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PT SE**(30) Priority: **06.01.1995 IE 950008**(71) Applicant: **Lee, Charles****County Longford (IE)**(72) Inventor: **Lee, Charles****County Longford (IE)**(74) Representative: **Weldon, Michael James et al****c/o Cruickshank & Co.,****1 Holles Street****Dublin 2 (IE)**(54) **A ground compacting machine**

(57) An compacting machine (1) is self-propelled and has a ballast (10). The downward force of the ballast (10) is directed to a side compactor (21) and to five rear compactor assemblies (20). Each compactor assembly (20, 21) operates over a small area and therefore there is compaction at the required level of small areas which are softer than surrounding areas. The required level of compaction force is provided at each compactor according to the ground reaction force or resistance. Accordingly, a uniform level of firmness is obtained over all of the ground being compacted. In a first pass, the compactors cause indentations in the ground and if a fine and dry aggregate is applied, there is a very high level of penetration of the aggregate into the ground to reduce the moisture content.

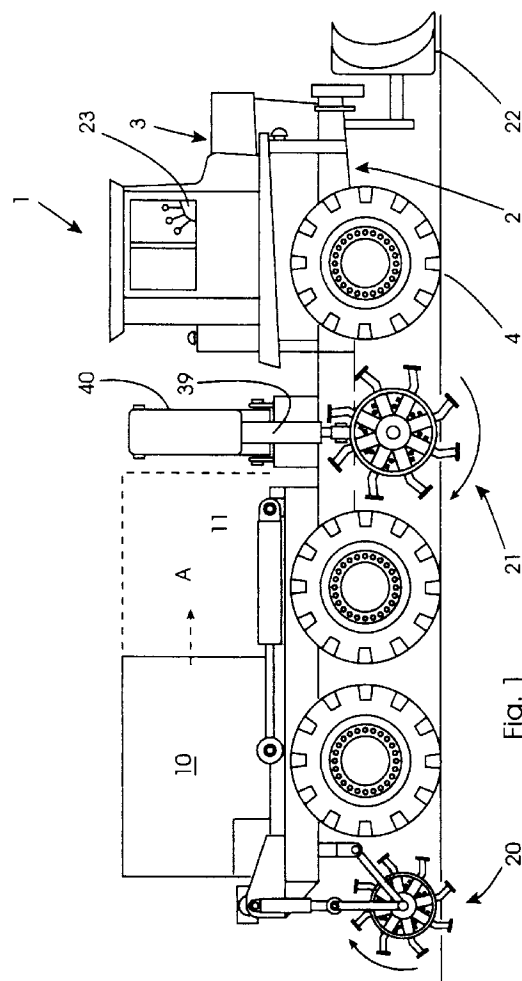


Fig. 1

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Description

The invention relates to a ground compacting machine of the type comprising a chassis, a ballast supported on the chassis, and a compactor assembly having at least one compactor mounted on the chassis by a compactor drive to transmit the weight of the ballast to the compactor assembly. Such a machine is described in US 3,146,686 in which a single compactor assembly is transversely mounted by way of an hydraulic ram.

It is also known to provide machines in which the weight of the roller provides the compacting pressure, for example the "sheepsfoot" roller described in GB 2201643.

Presently available compacting machines are not very effective in some circumstances. One of the reasons is that too little attention has been paid to the fact that the area being compacted is not homogenous in that some areas are softer than others.

Another problem is that conventional compaction often leads to excessive displacement of the soil, particularly if it has a high moisture content or if the soil composition is particularly prone to lateral displacement. Similarly, different quantities of stone mixed with the soil can cause different reactions to rolling over small areas, thus leading to irregularities in compaction and subsequent failure.

The solution has heretofore been one of what can be best described as "overkill" with excessive and repeated compaction and use of considerable quantities of infill.

It is apparent that what is required is firstly a construction of machine which will overcome the problems inherent in present constructions of machine and secondly a method of compaction which will ensure optimum utilisation of the machine time together with the use of the least amount of infill. Infill is often very expensive to quarry, transport and spread.

