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(71) Applicant *(for all designated States except US)*: **PRZEMYSŁOWY INSTYTUT MASZYN ROLNICZYCH** [PL/PL]; ul. Starołęcka 31, PL-60-963 Poznań (PL).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **RUTKOWSKI, Janusz** [PL/PL]; Koscielec Kolonia 45, PL-62-831 Korzeniew (PL). **SZYCHTA, Marek** [PL/PL]; Sielinko, ul. Lipowa 13/4, PL-64-330 Opalenica (PL). **IGNASIAK, Lukasz** [PL/PL]; ul. Trauguta 14 a / 26, PL-62-400 Słupca (PL). **BAKIEWICZ, Paweł** [PL/PL]; Adamowo 5, PL-64-117 Chrzypsko Wielkie (PL). **PAWLOWSKI, Tadeusz** [PL/PL]; ul. Grochowska 18/2, PL-60-277 Poznań (PL). **SZCZEPANIAK, Jan** [PL/PL]; oś. Jagiellonskie 12/35, PL-61-227 Poznań (PL).

(74) Agent: **KOWALKIEWICZ, Władysław**; Przemysłowy Instytut Maszyn Rolniczych, ul. Starołęcka 31, PL-60-963 Poznań (PL).

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(54) Title: A METHOD OF CARRYING OUT RENOVATION WORKS IN MELIORATION DITCHES AND A MULTIFUNCTION DEVICE FOR IMPLEMENTATION OF THE METHOD.

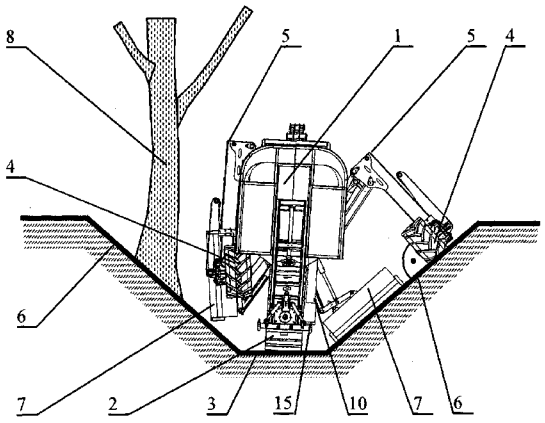

fig. 1

(57) Abstract: A method of carrying out renovation works in melioration ditches by means of a multifunction device, that can move inside a ditch space and avoid terrain obstacles occurring in this space, especially including trees and bushes growing on a ditch slope, a ditch bank or a ditch bottom. It is intended for works related to care for melioration ditches and channels and keeping them in a state of technical functionality. The device comprises one-track travel chassis (2), situated under the main frame (13) in its symmetry axis, whereas the side supports (5) with the supporting wheels (4) are situated on both sides of the main frame (13), while the front tool suspension unit (10) and the hydraulic manipulator (11) are situated in front of the travel chassis (2), whereas the hydraulic manipulator (11) is mounted on the main frame (13), above the front tool suspension unit (10), and there is the tool turn-table (14) at the end of the hydraulic manipulator (11), and furthermore, the rear tool suspension unit (15) is situated behind the travel chassis (2), and the operator cab (11) is situated on the main frame (13), between the hydraulic manipulator (11) and the side supports (5), and the motor aggregate (16) is situated behind the side supports (5).

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A method of carrying out renovation works in melioration ditches and a multifunction device for implementation of the method.

The object of the present invention is a method of carrying out renovation works in melioration ditches and a multifunction device for implementation of this method. The method and the device are intended for carrying out works related to care for melioration ditches and channels and keeping them in a state of technical functionality. The multifunction device can move inside a ditch space and avoid terrain obstacles occurring in this space, especially including trees and bushes growing on a ditch slope, a ditch bank or a ditch bottom.

Many examples of self-propelled devices for realization of operations related to renovation and care for melioration ditches and channels, which are provided with working tools for carrying out renovation operations are known in the art. Mowing grass, cutting down reeds, raking swath and desludging a bottom are considered to be the most often run

renovation operations. Working tools have to be put into a ditch, to the bottom level. These operations require application of active working tools, fastened on self-propelled devices, or use of hydraulic manipulators with working tools installed on them.

A typical self-propelled device known in engineering is a farm tractor. Tractors are provided with hydraulic manipulators, mounted at the front, on the side or at the back of the tractor. During carrying out renovation operations, tractor moves outside a ditch, on a bank strip, and hydraulic manipulator is put out aside and lowered into the ditch. This solution has numerous disadvantages, the most important of them may be cited as follows:

- a bank strip, ditch crown and ditch slopes cannot be wooded in order to eliminate any collision with hydraulic manipulator,

- a bank strip must be made accessible for tractor travel, which on agrotechnical terrains is impossible or considerably limited for a significant part of the year,

- operator's working position is not ergonomic and sometimes even dangerous as the operator has to control a renovation operation from the side or the back in relation to tractor travel direction,

- a tractor cannot move inside a ditch, wherein guiding of working tools would be most advantageous, because its wheels and suspension are not adapted for such travel conditions, and first of all tractor would not fit into narrow ditches and channels onto their bottom.

Another carrier of tools used for renovation works in ditches is construction equipment such as wheel excavators and caterpillar excavators or bulldozer loaders. Mostly they are used for desludging or excavating ditches. Like in the case of farm tractors, these devices are operated on the ground level, showing disadvantages similar to the ones of the tractors, i.e. they require free and accessible space and have dimensions and chassis that make work inside a ditch impossible. Moreover, work of such machines is not continuous, because operation requires performing cyclic working movements by a hydraulic manipulator, and apart from that, machine must stand still during work.

One example of an excavator, which may work inside a ditch is a walking excavator a91 type from Menzi Muck. The walking excavator is provided with four short supporting arms with ground wheels, forming its chassis, and a hydraulic manipulator, mounted rotationally together with a cab on a central frame. The supporting arms may be regulated vertically and horizontally, which enables to adapt their position and chassis width to terrain conditions, also in a ditch space. However, moving the excavator in a difficult terrain is slow and made by stepping, separately for each supporting arm. Therefore, efficiency of such excavator at renovation of ditches is low.

Numerous examples of specialized devices, also such designed for working inside a ditch, are known are also known in the art. One example is a device of 3100 type from German company Berky. The machine moves inside a ditch space in such a way, that it has four short side arms ended with tyred driven wheels, which roll on a slant ditch slope. A

disadvantage of this solution is the fact, that in case of steep slopes, already above the angle of slope of about 45 degrees, work with this machine is dangerous or impossible, as the wheels may slide down a ditch. In case of renovation of uncared-for ditches, often with degraded slopes and, moreover, with trees and bushes growing on it, use of this machine will be impossible.

3100 type Berky machine is provided with hydraulic manipulators, mounted at the front and at the back, for attachment of working tools, which are cutter bar mowers or finger mowers and belt rakes. The mowers are mounted at the front of the machine and they cut grass in front of the machine, while the belt rakes are suspended at the back of the machine and they rake cut grass up a ditch slope. Both the mowers and the rakes are mounted in pairs, i.e. on each side of the machine, for treating both ditch slopes at the same time. For controlling these tools there are two cabs installed on the machine, for two operators – for controlling the tools at the front and at the back of the machine, respectively. It is a disadvantageous solution, as two operators for one machine must be employed.

Berky company also offers machines marked with 2100, 2200, 2300 and 2400 type, which have a chassis consisting of three driven wheels, two wheels being located centrally under a main frame, and the third wheel being mounted on a single hydraulic manipulator stuck out aside of the machine. Driving the machine is carried out in such a way, that it is astride of a treated melioration ditch with its wheels moving at the top of ditch slopes, or on a bank strip. Furthermore, the machine is provided with a

few additional manipulators, each of which may be provided with a cutter bar mower or a finger mower, or a belt rake for carrying out renovation operations. According to the method offered by Berky company, tools are guided in a ditch space between ground wheels. Work with such machine is limited only to ditches without growing trees and bushes.

An example of devices of Berky company is also a machine of 3300 type, which like 3100 type, comprises four side arms with driven wheels, but at 3300 type the side arms have three degrees of freedom, i.e. they enable that the wheels are freely moved in vertical and horizontal direction (aside from the machine) and their angle of inclination with respect to the ground is adjusted as well. Such solution enhances mobility of machine, but the disadvantage consists in the number of degrees of freedom, which have to be controlled by an operator, who has to control 16 different movements of the machine, including a manipulator for excavating with a bucket. Mastering these movements and optimal control of them is very difficult for the operator. Furthermore, the machine may be provided interchangeably only with the excavator bucket or a mower, and thus the number of treatment operations for ditch renovation, which may be carried out the same time, is unfavourably limited only to one operation. The machine may move on a ditch bank strip, or on slopes which are not too steep. Also with this machine, work on ditches with growing trees is impossible or very difficult.

