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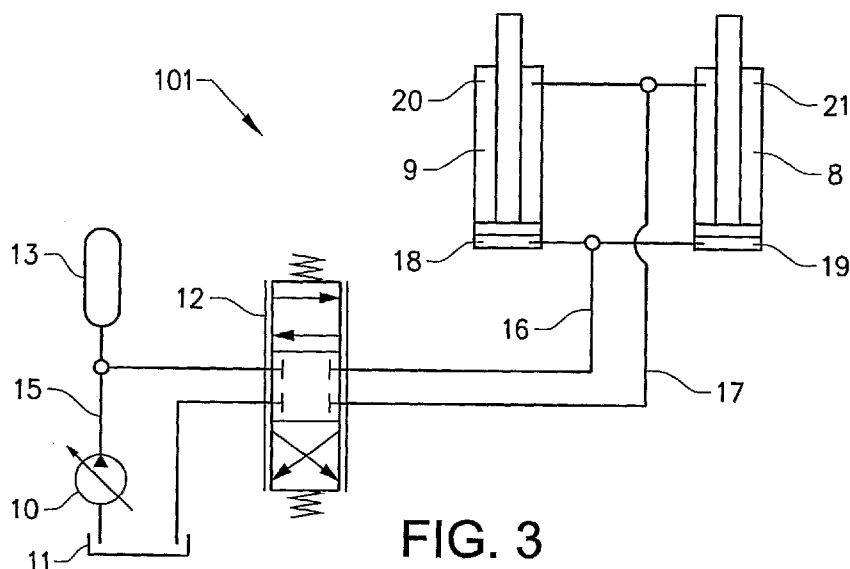
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(54) Title: A METHOD AND A DEVICE FOR DUMPING MATERIAL FROM A TILTABLE DUMP BODY OF A VEHICLE



(57) Abstract: The invention relates to a method for dumping material from a tiltable dump body of a vehicle having at least one expansible hydraulic cylinder (8,9) for raising the dump body toward a dumping angle; comprising the steps of automatically operating said hydraulic cylinder in such a way that vibrations are produced in said dump body to facilitate the dumping of the material.

**A method and a device for dumping material from a
tiltable dump body of a vehicle**

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FIELD OF THE INVENTION AND PRIOR ART

The present invention relates to a method for dumping material from a tiltable dump body of a vehicle having at least one expansible hydraulic cylinder for raising
10 the dump body toward a dumping angle. The invention also relates to a device for dumping said material. Further, the invention relates to different types of vehicles having a tiltable dump body, such as a dump truck or an articulated hauler.

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An articulated hauler is defined by a pivot joint arranged to allow a front frame and a rear frame to pivot in relation to each other around an imaginary longitudinal axis, that is an axis that runs in the
20 longitudinal direction of the vehicle. Travelling on uneven ground is substantially improved by virtue of such a joint. On the other hand, the term dump truck refers to a rigid hauler, ie a vehicle without such a longitudinal joint. The invention will below be
25 described with regard to an articulated hauler. This should however only be regarded as a non-limiting example.

In connection with transportation of heavy loads, e.g.
30 in contracting work, a work machine of the type of an articulated hauler is frequently used. Such vehicles may be operated with large and heavy loads in areas where there are no roads, for example for transports in

connection with road or tunnel building, sand pits, mines and similar environments.

5 An articulated hauler comprises a hydraulic system for moving the tiltable dump body between a lowered position and a raised position. The dump body is connected to the vehicle frame via a hinge at the rear of the vehicle and two hydraulic cylinders are arranged between the frame and the dump body for tilting the dump body.

10

Conventionally, an operator of the vehicle controls the tilting procedure by operating a control element, such as a tilt lever. During a tilting operation, the dump body is raised to its extreme limit (fully raised position) and then returned to its home position (fully lowered position).

15

Different materials slide out at different tilting angles depending upon the shape and texture of the material, the weight distribution and the condition of the floor of the dump body. If the contents of the box is dry, homogeneous and properly distributed throughout a smooth, dry dump body, dumping can be easily and smoothly accomplished. However, moisture distributed throughout the material or on the surface of the dump body may cause the particles to stick together and to stick to the insides of the dump body. Even if the material is dry when it is placed into the dump body, it can become wet while it is being transported or stored in the dump body. After a period of use, the inside of the dump body often becomes dented and rough so that it will tend to inhibit the easy slideout of the commodity. Dumping wet or frozen materials from a rough dump body can be very difficult since the

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particles can tend to stick together. Obviously, material sticking to the dump body has an adverse effect on productivity.

5 Operators sometimes try to lower and then raise the dump body quickly to the upper extreme limit in order to jar the load loose. It is also known to quickly reciprocating the tilt lever. However, such manual methods are usually not satisfactory ways to loosen the
10 retained material. A further way of removing the undumped contents is to engage a separate work machine, such as an excavator, which scrapes the bottom of the dump body by means of a bucket. It is however time consuming and thus non-efficient.

15

It is further known to alleviate this problem of the load sticking to the insides of the dump body or of the load sticking together, in trucks by placing vibrators on the bottom of the dump body to vibrate the contents
20 loose.

