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[Continued on next page]

(54) **Title**: HYDRAULIC SOLUTIONS ON A WORK MACHINE

(57) **Abstract**: Hydraulic solutions on a to an agricultural tractor or equivalent connected stone picker (1) where the stone picker shows at least one central work unit (13, 13') and at least one with this cooperative unit (2, 2') and at least one hydraulic cylinder (4, 4'. 11. 12, 12'), where the length of the height adjustment cylinder or cylinders (4, 4'. 12, 12') during work automatically is adapted to the pulling force of the machine (1) and/or the work unit (13') registered by one or more sensors (11) on the work machine.

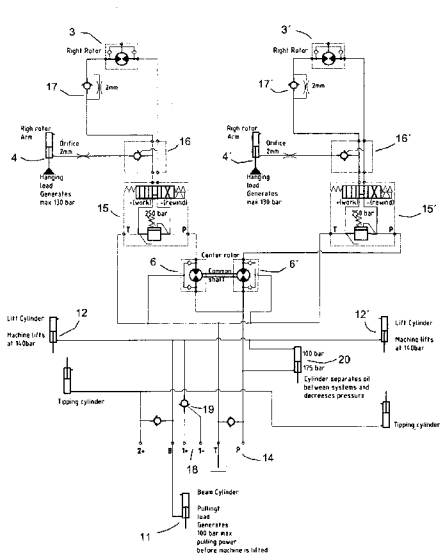

Fig 4

WO 2017/009521 A1

— *with amended claims and statement (Art. 19(1))*

Hydraulic solutions on a work machine.

This innovation is related to hydraulic solutions to automatically optimize the load and the load distribution for a work machine, for example a stone picker connected to a base machine, where at least part of the weight of the work machine during work is transmitted to a tractor or base machine and where the work machine show as well hydraulic motors and/ or hydraulic cylinders.

As the cultivated area pro farm has heavily increased during the last decades and new areas have been cultivated, the need to collect stones from arable fields has strongly increased.

A lot of different models of stone pickers have been presented in the patent literature as far as from early 1900 century, the oldest ones American or Canadian powered by horses, later powered by tractors and even self-propelled models.

From the simple (frequently British) tractor carried solutions presented in the patent literature in the late -50es and early -60es the Japanese started with their trailed solutions in the -70es. US and CA have also during this hole period a lot of patent applications. These were frequently intended to collect smaller stones in swaths, or different models of loading buckets to collect stones (from the swaths), or to take up single big stones, for example when new land was taken in cultivation.

In the USSR a big numbers of patent applications and utility models have been presented from early -80es to the Soviet dissolution

As a forerunner to the solutions, those also today are seen as modern, one can rightly consider the publication FR2595185 from March 1986, where Frenchman Maurice Tanguy presents a stone picker pulled by a tractor and equipped with a lifting rotor, that co-operate with a siew, who's frontend penetrate below the ground surface, collects stones and transport them to a tilting container positioned at the rear end.

The throwing rotor of Tanguy is mounted in a separate frame, movable in relation to the siew to enable also bigger stones to pass without blocking the rotor.

Here is the basic central solution presented, that is most common in Europe even today, particularly if completed with the solution presented in the patent publication CS263662 by the Czech Miroslav Svoboda and Co..

Here is the stone picker combined with the already known aligned stone rakes, one each side in front of the lifting rotor. In this manner, it was possible to increase the working width of the machine and to save one separate work pass, raking the stones in a swath.

One can quickly convince oneself, that these in the mid 1980es presented solutions still are dominating the market by checking on the internet the offers of today-, and the producers of stone pickers.

As an example we can from the home page of PEL-Tuote (*http://pel-tuote.fi/sv/esitteet/*) see how the Kivi-Pekka stone picker is build using the teachings from the French and the Czech solutions from 1986.
As well it is possible to find a fairly similar solution on the Kongskilde home page *(http://www.kongskilde.com/fi/fi-FI/Agriculture/Soil/Stone%20Collecting/Stone%20Collecting/JUKO%20STONEBEAR*)

Characteristically bout the raking rotors and the lifting rotor are mechanically driven from the tractor PTO by use of drive shafts, gearboxes and V-belts, showing as well benefits as disadvantages.

The benefit with the mechanical transmission is that it is possible by use of quite simple known components to transmit enough power and torque by normal load without disturbance.

The load on a stone picker is however all time strongly pulsating as a stone rake collects a flow of small and middle size stones to the lifting rotor. The load shows additionally sharp load peaks as single big stones enter the machine. If the stones are oversize or unsuitable formed and enter the machine in “wrong edge”, blockage will occur.

Of course the mechanical transmission in known stone pickers is equipped with overload protections, but really these are mostly their Achilles' heel. Known types of overload

protection used are multi disk friction clutches of standard type, or as in the above mentioned Kongskilde and PEL-Tuote machines V-belt transmissions between the gearbox and the rotors.

The all-time pulsating load creates heating of the overload protections and as it is very difficult to equip these rotating components with an effective cooling, they easily are overheated and get unusable until their central components are replaced.

The drive torque for V-belts used as overload protection is extremely sensitive to dirt and moisture on the belts. If they got vet ore dirty they first have to be cleaned and dried and their pre-tension has to be checked and adjusted before the work can continue after an overload. That the cleaning and the adjusting of the V-belts really is difficult can clearly be understood thereby that for Kongskilde Kivikarhu, the instructions for adjusting and cleaning the V-belts go over three pages in the instruction manual and include advise to grind the grooves in the pulleys when the machine is standing and to clean and dry the belts before the interrupted work can continue.

