(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 971 128 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
02.07.2025 Bulletin 2025/27

(21) Application number: **20196449.1**

(22) Date of filing: **16.09.2020**

(51) International Patent Classification (IPC):
B66F 9/22 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B66F 9/22

(54) MATERIAL HANDLING VEHICLE

HANDHABUNGSFAHRZEUG FÜR MATERIAL

VEHICULE DE MANUTENTION DE MATÉRIAU

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
23.03.2022 Bulletin 2022/12

(73) Proprietor: **Toyota Material Handling Manufacturing Sweden AB**
595 81 Mjölby (SE)

(72) Inventor: **KHUDAIR, Haider**
582 30 Linköping (SE)

(74) Representative: **Zacco Sweden AB**
P.O. Box 5581
Löjtnantsgatan 21
114 85 Stockholm (SE)

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Description

[0001] The present application is related to a material handling vehicle, a method for modifying a material handling vehicle, a method for operating a material handling vehicle and a computer software .

BACKGROUND

[0002] Material handling vehicles are used primarily in warehouses and when loading lorries for transporting and handling goods. Material handling vehicles are provided with a hydraulic system. The hydraulic system is provided in order to manoeuvre different power functions of the material handling vehicle. One such power function is the lift function, in which a load carrier most commonly in the form of two forks is used for lifting a lowering loads from different heights. A hydraulic cylinder provides the lift force for lifting the load carrier. A hydraulic pump pressurizes a hydraulic fluid which is fed to the hydraulic cylinder that is mechanically coupled to the load carrier. The increased pressure in the hydraulic cylinder provides for that the cylinder is extended and thus will lift the load carrier.

[0003] Document US 2006/0060409 A1, discloses an electronically controlled valve for a material handling vehicle. The electronically controlled valve functions as a check valve at de-energization. The electronically controlled valve, when de-energized closes, to prevent unintended decent in excess of a commanded speed of a carriage assembly.

SHORT DESCRIPTION OF THE INVENTION

[0004] It is increasingly important to increase the speed of material handling operations. It is important to move goods and material around a warehouse in an increasingly efficient manner. This includes also the lifting and in particular the lowering of the load carriers. There are safety norms that set the maximal lowering speed at full load for a material handling vehicle. No such maximal lowering speed is required at lower loads than the maximal allowable load. For safety reasons the load carrier is designed not fall down from a raised position if there is a malfunction of the hydraulic system. In particular if a pressurized hose is ruptured that is in fluid communication with the hydraulic cylinder, the risk a raised load will by gravity press down the load carrier and empty the hydraulic cylinder through the rupture. The maximum lowering speed is thus automatically applied in this situation. On preferred way of achieving this function is by means of a valve incorporated in an outlet of the hydraulic lift cylinder, wherein the valve has a mechanical function that limits the flow through the outlet valve in such a way that the lowering speed of the load carrier is kept below a predetermined maximum lowering speed. It is however a problem that the limiting of the lowering speed also limits the effectiveness of the material handling operation, in particular at a situation where the load is not maximal on the load carrier. It is desirable to achieve higher lowering speeds without jeopardizing the security in case of a malfunction. Also, it has been determined that the sensitive mechanic valves used might not activate in correct way when the load is less than maximal.

[0005] Thus there is suggested a material handling vehicle comprising a load carrier and a control unit. The vehicle further comprises a hydraulic system for operation of hydraulic functions of the material handling vehicle. The hydraulic system operations includes the lifting and lowering of the load carrier. The hydraulic system comprises at least one hydraulic lift cylinder, with a passage for hydraulic fluid. The hydraulic system also comprises a lowering valve and the hydraulic system comprises a lift valve. A passage valve is also comprised in the hydraulic system. The passage valve is arranged such that it is able to close the passage. The load carrier is connected to the hydraulic lift cylinder such that the load carrier is lowered when hydraulic fluid flows out of the hydraulic lift cylinder through the passage when said lowering valve is opened. The lowering of the load carrier requires that both lowering valve and passage valve are open. The control unit is connected to the passage valve. The control unit is able to control the hydraulic fluid flow through the passage valve by sending control commands to the passage valve. The passage valve is positioned directly in the hydraulic lift cylinder and/or in the passage of the hydraulic lift cylinder.

[0006] The advantage of the material handling vehicle above is that the effectiveness in a material handling situation can be controlled. I.e. by incorporation of a passage valve that is controlled electronically, the control of hydraulic fluid, in particular out of the hydraulic lift cylinder can be specified freely. Also it is possible to specify different passage valve openings for a specific need. With electronically is meant both control through electric voltage or controlling a serve motor of the passage valve with for example serial data signals from the control unit.

[0007] According to the invention there is disclosed a material handling vehicle wherein comprised is a sensor device. The sensor device is arranged to send sensor data to the control unit. The sensor device is arranged to detect a pressure corresponding to the pressure at the outlet of the passage valve of the passage. The detector can also be arranged in a hydraulic line directly connected to the outlet.

[0008] By adding a sensor for measuring the pressure in the hydraulic line at the outlet of the passage valve, it is possible to detect an undesired pressure drop in the hydraulic line. For example if a hydraulic hose is ruptured, and the hose comprised in the hydraulic line running from the passage valve to the main hydraulic bloc. By having this control a lowering speed in normal operation can set other than the predetermined lowering speed, e.g. at a higher value than the norm value if the weight of the load on the load carrier is lower than the maximal load weight.

[0009] According to a further aspect of the present disclosure there is disclosed a material handling vehicle wherein the control unit is arranged such that it is able to control the passage valve. In this way the lowering speed of the load carrier is below or equal to a predetermined emergency lowering speed. The control of the lowering speed is based on that a predetermined pressure condition is fulfilled.

[0010] The advantage of the above is a complete control of the emergency lowering speed by the control unit, this is very effective. Also this provides for that any mechanical failure in the valve can be detected as compared with a mechanically spring controlled valve.

[0011] According to a further aspect of the present disclosure there is disclosed a material handling vehicle wherein the predetermined pressure condition comprises at least one of the following predetermined pressure conditions:

- the detected pressure is close to or equal to zero, and no lowering command has been requested by the control unit and/or an operator;

[0012] The advantage being that a very quick determination on that the predetermined pressure condition is fulfilled is achieved.

- a first detected pressure is higher than a consecutive second detected pressure within a predetermined time, and no lowering command has been requested by the control unit /and/or an operator.

[0013] The advantage being that a simple set up with one sensor can be used for determining that the pressure condition is fulfilled, even though measured pressure is not zero.

[0014] According to a further aspect of the present disclosure there is disclosed a material handling vehicle wherein the passage valve is arranged such that a maximal fluid outlet flow through the passage valve corresponds to a lowering speed of the load carrier that is higher than the predetermined emergency lowering speed. Preferably the passage valve is arranged to allow for the lowering speed that is higher than the predetermined emergency lowering speed at a weight of load on the load carrier range from 0 % to 100 % of the maximal allowed weight of the load. It is even more preferred at any weight of the load less than 100 % of the maximal allowed weight of the load.

[0015] The advantage for material handling operations is improved as a lowering speed in normal operation that is higher than the predetermined emergency lowering speed can be set. This will speed up the material handling situation considerably

[0016] According to a further aspect there is disclosed a material handling vehicle the passage valve is mounted in the bottom section of the hydraulic lift cylinder.

[0017] By applying the passage valve directly in the bottom section of the hydraulic lift cylinder a good emptying of the cylinder is achieved.

[0018] According to the invention there is disclosed a material handling vehicle wherein a further sensor device is comprised in the material handling vehicle. The further sensor device is arranged to detect the pressure in the hydraulic lift cylinder. The control unit is arranged to receive sensor data from the further sensor device together with the sensor data from the first sensor device. The control unit is arranged to determine the pressure condition as a pressure difference between he first sensor device and the second sensor device. The determination of the pressure condition is made at the same moment in time. If the control unit determines that there is a pressure difference , the pressure condition is fulfilled and the control unit is arranged to control the passage valve such that the fluid flow out through the passage valve correspond to a lowering speed of the load carrier that is below or equal to a predetermined emergency lowering speed. Preferably the control unit is arranged to check if the passage valve is already set to correspond to, or below the predetermined emergency lowering speed at evaluation of the pressure difference.

[0019] The advantage of having a further sensor is that the pressure in the hydraulic cylinder and the pressure in the hydraulic line running from the cylinder can be compared at any moment. This provides for a very quick control, and an improved safety, when evaluating if there is a lower pressure outside the hydraulic cylinder than inside the hydraulic cylinder, thus allowing for a safe determination that the pressure condition is fulfilled. There can also be an inbuilt redundancy as the first sensor can in parallel detect pressures at different moments in time and compare a difference between these pressures with a difference between the pressure in the hydraulic lift cylinder and the hydraulic line running from the hydraulic lift cylinder. Thus two different pressure differences can be used for controlling the passage valve in parallel. This improves the precision in the control and also the safety in control of the passage valve.

[0020] According to a further aspect there is disclosed a material handling vehicle wherein the material handling vehicle comprises a further sensor that is arranged such that it can detect the speed in vertical direction of the load carrier. The further sensor is connected to the control unit such that the control unit is able use input from the sensor to control the vertical speed of the load carrier. Preferably the vertical speed is controlled by controlling the opening of the passage valve. The control can be combined with controlling the opening of the lowering valve or by only controlling the lowering valve.