SUMMARY OF THE INVENTION

A first purpose of the invention is to achieve a method which creates conditions for increasing productivity by
25 removing stuck material from a dump body in an efficient way.

This purpose is achieved by means of a method according to claim 1. Thus, it is achieved by the steps of
30 automatically operating said hydraulic cylinder in such a way that vibrations are produced in said dump body to facilitate the dumping of the material. The total tilting cycle time is thereby reduced.

Thus, the conventional hydraulic cylinders which are arranged for raising and lowering the dump body are operated in such a way that vibrations are produced in the dump body. In this way, no further arrangements are
5 necessary for producing said vibrations. Thus, the invention creates conditions for a cost-efficient way of removing stuck material.

According to a preferred embodiment, the method
10 comprises the step of vibrating the dump body at a frequency in the interval 20-40 Hz.

According to a further preferred embodiment, the method comprises the step of vibrating the dump body with at
15 least two different frequencies. Preferably, the frequency is varied during a single vibration procedure. The frequency at which a specific load is released from the dump body may differ depending on the shape, texture and moisture of the material, the weight
20 distribution and the condition of the floor of the dump body etc. By varying the frequency during a single vibration procedure, the material is more likely to be released independently of its shape, texture and moisture etc.

25 According to a further preferred embodiment, the method comprises the step of monitoring a load receiving part of the dump body during at least one vibration procedure and determining a desirable frequency for future
30 vibration procedures on the basis of the result of the at least one previous vibration procedure. The term "result" refers to the quantity of remaining material in the dump body. According to a first alternative, the dump body is vibrated with at least two different

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frequencies during a single vibration procedure. According to a second alternative, the dump body is vibrated with different frequencies during two different, for example consecutive, vibration
5 procedures. A single desirable vibration frequency, or frequency interval, is selected from the previous vibration procedure(s) or calculated on the basis of the previous vibration procedure(s) for use in the future vibration procedures.

10

The load monitoring may be performed in different ways, for example via radar or optical detection. Especially, an acceleration of the dump body is detected. A change in the acceleration of the dump body may indicate a
15 certain load state, preferably a substantially empty state. The acceleration may be detected via a dump body angle detecting sensor, a hydraulic cylinder extension detecting sensor or an accelerometer. According to an alternative or complement to the acceleration
20 detection, an amplitude of the movements of the dump body during the vibration is detected. A change in the amplitude may indicate a certain load state, preferably a substantially empty state. According to a further alternative, a sound of the dump body during the
25 vibration is detected. A change in the sound may indicate a certain load state, preferably a substantially empty state.

According to a further preferred embodiment, the method
30 comprises the step of monitoring a load receiving part of the dump body, determining whether the dump body is empty on the basis of the monitoring and initiating said operation of said hydraulic cylinder in such a way that

vibrations are produced in said dump body only if there is still material in the dump body.

5 According to a further preferred embodiment, the method comprises the step of monitoring a load receiving part of the dump body during said vibrating operation of said dump body, determining whether the dump body is empty on the basis of the monitoring and stopping said vibrating operation when the dump body is empty.

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A second purpose of the invention is to achieve a device which creates conditions for increasing productivity by removing stuck material from a dump body in an efficient way.

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This purpose is achieved by means of a device according to claim 14. Thus, it is achieved by device adapted for dumping material from a tiltable dump body of a vehicle having at least one expansible hydraulic cylinder for
20 raising the dump body toward a dumping angle, *characterized in that* the device comprises means for operating said hydraulic cylinder in such a way that vibrations are produced in said dump body to facilitate the dumping of the material.

25

According to a preferred embodiment, the operation means comprises a first hydraulic valve means adapted to be moved back and forth between two separate positions. Preferably, the operation means comprises a
30 controller adapted to control the first hydraulic valve means.

According to a further preferred embodiment, the device comprises monitoring means adapted to monitor a load

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receiving part of the dump body, that the monitoring means is adapted to generate a signal with information regarding the status of the dump body. The term "status" refers to the dump body load status, ie the quantity of material in the dump body.

Other advantageous features and functions of various embodiments of the invention are set forth in the following description and in the dependent claims.

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BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained below, with reference to the embodiments shown on the appended drawings, wherein FIG 1 shows an articulated hauler 1 with a raised dump

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body 2 in a perspective view,

FIG 2 shows the dump body in its two extreme positions in a side view,

FIG 3 shows a hydraulic system according to a first embodiment,

20

FIG 4 shows a control system for operating the dump body, and

FIG 5 shows a hydraulic system according to a second embodiment.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Figure 1 shows a dump vehicle in the form of an articulated hauler 1 with a raised dump body 2 in a perspective view. The articulated hauler 1 comprises a front vehicle section 3 comprising a front frame, a front axle and a cab for a driver. The articulated hauler 1 also comprises a rear vehicle section 4 comprising a rear frame, two axles and the tiltable dump body, or container, 2.

