Device for operating a service brake and locking a swinging axle of a mobile excavator

Abstract: The present disclosure is directed to providing mobile excavators with a firm footing when working on rough terrain. The disclosed device (70) for locking a swinging axle of a mobile excavator and for operating a service brake (66) of the mobile excavator has an activation state and a deactivation state and is configured to both lock the at least one swinging axle and also operate the service brake (66) in the activation state if predetermined operating conditions of the mobile excavator are fulfilled, and to unlock the at least one swinging axle and to release the service brake in the deactivation state if the predetermined operating conditions are not fulfilled.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
Description

DEVICE FOR OPERATING A SERVICE BRAKE AND LOCKING A SWINGING AXLE OF A MOBILE EXCAVATOR

Technical Field

[01] The present disclosure generally relates to a device for a mobile excavator, which can automatically operate the service brake of the mobile excavator and can lock a swinging axle of the mobile excavator if predetermined operating conditions of the mobile excavator are fulfilled.

Background

[02] Mobile excavators are working machines that mostly comprise two wheel axles and are designed to be moved on public roads. Mobile excavators, which are also referred to as wheeled excavators, are mostly equipped with all-wheel drive. Mobile excavators are also mostly provided with a hydrostatic drive that comprises a primary power source, for example, an internal combustion engine, and a hydraulic system with hydraulic pumps and hydraulic motors.

[03] Mobile excavators can also be fitted with at least one swinging axle, which essentially ensures that the wheels of the mobile excavator always make contact with the ground and can thus compensate for rough and difficult terrain, so that the excavator maintains a firm footing during the working processes. In order to be able to perform the working processes, the mobile excavator can comprise working equipment, such as, for instance, a backhoe, a face shovel, a tilt bucket, a grapple, a hook, a screening bucket, wrecking balls or other known attachment devices.

[04] In order to provide the mobile excavator with a secure footing during a working process, there are certain safety devices, such as, for example, automatic service brakes, that keep the mobile excavator from performing
undesired movements. For example, when standing on an inclined slope the provision of an automatic service brake can be necessary in order to give the excavator a firm and secure footing.

For example, US 201 1/0300992 A1 discloses an automatic service brake for a working machine that operates the service brake depending on defined operating conditions.

US 7 281 602 B2 also discloses a method of a device for controlling defined functions of a working machine during a working process.

Furthermore, a pneumatic working brake for a vehicle is known from US 2012/0296543 A1, which is automatically operated once defined operating conditions of the vehicle exist.


The present disclosure is at least partly directed to improving one or more aspects of known systems.

Summary of the disclosure

According to an aspect of the present disclosure, a device for operating a service brake of a mobile excavator and for locking a swinging axle of the mobile excavator may have an activation state and a deactivation state. In the activation state, the disclosed device may be configured to lock the at least one swinging axle and also to operate the service brake if predetermined operating conditions of the mobile excavator are fulfilled. In the deactivation state, the disclosed device may be configured to unlock the at least one swinging axle and to release the service brake if the predetermined operating conditions are not fulfilled.

According to another aspect of the present disclosure, a method for operating a service brake of a mobile excavator and for locking at least one
swinging axle may comprise checking whether predetermined operating conditions of the mobile excavator are fulfilled, locking the at least one swinging axle if the predetermined operating conditions of the mobile excavator are fulfilled, and operating the service brake if the predetermined operating conditions of the mobile excavator are fulfilled.

[12] According to another aspect of the present disclosure, a mobile excavator may comprise at least one swinging axle, a service brake and a device according to the present disclosure.

[13] In some embodiments the predetermined operating conditions may include that the gearbox of the mobile excavator is in the first gear.

[14] In some embodiments the predetermined operating conditions may include that the mobile excavator is moving at a speed that is below a predetermined speed threshold, or that the degree of operation of the accelerator pedal of the mobile excavator is below a degree of operation threshold.

