen (430) mindestens eines Steuersignals an mindestens ein Ventil (230), das die Absenkbewegung der Hebevorrichtung (120) mindestens teilweise steuert, wobei das mindestens eine Steuersignaldaten enthält, die einem Gewicht einer lastabhängigen Steuer-
rampe entsprechen.

8. Steuereinheit (210) nach Anspruch 7, wobei die Steuereinheit (210) ferner konfiguriert ist, um: ein Gewicht einer von der Hebevorrichtung (120) getragenen Last zu bestimmen (410).
9. Steuereinheit (210) nach Anspruch 8, wobei die Steuereinheit (210) konfiguriert ist, um eine Bestimmung des Gewichts der Last auf eine der folgenden Weisen durchzuführen: Erhalten von Messdaten von mindestens einem Sensor (240), der konfiguriert ist, um das Gewicht der Last zu messen; Erhalten von Daten, die das Gewicht der Last darstellen, aus einem Datenspeicher; Erhalten eines vom Gewicht der Last abhängigen Parameters von einem Hubmotor.
10. Steuereinheit (210) nach Anspruch 8 oder Anspruch 9, wobei die Steuereinheit (210) konfiguriert ist, um die Bestimmung des Gewichts als Reaktion auf die Erfassung eines Steuersignals durchzuführen, das eine Einleitung der Absenkbewegung der Hebevorrichtung (120) bewirkt.
11. Steuereinheit (210) nach einem der vorstehenden Ansprüche 7 bis 10, wobei die Steuereinheit (210) konfiguriert ist, um die für die Last mit einem Gewicht in einem ersten Bereich vorgesehene Steuerrampe so zu definieren, dass eine maximale Geschwindigkeit der Absenkbewegung schneller erreicht werden kann als mit der für die Last mit einem Gewicht in einem zweiten Bereich vorgesehenen Steuerrampe.
12. Steuereinheit (210) nach Anspruch 11, wobei das Gewicht im ersten Bereich geringer ist als das Gewicht im zweiten Bereich.
13. Flurförderzeug, wobei das Flurförderzeug umfasst:
 - eine Hebevorrichtung (120),
 - mindestens ein Ventil (230), das mindestens teilweise eine Absenkbewegung der Hebevorrichtung (120) steuert, und
 - eine Steuereinheit (210) nach einem der Ansprüche 8 bis 14.
14. Computerprogramm, umfassend einen computerlesbaren Programmcode, der konfiguriert ist, um das Durchführen des Verfahrens nach einem der Ansprüche 1 bis 6 zu veranlassen, wenn der Programmcode auf einer Steuereinheit (210) nach ei-

nem der Ansprüche 7 bis 12 ausgeführt wird.

Revendications

1. Procédé de commande d'un mouvement d'abaissement d'un dispositif de levage (120) d'un chariot élévateur industriel, **caractérisé en ce que** le procédé, réalisé par une unité de commande (210) du chariot élévateur, comprend :
 - la détermination (420) d'un poids d'une rampe de commande dépendante de la charge, dans lequel le poids de la rampe de commande dépendante de la charge définit des valeurs d'un signal de commande en fonction du temps afin d'amener le dispositif de levage (120) à atteindre sa vitesse d'abaissement maximale, le poids de la rampe de commande dépendante de la charge est déterminé (420) par :
 - la sélection de la rampe de commande dépendante de la charge parmi une pluralité de poids des rampes de commande dépendantes de la charge ; ou
 - la génération de la rampe de commande dépendante de la charge en adaptant une rampe de commande de référence au poids de la charge ; et
 - la génération (430) d'au moins un signal de commande vers au moins une vanne (230) commandant au moins en partie le mouvement d'abaissement du dispositif de levage (120), l'au moins un signal de commande transportant des données correspondant au poids de la rampe de commande dépendante de la charge.
2. Procédé selon la revendication 1, le procédé comprenant en outre :
 - la détermination (410) d'un poids d'une charge transportée par le dispositif de levage (120).
3. Procédé selon la revendication 2, dans lequel la détermination du poids de la charge est réalisée par l'un des procédés suivants : l'obtention de données de mesure à partir d'au moins un capteur (240) configuré pour mesurer le poids de la charge ; l'obtention de données représentant le poids de la charge en provenance d'un stockage de données ; l'obtention d'un paramètre à partir d'un moteur de levage dépendant du poids de la charge.
4. Procédé selon la revendication 2 ou la revendication 3, dans lequel la détermination du poids est réalisée en réponse à la détection d'un signal de commande provoquant le déclenchement du mouvement d'abaissement du dispositif de levage (120).
5. Procédé selon l'une quelconque des revendications précédentes, dans lequel la rampe de commande

