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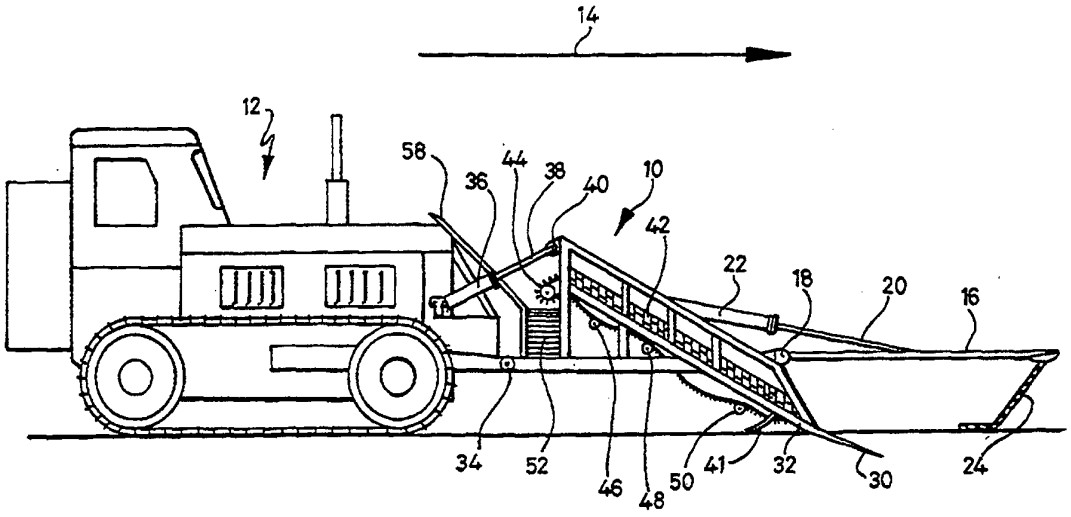
(54) Title: MINE CLEARING MACHINES



(57) Abstract

Mine clearing machine (100) comprises trailing steel mine detonating fingers (116), ground-penetrating tines (118), and an adjustable ground shear blade (120) able to plane the surface of, or to excavate, the ground to be cleared. A first conveyor or trace (134) conveys material cleared, including any undetonated mines, from the path of travel of machine (100) rearwardly from ground shear blade (120) and on to a second conveyor or trace (154) which deposits the material to the side of the cleared path. The traces (134, 154) are constructed to allow soil and sand to drop through them. Undetonated mines may be lifted from the either trace by an articulated crane (150). Undetonated mines (166) discharged to the side of the cleared path may be detonated or destroyed by a flame cutter (160). The mine clearing machine may be propelled by a dedicated prime mover (104), or mounted upon and propelled by tank, bulldozer or the like.

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Mine Clearing Machines

The present invention relates to a method and means for clearing explosive mines lying on or below the surface of the ground.

In warfare explosive mines may be laid on or below the surface of ground which is to be defended from advances by opposing forces. The mines may be set to be detonated by one or more of a number of events, or may be left unset for subsequent setting in the event of an attack.

When such territory has been taken by the opposing forces, or in the event of cessation of hostilities, the continued presence of such mines is a hazard to the movement of vehicles and personnel, both military and civilian, and can remain so for a long period unless effectively cleared.

The most usual manner of clearing mines in bulk from an area of ground is by use of mechanical flails carried by a boom mounted forward of a prime mover, such as a tank, bulldozer or other heavy vehicle, the flails rotating to strike the ground forward of the vehicle, thereby to detonate any mines set to be detonated, and to dislodge any remaining unset mines from, and from immediately below, the surface of the ground, for subsequent destruction or removal.

The disadvantages of such a method include the inability to dislodge mines buried more than a few inches below the ground, the scattering over a wide area of mines

dislodged, the production of task-disruptive or activity-identifying clouds of dust, particularly in dry or sandy ground, and the inability to progress at more than about 1 kilometre (approximately 0.7 miles) per hour.

Although preferable to the manual removal of mines, one by one, use of such a method is still slow and hazardous.

The object of the present invention is to provide a improved method and means of clearing explosive mines upon and below the surface of the ground, at a greater speed and to a greater depth than has hitherto been realised by previously known methods and means.

