PATENT APPLICATION FORM (CONVENTION AND NON-CONVENTION)

COMMONWEALTH OF AUSTRALIA — Regulation 9

Patents Act 1952

APPLICATION FOR A STANDARD PATENT OR A STANDARD PATENT OF ADDITION

LODGED AT SUB-OFFICE
- 9 JAN 1986
Sydney

(a) Insert full name(s) of applicant(s)

I/We (a) DAVID MACBETH MACWATT

(b) Insert address(es) of applicant(s)

of (b) 4 Reidhaven Street, Elgin, Morayshire, Scotland, Great Britain

(c) Delete as appropriate

hereby apply for the grant of a (c) Standard Patent for an invention entitled (d)

(d) Insert title of invention

APPARATUS FOR CLEARING MINES

which is described in the accompanying (complete) specification.

(e) For a Convention application — details of basic application(s) —

(e) for Convention cases only

NUMBER	COUNTRY	DATE OF APPLICATION
8500569	United Kingdom	10th January 1985

(f) For Patents of Addition only.

(f) ~~For Patents of Addition (Section 73):~~

I/We request that the Patent may be granted as a Patent of Addition to the Patent applied for on Application No. (g)

(g) Insert number of 'parent/main' application/or patent as appropriate.

Patent No. (g) in the name of (h)

(h) Insert name of applicant/patentee of 'parent/main' application or patent as appropriate.

I/We request that the term of the Patent of Addition be the same as that for the main invention or so much of the term of the patent for the main invention as is unexpired.

My/~~Our~~ address for service is ARTHUR S. CAVE & CO., Patent and Trade Mark Attorneys, 1 Alfred Street, Sydney, New South Wales, Australia 2000.

(i) Insert day, month and year form signed.

Dated this (i) 3rd day of January 1986

(j) Signature of applicant or Australian attorney.

DAVID MACBETH MACWATT
By His Patent Attorneys
ARTHUR S. CAVE & CO.

(j) (Signature)

(k) Seal, if any. (k)

To:

Commissioner of Patents

ARTHUR S. CAVE & CO.
PATENT AND TRADE MARK ATTORNEYS
SYDNEY

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 23.11.89

A.S.C. — 1

PATENT DECLARATION FORM (CONVENTION)
COMMONWEALTH OF AUSTRALIA
Patents Act 1952

Regulation 12 (2)

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

To be signed by the applicant(s) or in the case of a body corporate to be signed by a person authorised by the body corporate.

In support of the Convention application made for a patent for an invention entitled

(a) Insert title of invention.

(a) "Apparatus for Clearing Mines"

(b) Insert full name(s) of declarant(s).

I/~~We~~ (b) David MacBeth MacWatt
A British Subject

(c) Insert address(es) of declarant(s).

of (c) 4 Reidhaven Street, Elgin, Morayshire, Scotland, Great Britain

do solemnly and sincerely declare as follows:–

1. I am/~~are~~ the applicant(~~s~~) for the patent

~~[illegible]~~

2. The basic application(s) as defined by Section 141 of the Act was/were made in the following country or countries on the following date(s) namely:–

(d) Insert country in which basic application(s) was/were filed.
(e) Insert date of basic application(s).
(f) Insert full names of basic applicant(s).

in (d) United Kingdom on (e) 10th January 1985
by (f) David MacBeth MacWatt
in (d) ..... on (e) .....
by (f) .....
in (d) ..... on (e) .....
by (f) .....

3. I am/~~are~~ the actual inventor(~~s~~) of the invention referred to in the basic application.

~~(OR, WHERE A PERSON OTHER THAN THE INVENTOR IS THE APPLICANT)~~

(g) Insert full name(s) of actual inventor(s)
(h) Insert address(es) of actual inventor(s).

3. (g) .....
of (h) .....

is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:

(i) Set out how applicant(s) derive(s) title from actual inventor(s) i.e., assignee of the invention from the actual inventor(s).

(i) .....

4. The basic application(s) referred to in paragraph 2 of this Declaration was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

Attestation or legalization not required.

Declared at ELGIN-SCOTLAND this 20th day of December 1985

To:

The Commissioner of Patents

David MacBeth MacWatt
Signature of Declarant(s)

ARTHUR S. CAVE & CO.
PATENT AND TRADE MARK ATTORNEYS
SYDNEY

A S C - 1

(12) PATENT ABRIDGMENT (11) Document No. AU-B-52163/86
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 593230

(54) Title
APPARATUS FOR CLEARING MINES

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(74) Attorney or Agent
ARTHUR S. CAVE & CO.

(56) Prior Art Documents
AU 52230/86 F41H 11/16

(57) Claim

1. A flail vehicle comprising a tractor unit and rotatable ground-beating means mounted at one end of the tractor unit, the ground-beating means comprising a shaft which is rotatable about a central axis, said central axis being substantially parallel to the ground and transverse to the direction of travel of the vehicle, said shaft carrying a distributed array of flexible flail chains extending radially outwardly from said shaft, each of said flail chains having a direction connection to said shaft, the distribution of flail chains within said array being such that each said connection is angularly and axially offset around and along said shaft from the nearest adjacent said connection, and any two of said connections in said array which are adjacent in a direction substantially parallel to the central axis being spaced apart by at least thirty centimetres as measured along the shaft in a direction parallel to said central axis.

COMMONWEALTH OF AUSTRALIA

Form 10
Regulation
13(2)

PATENTS ACT, 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

593230

Application Number: 52163/86
Lodged:

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

Related Art:

This document contains the amendments made under Section 49.

and is correct for printing.

TO BE COMPLETED BY APPLICANT

Name of Applicant: David MacBeth MACWATT

Address of Applicant: 4 Reidhaven Street, Elgin, Morayshire, Scotland, Great Britain

Actual Inventor: David MacBeth MACWATT

Address for Service: ARTHUR S. CAVE & CO., Patent and Trade Mark Attorneys, 1 Alfred Street, Sydney, New South Wales, Australia, 2000.

Complete Specification for the invention entitled:

APPARATUS FOR CLEARING MINES

The following statement is a full description of this invention, including the best method of performing it known to me:-

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ASC-49

Apparatus for Clearing Mines

This invention relates to a vehicle for use in clearing mines.