30

The front frame is connected to the rear frame via a first pivot joint 5 that allows them to be pivoted relative to each other around a vertical axis for steering (turning) the vehicle. A pair of hydraulic cylinders (not shown) is arranged one on each side of the pivot joint for steering the vehicle. The hydraulic cylinders are controlled by the vehicle's driver via a steering wheel and/or a joystick (not shown).

10

A second pivot joint 6 is arranged to allow the front frame and the rear frame to pivot in relation to each other around an imaginary longitudinal axis, that is an axis that runs in the longitudinal direction of the vehicle.

15

The tiltable dump body 2 is connected to the rear frame via a pivot joint 7, at a rear part of the rear frame. A pair of hydraulically operated tilting cylinders 8,9 is connected at a first end to the rear frame and at a second end to the dump body 2. The tilting cylinders 8,9 are positioned one on each side of the central axis of the vehicle in its longitudinal direction. The dump body 2 is thus tilted up in relation to the rear frame upon activation of the tilting cylinders 8,9.

20

The dump body 2 typically is in the form of a box with a closed bottom, side walls, a front wall and an open top. During dumping the contents slide out of the box onto the ground or into a waiting receptacle.

25

The dump body 5 is shown in two extreme positions in figure 2: a fully lowered position and a fully raised position (see dotted lines). The fully raised position

corresponds to a maximum tilting angle α . A means 31 for monitoring an interior of the dump body 2 is arranged on the dump body. Said monitoring means 31 may be formed by a radar detection means. The dotted lines indicate
5 electromagnetic waves radiated from the radar detection means 31. Some material 32 is stuck in the dump body 2.

Figure 3 shows a hydraulic system 101 according to a first embodiment for operating the hydraulic cylinders
10 8,9. The hydraulic system 101 comprises a pump 10 adapted to provide the hydraulic cylinders 8,9 via hydraulic lines 15,16,17 with pressurized hydraulic fluid from a container 11. The tilting cylinders 8,9 are adapted to move in unison during a tilting motion.

15 A first valve means 12 in the form of a directional valve is arranged on the line 15 between the pump 10 and the hydraulic cylinders 8,9. The directional valve 12 is adapted, in a first position, to direct fluid to the
20 piston sides 18,19 of the cylinders via the line 16 and, in a second position, to direct fluid to the piston rod sides 20,21 via the line 17. When the flow is directed towards the piston sides 18,19 via the line 16, a corresponding flow will run from the piston rod sides
25 20,21 via the line 17 through the directional valve to the container 11, and vice versa. By quickly changing the position of the directional valve 12, hydraulic flow will be supplied to the piston sides 18,19 and the piston rod sides 20,21 in an alternating manner, wherein
30 the dump body will vibrate.

The hydraulic system 101 further comprises a means 13 for storing energy. The energy storage means is here an accumulator 13. The accumulator 13 is arranged in the

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line 15 between the pump 10 and the directional valve 12. The accumulator 13 is adapted to store a volume of hydraulic fluid that can quickly be released and forwarded to the hydraulic cylinders 8,9. In this way, a stronger vibration function is achieved.

Figure 4 shows a control system for operating the dump body 2 according to an example. The control system comprises a controller 25 or ECU (Electronic Control Unit). The monitoring means 31 is adapted to generate a signal to the controller 25 with information regarding the status (presence of material) of the dump body 2. The controller 25 is adapted to determine whether the dump body 2 should be vibrated or not on the basis of the status signal. The controller 25 is further adapted to control the hydraulic system 101 in response to said determination. More specifically, the controller 25 controls operation of the valve means 12.

Figure 5 shows a hydraulic system 201, which is a further development of the hydraulic system in figure 3. The hydraulic cylinders 8,9 are operated individually via one valve means 12,14 each. Thus, the first directional valve 12 is arranged to operate a first hydraulic cylinder 8 via lines 16,17 and a second directional valve 14 is arranged to operate a second hydraulic cylinder 9 via lines 18,19. In this way, the two cylinders 8,9 may be operated separately, wherein a small torsion of the dump body is achieved which can further enhance the release of stuck material.

The hydraulic systems 101, 201 in figure 3 and 5 are not only adapted for achieving the vibrations of the dump body for removing stuck material but also adapted for

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achieving the regular raising and lowering operations of the dump body 2. More specifically, each of the valve means 12,14 has three positions, wherein an intermediate position blocks any through-flow.

5

According to an alternative to the above described valve means 12,14, the valve means may comprise a four-position directional valve. In addition to the three positions described above, such a directional valve
10 comprises a fourth position, which connects both the piston side and the piston rod side to an atmospheric pressure, such as to the container, wherein a floating state is achieved. Such a floating state is advantageous during transport in that the hydraulic system is
15 relieved.

According to a further alternative, the hydraulic system comprises a first valve means for achieving the regular raising and lowering operations of the dump body 2 and a
20 second valve means for achieving the vibrations in the dump body 2 for removing stuck material. The first valve means may comprise the above described four-position directional valve. The second valve means may be a two-position valve comprising only the two outermost
25 positions of the three position directional valve described above. By virtue of such a two-position valve, the movements between the active positions may take place more rapidly, wherein the vibrating effect is enhanced.

