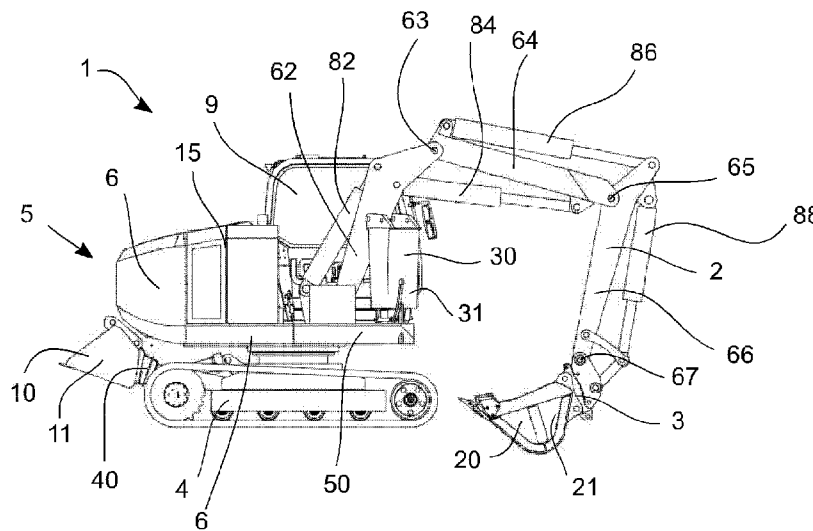




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(54) Title: MULTIPLE TOOL ELECTRIC CONSTRUCTION MACHINE

Fig. 1



(57) Abstract: The invention relates to a construction machine (1) comprising a machine frame (6) and an articulated boom (2), which is pivotably mounted to the machine frame (6). The construction machine (1) further comprises at least one electric motor (126), which is connected to the at least one battery (112) for operating at least one component of the construction machine (1). The construction machine (1) is configured to be operated in a loader mode in which a first tool (10) is mounted to the articulated boom (2), and in an excavator mode in which a second tool (20) is mounted to the articulated boom (2). The construction machine (1) further comprises a tool storage (40, 50) for storing the first tool (10) and/or the second tool (20). The construction machine (1) is configured to re-place one of the first tool (10) and second tool (20) when mounted to the articulated boom (2) with the other one of the first tool (10) and second tool (20) when stored in the tool storage (40, 50). The invention further relates to a method of changing an operational mode and to a method of selecting an operational mode of a construction machine (1).



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MULTIPLE TOOL ELECTRIC CONSTRUCTION MACHINETechnical field

The invention concerns a construction machine that is configured to be operated in a loader mode and in an excavator mode. Such a construction machine may be defined as a combined loader-excavator-machine.

The invention further concerns a method of selecting a tool of a construction machine having an articulated boom, and a method of changing a tool of a construction machine having an articulated boom. The invention also concerns a control system for executing such methods.

Prior art

On most construction sites, loaders and excavators are used for earthworks or material handling. Loader-type machines and excavator-type machines are often used next to each other for carrying out respective loading works and excavating works.

For providing the functionalities of a loader and an excavator on a single machine, multiple function construction machines with two separate booms, i.e. a loader boom at the front end of the machine with a loader bucket mounted thereto and an excavator boom at the rear end of the machine with an excavator bucket mounted thereto, are used on construction sites. For changing the operational mode of such a complex construction machine, the machine operator needs to change his sitting position for changing his field of view and for aligning himself to an instrument panel of the respective boom.

Furthermore, construction machines are known having a single boom at the front of the machine, the boom being operable in an excavator mode as well as in a loader mode. For changing the tool of the construction machine, the machine needs to lay down the tool of the one mode on and pick up the tool of the other mode from the ground of the construction site. Thus, changing of tools may be time consuming as the construction machine needs to be moved to the tool that needs to be picked up, the tool potentially being situated remote from the current working position.

Summary of the invention

The construction machine according to the present invention comprises a chassis, an upper structure and an articulated boom. The upper structure comprises a machine frame, which is pivotably mounted to the chassis. Furthermore, the construction machine comprises at least one battery and at least one electric motor. The at least one electric motor is connected to at least one battery for operating at least one component of the construction machine. The chassis and/or the upper structure comprises the at least one battery and/or the at least one electric motor. The articulated boom is pivotably mounted to the machine frame. The at least one component of the construction machine may be operable by the at least one electric motor with an electric actuation or indirectly via a hydraulic actuation. In the latter case, the at least one electric motor may run at least one hydraulic pump, wherein at least one component of the articulated boom and/or at least one component of the upper structure may be moved via a hydraulic system that is powered by said hydraulic pump.

The construction machine is configured to be operated in a loader mode, in which a first tool is mounted to the articulated boom, and in an excavator mode, in which a second tool, which is different from the first tool, is mounted to the articulated boom. The construction machine may be operated electrically in the loader mode and/or in the excavator mode.

In the loader mode, the construction machine is arranged to perform conventional loader, optionally wheel loader, tasks. Optionally, the construction machine is configured to perform conventional dozer tasks in the loader mode. In the excavator mode, the construction machine is arranged to perform conventional excavator tasks. The configuration of the construction machine to be operat-

ed in the loader and excavator modes implies that the machine is arranged, e.g. programmed, to perform said conventional loader and excavator tasks.

According to an embodiment of the construction machine, the chassis, the upper structure and/or the articulated boom is operable by the at least one electric motor. At least one component of the chassis may be operable by the at least one electric motor. The chassis may comprise at least one chain drive and/or at least one wheel drive, wherein the at least one chain drive and/or the at least one wheel drive may be drivable by the at least one electric motor. At least one component of the upper structure may be operable by the at least one electric motor. The upper structure may comprise a swing drive for rotating the upper structure with respect to the chassis, wherein the swing drive may be drivable by the at least one electric motor. At least one component of the articulated boom may be operable by the at least one electric motor.

According to an embodiment of the construction machine, the construction machine comprises a hydraulic pump for operating at least one hydraulic actuator for hydraulically actuating the at least one component of the construction machine. The hydraulic pump may be drivable by the at least one electric motor. The articulated boom may be operated hydraulically by means of the hydraulic pump, wherein the hydraulic pump is actuated by means of the at least one electric motor. The articulated boom may thus be operated electrically in an indirect manner.

For each electric operation, actuation or driving of the construction machine according to the present invention, a separate electric motor may each be provided on the construction machine. An electric motor may be arranged on the chassis and/or the upper structure. An electric motor may also be arranged on a respective component of the chassis and/or the upper structure.

The articulated boom of the construction machine may be a multi-armed working device, in particular a three-armed boom. Arms of the boom may be connected by articulations or joints. The articulated boom may exhibit different effective configurations between the different operational modes of the construction machine. For example, in the loader mode, the articulated boom may be effectively configured as a two-armed boom and/or, in the excavator mode, the boom may be effectively configured as a three-armed boom. A proximal arm of the articulated boom may be locked to the machine frame in the loader mode, wherein, in the excavator mode, this proximal arm of the articulated boom may not be locked to the machine frame.

The articulated boom may comprise at least a proximal arm and a distal arm, wherein the proximal arm is mounted in an articulated manner to the machine frame and the distal arm is connected in an articulated manner to the proximal arm. A bucket, a hammer or a cutter head may be held by and attached to the distal arm of the articulated boom. The proximal arm and the machine frame may be interlockable, wherein an interlocking of the proximal boom arm and the machine frame may be realized in the loader mode.

The interlocking of the proximal arm and the machine frame may consist of or may comprise at least one of a locking of the proximal arm in or to the machine frame, a locking of the machine frame in or to the proximal arm, a blocking of the articulation between the proximal arm and the machine frame and/or a latching of the proximal arm to the machine frame. A respective interlock, lock, block and/or latch may be mechanically or physically provided by an interlocking means, a locking means, a blocking means and/or a latching means. At least one of these means may be arranged on the machine frame or on the articulated boom. At least one of these means may be operable by the at least one electric motor. Respective means may also be arranged in a divided manner on both, the machine frame and on the articulated boom.

The proximal arm of the multi-armed boom can be mechanically locked to the machine frame. At least one respective articulation of the proximal arm, which is not intended to be used in an operational mode, may thus be substantially released from forces and moments directly acting on it. Additionally, forces and moments acting on a hydraulic positioning cylinder of the proximal arm may also be reduced. Limiting the degrees of freedom of the articulated boom by means of locking a boom arm to the machine frame may increase stiffness and load handling capability of the entire boom. Hence, for example, while operating the boom in a loader mode, arising push loads may be better absorbed by the boom and the machine frame. A further advantageous effect resides in the fact that an interlocking of the proximal arm and the machine frame may also result in a more compact machine design during a

certain operational mode. This may result in a lower center of gravity of the construction machine, which in turn may lead to an increased tilt stability of the construction machine.

The construction machine may be configured to be operated in at least one further operational mode, in which the proximal arm and the machine frame are not interlocked. The operational mode, in which the proximal arm and the machine frame are interlocked, may be the loader mode. An operational mode, in which the proximal arm and the machine frame are not interlocked, may be the excavator mode. Optionally, a further operational mode, in which the proximal arm and the machine frame are not interlocked, may be a dozer mode. Not interlocking the proximal arm may be understood as not locking the proximal arm in or to the machine frame, not blocking the articulation between the proximal arm and the machine frame and/or not latching the proximal arm to the machine frame. The distal arm may be movable in all operational modes, wherein the proximal arm may only be articulated when it is not interlocked. The movement range of the articulated boom may be larger when the proximal arm and the machine frame are not interlocked.

The construction machine may further comprise a locking device that is arranged on the machine frame, wherein the locking device is configured to engage with the proximal arm or vice versa so as to block any relative movement between said proximal arm and the machine frame. The locking device may be operable by the at least one electric motor. Alternatively or additionally, the locking device may be arranged on the proximal arm. The proximal arm may also be configured to engage with the locking device. The locking device provides a mechanical connection between the proximal arm and the machine frame, wherein the mechanical connection can be selectively toggled on and off. The connection may comprise a force-locking and/or a form-locking component. The locking device may be an integral part of the machine frame and/or the proximal arm. The locking device may also be a separate part that is mounted to the machine frame and/or the proximal arm. The locking device may be operated by a simple manual interaction or remotely without manual intervention. Thus, the locking device may efficiently provide a stiff and rigid connection between the proximal arm and the machine frame.

The locking device may comprise at least one hydraulically or electrically operated hook for engaging with the proximal arm and/or with the machine frame. The hydraulically or electrically operated hook may be operable by the at least one electric motor. The proximal arm or the machine frame may comprise a stud or pin, in which the hook may engage for interlocking the proximal arm and the machine frame. Optionally, the hook may be part of a hook fastener as the locking device. The hook fastener may be arranged on the proximal arm and/or on the machine frame. The hook may be swiveled between an unhooked position and a hooked-up position by a hydraulic cylinder or by an actuator to catch and release the stud or pin. Such a remotely or manually controlled connection of the proximal arm and the machine frame may provide a robust interlocking.

Additionally or alternatively to the hook, the locking device may consist of or may comprise a bolt, a detent or any other type of fastener. The bolt, the detent or the fastener may comprise the same functionality as the hook, in particular with respect to its mechanical engaging and interlocking ability.

The articulated boom may comprise a pin that is arranged on the proximal arm, in particular a pin for fixing a piston rod eye of a positioning cylinder of the proximal arm, wherein the pin is configured to be locked to the machine frame. The locking device or the hook may engage with the pin. The positioning cylinder of the proximal arm may be arranged on the machine frame, wherein its piston rod may be connected to the proximal arm at a distal end thereof. For this purpose, the piston rod eye may enclose the pin. Even though the pin may be circularly enclosed by the piston rod eye, the pin may comprise exposed portions to be used for interlocking the proximal arm and the machine frame. For example, at least one exposed portion of the pin may be locked with the locking device. The hydraulically or electrically operated hook may engage with the pin by hooking up at least one of the exposed portions of the pin. Utilizing and locking a pin of a piston rod eye may provide a compact and flush locking of the proximal arm in the machine frame or a locking device.

Alternatively, a double hook may be provided for engaging with a stud or pin of the proximal arm. The pin for fixing a piston rod eye of a positioning cylinder of the proximal arm may comprise two exposed portions sidewise of a middle portion of the pin. The piston

rod eye may enclose the pin at the middle portion. The hydraulically or electrically operated double hook may engage the pin via both exposed portions.

The machine frame and the articulated boom may further comprise an arm support that comprises a supporting portion for supporting the proximal arm when interlocked with the machine frame, wherein the arm support is configured to absorb forces induced by the proximal arm. The supporting portion may be a contact or engagement area on which the proximal arm may rest before, during or after being interlocked with the machine frame. The contact or engagement area may be a seating or a surface for supporting the proximal arm during the operational mode, in which the movement of the proximal arm is blocked. The proximal arm may be moved until a contact with the arm support is realized and then locked by the locking device. Thus, the arm support may comprise a double functionality in supporting the proximal arm and in providing a stop for locking the proximal arm. The position of the proximal arm, when resting on the arm support, may be defined as a locking position of the proximal arm. Especially a planar contact between the proximal arm and the machine frame may further increase the stiffness of the interconnection between the proximal arm and the machine frame.

In the interlocked position, the proximal arm may be arranged in a substantially flush fashion with respect to the machine frame or at least forming an acute angle with the machine frame. A substantially flush locking position of the proximal arm may be a folded position of the proximal arm. In the folded position, the proximal arm may be arranged substantially parallel to a base plate of the machine frame. The piston rod of the positioning cylinder of the proximal arm may be in a fully retracted position in said folded position. The proximal arm can be designed in a hollow manner for accommodating at least a part of the positioning cylinder when the proximal arm and the machine frame are interlocked. Specifically, the retracted positioning cylinder may rest in-between elongated side portions of the proximal arm. Operating an articulated boom, which proximal arm may be locked to the machine body of the construction machine in such a flush fashion, may provide a compact machine design. An operational mode suitable for height limited construction sites may thus be realized. A locked proximal arm may also increase transport safety and may lower the transport height of the construction machine when transported on a lorry, for example.

The articulated boom may be a three-armed boom. The articulated boom may further comprise an intermediate arm that is interconnected in an articulated manner between the proximal arm and the distal arm. The proximal arm and the distal arm of the articulated boom may be interconnected directly or indirectly via an intermediate arm. The proximal arm may be directly hinged to the machine frame, wherein the distal arm may be indirectly hinged to the machine frame with at least one intermediate arm therebetween. The proximal arm itself may be mounted on the machine frame via an articulation, in particular an articulated joint. The intermediate arm may respectively comprise an articulation with the proximal arm and an articulation with the distal arm. The intermediate arm may be pivotable when the proximal arm and the machine frame are interlocked and/or not interlocked. Optionally, the intermediate arm may be lockable to the proximal arm, the machine frame and/or the distal arm.

A positioning cylinder of the intermediate arm may be arranged below the intermediate arm, connecting the proximal arm and the intermediate arm at distal ends thereof. A distal end of an arm may be that end, which is remoter from the machine frame. The connection at distal ends of these arms increases the foldability of the intermediate arm. Furthermore, a positioning cylinder of the distal arm may be arranged above the intermediate arm. This positioning cylinder may connect the intermediate arm and the distal arm at proximal ends thereof. A proximal end of an arm may be the closer end of the arm with respect to machine. Hence, the positioning cylinder of the distal arm may be arranged above the positioning cylinder of the intermediate arm, also when the proximal arm and the machine frame are interlocked. Both of these cylinders may be arranged above the positioning cylinder of the proximal arm. All of these positioning cylinders may be arranged in a single plane.

The intermediate arm, a positioning cylinder of the intermediate arm and a positioning cylinder of the distal arm may be arranged substantially parallel to each other. An effect of this can be seen in that the positioning cylinder of the intermediate arm and the positioning cylinder of the distal arm may remain parallel to each other regardless of the articulation and moving positions of the proximal arm, the intermediate arm and/or of the distal arm. Hence, the cylinders that are provided between the proximal arm and the distal arm may permanently provide a stiff parallelogram-like cylinder arrangement.