In accordance with one aspect the invention consists in a method of clearing explosive mines consisting of the steps of:

passing detonating means over the surface of ground to be cleared, thereby to detonate any mines set to be detonated upon handling;

removing undetonated mines from the surface and/or the sub-surface of such ground; and

conveying mines so removed to a location remote from the ground traversed.

The removal of mines from the sub-surface of the ground may include the step of excavating the sub-surface, and the method may include the further step of separating the removed mines from some or all of the spoil excavated from the sub-surface.

The method in accordance with the invention may include the step of planing the surface of the ground to be cleared.

The method may further include the step of destroying the excavated mines following their removal to a location remote from the ground traversed.

In accordance with a further aspect of the invention mine clearance apparatus in accordance with the invention comprises detonating means adapted to be moved across the surface of the ground to be cleared, forward of the path of the mine clearance apparatus and of a prime mover upon which such mine clearance means is mounted, or by which such mine clearance means is propelled; mine collecting means adapted to collect from the ground traversed by the detonating means, mines not detonated; and conveying means adapted to convey mines from the mine collecting means to a location remote therefrom.

The detonating means may comprise trailing chains or trailing metal fingers.

The collecting means may comprise means adapted to excavate mines lying below the surface of the ground traversed by the detonating means and/or means adapted to collect mines from the surface of the ground by planing such ground.

Such means are conveniently provided by a ground shear blade mounted rearwardly of the mine detonating means. The depth to which the ground shear blade may be inserted into the ground to be cleared is adjustable. The ground shear

blade may be moved upwardly from the ground and rearwardly, to deposit material cleared from the ground on to the conveying means.

The mine clearance apparatus collecting means may further comprise ground penetrating means rearward of the detonating means but forward of the excavating means.

The conveying means may be a trace or conveyor adapted to convey material rearward from the collecting means. A further trace or conveyor may be provided to receive material from the first trace or conveyor and to transfer such material, including undetonated mines, to a location alongside the track of the mine clearing machine.

The, or both, traces or conveyors may comprise means to separate such mines from some or all of the material.

The mine clearance apparatus may also comprise means for detonating or otherwise destroying the excavated mines, for example, by means of a flame burner.

The mine clearance apparatus in accordance may also be provided with means for lifting unexcavated mines from the conveying means, for example, a crane or the like.

The invention will be described by way of example with reference to embodiments of the invention illustrated in the accompanying drawings of which:

Figure 1 is a diagrammatic side view of a mine clearance machine in accordance with the invention;

Figure 2 is a diagrammatic plan view of the mine clearance machine of Figure 1, on a different scale, viewed from above;

Figure 3 is a perspective view of a further mine clearance machine in accordance with the invention, carried by a separate prime mover; and

Figure 4 is a perspective view of a mine clearance machine similar to that illustrated in Figure 3, carried by a dedicated prime mover.

Referring to Figures 1 and 2 of the drawings, a mine clearance machine, generally indicated at 10, is attached to, or mounted upon, a prime mover 12, such as a bulldozer, tank or other heavy vehicle, in order to be moved in the direction indicated by the arrow 14 over ground to be cleared of explosive mines.

Machine 10, which may be constructed within a steel framework generally rectangular in plan, carries at its forward end a boom 16, pivotally supported and mounted at 18 and having attached near its mid-point piston-rod 20, one end of which is able to move inwardly into damping cylinder 22, against the force exerted by a spring contained in cylinder 22, in the event of any upward displacement of boom 16.

At its outer end boom 16 carries across its width a number of heavy chains 24 of sufficient length to reach the ground below the boom 16 and to trail along the ground in the manner shown, when the prime mover 12 and hence the machine 10 is driven forward in the direction of arrow 14.

Below the inner end of boom 16, a rigid ground shear 30, set substantially at right angles to the direction of travel of machine 10, is mounted on the framework

comprising members 32 and 33, pivotted at 34. The ground shear 30 is set at an angle of some 30 degrees to the surface of the ground through which it is moved. Ground shear 30 may be raised or lowered, in order to excavate the ground being cleared to a greater or lesser depth, by means of the hydraulic cylinder 36 and piston 38 pivottally attached to the framework comprising members 32 and 33, at 40.

A contouring sensor 41, operating in a known manner, is linked to control means associated with the prime mover 12, to maintain a selected depth of penetration into the ground of ground shear 30, by control of the position of piston 38 within cylinder 36.