30

The method comprises the steps of automatically operating said hydraulic cylinders 8,9 in such a way that vibrations are produced in said dump body 2 to facilitate the dumping of the material. The vibrations

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automatically induce frequency pulsations of the dump body. The hydraulic cylinders 8,9 are preferably operated in such a way as to achieve said vibrations upon receipt of a start signal. According to a first example, such a start signal is automatically generated when it is determined that the contents have not been entirely removed from the interior of the dump body at a certain dump angle, see further below. According to a second example, such a start signal is generated upon receipt of a command signal from an operator controlled element.

According to a first alternative, the method comprises the step of elevating the dump body 2 to a raised position prior to vibrating the dump body. Preferably, the dump body 2 is raised to a position in the vicinity of an extreme raised position (see figure 2) prior to vibrating the dump body.

According to an alternative, the method comprises the step of vibrating the dump body 2 during an elevating motion. Preferably, the dump body 2 is vibrated during a last part of an elevating motion.

According to a preferred embodiment, the method comprises the step of achieving the vibrations by repeatedly changing supply of hydraulic fluid to the piston side 18,19 and the piston rod side 20,21 of the hydraulic cylinders 8,9. Thus, the valve means 12,14 is operated back and forth between two separate positions in order to quickly change the supply of hydraulic fluid.

- Preferably, the dump body 2 is vibrated at a frequency in the interval 10-60 Hz and especially in the interval of 20-40 Hz. The optimum vibration frequency differs for different machine types, models and sizes.
- 5 Different designs have different natural frequencies. Some vibration frequencies may lead to an undesired vibration of the cab. Therefore, the frequency used for a particular machine is preferably tuned in.
- 10 According to one embodiment, see figures 2-4, the method comprises the step of determining whether there is any material left in the dump body during a tilting procedure in order to determine if the vibration should be initiated. Thus, it is first determined whether
- 15 there is still material in the dump body 2. Advantageously, the method comprises the step of monitoring the material during the elevating motion of the dump body 2. The method comprises the step of detecting a load state of the dump body 2 during the
- 20 elevating motion by means of radar and determining whether the dump body is empty on the basis of the radar detection.
- Further, according to an alternative embodiment, the
- 25 method comprises the step of optically detecting a load part of the dump body 2 during the elevating motion and determining whether the dump body is empty on the basis of the detection. Such optical detection may be performed via a camera.
- 30 Alternatively, a weight of a material in the dump body 2 is determined during the elevating motion and it is determined whether the dump body 2 is empty on the basis of the determination. A plurality of ways may be used to

determine the weight such as using a load cell in a dump body hinge and detecting a pressure in the hydraulic system 101,201.

- 5 According to a further alternative embodiment, the vibrating motion of the dump body 2 may be maintained as long as an operator controlled tilting lever is in an extreme end position corresponding to a full tilt. Alternatively, the vibrating motion is maintained during
10 a predetermined time period when the dump body reaches a pre-determined tilting angle.

According to a further development, the method may comprise the step of monitoring the material during the
15 vibrating motion of the dump body 2. This may be accomplished via optical or radar detection. The vibrating motion is stopped when it is determined that the dump body 2 has reached an empty state.

- 20 According to a further embodiment, an operator controlled element may be arranged to set the vibration function in an active state and an inactive state. Thus, the automatic detection of the load status (ie presence of material in the dump body) will then be initiated
25 after receipt of a command signal from the operator controlled element. Thus, the operator selects the active state if he believes that there is a risk of material sticking to the dump body.

- 30 According to an alternative, an operator controlled element may be arranged to initiate the vibrations directly during a current tilting cycle. Thus, the vibrations may be initiated directly after receipt of a start signal from an operator controlled element. The

vibrations may be set to continue for a predetermined period of time or as long as the operator controlled element is in the active position.

- 5 In a preferred embodiment, the controller comprises a microprocessor. The controller comprises a memory, which in turn comprises a computer program with computer program segments, or a program code, for implementing the control method when the program is run. This
10 computer program can be transmitted to the controller in various ways via a transmission signal, for example by downloading from another computer, via wire and/or wirelessly, or by installation in a memory circuit. In particular, the transmission signal can be transmitted
15 via the Internet.

The invention is not in any way limited to the above described embodiments, instead a number of alternatives and modifications are possible without departing from
20 the scope of the following claims.

The invention is of course not limited to using two hydraulic cylinders for achieving the dump body vibrations. According to an alternative, the method may
25 be used in a vehicle having only one tilting hydraulic cylinder. According to a further alternative, the method may be used in a vehicle having a plurality of tilting hydraulic cylinders, but only one or only some of them are used for achieving the vibrations.