dédiée à la charge ayant un poids dans une première plage est définie pour permettre d'atteindre une vitesse maximale du mouvement d'abaissement plus rapide que la rampe de commande dédiée à la charge ayant un poids dans une seconde plage.

6. Procédé selon la revendication 5, dans lequel le poids dans la première plage est inférieur au poids dans la seconde plage.

7. Unité de commande (210) d'un chariot élévateur industriel pour commander un mouvement d'abaissement d'un dispositif de levage (120) d'un chariot élévateur, **caractérisée en ce que** l'unité de commande (210) est configurée pour :
déterminer (420) un poids d'une rampe de commande dépendante de la charge, dans lequel le poids de la rampe de commande dépendante de la charge définit des valeurs d'un signal de commande en fonction du temps afin d'amener le dispositif de levage (120) à atteindre sa vitesse d'abaissement maximale, le poids de la rampe de commande dépendante de la charge est déterminé (420) par :

la sélection de la rampe de commande dépendante de la charge parmi une pluralité de poids des rampes de commande dépendantes de la charge ; ou

la génération de la rampe de commande dépendante de la charge en adaptant une rampe de commande de référence au poids de la charge ; et

générer (430) au moins un signal de commande vers au moins une vanne (230) commandant au moins en partie le mouvement d'abaissement du dispositif de levage (120), l'au moins un signal de commande transportant des données correspondant à un poids d'une rampe de commande dépendante de la charge.

8. Unité de commande (210) selon la revendication 7, l'unité de commande (210) étant en outre configurée pour :

déterminer (410) un poids d'une charge transportée par le dispositif de levage (120).

9. Unité de commande (210) selon la revendication 8, dans laquelle l'unité de commande (210) est configurée pour réaliser une détermination du poids de la charge par l'un des procédés suivants : l'obtention de données de mesure à partir d'au moins un capteur (240) configuré pour mesurer le poids de la charge ; l'obtention de données représentant le poids de la charge en provenance d'un stockage de données ; l'obtention d'un paramètre à partir d'un moteur de levage dépendant du poids de la charge.

10. Unité de commande (210) selon la revendication 8

ou la revendication 9, dans laquelle l'unité de commande (210) est configurée pour réaliser la détermination du poids en réponse à la détection d'un signal de commande provoquant le déclenchement du mouvement d'abaissement du dispositif de levage (120).

11. Unité de commande (210) selon l'une quelconque des revendications précédentes 7 à 10, dans laquelle l'unité de commande (210) est configurée pour définir la rampe de commande dédiée à la charge ayant un poids dans une première plage afin de permettre d'atteindre une vitesse maximale du mouvement d'abaissement plus rapide que la rampe de commande dédiée à la charge ayant un poids dans une seconde plage.

12. Unité de commande (210) selon la revendication 11, dans laquelle le poids dans la première plage est inférieur au poids dans la seconde plage.

13. Chariot élévateur industriel, le chariot élévateur industriel comprenant :

un dispositif de levage (120),
au moins une vanne (230) commandant au moins en partie un mouvement d'abaissement du dispositif de levage (120), et
une unité de commande (210) selon l'une quelconque des revendications 8 à 14.

14. Programme informatique comprenant un code de programme lisible par ordinateur configuré pour provoquer la réalisation du procédé selon l'une quelconque des revendications 1 à 6 lorsque ledit code de programme fonctionne sur une unité de commande (210) selon l'une quelconque des revendications 7 à 12.