If the drive do not manage to disengage the PTO of the tractor immediately in time when overload occurs, these mechanical overload protections are very quickly overheated. The friction discs of the multidisc overload clutches get glazed and has to be replaced. The V-belts burns and also they has to be replaced, adjusted and be running in with due care during the run in period and thereafter readjusted checking the pre-tension rate during the run in time. (if doubt, see the instruction manual of Kivikarhu). All these additional work reduce the efficiency, gives expensive downtimes in the work and increase the risks concerning work safety.

Therefore the Canadian producer Degelman for example, do produce stone pickers alternatively equipped with mechanical- or hydraulic transmissions. Check the presentation of their model Signature 7200 at:

http://www.degelman.com/products/agricultural_equipment/rock_pickers_rakes/signature/index.php

As seen from this presentation, the benefit with the mechanical transmission is that it can transmit high torques and the machine is therefore able to collect also big stones.

The easy reverse possibility for the collecting rotor, offered by the hydraulic transmission is a big advantage by blockage.

Additionally the pressure relief valve of the hydraulic transmission gives a very reliable overload protection. The disadvantage is, that the hydraulic capacity of most of the agricultural tractors normally available for this work, is not with conventional solutions big enough to ensure the separate working units enough power to collect also big stones.

To overcome these disadvantages with the known mechanical and hydraulic solutions for stone pickers, new hydraulic solutions according the present invention has been developed.

The most important benefits with these is, that effective and almost maintenance free overload protections are available for each separate work unit, and that the rotation speed of the separate driven units remain at required level also if the load between themselves variate.

Further a major advantage is that the load between the different driven units automatically is distributed to ensure that the heaviest loaded unit all time has access to the spare power the less loaded units does not momently use within the scope of the given maximal allowed drive power.

This ensure, that the working pressure in the system, and the hydraulic power taken from the tractor or the base machine all time is hold on the lowest possible level, as the system pressure is not desired by the most loaded work unit but by the total load.

Another big benefit is also that the cooling of the overload protections, in this case the pressure relief valves for the separate rotors is very effective as new oil all time flow through and cool them at possible stand stills for the single work unit, or at a total stop of the hole system.

The overload limit is neither sensitive for external dirt and does not need to be readjusted after an overload as for the above described traditional solutions.

Furthermore it is easy to reverse the rotors at minor blockages. Downtime at work therefor almost disappears and the efficiency of the machine can all time be optimally used.

Below an advantageous embodiment of the invention is described with use of the following drawings.

Fig 1. Shows a top view of a stone picker, using the hydraulic solutions of the invention.
Fig 2. Shows the same machine in a side view.
Fig 3. Shows the same machine in a rear view.
Fig 4. Shows a typical hydraulic scheme for the hydraulic solutions according to the present invention.

Fig 1. Shows a top view of the stone picker, where for the understanding of the invention the most essential components are numbered. Left and right rake units 2 and 2`, hydraulic motor for left and right rake 3 and 3`, lift cylinders for left and right rake units 4 and 4`, lift rotor 5, left and right hydraulic motor for the lift rotor 6 and 6`.

Fig 2. Shows a side view of the stone picker, where for the understanding of the invention the most essential components are numbered. Carrier frame 7, with tandem unit 8, support wheels for the stone rakes 9, drawbar 10, drawbar pull cylinder 11, drawbar height adjustment cylinder 12 and the siew heads 13`.

Fig 3. Shows a rear view of the stone picker, where for the understanding of the invention the most essential components are numbered. Siew under the lift rotor 13.

Fig 4 shows the hydraulic scheme of the stone picker where for the understanding of the invention the most essential components are numbered.
The rotors drive circuit: The tractor external hydraulic connection pressure 14, cylinder 20, left and right hydraulic motor 6 and 6`for the lifting rotor, control valves 15 and 15` for left and right rake units, pivot operated check valves 16 and 16`for the left and right lift cylinders, lift cylinders for left and right rake units 4 and 4`, non-return valves with restricted bypass left and right 17 and 17`, hydraulic motors for left and right rake units 3 and 3`.

Height adjustment circuit: The tractor external double acting connection 18, pivot operated check valve 19, height adjustment cylinders left and right 12 and 12`, cylinder 20 and the pull cylinder 11 of the drawbar.

Note, for the hydraulic connection to the tractor is only one double acting and one single acting connection + free return used. No from tractor electrically or cable operated hydraulic valves are needed.

The function of the hydraulic solutions according the invention is as follow:

The not shown mechanical transport security lock for the rakes are opened. The tractor external hydraulic 14 is activated and the lift rotor 5 starts. As the operating valves 15 and 15`for the rake units are activated in + position the rake units are lowered since the return pressure from the hydraulic motors 3 and 3`of the rake units are big enough to open the check valves 16 and 16`.

Bout of the rake units keeps now the same speed as they ar driven by the return oil from the equal sized hydraulic motors 6 and 6` which are synchronized with each other through the lift rotor shaft 5 and therefore distribute the oil from the reactor evenly to bout of the rake units independent of their load.

The required working depth is set by the tractor external hydraulic connection 18. The pivot operated check valve 19 prohibit during work the oil from leaking out of the height adjusting cylinders 12 and 12`back to the tractor.