It has been proposed in French Patent Nos. 914,284 and 2,509,849, British Patent No. 2,126,958, and US Patent No. 2,489,564 to clear mines by using a flail mounted at the forward end of a tractor or tank, the flail consisting of a number of chains attached at one end to a rotatable shaft, the other ends of the chains being free. The shaft in use is rotated at a height above the ground less than the length of the chains, so that the free ends of the chains beat the ground and detonate any mines which are present. French Patent No. 914,284 additionally suggests that such flails might be mounted on a single helix of 20 cm pitch. None of the other three of these prior documents specifies essential dimensions.

The working life of the chains of such flails has been severely limited due to damage resulting from detonation of mines. In particular substantial damage is done to a number of chains by each detonation in view of the gas and blast which removes several links of chains in contact with the mine. In the past, therefore, the long-term effectiveness of the flails has been in doubt since explosion damage to the chains prevents a regular beat pattern from being maintained; thus live mines can escape detonation by virtue of damaged chains passing over them

without contact.

The present invention is partially based on the discovery that by arranging axially adjacent flails at different angular positions on the rotating shaft, damage is much less likely to be caused to a flail adjacent one which has detonated a mine by hitting the ground, since the adjacent flail is angularly displaced and therefore likely to be safely off the ground during the explosion. (A regular pattern of flail mountings, such as a helix, also improves the uniformity of flail impacts over a wide area). The key to the present invention lies in the discovery that in the case where more than one flail is at the same angular position on the shaft and therefore during each revolution, such flails will be simultaneously in contact with the ground (the most vulnerable position), a critical minimum axial separation between adjacent co-angular flails gives maximum operational survivability to the flails. When a given flail hits the ground and detonates a mine, if other flails also contacting the ground at the instant of detonation are safely separated from the point of detonation by not less than the critical axial distance, these other flails reliably survive to continue their normal function. Angular separation of adjacent flails is effective in achieving blast protection for flails that are not widely separated axially. However, for flails that are not angularly separated, a critical minimum axial separation achieves the requisite blast protection. Sub-critical axial separation is not successful. Thus if co-angular flails are axially separated by at least 30 centimetres the results are satisfactory, whereas an axial separation of 20 centimetres is insufficient.

In more precise detail, the present invention provides a flail vehicle comprising a tractor unit and rotatable

ground-beating means comprising a shaft which is rotatable about a central axis, said central axis being substantially parallel to the ground and transverse to the direction of travel of the vehicle, said shaft carrying a distributed array of flexible flail chains extending radially outwardly from said shaft, each of said flail chains having a direct connection to said shaft, the distribution of flail chains within said array being such that each said connection is angularly and axially offset around and along said shaft from the nearest adjacent said connection, and any two of said connections in said array which are adjacent in a direction substantially parallel to the central axis being spaced apart by at least thirty centimetres as measured along the shaft in a direction parallel to said central axis.

The offset relationship of adjacent ground-beating members on the shaft does not prevent two or more spaced members being connected linearly on the shaft and therefore not angularly offset, but such linearly-connected members are spaced from each other by at least 30cms along the shaft. By having the adjacent ground-beating members offset angularly around the shaft, explosion damage is restricted and centred on the member whose flailing action detonates a mine. Adjacent members are either angularly ahead of or behind the detonating member and do not therefore receive the full effect of the explosion. Indeed, it is possible for the adjacent members to be spaced above the ground at the moment of detonation, and damage to these members can therefore be substantially avoided.

Preferably more than 5, and most effectively 8,

ground-beating members are connected along each 300mm length of the shaft. The connections of the adjacent ground-beating members on the shaft are preferably spaced by less than 10cms, most preferably about 3 to 4cms.

The ground-beating means is preferably disposed at an end of the tractor unit remote from the prime mover of the tractor unit, in order to protect the prime mover from the effect of explosions and to counterbalance the weight of the ground-engaging means.

The shaft may be rotatable on a pair of side arms extending between the shaft and a main body of the tractor unit; these side arms are preferably pivotable on the main body so that blast resulting from mine detonation can be absorbed by upward pivoting of the arms. If the arms are pivotal the ground-engaging means can also be adjusted in height to respond to variations in the contour of the terrain over which the vehicle passes. Further, the arms may pivot into an out-of-use position in which they raise the shaft so that it rests on the body of the tractor unit.

The side arms may also be telescopic so as to allow the shaft to be retracted towards the body of the tractor unit for storage or transport. Portions of the arms may be made of non-ferrous material for effective detonation of magnetic mines. Telescopic movement of the arms may be effected by hydraulic rams.

The arms may be adjustable towards or away from one another to accommodate different shaft lengths.

The ground-beating means is preferably driven from the prime mover of the tractor unit.

The ground-beating means may be driven by a hydraulic pump which is preferably disposed adjacent the tractor unit's prime mover. The pump is preferably driven directly from the prime mover, for example from the crankshaft of the engine of the tractor.

The flail vehicle of this invention may be used in mine clearance or for clearing a pathway through a fire-stricken area; in the latter case the ground-beating means may have a cooling water spray directed against it and a spoil plate to deflect debris thrown up by the ground-beating members. A steel deflector plate is preferably provided on the mine clearance version of the vehicle to deflect the blast of explosions, and the spoil plate of the firefighting version may be provided at a similar location on the tractor unit.

Embodiments of this invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a first embodiment of a vehicle of the present invention for use in clearing mines;

Fig. 2 is a side view corresponding to Fig. 1;

Fig. 3 is an exploded perspective view of a sub-frame assembly of a second embodiment of the present invention;

Fig. 4 is an exploded perspective view of a sub-frame assembly of the second embodiment of the present invention;

Fig. 5 is an exploded perspective view of the front and rear skid-frame assemblies of the second embodiment of the present invention;

Fig. 6 is a perspective view of a hydraulic control system of the second embodiment of the present invention;

Fig. 7 is a side view of a further embodiment of the flail vehicle of the invention; and

Fig. 8 is a side view of a still further embodiment of the flail vehicle of the invention.