[0021] The advantage of the incorporation of a sensor that is arranged to detect the vertical speed of the load carrier is that for example calibration of the vertical speed as a function of load weight applied to the load carrier is simplified, or can be avoided. Vertical speed is more important to determine in the lowering mode, than when lifting, thus the sensor need mandatory be able to detect

the lowering speed but not mandatory the lifting speed.

[0022] According to a further aspect there is disclosed a method for modifying a material handling vehicle by providing a material handling vehicle and by modifying the material handling vehicle such that it corresponds to any of the aspects above.

[0023] The advantage of the method is that an older material handling vehicle can be upgraded so as to implement the aspects of the present disclosure and achieve the advantages mentioned above.

[0024] According to a further aspect of the present invention there is disclosed method for operating a material handling vehicle comprising a control unit that is arranged to receive data from sensors and valves on the material handling vehicle. The material handling vehicle being arranged to control the hydraulic system of the material handling vehicle. The method comprises the step of, detecting a first pressure at the outlet of a passage valve in a hydraulic lift cylinder of the material handling vehicle.

[0025] The method also comprises applying a predetermined pressure condition. The application of applying a predetermined pressure condition comprises the step of, determining that the first pressure is close to or equal to zero, and no lowering command has been requested by the control unit and/or an operator. The pressure condition may in addition or alternatively comprise determining a consecutive second detected pressure within a predetermined time and determining that the first detected pressure is higher than the second detected pressure and no lowering command has been requested by the control unit/and/or an operator. The pressure condition may alternatively comprise an alternative pressure condition where the pressure inside the hydraulic cylinder is determined, this pressure condition may be combined with the previous pressure condition. The pressure inside the hydraulic cylinder is compared with the first pressure where both pressures are measured at the same moment in time. The method further may comprises the step to determine that the predetermined pressure condition is fulfilled if there is detected a difference between the first pressure and the pressure inside the hydraulic cylinder (3).The method further comprise the step if the predetermined pressure condition is fulfilled, to apply an opening ratio to the passage valve such that a lowering speed of the load carrier is equal to or below a predetermined emergency lowering speed.

[0026] The advantage of the method is that the operation of the material handling vehicle is improved, and the vehicle is more versatile. A more safe and better control of the predetermined lowering of the load carrier is also achieved.

[0027] According to a further aspect there is disclosed a method for operating a material handling vehicle according to the above, further comprising is the step to determine that the pressure condition is not fulfilled, and then apply the step to apply an opening ratio to the passage valve that allows a fluid flow out from the hydraulic lift cylinder such that a load carrier lifted by the hydraulic lift cylinder may be lowered at a higher speed than the predetermined emergency lowering speed. Preferably unless the load weight on the load carrier corresponds to a predetermined max value, in which case the maximal lowering speed is the same as the predetermined emergency lowering speed.

[0028] The advantage is that a much more efficient material handling can be achieved where the lowering speed can be higher than a predetermined emergency lowering speed, in normal operation. Thus a general advantage of the method above is that the operation of the material handling vehicle can be faster.

[0029] According to a further aspect there is disclosed a computer software according when stored and run on a control unit of a material handling vehicle makes the material handling vehicle perform one or all steps according to the aspects above.

[0030] The advantage of the above aspect is that the methods can be automatic, and no manual interaction of an operator is needed. A further advantage is that, the control can be easily adjusted by adapting the software to the desired requirements.

LIST OF DRAWINGS

[0031]

Figure 1 discloses a material handling vehicle according to the disclosure,

Figure 2 discloses a hydraulic system of the prior art.

Figure 3 discloses a hydraulic system of a material handling vehicle which is not part of the invention.

Figure 4 discloses a hydraulic system of a material handling vehicle according to the present invention.

Figure 5 discloses a method according to the present invention.

DETAILED DESCRIPTION

[0032] The present disclosure is related to material handling vehicles. The vehicle can also be named a truck not to be confused with a lorry. The material handling vehicle may have a load carrier in the shape of two forks. The load carrier can also be a gripping device, a lifting module comprising an operator. The material handling vehicle is powered by a motor that provides the ability to move the material handling vehicle. The vehicle also has a hydraulic system. The hydraulic system comprises a pump that is driven by a motor. The power source in the vehicle is in general a battery. The battery may be a lead acid battery or a Lithium Ion battery or any other type of battery. The battery is rechargeable. The material handling vehicle is mainly designed to operate indoors, thus

the vehicle is not provided with tires and suspension that allows it to travel long term outside. The vehicle is preferred to not release any exhaust gas. The vehicle has the ability through the hydraulic system to lift pallets, goods, material from floor level to a higher level.

[0033] The present disclosure is related to a material handling vehicle as exemplified in Fig. 1, which discloses a reach-truck. However the material handling vehicle 1 can be any load lifting material handling vehicle, such as a stacker, an order picking truck, a very narrow isle truck, etc. The material handling vehicle 1 has a load carrier 2. The load carrier may be slidably connected to a mast 11. The material handling vehicle 1 further comprises a hydraulic system 20, see fig. 3. The material handling vehicle 1 comprises a control unit 6 also. In Fig. 3 there is also disclosed a passage valve 5 that when closed does not allow any hydraulic fluid out from the hydraulic cylinder 3. The passage valve 5 may also allow to control the hydraulic fluid entering the hydraulic cylinder 3. The control unit 6 is in electric communication with the passage valve 5. The material handling vehicle also may comprise a pressure sensor device 10. The sensor device 10 is connected to hydraulic line 8 to detect the pressure and send the sensor data to the control unit 6. The sensor device 10 is preferred to be connect at the outlet of the passage valve 5 into the hydraulic line 8. But it is possible to position the sensor device 10 at any position along the hydraulic line 8.

[0034] The load carrier 2 on figure 1 is a pair of forks. This is in general the normal configuration of the load carrier in a material handling vehicle 1 related to the disclosure. A pair of forks is very good for handling pallets and goods stored on pallets. In particular in a warehouse situation where the material handling vehicle is mostly intended to be used, the pair of forks is very suitable. The pair of forks can be of different lengths and carry for example two pallets if they have the appropriate length. However for the present disclosure the load carrier can have any shape and form for lifting a load.

[0035] The control unit 6, is in general the central computer of the material handling vehicle 1. This means that the control unit 6 may be the main centre for processing power in the material handling vehicle. The control unit 6 is programmable, and can store and change software for the operation of the material handling vehicle. The control unit 6 may also be a dedicated control unit that is only used for the hydraulic system 20. This makes reparation and maintenance a bit easier as the replacement of the complete unit does not affect other functions on the material handling vehicle. Any control unit on the material handling vehicle is arranged to be able to communicate with devices or units in the material handling vehicle, generally by a serial protocol such as CAN. The communication may be through cable or wireless through a wireless interface such as Wi-Fi, Bluetooth or the like. There can also be an interface for communication to a central data centre, from the material handling vehicle to the central data centre. The external communication is preferably done via a local wireless protocol, but can also be made by for example GSM/3G/4G/5G communication etc. In particular the control unit 6 is arranged to communicate with the passage valve 5. It is in this to be understood that the communication can be bi-directional. For example the passage valve 5 may send information to the control unit 6 related to the open area of the valve 5.

[0036] Fig. 2 discloses a prior art hydraulic system comprising a passage valve in the form of a mechanical valve 5', that shuts down at a certain top value of flow out from the hydraulic lift cylinder 3. This flow is set at the maximal allowed flow for a required maximal lowering velocity of a raised load carrier. There is a spring loaded valve 5' that reduces the flow out of the cylinder to a maximal value regardless of the pressure in the hydraulic cylinder. Thus if a rupture in the hydraulic line 8 occurs the spring loaded valve 5' will limit the flow out of the cylinder such that a load carrier will not lower itself faster than a predetermined emergency lowering speed. The prior art hydraulic system also has an operation lowering valve 15, and also a pressure compensator 16. Further there is also a valve 21 used for raising the load carrier powered by the hydraulic lift cylinder 3. The valve 15 is always closed at lifting as the hydraulic fluid otherwise will be circulating back to the reservoir 12.

[0037] Predetermined emergency lowering speed is to be understood to be applicable when the load carrier 2 is moving downwards from a raised position without direct control from an operator. In general the predetermined emergency lowering speed is applicable to a situation where there is an unexpected pressure drop in the hydraulic line 8 that runs from the hydraulic lift cylinder, this in practise is due to a rupture of an hydraulic hose or the couplings that attached this hose. In general the emergency lowering speed is predetermined by norms, and is usually 0,6 m/s or lower for material handling vehicles that does not lift the operator. For material handling vehicle that lift the operator the predetermined emergency lowering speed is normally required to be 0,4 m/s or lower. The exact control of the passage valve 5 above in order to achieve this predetermined emergency lowering speed must be determined for each material handling vehicle, and is dependent on dimensions in the hydraulic lift cylinder 3, maximal load 19 allowed etc. An alternative way is to add a sensor that is able to detect the lowering speed of the load carrier 2. I.e. in this way the control unit 6 is able to detect the speed of load carrier 2 in vertical direction. The control unit 6 may then control the maximal lowering speed by adjusting the opening of the passage valve 5.