For moving in a ditch space there are also used boats or amphibians. An example of such solution is C430H boat with a cutter bar mower offered by a Dutch company Conver. Use of boats is limited by amount of water in a

ditch and its width and therefore they are used for works in large channels and rivers. Impossibility of using them in small melioration ditches is a disadvantage of these solutions. Furthermore, boats may only carry out an operation of mowing or removing mowed vegetation.

Kind of amphibian vehicle, of C580H type, is another solution of Conver company. As it has a caterpillar chassis, it may both travel on land and float on water. A limitation in use of this device for renovation of ditches is its width, which allows to operate only in ditches with the bottom width larger than 2m. Most of ditches requiring renovations cannot be serviced with this device.

There are also known solutions of specialized machines, similar to a device according to the invention, for example like in Polish patent PL 169053 B. This device comprises a one-track caterpillar chassis moving on a ditch bottom, and supporting arms, which are used to stabilize machine balance. The machine is intended for excavating or desludging melioration ditches. Because of large overall dimensions and output transporting tools, protruding aside, with which the machine is provided, it is not suitable for work in a terrain with trees. Moreover, the device does not have any possibility to move into and out of a ditch by itself and use of a crane is needed for this purpose.

A device according to patent FR2010583 is characterised in that it is provided with wheels mounted on arms, and the device may only move on one ditch slope, or astride of a ditch and move on both ditch slopes, but the side wheels have only possibility of changing wheel track, height in relation to a frame and inclination angle, and these movements are not

driven hydraulically, and the arms consist of members which are orthogonally slidable. The wheels may be adjusted manually, once before starting work, and during work their position cannot be changed without stopping the machine.

Similar to the solutions of Berky company is a device according to Swiss patent CH 697556, wherein two supporting side arms with ground wheels are mounted to a main frame. The device moves inside a ditch space such that the wheels roll on ditch slopes and the main frame hangs on the side arms, centrally above a ditch bottom. The wheels are adjusted perpendicularly to ditch slopes by inclining the side arms. Such solution is not suitable for moving on steep ditch slopes and avoiding obstacles occurring on slopes, or growing trees.

There are also known other solutions serving the same function, as for example those claimed in Japanese patent JP3049614. An inclinable chassis of a mowing machine, consisting of a main chassis and supporting wheels on hydraulically controlled rockers, adapts to terrain roughness by the change of position of the supporting wheels, and thereby keeps vertical position of the main chassis. The solution according to the above mentioned patent relates to a device intended only for regular mowing of surfaces overgrown with low grass vegetation, also on a slant slopes. Kinematic system used in this machine does not allow working inside a melioration ditch, as it cannot move on a boggy terrain. Moreover, introducing the machine into ditches with greater depth requires a special formation of slopes or use of an external introducing device, which makes use of this machine significantly difficult.

A method of carrying out renovation works in melioration ditches by means of a multifunction device according to the present invention is devoid of the above mentioned disadvantages.

Preferably, a multifunction device is guided along a ditch in such a way, that with ground wheels of a travel chassis it rests on a ditch bottom, and with supporting wheels of a side support on one side of the multifunction device it rests on a ditch slope, perpendicularly to its surface, and at least one of working tools rests on the same ditch slope and/or on the ditch bottom, and an operation of ditch renovation is uninterruptedly carried out at that time, while on the opposite ditch slope a terrain obstacle occurs, which is avoided by the multifunction device.

Preferably, the multifunction device is set in the ditch in such a way, that at the same time the supporting wheels of the side support on one side rest on the ditch bottom, perpendicularly to its surface, and the supporting wheels of the side support on the other side rest on a ditch bank, perpendicularly to the ground surface, whereas the travel chassis is in the air, above the ditch slope, and moves across the ditch between the ditch bottom and the ditch bank along trajectory T, wherein at extreme positions of this movement it rests on the ditch bottom or the ditch bank in such a way that, the terrain obstacle occurring before or behind the multifunction device, inside the ditch with the ditch depth G of at least 1.5 m, is avoided.

Preferably, the multifunction device is set in the ditch in such a way that, at the same time the travel chassis rests on the ditch bottom and each of the

supporting wheels of the side supports rest on both ditch slopes, perpendicularly to the ground surface, wherein the inclination angle K of each slope is greater than 75 degrees, and moreover, the working tools on a front tool suspension unit rest on both ditch slopes and/or on the ditch bottom, and the operation of ditch renovation is uninterruptedly carried out at that time, while the multifunction device moves along the ditch.

Preferably, the multifunction device moves on the travel chassis on ditch drive up gullies made by a hydraulic manipulator, along trajectory T, and rests on at least one supporting wheel of the side support in such a way, that the terrain obstacles occurring on the ditch bottom and/or on any ditch slope are avoided.

Preferably, the multifunction device comprises the one-track travel chassis with wheels, situated under a main frame in its symmetry axis, the side supports with the supporting wheels being situated on both sides of the main frame, the front tool suspension unit and the hydraulic manipulator being situated in front of the travel chassis, whereas the hydraulic manipulator is mounted on the main frame, above the front tool suspension unit, and there is a tool turn-table at the end of the hydraulic manipulator, and furthermore, a rear tool suspension unit is situated behind the travel chassis, and an operator cab is situated on the main frame, between the hydraulic manipulator and the side supports, and a motor aggregate is situated behind the side supports, and a tool magazine is situated above the motor aggregate and/or the operator cab, within reach of the end of the hydraulic manipulator, and the working tools are situated on the front tool suspension unit and/or on the rear tool

suspension unit and/or on the tool turn-table, and spare working tools for exchange at the end of the hydraulic manipulator, are stored on the tool magazine.

Preferably, the travel chassis with the ground wheels includes at least two ground wheels, wherein at least one driven wheel, and each side support with the supporting wheels, has at least two supporting wheels driven, the distance L between the utmost supporting wheels being at least 1.8 metre. Thereby a considerable mobility in the melioration ditch is obtained, and an appropriate distance between the supporting wheels provides for supporting the multifunction device in such a way, that the centre of gravity of the multifunction device is between the supporting wheels.

Preferably, the side support with the ground wheels of the multifunction device is made such that a wheel hub is stiffly mounted to a hub sleeve, the hub sleeve is connected by means of rotary joints with a wheel support, and this one is connected by means of the rotary joints with an outer end of a rocker pair assembly, in turn inner ends of the rocker pair assembly are connected by means of the rotary joints with a yoke of rockers, the yoke of rockers is stiffly connected with a yoke beam, the yoke beam is rotationally set in a beam clasp, and the beam clasp is in a stiffly way mounted to a third member of the side support, and furthermore, a support in which longitudinally a pin guide is stiffly mounted, is mounted in a stiffly way to the beam clasp, a lever is mounted in a stiffly way to the yoke beam, a tension member is rotationally connected with an end of the lever, while another end of the tension member has a rotationally mounted guiding pin, which is slidably located in the pin guide

and connected with one end of an actuator of rotation, the other end of which is pivotally connected with the support, and furthermore, an actuator of angle with its one end is pivotally connected with the hub sleeve, while with the other end is pivotally connected with the wheel support, an actuator of rockers with its one end is pivotally connected with the wheel support, while with the other end is pivotally connected with the yoke of rockers, and on the wheel hubs are rotationally mounted the supporting wheels which, moreover, are coupled with a driving motor in such a way that it is possible to transmit torque from the driving motor to the supporting wheel.

Preferably, in the side support with the support wheels, a first member with its one end is rotationally connected with the main frame of the multifunction device, while with the other end is rotationally connected with a second member by means of a first pin, and the third member is situated along the second member and slidably connected with it and, furthermore, a long tension member with its lower end is rotationally connected with the main frame, and a short tension member with its lower end is rotationally connected with the first member by means of a second pin, while an upper end of the long tension member and an upper end of the short tension member and an upper end of a first actuator are rotationally connected together by means of a third pin, and a lower end of the first actuator is rotationally connected with the frame, and furthermore, a second actuator with its one end is rotationally connected with the first member by means of a fourth pin, and with the other end is connected with the second member by means of a fifth pin, and a third actuator with its one end is

connected with the second member, while with the other end is connected with the third member.

Preferably, in each member of the side support there are at least two parallel to each other longitudinal beams, stiffly connected by means of at least one cross bar, and the spacing R of the utmost longitudinal beams in each member is at least 0.8 metre, which is required to enable carrying the weight of the whole device in a stable manner, having only two side supports at disposal.

The solution according to the invention enables in an easy way avoiding obstacles occurring on a ditch slope and on a ditch bank – especially trees growing there and being the result of many years of carelessness in renovation or occurring in places where a ditch runs through woodland.

Thank to setting on the rotary longitudinal beam, the supporting wheels of the side support rest on the ground perpendicularly to its surface in each position of their arrangement in relation to the multifunction device, which provides for the best conditions of interaction between the wheel and the ground.