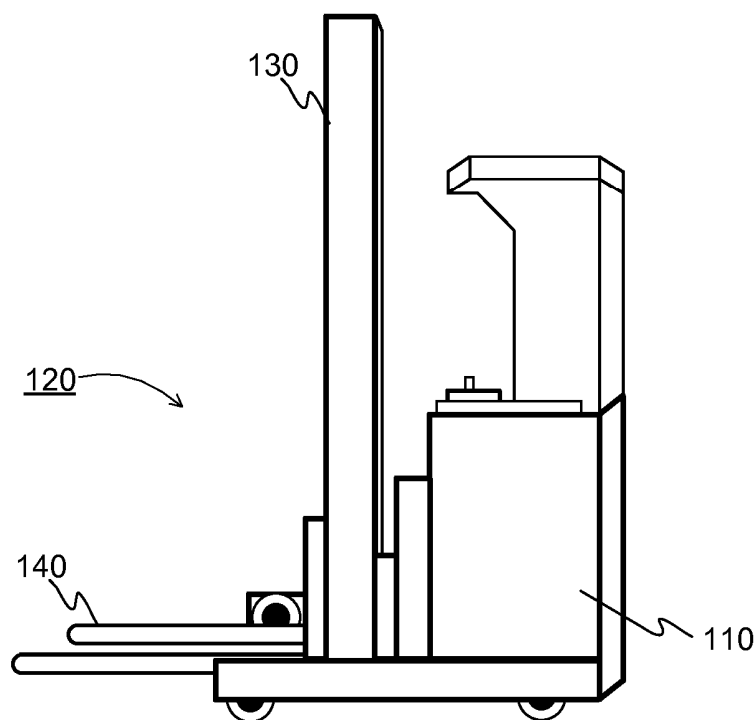


FIGURE 1
PRIOR ART