[0038] The hydraulic system 20 is mandatory for the present disclosure as disclosed in Fig. 3. The hydraulic system 20, which relates to the present disclosure comprises hoses, lines, a pressure device, such as a pump 4. The hydraulic system 20 comprises a hydraulic fluid. The hydraulic system 20 comprises a reservoir 12 for the hydraulic fluid. The pump 4 is powered by a motor 13. The hydraulic system 20 comprises the valves 5, 15

necessary for operation of the hydraulic functions. The hydraulic functions that is in general powered by the hydraulic system includes lifting and lowering of goods by means of the load carrier 2. The hydraulic functions may also comprise other functions, such as reach function, tilting functions of the mast 11, spreading of the forks, gripping movement or other functions. In particular the hydraulic system comprises a lowering valve 15, and a passage valve 5.

[0039] The hydraulic system 20 comprises at least one hydraulic lift cylinder 3. The hydraulic lift cylinder 3 is connected to the load carrier 2 in order to be able to lift and lower the load carrier 2, see Fig. 1. The hydraulic cylinder 3 can be combined with further hydraulic lift cylinders in order to provide more lift capacity and/or higher lifting heights. The further hydraulic lift cylinders are not disclosed but can be installed in parallel in the with the current hydraulic lift cylinder 3. It is possible to apply the present disclosure and to all or part of the group of hydraulic lift cylinders. It is preferred to use the present disclosure with the hydraulic lift cylinder that is operative from floor level.

[0040] The hydraulic lift cylinder 3 has a passage 9. The passage 9 is used by the hydraulic fluid to exit the hydraulic lift cylinder 3. The passage 9 may only be used for this purpose, in combination with a further passage for the hydraulic fluid for entering the hydraulic lift cylinder 3. However the preferred way is that the passage 9 is used both as inlet and outlet for the hydraulic fluid to the hydraulic lift cylinder 3. The passage 9 is preferred to be situated close to the bottom of the hydraulic lift cylinder 3. This is an advantage as the hydraulic lift cylinder 3 is easier to empty. The passage has in general the shape of an opening in the bottom of the hydraulic lift cylinder 3. The opening is preferably circle shaped. A hydraulic line section 8a can be attached to the passage 9. The hydraulic line section 8a has its other end attached to a passage valve 5, however the hydraulic line section 8a, is not to be understood as a long line, it is to be understood that this is part of the passage 9 and the passage 9 is preferably comprised directly in the hydraulic lift cylinder 3. Thus the passage valve 5 is preferred to arranged directly in the passage 9. It should also be understood that no other valve, restriction or other device is to be positioned between the passage valve 5 and the inner volume of the hydraulic lift cylinder 3. The passage valve 5 should thus be in direct fluid communication with the inner volume of the hydraulic lift cylinder 3. It should be understood thus that the passage valve 5 is preferred to be positioned directly in the passage 9. The passage valve 5 can be mounted directly in the bottom section 17 of the hydraulic lift cylinder 3. Bottom section 17 is to be construed a position that allows the piston 18 of the hydraulic lift cylinder 3 to fully operate for emptying the hydraulic lift cylinder 3. The passage 9 and the passage valve 5 is discussed in terms of having an outlet and an inlet. The outlet 22 of the passage 9 and the valve 5 is actually an outlet when the lowering movement of the load carrier 2 is in occurring. Also in at lowering the inlet to the passage 9, and the passage valve 5 is in direction from the hydraulic lift cylinder 3 out from the hydraulic.

[0041] The passage valve 5 is controllable by electronic input. The electronic input comes from the control unit 6. The electronic input can either be a serial data package sent to a control module on the passage vale 5, or an electric current that acts directly on an actuator on the passage valve 5. The control of the passage valve 5 can either be through cable or wirelessly. The passage valve 5 may be arranged to send back data to the control unit. Data sent back can include, opening percentage of the valve area, control signal for status, confirmation on command data received etc. The passage valve 5 is preferred to have a dual function as a safety valve in case of rupture in the hydraulic line 8, but also as a valve 5 that opens at lowering and lifting for participation in the lifting and lowering of loads on the load carrier.

[0042] The passage valve 5 should be able to attain at least three positions, corresponding to closed, fully open/high-speed lowering and emergency speed lowering. In general the opening of the passage valve 5 may be referred to be the opening ratio of the passage valve 5. I.e. a closed passage valve 5 has an opening ratio of 0 %, a half open valve has an opening ratio of 50 %, and a fully open passage valve 5 has an opening ratio of 100 %. The term high-speed lowering means that the passage valve 5 is fully open and hydraulic fluid can flow from the hydraulic cylinder (3) at the highest possible speed. It should be understood that fully open area and high-speed lowering area could correspond to two different opening areas of the passage valve 5. I.e. the passage valve 5 could have a less open area at high-speed lowering than when the passage valve 5 is fully open. The emergency lowering speed opening ratio of the passage valve 5 may mandatory have a lower opening area than the fully open valve, i.e. opening ratio 100 %, and also may thus have a mandatory lower opening area than the high-speed lowering area of opening of the passage valve 5. The passage valve 5 can have an analogue open area valve setting. This means that the open area of the passage valve 5 can be set from fully open to fully closed without any steps. Regardless of this the high-speed lowering mode always has a larger area opening than the emergency lowering mode area. The emergency lowering speed is equal to that the hydraulic line 8, e.g. a hose on this line has ruptured and the hydraulic fluid would flow out of the hydraulic lift cylinder 3 without control. I.e. the risk for an operator would be sever and the load carrier would fall down very quickly without possibility of control.

[0043] Lowering valve 15 is used for controlling normal lowering, in which case the passage valve 5 is preferred to be fully open, i.e. at an opening ratio of 100 %.

[0044] A sensor device 10, see figure 3, is incorporated in the hydraulic system 20. The sensor device 10 is a pressure sensor, that can detect hydraulic pressures in a hydraulic line 8 that extends from the passage valve 5

and away from the hydraulic cylinder 3. The pressure sensor 8 can be of any type. The pressure sensor device 10 send sensor data to the control unit 6, either through cable or wirelessly, according to general communication protocols as already mentioned above. The pressure sensor device 10 is arranged such that it can measure pressures continuously as the material handling vehicle 1 is operating.

[0045] The control unit 6 as arranged to compare continuously pressure data that comes from the pressure sensor device 10. In particular it measures a pressure difference between a first measured pressure P1 and a consecutive pressure P2. I.e. P1 is measured before P2 in time. Each pressure is detected within a predetermined time period t, which could be for example 0,1 second long, or 0,0020 seconds or any suitable time period.

[0046] There are different ways in which the control unit 6 may evaluate the pressures. In general a preferred way of evolution is simply checking for differences within the time frame:

The control unit 6 thus performs the following comparison:

Pcond: PDiff =P1-P2 at a time stamp t is not higher than a predetermined value.

[0047] If the condition above is fulfilled the control unit 6 is arranged to set the passage valve 5 so that the emergency lowering speed of the load carrier 2 is not exceed.

[0048] It should be understood that it is suitable to apply a further condition. That is if the control unit 6, and/or the operator of the vehicle has commanded a lowering. If this is the case the pressure condition is still not fulfilled. That is if the lowering is undesired and still occurs the pressure condition is set to be fulfilled. But on the contrary if a lowering is not commanded, the pressure condition is set to not be fulfilled.

[0049] From the above it should be understood thus that the pressure difference can be enlarged without the emergency lowering speed is set, by allowing the pressure drop in hydraulic line 8 to be lowered slower than the pressure condition, or as said above if no command for lowering has been issued. From this it should be understood also that the maximal outlet flow through the passage valve 5 can be higher than the flow allowed for when the emergency lowering speed is set. In other words the emergency lowering speed will only be set if the pressure drop P1-P2 is attained too quickly, i.e. in a time period equal to or shorter than t.

[0050] Another way of performing the evaluation of pressures is to detect whether the detected pressure P1 is below a certain predetermined pressure. For example if P1 is 1 atm, i.e. the pressure in the hydraulic is the same as the environment for the material handling vehicle 1. This gives the formula Pcond : P1 = 1 atm or 0 atm over pressure.

[0051] It is preferred that the Pcond is not set precisely at 1 atm, but for example 1,1 atm which gives a better response time for the system.

[0052] In an alternative aspect that can be achieved together with the described aspects above or as a special own aspect. In this aspect , see Fig. 4, a further sensor device 14 is added. This sensor device 14 is arranged to detect the pressure inside the hydraulic lift cylinder 3, see figure 4. Thus in an alternative aspect the control unit 6 is arranged to compare a pressure P2' inside the hydraulic cylinder with a pressure P1 in the hydraulic line 8. In this case the pressure condition Pcond' would be if P2' differs from PP1, i.e. PDiff'= P2'-P1, is larger than zero. Then the control unit 6 should set the passage valve 5 to the opening corresponding at the predetermined emergency lowering speed S1 for the load carrier. This can be combined with the Pcond above i.e. that there is also a check for differences in P1 according to P1 <> P2 over a predetermined time period as descried above. Then one of the first Pcond and second Pcond' corresponding to PDiff' may be predetermined as the main criterion and the other Pcond is used as a confirmation criterion before setting the lowering speed to the predetermined lowering speed by means of the passage valve 9. P1 is preferred to be detected close to the outlet 22 of the passage valve 5 to the hydraulic line 8.

[0053] It is possible to modify an old material handling vehicle according to the above. Thus it is possible to improve an older material handling vehicle and make it more effective.

[0054] For the present disclosure is also disclosed a method for operating a material handling vehicle, see also Fig. 5.

