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[54] **CRUST-BREAKERS**

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[51] **Int. Cl.²** **E21C 33/00;** C22D 3/02

[58] **Field of Search** 299/37, 38, 40, 70; 173/24, 28, 43; 404/121

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[57] **ABSTRACT**

Crust-breaker unit for ready assembly in or disassembly from a vehicle having front and rear wheels. The unit includes a crust-breaking tool and an arm construction adapted to connect said tool to said vehicle. The arm construction includes a pressure medium cylinder actuable to cause pivoting of link arms of said construction in a vertical plane transversely of the longitudinal direction of the vehicle whereby the tool can be swung from an inactive position close to the side of the vehicle to an outwardly swung working position and vice-versa. The unit further includes a rigid supporting member adapted to be detachably secured to the under side of the vehicle at positions adjacent the vehicle wheels to form the connection of the arm construction to the vehicle.

15 Claims, 2 Drawing Figures

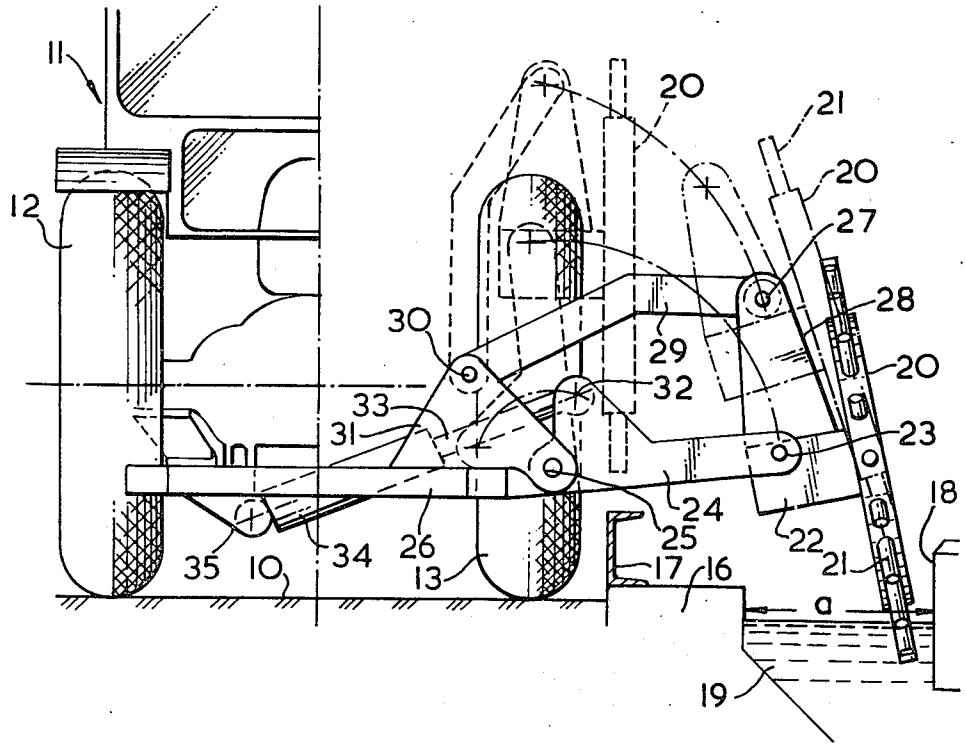
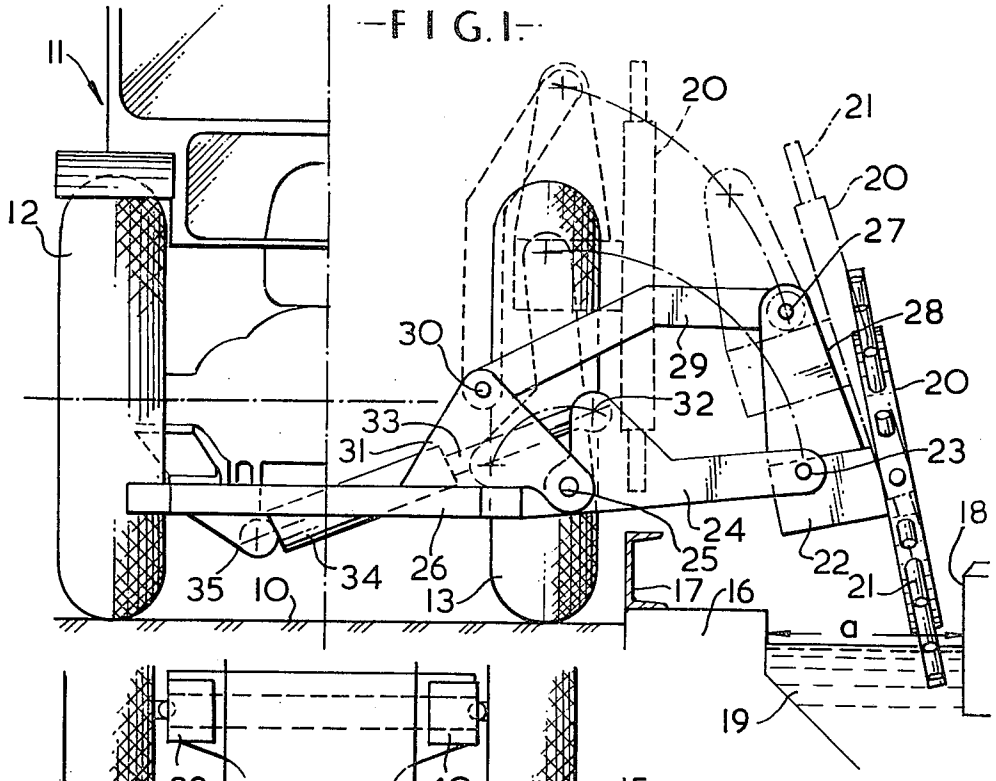