The construction machine further comprises a tool storage for storing the first tool and/or the second tool. The tool storage may be operable by the at least one electric motor. The tool storage is configured to store a tool, which is not mounted to the boom and which is therefore currently not in use. The construction machine is configured to replace one of the first tool and second tool, which is mounted to the articulated boom, with the other one of the first tool and second tool, which is not mounted to the boom but stored in the tool storage. The tool storage may be a tool deposit and/or a tool retainer. The first tool and the second tool can be different, for example have different sizes, volumes and/or shapes. The configuration of the construction machine to replace the tool, which is mounted to the boom, with the tool, which is provided in the tool storage, implies that the machine is arranged, e.g. programmed, to conduct this task.

The distal arm of the articulated boom may be pivoted to the tool, which is stored in the tool storage, to be picked by the tool mount. Picking or changing a tool may be carried out when the proximal arm and the machine frame are interlocked or not interlocked. In particular, an unlocking step of the proximal arm may precede the picking or changing step of the tool. Said different tools, which can be mounted to the tool mount, may be provided for different operational modes. The different tools may be buckets of different sizes, for example an excavator bucket and a loader bucket.

The upper structure of the construction machine may further comprise a recess for accommodating the proximal arm when interlocked with the machine frame. Further machine equipment may be arranged on the machine frame sidewise of the recess. The recess allows for a flush interlocking of the proximal arm with the machine frame. The construction machine may further be configured to be operated in a loader mode, in which the proximal arm is interlocked with the machine frame and/or in an excavator mode, in which the proximal arm is not interlocked with the machine frame. The articulated boom may preferably be a three-armed boom. When operated in the loader mode, the three-armed articulated boom may be moved by pivoting the intermediate arm and the distal arm only, while the proximal arm is locked to the machine frame. When operated in the excavator mode, also the proximal arm of the three-armed boom may be pivotable.

A core idea resides in the fact that an at least partly electrically operated construction machine with a single multi-functional boom is configured to change its mode of operation in situ. In other words, the at least partly electrically operated construction machine is designed to completely change its tools and its mode of operation at an arbitrary position, as the machine itself carries the different tools for the different modes of operation. Accordingly, a tool change can be carried out without macroscopically moving the machine. A further advantageous effect may be seen in that a tool, which is not in use, does not have to be put aside or stored in a warehouse, but is directly available on the construction machine for use when needed. As the construction machine is at least partly electrically operated, a further advantage can be seen in that exhaust and noise emissions may be reduced during operation of the construction machine.

The construction machine comprises a chassis, wherein the machine frame is pivotably mounted to the chassis. The machine frame may be pivotable with respect to the chassis around a vertical axis. The chassis may comprise an arrangement for locomotion of the construction machine on the ground. For that purpose, the chassis may comprise the chain drive and/or the wheel drive. The chassis may also be defined as a lower machine frame of the construction machine. The articulated boom can be mounted to the machine frame and/or the chassis.

The tool storage comprises a first tool carrier adapted to carry the first tool and a second tool carrier being separate from the first tool carrier and being adapted to carry the second tool. A tool carrier may be a tool changer or may be configured as such. The first tool carrier and/or the second tool carrier may comprise a tool shelf and/or a tool holder. The first tool carrier and the second tool carrier are provided at different locations of the construction machine. The provision of a first and a second tool carrier on the construction machine has the advantage that picking and depositing of the first and second tools during a change of the mode of operation may be carried out without putting down one of the tools on the ground. Thus, both the first tool and the second tool may be provided on the construction machine during all phases of operation. The first tool carrier and/or the second tool carrier may comprise a housing for enclosing the first and/or second tool.

According to an embodiment of the construction machine, the first tool carrier and/or the second tool carrier is powered by the at least one battery and the at least one electric motor. At least one component of the first tool carrier and/or the second tool carrier may be operable by the at least one electric motor. The first tool carrier may be movably arranged at the chassis. The first tool carrier may be movable by a tilting device for tilting the first tool carrier from an upward position to a downward position or vice versa. The tilting device may be operable by the at least one electric motor. Also the tilting device may be arranged on the chassis. The second tool carrier may be movably arranged at the machine frame. The second tool carrier may be movable by a pivoting device for pivoting the second tool carrier from a stowed position to a moved out position or vice versa. The pivoting device may be operable by the at least one electric motor. Also the pivoting device may be arranged at the machine frame.

The first and/or second tool carrier can be arranged on the construction machine in a movable manner. Said tool carrier can be arranged on the machine frame or on the chassis in a pivotable and/or shiftable manner such that it can be pivoted and/or shifted with respect to the machine frame or to the chassis. The tool carrier can be arranged on the left or right side of the machine frame, and can be pivoted to the front or rear side of the construction machine with respect to the forward moving direction thereof. Thus, tools can be picked or deposited by the articulated boom at the front or rear of the machine without the need of pivoting the boom around a vertical axis, as the tool carrier itself is able to pivot towards the boom.

The first tool carrier is arranged at the chassis and the second tool carrier is arranged at the machine frame of the construction machine. For picking and depositing the first tool from/in the first tool carrier, the articulated boom may be pivoted to the first tool carrier by pivoting the machine frame relative to the chassis. For picking and depositing the second tool from/in the second tool carrier, the second tool carrier may be moved, in particular pivoted, towards the articulated boom. This embodiment has the advantage that the first tool for the loader mode, which is usually bulky and rather heavy, may be provided at a lower portion of the construction machine so as to minimize loading. Additionally, this embodiment allows for an optimal utilization of space on the construction machine for storing the different tools.

The first tool carrier may comprise first retaining means for holding the first tool and/or the second tool carrier may comprise second retaining means for holding the second tool. A retaining means may comprise at least one clamp for engaging with a tool to be carried. The retaining means may be adapted to exert a pressing force onto the tool to be held. Alternatively or additionally, the retaining means may comprise at least one pin for engaging with the tool to be carried. The pin may be hydraulically or electrically driven. The pin may be electrically driven by the at least one electric motor. Providing a retaining means may increase a safe stowing of tools on the construction machine.

According to an embodiment, the construction machine comprises a first tool mountable to the articulated boom in the loader mode and a second tool mountable to the articulated boom in the excavator mode. The first tool and the second tool as well as the articulated boom may be configured such that the tools may be picked by a tool mount at the distal end of the articulated boom, optionally without the support of an operator. In other words, picking and depositing of a tool can be conducted by the construction machine itself.

The first tool may be a loader bucket, and the second tool may be an excavator bucket. The first tool carrier may be adapted to carry the loader bucket and the second tool carrier may be adapted to carry the excavator bucket. The loader bucket may have a larger bucket volume compared to the excavator bucket. The loader bucket may be wider than the excavator bucket. The loader bucket may be configured to be used as a dozer tool.

Pursuant to an embodiment of the construction machine, the tool storage is further configured to simultaneously store a third tool. The second tool carrier may be configured to carry the third tool additionally to the second tool. Optionally, the second tool carrier comprises a retaining means for locking the second and a further retaining means for locking the third tool. Alternatively or additionally, the construction machine may comprise an additional third tool carrier for carrying the third tool. The third tool carrier may be separate from the first and/or second tool carrier. The construction machine may be configured to pick and deposit the third tool

from the tool storage with the articulated boom. Hence, the construction machine may be a multiple tool construction machine with three tools for different operational tasks, wherein all of these tools may be carried simultaneously by the construction machine.

The construction machine may comprise a third tool mountable to the articulated boom in the excavator mode. The third tool may be a hammer. The hammer may be a hydraulic hammer for loosening of concrete and/or rock. Additionally or alternatively, the construction machine may comprise a cutter head, a crusher, a drilling tool, a fork for lifting pallets, a hook and/or a basket for lifting a human. Optionally, the tool storage is configured to carry the additional tool(s), and the construction machine is configured to automatically pick and deposit the tool(s) from/in the tool storage with the articulated boom.

Pursuant to an embodiment of the construction machine, the articulated boom comprises multiple, optionally three, arms pivotably connected in series to each other, wherein the construction machine further comprises a locking device for selectively locking the arm of the articulated boom, which is directly connected to the machine frame, so as to block any relative movement between said arm and the machine frame in the loader mode. The locking device may be operable by the at least one electric motor. The arm of the articulated boom, which is directly connected to the machine frame, may also be defined as a proximal arm. The proximal arm may be connected to an intermediate arm and the intermediate arm may be connected to a distal arm. The locking device allows for an easy change of the operational mode of the construction machine between the loader mode and the excavator mode. Specifically, via the locking device, the effective configuration of the articulated boom can be changed from a three-armed boom in the excavator mode to a two-armed boom in the loader boom, allowing for an increased stiffness in the loader mode and an increased operational flexibility in the excavator mode.

The second tool carrier may be a second tool carrier or may be configured as a second tool carrier. The second tool carrier may comprise at least one tool retaining portion for holding a tool, wherein the tool is configured to be mounted on a tool mount of the articulated boom. The second tool carrier may be configured to be movably attached to the construction machine and may comprise a moving mechanism for moving the tool retaining portion in alignment with the articulated boom of the construction machine to allow for picking of the tool by the tool mount. The moving mechanism may be operable by the at least one electric motor.

The second tool carrier may be a device for providing an additional tool on the construction machine, wherein the additional tool may be mounted on the tool mount of the construction machine. The second tool carrier may also be a device for changing of tools of a construction machine. Mounting or changing a tool may be carried out automatically, in particular without manual tool handling by a machine driver or a further construction worker. Mounting or changing a tool may be carried out electrically.

Thus, the second tool carrier may provide a mechanism for self-mounting or self-exchanging of tools on the construction machine. Utilizing the second tool carrier on the construction machine may provide an additional tool for carrying out an additional work task. For instance, a hydraulic hammer or a cutter head may be provided on the construction machine next to a conventional bucket, e.g. an excavator bucket or a loader bucket.

The second tool carrier may be movably attachable to the upper structure or to the chassis of the construction machine. The second tool carrier may be movably attached to the machine frame or to the machine body of the construction machine.

For holding and storing a tool with the second tool carrier, at least one tool retaining portion may be provided on the second tool carrier. The tool retaining portion may be a separate part, e.g. a tool retainer. The second tool carrier may comprise a base plate or base frame, at which the at least one tool retaining portion may be provided. The tool retaining portion may be a recess inside the base plate or a tool counterpart constructed on the base plate, both for accommodating and supporting a tool. The recess or counterpart may be designed to include at least a portion corresponding in shape to the shape of the tool to be carried for providing an intimate fit between the respective tool and the tool retaining portion.

The second tool carrier may be movably attached to the machine body and may be shifted and/or rotated with respect to the latter. Shifting and/or rotation of the second tool carrier may provide movability of the tool being held on the second tool carrier towards

and into the working range of the tool mount of the construction machine. Shifting and/or rotation of the second tool carrier may be caused by the at least one electric motor. The movability of the second tool carrier itself may compensate for a limited movability of the tool mount that is mounted on the articulated boom. Accordingly, the second tool carrier allows for a tool storage at areas of the machine, which are not reachable by the tool mount of the articulated boom. The movability of the second tool carrier may be adapted to the existing movability of the articulated boom to allow for an integrated direct picking of a tool from the second tool carrier by the tool mount.

The construction machine may change its tools autonomously and in situ when being equipped with the second tool carrier. Accordingly, a tool change can be carried out without macroscopically moving a chassis of the construction machine and even further without any rotation of construction machine's machine body. A further advantageous effect may be seen in the fact that a tool, which is not in use, does not have to be put aside or stored in a warehouse, but is directly provided on the construction machine by the second tool carrier. A further advantageous effect may be seen in the fact that a tool may be changed electrically without the usage of a combustion engine.

The moving mechanism of the second tool carrier may comprise a pivoting mechanism for pivoting the tool retaining portion in alignment with the articulated boom of the construction machine. The pivoting mechanism may be operable by the at least one electric motor. The second tool carrier as well as the articulated boom may be pivotably mounted on or hinged to a rigid machine frame of the construction machine. The second tool carrier may be rigidly or movably attached to links that in turn may be rigidly or movably attached to the machine frame. The links may thus interconnect the second tool carrier and the rigid machine frame. The second tool carrier may be pivoted in a horizontal plane about a vertical axis and the articulated boom may be pivoted in a vertical plane at least about a horizontal axis.

Alternatively or additionally, the moving mechanism of the tool may comprise a linear shifting mechanism for shifting the tool retaining portion in alignment with the articulated boom of the construction machine. The shifting mechanism may be operable by the at least one electric motor. The shifting mechanism may be a drawer-like mechanism. The shifting may comprise a translation of the tool retaining portion towards the tool mount of the articulated boom. The shiftable second tool carrier may be mounted on the machine frame or on the chassis of the construction machine, wherein the machine frame and the chassis may be rotatable with respect to each other. The second tool carrier may be shifted in a horizontal plane, wherein the articulated boom may be pivoted in a vertical plane. The shifting direction of the second tool carrier may be in line with the pivoting plane of the articulated boom to allow for picking of the tool by the tool mount of the articulated boom.

The second tool carrier may further comprise a hinging portion, in particular a pivot arm, for pivotably attaching the second tool carrier to the construction machine. The hinging portion may interconnect the machine frame of the construction machine with the tool retaining portion of the second tool carrier. The hinging portion may provide a spacing between the machine frame and the tool retaining portion when pivoting the second tool carrier with respect to the machine frame. The second tool carrier may comprise at least components of a four-bar linkage. The four-bar linkage may comprise two hinging portions, in particular two pivot arms, for pivotably attaching the second tool carrier to the construction machine. At least one hinging portion and/or pivot arm may interconnect the machine frame of the construction machine with the tool retaining portion of the second tool carrier.

The moving mechanism of the second tool carrier may comprise an actuator for providing the movability of the second tool carrier. The actuator may be a hydraulic actuator, e.g. a hydraulic positioning cylinder, or an electric actuator. The second tool carrier may be moved electrically or hydraulically with respect to the construction machine. The electric or hydraulic actuator may interconnect the tool retaining portion with the machine frame of the construction machine. The hinging portion of the second tool carrier and the actuator may be connected with the tool retaining portion at opposite sides thereof so as to provide an advantageous lever arm when pivoting the retaining portion with the actuator around a pivot point of the hinging portion.

An electric motor of the at least one electric motor may be provided on the second tool carrier. The actuator may be directly or indirectly, e.g. via a hydraulic pump, operable by the electric motor. The actuator may thus electrically allow for an automatic

movement of the second tool carrier to an alignment position with the articulated boom of the construction machine. Accordingly, also a remote control of the moving mechanism is possible.

The second tool carrier may further comprise at least one clamping means for securing the tool on the tool retaining portion. The clamping means may be arranged on the tool retaining portion or may be part of a tool retaining means which may be additionally provided adjacent to the tool retaining portion on the second tool carrier. The clamping means may comprise at least one clamp for engaging with the tool to be carried. The clamp may be adapted to exert a pressing force onto the tool to be hold. Alternatively or additionally, the second tool carrier may comprise at least one pin for engaging with the tool to be carried. The clamping means, the at least one clamp or the at least one pin may be electrically or hydraulically drivable by the at least one electric motor.

The movable attachment of the second tool carrier to the upper structure of the construction machine may provide a movement of the second tool carrier between a stowed condition of the second tool carrier remote from the tool mount of the articulated boom to a changing condition, in which the second tool carrier is aligned with the articulated boom and/or the tool mount. The stowed condition may be a stowed position of the second tool carrier close to or adjacent to the upper structure, at which the second tool carrier may be integrated into the upper structure. The changing condition may be a position of the second tool carrier away from the upper structure. With respect to the machine body of the construction machine, the stowed condition may be a proximal condition and the changing condition may be a distal condition of the second tool carrier. At the changing condition of the second tool carrier, the tool retaining portion of the second tool carrier may be in alignment with the tool mount of the articulated boom.

The upper structure may comprise a recess for accommodating the second tool carrier in a stowed condition. The second tool carrier may be at least partly located in the recess when being in a stowed condition. For accommodating the second tool carrier, the second tool carrier may be pivoted and/or shifted in the recess. For moving the second tool carrier to a changing condition, the second tool carrier may be pivoted and/or shifted out of the recess. Providing the recess allows for an integration of the second tool carrier in the machine body and prohibits an enlargement of the machine.