[0055] The first step being:

- detecting a first pressure P1 at the outlet of a passage valve 5 in a hydraulic lift cylinder 3 of the material handling vehicle;

[0056] This is performed with the pressure sensor device 10 as described above.

[0057] The second step being

- applying a predetermined pressure condition Pcond that comprises furthers steps:
  The first step of the pressure condition being:
  - determining that the first pressure P1 is close to or equal to zero, and no lowering command has been requested by the control unit 6 and/or an operator; or/and
    The second/or optional first step of the pressure condition being:
  - determining a consecutive second detected pressure P2 within a predetermined time t and that the first detected pressure P1 is higher than the second detected pressure and no lowering command has been requested by the control unit/and/or an operator.

[0058] Within a predetermined time t may be for ex-

ample be a time range of 0,020 seconds or a suitable time period.

[0059] The method further comprises a concluding step of:

- if the predetermined pressure condition Pcond is fulfilled, apply an opening ratio to the passage valve 5 such that a lowering speed of the load carrier 2 is equal to or below a predetermined emergency lowering speed S1.

[0060] The method optionally comprising the steps of:

- determine that the pressure condition is not fulfilled, apply the step of:

- apply an opening ratio to the passage valve 5 that allows a fluid flow out from the hydraulic lift cylinder 3 such that a load carrier lifted by the hydraulic lift cylinder 3 may be lowered at a higher speed S2 than the predetermined emergency lowering speed S1, preferably unless the load weight on the load carrier 2 corresponds to a predetermined max value, in which case the maximal lowering speed is the same as the predetermined emergency lowering speed S1.

[0061] The method alternatively or together with the first determination of the pressure condition Pcond' can comprise the steps of:

- determine the pressure P2' inside the hydraulic cylinder 3,

- compare the pressure inside P2' the hydraulic cylinder 3 with the first pressure P1, both P2' and P1 being measured at the same moment in time,

- determine that the predetermined pressure condition is fulfilled if there is detected a difference between the first pressure P1 and the pressure P2' inside the hydraulic cylinder 3.

[0062] Thus by applying measurement inside the cylinder a very simple method is achieved.

[0063] There is also disclosed a computer software that when executed on a computer performs the above method. The computer is preferably the control unit 6 of the material handling vehicle 1 described above. It could also be a special control unit that is dedicated to only perform the method.

Claims

1. Material handling vehicle (1) comprising:

a load carrier (2),
a control unit (6),
a hydraulic system (20) for operation of hydraulic functions of the material handling vehicle (1), including the lifting and lowering of the load carrier (2), the hydraulic system (20) comprising at least one hydraulic lift cylinder (3) with a passage (9) for hydraulic fluid, a lowering valve (15), a lift valve (21) and a passage valve (5) arranged such that it is able to close the passage (9),
wherein the load carrier (2) is connected to the hydraulic lift cylinder (3) such that the load carrier (2) is lowered when hydraulic fluid flows out of the hydraulic lift cylinder (3) through the passage (9) when said lowering valve (15) is opened,
wherein the lowering of the load carrier (2) requires that both lowering valve (15) and passage valve (5) are open,
wherein control unit (6) is connected to the passage valve (5), such that the control unit (6) is able to control the hydraulic fluid flow through the passage valve (5) by sending control commands to the passage valve (5),
wherein the passage valve (5) is positioned directly in the hydraulic lift cylinder (3) and/or in the passage (9) of the hydraulic lift cylinder (3)
wherein further comprised is a sensor device (10) that is arranged to send sensor data to the control unit (6), wherein the sensor device (10) is arranged to detect a pressure corresponding to the pressure at the outlet (22), or in a hydraulic line (8) directly connected to the outlet (22), of the passage valve (5) of the passage (9),
characterized in that
a further sensor device (14) is comprised in the material handling vehicle (1), wherein the further sensor device (14) is arranged to detect the pressure (P2') in the hydraulic lift cylinder (3), wherein the control unit (6) is arranged to receive sensor data from the further sensor device (14) together with the sensor data from the first sensor device (10), wherein the control unit (6) is arranged to determine the pressure condition as a pressure difference (PDiff') between the first sensor device (10) and the second sensor device (14), at the same moment in time, wherein if the control unit (6) determines that there is a pressure difference (PDiff'), the pressure condition (Pcond') is fulfilled and the control unit (6) is arranged to control the passage valve (5) such that the fluid flow out through the passage valve (5) correspond to a lowering speed of the load carrier (2) that is below or equal to a predetermined emergency lowering speed (S1), preferably the control unit (6) is arranged to check if the passage valve (5) is already set to correspond to, or below the predetermined emergency low-

ering speed (S1) at evaluation of the pressure difference (PDiff').

2. Material handling vehicle (1) according to claim 1, wherein the control unit (6) is arranged such that it is able to control the passage valve (5) so that the lowering speed of the load carrier (2) is below or equal to a predetermined emergency lowering speed (S1) based on that a predetermined pressure condition (Pcond; Pcond') is fulfilled.

3. Material handling vehicle (1) according to claim 2, wherein the predetermined pressure condition comprises at least one of the following predetermined pressure conditions:

- the detected pressure (P1) is close to or equal to zero, and no lowering command has been requested by the control unit (6) and/or an operator;
- a first detected pressure (P1) is higher than a consecutive second detected pressure (P2) within a predetermined time (t), and no lowering command has been requested by the control unit (6)/and/or an operator.

4. Material handling vehicle (1) according to any of the claims above, wherein the passage valve (5) is arranged such that a maximal fluid outlet flow through the passage valve (5) corresponds to a lowering speed (S2) of the load carrier (2) that is higher than the predetermined emergency lowering speed (S1), preferably the passage valve (5) is arranged to allow for the lowering speed that is higher than the predetermined emergency lowering speed (S2) at a weight of load on the load carrier (2) range from 0 % to 100 % of the maximal allowed weight of the load, even more preferred at any weight of the load less than 100 % of the maximal allowed weight of the load.

5. Material handling vehicle (1) according to any of the claims above, wherein the passage valve (5) is mounted in the bottom section of the hydraulic lift cylinder (3).

6. Material handling vehicle (1) according to any of the claims above, wherein the material handling vehicle comprises a further sensor (23) that is arranged such that it can detect the speed in vertical direction of the load carrier (2), and further sensor (23) is connected to the control unit (6) such that the control unit (6) is able use input from the sensor (23) to control the vertical speed of the load carrier (2), preferably by controlling the opening of the passage valve (5), and/or the opening of the lowering valve (15).

7. Method for modifying a material handling vehicle (1) comprising the steps of:

- providing a material handling vehicle (1),
- modifying the material handling vehicle (1) such that it corresponds to any of the claims 1-6.

8. Method for operating a material handling vehicle (1) according to any of the claims 1-6, comprising a control unit (6) that is arranged to receive data from sensors and valves on the material handling vehicle and being arranged to control the hydraulic system of the material handling vehicle (1), the method comprises the steps of:

- detecting a first pressure (P1) at the outlet of a passage valve (5) in a hydraulic lift cylinder (3) of the material handling vehicle;
- applying a predetermined pressure condition (Pcond) that comprises the step/s of:
- determining that the first pressure (P1) is close to or equal to zero, and no lowering command has been requested by the control unit (6) and/or an operator; or/and
- determining a consecutive second detected pressure (P2) within a predetermined time (t) and determining that the first detected pressure (P1) is higher than the second detected pressure and no lowering command has been requested by the control unit/and/or an operator;
- and/or applying the pressure condition (Pcond') comprising the steps of:

  - determine the pressure (P2') inside the hydraulic cylinder (3),
  - compare the pressure inside (P2') the hydraulic cylinder (3) with the first pressure (P1), both pressures being measured at the same moment in time,
  - determine that the predetermined pressure condition is fulfilled if there is detected a difference between the first pressure (P1) and the pressure inside (P2') the hydraulic cylinder (3);

wherein the method further comprises the step of:

- if the predetermined pressure condition (Pcond; Pcond') is fulfilled, apply an opening ratio to the passage valve (5) such that a lowering speed of the load carrier (2) is equal to or below a predetermined emergency lowering speed (S1).

9. Method according to claim 8, wherein further comprised is the step of:

- determine that the pressure condition (Pcond; Pcond') is not fulfilled, apply the step of:

- apply an opening ratio to the passage valve (5) that allows a fluid flow out from the hydraulic lift cylinder (3) such that a load carrier lifted by the hydraulic lift cylinder (3) may be lowered at a higher speed (S2) than the predetermined emergency lowering speed (S1), preferably unless the load weight on the load carrier (2) corresponds to a predetermined max value, in which case the maximal lowering speed is the same as the predetermined emergency lowering speed (S1).

10. Computer software that when stored and run on a control unit of a material handling vehicle (1) according to any of the claims 1-6, makes the material handling vehicle (1) perform the method according to any of the claims 8-9.