When the machine is operating normally, the pressure in the height adjustment cylinders 12 is equal high as the pressure on the piston rod side in the pull cylinder 11 of the drawbar.

If the machine tends to sink to deep, the pulling resistance will increase and the pressure in the pull cylinder 11 of the drawbar will increase. Then oil is led from this cylinder 11 to the high adjustment cylinders 12 and the working depth will decrease.

Here we have a kind of an automatic depth control based on the pulling force, it means depending on how deep the siew edges 13`penetrate in the soil and how hard the soil is.

How deep the siew edges work desire also how deep the lifting rotor 5 and also how deep towards the raking rotors directed parts of the rakes do work. At increased working deep and or at heavier soil or by increased stone presence or by increased speed, the rotation resistance for all three rotors does increase, most of course for the lifting rotor 5 but also for the rake unit rotors 2.

From the hydraulic scheme we can see that the pistonrod side of the cylinder 20 is in connection with the height adjustment cylinders 12. The cylinder 20 thus separate the oil in the rotation drive and in the height adjustment circuits from each other, but keeps the pressure relation between the pressure in these circuits on the level given by the area relation between the bout chambers of the cylinder 20 gives.

This mean that the higher rotation resistance the rotors get, the more oil will be pressed out of the cylinder 20 to the height adjustment cylinders 12 and opposite, the lower the rotation resistance for the rotors is, the more oil is let out from the height adjustment cylinders 12 to the cylinder 20 and the working depth of the machine will increase.

Therefore we get a load adapting depth regulation that not only take in account the pulling force, but the depth regulation is a function of all the parameters: working depth, soil stiffness, stone presence, working speed and the rotation speed of the rotors. If the depth control is marked by Z, this regulation can be written as a function

$$Z = \int (\Delta_{\text{working depth}}, \Delta_{\text{soil stiffness}}, \Delta_{\text{stone presence}}, \Delta_{\text{working speed}}, \Delta_{\text{rotation speed}})$$

The area ratio between the piston- and piston rod sides of the cylinder 20 determinate, to what amount the of the rotation resistance depended parameters influence on the depth control, in relation to how those parameter, who only are related to the pulling force in the drawbar.

Thus it can oft be a benefit to connect a second cylinder with another area ratio in parallel th the cylinder 20 to get the possibility to during work adjust what influence (how heavily) the different parameters will have on the load depending depth control Z.

When we look at the rotor drive we did already notice that bout of the hydraulic motors of the lifting rotor do work also as flow dividers and do synchronize the speed between the rotors.

When we look at the dynamic pressure drop over the hydraulic motors we can for example look at a situation where the load on the left rake unit 2 increase while the load on the right hand rake unit 2` remain constant. The pressure drop over the hydraulic motor 3 of the left hand rake unit increase. This results in a decreasing of the pressure drop over the hydraulic motor 6 of the lifting rotor. The two hydraulic motors 6 and 6`do therefore give different torque on the shaft of the lifting rotor 5, in extreme case so that the left hydraulic motor instead of giving part of its effect to the lifting rotor instead is driven by this and then will act as a pump and can increase the working pressure of the hydraulic motor 3 of the left rake unit to the maximum pressure limit of the control valve 15, thus much higher than the system pressure of the tractor external hydraulic.

The connection of the hydraulic motors according to the present innovation, results in a power distribution between the hydraulic motors of the three rotors and supply the maximum power to that hydraulic motor that instantaneous has the highest external load. Here is not only the hydraulically supplied power used, but also the kinetic energy stored especially in the heavy lifting rotor 4 with large diameter, but also the kinetic energy of the right had rake rotor is used to help the hydraulic motor of the left hand rake rotor over the load peak and vice versa.

Is the load of the hydraulic motor of the left hand rake rotor all too big, the pressure relief valve of the control valve 15 at 250 bar and oil can the free bypass the motor 3 to tank. Thus at this overload also heavy heating will occur, an effective cooling of the overload protection is present by the continuous oil flow through the valve and the relief pressure of the valve is kept on an even level without need of readjustment, cleaning operations or changing of parts as usually is the case by the traditional over load protections that up to now have been dominating on the stone pickers on the market.

If the rake rotor tends to stop because of tree roots or branches winding around it, or because of a suitably shaped stone that itch in between its throw fingers and the frame, with an hydraulic solution according the present innovation it is only needed to reverse its control valve 15. The oil will then be directed to the lift cylinder 4 of the rake unit and release the

unit from the ground. Simultaneous part of the oil will flow through the restricted bypass 17 of the relief valve to slowly reverse the rake rotor to release the blockage and the work can continue with a minimum of standstill and with maximum of safety for the driver.

The fact that the load on the rotor first is automatically reduced by the oil supplied to the lit cylinder will of course help to reverse the rotor and release the blockage.

As the above-described examples shows, the hydraulic solution of the present innovation has many advantages compared to the state of the art hydraulic solutions in stone pickers. The work machine does of course not be a stone picker, but can be any work machine getting its hydraulic power supply from a base machine and who`s own weight at least partly is unloaded by this. The number of driven rotors is neither limited to two, but can be any number.

The area of use is neither limited to a within the agriculture used working machine, but can be for example a machine used within road or landscape construction and many variations thereof are possible within the scope of the patent claims below.