[15] In some embodiments the disclosed device may comprise an actuator configured to be operated by an operator of the mobile excavator and to switch the device into the activation state or the deactivation state.

[16] Further features and aspects of this disclosure will become apparent from the following description and the accompanying figures.

**Brief description of the drawings**

[17] Fig. 1 is a schematic illustration of a mobile excavator comprising a locking device disclosed by way of example,

Fig. 2 is a schematic front view of the mobile excavator of Fig. 1, and

Fig. 3 is a schematic illustration of the locking device of the mobile excavator of Fig. 1 disclosed by way of example.
Detailed description

[18] The following description is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiments, which are described herein and which are illustrated in the figures, are considered to teach the principles of the present disclosure to enable the person skilled in the art to implement the same and to use the present disclosure in various environments and for various applications. Therefore the exemplary embodiments are not to be considered, and should also not be viewed as, a limiting description of the scope of protection. Rather, the scope of protection of the present disclosure is defined by the accompanying claims.

[19] The present disclosure may be at least partially based on the realization that the provision of a locking device, which can simultaneously lock the swinging axle and operate the service brake, facilitates working in rough terrain for the driver. For example, the driver can switch the device disclosed herein into the activation state, whereupon the swinging axle is automatically locked and the service brake is automatically operated once predetermined operating conditions are fulfilled. The predetermined operating conditions of the mobile excavator may include, for example, that the gearbox of the mobile excavator is in the first gear, that the mobile excavator is moving below a certain speed threshold and that there is no accelerator pedal operation. If the just mentioned conditions are at least partly fulfilled, the swinging axle is automatically locked and the service brake is automatically operated, so that the driver of the mobile excavator does not have to be concerned with said locking and operation. For this reason the driver of the mobile excavator can devote his attention to the work connected with the working equipment of the machine.

[20] The present disclosure may be further at least partially based on the realization that a hydraulic valve may be configured to receive a control pressure from the gearbox, which indicates that the gearbox is in the first gear. Consequently, the hydraulic valve may be controlled by the control pressure such
that a hydraulic medium under pressure may flow out of a hydraulic reservoir and may flow into the hydraulic cylinder attached to the swinging axle in order to lock the swinging axle in the current state and thus to stiffen it. At the same time, hydraulic medium may flow into the service brake and may brake the wheels of the mobile excavator and hold them at rest.

[21] The mobile excavator disclosed herein may comprise two braking devices: a service brake disposed in the individual wheels of the mobile excavator, and a parking brake, which may be disposed in the gearbox of the mobile excavator. The service brake may thus include four units, which may be disposed in each of the four wheels of the mobile excavator. The service brake may be mostly operated hydraulically by means of a brake pedal disposed in the driver's cab. In contrast, the parking brake may be disposed in the gearbox and may, for instance, be operated by the driver by means of an electronic switch.

[22] The locking state of the swinging axle may be defined herein in that the swinging axle movements about a point of rotation are blocked. Thus a locked swinging axle may be comparable with a rigid axle.

[23] In the following, reference is made to the drawings, in which the same reference characters are used for the same or similar parts where this is appropriate and possible.

[24] A construction machine in the form of a mobile excavator 10 is illustrated in Fig. 1. The mobile excavator 10 comprises a power source, such as, for example, an internal combustion engine 12. Furthermore, the mobile excavator 10 comprises a superstructure 14 that is rotatably attached to an undercarriage 16.

[25] The mobile excavator 10 contains a traction system 18, for instance, a plurality of wheels that are driveably attached to the undercarriage 16. In addition, the mobile excavator 10 comprises a working device 20 and an operator station 22 from which the working device 20 can be operated. The
mobile excavator 10 illustrated in Fig. 1 can be any type of mobile excavator or wheeled front-end loader.

[26] The superstructure 14 is rotatably attached to the undercarriage 16 by means of a rotary lead through 15. Alternatively, the superstructure 14 can also be attached to the undercarriage 16 so as to rotate with it.