The second tool carrier may have a plurality of tool retaining portions, in particular two tool retaining portions, each of them for holding a tool. Furthermore, the second tool carrier may be movably attached to the upper structure for providing movability of the second tool carrier from a stowed condition to a plurality of alignment conditions with the tool mount of the articulated boom, in particular two different alignment conditions. Each of the alignment conditions allows for picking of one of the tools by the tool mount. At least one of the alignment conditions may be the changing condition of the second tool carrier. At least two different tools may be provided in the plurality of tool retaining portions. The movability of the second tool carrier may be continuous, meaning that the position of the second tool carrier may be adjustable in a stepless manner. Alternatively, the second tool carrier may be moved to discrete moving positions. Providing a multi-tool changer with multiple alignment conditions allows for the provision of multiple operational modes of a construction machine, wherein the tools for the different operational modes are provided on the machine.

The upper structure of the construction machine and the second tool carrier may be interconnected by at least one articulation, in particular at least one pivot joint, for providing a pivot movability of the second tool carrier with respect to the upper structure. The pivot joint may be a swivel for turning of the second tool carrier. The pivot joint may be located at the bottom side of a machine frame of the upper structure. The location of the pivot joint may also be adjacent to a recess of the upper structure for accommodating the second tool carrier. A four-bar linkage may be provided for providing the pivot movability of the second tool carrier with respect to the upper structure. The four-bar linkage may comprise the at least one articulation. The four-bar linkage may also be described as a double pivot joint that may be located at the bottom side of the machine frame of the upper structure.

All further components of the construction machine, insofar not explicitly described, may also be operable alone or in combination by the at least one electric motor or powered alone or in combination by the at least one battery.

Furthermore, according to a further aspect of the invention, the present invention relates to a method of changing an operational mode of a construction machine with a chassis, an upper structure and an articulated boom. The upper structure comprises a ma-

chine frame, which is pivotably mounted to the chassis, at least one battery and at least one electric motor, which is connected to the at least one battery. The construction machine may be the construction machine according any of the above described embodiments.

The method comprises the step of operating the articulated boom by the at least one electric motor. The method further comprises the step of depositing, by the articulated boom, a tool, which is mounted to the articulated boom, for one of a first and second operational modes. Subsequently, the method comprises the step of picking, by the articulated boom, a tool for the other one of the first and second operational modes from a tool storage provided on the construction machine. Picking the first tool or the second tool by the articulated boom may comprise mounting or installing the selected tool on a tool mount at a distal end of the boom. This step can be carried out automatically by the boom without manual intervention. The depositing and/or the picking of the tool may be carried out by respectively operating the articulated boom by the at least one electric motor.

Pursuant to an embodiment of the method, the tool is deposited in the tool storage. Thus, the tool for one of the first and second operational modes, which is mounted to the articulated boom, may be deposited in the tool storage before picking the tool for the other one of the first and second operational modes from the tool storage. Depositing and picking is carried out by the articulated boom itself. This embodiment has the advantage that both tools are provided on the machine during a tool change. Thus, none of the tools has to be put down on the ground or somewhere else. A further advantage resides in the fact that no additional machine or tool is needed for conducting a tool change.

The method for changing an operational mode of a construction machine may comprise the step of interlocking or unlocking a proximal arm of an articulated boom with or from a machine frame for switching between a first operational mode and a second operational mode of the construction machine. The construction machine comprises the machine frame and the articulated boom, wherein the articulated boom is arranged on the machine frame. The proximal arm and the machine frame may be interlocked in the first operational mode, wherein the proximal arm and the machine frame may not be interlocked in the second operational mode. Changing an operational mode may comprise switching from an excavator mode to a loader mode or vice versa. Said changing of an operational mode may also comprise the interchanging of tools by dropping or grabbing a tool by a tool mount, which is arranged at a distal end of the articulated boom.

According to a further aspect of the invention, a method of selecting an operational mode of a construction machine with a chassis, an upper structure and an articulated boom is provided. The upper structure comprises a machine frame, which is pivotably mounted to the chassis, at least one battery and at least one electric motor, which is connected to the at least one battery. The construction machine is operable in a first operational mode and in a second operational mode, which is different from the first operational mode. Optionally, the construction machine is the construction machine according to any of the above described embodiments.

The method comprises the step of simultaneously providing a first tool for the first operational mode and a second tool for the second operational mode on the construction machine, operating the articulated boom by the at least one electric motor and selecting and picking one of the first tool and second tool by the articulated boom for operation of the construction machine in the first or second operational mode. Providing the first tool and the second tool on the construction machine may be understood as carrying, holding and/or supporting these tools on or by the construction machine. In other words, the construction machine may simultaneously carry, hold and/or support at least two tools.

Pursuant to an embodiment, a method according to the invention comprises the step of locking an arm of the articulated boom that is directly connected to a machine frame, i.e. a proximal arm, to the machine frame of the construction machine so as to block any relative movement between said arm and the machine frame. Locking the proximal arm may enable the construction machine to operate in a loader mode, and unlocking the proximal arm may enable the construction machine to operate in an excavator mode. The articulated boom may be a three-armed boom, which may effectively be reduced to a two-armed boom by locking the proximal arm.

Pursuant to an embodiment, the first operational mode is a loader mode and the second operational mode is an excavator mode.

All further method steps, insofar not explicitly described, may also be performed alone or in combination based on operating or driving respective components of the construction machine by the at least one electric motor.

According to a further aspect of the invention, the present invention further relates to a control system which is configured to execute the method of selecting a tool on a construction machine and/or the method of changing a tool on a construction machine according any of the above described embodiments.

Brief description of the figures

- Fig. 1 shows a side view of a construction machine according to an embodiment of the present invention in an excavator mode.
- Fig. 2 shows a perspective view of the construction machine of Fig. 1 during an operational mode change from or to the excavator mode shown in Fig. 1.
- Fig. 3 shows a side view of the construction machine of Fig. 1 in a hammer mode.
- Fig. 4 shows a perspective view of the construction machine of Fig. 1 during an operational mode change from or to the hammer mode shown in Fig. 3.
- Fig. 5 shows a side view of the construction machine of Fig. 1 in a loader mode.
- Fig. 6 shows a side view of the construction machine of Fig. 1 in a dozer mode or during an operational mode change from or to the loader mode shown in Fig. 5.
- Fig. 7 shows a plan view of the bottom side of an upper structure of the construction machine of Fig. 1 with a second tool carrier in a stowed condition.
- Fig. 8 shows a plan view of the upper side of the upper structure of the construction machine of Fig. 1 with the second tool carrier in the stowed condition.
- Fig. 9 shows a plan view of the bottom side of the upper structure of the construction machine of Fig. 1 with the second tool carrier in an alignment condition.
- Fig. 10 shows a plan view of the upper side of the upper structure of the construction machine of Fig. 1 with the second tool carrier in the alignment condition of Fig. 9.
- Fig. 11 shows a plan view of the bottom side of the upper structure of the construction machine of Fig. 1 with the second tool carrier in a further alignment condition.
- Fig. 12 shows a plan view of the upper side of the upper structure of the construction machine of Fig. 1 with the second tool carrier in the further alignment condition of Fig. 11.
- Fig. 13 shows a side view of a loaded second tool carrier of the construction machine of Fig. 1 according to an embodiment of the present invention.
- Fig. 14 shows a further side view of the loaded second tool carrier of Fig. 13.
- Fig. 15 shows a plan view from above of the loaded second tool carrier of Fig. 13.
- Fig. 16 shows a side view of the second tool carrier of Fig. 13 without tools.
- Fig. 17 shows a further side view of the second tool carrier of Fig. 16.
- Fig. 18 shows a plan view from above of the second tool carrier of Fig. 16.
- Fig. 19 shows a perspective view of an arrangement comprising a machine frame and an articulated boom of the construction machine of Fig. 1 according to an embodiment of the present invention in an unlocked configuration.
- Fig. 20 shows a sectional side view of the arrangement of Fig. 19.
- Fig. 21 shows a perspective view of the arrangement of Fig. 19 in a locked configuration.
- Fig. 22 shows a sectional side view of the arrangement of Fig. 21.
- Fig. 23 shows schematically an electric operation system of the construction machine of Fig. 1 according to an embodiment.
- Fig. 24 shows schematically an electric operation system of the construction machine of Fig. 1 according to a further embodiment.

Fig. 25 shows schematically an electric operation system of the construction machine of Fig. 1 according to a further embodiment.

Detailed description of embodiments

Embodiments of the present invention are subsequently described with reference to the attached Figs. 1 to 22.

Figs. 1 to 6 show a multi tool construction machine 1 according to an embodiment of the present invention, wherein the construction machine 1 is shown in different operational modes. The construction machine 1 comprises a chassis 4, an upper structure 5 and an articulated boom 2.

The chassis 4 may be a chain-driven chassis 4 or a wheel-driven chassis (not shown). The upper structure 5 may be arranged on the chassis 4 in a pivotable manner to be rotatable with respect to the chassis 4. The rotatability of the upper structure 5 with respect to the chassis 4 may be provided around a vertical axis of rotation. Optionally, the upper structure 5 is 360°-rotatable with respect to the chassis 4.

The upper structure 5 may comprise a machine frame 6 as a base frame or basic framework of the upper structure 5. The upper structure 5 may further comprise a driver cabin 9, a hydraulic unit (not shown) or an optional engine-hydraulic unit 15, and/or a counterweight 16. The hydraulic unit may be powered by at least one electric battery and/or at least one electric motor (shown in Figs. 23 to 25). The hydraulic unit may carry out the same tasks as described with respect to the engine-hydraulic unit 15. The upper structure 5 may further comprise at least one battery and at least one electric motor, which may be connected to the at least one battery for operating the multi tool construction machine 1 or at least one component thereof. For example, the chassis 4, the upper structure 5 and/or the articulated boom 2 may be operated by the electric motor. A hydraulic pump for operating hydraulic actuators and a swing drive for rotating the upper structure 5 with respect to the chassis 4 may further be provided. The at least one electric motor may drive the hydraulic pump. The driver cabin 9, the engine-hydraulic unit 15, and the counterweight 16 may be arranged on the machine frame 6. The upper structure 5 may further comprise a recess 7. The recess 7 may be formed above the machine frame 6 for accommodating at least part of the articulated boom 2, i.e. a proximal arm of the articulated boom 2, when being folded towards or against the machine frame 6. The driver cabin 9, the engine-hydraulic unit 15 and/or the counterweight 16 may be arranged around the recess 7. In other words, the recess 7 may be surrounded by the driver cabin 9, the engine-hydraulic unit 15 and/or the counterweight 16. As illustrated in Figs. 8, 10 and 12, the engine-hydraulic unit 15 may be arranged on both sides of the recess 7. The driver cabin 9 as well as the engine-hydraulic unit 15 may be arranged on opposite sides of the upper structure 5 and the machine frame 6, respectively. The articulated boom 2 may be arranged between the driver cabin 9 and the engine-hydraulic unit 15.

The articulated boom 2 may be arranged on the upper structure 5, wherein the articulated boom 2 may be in particular a three-armed boom 2 or optionally a two-armed boom (not shown). At one boom end, the articulated boom 2 may be pivotably attached to the machine frame 6 by means of a first articulation 61. The first articulation 61 may be a pivot joint. The first articulation 61 may be provided at a central position of the machine frame 6 in widthwise direction of the upper structure 5 and in front of to the vertical axis of rotation of the upper structure 5 in lengthwise direction of the upper structure 5. At the other end of the articulated boom 2, which is not attached to the machine frame 6, a tool mount 3 may be pivotably arranged.

The articulated boom 2 may comprise a proximal arm 62, an intermediate arm 64 and a distal arm 66. The proximal arm 62 may be hinged to the machine frame 6 by means of the first articulation 61, the intermediate arm 64 may be hinged to the proximal arm 62 by means of a second articulation 63 and/or the distal arm 66 may be hinged to the intermediate arm 64 by means of a third articulation 65. The articulations 61, 63, 65 may be designed as pivoting joints. The first articulation 61 may interconnect the proximal arm 62 and the upper structure 5 and the machine frame 6, respectively, the second articulation 63 may interconnect the intermediate arm 64 and the proximal arm 62 and the third articulation 65 may interconnect the distal arm 66 and the intermediate arm 64.

The articulated boom 2 may further comprise a first positioning cylinder 82 for pivoting the proximal arm 62, a second positioning cylinder 84 for pivoting the intermediate arm 64, a third positioning cylinder 86 for pivoting the distal arm 66 and/or a fourth positioning cylinder 88 for pivoting the tool mount 3.

The first positioning cylinder 82 may be hinged to the machine frame 6 rearward of the first articulation 61. Furthermore, the first positioning cylinder 82 may be hinged to the backside of the distal end of the proximal arm 62, the backside being that side which is facing away from the intermediate arm 64. The first positioning cylinder 82 may be a boom cylinder for pivoting the entire articulated boom 2 with respect to the machine frame 6. The second positioning cylinder 84 may be hinged to the distal end of the proximal arm 62 and to a distal end of the intermediate arm 64. The second positioning cylinder 84 may be arranged beneath the intermediate arm 64. The third positioning cylinder 86 may be hinged to a proximal end of the intermediate arm 64 and to a proximal end of the distal arm 66. The third positioning cylinder 86 may be arranged above the intermediate arm 64 and/or above the second positioning cylinder 84. The second positioning cylinder 84 and the third positioning cylinder 86 may be arranged substantially parallel to each other in all operating positions of the boom. The fourth positioning cylinder 88 may be hinged to a proximal end of the distal arm 66 and to the tool mount 3 at the distal end of the distal arm 66. The fourth positioning cylinder 88 may be arranged above the distal arm 66, i.e. on that side of the distal arm 66 which is facing away from the proximal arm 62.

Different tools 10, 20, 30 may be provided on the construction machine 1, which are configured to be mounted to the tool mount 3 that may be pivotably attached to the distal arm 66. A fourth articulation 67 may interconnect the distal arm 66 and the tool mount 3. Tools 10, 20, 30 not mounted to the tool mount 3 are carried by the construction machine 1. A first tool 10 may be a loader bucket 11, a second tool 20 may be an excavator bucket 21 and a third tool 30 may be a hammer 31, wherein at least the loader bucket 11 and the excavator bucket 21 may be provided on the construction machine 1. The hammer 31 may be a hydraulic hammer. Alternatively, only two tools out of the different tools 10, 20, 30 may be provided on the machine.

The chassis 4 may comprise a first tool carrier 40 and the upper structure 5 may further comprise a second tool carrier 50, wherein the first tool carrier 40 and/or the second tool carrier 50 may provide a tool storage and/or a tool changer on the construction machine 1. The first tool carrier 40 may be arranged at the rear side of the chassis 4 and may be configured to carry or change the first tool 10. The first tool carrier 40 may be tiltable and may be moved between an upward position as shown in Figs. 1 to 5 and a downward position as shown in Fig. 6. The upward position may serve for carrying the first tool 10 and the downward position may serve for utilizing the first tool 10, e.g. the loader bucket 11, for carrying out dozer work with the construction machine 1. In other words, in the upward position, the first tool 10 is spaced from the ground, whereas it is in contact with or at least in proximity of the ground in the downward position. The first tool carrier 40 and/or the second tool carrier 50 may be powered by the at least one battery and the at least one electric motor.

The second tool carrier 50 may be arranged at the front end of the upper structure 5, wherein the second tool carrier 50 may be positioned adjacent to the articulated boom 2 and/or in front of the engine-hydraulic unit 15. The articulated boom 2 may be arranged in between the driver cabin 9 and the second tool carrier 50. The second tool carrier 50 may be accommodated in a frame recess 8 of the machine frame 6 and may be pivoted from a stowed position, as shown in Figs. 1, 3, 5 and 6, to at least one pivot position, as shown in Figs. 2 and 4. Hereto, the second tool carrier 50 may be pivotably attached to the machine frame 6. A pivoting movement of the second tool carrier 50 may be provided by a positioning cylinder 52, for example a hydraulic positioning cylinder. Two tools 20, 30 may be carried on the second tool carrier 50. The tools 20, 30 may be the excavator bucket 21 and the hammer 31, both mountable to the tool mount 3.