Claims

1. Hydraulic solutions on a to an agricultural tractor or equivalent connected stone picker (1) where the stone picker shows at least one central work unit (13, 13`) and at least one with this cooperative unit (2, 2`) and at least one hydraulic cylinder (4, 4′. 11 . 12, 12′), **characterized in that** the length of the height adjustment cylinder or cylinders (4, 4′. 12, 12′) during work automatically is adapted to the pulling force of the machine (1) and/or the work unit (13`) registered by one or more sensors (11) on the work machine.

2. A work machine according to the preceding claim, **characterized in that** at least one of the sensors (11) at the same time work as a damper to dampen shock loads between the pulling unit and the work machine.

3. Hydraulic solutions on a to a stone picker (1) where the stone picker shows at least one work unit (13, 13`), at least one hydraulic motor (3, 3`, 6, 6`) and at least one hydraulic cylinder (4, 4′. 11 . 12, 12′), **characterized in that** the length of the height adjustment cylinder or cylinders (12, 12′) during work automatically is adapted to the registered rotation resistance of one or more work units (5. 2, 2′).

4. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the length of the height adjustment cylinder or cylinders (12, 12′) during work automatically is adapted bout to registered pulling resistance of the working unit/ -units (4, 4′. 12, 12′) and to the registered rotation resistance of one or more rotating work units (5. 2, 2′).

5. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the length of the height adjustment cylinder or cylinders (4, 4`,12, 12′) during work automatically are adapted as a function of several different parameters ($\Delta_{\text{working depth}}$, $\Delta_{\text{soil stiffness}}$, $\Delta_{\text{stone presence}}$, $\Delta_{\text{working speed}}$, $\Delta_{\text{rotation speed}}$)

6. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the height adjusting cylinder or cylinders (12, 12`) and the hydraulic motor or motors of the rotating work elements (5, 2, 2`) are hydraulically separated from each other with one double acting cylinder (20) to avoid that the oil in the two hydraulic circuits do mixed with each other.

7. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the area ratio of the double acting cylinder (20) decide how the ratio between the registered rotation resistance and the registered pulling resistance of the work element or work elements (2, 2`,5, 13, 13`) do effect the length of the height adjustment cylinder, or height adjustment cylinders (4, 4`, 12, 12`).

8. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the height adjusting cylinder or height adjusting cylinders (12, 12`) and the hydraulic motor or -motors of the rotating work elements (5, 2, 2`) are hydraulically separated from each other with two single acting with each other connected cylinders to avoid that the oil in the two hydraulic circuits do mixed with each other.

9. Hydraulic solutions on a to an agricultural tractor or equivalent connected work machine (1) where the work machine shows at least one central work unit (13, 13`) and at least one by an hydraulic motor driven work unit (2, 2`), at least one hydraulic motor (3, 3`) and at least one hydraulic cylinder (4, 4`) **characterized in that** the hydraulic cylinder (4, 4`) of the work unit (2, 2`) is pressurised by reversing the oil supply to the hydraulic motor (3, 3`) of the work unit in question.

10. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the hydraulic driven work unit (2, 2`) automatically is lightened from the ground when the hydraulic motors (3, 3`) are reversed to free the work unit from a blockage.

11. Hydraulic solutions according to the preceding claim, **characterized in that** the rotation speed of the hydraulic driven work unit (2, 2`) when it is reversed to be released from a blockage is markedly less than its rotation speed during work.

12. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the working resistance of the central work unit (13`) is registered by one or more hydraulic cylinders (11) connected to the connection between the work machine (1) and the tractor or the base unit.

13. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the height adjusting cylinder or height adjusting cylinders (12, 12`) also are connected to the double acting hydraulic connection (18) of the hydraulic power supply unit to under work be able to override the automatic depth control.

14. Hydraulic solutions according to any one or any ones of the preceding claims, **characterized in that** the cylinder volume of the cylinder or cylinders (20) to separate the height adjusting cylinder or height adjusting cylinders (12, 12`) and the hydraulic motors (5, 2, 2`) from each other limits the motion range of the load depending depth control.

AMENDED CLAIMS
received by the International Bureau on 15 December 2016 (15.12.2016)

1. Hydraulic solutions in to an agricultural tractor or equivalent connected stone picker (1) where the stone picker shows at least one not rotating central work unit (13, 13`) and at least one with this cooperative rotating work unit (5, 2, 2`) at least one hydraulic motor (6, 6`, 3, 3`) and at least one hydraulic actuator (4, 4´. 11 . 12, 12´), **characterized in that** the hydraulic actuator or actuators (4, 4´. 11 . 12, 12´) and the hydraulic motor or motors (6, 6`, 3, 3`) of the rotating work units (5, 2, 2`) are hydraulically separated from each other and where the length of the actuator or actuators (4, 4´. 12, 12´) for the height adjustment, without supply of extern pressure fluid to the automatic height adjustment circuit, during work automatically is adapted as well to the pulling resistance of the stone picker (1) as to the rotation resistance of its rotating work elements (5, 2, 2`) within the scope of a limited work range of the automatic depth control.