FIG. 1


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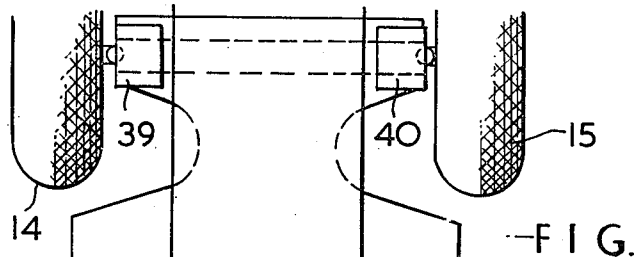
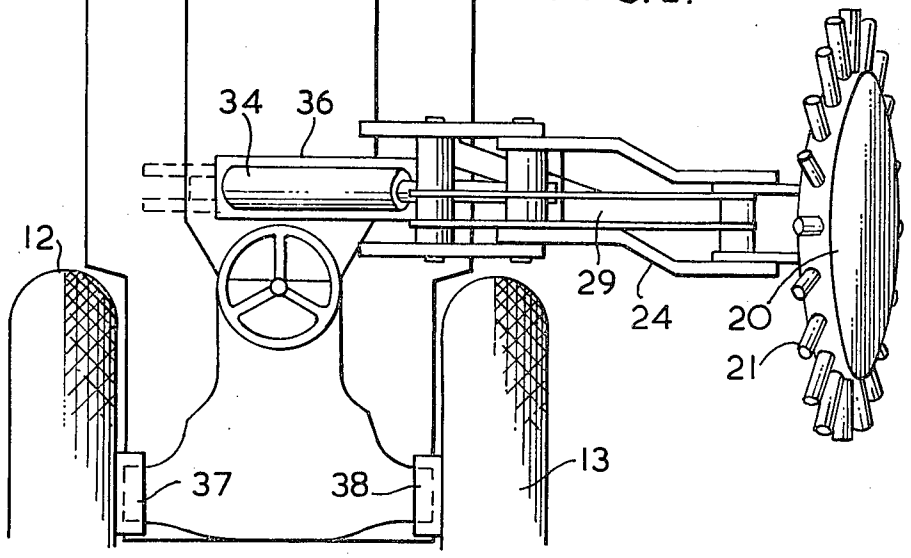

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FIG. 2


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CRUST-BREAKERS

This invention relates, inter alia, to crust-breaker units for ready assembly in or disassembly from a vehicle having front and rear wheels.

In the electrolytic production of aluminium, the crust which is formed on top of the electrolytic bath must be broken down at regular intervals, for example every 3 – 5 hours in order to promote the electrolytic process. Hitherto, this breaking operation has usually been performed by means of a striking tool or a freely rotatable tool, in the form of a wheel having a rim of outwardly projecting radial breaking pins, for example as described in Norwegian Patent Specification No. 106,659.