The travel chassis and the supporting wheels enable realization of travel in a melioration ditch, as the main weight of the device rests on the ditch bottom, and the side supports with the supporting wheels provides for balance and allow avoiding obstacles on ditch slopes, without stopping the

multifunction device and interrupting an operation of melioration ditch renovation.

The side supports with the supporting wheels are located in the area near the centre of gravity of the multifunction device, which enables carrying the weight of the whole multifunction device on them when putting it into a ditch.

Location of the hydraulic manipulator at the front provides for a good work ergonomics, and most of all, working tools for stumping branches and bushes may be placed on it, with witch a ditch space is cleared for travel of the multifunction device.

Working tools like mowers, desludger and belt rake may be mounted at the front of the multifunction device on the main suspension system, which ensures that they are well visible from the operator cab. In turn, at the back of the multifunction device there is situated the rear tool suspension unit, on which finishing tools, for example like rakes or branch chopper, may be installed.

Use of working tools at the front of the multifunction device, in front of the travel chassis with the wheels, makes that the travel chassis does not press grass and reeds before mowing them, and in case of desludging and deepening a ditch, terrain roughness and mud is removed in front of the ground wheels.

The operator cab is situated in front of the side supports which provides for a very good visibility for the operator, and the supplying motor

aggregate, situated at the back, moves back the centre of gravity of the whole device, balancing against the hydraulic manipulator.

The front tool suspension unit is situated under the frame, on relatively short arms, near the ditch bottom, thanks to which the working tools are guided stiffly and are not susceptible to jerks caused by varying working loads.

The rocker pair assembly provides for smooth compensating for ground roughness and also gives an additional increase of reach of the supporting wheels of the side supports.

The solution of suspension of the supporting wheels of the side support allows to obtain changes of the position of the supporting wheels in relation to the multifunction device, which wheels are raised in a ditch and rest on the ditch slope, and may be moved from the slope onto the ditch bank, and during putting the multifunction device into a ditch they provide for a very long reach, required to reach the ditch bottom when the device stands on the ditch slope.

In each member of the side support the multifunction device comprises at least two parallel to each other longitudinal beams, stiffly connected by means of at least one cross bar, and the spacing R of the utmost longitudinal beams in each member is at least 0.8 metre, which is required to enable carrying the weight of the whole device in a stable manner, having only two side supports at disposal.

There are only two side supports, which makes it easier for the operator to master control of the multifunction device.

The method of carrying out renovation works in melioration ditches by means of the multifunction device is explained in the drawing, in which fig. 1 shows the front view of the multifunction device during avoiding a terrain obstacle occurring on a ditch slope, fig. 2 shows the front view presenting the method of putting the multifunction device into/out of a ditch, and fig. 3 shows the top view presenting the method of putting the multifunction device into/out of a ditch and avoiding a transverse terrain obstacle or an obstacle occurring in the ditch bottom, and fig. 4 shows the method of moving the device in a ditch with steep slopes, and fig. 5 shows the method of avoiding a transverse obstacle by driving the multifunction device out of and into a ditch on a gully, and fig. 6 shows the multifunction device and location of its constituent assemblies, and fig. 7 shows the side support viewed from the outside, and fig. 8 shows the side support viewed from the inside, and fig. 9 shows the cross-sectional view of the side support in the place of the actuator of rotation, and fig. 10 shows the rocker pair assembly in a larger scale, and fig. 11 shows the cross-sectional view of a fixing mechanism of the supporting wheel.

In an embodiment of the method according to the invention, shown in fig. 1, a multifunction device 1 is located in a ditch in such a way, that at the same time a travel chassis 2 rests on a ditch bottom 3 and supporting wheels 4 of a side support 5 on one side of the multifunction device rest on a ditch slope 6, perpendicularly to its surface, and at least one working tool 7 rests on the same ditch slope 6 and/or on the ditch bottom 3, and an

operation of ditch renovation with the working tool 7 is uninterruptedly carried out at that time, while on the opposite ditch slope 6 a terrain obstacle 8 occurs, which is avoided by the multifunction device 1.

In an embodiment of the method according to the invention, shown in fig. 2 i fig. 3, the multifunction device 1 is put in the ditch in such a way that, at the same time the supporting wheels 4 of the side support 5 on one side rest on the ditch bottom 3, perpendicularly to its surface, and the supporting wheels 4 of the side support 5 on the other side rest on a ditch bank 9, perpendicularly to the ground surface, while the travel chassis 2 is in the air, above the ditch slope 6, and moves across the ditch, together with the rest of the multifunction device 1, between the ditch bottom 3 and the ditch bank 9 along trajectory T of movement, wherein at extreme positions of this movement it rests on the ditch bottom 3 or the ditch bank 9 in such a way that the terrain obstacle 8 occurring before or behind the multifunction device 1, inside the ditch the depth G of which is larger than 1.5 metre, is avoided.

In an embodiment of the method according to the invention, shown in fig. 4, the multifunction device 1 is put in the ditch in such a way, that at the same time the travel chassis 2 rests on the ditch bottom 3 and all supporting wheels 4 of the side supports 5 rest on both ditch slopes 6, perpendicularly to the ground surface, wherein the inclination angle K of each slope is greater than 75 degrees, and moreover, the working tools 7 on a front tool suspension unit 10 rest on both ditch slopes 6 and/or on the ditch bottom 3, and the operation of ditch renovation is carried out

uninterruptedly at that time, while the multifunction device 1 moves along the ditch.

In an embodiment of the method according to the invention, shown in fig. 5, the multifunction device 1 moves on the travel chassis 2 on ditch drive up gullies 12, made by a hydraulic manipulator 11, along trajectory T of movement, and rests on at least one supporting wheel 4 of the side support 5 in such a way that the terrain obstacles 8, occurring on the ditch bottom 3 and/or on any ditch slope 6, are avoided.

In fig. 6 a configuration system of the multifunction device 1 is shown, which includes: the travel chassis 2, a main frame 13, at least two side supports 5 with the supporting wheels 4, the hydraulic manipulator 11, a tool turn-table 14, the front tool suspension unit 10, a rear tool suspension unit 15, a motor aggregate 16, an operator cab 17 and a tool magazine 18. These sub-assemblies are connected in such a way, that the one-track travel chassis 2, is situated under the main frame 13 in its symmetry axis, whereas the side supports 5 with the supporting wheels 4 are situated on both sides of the main frame 13, while the front tool suspension unit 10 and the hydraulic manipulator 11 are situated in front of the travel chassis 2, whereas the hydraulic manipulator 11 is mounted on the main frame 13, above the front tool suspension unit 10, and there is the tool turn-table 14 at the end of the hydraulic manipulator 11, and furthermore, the rear tool suspension unit 15 is situated behind the travel chassis 2, and the operator cab 17 is situated on the main frame 13, between the hydraulic manipulator 11 and the side supports 5, and the motor aggregate 16 is situated behind the side supports 5, and the tool magazine 18 is situated

above the motor aggregate 16 and the operator cab 17, within reach of the end of the hydraulic manipulator 11. The working tools 7 are situated on the front tool suspension unit 10 , for example flail mowers, on the rear tool suspension unit 15 ,for example branch chopper, on the tool turn-table 14 , for example an excavator bucket, and the spare working tools 7 , for example a stumper for removing roots, for exchange on the hydraulic manipulator 11, are stored on the tool magazine 18.

The multifunction device 1 has the travel chassis 2 in the form of a caterpillar, in which there are a few ground wheels 19, therein one driven ground wheel 20, driven with a driving motor 21, and ground rolls 22, and each side support 5 has two supporting wheels 4 which are driven with the driving motors 21 and are mounted on the side supports 5.

The side support 5, shown in fig. 7, fig. 8, fig. 9, fig 10 and fig. 11, includes three members 23, 24 and 25, two wheel hubs 26 with the driving motor 22, two hub sleeves 27, two wheel supports 28, two rocker pair assemblies 29, two yokes 30 of rockers, a yoke beam 31, a beam clasp 32, a support 33, a lever 34, a tension member 35, a tension member pin 36, a pin guide 37, an actuator 38 of rotation, an actuator 39 of angle, an actuator 40 of rockers, which are connected in such a way that the wheel hub 26 is stiffly mounted to the hub sleeve 27, and the hub sleeve 27 by means of rotary joints 41 is connected with the wheel support 28, and the latter by means of the rotary joints 41 is connected with an outer end of the rocker pair assembly 29. In turn, inner ends of the rocker pair assembly 29 by means of the rotary joints 41 are connected with the yoke 30 of rockers, and this one in turn is in a stiffly way connected with the

yoke beam 31 which is rotationally set in the beam clasp 32. The beam clasp 32 is in a stiffly way mounted to the third member 25 of the side support 5. Furthermore, the support 33, in which the pin guide 37 is stiffly mounted longitudinally, in a stiffly way is mounted to the beam clasp 32. In turn, the lever 34 in a stiffly way is mounted to the yoke beam 31, and the tension member 35 is rotationally connected with another end of the lever 34. Next, another end of the tension member 35 is rotationally connected with the guiding pin 36, which is slidably placed in the pin guide 37 and is connected with one end of the actuator 38 of rotation, the other end of which is pivotally connected with the support 33. Furthermore, the actuator 39 of angle with its one end is pivotally connected with the hub sleeve 27, and with the other end is pivotally connected with the wheel support 28. Next, the actuator 40 of rockers with its one end is pivotally connected with the wheel supports 28, and with the other end is pivotally connected with the yoke 30 of rockers. On the wheel hubs 26 rotationally are mounted the supporting wheels 4 which, moreover, are coupled with the driving motor 21 in such a way that it is possible to transmit torque from the driving motor 21 to the supporting wheel 4.