[27] In addition, the mobile excavator 10 can comprise a cab hoist that is configured to raise and lower the cab relative to the superstructure 14 and to the undercarriage 16. The cab hoist is, for example, a hydraulically operable lifting device.

[28] The traction system 18 can, for example, be a traction device comprising a first set of wheels 24 and a second set of wheels 26 (see Fig. 1). At least one of the sets of wheels 24, 26 is steerable. The mobile excavator 10 can be configured to comprise all-wheel drive. The first set of wheels 24 is attached to the undercarriage 16 by means of a first wheel axle 25 and the second set of wheels 26 is attached to the undercarriage 16 by means of a second axle 27. At least one of the two wheel axles 25, 27 is implemented as a swinging axle, which is used to guarantee that all wheels are in contact with the ground at each point in time of working, despite the uneven terrain in which mobile excavators 10 are mostly located. The exact implementation of the swinging axle and its operation are more accurately described with reference to Fig. 2.

[29] The working device 20 can be any known working device and can, for instance, comprise a bucket, a scoop, a hook, a hydraulic hammer, rotary brushes or shears.

[30] As shown in Fig. 1, the working device 20 comprises a boom 28, a stick 30 and a working tool 32 attached to the end of the stick 30. The boom 28 is pivotably attached to the superstructure 14. A boom actuator 34 is attached to the superstructure 14 and to the boom 28 such that a distal end 36 of the boom 28 can be raised and lowered by operating the boom actuator 34.
The distal end 36 of the boom 28 can also be moved laterally. In the embodiment illustrated by way of example, the boom 28 can be turned about an axis 38 relative to the undercarriage 16 by rotation of the superstructure 14 and can thus be moved laterally.

The stick 30 is pivotably mounted on the boom 28 at a proximal end 42. A stick actuator 44 is attached to the boom 28 and to the stick 30 such that operation of the stick actuator 44 causes the stick 30 to move out and in relative to the boom 28 like a folding knife. This means that a distal end 46 of the stick 30 can be moved further away from the undercarriage 16 and closer to the superstructure 14 by operating the stick actuator 44.

The working tool 32 is attached to the distal end 46 of the stick 30. Although the working tool 32 is shown in Fig. 1 as a bucket 48, the working tool 32 can be any known working tool. The working tool 32 is pivotably mounted on the distal end 46 of the stick 30. A working tool actuator 50 is mounted on the stick 30 and on the working tool 32 such that operation of the working tool actuator 50 causes the working tool 32 to pivot relative to the stick 30.

The operator station 22 is, as shown in Fig. 1, a cab and can be attached to the superstructure 14 or formed integrally therewith. The operator station 22 comprises a seat 52, a first steering device, such as, for example, a steering wheel 54, a display 55 and at least one manually operated working equipment control device 56, such as, for instance, a joystick. The steering wheel 54 is connected to the wheel axles 25 and 27 such that by operating the steering wheel 54 a direct movement of the mobile excavator 10 can be influenced.

The mobile excavator 10 illustrated in Fig. 1 also comprises a hydrostatic drive system that is supplied with energy by an internal combustion engine 12. The hydrostatic drive system is attached to the mobile excavator 10 in a known manner and comprises hydraulic motors and hydraulic pumps that carry out the traction drive of the mobile excavator 10. For the purpose of a clear illustration, the hydrostatic drive system is not shown in the figures.
As also illustrated in Fig. 1, the operator station 22 also comprises an actuation module 58, on which various operating devices such as knobs and levers can be disposed. By means of the actuation module 58, for example, functions of the hydrostatic drive system can be controlled.

Furthermore, it is provided that the driver can switch the device disclosed herein for automatic locking of the swinging axle and for automatic operation of the service brake into the activation state or deactivation state by means of an operating device. For example, the driver or operator of the mobile excavator 10 can, by means of the display 55, enter the menu of the excavator controller and activate or deactivate the functions of the device 70. The device 70 for automatic locking of the swinging axle and for automatic operation of the service brake and the functions connected therewith are more precisely described with reference to Fig. 3.