During use the difference in level between highest and lowest crust levels in the various electrolytic cells amounts to about half a metre, so that in practice there is a need for an operating range for the tool of about half a metre reckoned in a vertical direction. Within this operating range it is desirable to have the least possible horizontal displacement of the tool during movement from or towards a highest or a lowest crust level and the least possible swinging of the lower portion of the tool inwards towards the oven structures during the swing-over of the tool to and from the operating range, viz. away from and towards the inactive position. On the surface of the bath itself, there is usually a relatively narrow gap for the breaking down of the crust, the width of the gap being of the order of magnitude of approximately 40 cm, and inwards towards the center of the electrolytic cell one is limited by the upwardly projecting side surfaces of the electrodes together with other constructional equipment. Furthermore, at the ends of the cell one can be limited by upwardly extending vertical cell supports. In order to drive the vehicle quickly and easily along the row of electrolytic cells without substantial swinging movements, it is of the greatest importance that the tool be displaced as little as possible horizontally during the vertical adjustment of the tool in the operating range above the surface of the bath. It is also desirable to maintain the tool within the operating range in a position which is as far as possible uniform so as to obtain thereby the best possible breaking force regardless of whether the crust is at a high or low level relative to the top of the electrolysis oven.

In a case where a long support arm is utilised for the tool, the weight of the tool will readily give the vehicle a high centre of gravity in the inactive position of the tool when it is swung inwards over the vehicle. As a result, danger can readily occur from the vehicle overturning. The weight of the tool should, therefore, be kept relatively moderate and lower than desirable. Furthermore, there should be a transfer of a correspondingly larger counterweight to the vehicle itself. In solutions with long support arms there are difficulties in distributing the weight of the vehicle and extra counterweight in a desired manner on the vehicle, and in practice there is a poor utilisation of the weight of the vehicle and a series of operating disadvantages. Besides, it has been necessary to use special vehicles of relatively complicated and particularly expensive construction.

With the present invention the aim is to provide a crust-breaker assembly in which the afore-mentioned problems are avoided.

In U.S.S.R. Patent Specification No. 176,690, there is disclosed a crust-breaker having an axially extending striking tool secured to an arm construction having link arms which, by way of a pressure medium cylinder, are pivotable in a vertical plane transversely of the longitudinal direction of the vehicle. The arm construction permits the striking tool to be swung from an inactive position close up to the vehicle to a swung-out working position, and vice-versa. Since an axially extending striking tool is employed, it is required that the vehicle remains at rest during the strike movement so as to avoid thereby undesired loading on the arm construction. With the known construction, the vehicle can be driven intermittently between each crust-breaking operation. The movement of the vehicle and of the tool can be effected, therefore, at their respective points of time totally independently of each other. No particular problems exist with respect to controlling the different movements relative to each other when axially movable striking tools are used.

In the present case, where an axially extending striking tool is replaced by a rolling tool, there occur, on the other hand, problems which are due to the fact that the tool and the vehicle must be moved at the same time and in complete dependence upon each other. Firstly the rolling tool must accompany the movement of the vehicle, that is to say the tool is rolled towards the base of the crust, while the vehicle is driven simultaneously along the crust of the cell. Secondly the rolling movement of the tool towards the base of the crust must be adjusted according to the conditions and according to possible obstacles in or by the base of the crust, that is to say the movement of the tool in the direction of movement of the vehicle must be controlled visually during the simultaneous movement of the tool upwards and downwards in a vertical direction during the simultaneous exertion of a suitable pressure against the base. In order to achieve a completely controllable working relationship, it is essential that the driver of the vehicle is not hindered visually by an upwardly projecting arm construction. In order that the loading on the arm construction, as well as on the construction of the vehicle, shall be the least possible, as a consequence of the movement of the tool in the longitudinal direction of the vehicle, it is also important that the arm construction be of compact design and have a favourable disposition in the vehicle.

According to the present invention a crust-breaker unit for ready assembly in or disassembly from a vehicle having front and rear wheels comprises a crust-breaking tool, a rigid supporting member adapted to be secured to the under side of said vehicle at positions adjacent said wheels thereof and an arm construction interconnecting said tool and said supporting member, said tool consisting of a freely rotatable wheel having breaker pins projecting radially outwards therefrom, said arm construction comprising first and second link arms and a pressure medium cylinder having at one end its piston rod connected to said first link arm and its other end connected to said supporting member, said cylinder being actuable to cause pivoting of said link arms about respective first and second stationary link points thereof forming additional connections with said supporting member at positions remote from said tool, said pivoting being in a vertical plane transversely of the longitudinal direction of the vehicle in which said unit is designed to be assembled whereby the tool can

be swung from an inactive position close to the side of the vehicle to an outwardly swung working position and vice-versa.