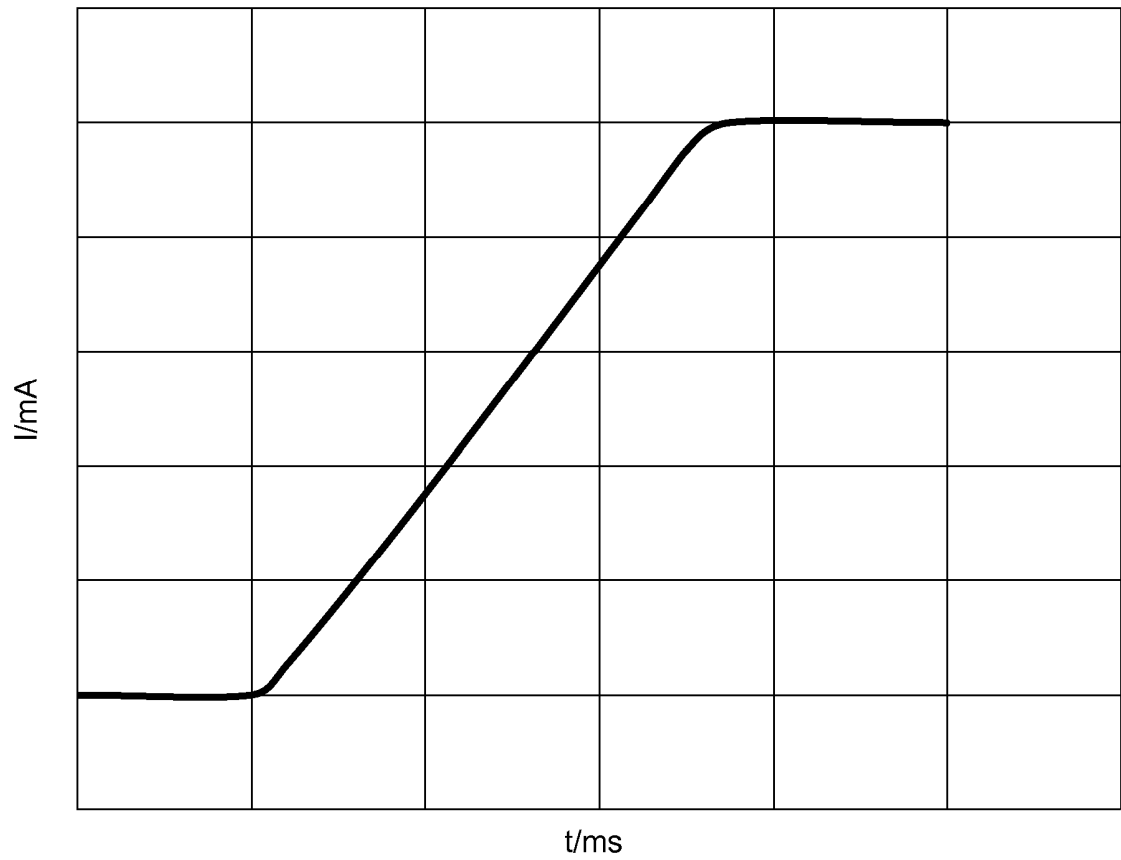


FIGURE 2
PRIOR ART