The side support 5 includes three pairs of actuators 42, 43, 44, three members 23, 24 and 25, two tension members 45 and 46, and pins 47, 48, 49, 50, 51, 52 and 53, which are connected in such a way, that the first member 23 with its one end is rotationally connected with the main frame 13 of the multifunction device 1, and with the other end is rotationally connected with the second member 24, by means of the first pin 47, and the third member 25 is situated along the second member 24 and slidably

connected with it. Furthermore, the long tension members 45 with its lower end is rotationally connected with the main frame 13, whereas the short tension members 46 with its lower end is rotationally connected with the first member 23 by means of the second pin 48. In turn, an upper end of the long tension members 45 and an upper end of the short tension members 46 and an upper end of the first actuators 42 are rotationally connected together by means of the third pin 49, whereas a lower end of the first actuators 42 is rotationally connected with the main frame 13. Furthermore, the second actuators 43 with their one end are rotationally connected with the first member 23 by means of the fourth pin 50, whereas with the other end are connected with the second member 24, by means of the fifth pin 51, and the third actuator 44 with its one end is connected with the second member 24 by means of the sixth pin 52, whereas with the other end is connected with the third member 25 by means of the seventh pin 53. Moreover, in each member 23, 24 and 25 of the side support 5 are located two parallel to each other longitudinal beams 54, stiffly connected by means of cross bars 55, and the spacing R of the utmost longitudinal beams 54 in each member 23, 24 and 25 is at least 0.8 metre. Moreover, the cross bar 55 of the third member 25 is the beam clasp 32 at the same time.

List of reference numbers

1 - multifunction device
2 - travel chassis
3 - ditch bottom
4 - supporting wheel
5 - side support
6 - ditch slope
7 - working tool
8 - terrain obstacle
9 - ditch bank
10 - front tool suspension unit
11 - hydraulic manipulator
12 - drive up gully
13 - main frame
14 - tool turn-table
15 - rear tool suspension unit
16 - motor aggregate
17 - operator cab
18 - tool magazine
19 - ground wheel
20 - driven wheel
21 - driving motor
22 - ground roll
23 - first member
24 - second member
25 - third member (the last one)
26 - wheel hub
27 - hub sleeve
28 - wheel support
29 - rocker pair assembly
30 - yoke of rockers
31 - yoke beam
32 - beam clasp
33 - support
34 - lever
35 - tension member
36 - guiding pin
37 - pin guide
38 - actuator of rotation
39 - actuator of angle
40 - actuator of rockers
41 - rotary joint
42 - first actuator
43 - second actuator
44 - third actuator
45 - long tension member
46 - short tension member

47 - first pin
48 - second pin
49 - third pin
50 - fourth pin
51 - fifth pin
52 - sixth pin
53 - seventh pin
54 - longitudinal beam
55 - cross bar
T - trajectory of movement
G - ditch depth
K – slope inclination angle
L - distance between supporting wheels
R - longitudinal beams spacing

Claims

1. A method of carrying out renovation works in melioration ditches by means of a multifunction device, which comprises at least one travel chassis, side supports with supporting wheels, and at least one working tool, **characterized in that** the multifunction device (1) is guided along the ditch in such a way that with ground wheels (19) of the travel chassis (2) it rests on a ditch bottom (3), and with the supporting wheels (4) of the side support (5) on one side of the multifunction device (1) it rests on a ditch slope (6), perpendicularly to its surface, and at least one of the working tools (7) rests on the same ditch slope (6) and/or on the ditch bottom (3) and an operation of ditch renovation is uninterruptedly carried out at that time, while on the opposite ditch slope (6) a terrain obstacle (8) occurs which is avoided by the multifunction device (1) **or** the multifunction device (1) is set in the ditch in such a way that at the same time the supporting wheels (4) of the side support (5) on one side rest on the ditch bottom (3), perpendicularly to its surface, and the supporting wheels (4) of the side support (5) on the other side rest on a ditch bank (9), perpendicularly to the ground surface, whereas the travel chassis (2) is in the air, above the

ditch slope (6), and moves across the ditch between the ditch bottom (3) and the ditch bank (9) along trajectory T of movement, wherein at extreme positions of this movement it rests on the ditch bottom (3) or the ditch bank (9) in such a way that the terrain obstacle (8) occurring before or behind the multifunction device (1), inside the ditch with the ditch depth G of at least 1.5 metre, is avoided, **or** the multifunction device (1) is set in the ditch in such a way that at the same time the travel chassis (2) rests on the ditch bottom (3) and each of the supporting wheels (4) of the side supports (5) rest on both ditch slopes (6), perpendicularly to the ground surface, wherein the inclination angle K of each slope is greater than 75 degrees, and moreover, the working tools (7) on a front tool suspension unit (10) rest on both ditch slopes (6) and/or on the ditch bottom (3), and the operation of ditch renovation is uninterruptedly carried out at that time, while the multifunction device (1) moves along the ditch.

2. A method of carrying out renovation works according to claim 1, **characterized in that** the multifunction device (1) moves on the travel chassis (2) on ditch drive up gullies (12) made by a hydraulic manipulator (11), along trajectory T of movement, and rests on at least one supporting wheel (4) of the side support (5) in such a way that the terrain obstacles (8) occurring on the ditch bottom (3) and/or on any ditch slope (6) are avoided.

3. A multifunction device comprising a main frame, a travel chassis with wheels, at least two side supports with supporting wheels, a hydraulic manipulator, a tool turn-table, a front tool suspension unit, a rear tool suspension unit, an operator cab, a motor aggregate, a tool magazine,

characterized in that it includes the one-track travel chassis (2) situated under the main frame (13) in its symmetry axis, whereas the side supports (5) with the supporting wheels (4) are situated on both sides of the main frame (13), while the front tool suspension unit (10) and the hydraulic manipulator (11) are situated in front of the travel chassis (2), whereas the hydraulic manipulator (11) is mounted on the main frame (13), above the front tool suspension unit (10), and there is the tool turn-table (14) at the end of the hydraulic manipulator (11), and furthermore, the rear tool suspension unit (15) is situated behind the travel chassis (2), and the operator cab (17) is situated on the main frame (13), between the hydraulic manipulator (11) and the side supports (5), and at the same time the motor aggregate (16) is situated behind the side supports (5), whereas the tool magazine (18) is situated above the motor aggregate (16) and/or the operator cab (17), but within reach of the end of the hydraulic manipulator (11), and working tools (7) are situated on the front tool suspension unit (10) and/or on the rear tool suspension unit (15) and/or on the tool turn-table (14), and spare working tools (7) for exchange at the end of the hydraulic manipulator (11), are stored on the tool magazine (18).

4. A multifunction device according to claim 3, comprising the travel chassis with wheels and the side supports with the supporting wheels, **characterized in that** the travel chassis (2) includes at least two ground wheels (19), wherein at least one driven wheel (20), and each side support (5) has at least two supporting wheels (4) driven, the distance L between the utmost supporting wheels being at least 1.8 metre.

5. A multifunction device according to claim 3, in which the side support with the supporting wheels includes at least three members of the support, one wheel hub with a driving motor, a hub sleeve, a wheel support, a rocker pair assembly, a yoke of rockers, a yoke beam, a beam clasp, a support, a lever, a tension member, a tension member pin, a pin guide, an actuator of rotation, an actuator of angle, an actuator of rockers, **characterized in that** the wheel hub (26) is stiffly mounted to the hub sleeve (27), the hub sleeve (27) is connected by means of rotary joints (41) with the wheel support (28), and this one is connected by means of rotary joints (41) with an outer end of the rocker pair assembly (29), in turn inner ends of the rocker pair assembly (29), are connected by means of the rotary joints (41) with the yoke (30) of rockers, the yoke (30) of rockers is in a stiffly way connected with the yoke beam (31), the yoke beam (31) is rotationally set in the beam clasp (32), and the beam clasp (32) is in a stiffly way mounted to the third member (25) of the side support (5), and furthermore, the support (33) in which longitudinally the pin guide (37) is stiffly mounted, is mounted in a stiffly way to the beam clasp (32), the lever (34) is mounted in a stiffly way to the yoke beam (31), the tension member (35) is rotationally connected with an end of the lever (34), while another end of the tension member (35) is rotationally connected with the guiding pin (36), which is slidably located in the pin guide (37) and connected with one end of the actuator (38) of rotation, the other end of which is pivotally connected with the support (33), and furthermore, the actuator (39) of angle with its one end is pivotally connected with the hub sleeve (27), while with the other end is pivotally connected with the wheel support (28),

the actuator (40) of rockers with its one end is pivotally connected with the wheel support (28), while with the other end is pivotally connected with the yoke (30) of rockers, and on the wheel hubs (26) are rotationally mounted the supporting wheels (4) which, moreover, are coupled with the driving motor (21) in such a way that it is possible to transmit torque from the driving motor (21) to the supporting wheel (4).