CLAIMS

1. A method for dumping material from a tiltable dump
5 body (2) of a vehicle (1) having at least one
expansible hydraulic cylinder (8,9) for raising the
dump body toward a dumping angle; comprising the steps
of automatically operating said hydraulic cylinder
10 (8,9) in such a way that vibrations are produced in
said dump body to facilitate the dumping of the
material.
2. A method according to claim 1, comprising the step
of elevating the dump body (2) to a raised position
15 prior to initiating said vibrations to the dump body.
3. A method according to claim 1 or 2, comprising the
step of vibrating the dump body (2) during an elevating
motion.
- 20 4. A method according to any preceding claim,
comprising the step of achieving the vibrations by
repeatedly changing supply of hydraulic fluid to a
piston side (18,19) and a piston rod side (20,21) of
25 the hydraulic cylinder (8,9).
5. A method according to claim 4, comprising the step
of operating at least a first valve means (12,14) back
and forth between two separate positions.
- 30 6. A method according to claim 4 or 5, comprising the
step of providing the hydraulic cylinder (8,9) with
hydraulic fluid from an energy storage means (13) in
order to achieve said vibrations.

7. A method according to any preceding claim, comprising the step of vibrating the dump body at a frequency in the interval 20-40 Hz.

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8. A method according to any preceding claim, comprising the step of vibrating the dump body with at least two different frequencies.

10 9. A method according to any preceding claim, comprising the step of monitoring a load receiving part of the dump body (2) during at least one vibration procedure and determining a desirable frequency for future vibration procedures on the basis of the result
15 of the at least one previous vibration procedure.

10. A method according to any preceding claim, comprising the step of monitoring a load receiving part of the dump body (2), determining whether the dump body
20 is empty on the basis of the monitoring and initiating said operation of said hydraulic cylinder (8,9) in such a way that vibrations are produced in said dump body only if there is still material in the dump body.

25 11. A method according to any preceding claim, comprising the step of monitoring a load receiving part of the dump body (2) during said vibrating operation of said dump body, determining whether the dump body is empty on the basis of the monitoring and stopping said
30 vibrating operation when the dump body is empty.

12. A computer program comprising computer program segments for implementing the method as claimed in any

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one of claims 1-11 when the program is run on a computer.

13. A computer program product comprising computer
5 program segments stored on a computer-readable means
for implementing the method as claimed in any one of
claims 1-11 when the program is run on a computer.

14. A device adapted for dumping material from a
10 tiltable dump body (2) of a vehicle (1) having at least
one expansible hydraulic cylinder (8,9) for raising the
dump body toward a dumping angle, *characterized in that*
the device comprises means (12,14,25) for operating
said hydraulic cylinder (8,9) in such a way that
15 vibrations are produced in said dump body to facilitate
the dumping of the material.

15. A device according to claim 14, *characterized in*
that the operation means comprises a first hydraulic
20 valve means (12,14) adapted to be moved back and forth
between two separate positions.

16. A device according to claim 14 or 15, *characterized*
in that the operation means comprises a controller (25)
25 adapted to control the first hydraulic valve means
(12,14).

17. A device according to any one of claims 14-16,
characterized in that the device comprises monitoring
30 means (31) adapted to monitor a load receiving part of
the dump body (2), that the monitoring means (31) is
adapted to generate a signal with information regarding
the status of the dump body (2).

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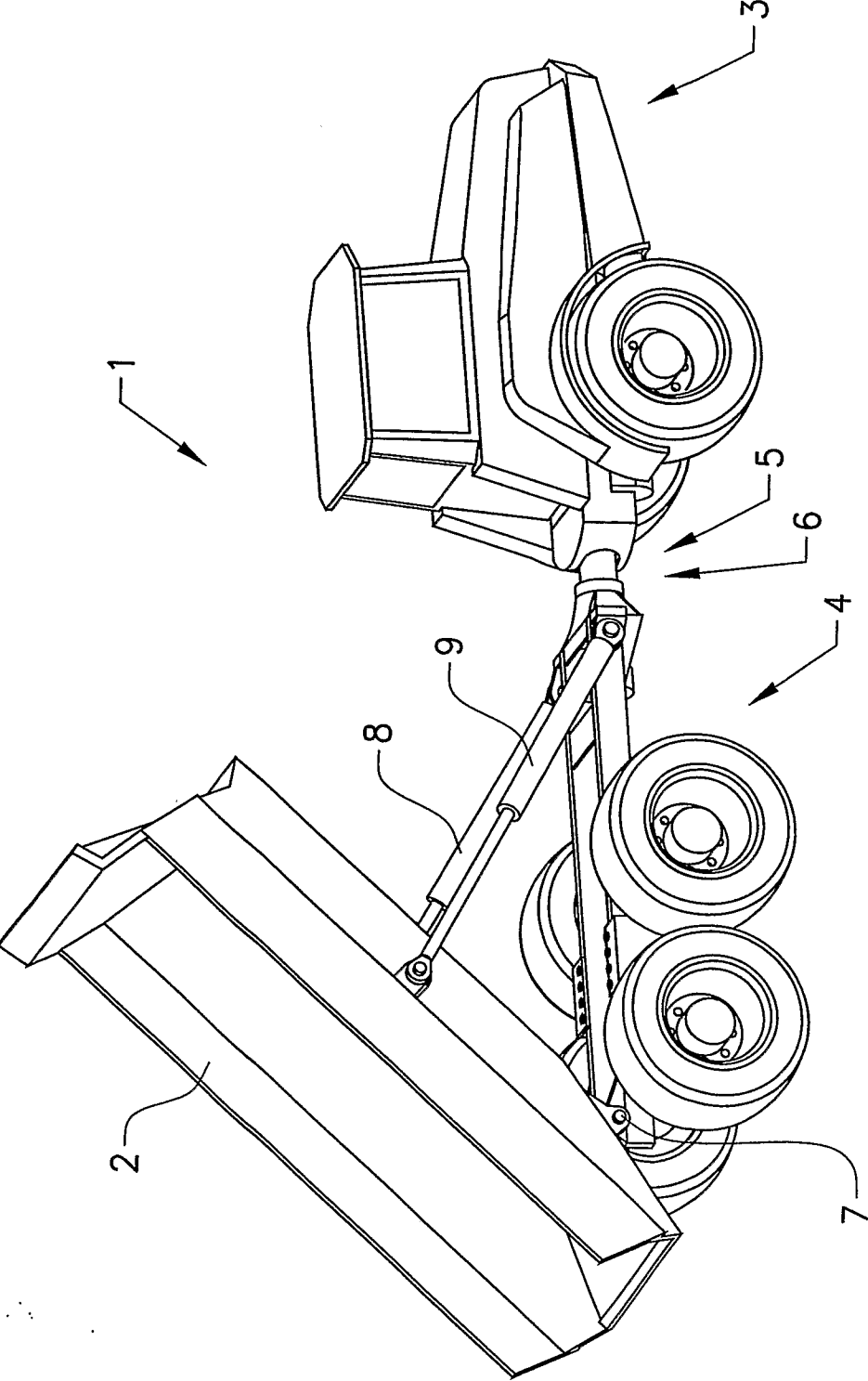