Referring to Figs. 1 and 2, the vehicle of the first embodiment of the invention has an agricultural tractor 1 having a cab 2 and an engine compartment 3. The tractor 1 has front road wheels 4 and rear continuous-track units 5 for ease of movement over uneven terrain. A hydraulic pump 6 is mounted adjacent the engine compartment 3 at the forward end of the tractor 1 and is driven directly from the crankshaft of the engine. A winch 7 is also mounted at the front of the tractor 1 for towing purposes.

Brackets are secured at the rear of the tractor cab 2 on structural members and have bolted to them at each side of the tractor 1 struts 8, 9 and 10 and a pair of hydraulic rams 11. The struts 8 and 9 support a baffle plate 12 which extends across the entire width of the tractor 1 and which terminates at its upper portion in a mesh panel 13.

The strut 10 is pivotally connected to a cylinder-and-ram arrangement 14 which is in turn pivotally connected to the strut 9. The connection of the strut 9 with the baffle plate 12 is common to one point of a three-point linkage which carries a terrain-following wheel 16, the arrangement being such that the wheels 16 move up and down in response to undulations in the ground, and this causes the baffle plate 12 to move with the wheels.

The hydraulic rams 11 are connected to bell-crank levers 17 pivotal about an axis 18 and carrying support arms 19 between whose free ends is a pivotal shaft 20. This shaft 20 carries a number of chains 21 and is driven by a drive belt from a hydraulic motor 22 powered from the hydraulic pump 6.

Spring-loaded carriers 23 are mounted on the baffle plate 12 to receive the support arms 19.

In use, the vehicle of the first embodiment is driven in reverse across a minefield so as to cover the minefield in a predetermined pattern. The hydraulic pump 6 is driven from the crankshaft and powers the motor 22 which rotates the shaft 20. This causes the chains 21 to beat the ground with a flailing action, thus detonating mines which they encounter. The baffle plate 12 provides a shield from the blast for the tractor driver and the equipment other than the flail itself and its support arms 19. In use the arms 19 are controlled in angle by the effect of the chains 21 on the ground, and thus "float" to retain the shaft 20 at the desired height above the ground. If a mine is detonated by the chains 21 the arms 19 can pivot upwardly to absorb the effect of the explosion, and in this the hydraulic rams 11 can act as shock absorbers to dampen the movement of the arms 19.

When not in use the mine-clearing apparatus can be simply and quickly disconnected from the tractor 1 by removing the bolts holding the strut 8 and the ram 11 on the brackets at the rear of the cab 2 and a bolt midway along the strut 10, and disconnecting the hydraulic line between the pump 6 and the motor 22. The tractor 1 can then be driven away for other duties.

When the vehicle of the first embodiment is to be driven from one site to another the mine-clearing equipment can be moved to an out-of-use position by retracting the hydraulic rams 11, thus pulling the bell-crank levers 17 and pivoting the support arms 19 about the axis 18. This pivoting continues until the shaft 20 engages in a cradle 24 on the cab 2. The terrain-following wheels 16 are also retracted from their in-use position by pivoting the strut 10 upwardly about its bracket at the rear of the cab 2. This frees the tractor's power take-off for other uses.

In modifications to the vehicle and apparatus of this embodiment, the shaft 20 and its chains 21 can be removed and replaced with a drum (not shown) for laying instant roads, especially for military use. Further, the support arms 19 can be adjustable in spacing from one another to accommodate different lengths of shaft 20 or road-laying drums.

The direct connection of the hydraulic pump 6 to the tractor's crankshaft makes the equipment more efficient than if the connection was through the power take-off, and the mounting of the flail at the rear of the tractor allows excellent weight distribution.

The shaft 20 and its chains 21 are of the same construction and assembly as will be described below with reference to Fig. 3 for the rotor 40 and chains 21.

Referring to Figs. 3, 4, 5 and 6, the apparatus for clearing mines of the second embodiment of the invention has a boom assembly 30, a sub-frame assembly 31, a rear skid-frame assembly 32, a front skid-frame assembly 33, and a hydraulic system 34.

The boom assembly 30 has a main boom structure 35 and two boom extensions 36, 37 between whose free ends 38, 39 is a rotor 40. Lugs 41 integral with the rotor 40 extend radially outwardly from the rotor surface. The lugs 41 are disposed in helical formation on the rotor surface, adjacent lugs 41 being angularly spaced by 30° around the rotor and disposed 3.5 cm apart. The helical arrangement is such that no two lugs 41 are linearly spaced along the rotor surface less than 45 cm apart. The rotor 40 is 3 m in length and lugs are linearly spaced at equal intervals of 45 cm along it.

This helical arrangement of the lugs 41 ensures that in use when the rotor 40 is at its optimum working distance above the ground the chains beat a regular and very dense flail pattern, but when any one chain 21 is in contact with the ground and therefore liable to damage should it detonate a mine the immediately adjacent chains are either ahead of it or behind it in rotation. The adjacent chains are therefore clear of the ground at that point and less likely to be damaged or broken by detonation. Thus only the linearly-spaced chains 45 cm apart contact the ground simultaneously, and these are sufficiently far apart to avoid damage to more than one chain should detonation occur. The lugs 41 provided on the rotor 40 are designed to eliminate wear to the rotor 40. All wear is taken up on a chain interlink 41a and on the shank of a fixing bolt 41b. The rotor 40 is provided with a pulley 42 which is driven by a number of 'V' belts 43 mounted within the boom extension 36, 37 and the main boom structure 35.

The 'V' belts 43 are in turn driven by a second pulley 44 in the main boom structure 35. This pulley 44 is driven via a rubber coupling 45 driven by a toothed wheel 46 in turn driven via a toothed belt 47 from a gearbox 48.

A power take-off (PTO) shaft 49 transfers power from the PTO point of a tractor, for example, to the gearbox 48.

A torque distribution coupling (not shown) is provided to ensure that the belts 47 from the gearbox 48 take equal loading and prevents unequal Rotor Torque being balanced out in the main drive gearbox (not shown).

The boom arms 50, 51 can be shortened quickly using hydraulic rams (not shown) for transport or to facilitate easy servicing of the 'V' belts 43.

The boom assembly 30 is pivotally mounted on the sub-frame assembly 31 on four fixing caps 52.