6. A multifunction device according to claim 3, in which the side support with the supporting wheels includes at least three actuators, three members, two tension members and seven pins, **characterized in that** the first member (23) with its one end is rotationally connected with the main frame (13) of the multifunction device (1), while with the other end is rotationally connected with the second member (24) by means of the first pin (47), and the third member (25) is situated along the second member (24) and slidably connected with it and, furthermore, the long tension member (45) with its lower end is rotationally connected with the main frame (13), and the short tension member (46) with its lower end is rotationally connected with the first member (23) by means of the second pin (48), while an upper end of the long tension member (45) and an upper end of the short tension member (46) and an upper end of the first actuator (42) are rotationally connected together by means of the third pin (49), and a lower end of the first actuator (42) is rotationally connected with the frame (13), and furthermore, the second actuator (43) with its one end is rotationally connected with the first member (23) by means of the fourth pin (50), and with the other end is connected with the second member (24) by means of the fifth pin (51), and the third actuator (44) with its one end is connected

with the second member (24) by means of the sixth pin (52), while with the other end is connected with the third member (25) by means of the seventh pin (53).

7. A multifunction device according to claim 3, in which the side support with the supporting wheels comprises at least longitudinal beams and cross bars, **characterized in that** each of members (23), (24) and (25) of the side support (5) includes at least two parallel to each other longitudinal beams (54), stiffly connected by means of at least one cross bar (55) and, moreover, the cross bar (55) of the last member (25) is a beam clasp (32) at the same time.