The invention also includes a crust-breaker assembly which comprises a vehicle having front and rear wheels, a crust-breaking tool, an arm construction and a rigid supporting member, said tool consisting of a freely rotatable wheel having breaker pins projecting radially outwards therefrom and being connected by said arm construction to said rigid supporting member which is secured at the under side of said vehicle adjacent its front and rear wheels, said arm construction comprising first and second link arms and a pressure medium cylinder having at one end its piston rod connected to said first link arm and its other end connected to said supporting member, said cylinder being actuable to cause pivoting of said link arms about respective first and second stationary link points thereof forming additional connections with said supporting member remote from the tool, said pivoting being in a vertical plane transversely of the longitudinal direction of the vehicle to bring about swinging of said tool from an inactive position close to the side of the vehicle to an outwardly swung working position and vice-versa and the disposition of said supporting member relative to said vehicle providing said tool with a low-lying attack point for its breaking force and enabling the load to be transferred directly to said front and rear wheels of said vehicle.

In the solution according to the invention, several advantages are obtained of a constructional as well as utilitarian nature.

By placing the support member of the arm construction at the under side of the vehicle, the result is that the arm construction can be designed in a robust and simple manner with short link arms. A particular advantage is that the arm construction with associated tool occupies little space in the inactive as well as in the active position, so that the arm construction with tool does not need to hinder the view of the driver of the vehicle. Another advantage is that there is provided a low-lying attack point for the breaking force of the tool and a low-lying centre of gravity for vehicle with attachments, so that there can be obtained an effective transfer of the weight of the vehicle to the tool without loading the vehicle thereby. This follows from the support member being fixed to the under side of the vehicle just by its rear and front wheels for transfer of the load, via the support member, directly to the wheels of the vehicle.

The solution according to the invention thus opens up the possibility of allowing the support member with the arm construction and associated tool to form a coherent crust-breaker unit readily and detachably secureable to the under side of the vehicle. In consequence, such a unit can be utilised for an arbitrary vehicle, for example, a conventional tractor or other vehicle which, in addition, can be used arbitrarily for other purposes. It is also possible to transfer such a unit from vehicle to vehicle as required. A particular advantage is that the support member of the arm construction can serve as an extra reinforcing frame for the vehicle which is used so that an arbitrary vehicle can be utilised for the purpose, without being specially dimensioned originally for such a purpose.

In order that the invention can be more clearly understood, a preferred embodiment thereof will now be described, by way of example, with reference to the accompanying drawings, in which

FIG. **1** is a rear view of a crust-breaker assembly according to the invention, there being excluded, for the sake of simplicity, certain details from the right half thereof and

FIG. **2** is a plan view of the assembly of FIG. **1**, only certain details of the vehicle being indicated.

Referring to FIGS. **1** and **2**, there is illustrated a road surface **10** for a vehicle in the form of a normal commercial tractor **11** having two large rear wheels **12, 13** and two small steerable front wheels **14, 15.**

The side portions of an electrolytic cell are indicated by the referende numeral **16.** Along the upper side portion of the cell extends a channel beam **17** which forms the upper side boundary of the cell with the road surface **10.** Between the side portion **16** of the cell and the cell's electrodes **18** there is shown the bath surface **19** of the cell. The crust which is formed on the top of the bath surface usually has a width of about **40** cm.

The elctrolytic cells are usually installed relatively close to each other in a row, so that one can drive along the row of electrolytic cells and currently break down the crust on these. As required one can drive to and fro along the individual electrolytic cell or progressively from cell to cell, first on the one side of the cell and later on the opposite side of the cell. In certain circumstances the crust can be broken down close to the electrodes, as is indicated in FIG. **1,** and in other circumstances the crust can be broken down closer to the side portion of the cell since the vehicle can be driven to a greater or lesser extent laterally outwards from the beam **17.**