The mobile excavator 10 is, moreover, configured to be a hydraulically operated mobile excavator. Thus, for instance, the boom actuator 34, the stick actuator 44 and the working tool actuator 50 are designed to be operated with a hydraulic medium under pressure, which originates from a hydraulic system. The hydraulic system, which controls the basic functions of the mobile excavator 10, is not explicitly shown in the figures. However, it is known to the person skilled in the art how the arrangement of the hydraulic system functions, such as, for instance, that the internal combustion engine 12 drives a hydraulic pump, which places the hydraulic medium under pressure and a control unit is configured to control the hydraulic flow such that the functions desired and demanded by the driver can be implemented.

With reference to Fig. 2, a front view of the mobile excavator 10 of Fig. 1 is shown, in which for simplicity the mobile excavator 10 is illustrated without the working device 20. As can be seen from Fig. 2, the first wheel axle of the mobile excavator 10 is a swinging axle 25 to which the first set of wheels 24 is attached. The swinging axle 25 is pendulum mounted relative to a point of
rotation 60, so that the sets of wheels 24 can move in an essentially vertical
direction in a pendulum fashion relative to the undercarriage 16. Said vertical
movements can be controlled by a first hydraulic cylinder 62 and a second
hydraulic cylinder 64. For example, the first hydraulic cylinder 62 and the second
hydraulic cylinder 64 are configured to damp said pendulum movements.
Moreover, the first and second hydraulic cylinders 62, 64 can fix the swinging
axle 65 in any position. The first and second hydraulic cylinders 62, 64 are each
supplied with hydraulic medium placed under pressure, which will be described
below in detail with reference to Fig. 3.

[40] It can be seen from Fig. 2 that in the fixed state of the first and
second hydraulic cylinders 62, 64 no pendulum movement of the swinging axle
25 can be performed, i.e. that the first set of wheels 24 is fixed relative to the
undercarriage 16 and no rotational movements can occur at the point of rotation
60. This state is, moreover, referred to as the locking state or locked state of the
swinging axle.

[41] As also schematically illustrated in Fig. 2, the set of wheels 24
comprises a service brake 66 at least on one side, which is configured to be
disposed in a wheel of the set of wheels 24 and to brake the wheels and thus the
entire mobile excavator when operated. The service brake 66 can be a service
brake known in the prior art, such as, for example, a disc brake or drum brake,
which is hydraulically operated. Furthermore, each of the wheels of the first set
of wheels 24 can comprise a service brake. The service brake 66 is configured to
brake the mobile excavator 10 and to hold it at rest when operated, so that the
mobile excavator 10 can no longer move. This can, for example, be an advantage
when standing on an inclined slope.

[42] As illustrated in Fig. 2, the front wheel axle is designed as the
swinging axle 25. However, in another embodiment the rear wheel axle 27 can
also be implemented as a swinging axle, or even only the rear wheel axle 27 can
be implemented as swinging axle. In other embodiments, both the first wheel axle
25 and also the second wheel axle 27 can be configured as independent suspensions, which can ensure that all wheels of the mobile excavator 10 are permanently in contact with the ground, wherein this is especially very important when working with the working device 20.

The mobile excavator 10 also comprises a gearbox 90 (see Fig. 3), which can essentially be in two gears: in a first gear, which enables slow travel of the mobile excavator 10, and a second gear, which enables faster travel of the mobile excavator 10. If the mobile excavator 10 is on a building site, then mostly the first gear is activated, because the mobile excavator 10 is moving on the building site at only low speeds. However, if the mobile excavator 10 is to be moved over a long distance, for example, over public roads from one building site to another building site, then higher speeds are necessary, which the second gear can provide. For example, the excavator can achieve a speed up to 40 km/h if the second gear of the gearbox is engaged.