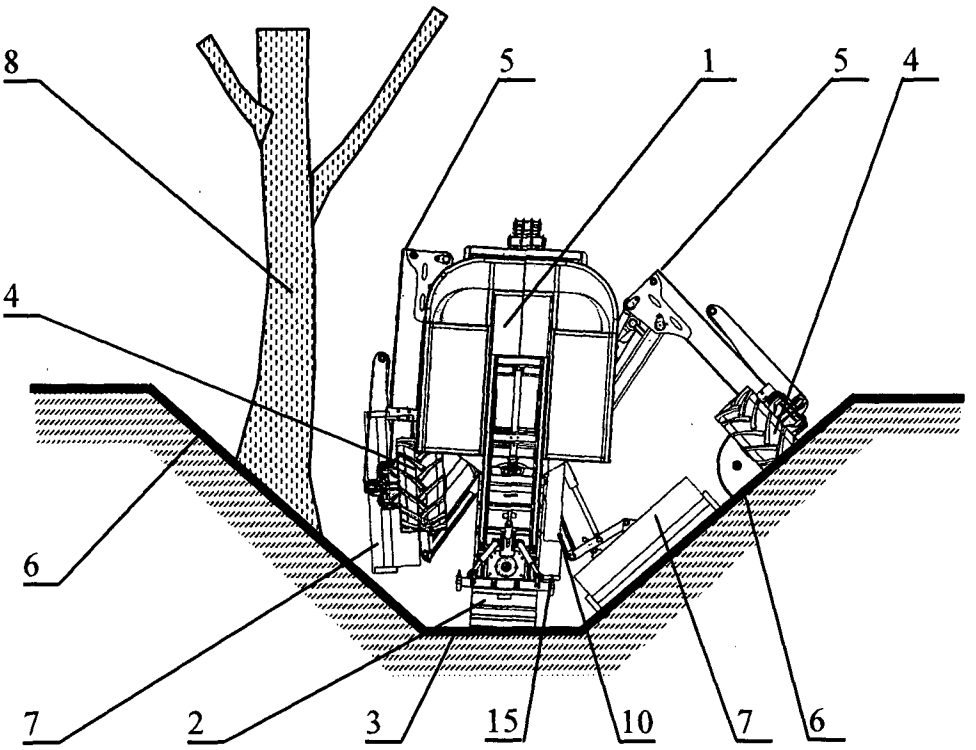

fig. 1

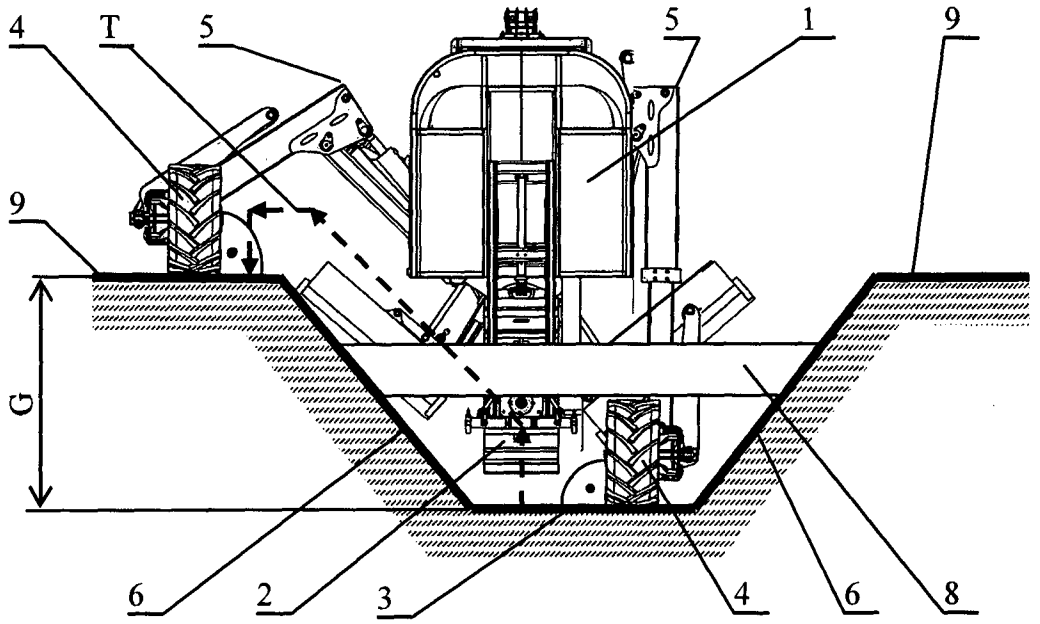

fig. 2

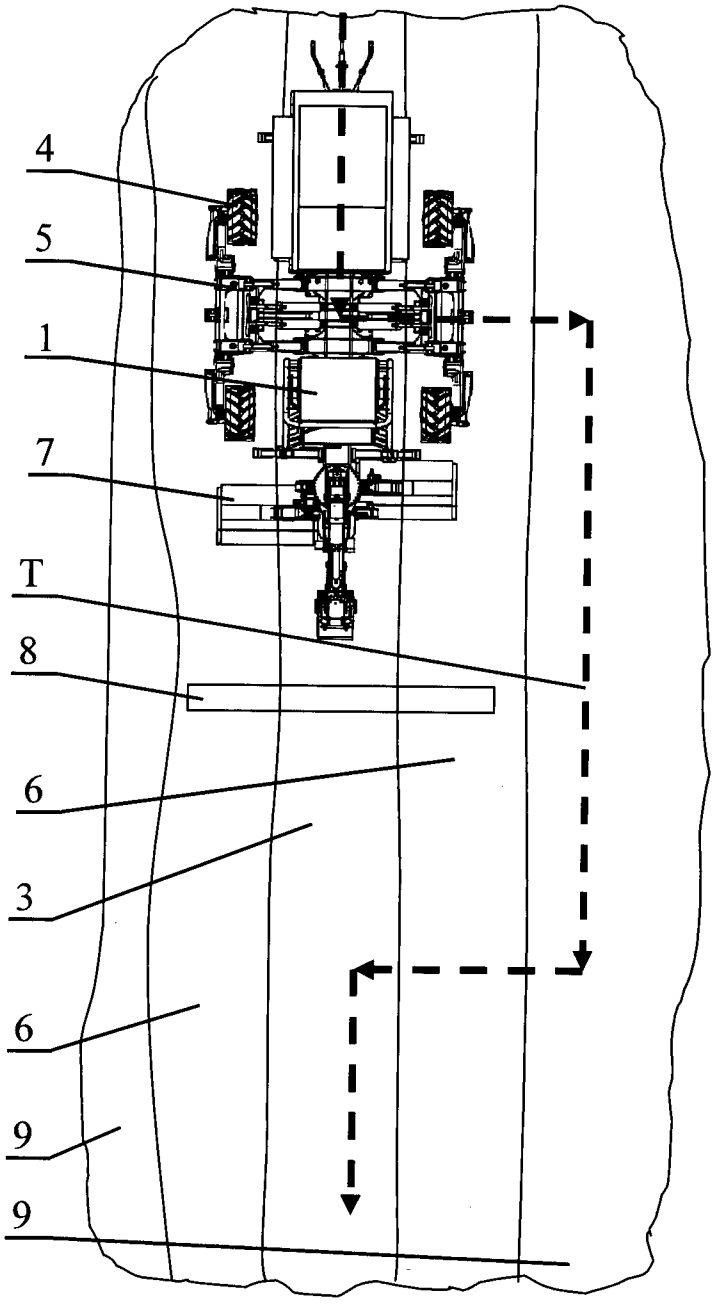

fig. 3

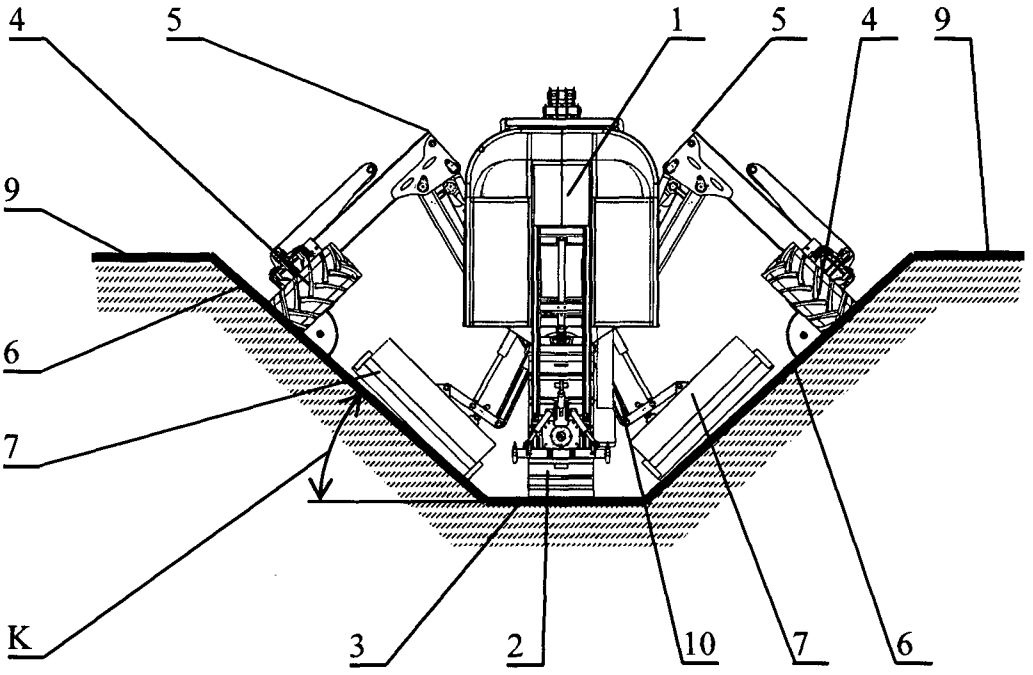

fig. 4

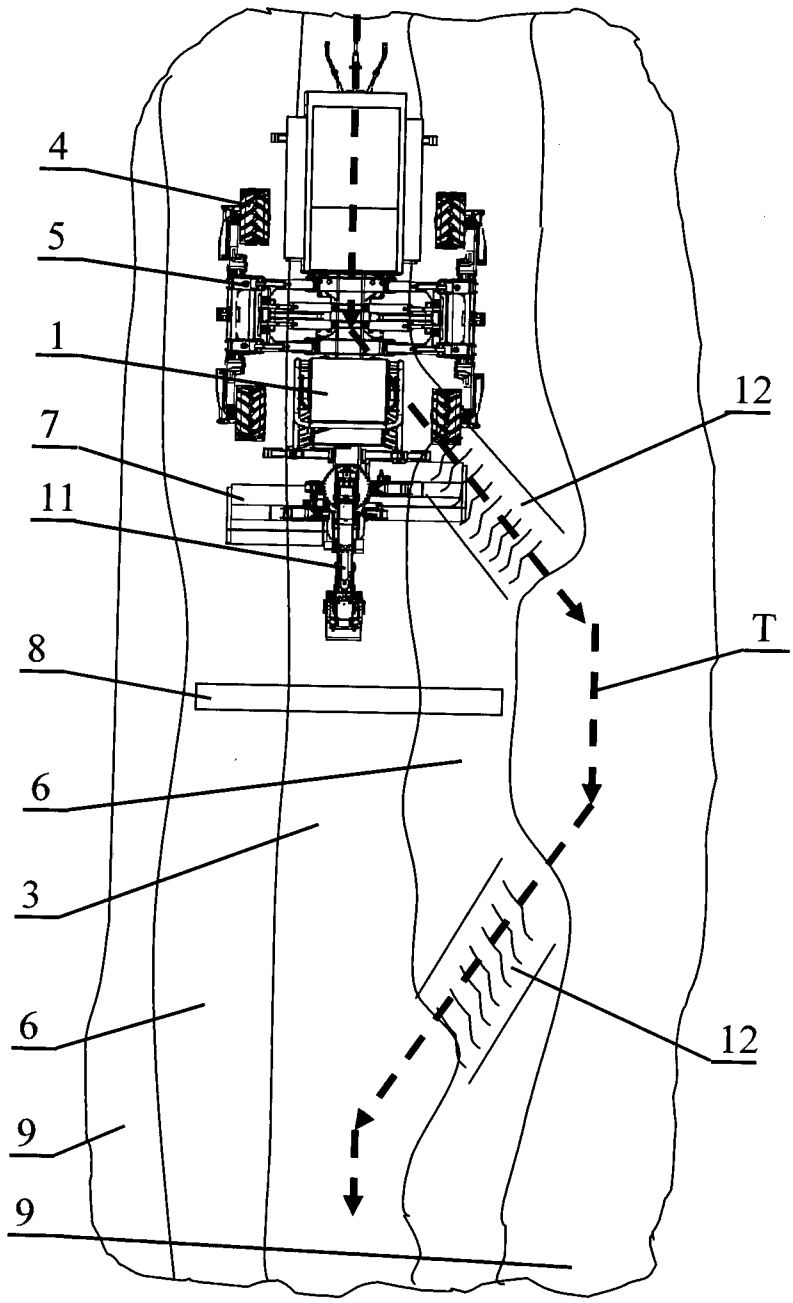

fig. 5

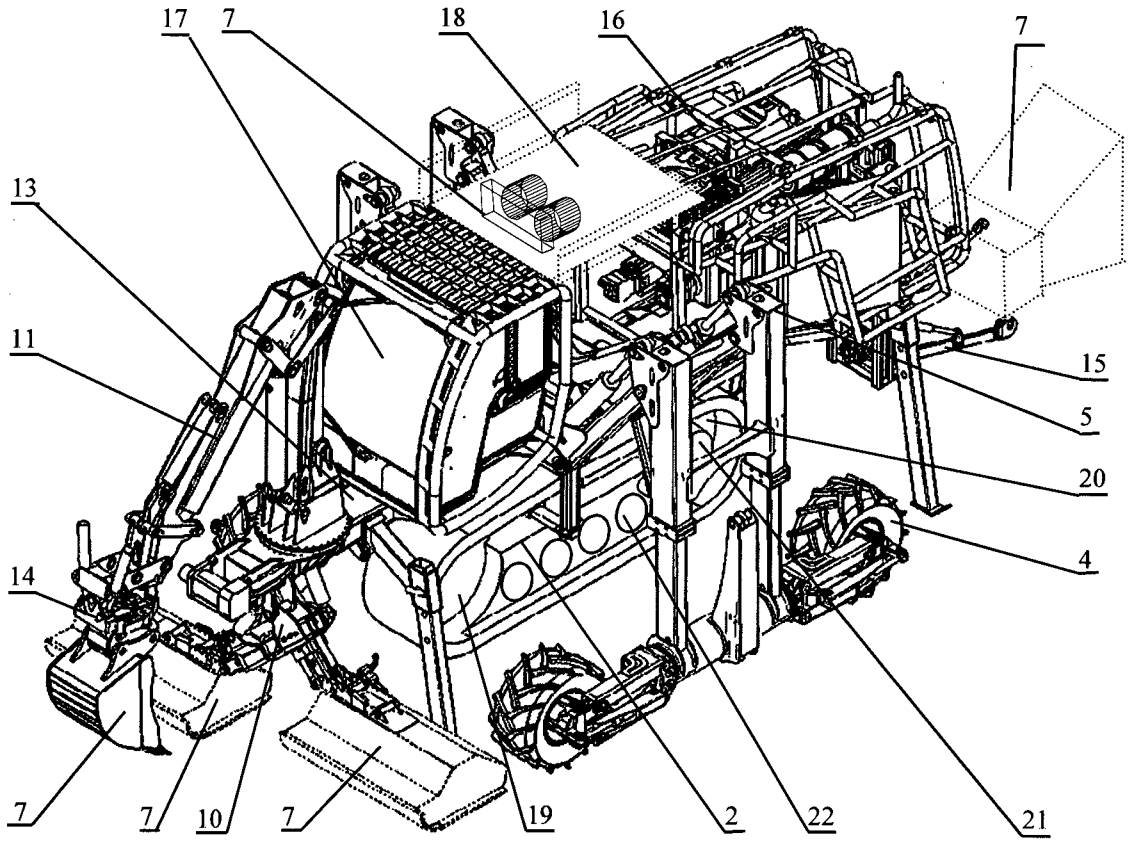

fig. 6