Alternatively, with respect to the movable attachment of the second tool carrier 50 to the machine frame 6, the second tool carrier 50 may also be attached to the machine frame 6 with at least two links or articulations (not shown). The links may be arranged on the machine frame 6 and/or on the second tool carrier 50, wherein the links may comprise swivel joints or pivot joints for supporting and pivotably moving the second tool carrier 50 from a stowed position, as for example shown in Figs. 1, 3, 5 and 6, to at least one pivot position, as for example shown in Figs. 2 and 4. The links may thus interconnect the second tool carrier 50 and the machine frame 6 in a hinge-like manner. The links may further provide a four-bar linkage or a crank rocker for pivoting the second tool carrier

50. The four-bar linkage may comprise four joints, two of those may be arranged on the machine frame 6. The second tool carrier 50 may be pivotably or rigidly attached to at least one of the two further joints of the four-bar linkage, which are not arranged on the machine frame 6 and which are both pivotably movable with respect to the machine frame 6. According to one of these mechanisms, the second tool carrier 50 may be moved on a segment of a circular arc. Such an attachment design of the second tool carrier 50 to the machine frame 6 may be advantageous, as it may provide more flexibility in positioning the second tool carrier 50 for a tool change or a tool carriage.

Further alternatively, with respect to the movable attachment of the second tool carrier 50 to the machine frame 6, the second tool carrier 50 may also be attached to the machine frame 6 with at least one not pivotable link (not shown), preferably with two not pivotable links. The not pivotable one link may be arranged on the machine frame 6 and/or on the second tool carrier 50, wherein the not pivotable one link may be a slide or runner for carrying and linearly moving the second tool carrier 50 from a stowed position, as for example shown in Figs. 1, 3, 5 and 6, to at least one moved out position, as for example shown in Figs. 2 and 4. The not pivotable one link may thus interconnect the second tool carrier 50 and the machine frame 6 in a linearly adjustable manner. Here-with, the second tool carrier 50 may be moved along a linear path of movement. Thus, the at least one link may provide a linear pullout of the second tool carrier 50.

Different operational modes of the construction machine 1 are subsequently described with reference to the Figs. 1 to 6.

Fig. 1 shows the construction machine 1 in an excavator mode being an operational mode of the construction machine 1. In this operational mode, the articulated boom 2 may be arranged in an unlocked configuration such that all boom articulations 61, 63, 65, 67 are unlocked and all arms 62, 64, 66 are movable. In this excavator mode, the excavator bucket 21 may be mounted to the tool mount 3. The loader bucket 11 and the hammer 31 may be carried by the construction machine 1 by depositing them in the tool storage, i.e. in the first tool carrier 10 or in the second tool carrier 50.

Fig. 2 shows the construction machine 1 of Fig. 1 during a step of selecting or picking of the excavator bucket 21 by the tool mount 3 attached to the distal arm 66 of the articulated boom 2 for operation of the construction machine 1 in the excavator mode as shown in Fig. 1. Hereto, the excavator bucket 21 may be taken by the tool mount 3 from a first tool retaining portion 152 of the second tool carrier 50. To allow for such a pickup, the second tool carrier 50 may be pivoted from a stowed position as shown in Fig. 1 to a first changing position. In the first changing position of the second tool carrier 50, the excavator bucket 21 may be picked from the tool carrier 50 by the tool mount 3. Thus, said first changing position is situated in a working space of the articulated boom 2, i.e. at a position that is reachable by the tool mount 3 of the articulated boom 2. The tool mount 3 may snap in the excavator bucket 21 automatically. For reaching the first changing position, the second tool carrier 50 may be pivoted from the stowed position by 90°, as derivable from a comparison of Figs. 1 and 2.

Fig. 3 shows the construction machine 1 in a hammer mode as a further operational mode of the construction machine 1. In this operational mode, the articulated boom 2 may be arranged in an unlocked configuration, in which all boom articulations 61, 63, 65, 67 are movable. The hammer 31 may be mounted on the tool mount 3, and the loader bucket 11 and the excavator bucket 21 may be carried by the construction machine 1.

Fig. 4 shows the construction machine 1 in a step of selecting or picking of the hammer 31 by the tool mount 3 attached to the distal arm 66 of the articulated boom 2 for operation of the construction machine 1 in the hammer mode as shown in Fig. 3. Hereto, the hammer 31 may be taken from a second tool retaining portion 154 of the second tool carrier 50 by the tool mount 3. To allow for such a pickup, the second tool carrier 50 may be pivoted from a stowed position as shown in Fig. 3 to a second changing position. In the second changing position of the tool carrier 50, the hammer 31 may be picked from the tool carrier 50 by the tool mount 3. Thus, said second changing position is situated in a working space of articulated boom 2. The tool mount 3 may snap into the hammer 31 automatically. For reaching the second changing position, the second tool carrier 50 may be pivoted from the stowed position by an angle less than 90°, as derivable from a comparison of Figs. 3 and 4.

Fig. 5 shows the construction machine 1 in a loader mode as a further operational mode of the construction machine 1. In this operational mode, the articulated boom 2 may be arranged in a partly locked configuration, in which the first articulation 61 may be blocked by interlocking the proximal arm 62 of the articulated boom 2 with the upper structure 5 and/or the machine frame 6 of the construction machine 1. In the loader mode, the articulated boom 2 may be de facto a two-armed boom. The loader bucket 11 may be mounted to the tool mount 3, and the excavator bucket 21 and the hammer 31 may be carried by the construction machine 1.

Fig. 6 shows the construction machine 1 in a dozer mode as a further operational mode of the construction machine 1. In this operational mode, the articulated boom 2 may be not operated. The construction machine 1 exhibits an identical configuration as that shown in Fig. 6 during a change of the operational mode to an excavator mode. For conducting such a change, the loader bucket 11 may be taken by the tool mount 3 from the first tool carrier 40 by pivoting the upper structure 5 around a vertical rotation axis to move the tool mount 3 of the articulated boom 2 above the loader bucket 11 attached to the first tool carrier 40. The upper structure 5 may be pivoted about 180 degrees from the front of the chassis 4 to the rear of the chassis 4 for picking up the loader bucket 11. The tool mount 3 may snap in the loader bucket 11 automatically. After picking of the loader bucket 11 with the tool mount 3, the upper structure 5 may be rotated by 180 degrees with respect to the chassis 4. Thereafter, the proximal arm 62 may be interlocked with the upper structure 5 and the machine frame 6, respectively, as shown in Fig. 5.

The configuration of the second tool carrier 50 is subsequently described with reference to Figs. 7 to 12. In these figures, only the upper structure 5 of the construction machine 1 together with the second tool carrier 50 is illustrated from above and below. The second tool carrier 50 comprises the positioning cylinder 52 and a tool carrier articulation 54, for example a pivot joint.

The positioning cylinder 52 may be pivotably attached to the machine frame 6 adjacent to the vertical axis of rotation of the upper structure 5 and further pivotably attached to a base plate 55 of the second tool carrier 50. When extending a piston rod 53 of the positioning cylinder 52, the second tool carrier 50 may be pivoted outwardly to at least one changing position, i.e. to the first and second changing positions, and when retracting the piston rod 53, the second tool carrier 50 may be pivoted back inwardly into its stowed position.

For providing a defined pivoting movement of the second tool carrier 50 by means of the positioning cylinder 52, the tool carrier articulation 54 of the second tool carrier 50 may be arranged on the upper structure 5 and the machine frame 6, respectively. The second tool carrier 50 may be hinged to the tool carrier articulation 54 via a hinging portion 156, which may be attached to the base plate 55 and may be constructed as a pivot arm 157 for providing said pivoting movement. As described above, this may also be realized with a four-bar linkage.

Figs. 7 and 8 show the second tool carrier 50 in a stowed position, in which the second tool carrier 50 is accommodated in the upper structure 5 and the machine frame 6, respectively. Specifically, in the stowed position, the second tool carrier 50 is positioned in the frame recess 8 within the upper structure 5 and the machine frame 6, respectively. Said frame recess 8 can be seen from above in Figs. 10 and 12, for example. If the second tool carrier 50 is in said stowed position, the construction machine 1 may be in a loader mode, in which the excavator bucket 21 and the hammer 31 may be carried by the tool carrier 50 as shown in Fig. 8. The stowed position of the second tool carrier 50 may also be defined as an initial position of a tool exchange process.

Figs. 9 and 10 show the second tool carrier 50 in the first changing position, in which the second tool carrier 50 is pivoted outwardly and away from the machine frame 6. This first changing position may be an alignment condition, in which a hammer 31 that is provided on the second tool carrier 50 may be picked up with the tool mount 3 of the articulated boom 2 (both not shown). By picking the hammer 31 with the articulated boom 2 from the second tool carrier 50, the operational mode of the construction machine 1 may be changed to a hammer mode. In said hammer mode, the excavator bucket 21 may still be carried on the second tool carrier 50.

Figs. 11 and 12 show the second tool carrier 50 in the second changing position pivoted outwardly and away from the machine frame 6. This second changing position may be an alignment condition, in which an excavator bucket 21 that is provided on the

second tool carrier 50 may be picked up with the tool mount 3 of the articulated boom 2 (both not shown). By picking the excavator bucket 21 from the second tool carrier 50, the operational mode of the construction machine 1 may be changed to an excavator mode. In said excavator mode, the hammer 31 may still be carried on the second tool carrier 50.

Figs. 13 to 18 show the second tool carrier 50 with and without tools 20, 30. The excavator bucket 21 and the hammer 31 may be arranged adjacent to each other on the second tool carrier 50, wherein the excavator bucket 21 may be arranged next to the positioning cylinder 52 and the hammer 31 may be arranged next to the hinging portion 156. The excavator bucket 21 and the hammer 31 may be situated at opposite portions of the tool carrier 50. In the stowed position of the second tool carrier 50, the excavator bucket 21, i.e. a symmetry plane thereof, may be arranged perpendicular to a working plane of the articulated boom 2, in which the proximal arm 62, the intermediate arm 64 and the distal arm 66 of the articulated boom 2 are moved. The hammer 31 may be arranged obliquely with respect to the excavator bucket 21 in a top view from above. Furthermore, the tools 21, 31 may be arranged on the second tool carrier 50 in such a way that they are aligned, i.e. such that a symmetry plane thereof is parallel, with the working plane of the articulated boom 2 in the first (excavator bucket 21) and second changing positions (hammer 31), respectively, as illustrated in Figs. 2, 4, 10 and 12.

Alternatively, with respect to the arrangement of the excavator bucket 21 and the hammer 31 on the second tool carrier 50, the excavator bucket 21 may be arranged next to the hinging portion 156 and the hammer 31 may be arranged next to the positioning cylinder 52 (this arrangement is not shown). The excavator bucket 21 and the hammer 31 may be arranged in an interchanged manner as shown and described above. Also in this alternative arrangement, in the stowed position of the second tool carrier 50, the excavator bucket 21, i.e. a symmetry plane thereof, may be arranged perpendicular to the working plane of the articulated boom 2. However, it is also possible that the excavator bucket 21 is arranged obliquely with respect to the working plane of the articulated boom 2 in the stowed position of the second tool carrier 50. The hammer 31 may be arranged obliquely with respect to the excavator bucket 21 in a top view from above. In an embodiment, a symmetry plane of the hammer 31 is arranged obliquely with respect to a symmetry plane of the excavator bucket 21 in said top view. Furthermore, also in this alternative arrangement, the tools 21, 31 may be arranged on the second tool carrier 50 in such a way that they are aligned, i.e. such that a symmetry plane thereof is parallel, with the working plane of the articulated boom 2 in the first (excavator bucket 21) and second changing positions (hammer 31), respectively. In this alternative arrangement, for reaching the first changing position, the second tool carrier 50 may be pivoted from the stowed position by an angle of 90°, as described above. However, for reaching the second changing position in this alternative arrangement, the second tool carrier 50 may be pivoted from the stowed position by an angle larger than 90°. This alternative arrangement may be advantageous, as the construction machine 1 might be operated more often with the excavator bucket 21 than with the hammer 31, the arrangement of the excavator bucket 21 next to the hinging portion 156 allowing for quick installation. This alternative arrangement of the tools 21, 31 on the second tool carrier 50 may further improve visibility of a driver sitting in the driver cabin 9.

The second tool carrier 50 may have two tool retaining portions 152, 154. The excavator bucket 21 may be carried at the first tool retaining portion 152 and the hammer 31 may be carried at the second tool retaining portion 154. The base plate 55 may be divided into said two retaining portions 152, 154. Within the first tool retaining portion 152, a seating 56 may be provided for supporting an excavator bucket 21. The seating 56 may comprise an inclined surface for accommodating the excavator bucket 21.

For securing the tools, the second tool carrier 50 may comprise clamping means 153, 155 for holding the tools. A first clamping means 153 may be provided as a clamp on the first tool retaining portion 152 for holding the excavator bucket 21 and a second clamping means 155 may be provided as a further clamp on the second tool retaining portion 154 for holding the hammer 31. Both clamping means 153, 155 may be actuated by a hydraulic cylinder 151. The first clamping means 153 may be of a pusher-type or pestle-type to exert a pressing force onto the excavator bucket 21 against the seating 56. The second clamping means 155 may be of a pliers-type to exert a holding or pressing force onto the hammer 31 from two opposite sides thereof.

For securing the loader bucket 11 to the first tool carrier 40, an interface might be provided on the machine frame 6, which may comprise at least one element for engaging with the loader bucket 11. For example, pins are driven into a wedge for realizing the engagement.

Figs. 19 to 22 show an arrangement 100 comprising at least part of the machine frame 6, the articulated boom 2, which is pivotably attached to the machine frame 6, and a locking device 70. The articulation 61 of the proximal arm 62 of the articulated boom 2 may be arranged at the front portion of the machine frame 6 and the locking device 70 may be arranged at the rear portion of the machine frame 6. The distance lying therebetween may substantially correspond to the length of the proximal arm 62.

Furthermore, Figs. 19 to 22 show a folded-in position of the proximal arm 62 and the intermediate arm 64 of the articulated boom 2, wherein the machine frame 6 and the proximal arm 62 as well as the proximal arm 62 and the intermediate arm 64 each form an acute angle. Folded in, the first positioning cylinder 82, the second positioning cylinder 84 and the third positioning cylinder 86 of the articulated boom 2 are substantially parallel to each other.

The locking device 70 may comprise a double hook 72 or a single hook (not shown) and an arm support 74. The arm support 74 provides a rest surface, against which the proximal arm 62 can be supported. The hook 72 may be actuated by a hydraulic cylinder 73. The hook 72 may be arranged to engageable with a pin 89 that is mounted to the proximal arm 62. Besides, the pin 89 may primarily serve for fixing a piston rod eye 90 of the first positioning cylinder 82 of the proximal arm 62.

Figs. 19 and 20 show an unhooked condition, in which the hook 72 does not engage with the pin 89. However, the proximal arm 62 rests on the arm support 74 allowing for hooking up of the hook 72. In this unhooked condition, the articulated boom 2 may be operated as a three-armed boom, for example in the excavator or hammer mode.

Figs. 21 and 22 show a hooked-up condition, in which the hook 72 engages with the pin 89. The proximal arm 62 rests on the arm support 74 for stabilizing the arrangement 100. Based on this hooked-up condition, the articulated boom 2 may be operated as a two-armed boom, for example in the loader or dozer mode. In this hooked-up condition, the proximal arm 62 is interlocked with the machine frame 6.

According to the embodiments of the present invention as shown in Figs. 1 to 22, a single construction machine 1 may be efficiently operated in several different operational modes as a plurality of tools 10, 20, 30 is directly provided on the machine body. These tools may be automatically changed by utilizing the second tool carrier 50, wherein a multiple-armed boom 2 may be partly blocked to allow for variable boom operations tailored to the different operational modes of the construction machine 1.

Fig. 23 shows a first electric operation system 200 of the construction machine 1 according to an embodiment. The first electric operation system 200 comprises a battery pack 110 and a plurality of electric motors 122, 124, 126, e.g. three electric motors 122, 124, 126. The battery pack 110 is electrically connected to the electric motors 122, 124, 126 for supplying electric power to the electric motors 122, 124, 126. The battery pack 110 may comprise three batteries 112, 114, 116 that are electrically interconnected in the battery pack 110. Each battery 112, 114, 116 of the battery pack 110 may be configured to power each electric motor 122, 124, 126. The battery pack 110 may be part of the upper structure 5 of the construction machine 1 and may further function as a counterweight of the construction machine 1.