Within the framework comprising members 32 and 33 there is mounted a trace or conveyor 42 comprised of a series of rubber belts 42a, arranged side-by-side and attached to one another by means of a series of steel cross bars 42b. Gaps between the bars 42b are sufficient to allow soil and smaller stones to be discharged therethrough, but not any mines which may be picked up or excavated by ground shear 30.

The trace 42 is continuous, passing at its upper end around driven roller 44, and returning downwardly over idler rollers 46, 48, and 50.

At its upper extremity trace 42 passes above a further trace or conveyor 52, mounted substantially at right angles to trace 42, and driven, by means not shown, in the direction of the arrow 54, thereby to convey any

undetonated mines to mine destruction means 56, such as a flame burner and/or cutter.

An angled steel deflector plate 58 is mounted rearwardly of trace 52 and mine destruction means 56, to provide protection for the prime mover 12 and its operating personnel.

In operation, mine clearance machine 10 is driven over ground to be cleared by the prime mover 12, chains 24 trailing over the ground from boom 16, in order to detonate any mines set to be detonated by the passage of vehicles or personnel, and any mines unset but fitted with anti-handling devices. The force of any explosions sufficient to deflect boom 16 upwardly are absorbed by the movement of piston rod 20 against the coil spring contained within cylinder 22.

Shear blade 30 penetrates the ground to a pre-set and contour-regulated depth determined by the setting of hydraulic control means associated with cylinder 36, and causes soil, larger particles, and any unexploded mines to lift on to the trace 42, which moves them upwardly, discharging soil and smaller stones from the spaces between the bars 42b. Other material, including unexploded mines, is conveyed by trace 42 over roller 44, deposited upon the further trace 52 and conveyed to the mine destruction means 56. Destroyed mines, together with the larger excavated particles, are discharged from trace 52 either on to the surface of the ground to one side of the mine clearance machine 10, out of the path of the prime mover 12, or, if

trace 52 is sufficiently elevated, into a vehicle travelling alongside the machine 10.

It will be appreciated that modifications may be made to the embodiment of the invention described in relation to Figures 1 and 2, without exceeding the scope of the invention. For instance means other than chains 24 may be used to detonate any detonatable mines forward of the ground shear 30 of the clearance machine 10, and any undetonated mines may simply be discharged from trace 52 to one side of the path of prime mover 12, or into a vehicle, for inspection prior to destruction, which could be at a location remote from the machine 10. The mine clearance machine may be constructed to be attached to, and may be powered by, a separate prime mover such as 12, or may be provided with a dedicated prime mover.

The mine clearance machines generally shown as 100 in Figures 3 and 4, are essentially similar except for the mode of propulsion and powering, the first being attached to a tracked and armoured bulldozer 102 and the second to dedicated armoured motor unit 104.

Referring to Figures 3 & 4, the mine clearance machine 100 is constructed with a generally rectangular steel framework with a forward boom element 114 which carries a series of downwardly-depending trailing steel fingers 116 arranged across the path of travel of the machine 100 and intended to detonate any detonatable mines which may be encountered. To the rear of the fingers 116 are mounted four sprung tines 118, concave in the direction of travel,

similarly arranged across the path of travel. Tines 118 are of such a length to penetrate and loosen the ground surface ahead of ground shear blade 120 besides being able to detonate any sub-surface detonatable mines not activated by fingers 116.

Shear blade 120 is carried between the side members 122 of a steel sub-frame 124, mounted to pivot at points 126 on each side of the main frame, under the control of pistons 128, operated by hydraulic cylinders 130, and pivotally attached to sub-frame 124 at points 132. Shear blade 120 may thus be set to penetrate the ground to a controllable extent, and to be brought upwardly and rearwardly to dislodge spoil, including any undetonated mines, on to the trace 134 to its rear.

Trace 134 comprises a series of continuous side-by-side rubber belts 136, tied together by steel bars 138, and driven by a powered roller, not shown, to convey rearwardly spoil riding up on to it, including any undetonated mines such as 140, from ground shear blade 120.

Openings 142 along the sidewalls 144 along the leng of trace 134 are closed with armoured steel mesh 146, to protect personnel alongside the machine 100 from any blast fragments due to inadvertent detonation on the trace 134 of any previously undetonated mines.