The sub-frame assembly 31 features a blast plate 53 which is mounted on aeon rubber springs 54, 55 which cushion the blast plate 53 from the boom assembly 30.

Boom lifting rams (not shown) and damping rams 56 are provided on the sub-frame 31a and are designed to allow the boom assembly 30 to rise without any hydraulic restriction, but to damp the free fall of the boom assembly 30.

Two jacks 57, 58 are provided at the rear of the sub-frame 31a and can be used to support the weight of the sub-frame assembly 31 and the boom assemblies 30 when the apparatus is not in use.

The rear skid-frame assembly 32 may be mounted on the rear of a tractor such as that shown in Fig. 1. The rear skid-frame assembly 32 is provided with two tapered square section mounting probes 60, 61. When the sub-frame assembly 30 and boom assembly 31 are in use the probes 60, 61 are mounted within the horizontal square section tubes 62, 63 of the sub-frame 31a and held in position by locking pins 64.

The mounting probes 60, 61 allow the sub-frame assembly 30 and boom assembly 31 to be attached and detached from the tractor quickly.

The front sub-frame assembly 33 is mounted on the front of a tractor, to act as a counterbalance.

The hydraulic system 34 of the apparatus is connected to the hydraulic power take-off of a tractor. A control box 70

allows the operator to raise or lower the apparatus.

The control box 70 also monitors the tractor's engine speed via an engine speed sensor and sends the appropriate corrective signal to an electro-magnetic hydraulic spool valve, which in turn raises or lowers the boom arms. The control box 70 can be tuned to a wide range of operating bands.

The use of mechanical drive in this embodiment of the invention eliminates the need for large oil tanks which are required when an oil pump is used. Also, mechanical drive is more reliable and more easily maintained than an oil pump system.

Figs. 7 and 8 each illustrate flail vehicles whose rotor 40 has the chains 21 arranged substantially in the same number and relationship as shown in Fig. 3 and described above, i.e. with the helical arrangement of the chain connections to the rotor. In Fig. 7 the vehicle is a half-track military vehicle and the rotor 40 has at its ends a pair of wire cutters 72 which rotate with the rotor 40. The rotor in each case is mounted between side arms 74 of telescopic construction, each outer portion 74A extending within the inner portion 74B and movable to extend or retract by means of a hydraulic ram 76. The telescopic construction allows a constant tension to be maintained on the V-belt 43.

The vehicle of Fig. 7 has a rotor 40 which is 3.05 m in length and the vehicle weighs 9500 kg. The rotor has 72 chains connected to it and has an operating speed of up to 270 revolutions per minute, powered by a 120 hp take-off from the vehicle's main engine turning at 1900 revolutions per minute. This vehicle can detonate anti-tank mines buried to a depth of 230 mm. The dense flail pattern of

the chains 21 allows single impulse anti-tank mines to be detonated in muddy conditions at a vehicle speed of 4.6 km/h and small anti-personnel mines at a speed of 3.4 km/h.

In Fig. 8 the vehicle of Fig. 7 has been specially adapted for firefighting work and particularly for clearing a pathway through burning scrub or woodland. In this case the deflector plate 12 has an upper portion 78 of mesh which extends over the rotor 40 to deflect debris thrown up by the chains 21. A water tank 79 feeds sprinkler nozzles 80 directed against the rotor 40 and chains 21.

A further deflector plate 81 is provided at the front of the vehicle, and also provided are a periscope 82, a hose reel 83, a lamp 84, a water cannon 85, a flare launcher 86, a front winch 87 and an air filter 88.

Modifications and improvements may be incorporated without departing from the scope of the invention.

The claims defining the invention are as follows:

1. A flail vehicle comprising a tractor unit and rotatable ground-beating means mounted at one end of the tractor unit, the ground-beating means comprising a shaft which is rotatable about a central axis, said central axis being substantially parallel to the ground and transverse to the direction of travel of the vehicle, said shaft carrying a distributed array of flexible flail chains extending radially outwardly from said shaft, each of said flail chains having a direct ~~direction~~ connection to said shaft, the distribution of flail chains within said array being such that each said connection is angularly and axially offset around and along said shaft from the nearest adjacent said connection, and any two of said connections in said array which are adjacent in a direction substantially parallel to the central axis being spaced apart by at least thirty centimetres as measured along the shaft in a direction parallel to said central axis.

2. A flail vehicle as claimed in claim 1, wherein said next adjacent connections are mutually separated by an angular spacing of 30 degrees around said central axis and by an axial spacing of between 3 and 4 centimetres as measured along the shaft in a direction parallel to said central axis.

3. A flail vehicle as claimed in claim 1 or claim 2, wherein any two of said connections which are co-angular with respect to said central axis of the shaft are spaced apart by 45 centimetres as measured along the shaft in a direction parallel to said central axis.

14. A flail vehicle substantially as herein described with reference to the drawings.

DATED this 17th day of August, 1988.

D.M. MacWATT
By His Patent Attorneys
ARTHUR S. CAVE & CO.