The invention is characterised in that the compactor drive comprises a control means for monitoring the compacting force of the compactor assembly to indicate ground resistance.

This allows the machine operator to immediately identify areas of ground which are soft and require additional compaction locally. Because there is a compacting drive between the compactor assembly and the chassis, the monitoring may be very easily carried out. Therefore the invention is very simple to implement.

In one embodiment, there are a plurality of compactor assemblies transversely arranged across the machine with respect to the direction of travel. In this way, the weight of the ballast may be distributed between the assemblies for individual compaction in small areas, each area associated with a single assembly.

Preferably there are a plurality of compactor assemblies mounted at the rear of the machine. This is a particularly effective way of compacting and there are a

number of ground areas individually compacted across the width of the machine.

In one embodiment, the compactor drive comprises a fluid drive and the control means comprises means for sensing fluid pressure. This is a particularly simple way of monitoring the compacting force as the fluid pressure varies according to ground resistance. The fluid drive may be an hydraulic drive and the control means comprises an hydraulic pressure indicator. Hydraulic drives are widely used on compacting machines and are a particularly effective and inexpensive way of providing the drive and pressure sensing.

In another embodiment, each compactor comprises a rotatable hub carrying a plurality of compacting feet. This is a very simple way of allowing compaction of individual areas, leaving other areas uncompacted. This helps to avoid soil displacement and allows effective impregnation of fine infill to the ground to dry it. The feet may be disc-shaped for very effective ground penetration.

Preferably the foot is mounted on a radially arranged arm so that the leading edge of the foot is further away from the hub than the trailing edge. This also helps ground penetration and also allows deep penetration - limited only by the length of the arms.

The compactor assembly may include a vibrator means to improve effectiveness.

In another embodiment there are a plurality of compactor assemblies mounted at the rear of the machine and a compactor assembly mounted transversely of the machine at a location forwardly of those at the rear, and the machine further comprises means for moving the ballast to different operative positions on the chassis. These features allow the machine to be very versatile as all compactors may be used for general compaction, and the machine may also be used for verge compaction for road widening.

According to another aspect, the invention provides a ground compacting machine comprising a chassis, a ballast supported on the chassis and a compactor assembly having at least one compactor mounted on the chassis by a compactor drive to transmit the weight of the ballast to the compactor assembly, characterised in that:-

the compactor drive comprises a control means for monitoring the compacting force of the compactor assembly to indicate ground resistance;

there are a plurality of compactor assemblies transversely arranged across the machine with respect to the direction of travel; and

each compactor comprises a rotatable hub carrying a plurality of compacting feet.

This combination of features provide for effective compaction of all areas and deep penetration at sepa-

rate discrete locations to avoid soil displacement.

According to another aspect, the invention provides a method of compacting the ground, the method comprising the steps of:-

urging a compactor against the ground; and

continuously monitoring the compacting force as the compactor is applied to the ground.

This allows identification of soft areas so that the necessary additional compaction may be carried out.

In a further aspect, the invention provides a method of compacting the ground over a base area using a compacting machine, the method comprising:

compacting in any one pass of the machine discrete individual areas of the base while leaving other areas uncompacted in that pass; and

monitoring the compacting force at the individual areas.

By compacting individual areas, displacement of soil is considerably reduced and there is much more effective impregnation of the ground by added aggregate.

The invention will be more clearly understood from the following described of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic side view of a ground compacting machine of the invention;

Fig. 2 is a diagrammatic front view of the machine with some parts omitted;

Fig. 3 is a diagrammatic front view showing the manner in which a transverse compactor is connected to the machine frame;

Fig. 4 is a detailed side view showing a rear compactor in operation;

Figs. 5(a) to 5(d) inclusive are diagrammatic sketches illustrating a ground compacting method carried out by the machine;

Fig. 6 is a rear view showing the manner in which rear compactors operate; and

Fig. 7 is a plan view showing rear compactors in operation in one configuration.