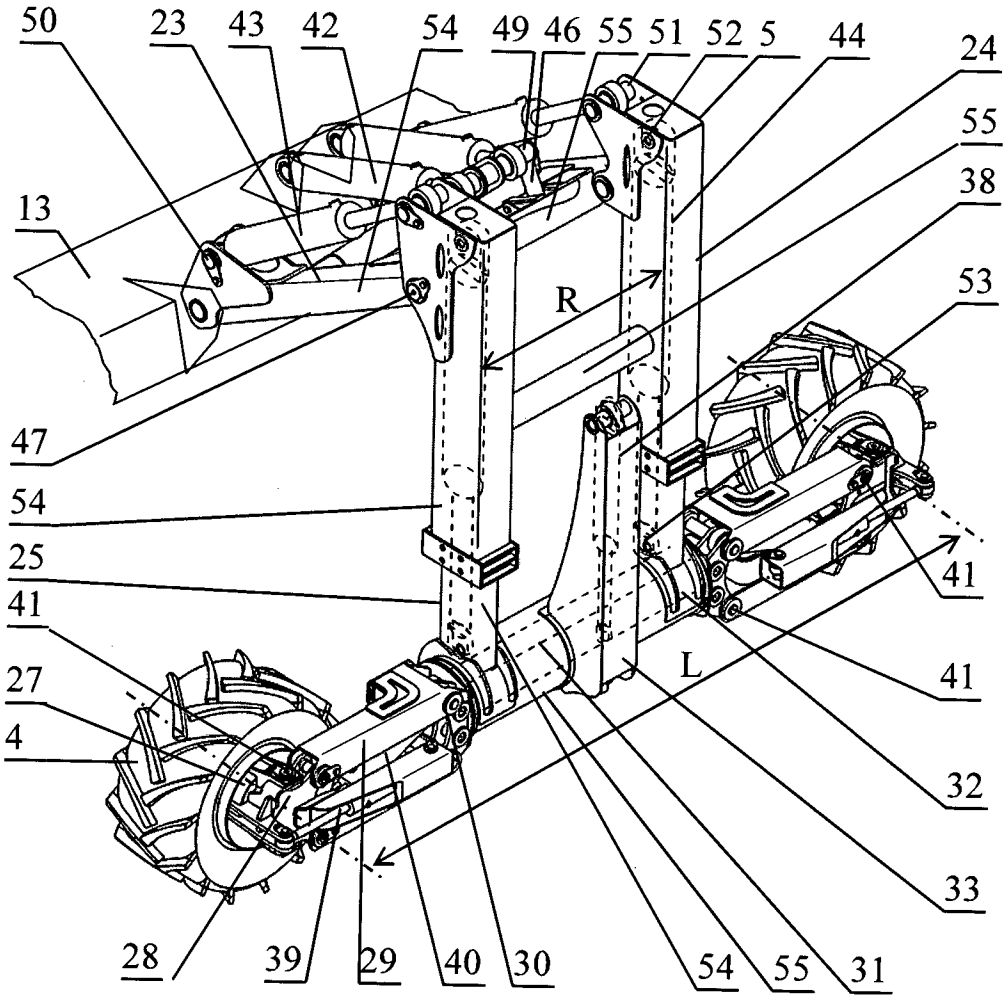
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fig. 7

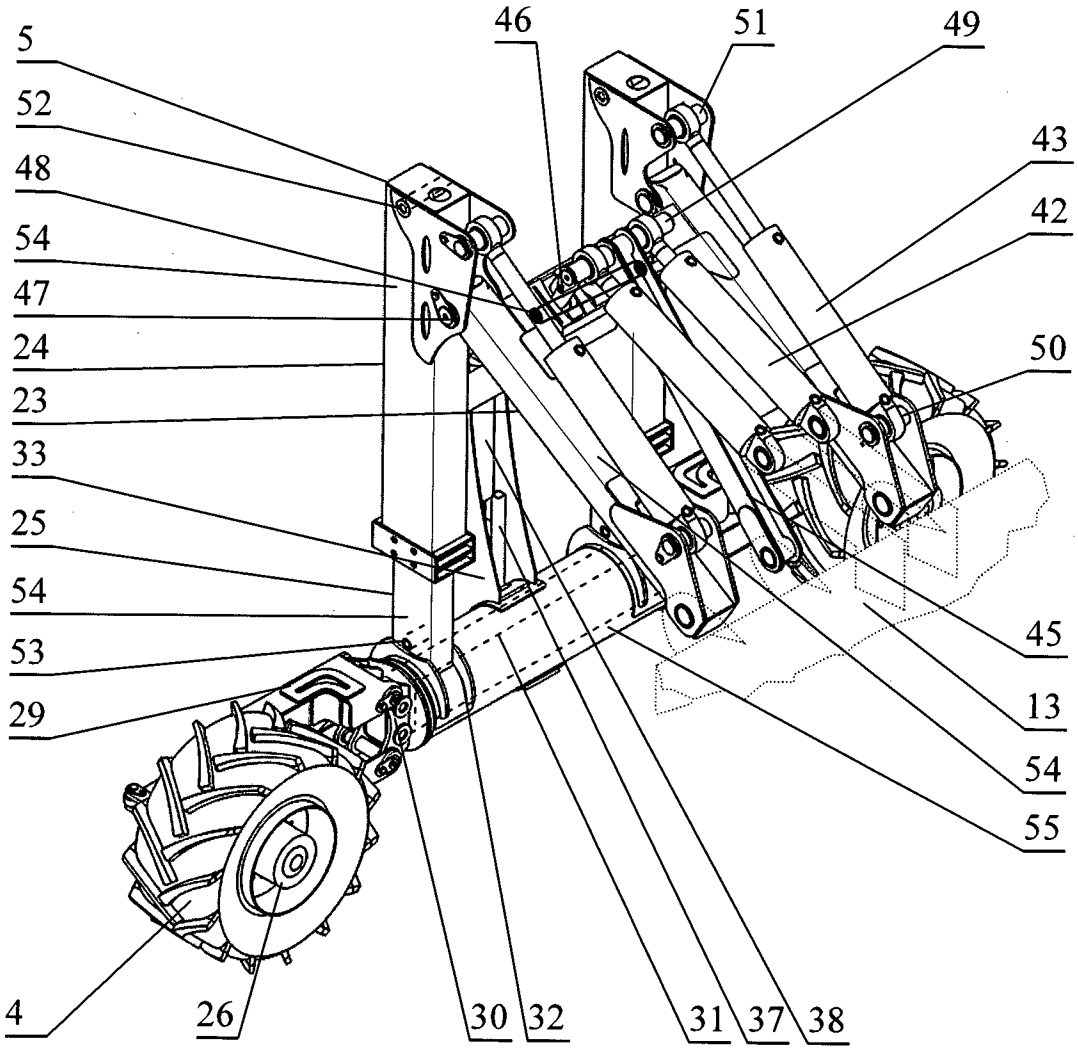
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fig. 8

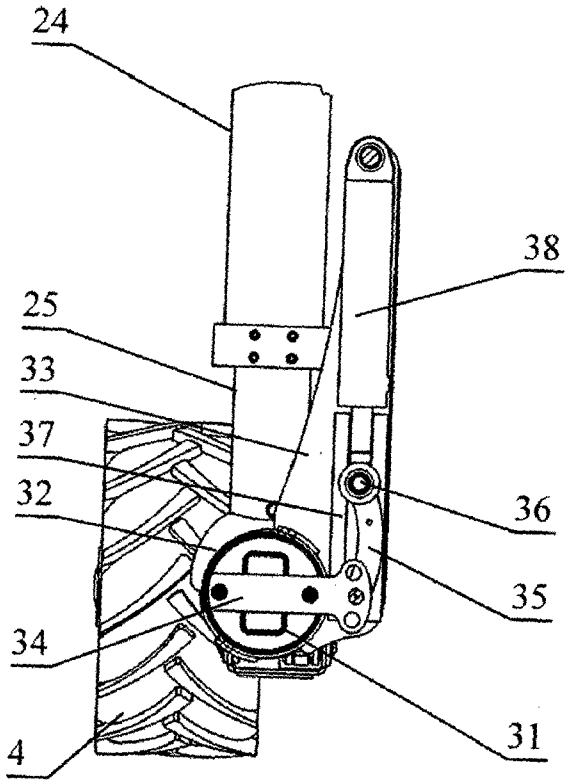
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fig. 9