Patentansprüche

1. Fahrzeug (1) zur Materialhandhabung, umfassend:

einen Lastträger (2),
eine Steuerungseinheit (6),
ein Hydrauliksystem (20) zum Betrieb hydraulischer Funktionen des Fahrzeugs (1) zur Materialhandhabung, was das Heben und Senken des Lastträgers (2) beinhaltet, wobei das Hydrauliksystem (20) mindestens einen hydraulischen Hubzylinder (3) mit einem Durchlass (9) für Hydraulikflüssigkeit, ein Absenkventil (15), ein Hubventil (21) und ein Durchlassventil (5) umfasst, das derart angeordnet ist, dass es den Durchlass (9) schließen kann, wobei der Lastträger (2) derart mit dem hydraulischen Hubzylinder (3) verbunden ist, dass der Lastträger (2) abgesenkt wird, wenn Hydraulikflüssigkeit aus dem hydraulischen Hubzylinder (3) durch den Durchlass (9) fließt, wenn das Absenkventil (15) geöffnet wird,
wobei das Absenken des Lastträgers (2) erfordert, dass sowohl das Absenkventil (15) als auch das Durchlassventil (5) offen sind,
wobei die Steuerungseinheit (6) derart mit dem Durchlassventil (5) verbunden ist, dass die Steuerungseinheit (6) den Strom der Hydraulikflüssigkeit durch das Durchlassventil (5) durch Senden von Steuerungsbefehlen an das Durchlassventil (5) steuern kann, wobei das Durchlassventil (5) direkt in dem hydraulischen Hubzylinder (3) und/oder in dem Durchlass (9) des hydraulischen Hubzylinders (3) positioniert ist,
wobei ferner ein Sensorgerät (10) umfasst ist, das dazu angeordnet ist, Sensordaten an die Steuerungseinheit (6) zu senden, wobei das Sensorgerät (10) dazu angeordnet ist, einen Druck zu erkennen, der dem Druck am Ausgang (22) oder in einer Hydraulikleitung (8), die direkt mit dem Ausgang (22) verbunden ist, des Durchlassventils (5) des Durchlasses (9) entspricht,
dadurch gekennzeichnet, dass
ein weiteres Sensorgerät (14) in dem Fahrzeug (1) zur Materialhandhabung umfasst ist, wobei das weitere Sensorgerät (14) dazu angeordnet ist, den Druck (P2') in dem hydraulischen Hubzylinder (3) zu erkennen, wobei die Steuerungseinheit (6) dazu angeordnet ist, Sensordaten von dem weiteren Sensorgerät (14) zusammen mit den Sensordaten von dem ersten Sensorgerät (10) zu empfangen, wobei die Steuerungseinheit (6) dazu angeordnet ist, die Druckbedingung als eine Druckdifferenz (PDiff') zwischen dem ersten Sensorgerät (10) und dem zweiten Sensorgerät (14) zum selben Zeitpunkt zu bestimmen, wobei, wenn die Steuerungseinheit (6) bestimmt, dass es eine Druckdifferenz (PDiff') gibt, die Druckbedingung (Pcond') erfüllt ist und die Steuerungseinheit (6) dazu angeordnet ist, das Durchlassventil (5) derart zu steuern, dass der ausgehende Flüssigkeitsstrom durch das Durchlassventil (5) einer Absenkgeschwindigkeit des Lastträgers (2) entspricht, die kleiner oder gleich einer vorbestimmten Notabsenkgeschwindigkeit (S1) ist, wobei die Steuerungseinheit (6) vorzugsweise dazu angeordnet ist, zu prüfen, ob das Durchlassventil (5) bereits so eingestellt ist, dass es bei der Bewertung der Druckdifferenz (PDiff') der vorbestimmten Notabsenkgeschwindigkeit (S1) entspricht oder darunter liegt.

2. Fahrzeug (1) zur Materialhandhabung nach Anspruch 1, wobei die Steuerungseinheit (6) derart angeordnet ist, dass sie das Durchlassventil (5) derart steuern kann, dass die Absenkgeschwindigkeit des Lastträgers (2) kleiner oder gleich einer vorbestimmten Notabsenkgeschwindigkeit (S1) ist, basierend darauf, dass eine vorbestimmte Druckbedingung (Pcond; Pcond') erfüllt ist.

3. Fahrzeug (1) zur Materialhandhabung nach Anspruch 2, wobei die vorbestimmte Druckbedingung mindestens eine der folgenden vorbestimmten Druckbedingungen umfasst:

- der erkannte Druck (P1) ist nahe an oder gleich Null und es wurde von der Steuerungseinheit (6) und/oder einem Betreiber kein Absenkbefehl angefordert;
- ein erster erkannter Druck (P1) ist höher als ein nachfolgender zweiter erkannter Druck (P2) innerhalb einer vorbestimmten Zeit (t) und es wurde von der Steuerungseinheit (6) und/oder einem Betreiber kein Absenkbefehl angefordert.

4. Fahrzeug (1) zur Materialhandhabung nach einem der vorhergehenden Ansprüche, wobei das Durchlassventil (5) derart angeordnet ist, dass ein maximaler Flüssigkeitsausgangsstrom durch das Durchlassventil (5) einer Absenkgeschwindigkeit (S2) des Lastträgers (2) entspricht, die höher ist als die vorbestimmte Notabsenkgeschwindigkeit (S1), wobei das Durchlassventil (5) vorzugsweise dazu angeordnet ist, zu ermöglichen, dass die Absenkgeschwindigkeit höher ist als die vorbestimmte Notabsenkgeschwindigkeit (S2) bei einem Gewicht einer Last auf dem Lastträger (2) im Bereich von 0 % bis 100 % des maximal zulässigen Gewichts der Last, noch mehr vorzugsweise bei jedem Gewicht der Last von weniger als 100 % des maximal zulässigen Gewichts der Last.

5. Fahrzeug (1) zur Materialhandhabung nach einem der vorhergehenden Ansprüche, wobei das Durchlassventil (5) in dem Unterteil des hydraulischen Hubzylinders (3) montiert ist.

6. Fahrzeug (1) zur Materialhandhabung nach einem der vorhergehenden Ansprüche, wobei das Fahrzeug zur Materialhandhabung einen weiteren Sensor (23) umfasst, der derart angeordnet ist, dass er die Geschwindigkeit in vertikaler Richtung des Lastträgers (2) erkennen kann, und der weitere Sensor (23) derart mit der Steuerungseinheit (6) verbunden ist, dass die Steuerungseinheit (6) die Eingabe von dem Sensor (23) verwenden kann, um die vertikale Geschwindigkeit des Lastträgers (2) zu steuern, vorzugsweise durch Steuern der Öffnung des Durchlassventils (5) und/oder der Öffnung des Absenkventils (15).

7. Verfahren zum Modifizieren eines Fahrzeugs (1) zur Materialhandhabung, das die folgenden Schritte umfasst:

- Bereitstellen eines Fahrzeugs (1) zur Materialhandhabung,
- Modifizieren des Fahrzeugs (1) zur Materialhandhabung derart, dass es einem der Ansprüche 1-6 entspricht.

8. Verfahren zum Betreiben eines Fahrzeugs (1) zur Materialhandhabung nach einem der Ansprüche 1-6, umfassend eine Steuerungseinheit (6), die dazu angeordnet ist, Daten von Sensoren und Ventilen an dem Fahrzeug zur Materialhandhabung zu empfangen, und die dazu angeordnet ist, das Hydrauliksystem des Fahrzeugs (1) zur Materialhandhabung zu steuern, wobei das Verfahren die folgenden Schritte umfasst:

- Erkennen eines ersten Drucks (P1) an dem Ausgang eines Durchlassventils (5) in einem hydraulischen Hubzylinder (3) des Fahrzeugs zur Materialhandhabung;
- Anwenden einer vorbestimmten Druckbedingung (Pcond), umfassend den/die folgenden Schritt(e):

  - Bestimmen, dass der erste Druck (P1) nahe an oder gleich Null ist und von der Steuerungseinheit (6) und/oder einem Betreiber kein Absenkbefehl angefordert wurde; und/oder
  - Bestimmen eines nachfolgenden zweiten erkannten Drucks (P2) innerhalb einer vorbestimmten Zeit (t) und Bestimmen, dass der erste erkannte Druck (P1) höher ist als der zweite erkannte Druck und von der Steuerungseinheit und/oder einem Betreiber kein Absenkbefehl angefordert wurde;
  - und/oder Anwenden der Druckbedingung (Pcond'), umfassend die folgenden Schritte:

    - Bestimmen des Drucks (P2') im Innern des Hydraulikzylinders (3),
    - Vergleichen des Drucks im Innern (P2') des Hydraulikzylinders (3) mit dem ersten Druck (P1), wobei beide Drücke zum selben Zeitpunkt gemessen werden,
    - Bestimmen, dass die vorbestimmte Druckbedingung erfüllt ist, wenn eine Differenz zwischen dem ersten Druck (P1) und dem Druck im Innern (P2') des Hydraulikzylinders (3) erkannt wird;

wobei das Verfahren ferner den folgenden Schritt umfasst:

- wenn die vorbestimmte Druckbedingung (Pcond; Pcond') erfüllt ist, Anwenden eines Öffnungsverhältnisses auf das Durchlassventil (5) derart, dass eine Absenkgeschwindigkeit des Lastträgers (2) gleich oder kleiner einer vorbestimmten Notabsenkgeschwindigkeit (S1) ist.