The first electric operation system 200 of the construction machine 1 comprises a battery pack controller 118 for controlling a charging and/or a discharging of each battery 112, 114, 116 of the battery pack 110 during an operational mode, e.g. during the loader mode and/or during the excavator mode. The electric motors 122, 124, 126 may be controlled by an electric motor controlling system 120. The electric motor controlling system 120 may comprise electric motor controllers 121, 123, 125 for respectively controlling an electric motor 122, 124, 126 of the first electric operation system 200.

A first electric motor 122 of the plurality of electric motors 122, 124, 126 of the first electric operation system 200 may be controlled by a first electric motor controller 121 for operating a ground drive 13 of the construction machine 1. The ground drive 13 may be a wheel-drive or a chain-drive for moving the construction machine 1 on the ground. The electric motor controller 121, the electric motor 122 and/or the ground drive 13 may be arranged on the chassis 4 of the construction machine 1.

A second electric motor 124 of the plurality of electric motors 122, 124, 126 of the first electric operation system 200 may be controlled by a second electric motor controller 123 for operating the swing drive 12 of the construction machine 1. The second electric motor controller 123, the second electric motor 124 and/or the swing drive 12 may be arranged on the chassis 4 and/or on the upper structure 5 of the construction machine 1.

A third electric motor 126 of the plurality of electric motors 122, 124, 126 of the first electric operation system 200 may be controlled by a third electric motor controller 125 for operating the articulated boom 2 of the construction machine 1. The articulated boom 2 may be operated via a hydraulic pump 131 for hydraulically operating the articulated boom 2. The hydraulic pump 131 may be actuated electrically by the third electric motor 126. The articulated boom 2 may thus be electro-hydraulically operated by the third electric motor 126. The third electric motor controller 125, the third electric motor 126 and/or the hydraulic pump 131 may be arranged on the upper structure 5 and/or on the articulated boom 2 of the construction machine 1. The proximal arm 62, the intermediate arm 64 and/or the distal arm 66 may be operated via the hydraulic pump 131 for operating the articulated boom 2 in the loader mode and/or in the excavator mode.

Fig. 24 shows a second electric operation system 300 of the construction machine 1 according to further embodiment. The second electric operation system 300 shown in Fig. 24 may be combined with at least one component of the first electric operation system 200 shown in Fig. 23 or vice versa.

The second electric operation system 300 comprises a battery pack 110, which may be the battery pack 110 shown in Fig. 23 and two electric motors 128, 130. The battery pack 110 is electrically connected to the electric motors 128, 130 for supplying electric power to the electric motors 128, 130. Each battery of the battery pack 110 may be configured to power each electric motor 128, 130 of the second electric operation system 200. The electric motors 128, 130 may be controlled by an electric motor controlling system 120. The electric motor controlling system 120 may comprise electric motor controllers 127, 129 for respectively controlling an electric motor 128, 130 of the second electric operation system 300. The electric motor controlling system 120 may be combined with the electric motor controlling system 120 shown in Fig. 23 or vice versa.

A first electric motor 128 of the plurality of electric motors 128, 130 of the second electric operation system 300 may be controlled by a first electric motor controller 127 for operating the first tool carrier 40 of the construction machine 1. The electric motor controller 127 and/or the electric motor 128 may be arranged on the chassis 4 of the construction machine 1.

A second electric motor 130 of the plurality of electric motors 128, 130 of the second electric operation system 300 may be controlled by a second electric motor controller 129 for operating the second tool carrier 50 of the construction machine 1. The electric motor controller 129 and/or the electric motor 130 may be arranged on the machine frame 6 of the construction machine 1.

Fig. 25 shows a third electric operation system 400 of the construction machine 1 according to a further embodiment. The third electric operation system 400 shown in Fig. 25 may be combined with at least one component of the first electric operation system 200 shown in Fig. 23 and/or with at least one component of the second electric operation system 300 shown in Fig. 24 or vice versa. The third electric operation system 400 corresponds to the second electric operation system 300 shown in Fig. 24 except for the differences outlined below.

In this third electric operation system 400, the first tool carrier 40 may be operated via a hydraulic pump 132 for hydraulically operating the first tool carrier 40. The hydraulic pump 132 may be actuated electrically by the first electric motor 128. The first tool carrier 40 may thus be electro-hydraulically operated by the first electric motor 128. The electric motor controller 127, the electric motor

128 and/or the hydraulic pump 132 may be arranged on the chassis 4 of the construction machine 1. The second tool carrier 50 may be operated via a hydraulic pump 134 for hydraulically operating the second tool carrier 50. The hydraulic pump 134 may be actuated electrically by the second electric motor 130. The second tool carrier 50 may thus be electro-hydraulically operated by the electric motor 130. The electric motor controller 129, the electric motor 130 and/or the hydraulic pump 134 may be arranged on the machine frame 6 of the construction machine 1. The hydraulic pumps 132, 134 may be embodied by a single hydraulic pump unit or may be multiple hydraulic pump units.

Each component of the first tool carrier 40 described may thus also be powered indirectly via a hydraulic pump 132 or by an electric motor 128. Also each component of the second tool carrier 50 described may thus be powered indirectly via a hydraulic pump 134 or by an electric motor 130.

REFERENCE SIGNS

1	construction machine
2	articulated boom
3	tool mount
4	chassis
5	upper structure
6	machine frame
7	recess
8	frame recess
9	cabin
10	first tool
11	loader bucket
12	swing drive
13	ground drive
15	engine-hydraulic unit
16	counterweight
20	second tool
21	excavator bucket
30	third tool
31	hammer
40	first tool carrier
50	second tool carrier
52	positioning cylinder
53	piston rod
54	tool carrier articulation
55	base plate
56	seating
61	first articulation
62	proximal arm
63	second articulation
64	intermediate arm
65	third articulation
66	distal arm
67	fourth articulation
70	locking device

72	hook
73	hydraulic cylinder
74	arm support
82	first positioning cylinder
84	second positioning cylinder
86	third positioning cylinder
88	fourth positioning cylinder
89	pin
90	piston rod eye
100	arrangement
110	battery pack
112	battery
114	battery
116	battery
118	battery pack controller
120	electric motor controlling system
121	electric motor controller
122	electric motor
123	electric motor controller
124	electric motor
125	electric motor controller
126	electric motor
131	hydraulic pump
132	hydraulic pump
134	hydraulic pump
151	hydraulic cylinder
152	first tool retaining portion
153	first clamping means
154	second tool retaining portion
155	second clamping means
156	hinging portion
157	pivot arm
200	first electric operation system
300	second electric operation system
400	third electric operation system

CLAIMS

1. Construction machine (1), comprising
a chassis (4);
an upper structure (5) comprising a machine frame (6), which is pivotably mounted to the chassis (4);
at least one battery (112) and at least one electric motor (126), which is connected to the at least one battery (112) for operating at least one component of the construction machine (1);
wherein the at least one battery (112) and/or the at least one electric motor (126) is arranged at the chassis (4) and/or the upper structure (5); and
an articulated boom (2), which is pivotably mounted to the machine frame (6);
the construction machine (1) being configured to be operated in a loader mode in which a first tool (10) is mounted to the articulated boom (2), and in an excavator mode in which a second tool (20) is mounted to the articulated boom (2);
wherein the construction machine (1) further comprises a tool storage (40, 50) for storing the first tool (10) and/or the second tool (20);
wherein the tool storage (40, 50) comprises a first tool carrier (40) adapted to carry the first tool (10) and a second tool carrier (50) adapted to carry the second tool (20);
wherein the first tool carrier (40) is arranged at the chassis (4) and the second tool carrier (50) is arranged at the machine frame (6); and
wherein the construction machine (1) is configured to replace one of the first tool (10) and second tool (20) when mounted to the articulated boom (2) with the other one of the first tool (10) and second tool (20) when stored in the tool storage (40, 50).
2. Construction machine (1) according to claim 1,
wherein the chassis (4), the upper structure (5) and/or the articulated boom (2) is operable by the at least one electric motor (122, 124, 126).
3. Construction machine (1) according to claim 1 or 2, further comprising
a hydraulic pump (131) for operating at least one hydraulic actuator for hydraulically actuating the at least one component of the construction machine (1);
wherein the hydraulic pump (131) is drivable by the at least one electric motor (126).
4. Construction machine (1) according to any one of the preceding claims,
wherein the first tool carrier (40) and/or the second tool carrier (50) is powered by the at least one battery (112) and the at least one electric motor (128, 130).
5. Construction machine (1) according to any one of the preceding claims,
wherein the first tool carrier (40) or the second tool carrier (50) comprises retaining means for holding the first tool (10) or second tool (20);
wherein the retaining means in particular comprise at least one electrically driven pin for engaging with the first tool (10) or second tool (20).
6. Construction machine (1) according to one of the preceding claims, comprising
a first tool (10) mountable to the articulated boom (2) in the loader mode; and
a second tool (20) mountable to the articulated boom (2) in the excavator mode.
7. Construction machine (1) according to claim 6,
wherein the first tool (10) is a loader bucket (11) and the second tool (20) is an excavator bucket (21).
8. Construction machine (1) according to any one of the preceding claims,
wherein the tool storage (40, 50) is further configured to simultaneously store a third tool (30).
9. Construction machine (1) according to any one of the preceding claims, comprising
a third tool (30) mountable to the articulated boom (2) in the excavator mode;
wherein the third tool (30) is in particular a hammer (31).
10. Construction machine (1) according to any one of the preceding claims,
the articulated boom (2) comprising multiple, optionally three, arms pivotably connected in series to each other;

wherein the construction machine (1) further comprises

a locking device (70) for selectively locking the arm of the articulated boom (2), which is directly connected to the machine frame (6), so as to block any relative movement between said arm and the machine frame (6) in the loader mode.

11. Method of changing an operational mode of a construction machine (1) with a chassis (4);
an upper structure (5) comprising
 - a machine frame (6), which is pivotably mounted to the chassis (4),
 - at least one battery (112), and
 - at least one electric motor (126), which is connected to the at least one battery (112); andan articulated boom (2);
the construction machine (1) optionally being the construction machine according to any one of claims 1 to 10;
comprising the steps:
operating the articulated boom (2) by the electric motor (126);
depositing, by the articulated boom (2), a tool for one of a first and second operational modes that is mounted to the articulated boom (2); and
subsequently picking, by the articulated boom (2), a tool for the other one of the first and second operational modes from a tool storage (40, 50) provided on the construction machine (1), wherein the tool storage (40, 50) comprises a first tool carrier (40) adapted to carry the tool and arranged at the chassis (4) and a second tool carrier (50) adapted to carry the tool and arranged at the machine frame (6).
12. Method according to claim 11,
wherein the tool is deposited in the tool storage (40, 50).
13. Method of selecting an operational mode of a construction machine (1) with a chassis (4);
an upper structure (5) comprising
 - a machine frame (6), which is pivotably mounted to the chassis (4),
 - at least one battery (112), and
 - at least one electric motor (126), which is connected to the at least one battery (112); andan articulated boom (2);
the construction machine (1) being operable in a first operational mode and a second operational mode, which is different from the first operational mode, wherein the first operational mode is in particular a loader mode and the second operational mode is in particular an excavator mode;
the construction machine (1) optionally being the construction machine according to any one of claims 1 to 10;
comprising the steps:
simultaneously providing a first tool (10) for the first operational mode and a second tool (20) for the second operational mode on the construction machine (1);
operating the articulated boom (2) by the electric motor (126); and
selecting and picking one of the first tool (10) and second tool (20) by the articulated boom (2) for operation of the construction machine (1) in the first or second operational mode from a tool storage (40, 50) provided on the construction machine (1), wherein the tool storage (40, 50) comprises a first tool carrier (40) adapted to carry the first tool (10) and arranged at the chassis (4) and a second tool carrier (50) adapted to carry the second tool (20) and arranged at the machine frame (6).
14. Method according to any one of claims 11 to 13, further comprising
locking an arm (62) of the articulated boom (2) that is directly connected to a machine frame (6) of the construction machine (1) so as to block any relative movement between said arm (62) and the machine frame (6).
15. Control system that is configured to execute one of the methods according to any one of claims 11 to 14.