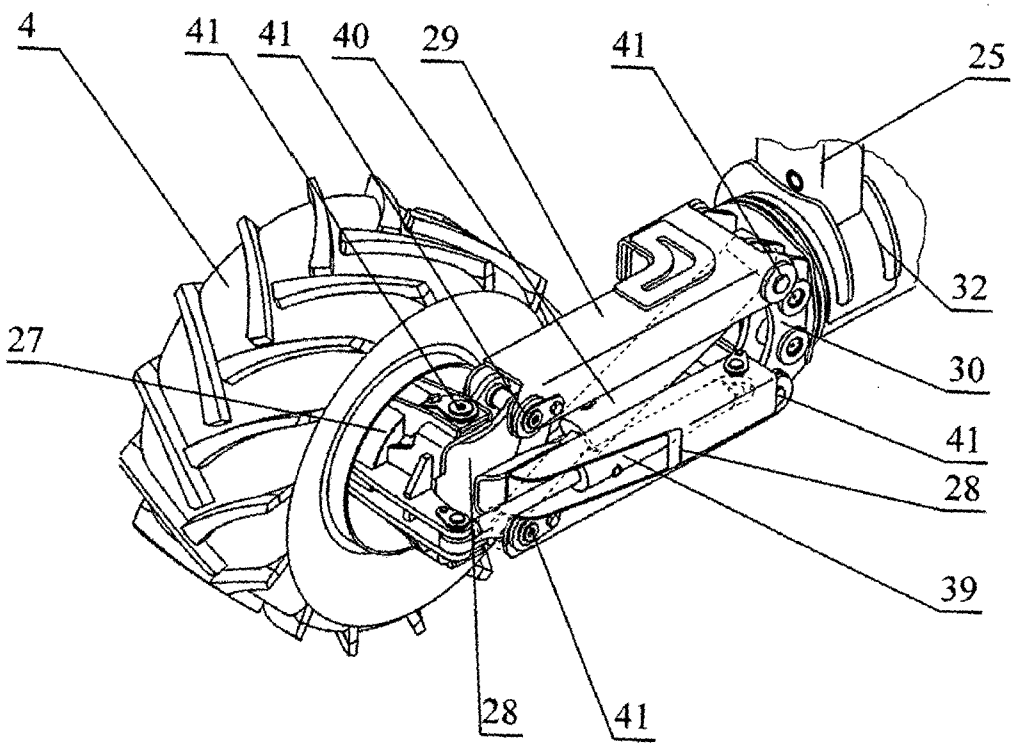
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fig. 10

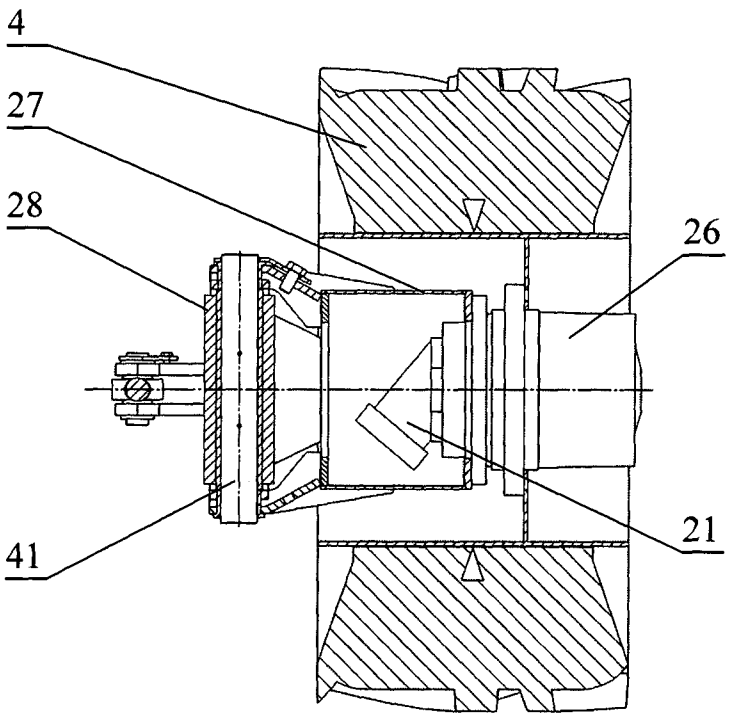

fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2012/000020

A. CLASSIFICATION OF SUBJECT MATTER
INV. E02F3/96 E02F5/28 E02F9/02 B62D55/02 E02F9/08
ADD.

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 B62D B60S

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 1 353 228 A (M. ANTON BERKENHEGER) 21 February 1964 (1964-02-21)	1
Y	the whole document	1
A		2,3

Y	FR 1 332 294 A (MME LAVEDAN) 12 July 1963 (1963-07-12)	1
A	page 1, column 2, line 11 - line 15; figure 3	2

A	WO 2010/028649 A1 (LMB ANDKAER SMEDIE LYNGE MASKI [DK]; LYNGE PEDERSEN HANS OTTO [DK]) 18 March 2010 (2010-03-18) figures 1-7	1,2

A	JP 63 227481 A (KUBOTA LTD) 21 September 1988 (1988-09-21) figure 2	1,2

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 April 2013	06/05/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bultot, Coralie

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2012/000020

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/037211 A1 (KORYCAN GEORGE [US] ET AL) 28 March 2002 (2002-03-28) paragraphs [0002], [0078]; figures 5, 8B, 12, 14-18	3-7
A	DE 10 2006 005213 A1 (LINDE AG [DE]) 14 December 2006 (2006-12-14) paragraphs [0043] - [0045]; figures 1-4	3
A	US 4 274 795 A (TAYLOR ROBERT A) 23 June 1981 (1981-06-23) figures 3, 4	6,7
A	US 2 974 976 A (LYALL RALPH G) 14 March 1961 (1961-03-14) figures 1-3	5-7
A	FR 1 404 977 A (UNIVERSAL MARION CORP) 2 July 1965 (1965-07-02) figures 1-10	4,5

2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/PL2012/000020

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

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

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

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

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

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

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

see additional sheet

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

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

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

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

Remark on Protest

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

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

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2

A method of carrying out renovation works in melioration ditches wherein the multifunction device avoid obstacles on a ditch slope by having the ground wheels of the travel chassis resting on a ditch bottom and with the supporting wheels of the side support on one side resting on a ditch slope, or wherein the multifunction device avoid obstacles within the ditch depth by having the travel chassis in the air moving between the two side supports positions, or wherein the multifunction device rests with its travel chassis on the ditch bottom and with each of the supporting wheels of the side supports on both ditch slopes and works uninterruptedly while moving along the ditch.

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2. claims: 3-7

A multifunction device further comprising a hydraulic manipulator, a tool turn-table, an operator cab, a tool magazine, while the hydraulic manipulator is situated in front of the travel chassis, whereas the hydraulic manipulator is mounted on the main frame, above the front tool suspension unit, and there is the tool turn-table at the end of the hydraulic manipulator, and furthermore, the rear tool suspension unit is situated behind the travel chassis, and the operator cab is situated on the main frame, between the hydraulic manipulator and the side supports, and at the same time the motor aggregate is situated behind the side supports, whereas the tool magazine is situated above the motor aggregate and/or the operator cab, but within reach of the end of the hydraulic manipulator, and working tools are situated on the front tool suspension unit and/or on the rear tool suspension unit and/or on the tool turn-table, and spare working tools for exchange at the end of the hydraulic manipulator, are stored on the tool magazine.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/PL2012/000020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 1353228 A	21-02-1964	NONE	
FR 1332294 A	12-07-1963	NONE	
WO 2010028649 A1	18-03-2010	DK 176929 B1	25-05-2010
		WO 2010028649 A1	18-03-2010
JP 63227481 A	21-09-1988	---	
US 2002037211 A1	28-03-2002	AU 1203901 A	30-04-2001
		US 2002037211 A1	28-03-2002
		WO 0129328 A1	26-04-2001
DE 102006005213 A1	14-12-2006	NONE	
US 4274795 A	23-06-1981	DE 2913685 A1	18-10-1979
		FR 2421787 A1	02-11-1979
		GB 1577310 A	22-10-1980
		IT 1118474 B	03-03-1986
		JP S54132958 A	16-10-1979
		SE 7903043 A	06-10-1979
		US 4274795 A	23-06-1981
US 2974976 A	14-03-1961	NONE	
FR 1404977 A	02-07-1965	NONE	