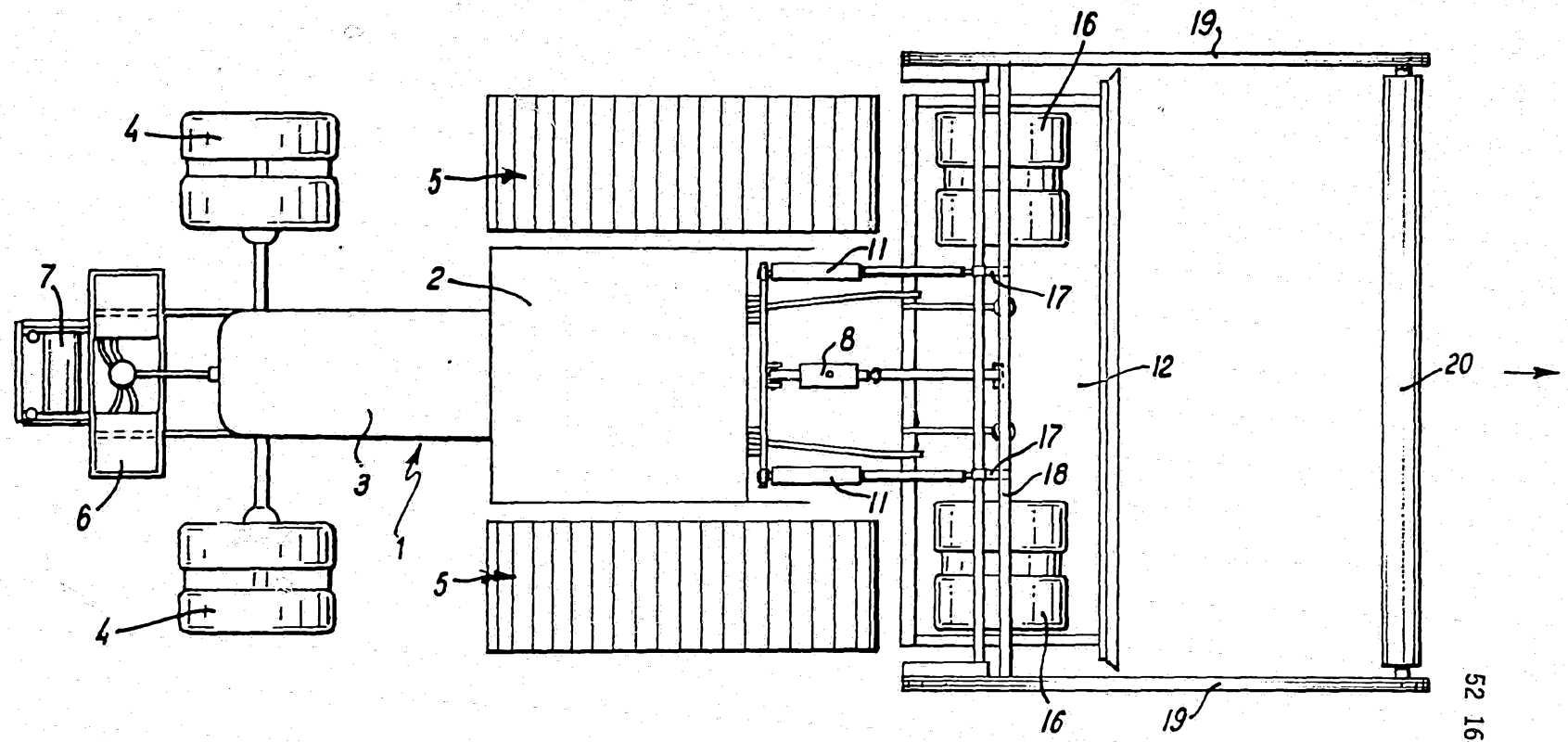

FIG.1

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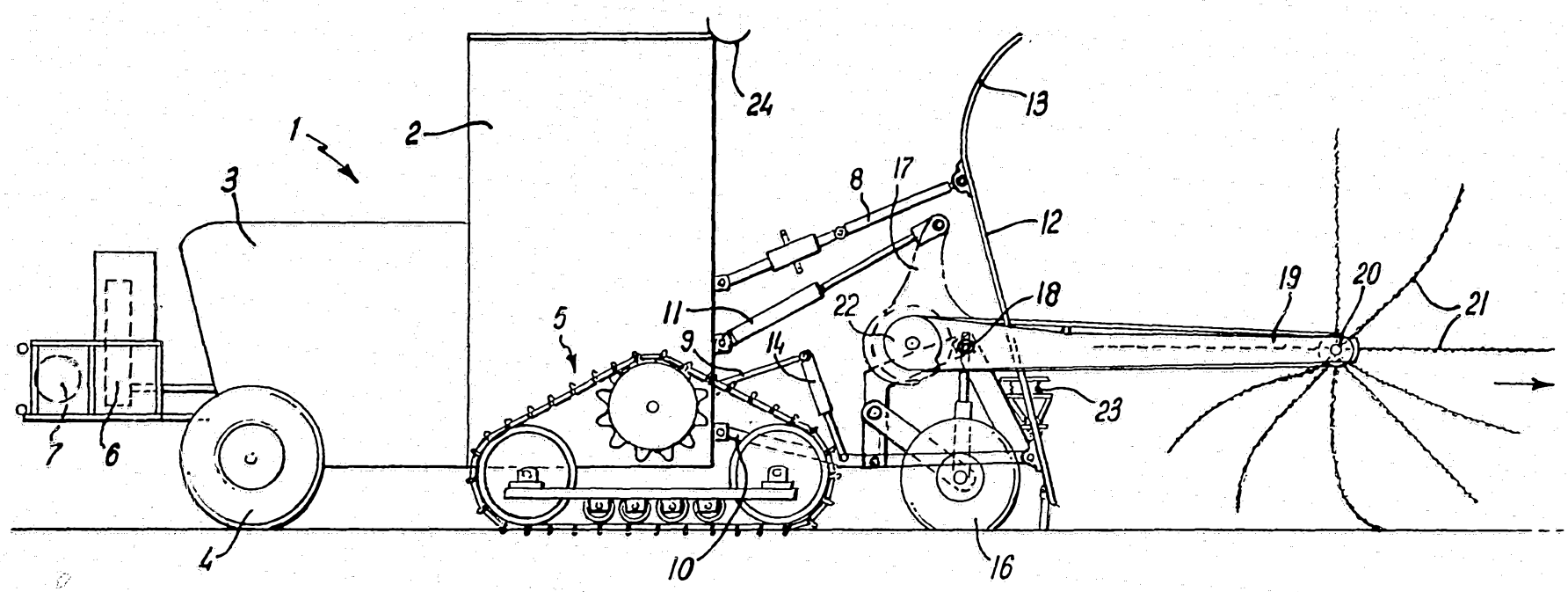