Fig. 1

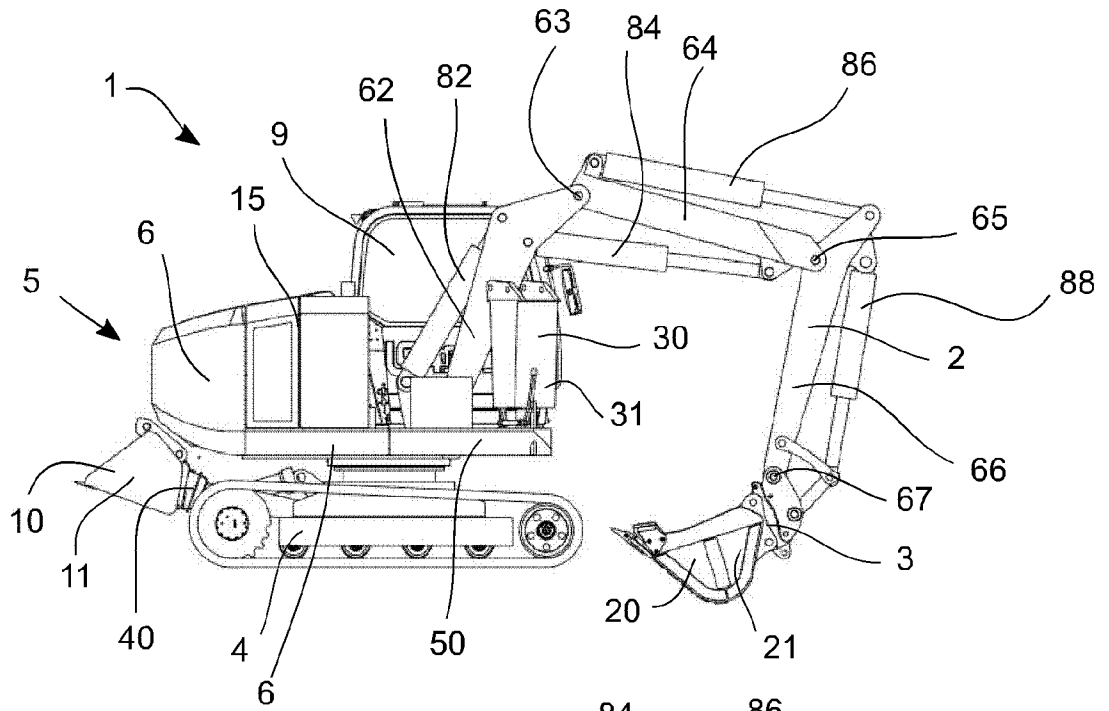


Fig. 2

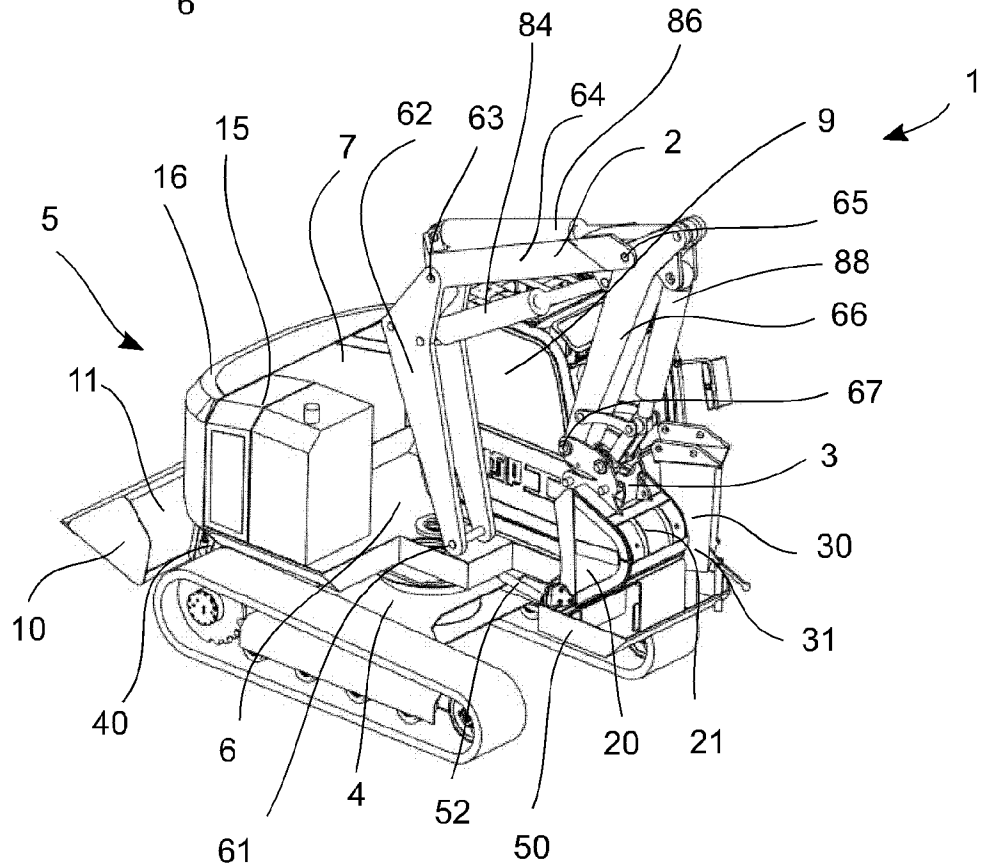


Fig. 3

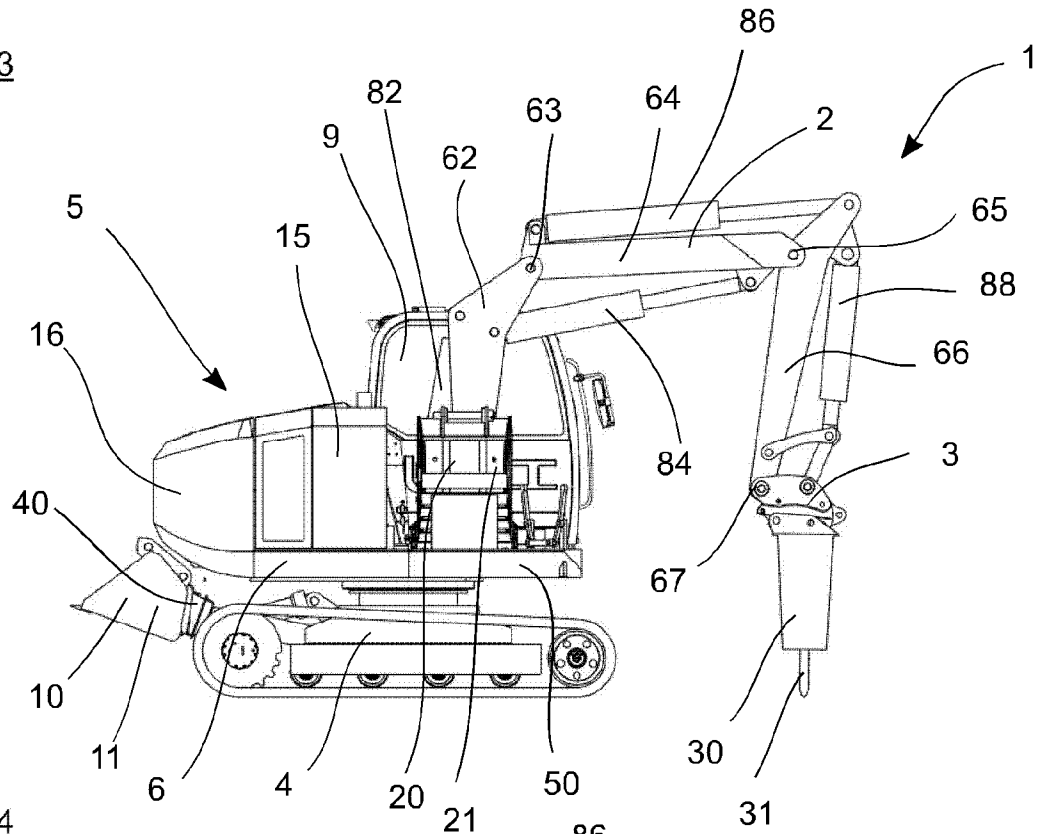


Fig. 4

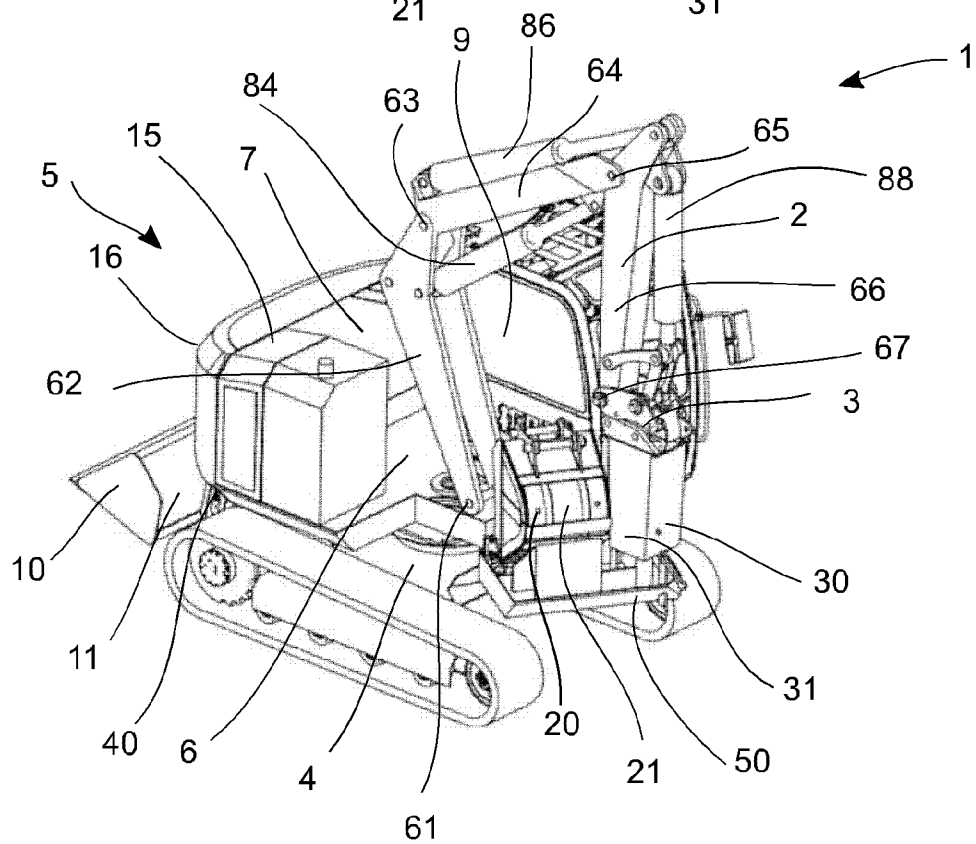


Fig. 5

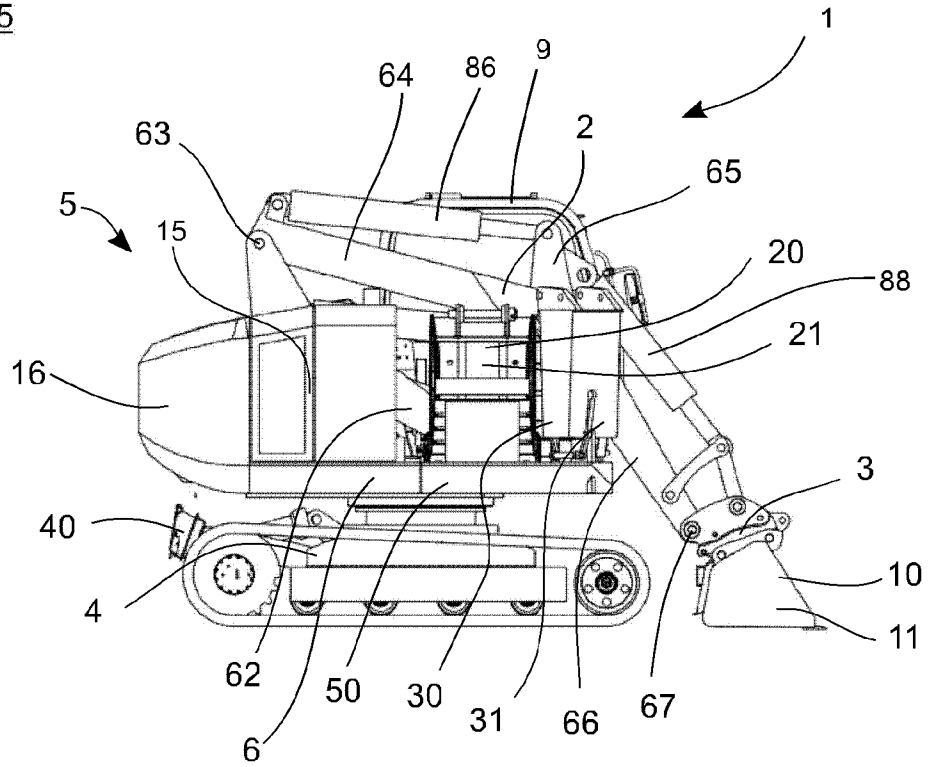


Fig. 6

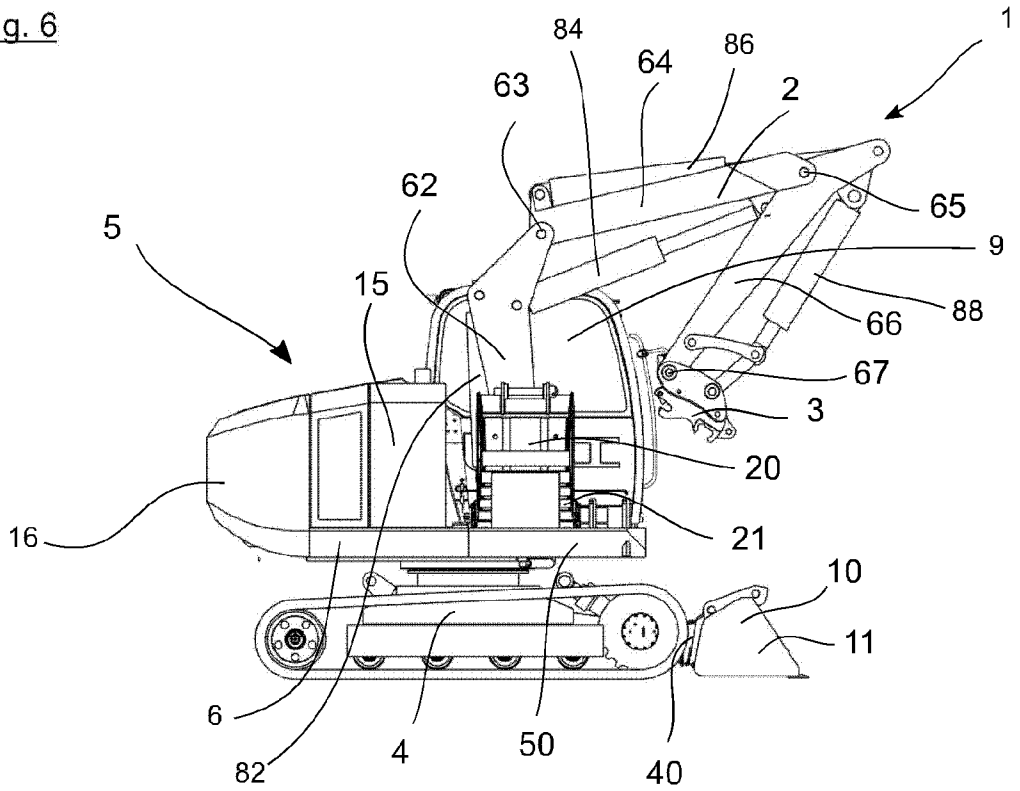


Fig. 7

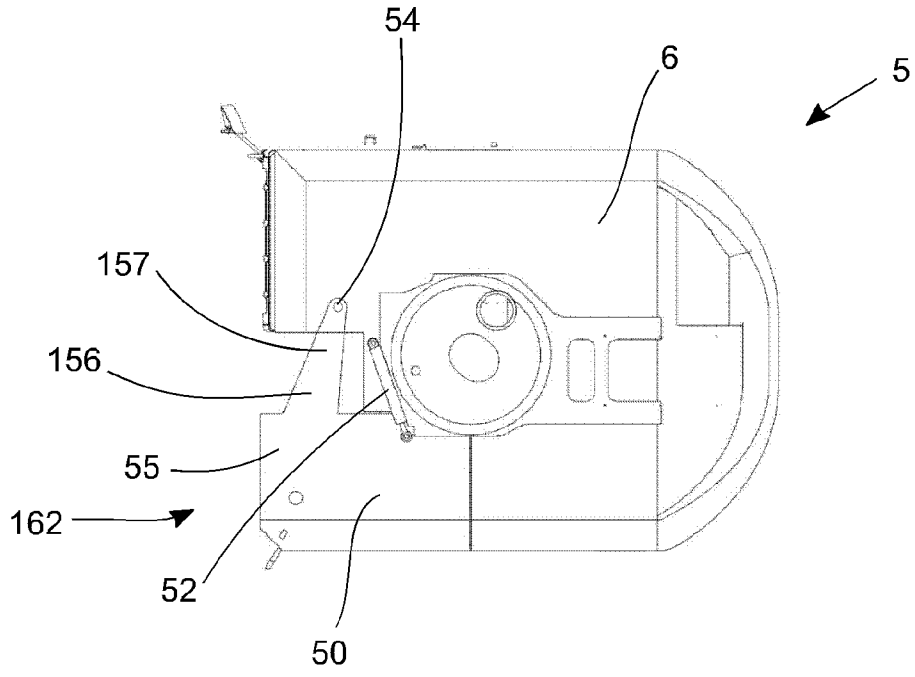


Fig. 8