The breaking tool is in the form of a wheel **20** having a rim of breaking pins **21** directed radially outwards which are adapted, in a manner known per se, to break down the crust by the local pressure loading from each individual pin gradually as the wheel is rotated. The wheel **20** is freely rotatably mounted in a bearing **22** which at a lower link point **23** is jointed to a first, lower link arm **24** which, in turn, is jointed to a stationary link point **25** to a supporting frame **26** on the vehicle. The bearing **22** is jointed, via an upper joint point **27** in a bracket **28,** with a second upper link arm **29** which, in turn, is jointed at a stationary link point **30** to the upper end of a bracket **31** on the supporting frame **26** at a suitable level above and at a suitable distance laterally within the link point **25.** The link arm **24** is jointed, via a link point **32** between the link points **23** and **25,** to the outer end of a piston rod **33** of a pressure medium cylinder **34,** the opposite end of which is jointed to a bracket **35** on the under side of the supporting frame **26.** The cylinder **34** with piston rod **33** is swingable in a gap **36** in the supporting frame **26.** In the fully retracted position of the piston rod, the wheel **20** occupies a vertical position as indicated by the dotted lines in FIG. **1** and which constitutes the inactive position of the wheel, for example, for driving the vehicle to and from the electrolysis hall. By the chain dotted lines, the wheel is illustrated in a first working position by acting on the crust at an upper level of the bath surface of the cell, and by the full lines the wheel is illustrated in a second working position by acting on the crust at a lower level of the bath surface of the cell, where the piston rod of the cylinder is shown approximately fully extended. The two working positions illustrated constitute substantially the limits of the operating range for

which the wheel is to be utilised during the breaking down of the crust in the various cells. It will be evident that in both the illustrated outer positions of the operating range, the wheel has a certain lesser oblique position relative to a vertical plane, with only a lesser mutual angle deviation in the two outer positions. A particular object of the oblique position of the wheel is that the pins can now reach the furthest towards the electrodes without, in addition, being obstructed by the wheel.

Since the wheel performs a minimal swinging movement in the operating range and between the operating range and the inactive position and is only moved within a relatively restricted range vertically and sideways relative to the vehicle, it is possible to effect a relatively rapid adjustment of the wheel between the different positions available without substantially altering the centre of gravity of the vehicle. This involves firstly a ready adjustment of the wheel during use. Secondly the range of movement permits the utilisation of a relatively large proportion of the weight in the wheel itself so as to obtain thereby a favourable breaking force against the crust via the wheel.

Upper link arm **29** can, if desired, be replaced by an extra pressure medium cylinder which is jointed at the one end of the cylinder and at the opposite end of the associated piston rod. As a consequence, there is the possibility, if desired, of being able to regulate the angular position of the wheel **20** independently of the swinging movement of the link arm **24.** In the illustrated embodiment there is the possibility of being able to effect the swing-over of the wheel **20** by a relatively uncomplicated action by means of a single pressure medium cylinder, while by the alternative embodiment there can be obtained a more precise swing-over of the wheel according to need by operating, separately, two pressure medium cylinders which are independently actuable. If desired, the two pressure medium cylinders can be jointly controlled by pressure medium action in certain phases of the swing-over movement and separately in other phases of the swing-over movement away from and towards the inactive position.

The supporting frame **26** is designed in the form of a rigid, relatively thick steel plate, the considerable weight of which together with the weight of the vehicle, in addition, constitutes a counterweight for the breaking force of the wheel **20** against the crust. The frame or the plate **26** is secured relatively low down on the vehicle so that the crust-breaker has a relatively low-lying centre of gravity and so that the arm construction has a relatively low-lying point of engagement on the frame. The frame is fastened to the vehicle in a rigid connection with the latter at the four corners of the frame via fastening means **37, 38, 39, 40** located adjacent rear wheels **12, 13** and front wheels **14, 15** respectively, so that the weight loading of the frame and the other loading on the frame during use can be transferred directly to respective wheels without loading the vehicle with adverse stresses. At the same time the frame will serve to reinforce the vehicle in a desired manner so that, with advantage, one can employ, for example, a conventional tractor having a fairly elastic connection between front and rear wheels, as a fully supported vehicle. On replacing the vehicle or other parts of the crust-breaker, the frame **26** can be disassembled from the vehicle in a relatively easy manner with the arm construction and wheels as a unit so that the frame with arm construction and wheels and vehicle can be handled respectively as independent units. In this connection, the frame can be connected to the vehicle by means of screw bolts or similar fastening means not shown further.

As a practical working example, there is utilised a tractor of the type "FORD 5000" which with a total weight of the crust-breaker assembly (vehicle, arm construction and tool) of approximately 6000 kg., a breaking force of 2,500 kg. has been obtained. In comparison, crust-breakers of known construction having a total weight of crust-breaker of over 7000 kg. produce a breaking force of only 17 – 1800 kg.