9. Verfahren nach Anspruch 8, wobei ferner der folgende Schritt umfasst ist:

- Bestimmen, dass die Druckbedingung (Pcond; Pcond') nicht erfüllt ist, Anwenden des folgenden Schritts:

  - Anwenden eines Öffnungsverhältnisses auf das Durchlassventil (5), das einen Flüssigkeitsstrom aus dem hydraulischen Hubzylinder (3) derart ermöglicht, dass ein Lastträger, der von dem hydraulischen Hubzylinder (3) gehoben wird, mit einer höheren

Geschwindigkeit (S2) als der vorbestimmten Notabsenkgeschwindigkeit (S1) abgesenkt werden kann, vorzugsweise bis das Lastgewicht auf dem Lastträger (2) einem vorbestimmten Maximalwert entspricht, in diesem Fall ist die maximale Absenkgeschwindigkeit dieselbe wie die vorbestimmte Notabsenkgeschwindigkeit (S1).

10. Computersoftware, die, wenn sie auf einer Steuerungseinheit eines Fahrzeugs (1) zur Materialhandhabung nach einem der Ansprüche 1-6 gespeichert und ausgeführt wird, das Fahrzeug (1) zur Materialhandhabung dazu veranlasst, das Verfahren nach einem der Ansprüche 8-9 durchzuführen.

Revendications

1. Véhicule de manutention de matériau (1) comprenant :

un porte-charge (2),
une unité de commande (6),
un système hydraulique (20) pour le fonctionnement des fonctions hydrauliques du véhicule de manutention de matériau (1), incluant le levage et l'abaissement du porte-charge (2), le système hydraulique (20) comprenant au moins un vérin de levage hydraulique (3) avec un passage (9) pour le fluide hydraulique, une soupape d'abaissement (15), une soupape de levage (21) et une soupape de passage (5) agencée de manière à pouvoir fermer le passage (9),
dans lequel le porte-charge (2) est relié au vérin de levage hydraulique (3) de telle sorte que le porte-charge (2) est abaissé lorsque le fluide hydraulique s'écoule hors du vérin de levage hydraulique (3) à travers le passage (9) lorsque ladite soupape d'abaissement (15) est ouverte,
dans lequel l'abaissement du porte-charge (2) nécessite que la soupape d'abaissement (15) et la soupape de passage (5) soient ouvertes,
dans lequel l'unité de commande (6) est connectée à la soupape de passage (5), de telle sorte que l'unité de commande (6) est capable de contrôler le débit de fluide hydraulique à travers la soupape de passage (5) en envoyant des commandes de contrôle à la soupape de passage (5),
dans lequel la soupape de passage (5) est positionnée directement dans le vérin de levage hydraulique (3) et/ou dans le passage (9) du vérin de levage hydraulique (3)
dans lequel est en outre compris un dispositif de capteur (10) qui est agencé pour envoyer des données de capteur à l'unité de commande (6),
dans lequel le dispositif de capteur (10) est agencé pour détecter une pression correspondant à la pression à la sortie (22), ou dans une conduite hydraulique (8) directement connectée à la sortie (22), de la soupape de passage (5) du passage (9),
caractérisé en ce que
un autre capteur (14) est intégré au véhicule de manutention de matériau (1), dans lequel l'autre capteur (14) est agencé pour détecter la pression (P2') dans le vérin de levage hydraulique (3), dans lequel l'unité de commande (6) est agencée pour recevoir des données de capteur en provenance de l'autre capteur (14) ensemble avec les données de capteur en provenance du premier dispositif de capteur (10), dans lequel l'unité de commande (6) détermine la pression sous forme de différence de pression (PDiff') entre le premier dispositif de capteur (10) et le second dispositif de capteur (14), au même instant, dans lequel si l'unité de commande (6) détermine l'existence d'une différence de pression (PDiff'), la condition de pression (Pcond') est remplie et l'unité de commande (6) commande la soupape de passage (5) de sorte que le débit de fluide à travers la soupape de passage corresponde à une vitesse d'abaissement du porte-charge (2) qui est inférieure ou égale à une vitesse d'abaissement d'urgence prédéterminée (S1), préférablement l'unité de commande (6) est agencée pour vérifier si la soupape de passage (5) est déjà réglée pour correspondre à, ou être inférieure à la vitesse d'abaissement d'urgence prédéterminée (S1) lors de l'évaluation de la différence de pression (PDiff').

2. Véhicule de manutention de matériau (1) selon la revendication 1, dans lequel l'unité de commande (6) est agencée de telle sorte qu'elle est capable de commander la soupape de passage (5) de telle sorte que la vitesse d'abaissement du porte-charge (2) soit inférieure ou égale à une vitesse d'abaissement d'urgence prédéterminée (S1) sur la base du fait qu'une condition de pression prédéterminée (Pcond ; Pcond') est remplie.

3. Véhicule de manutention de matériau (1) selon la revendication 2, dans lequel la condition de pression prédéterminée comprend au moins l'une des conditions de pression prédéterminées suivantes :

- la pression détectée (P1) est proche ou égale à zéro, et aucune commande d'abaissement n'a été demandée par l'unité de commande (6) et/ou un opérateur ;
- une première pression détectée (P1) est supérieure à une seconde pression détectée consécutive (P2) dans un délai prédéterminé

(t), et aucune commande d'abaissement n'a été demandée par l'unité de commande (6) et/ou un opérateur.

4. Véhicule de manutention de matériau (1) selon l'une quelconque des revendications précédentes, dans lequel la soupape de passage (5) est agencée de telle sorte qu'un débit de sortie de fluide maximal à travers la soupape de passage (5) corresponde à une vitesse d'abaissement (S2) du porte-charge (2) qui est supérieure à la vitesse d'abaissement d'urgence prédéterminée (S1), préférablement la soupape de passage (5) est agencée pour permettre la vitesse d'abaissement qui est supérieure à la vitesse d'abaissement d'urgence prédéterminée (S2) à un poids de charge sur le porte-charge (2) compris entre 0 % et 100 % du poids maximal autorisé de la charge, encore plus préférablement à tout poids de la charge inférieur à 100 % du poids maximal autorisé de la charge.

5. Véhicule de manutention de matériau (1) selon l'une quelconque des revendications précédentes, dans lequel la soupape de passage (5) est montée dans la section inférieure du vérin de levage hydraulique (3).

6. Véhicule de manutention de matériau (1) selon l'une quelconque des revendications précédentes, dans lequel le véhicule de manutention de matériau comprend un autre capteur (23) qui est agencé de telle sorte qu'il peut détecter la vitesse dans la direction verticale du porte-charge (2), et l'autre capteur (23) est connecté à l'unité de commande (6) de telle sorte que l'unité de commande (6) est capable d'utiliser l'entrée en provenance du capteur (23) pour commander la vitesse verticale du porte-charge (2), préférablement en commandant l'ouverture de la soupape de passage (5) et/ou l'ouverture de la soupape d'abaissement (15).

7. Procédé de modification d'un véhicule de manutention de matériau (1) comprenant les étapes consistant à :

- fournir un véhicule de manutention de matériau (1),
- modifier le véhicule de manutention de matériau (1) de telle sorte qu'il corresponde à l'une quelconque des revendications 1 à 6.

8. Procédé de fonctionnement d'un véhicule de manutention de matériau (1) selon l'une quelconque des revendications 1 à 6, comprenant une unité de commande (6) qui est agencée pour recevoir des données provenant de capteurs et de soupapes du véhicule de manutention de matériau et pour commander le système hydraulique du véhicule de manutention de matériau (1), le procédé comprend les étapes consistant à :

- détecter une première pression (P1) à la sortie d'une soupape de passage (5) dans un vérin de levage hydraulique (3) du véhicule de manutention de matériau ;
- appliquer une condition de pression prédéterminée (Pcond) qui comprend les étapes consistant à :

  - déterminer que la première pression (P1) est proche ou égale à zéro, et qu'aucune commande d'abaissement n'a été demandée par l'unité de commande (6) et/ou un opérateur ; et/ou
  - déterminer une seconde pression détectée consécutive (P2) dans un temps prédéterminé (t) et déterminer que la première pression détectée (P1) est supérieure à la seconde pression détectée et qu'aucune commande d'abaissement n'a été demandée par l'unité de commande et/ou un opérateur ;
  - et/ou appliquer la condition de pression (Pcond') comprenant les étapes consistant à :

    - déterminer la pression (P2') à l'intérieur du vérin hydraulique (3),
    - comparer la pression à l'intérieur (P2') du vérin hydraulique (3) avec la première pression (P1), les deux pressions étant mesurées au même instant,
    - déterminer que la condition de pression prédéterminée est remplie une différence est détectée entre la première pression (P1) et la pression à l'intérieur (P2') du vérin hydraulique (3) ;

dans lequel le procédé comprend en outre l'étape consistant à :

- si la condition de pression prédéterminée (Pcond ; Pcond') est remplie, appliquer un rapport d'ouverture à la soupape de passage (5) de telle sorte qu'une vitesse d'abaissement du porte-charge (2) soit égale ou inférieure à une vitesse d'abaissement d'urgence prédéterminée (S1).

9. Procédé selon la revendication 8, dans lequel comprise en outre l'étape consistant à :

- déterminer que la condition de pression (Pcond ; Pcond') n'est pas remplie, appliquer l'étape consistant à :

- appliquer un rapport d'ouverture à la soupape de passage (5) qui permet un débit de fluide hors du vérin de levage hydraulique (3) de telle sorte qu'un porte-charge soulevé par le vérin de levage hydraulique (3) puisse être abaissé à une vitesse supérieure (S2) à la vitesse d'abaissement d'urgence prédéterminée (S1), préférablement à moins que le poids de la charge sur le porte-charge (2) ne corresponde à une valeur maximale prédéterminée, auquel cas la vitesse d'abaissement maximale est la même que la vitesse d'abaissement d'urgence prédéterminée (S1).