Multiply-articulated crane 150 mounted to the rear of machine 100 and controlled hydraulically from within the motive power unit has a grip head 152 able to pick up any mines such as 140, either for disposal clear of the track

of machine 100 and its motive power unit, or for direct deposit on to the second trace 154, or for remote inspection by the crew seated behind armoured glass in the motive power unit.

Trace 154, arranged substantially at right angles to trace 134 and running from left-to-right driven by a further powered roller (not shown), is mounted below the turn-over of trace 134 and receives from it spoil and undetonated mines conveyed upwardly from ground shear blade 120. Such material is conveyed by trace 154, which projects outwardly at 156 clear of the track of the motive power unit.

Mounted to the rear of armour plate shield 158 is a burner unit 160, carried upon an extending arm 162, and able, under the control of the crew of the motive power unit, to destroy by flame cutting, or to detonate, any previously undetonated mines 164,166 deposited by trace 154.

The mass of the mine clearance machine 100 is largely supported by wheels 170 mounted either side of the main frame member of the mine clearance machine 100, which is pivotally linked to the motive power unit about an axis substantially at right angles to the direction of travel of the combination, to enable the mine clearance machine 100 to be deflected upwardly, for example by the blast from a mine, independently of the motive power unit.

A mine clearance machine as described herein for attachment to a separate prime mover such as 102 has been

constructed having the approximate dimensions 3.6M long, 3.2M wide and 1.0M high, with a path clearance width of 3.2M, being able to excavate the ground to a depth of some 1.0M, dependent upon the nature of the sub-surface.

With a dedicated motive power unit such as 104, a mine clearance machine has been constructed having the approximate inclusive dimensions 6.0M long, 2.15M wide, 1.8M high, with a path clearance width of 2.4M.

The machines 100 are able to travel whilst operating at between 1.5kM and 15kM (approximately 1 mile to 10 miles) per hour, dependent upon the setting of ground shear 120, which may, at one extreme, plane the surface of the ground, for example when collecting bomblets from an airfield runway, or, at the other, penetrate and excavate ground to a depth of some 1.0M, dependent upon the nature of the sub-soil.

It will be appreciated that a mine clearance machine in accordance with the invention enables mined ground to be more speedily, more effectively, and more safely cleared than with prior art machines and methods.

Claims

1. A method of clearing explosive mines consisting of the steps of:

passing detonating means over the surface of ground to be cleared, thereby to detonate any mines set to be detonated upon handling;

removing undetonated mines from the surface and/or the sub-surface of such ground; and

conveying mines so removed to a location remote from the ground traversed.

2. A method according to Claim 1 in which the removal of mines from the sub-surface of the ground includes the step of excavating the sub-surface.

3. A method according to claim 2 including the further step of separating the removed mines from some or all of the spoil excavated from the sub-surface, during the conveying step.

4. A method according to Claim 1 in which the removal of mines from the surface includes the step of planing the surface of the ground to be cleared.

5. A method according to any previous claim including the step of destroying the excavated mines following their removal to a location remote from the ground traversed.

6. Mine clearance apparatus comprising detonating means adapted to be moved across the surface of the ground to be cleared, forward of the path of the mine clearance apparatus and of a prime mover upon which such mine clearance means is mounted, or by which such mine clearance

means is propelled; mine collecting means adapted to collect from the ground traversed by the detonating means, mines not detonated; and conveying means adapted to convey mines from the mine collecting means to a location remote therefrom.

7. Mine clearance apparatus in accordance with claim 6 in which the detonating means comprises trailing chains.

8. Mine clearance apparatus in accordance with Claim 6 in which the detonating means comprises trailing metal fingers.

9. Mine clearance apparatus in accordance with any one of Claims 6, 7, or 8 in which the collecting means comprises means adapted to excavate mines lying below the surface of the ground traversed by the detonating means.

10. Mine clearance apparatus in accordance with Claim 6, 7 or 8 which the collecting means comprises means adapted to collect mines from the surface of the ground by planing such ground.

11. Mine clearance apparatus in accordance with Claim 9 or Claim 10 in which the means adapted to excavate or to plane such ground is a ground shear blade mounted rearwardly of the mine detonating means.

12. Mine clearance apparatus in accordance with Claim 11 in which depth to which the ground shear blade may be inserted into the ground to be cleared is adjustable.