Special advantages which are achieved according to the invention are that the tool can be brought rapidly and readily upwards and outwards from the bath, the path of movement being short and the operation time correspondingly short,

that the centre of gravity is maintained low the whole time in relation to the vehicle so that there is obtained good stability and favourable operating conditions for the crust-breaker,

that an overhang of the tool is avoided in front or behind the vehicle and the adjustment of the crust-breaker is thereby made easier,

that the view of the tool is not obstructed in its inactive position and at the same time the total breadth and/or height of the vehicle is reduced,

that the best possible uniform and advantageous distribution of the weight of the crust-breaker on the whole vehicle can be achieved and a simultaneous effective reinforcement of the vehicle by means of the heavy plate-shaped frame,

and that a relatively large proportion of the weight can be transferred to the tool itself so as to obtain thereby a favourable breaking force.

What we claim is:

1. A crust-breaker unit for ready assembly in or disassembly from a vehicle having front and rear wheels which comprises a crust-breaking tool, a rigid supporting member adapted to be secured to the under side of said vehicle at positions adjacent said wheels thereof and an arm construction interconnecting said tool and said supporting member, said tool consisting of a freely rotatable wheel having breaker pins projecting radially outwards therefrom, said arm construction comprising first and second link arms and a pressure medium cylinder having at one end its piston rod connected to said first link arm and its other end connected to said supporting member, said cylinder being actuable to cause pivoting of said link arms about respective first and second stationary link points thereof forming additional connections with said supporting member at positions remote from said tool, said pivoting being in a vertical plane transversely of the longitudinal direction of the vehicle in which said unit is designed to be assembled whereby the tool can be swung from an inactive position close to the side of the vehicle to an outwardly swung working position and vice-versa.

2. The unit according to claim **1,** wherein the supporting member is formed from thick, heavy metal plate.

3. The unit according to claim **1,** wherein the first stationary link point is located adjacent a longitudinal edge of the supporting member and substantially at the level of the latter while the second stationary link point

is located at a somewhat higher level and laterally inside said first stationary link point.

4. The unit according to claim 1, wherein the wheel of the crust-breaking tool is mounted for free rotation in a bearing which at a lower joint point is connected to an end of the first link arm and at an upper joint point to an end of the second link arm.

5. The unit according to claim 4, wherein the connection of the piston rod with the first link arm is between the connections of that arm with the bearing and with the supporting member respectively.

6. The unit according to claim 4, wherein the second link arm is replaced by a second pressure medium cylinder having its piston rod connected to the upper joint point while the other end is connected to the second stationary link point.

7. A crust-breaker assembly which comprises a vehicle having front and rear wheels, a crust-breaking tool, an arm construction and a rigid supporting member, said tool consisting of a freely rotatable wheel having breaker pins projecting radially outwards therefrom and being connected by said arm construction to said rigid supporting member which is secured at the under side of said vehicle adjacent its front and rear wheels, said arm construction comprising first and second link arms and a pressure medium cylinder having at one end its piston rod connected to said first link arm and its other end connected to said supporting member, said cylinder being actuable to cause pivoting of said link arms about respective first and second stationary link points thereof forming additional connections with said supporting member remote from the tool, said pivoting being in a vertical plane transversely of the longitudinal direction of the vehicle to bring about swinging of said tool from an inactive position close to the side of the vehicle to an outwardly swung working position and vice-versa and the disposition of said supporting member relative to said vehicle providing said tool with a low-lying attack point for its breaking force and enabling the load to be transferred directly to said front and rear wheels of said vehicle.

8. The assembly according to claim 7, wherein the supporting member is formed from thick, heavy metal plate.

9. The assembly according to claim 8, wherein the supporting member is detachably secured at the under side of the vehicle permitting joint disassembly from the latter of said member, the arm construction and the crust-breaking tool constituting a crust-breaker unit.

10. The assembly according to claim 9, wherein the vehicle is a tractor.

11. The assembly according to claim 9, wherein the supporting member forms an extra reinforcing frame for the vehicle and confers a low-lying centre of gravity on the latter.

12. The assembly according to claim 7, wherein the first stationary link point is located adjacent a longitudinal edge of the supporting member and substantially at the level of the latter while the second stationary link point is located at a somewhat higher level and laterally inside said first stationary link point.

13. The assembly according to claim 7, wherein the wheel of the crust-breaking tool is mounted for free rotation in a bearing which at a lower joint point is connected to an end of the first link arm and at an upper joint point to an end of the second link arm.

14. The assembly according to claim 13, wherein the connection of the piston rod with the first link arm is between the connections of that arm with the bearing and with the supporting member respectively.

15. The assembly according to claim 13, wherein the second link arm is replaced by a second pressure medium cylinder having its piston rod connected to the upper joint point while the other end is connected to the second stationary link point.

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