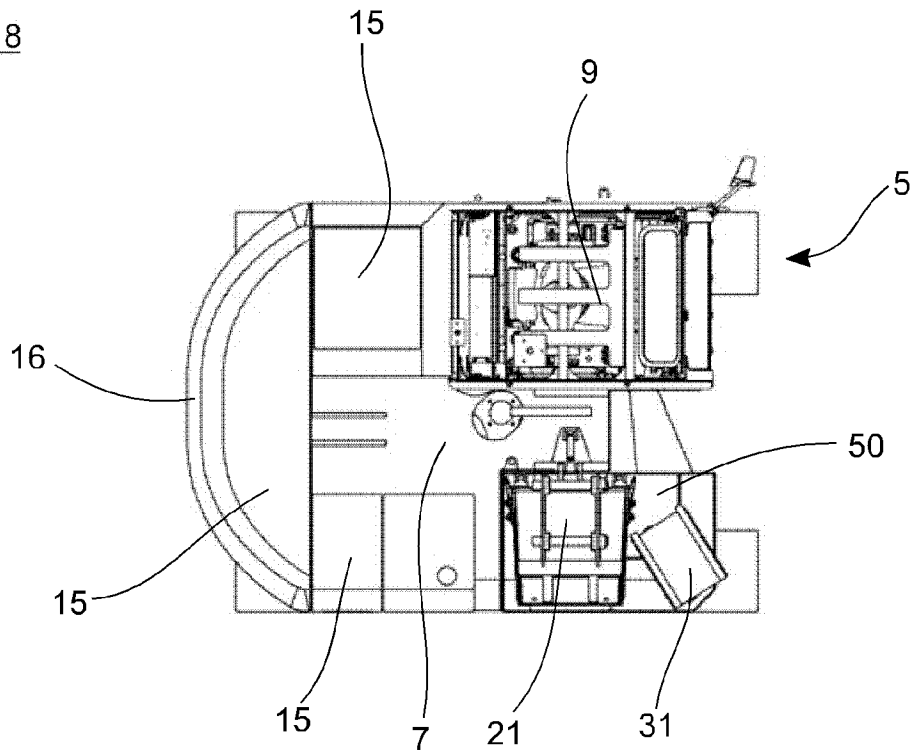


Fig. 9

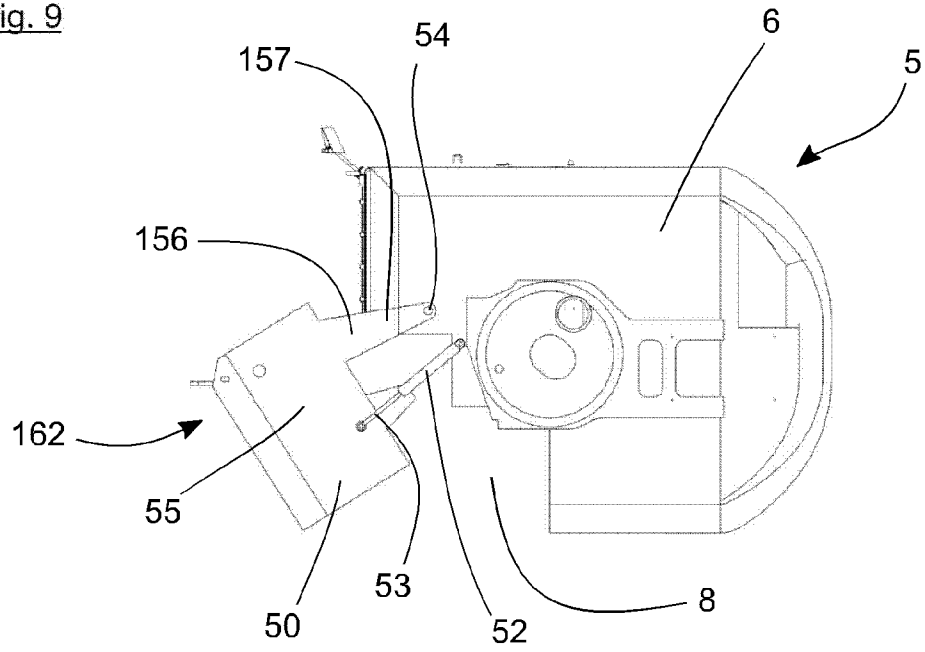


Fig. 10

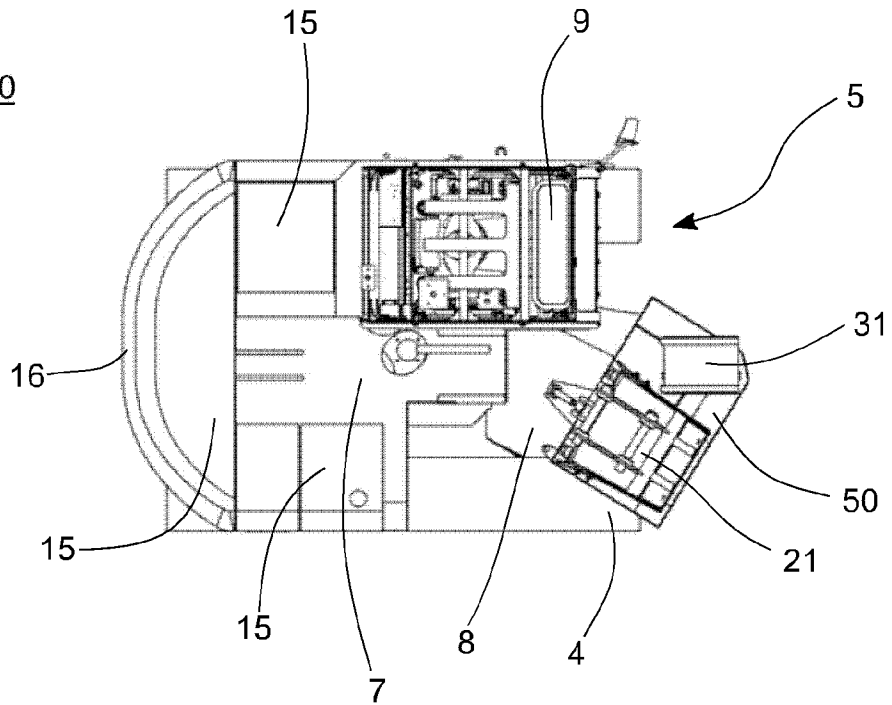


Fig. 11

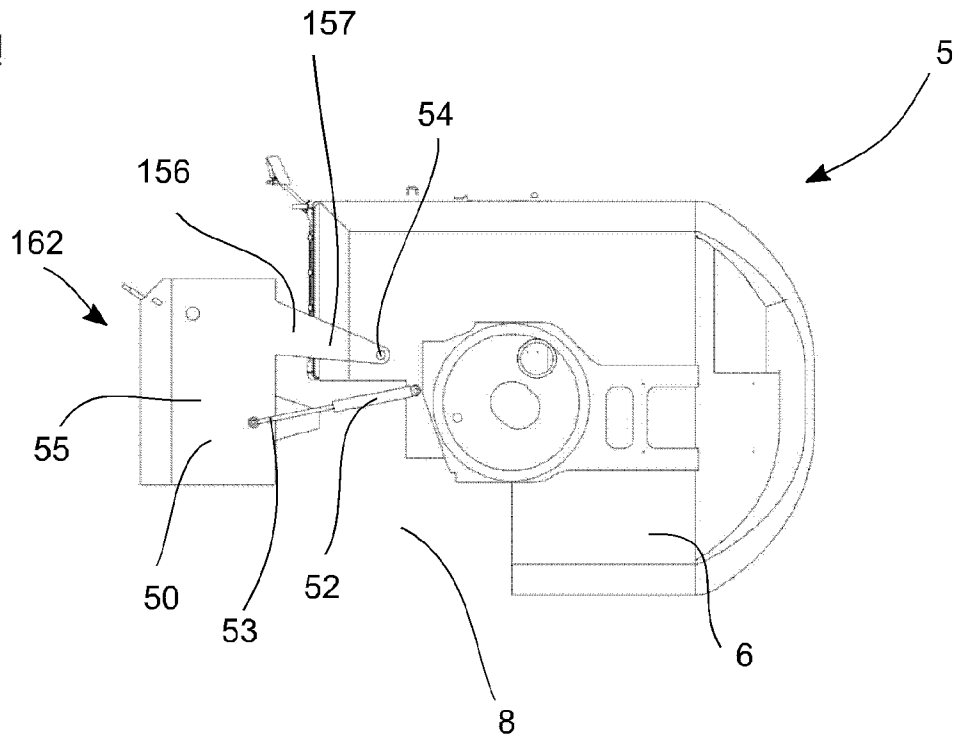
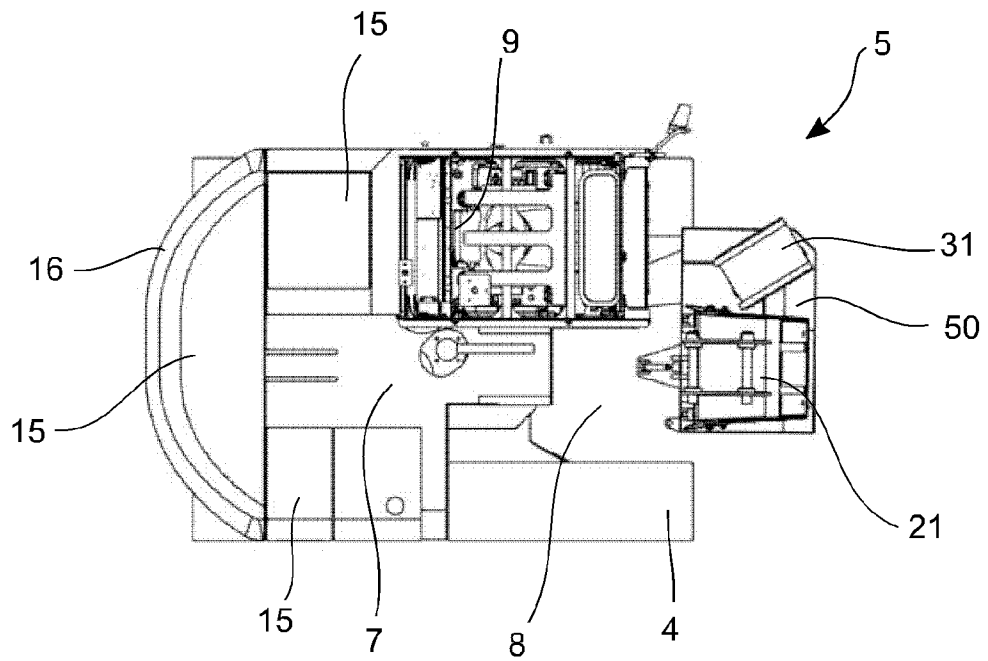


Fig. 12



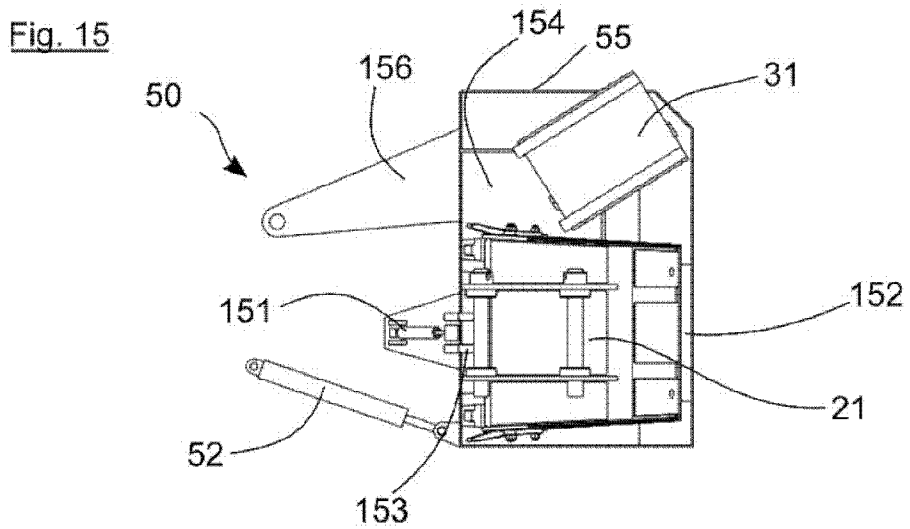
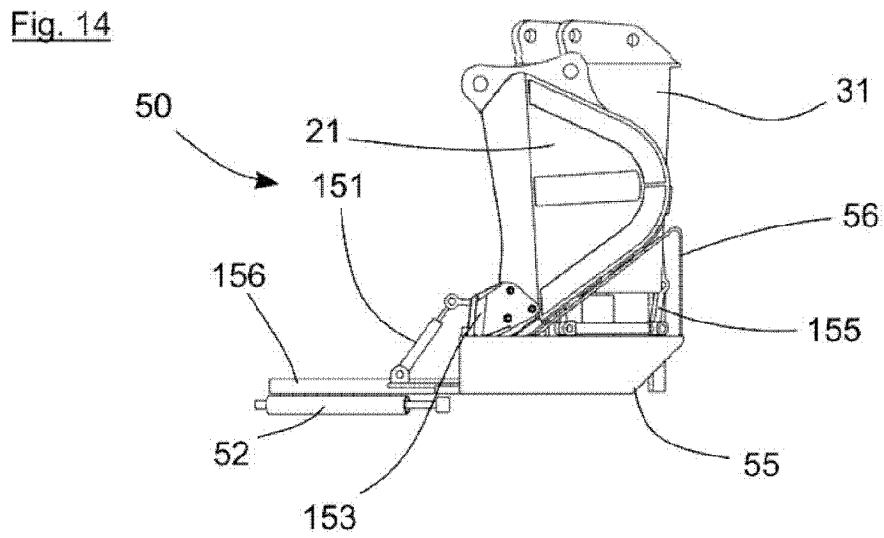
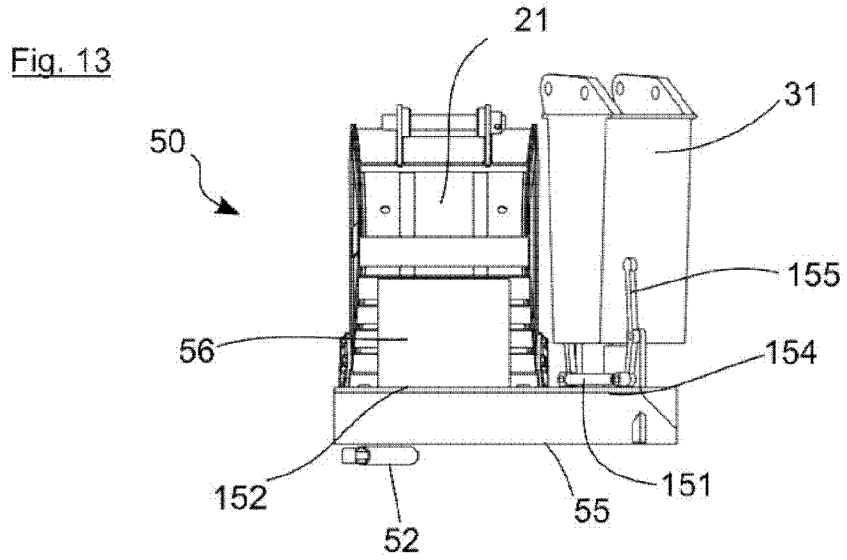