13. Mine clearance apparatus in accordance with Claim 11 or Claim 12, in which the ground shear blade may be moved upwardly from the ground and rearwardly, to deposit

material cleared from the ground on to the conveying means.

14. Mine clearance apparatus in accordance with any one of Claims 6 to 13 in which the collecting means further comprises ground penetrating means rearward of the detonating means but forward of the excavating means.

15. Mine clearance apparatus in accordance with any one of Claims 6 to 14 in which the conveying means is a trace or conveyor adapted to convey material rearward from the collecting means.

16. Mine clearance apparatus in accordance with Claim 16 comprising a further trace or conveyor adapted to receive material from the first trace or conveyor and to transfer such material, including undetonated mines, to a location alongside the track of the mine clearing machine.

17. Mine clearance apparatus in accordance with Claim 15 or Claim 16 in which the, or both, such traces or conveyors comprise means adapted to separate such mines from some or all of the material.

18. Mine clearance apparatus in accordance with anyone of Claims 6 to 17, further comprising means for detonating or otherwise destroying the excavated mines.

19. Mine clearance apparatus in accordance with Claim 18 in which said means is a flame burner.

20. Mine clearance apparatus in accordance with any one of Claims 6 to 19 comprising means for lifting unexcavated mines from the conveying means.

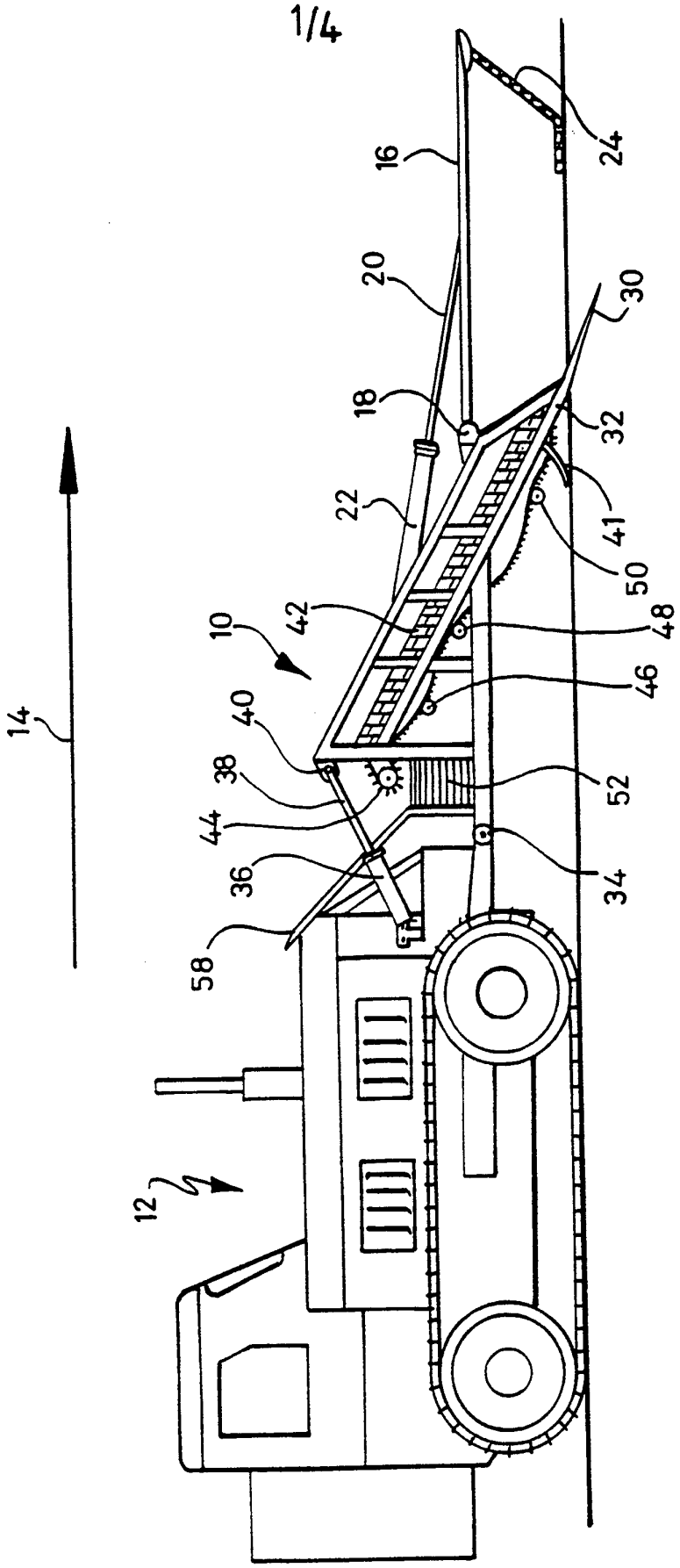

Fig. 1

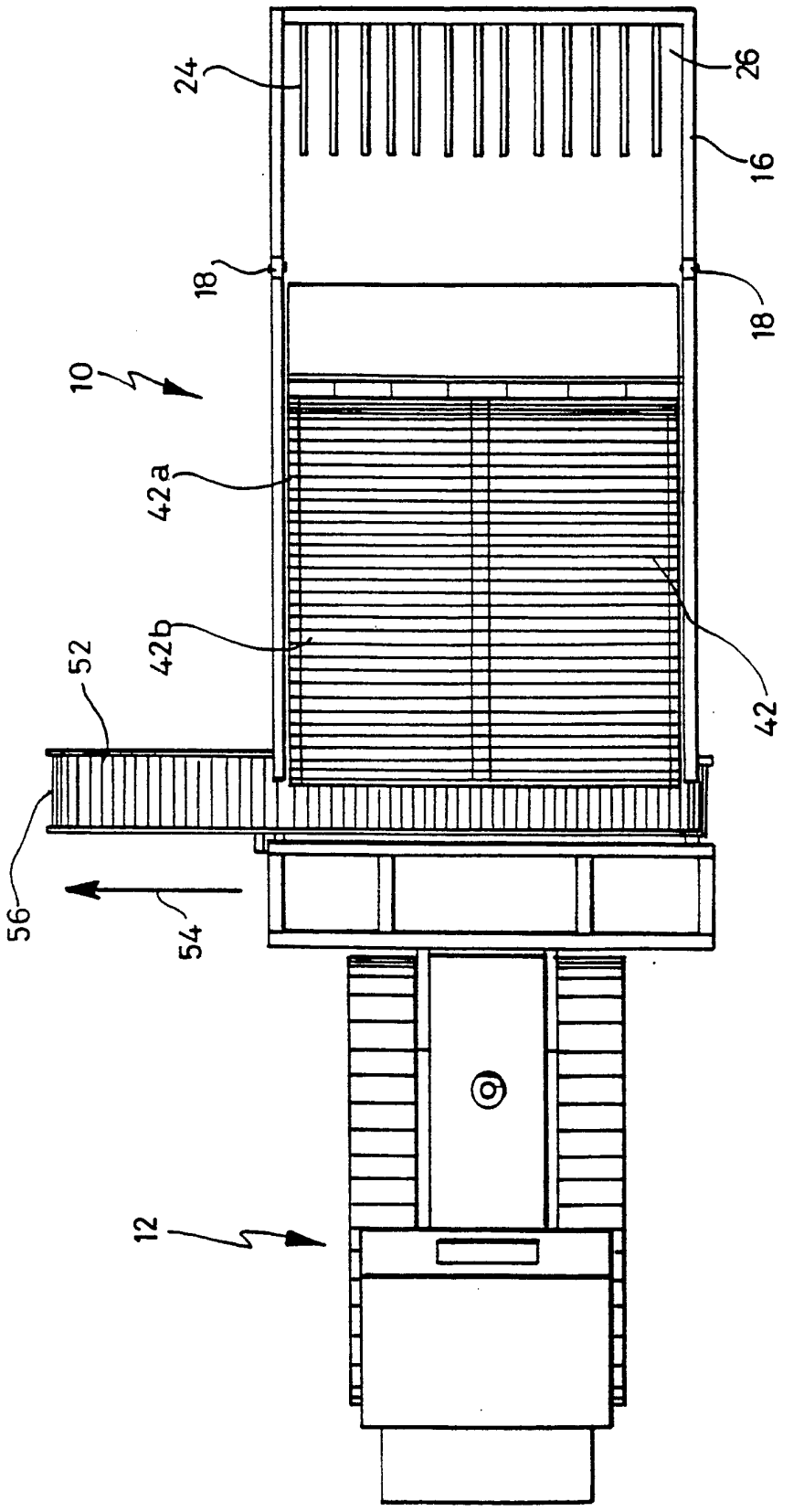

Fig. 2

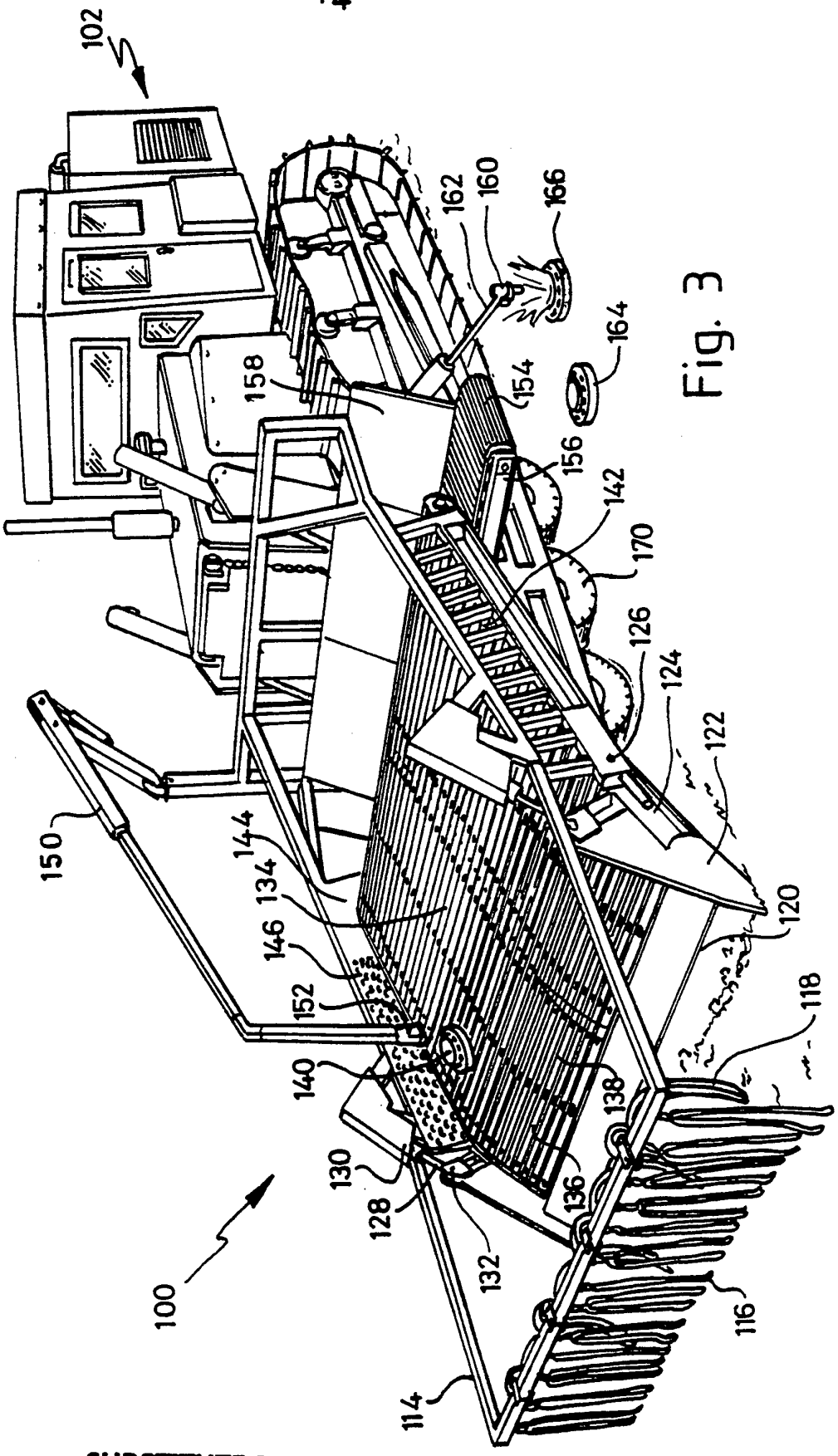
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Fig. 3