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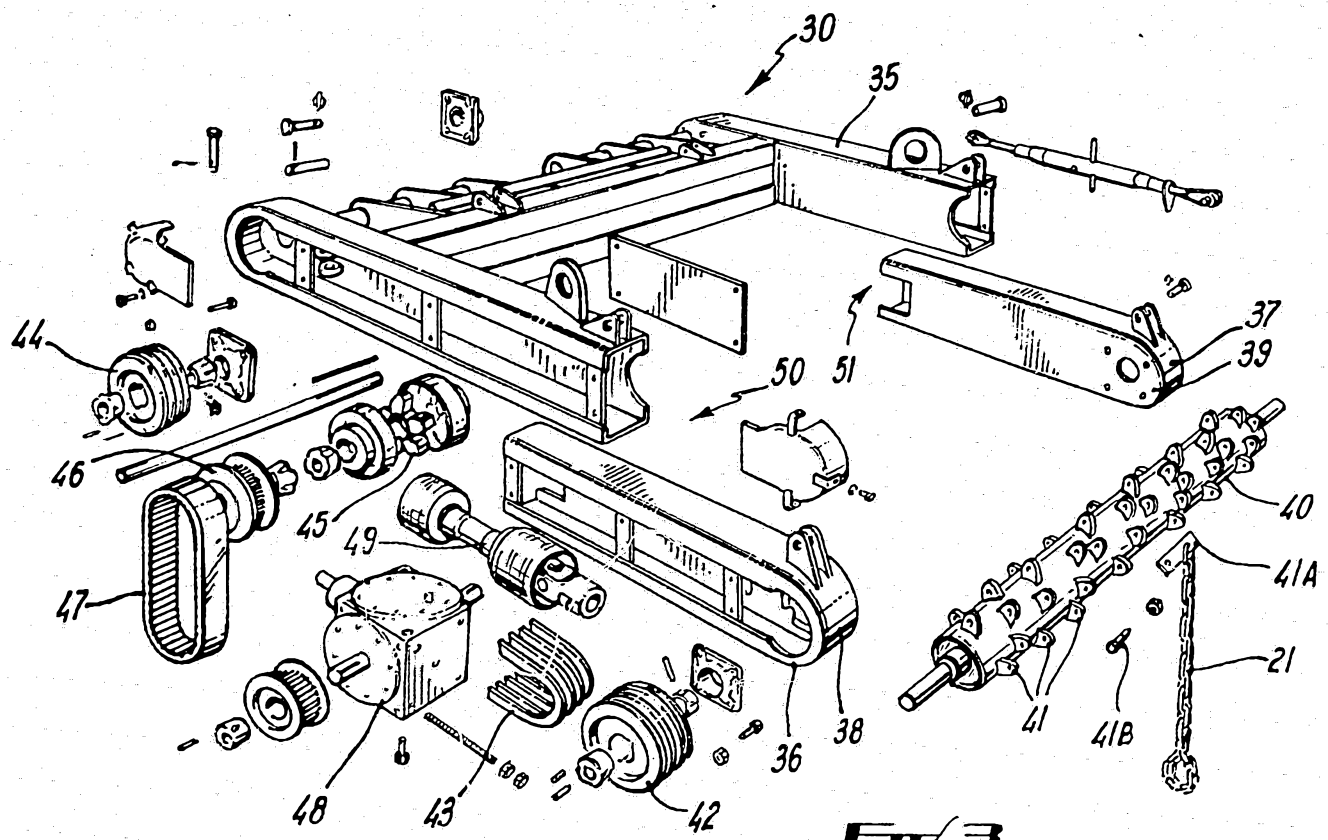

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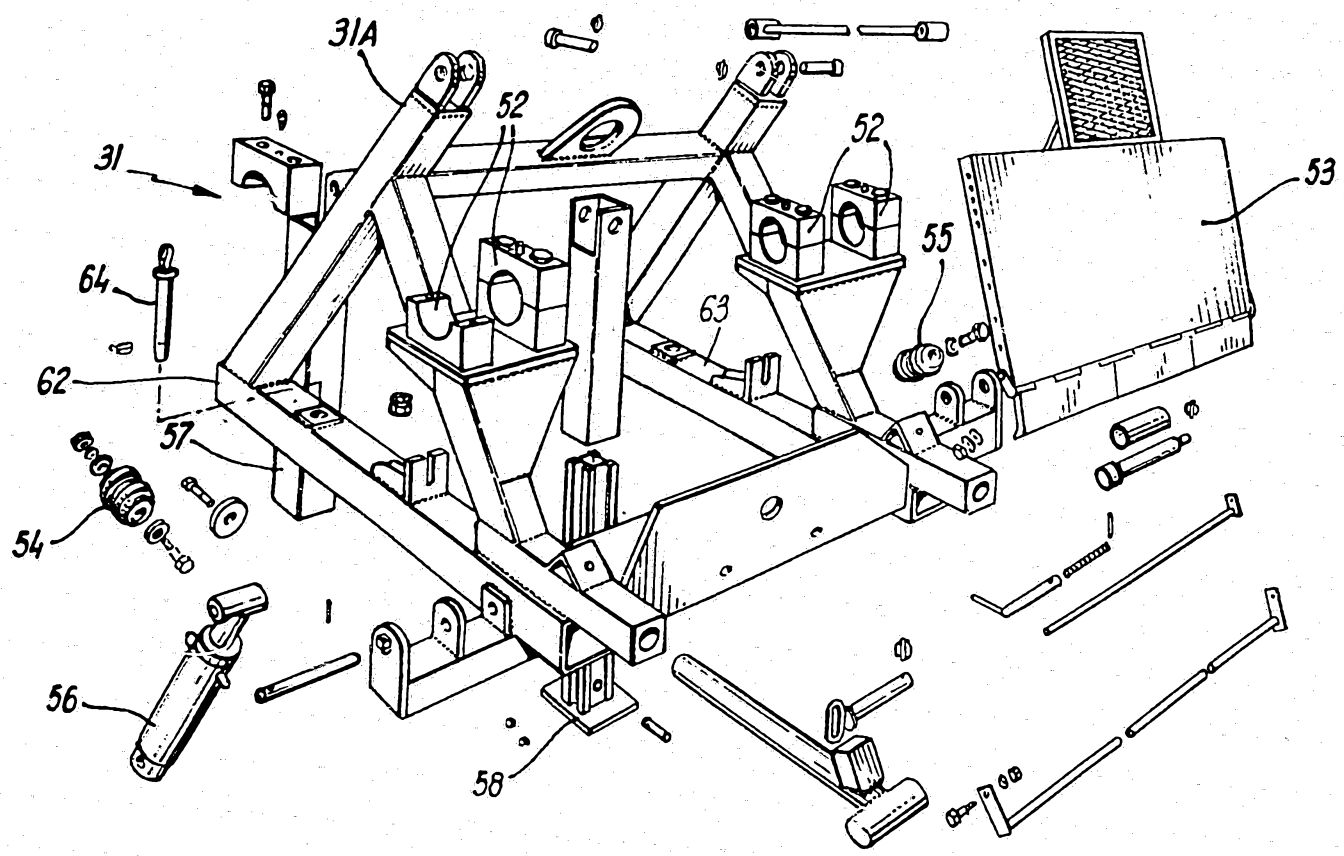