FIG. 1

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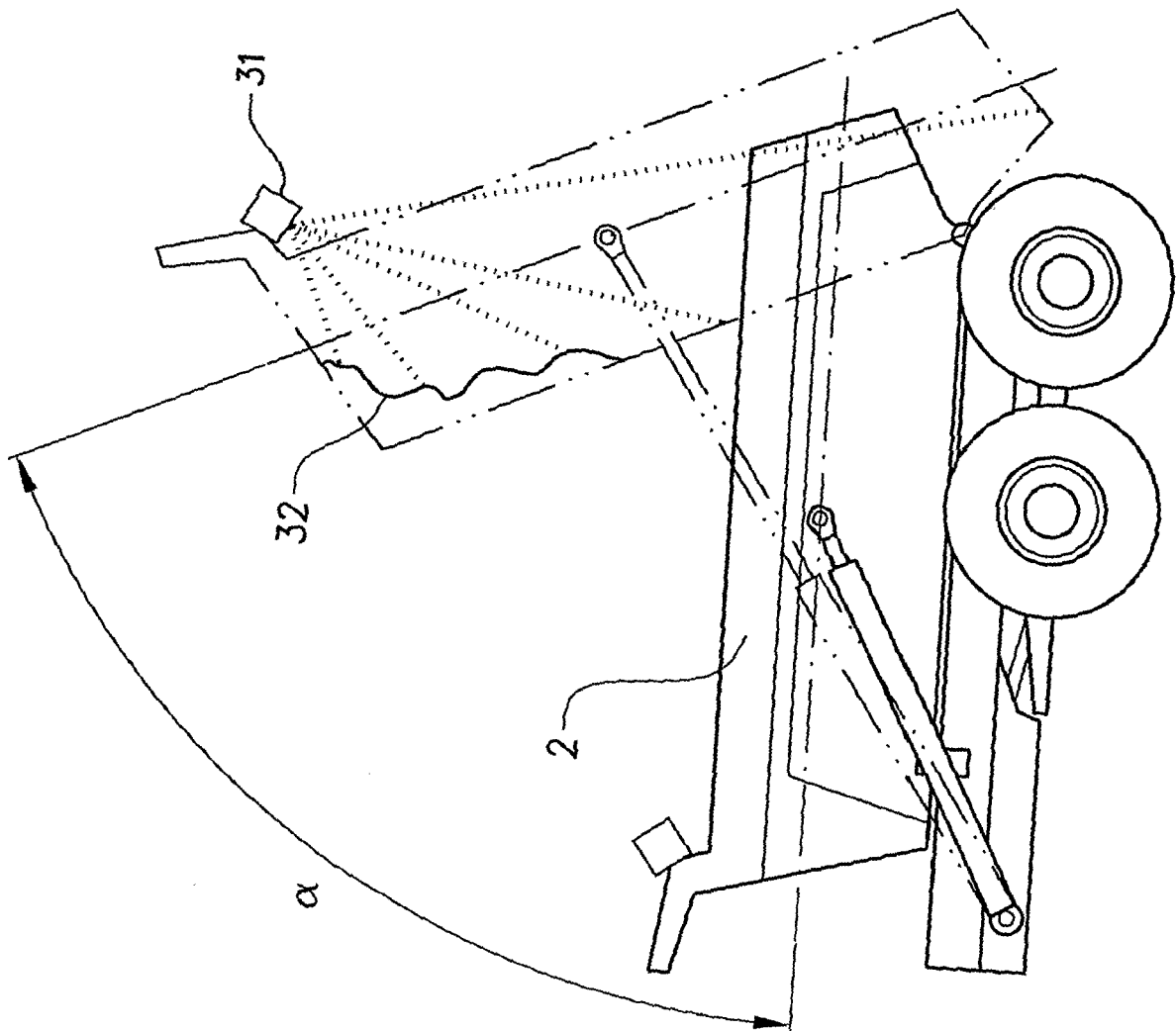