In the second gear it should also be noted that all working devices, such as, for instance, the working device 20, are deactivated and also the rotary movements of the superstructure 14 relative to the undercarriage 16 are blocked. Said blockings of the above described functions are due to safety, which must be guaranteed on public roads and is partly required by law.

With reference to Fig. 3, a device 70 for locking the swinging axle 25 and for operating the service brake 66 is shown. The device 70 comprises a first pressure supply source 72, a second pressure supply source 74, a third pressure supply source, a hydraulic valve 80, a first control valve 102 and a second control valve 104. The hydraulic valve 80 is fluidly connected to the first pressure supply source 72. The gearbox 90, which is shown schematically in Fig. 3, outputs a control pressure if the gearbox 90 is in the first gear. The first, second and third pressure supply sources 72, 74, 76 each provide a hydraulic medium under pressure, which is delivered from a hydraulic tank by pumps (not explicitly illustrated) to the individual pressure supply sources 72, 74, 76.
Regarding the device 70 and the hydraulic system illustrated in Fig. 3, it should be mentioned that only relevant elements are shown. Thus some elements such as, for example, hydraulic pumps, non-return valves, sensor lines and charging circuit systems are not explicitly illustrated for simplicity.

The hydraulic valve 80 is illustrated in Fig. 3 as a 3/2-way valve, which in the first position shown makes a fluid connection between the first pressure supply source 72 and a hydraulic reservoir 82. If the hydraulic valve 80 receives the control pressure of the gearbox 90 via the hydraulic line 92, then the hydraulic valve 80 changes to the second position, in which the first pressure supply source 72 has a fluid connection to the second control valve 104.

The second control valve 104, which is connected to the hydraulic valve 80, is also connected to the service brake 66 and is configured to fluidly connect the second supply source 74 to the service brake 66 if the predetermined operating conditions are met. The first control valve 102 is fluidly connected to the third pressure supply source 76 and to the first hydraulic cylinder 62 and the second hydraulic cylinder 64. As already explained with reference to Fig. 2, the first hydraulic cylinder 62 and the second hydraulic cylinder 64 are connected to the swinging axle 25 and are configured to lock the swinging axle 25 on activation of the disclosed device 70.

The first control valve 102 and the second control valve 104 are also configured to receive electronic signals, for instance, from an electronic control unit 110 that can be disposed on the mobile excavator 10 as a standard item, the signals controlling the first control valve 102 and the second control valve 104. For example, the electronic control unit 110 is configured to output signals that relate to the speed of the mobile excavator 10, a degree of operation of the accelerator pedal, a degree of operation of the brake pedal or operation of the device 70.

The second control valve 104 is also configured to receive signals from a brake pedal sensor (not illustrated), which is disposed on the brake pedal
120 of the mobile excavator 10 and is configured to be able to output the degree of operation of the brake pedal 120 and to provide this as an electronic/mechanical signal to the second control valve 104. In particular, the brake pedal sensor can be in the form of a pressure sensor and can be disposed in the brake block so as to detect the degree of operation of the brake pedal 120 and to provide the same as an electronic signal.

For example, the brake pedal sensor outputs an electronic signal to the second control valve 104 if the brake pedal 120 is in the fully depressed position. The brake pedal 120 can thereby be mechanically locked in the depressed position, whereupon the first control valve 102 is switched such that the fluid connection between the second pressure supply source 74 and the service brake 66 is opened. The driver of the mobile excavator is thus able to allow the service brake 66 to be permanently operated by means of full operation, i.e. depression, of the brake pedal 120.

The first control valve 102 is preferably a 3/2-way valve that is controlled by the electronic control unit 110. The electronic control unit 110 is also configured to transmit a signal to the first control valve 102 and to the second control valve 104 that relates to the activation state of the device 70, which is described more precisely below.