Fig 4

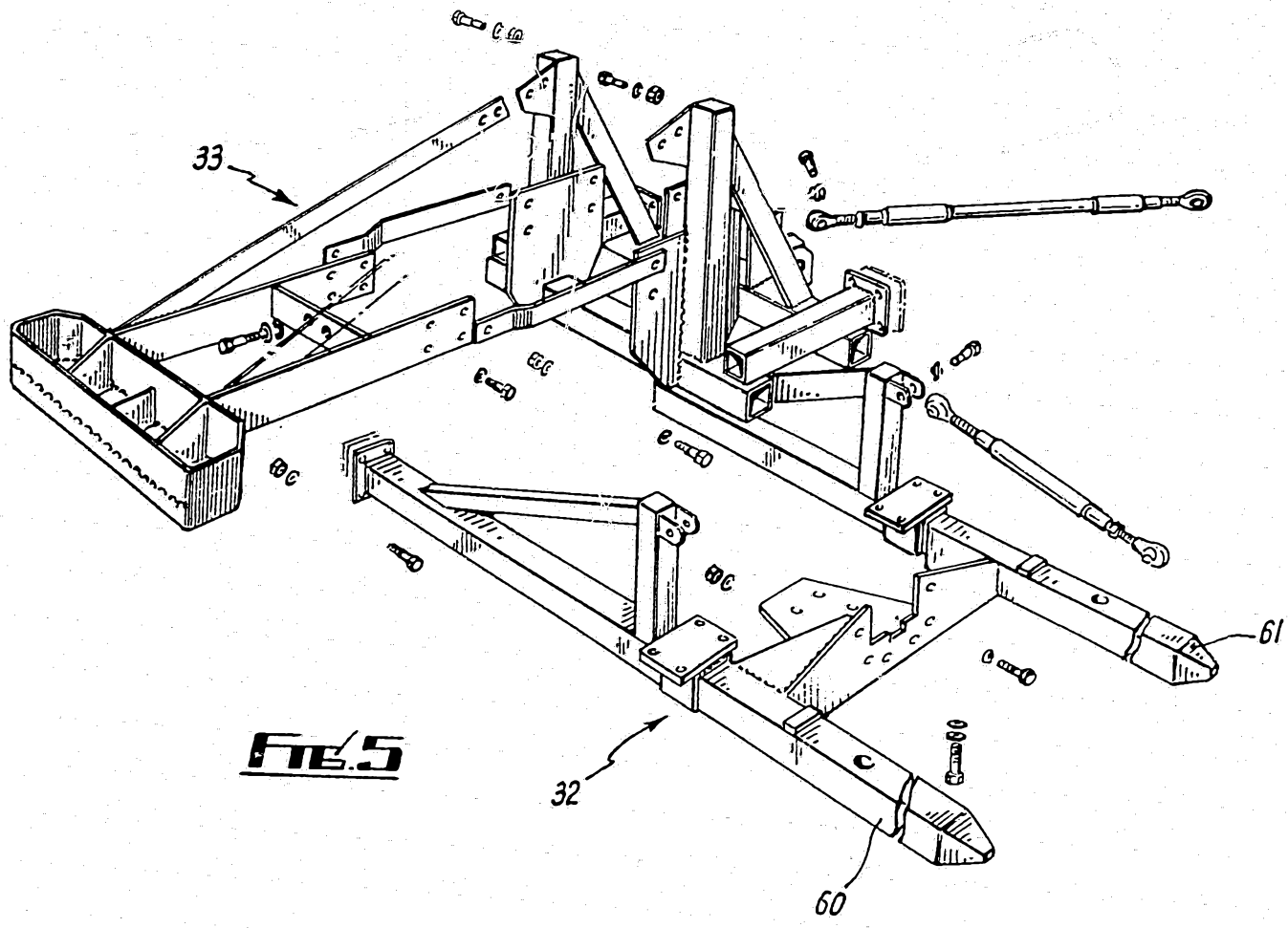

FIG.5

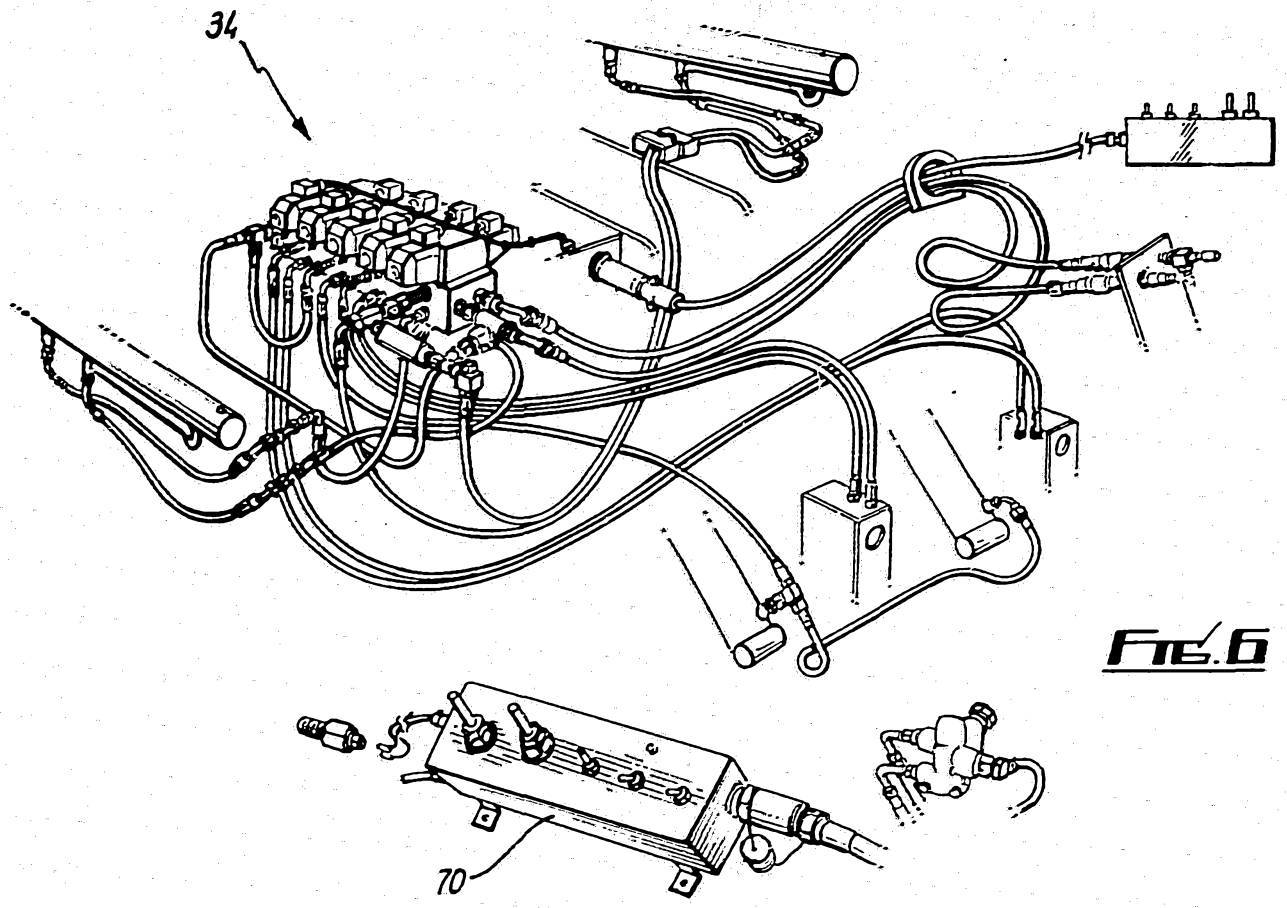

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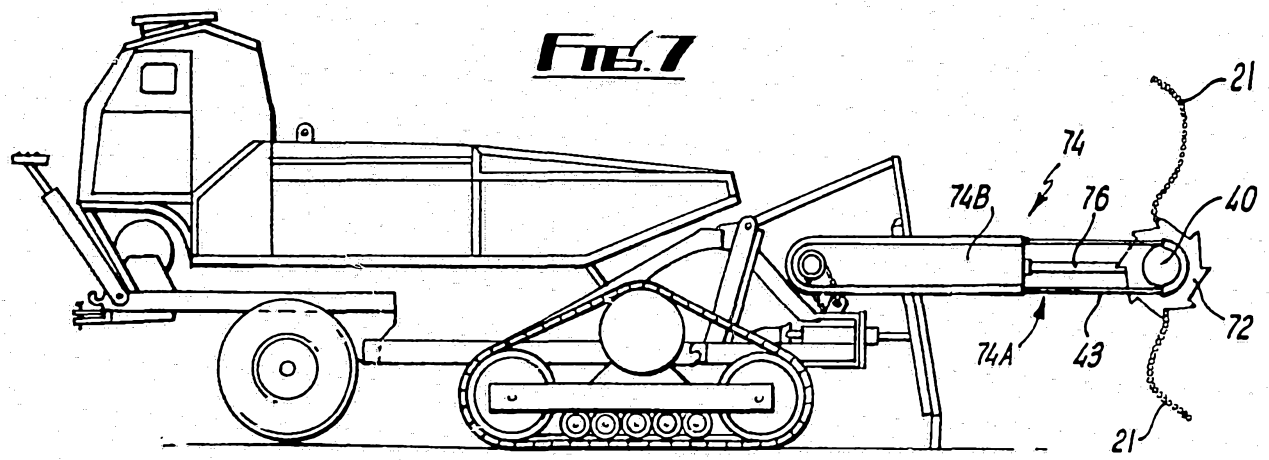