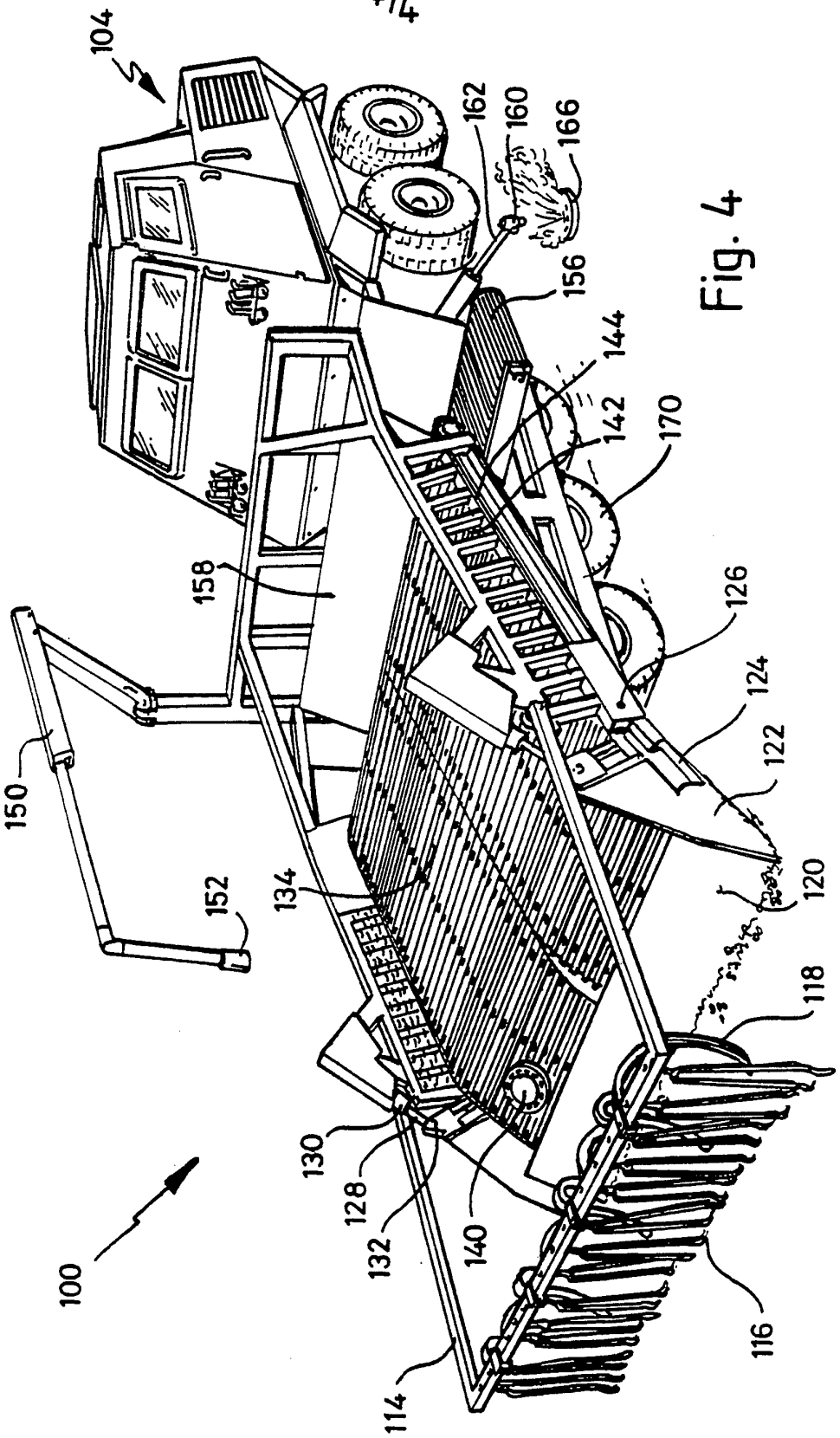
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Fig. 4

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 96/01231

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F41H11/16

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F41H

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US,A,5 291 819 (H. HAMBRIC) 8 March 1994 see column 4, line 58 - column 6, line 51; figures 1-5 ---	1-12, 14-17,20
Y	US,A,5 189 243 (H. HAMBRIC) 23 February 1993 see column 5, line 31 - column 6, line 10; figures 8,9 --- -/--	1-3,6, 9-11,14, 15,17

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 June 1996	12. 07. 96

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ›nal Application No
PCT/GB 96/01231

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