**Industrial applicability**

The device 70 for locking the swinging axle 25 and operating the service brake 66 is explained below with reference to Figs. 1 to 3.

The driver of the mobile excavator 10 can switch the device 70 into an activation state or a deactivation state. In the deactivation state of the device 70 no automatic activities of the mobile excavator 10 are controlled by the device 70. However, if the device 70 is in the activation state, the device 70 can automatically lock the swinging axle 25 and can automatically operate the service brake 66, which is described more precisely below.
The driver can activate or deactivate the functions of the device 70 by means of the display 55. In another embodiment, the driver can activate or deactivate the device 70 and the connected functions by means of the actuation module 58, more precisely speaking by means of a knob on the actuation module 58.

If the mobile excavator 10 is, for instance, located on a building site and if the driver activates the device 70 by means of the display 55, then the device 70 is in the activation state. At the same time the speed of the mobile excavator 10 and the degree of operation of the accelerator pedal are monitored by the electronic control unit 110. The speed of the mobile excavator 10 can, for example, be obtained by means of a speed sensor disposed in the gearbox 90 and the revolution rate of a gearwheel of the gearbox 90 can be detected and said revolution rate is provided by means of a signal to the electronic control unit 110, which can determine the speed of the mobile excavator 10 from this and from the predetermined ratio of the gearbox 90. The degree of operation of the accelerator pedal can, for instance, be determined by a suitable sensor on the accelerator pedal.

So that the device 70 can automatically lock the swinging axle 25 and can automatically operate the service brake 66, predetermined operating conditions of the mobile excavator 10 must be fulfilled. The operating conditions include the operation of the device 70, the speed of the mobile excavator 10, the degree of operation of the accelerator pedal and the gear selection of the gearbox 90.

Accordingly, the gearbox 90 must be in the first gear. If this precondition is fulfilled, then the gearbox 90 outputs a control pressure to the hydraulic valve 80 that switches the hydraulic valve 80 into the second position, so that the first pressure supply source 72 is fluidly connected to the second control valve. The control pressure provided by the gearbox 90 can, for example, be a hydraulic pressure that is provided to the hydraulic valve 80 via the
hydraulic line 92. In another embodiment, the control pressure can be an electronic signal, which, for example, the gearbox control unit (not illustrated) sends to the hydraulic valve 80. Said electronic signal can indicate the gear engaged in the gearbox 90.

[59] The electronic control unit 110 determines whether the speed of the mobile excavator 10 lies below a speed threshold as a further predetermined operating condition of the mobile excavator 10. As already mentioned, a speed sensor can determine the revolution rate of the mobile excavator 10 from the revolution rate of a gearwheel of the gearbox 90. The value of the speed threshold can, for instance, lie between about 0 km/h and 5 km/h, but preferably between about 0 km/h and 2 km/h.

[60] Furthermore, the electronic control unit 110 can determine the degree of operation of the accelerator pedal as another predetermined operating condition. If there is no accelerator pedal operation, i.e. the degree of operation of the accelerator pedal is 0 %, then said predetermined operating condition is fulfilled. In some embodiments, the degree of operation threshold, below which the accelerator pedal operation is fulfilled as a predetermined condition, can lie between 0 % and 10 %.

[61] The electronic control unit 110 switches the second control valve 104 into a state in which the fluid connection between the hydraulic valve 80 and the service brake 66 is made if the device 70 is in the activation state, the speed of the mobile excavator 10 lies below the speed threshold and there is no operation of the accelerator pedal. The electronic control unit 110 provides the corresponding signal for this. Furthermore, the gearbox 90 must be in the first gear so that the second control valve 104 can pass the hydraulic medium under pressure from the second pressure supply source 74 through the second control valve 104 into the service brake 66, whereby the service brake 66 is operated.