Fig. 16

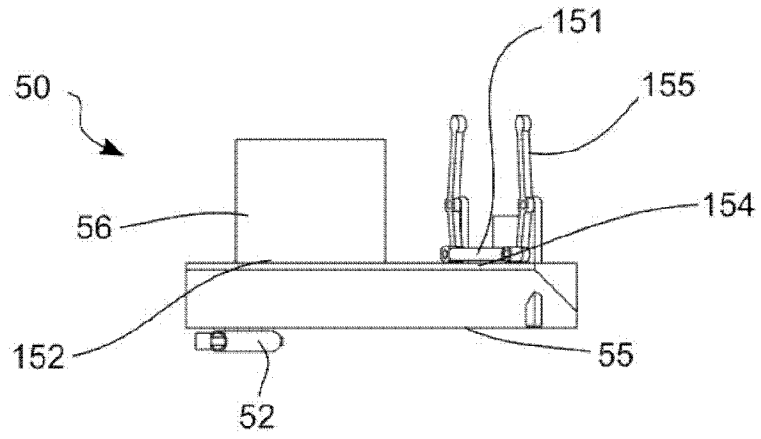


Fig. 17

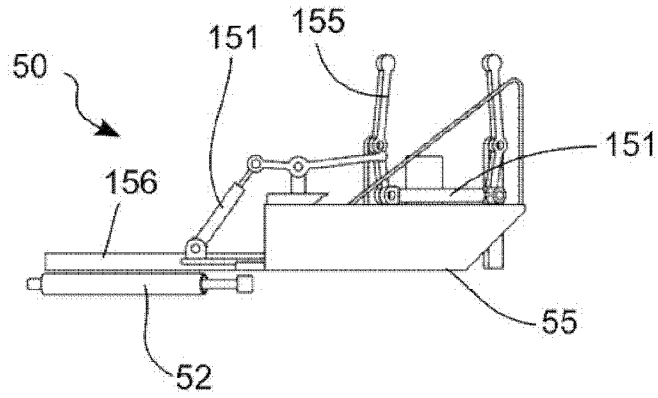


Fig. 18

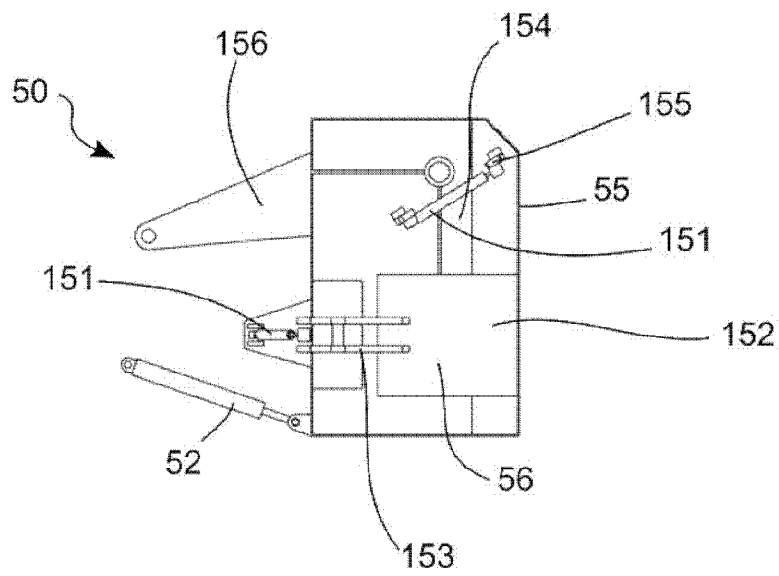


Fig. 19

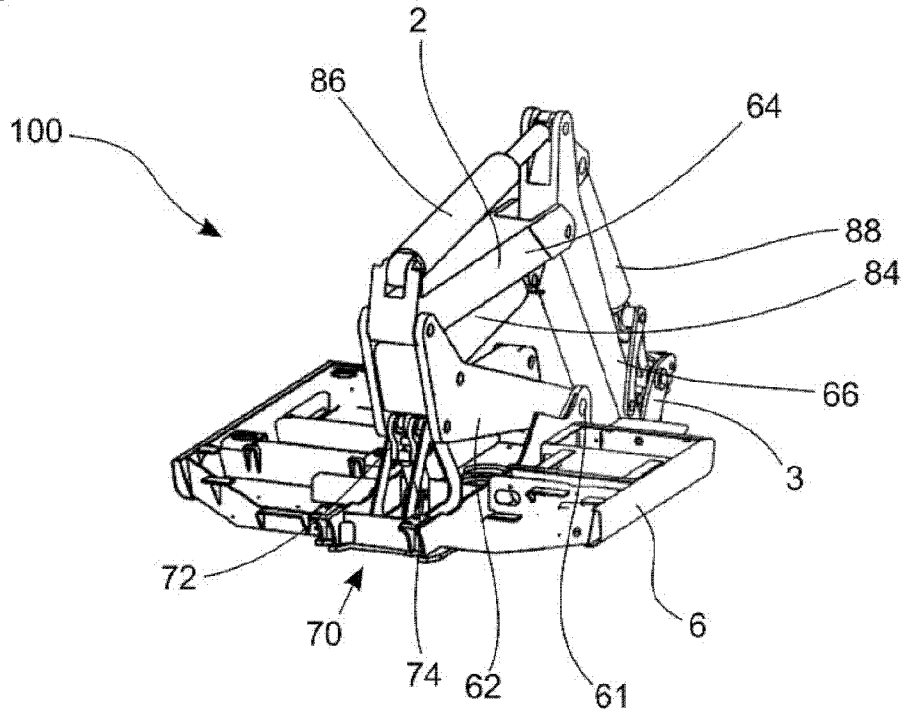


Fig. 20

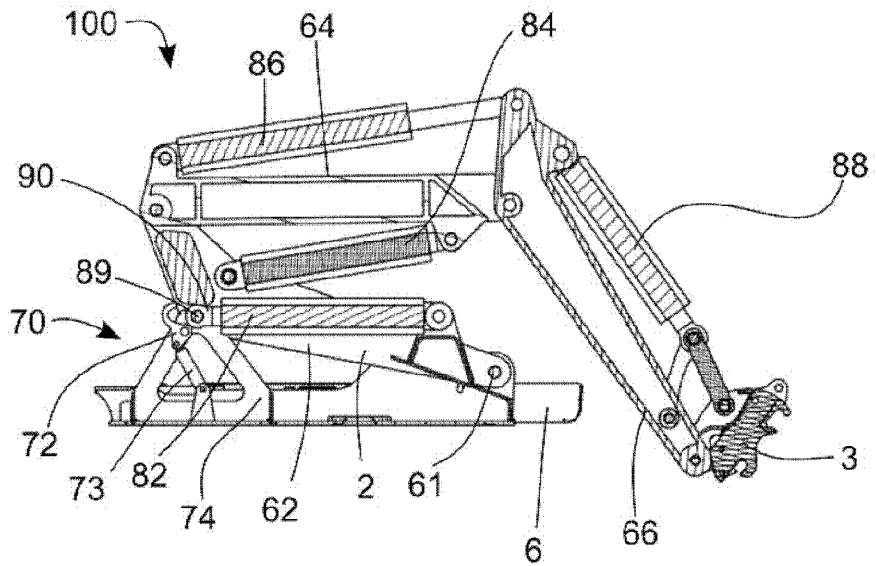


Fig. 21

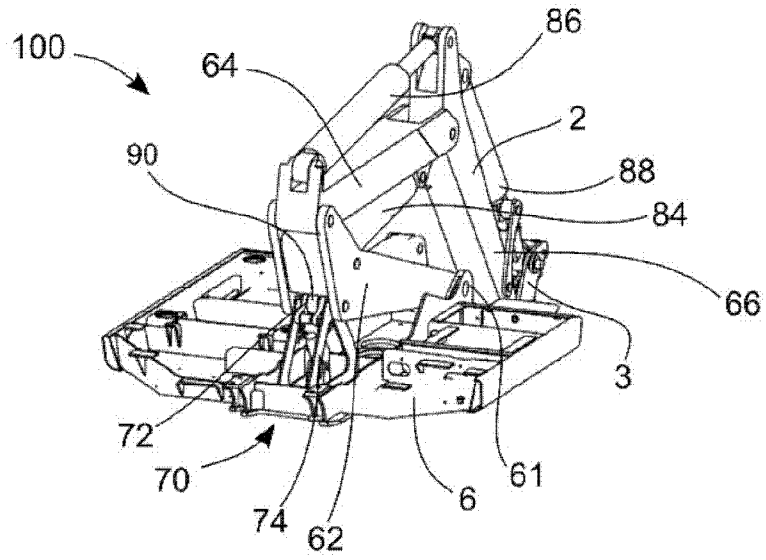


Fig. 22

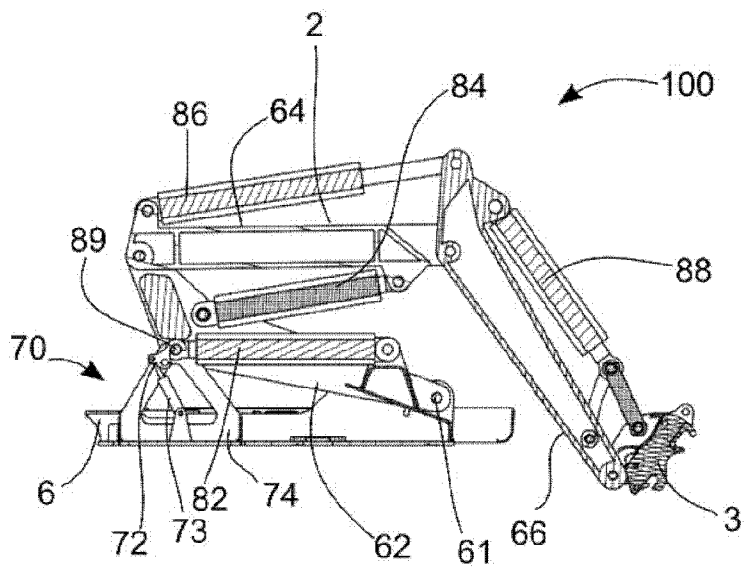


Fig. 23

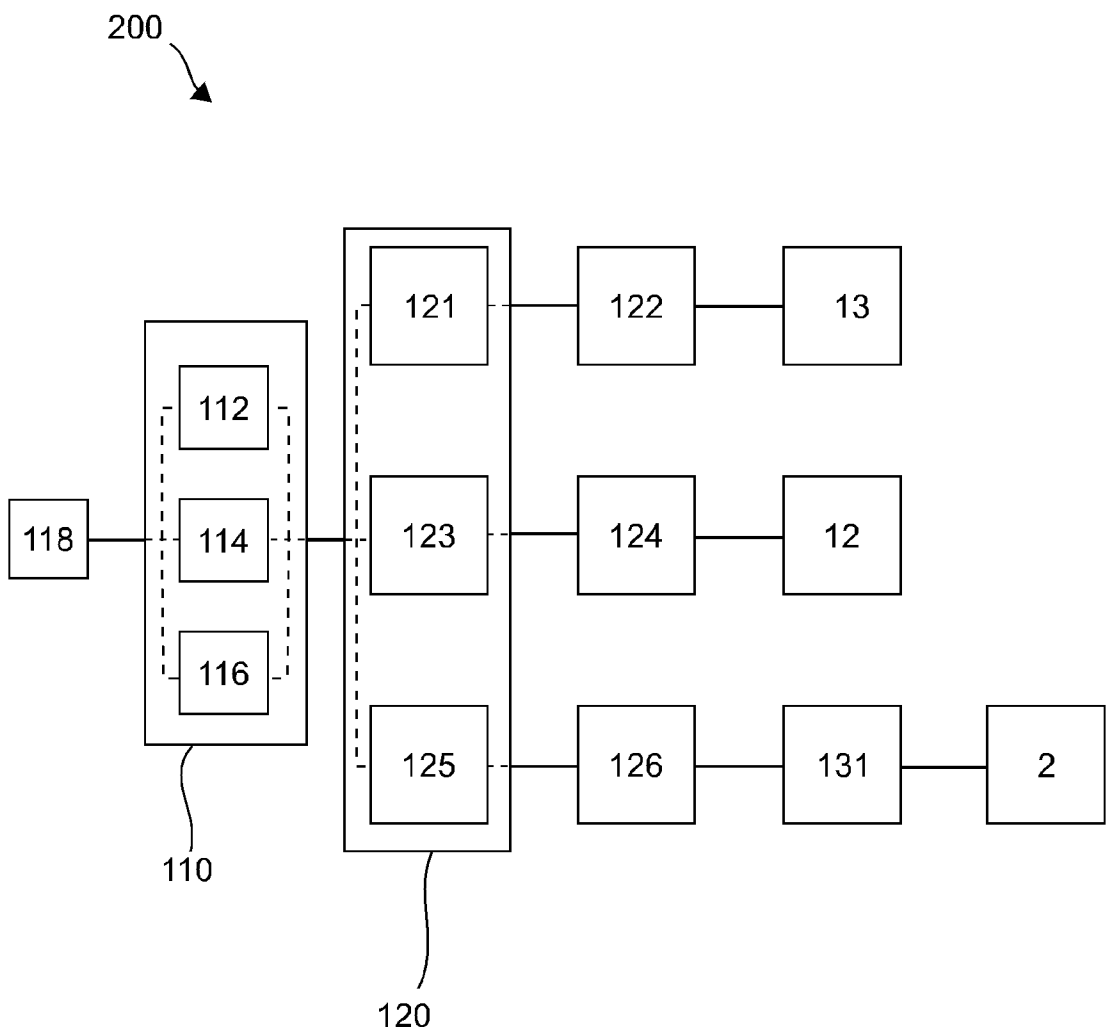


Fig. 24

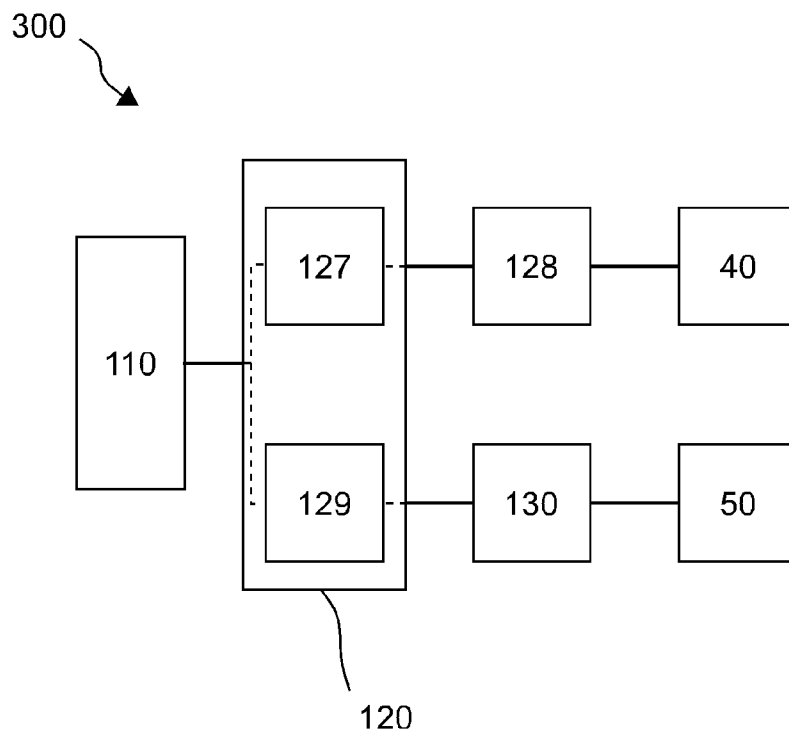
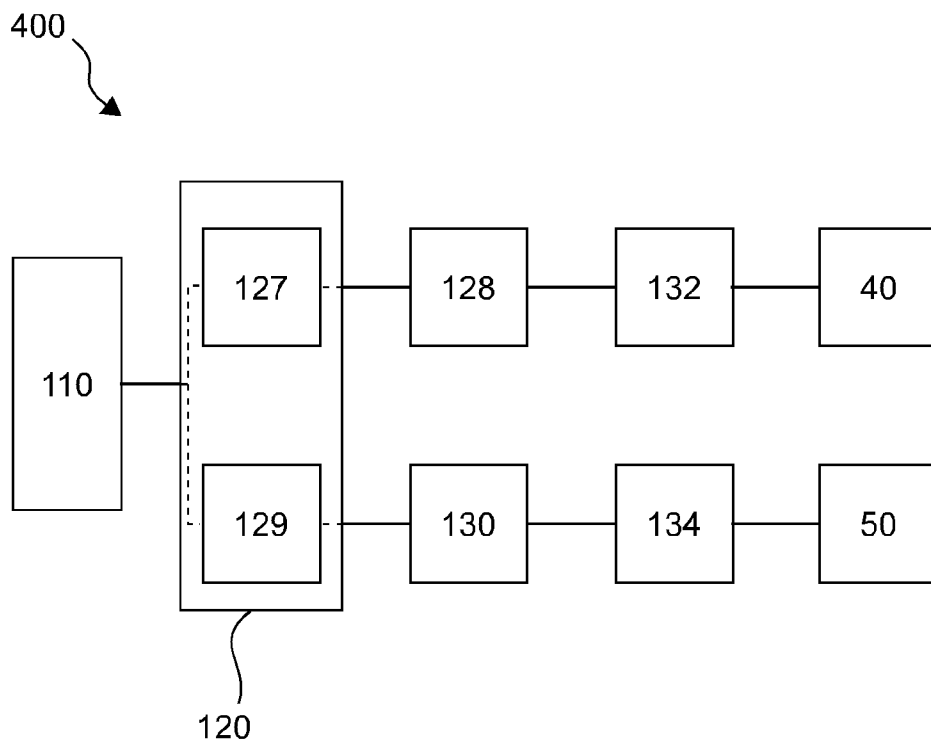


Fig. 25



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/089534

A. CLASSIFICATION OF SUBJECT MATTER		
E02F 3/28(2006.01)i; E02F 3/96(2006.01)j		
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) 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) VEN;SIPOABS;CNABS: construction, machine, chassis, electric motor, boom, load, excavator, mode, change		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 101413279 A (HUNAN SHANHE INTELLIGENT MECHANISM CO LT ET AL.) 22 April 2009 (2009-04-22) description, pages 2-5, figures 1-10	1-15
Y	CN 203613571 U (HU, JUN ET AL.) 28 May 2014 (2014-05-28) description, pages 2 and 3, figure 1	1-15
A	JP 2007146547 A (CATERPILLAR MITSUBISHI LTD) 14 June 2007 (2007-06-14) the whole document	1-15
A	CN 203808123 U (GUIZHOU JONYANG KINETICS CO) 03 September 2014 (2014-09-03) the whole document	1-15
A	CN 105019494 A (UNIV CHONGQING RADIO & TV ET AL.) 04 November 2015 (2015-11-04) the whole document	1-15
A	CN 107002379 A (YOON YOUNG-DUG) 01 August 2017 (2017-08-01) the whole document	1-15
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search 25 June 2019		Date of mailing of the international search report 26 July 2019
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