2. Hydraulic solutions in to an agricultural tractor or equivalent connected stone picker (1) where the stone picker shows at least one not rotating central work unit (13, 13`) and at least one with this cooperative rotating work unit (5, 2, 2`) at least one hydraulic motor (6, 6`, 3, 3`) and at least one hydraulic actuator (4, 4´. 11 . 12, 12´), **characterized in that** the hydraulic actuator or actuators (4, 4´. 11 . 12, 12´) and the hydraulic motor or motors (6, 6`, 3, 3`) of the rotating work units (5, 2, 2`) are hydraulically separated from each other and where the length of the actuator or actuators (4, 4´. 12, 12´) for the height adjustment, without use of electrically, hydraulically or mechanically controlled metering units, during work automatically is adapted as well to the pulling resistance of the stone picker (1) as to the rotation resistance of its rotating work elements (5, 2, 2`) within the scope of a limited work range of the automatic depth control.

3. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the actuator or actuators (4, 4´. 11 . 12, 12´) and the hydraulic motor or motors (6, 6`, 3, 3`) of the rotating work units (5, 2, 2`) are hydraulically separated from each other by one or more double acting cylinders (20) separating the two hydraulic circuits from each other.

4. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the actuator or actuators (4, 4´. 11 . 12, 12´) and the hydraulic motor or motors (6, 6`, 3, 3`) of the rotating work units (5, 2, 2`) are hydraulically separated from each other by two or more single acting, in pairs with each other mechanically connected, hydraulic cylinders (20) separating the two hydraulic circuits from each other.

5. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the area ratio, of the double acting cylinder or cylinders (20) or of the in pairs with each other mechanically connected single acted cylinders, decide how the ratio between the registered rotation resistance and the registered pulling resistance of the work element or work elements (2, 2`,5, 13, 13`) do effect the length of the height 10 adjustment actuator, or height adjustment actuators (4, 4`, 12, 12`).

6. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the hydraulic volume of the cylinder or cylinders (20) to separate the height adjusting actuator or height adjusting actuators (4, 4`,12, 12`) and the hydraulic motors (6, 6`, 3, 3`) from each other limits the motion range of the load depending depth control.

7. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the by driver regulated oil supply to the actuators (4, 4`,12, 12`) always can displace the automatic depth control.

8. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** at least one lift cylinder (4, 4`) of the hydraulic driven rake units (2, 2`) is connected to the return line of the hydraulic motor (3, 3`) of the rake unit and that between the lift cylinder and the hydraulic motor is an one way restrictor valve (17, 17`) to increase the pressure in the return line when the motor (3, 3`) is reversed so that the rake unit (2, 2`) automatically is offloaded from the ground when its motor (3, 3`) is reversed to free the rotor from a blockage and to simultaneous reduce the reverse speed of the rotor.

9. Hydraulic solutions according to one or more of the preceding claims, **characterized in that** the pulling resistance of the not rotating central work unit (13`) is registered by one or more hydraulic cylinders (11) co-operating with the connection between the work machine (1) and the tractor.

STATEMENT UNDER ARTICLE 19 (1)

The new claim 1 narrows the scope of the invention:

(i) From a general work machine (1) to a stone picker (connected to an agricultural tractor or equivalent).
(ii) By adding subject matter of claims 3 (hydraulic motor) into first part of the claim.

In the **characterized** part of the claim 1, it further narrows the scope of the invention:

(iii) By combining subject matter of the claims 1, 3 and 4 into the first claim.

(iv) By adding: *without supply of extern pressure fluids to the automatic height adjustment*, into the first claim.

(v) By adding: *…as well ….as to the rotation resistance of its rotating work elements (5, 2, 2`) within the scope of a limited work range of the automatic depth control.*

The new claim 2 also narrows the scope of the invention;

(i) By adding; *without use of electrically, hydraulically or mechanically controlled metering units*

By these amendments, the new claims 1 and 2 are clearly distinguished from the entire prior art documents D1 to D5 in the international search report and in the Written opinion of the International Search Authority of 04.11.2016.

It should in particular be noted, that none of the prior art documents do disclose an automatic depth control: *without supply of extern pressure fluids to the automatic height adjustment circuit, and without use of electrical or electronic control systems*

As all the other claims 3 – 9 are depending claims under claim 1 or claim 2, all these claims has also to be considered as new.