[62] At the same time the electronic control unit 110 sends an electronic signal to the first control valve 102 indicating that the predetermined
operating conditions of the mobile excavator 10 are established. Consequently, the hydraulic medium under pressure can flow from the third pressure supply source 76 through the first control valve into the first hydraulic cylinder 62 and the second hydraulic cylinder 64, whereby the swinging axle 25 is locked in the swinging axle position at the present point in time.

In summary, it can again be noted that the device 70 automatically locks the swinging axle 25 and automatically operates the service brake 66 once the device 70 is in the activation state, the first gear of the gearbox 90 of the mobile excavator 10 is engaged, the speed of the mobile excavator 10 lies below a speed threshold and the accelerator pedal is not being operated. Non-operation of the accelerator pedal indicates that the driver is not intending to allow the mobile excavator 10 to move.

In order to deactivate the device 70, i.e. to switch it into the deactivation state, the driver can depress the accelerator pedal, therefore the sensor for determining the degree of operation of the accelerator pedal outputs a value not equal to 0%. The electronic control unit 110 controls the first control valve 102 and the second control valve 104 such that the fluid connections between the second pressure supply source 74 and the service brake 66, and between the third pressure supply source 76 and the first hydraulic cylinder 62 and the second hydraulic cylinder 64 are disconnected.

If all predetermined operating conditions of the mobile excavator 10 are again fulfilled in the following, then the device 70 can automatically lock the swinging axle 25 and automatically operate the service brake 66 again.

During the automatic locking of the swinging axle 25 and the automatic operation of the service brake 66 by the device 70, the parking brake is also automatically released.

The driver can, moreover, operate the swinging axle 25 by means of the actuation module 58 as required by using an independent, separate switch (not illustrated in the figures). Said operation of the swinging axle locking alone
has a higher priority than the activation state of the device 70, so that the device 70 is not switched on for the operation of said separate swinging axle locking, although the predetermined operating conditions of the mobile excavator 10 are fulfilled. This can also be controlled by the electronic control unit 110.

Furthermore, the driver of the mobile excavator 10 has the option to operate the service brake 66 separately and permanently by fully depressing the brake pedal 120. In such a depressed position the brake pedal 120 can be mechanically locked, whereby an electronic/mechanical signal is output to the second control valve 104 that makes a fluid connection between the second pressure supply source 74 and the service brake 66.

It should be mentioned that both the separate operation of the swinging axle locking and also the separately triggered locking of the service brake 66 caused by full depression of the brake pedal 120 are to be distinguished from the device 70, which only automatically locks the swinging axle 25 and automatically operates the service brake 66 when it is activated if the predetermined operating conditions set out above are established. The separate operation of the swinging axle locking and the separately triggered locking of the service brake 66 caused by full depression of the brake pedal 120 thus have priority relative to the device 70.

Furthermore, the device 70 can contain a loudspeaker disposed in the operator station 22 that is configured to output an audible signal if the predetermined operating conditions are fulfilled and thus the device 70 is activated so that the swinging axle 25 is automatically locked and the service brake 66 is automatically operated. For example, a single signal tone is thereby output. If the device 70 is deactivated, for instance, by operation of the accelerator pedal, the said loudspeaker is also configured to output a double signal tone that notifies the driver of the mobile excavator 10 that the device 70 is deactivated and the swinging axle 25 is unlocked and the service brake 66 is released.
The output signal tone is above all connected with the locking of the swinging axle 25. Therefore for separate, sole locking of the swinging axle 25 the above-mentioned signal tone is thus output as a single tone if the swinging axle 25 is locked or as a double tone if the swinging axle 25 is released from locking again.

The deactivation of the device 70 is possible at any time, so that the latitude of the driver of the mobile excavator 10 is not significantly limited. However, the device 70 remains active until the driver, for example, soperates the accelerator pedal and the device 70 is thus deactivated.

Furthermore, the mobile excavator 10 can comprise an electrical safety mode, which is configured to enable the mobile excavator 10 to still drive away from a point of danger in the event of a failure of the electronic system. Thus, if an electronic problem is determined, the mobile excavator 10 can still be operated with limited functions, but this means that the device 70 can no longer be activated.