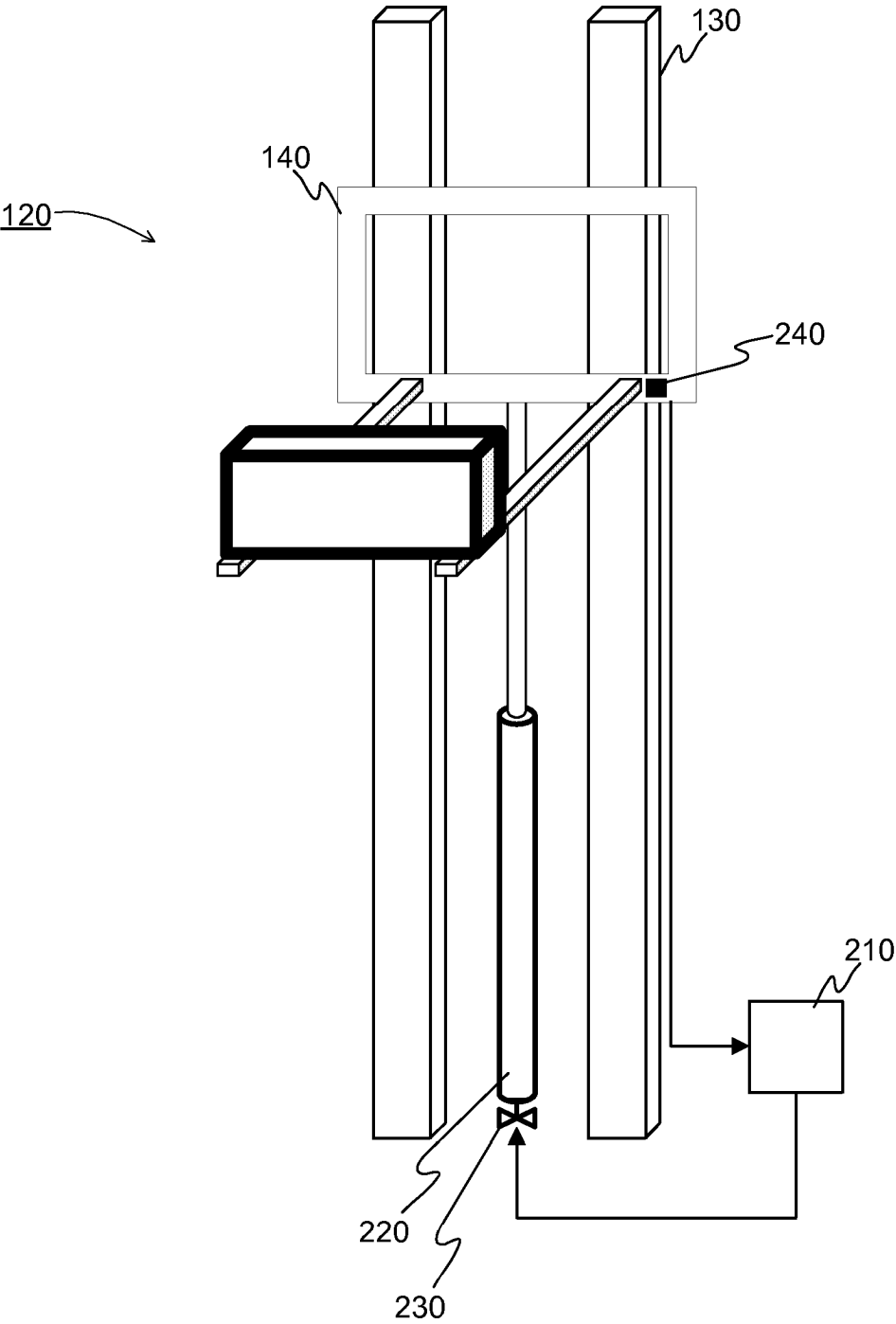
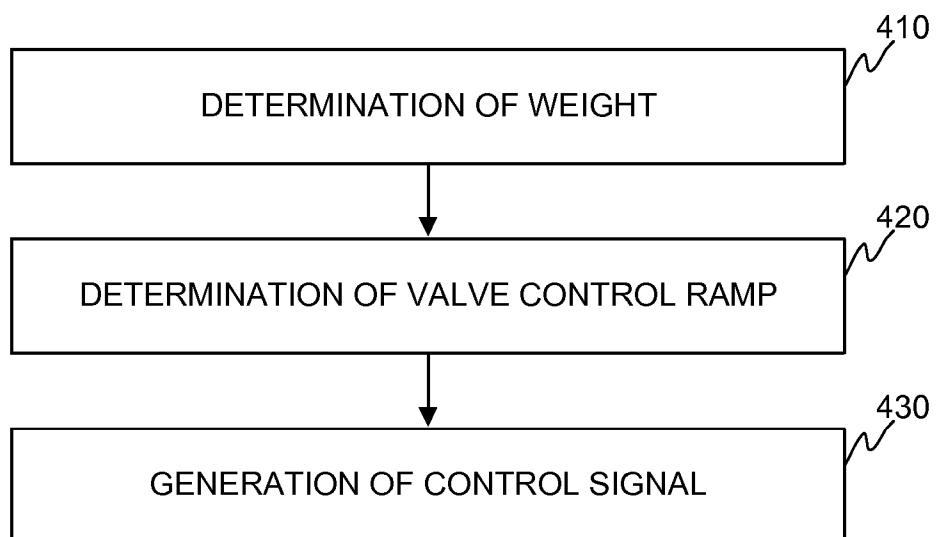