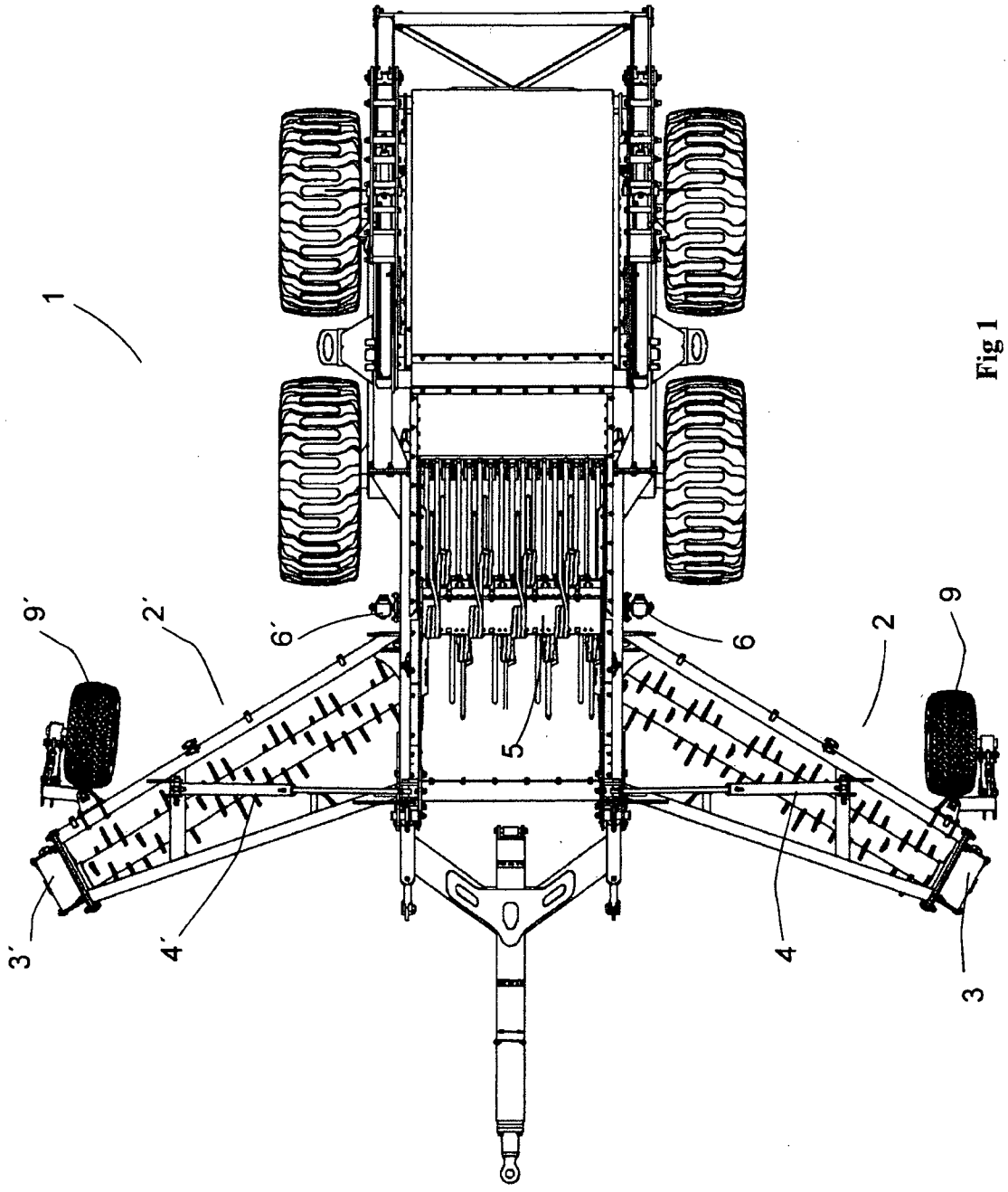

Fig 1

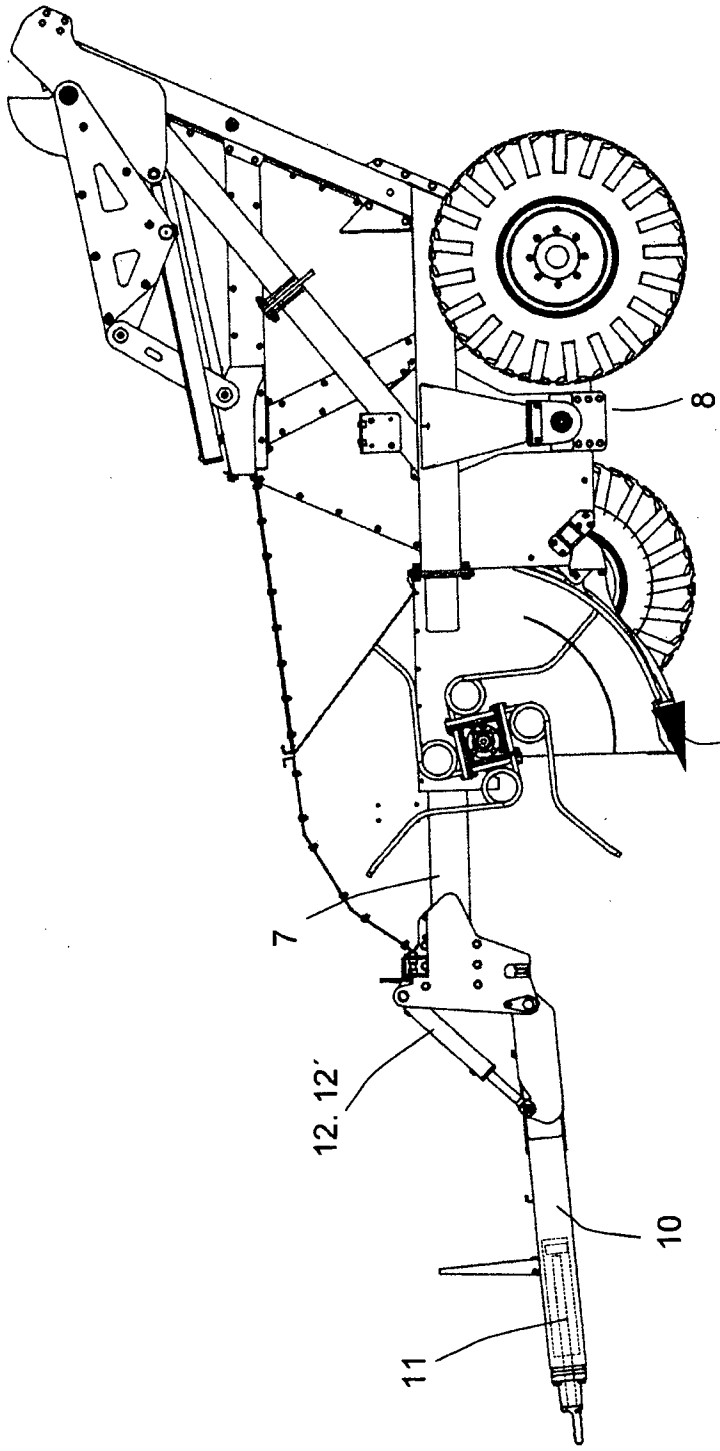

Fig 2

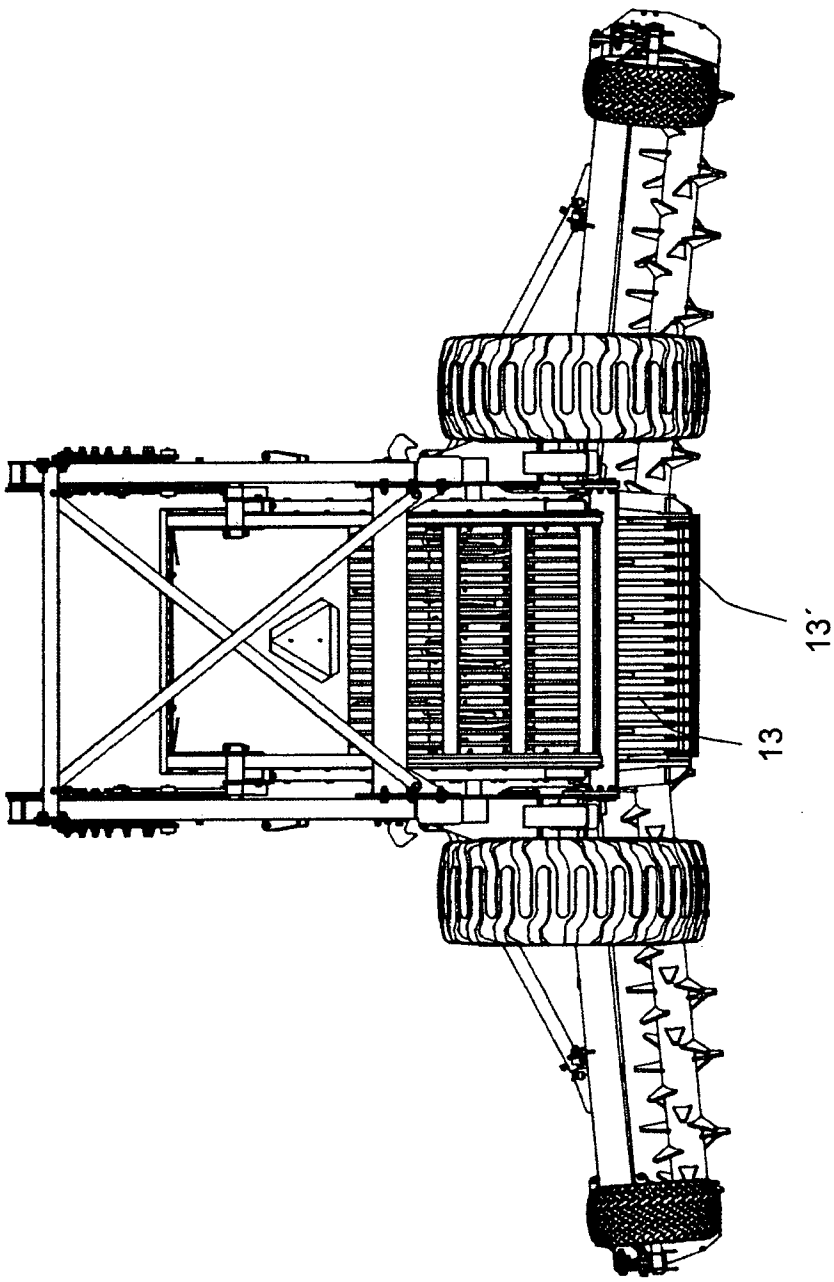

Fig 3

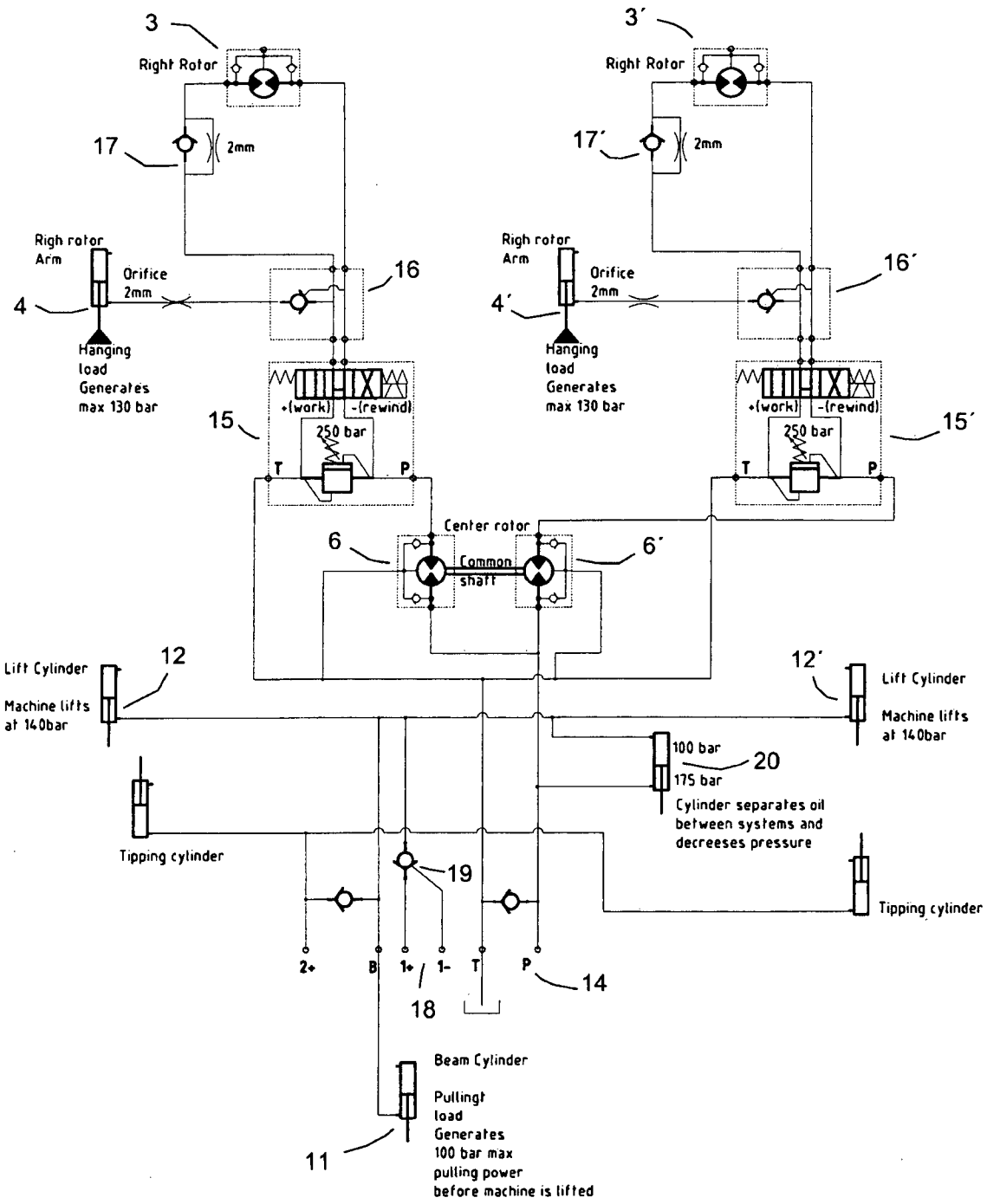
3
Right Rotor
17
2mm
Righ rotor Arm
Orifice 2mm
4
Hanging load Generates max 130 bar
16
+(work)
-(rewind)
15
250 bar
T
P
3´
Right Rotor
17´
2mm
Righ rotor Arm
Orifice 2mm
4´
Hanging load Generates max 130 bar
16´
+(work)
-(rewind)
15´
250 bar
T
P
Center rotor
6
Common shaft
6´
Lift Cylinder
Machine lifts at 140bar
12
12´
Lift Cylinder
Machine lifts at 140bar
100 bar
175 bar
20
Cylinder separates oil between systems and decreeses pressure
Tipping cylinder
19
Tipping cylinder
2+
B
1+
1-
T
P
14
18
Beam Cylinder
Pulling load Generates 100 bar max pulling power before machine is lifted
11

Fig 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2016/000018

A. **CLASSIFICATION OF SUBJECT MATTER**

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: A01B, F15B