Although the preferred embodiments of this disclosure have been described herein, improvements and modifications can be incorporated herein without departing from the scope of protection of the following claims.
1. A device (70) for operating a service brake (66) and for locking a swinging axle (25, 27) of the mobile excavator (10), wherein the device (70) has an activation state and a deactivation state and is configured to both operate the service brake (66) and also lock the at least one swinging axle (25, 27) in the activation state if predetermined operating conditions of the mobile excavator (10) are fulfilled, and release the service brake (66) and unlock the at least one swinging axle (25, 27) in the deactivation state if the predetermined operating conditions are not fulfilled.

2. The device (70) according to claim 1, wherein the predetermined operating conditions include that the gearbox (90) of the mobile excavator (10) is in the first gear.

3. The device (70) according to claim 2, further comprising: a first pressure supply unit (72) configured to store hydraulic medium under pressure; and a hydraulic valve (80) fluidly connected to the at least one pressure supply unit (72) and configured to receive a control pressure from the gearbox (90) of the mobile excavator (10) if the gearbox (90) is in the first gear, the control pressure of the gearbox (90) being configured to control the hydraulic valve (80).

4. The device (70) according to claim 3, further comprising: a first control valve (102) fluidly connected between a second pressure supply unit (74) and the at least one swinging axle (25, 27) of the mobile

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excavator (10) and configured to receive electronic signals from an electronic control unit (110) that indicate the predetermined operating conditions; and a second control valve (104) fluidly connected between the hydraulic valve (80) and the service brake (66) and configured to receive electronic signals from the electronic control unit (110) that indicate the predetermined operating conditions.

5. The device (70) according to any one of the preceding claims, further comprising an actuator (55) configured to be operated by an operator of the mobile excavator (10) and to switch the device (70) into the activation state or the deactivation state.

6. The device (70) according to any one of the preceding claims, wherein the predetermined operating conditions include the condition that the speed of the mobile excavator (10) is below a predetermined threshold speed.

7. The device (70) according to claim 6, wherein the speed of the mobile excavator (10) is derived from a speed of a gearwheel of the gearbox (90), which is detected by a speed sensor mounted in the gearbox of the mobile excavator (10).

8. The device (70) according to any one of the preceding claims, wherein the predetermined operating conditions include the condition that the degree of operation of the accelerator pedal of the mobile excavator (10) is below a predetermined degree of operation threshold.

9. The device (70) according to one of claims 3 or 4, wherein the hydraulic valve is a 3/2-way valve (80).
10. A mobile excavator (10) comprising:
   at least one swinging axle (25, 27);
   a service brake (66); and
   a device (70) according to any one of the preceding claims.

11. The mobile excavator (10) according to claim 10, further
   comprising at least one hydraulic cylinder (62, 64) disposed on the swinging axle
   (25, 27) and configured to lock the swinging axle (25, 27).

12. The mobile excavator (10) according to one of claims 10
   or 11, further comprising a gearbox (90) with a first gear and at least one second
   gear, wherein the gearbox (90) is configured to output a control pressure if the
   first gear is engaged.

13. A method for operating a service brake (66) of a mobile
    excavator (10) and for locking at least one swinging axle (25, 27) of the mobile
    excavator (10), the method comprising:
    checking whether predetermined operating conditions of the
    mobile excavator (10) are fulfilled, and
    operating the service brake (66) and locking the at least one
    swinging axle (25, 27) if the predetermined operating conditions of the mobile
    excavator (10) are fulfilled.
A. CLASSIFICATION OF SUBJECT MATTER

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

B60G9/02 B60G17/005 B60T7/12 E02F9/00

ADD.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60G B60T E02F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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See patent family annex.

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Date of the actual completion of the international search

26 August 2014

Date of mailing of the international search report

10/09/2014

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Dekker, Wouter
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