FIGURE 3

**FIGURE 4**

LOAD WEIGHT	CONTROL RAMP
< W1	RAMP A
W1 - W2	RAMP B
> W2	RAMP C

FIGURE 5

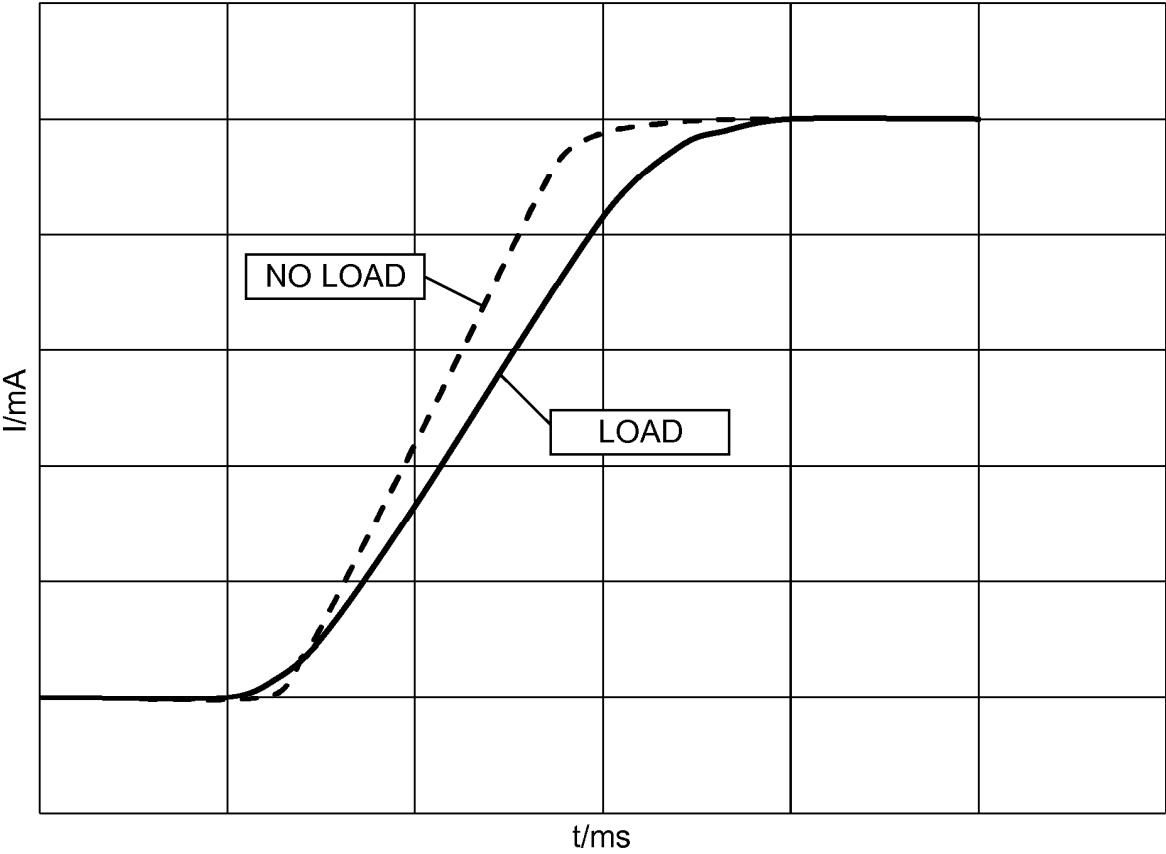


FIGURE 6

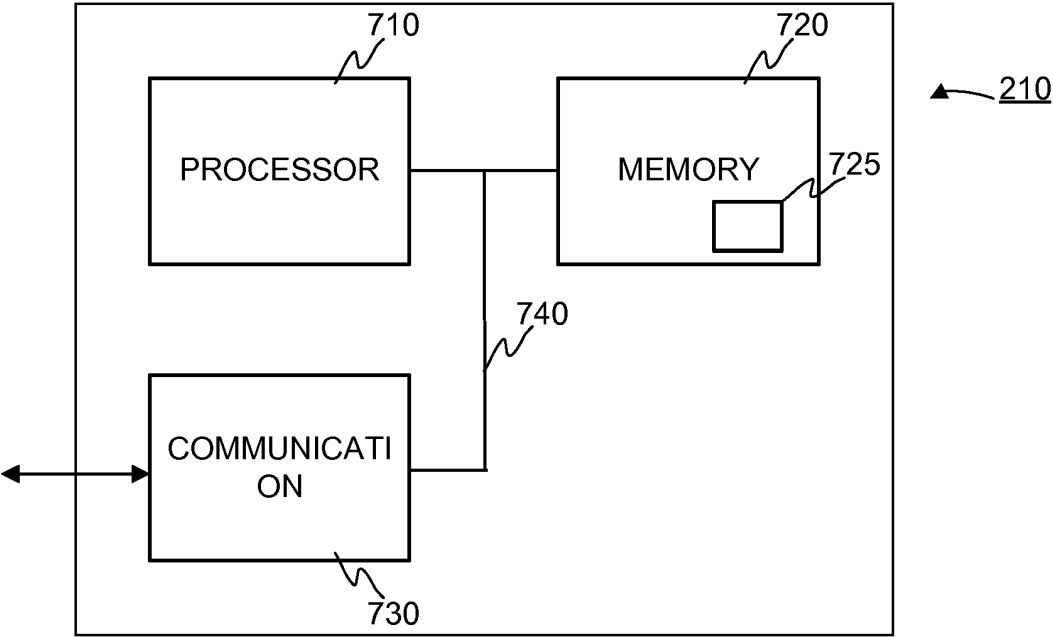


FIGURE 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9916698 A1 [0006]
- WO 2016160113 A2 [0006]
- WO 9916698 A [0006]