FIG. 7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74B
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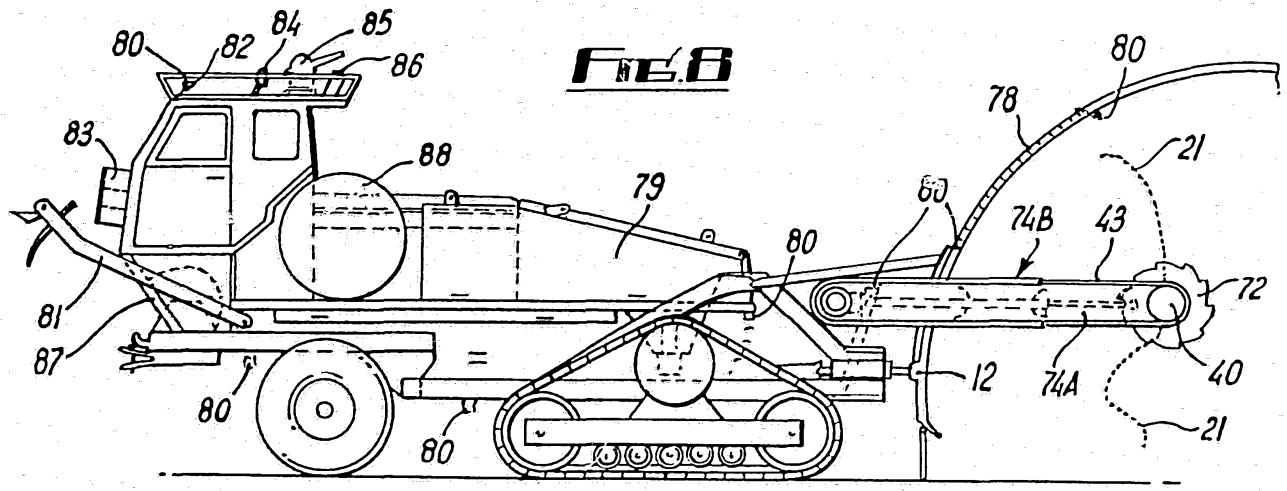
FIG. 8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