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

FI, SE, NO, DK

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

EPO-Internal, WPIAP, PRH-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011078846 A1 (AHO MELVIN S [US]) 30 June 2011 (30.06.2011) paragraphs [0001] - [0003], [0006], [0007], [0017], [0038], [0039], [0046] - [0054], [0058] - [0063]; figures 1-3, 5-7 and 9	9-11
Y		1-8, 12-14
Y	US 4637474 A (LEONARD WILLIE B [US]) 20 January 1987 (20.01.1987) figures 1-2; column 3, line 39 - column 4, line 68; column 6, lines 36-64	1-2, 6-8, 12-14
Y	US 3670822 A (REINHARDT ROBERT L) 20 June 1972 (20.06.1972) figures 1-4; column 3, lines 38-60	1-2, 6-8, 12-14
Y	US 3627053 A (HOOK RICHARD WAYNE et al.) 14 December 1971 (14.12.1971) figures 1-2; column 4, lines 40-66	1, 6-8, 12-14
Y	EP 2524587 A1 (DEERE & CO [US]) 21 November 2012 (21.11.2012) paragraph [0012]; figure 1	1, 3-5

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 November 2016 (02.11.2016)	04 November 2016 (04.11.2016)

Name and mailing address of the ISA/FI
Finnish Patent and Registration Office
P.O. Box 1160, FI-00101 HELSINKI, Finland
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INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2016/000018

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
WO 2011078846 A1	30/06/2011	None	
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2016/000018

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Invention 1: Claims 1-8 and 12-14, directed to hydraulic solutions in a stone picker.

Invention 2: Claims 9-11, directed to hydraulic solutions in a work machine.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2016/000018

CLASSIFICATION OF SUBJECT MATTER

IPC
A01B 43/00 (2006.01)
A01B 63/112 (2006.01)
F15B 3/00 (2006.01)

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