10. Logiciel informatique qui, lorsqu'il est stocké et exécuté sur une unité de commande d'un véhicule de manutention de matériau (1) selon l'une quelconque des revendications 1 à 6, amène le véhicule de manutention de matériau (1) à réaliser le procédé selon l'une quelconque des revendications 8 à 9.

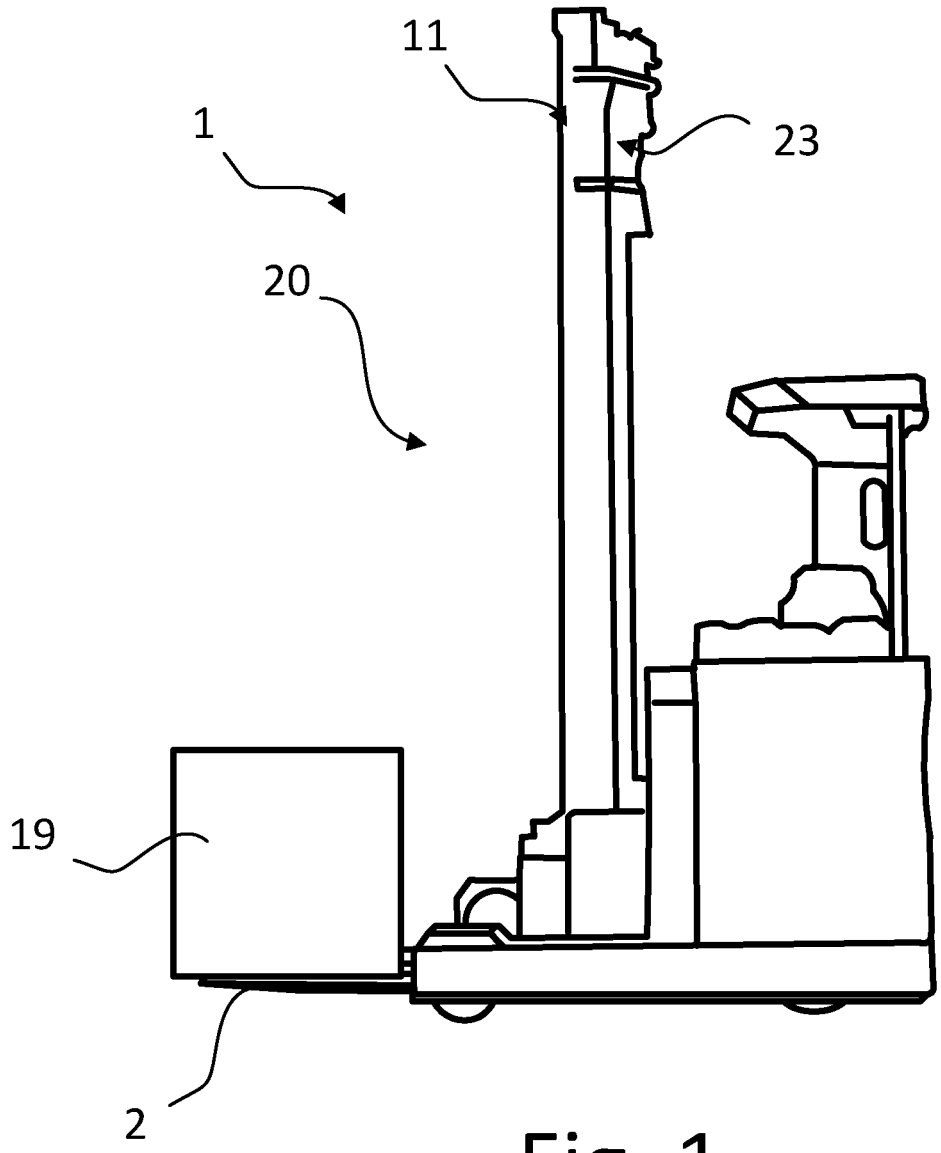

Fig. 1