FIG. 2

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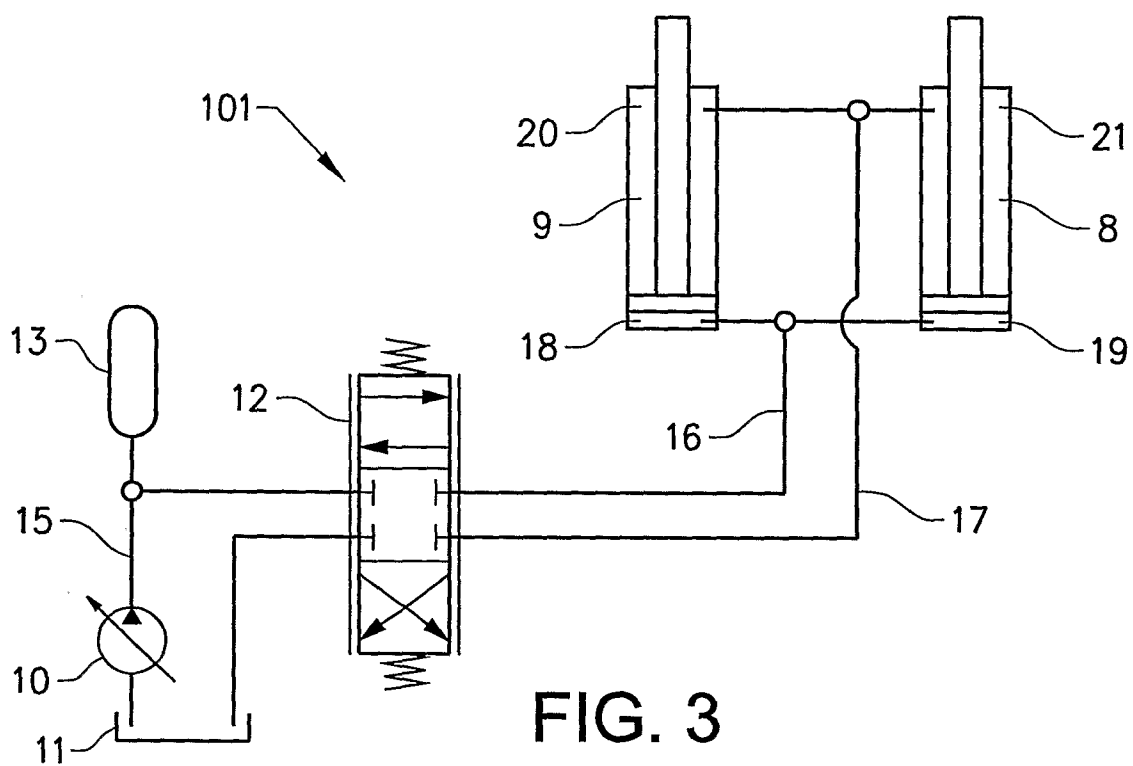


FIG. 3

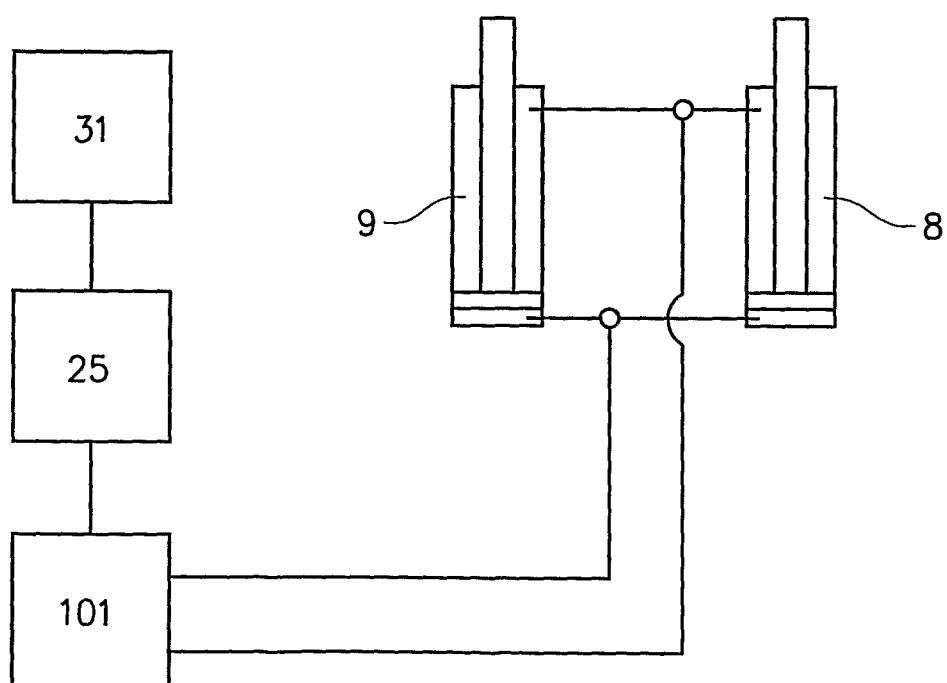


FIG. 4

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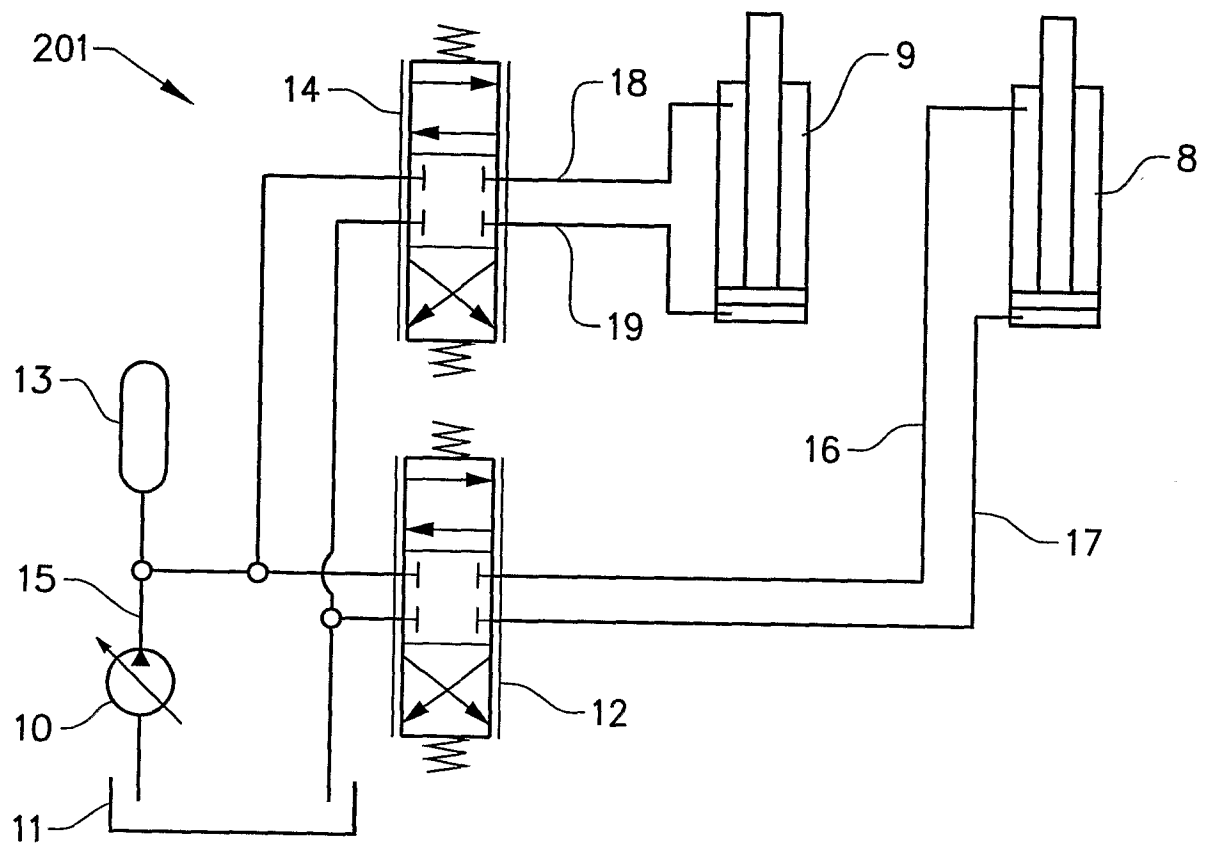


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/001163

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B60P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1942402 A (ANTHONY, W C ET AL), 9 January 1934 (09.01.1934), page 4, line 50 - line 130, figures 3,8 --	1-7,12-16
A	GB 827913 A (TATRA NARODNI PODNIK), 10 February 1960 (10.02.1960) --	1-17
A	GB 2417719 A (MORTEN, J E), 8 March 2006 (08.03.2006) --	1-17
A	US 4175906 A (JOHNSTON, W T ET AL), 27 November 1979 (27.11.1979) --	1-17

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1573020 A (STRÖM, N E ET AL), 13 August 1980 (13.08.1980) --- -----	1-17

International patent classification (IPC)**B60P 1/16** (2006.01)**B60P 1/58** (2006.01)**Download your patent documents at www.prv.se**

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Cited literature, if any, will be enclosed in paper form.

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26/01/2008

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