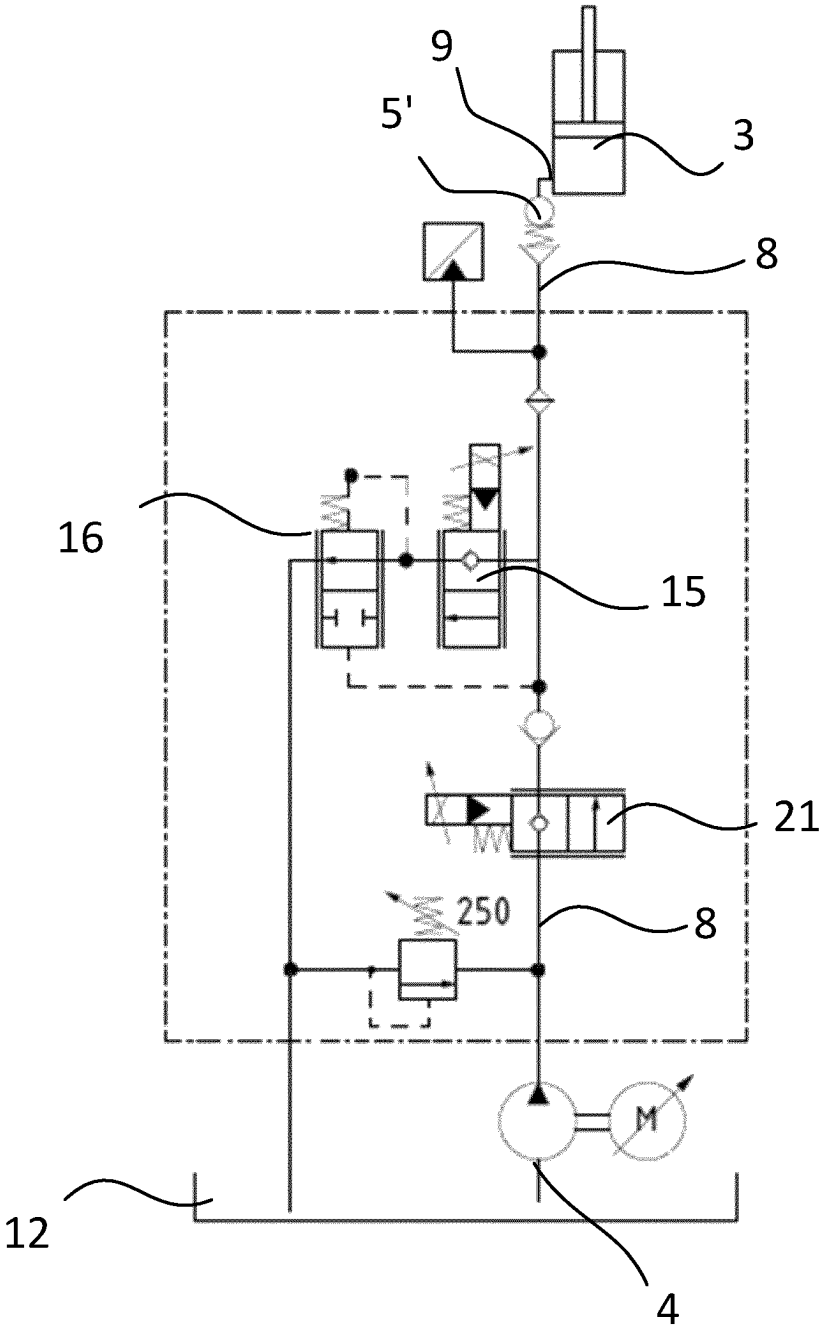

Fig. 2
Prior art

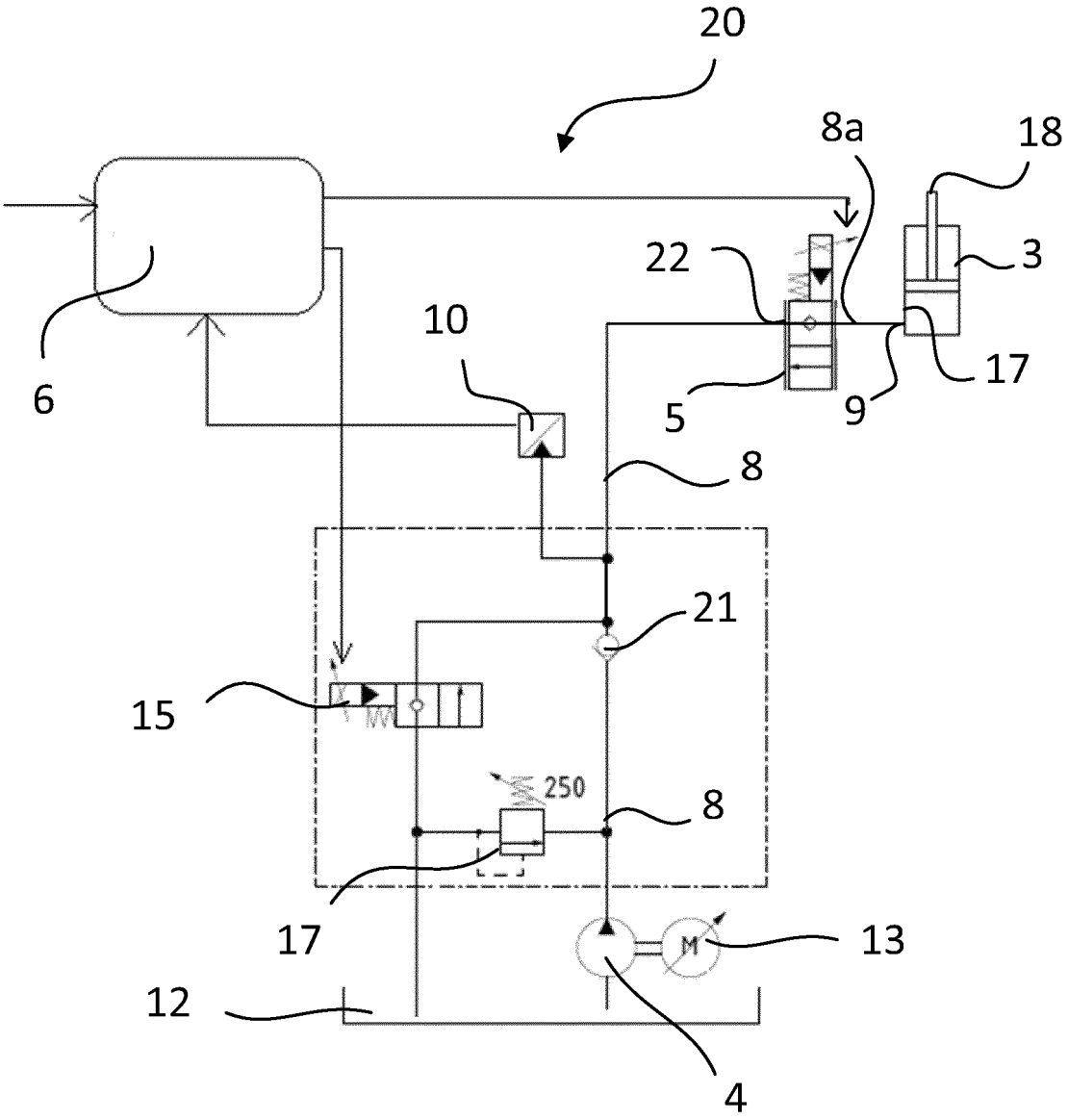

Fig. 3

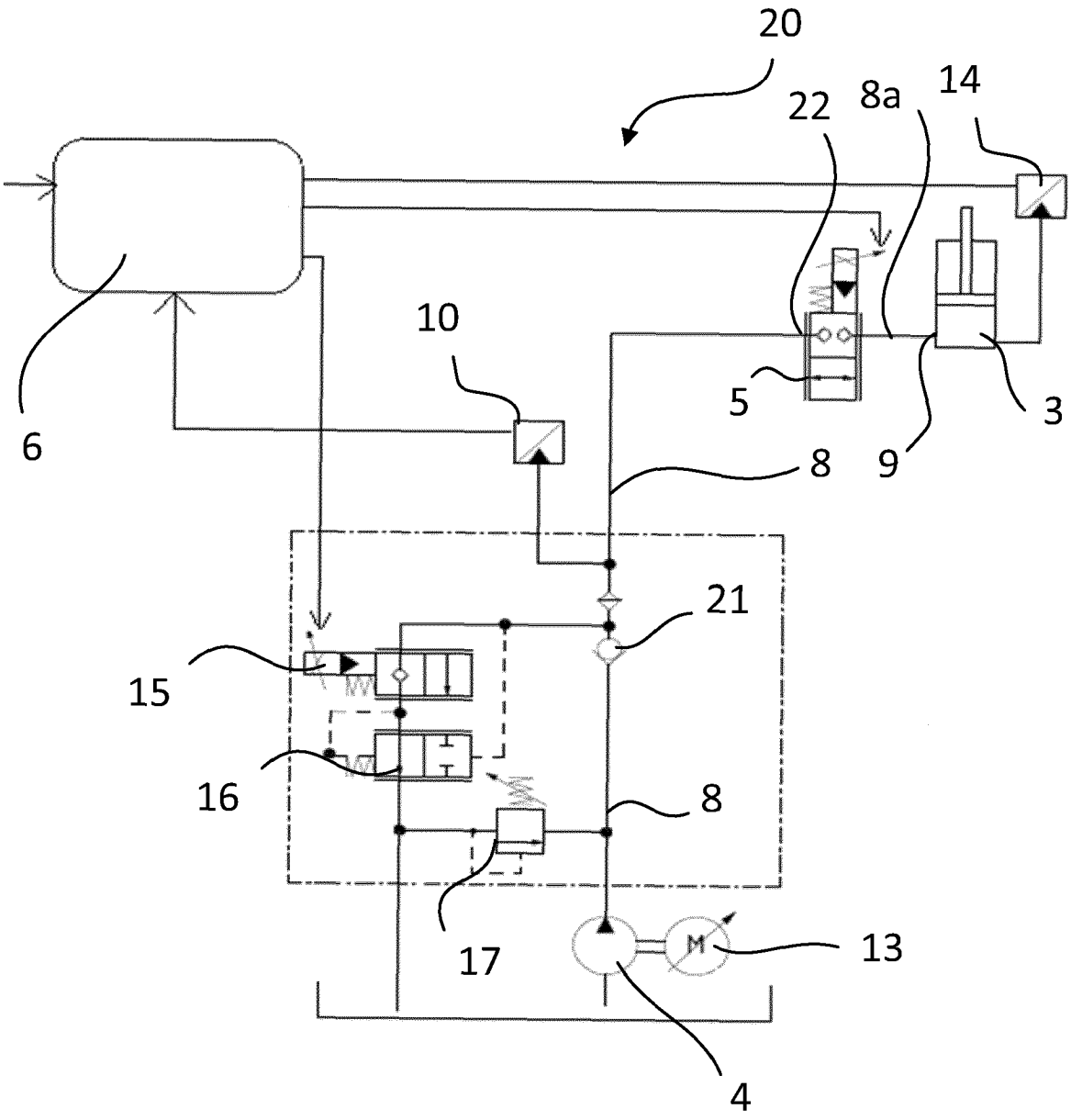

Fig. 4

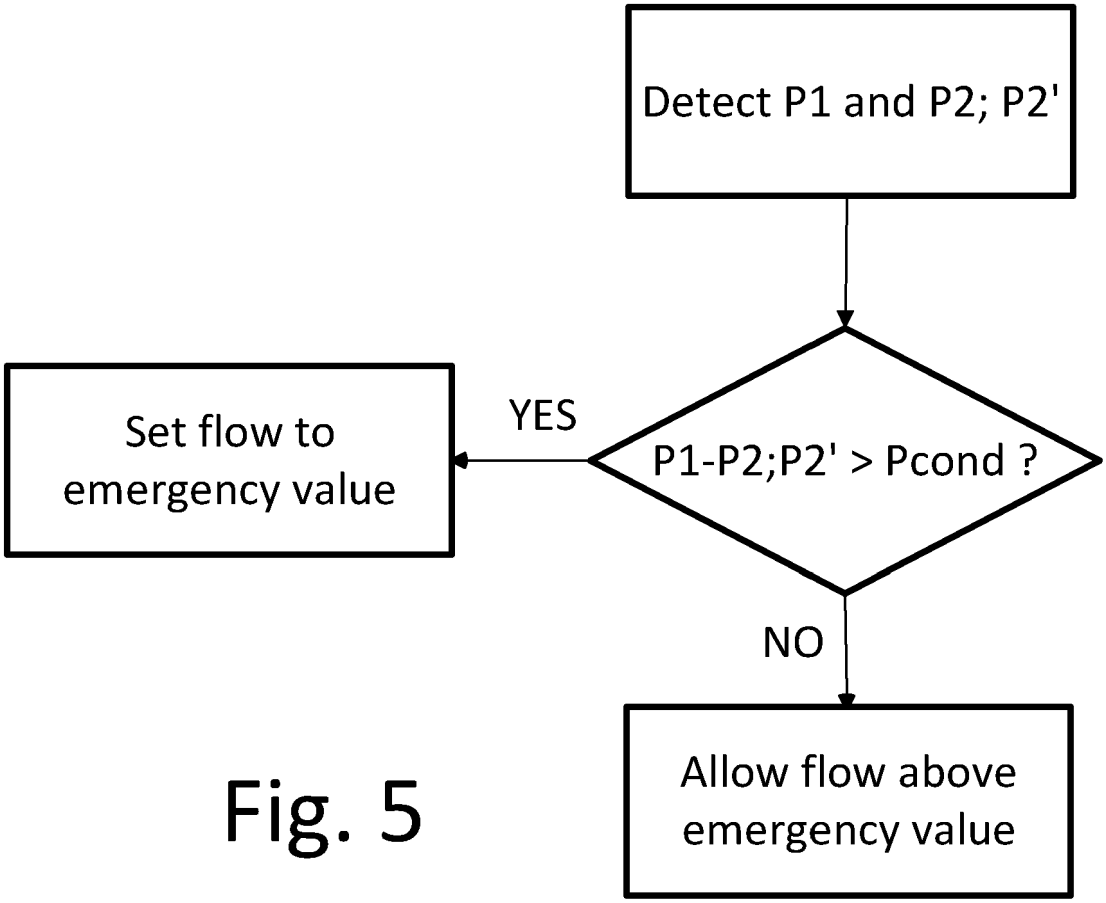
Detect P1 and P2; P2'
P1-P2;P2' > Pcond ?
YES
Set flow to emergency value
NO
Allow flow above emergency value

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20060060409 A1 **[0003]**