Referring to the drawings, there is illustrated a ground compacting machine 1 of the invention. The machine 1 is self-propelled and comprises a mobile frame or chassis 2, a drive cab 3 and wheels 4. The chassis 2

supports a ballast 10 which in this embodiment has a weight of 25 tonnes. The ballast 10 is slidable back and forth on the chassis 2 between various longitudinal positions as indicated by the arrow A and the interrupted lines by a pair of hydraulic rams 11, one on each side of the chassis 2.

The machine 1 also comprises a set of five rear compactor assemblies 19, each having two compactors 20 mounted at the rear of the machine. There is also a side assembly comprising a single compactor 21 mounted transversely of the machine. Further, an aggregate spreading blade 22 is mounted forwardly of the machine.

An hydraulic control panel 23 is mounted in the cab 3 to allow driver control of the various compactor assemblies. The hydraulic circuits connecting the hydraulic power plant (not shown), the control panel 23 and the compactors 20 and 21 have pressure release valves which can be selectively introduced. There is a separate hydraulic circuit for each compactor assembly 20 and each has an hydraulic sensor connected to a dial in the control panel 23 to indicate hydraulic pressure in the circuit. Thus, the release valves set the maximum pressure for transmission of the ballast weight to the compactors, and the sensors allow the driver to monitor the pressure required. This indicates the ground resistance at the associated compactor(s).

Referring in particular to Figs. 2 and 3, the side compactor 21 is described in more detail. The compactor 21 comprises a hub 30 from which eight arms 31 extend. A compacting foot 32 ("sheepsfoot") is mounted at the end of each arm 31. Each foot is disc-shaped having a diameter of 75 mm. The arms 31 are cranked so that the leading edge of the feet as they rotate in the direction of travel of the machine 1 is at a slightly lower level. This provides for compaction in a simpler manner. The hub 30 is rotatably supported by an axle 33 which is pivotally connected to a support plate 34 which has pivot holes 35, by a pivot pin 36 in one of the holes 35. The hub is connected by bearings to a non-rotating sleeve 37 which extends around the axle 33 and is connected to it at one of a number of transverse adjustment holes 38 to provide different transverse settings as indicated by the arrow B. The sleeve 37 is pivotally connected to a compacting drive, namely, a vertically arranged hydraulic ram 39 connected to an anchorage 40, shown in Fig. 1.

The different pivot holes 35 allow different pivot axes to provide different responses to movement of the ram 39 - providing different angles of inclination of the compactor 21. The anchorage 40 is a laterally extending cantilevered arm rigidly connected to the chassis.

Referring in particular to Fig. 4, a rear compactor 20 is now described. Parts similar to those described with reference to the previous drawings are identified by the same reference numerals. A hub 42 for a pair of compactors 20 is connected to a support arm 43 which is in turn pivotally connected to a vertically arranged hydraulic ram 45. The hub 42 is also connected by a sus-

pension strut 44 to the chassis. The ram 45 is connected at its upper end to a bracket 46 on the chassis 2. A vibrator 47 having an eccentric shaft driven by the machine's hydraulic circuits is connected to the bracket 46. As is clear from Fig. 6, there are ten rear compactors 20 arranged in five assemblies 19 having a pair of compactors on each side of the support arm 43.

Referring to Figs. 5 and 6, operation of the machine 1 for compaction of ground to provide a base for road construction is now described. The rear compactors 20 are used for this purpose although the side compactor 21 may also be used. All five of the hydraulic rams 45 are operated to lower the compactors to a desired level for penetration of the ground. This level is chosen according to the firmness of the ground, taking into account the pressure which can be applied.

As shown in Fig. 5(a), the machine 1 is driven over the ground 30 with the compactors 20 in their operative positions. The hydraulic pressure in the hydraulic circuits indicates the ground resistance at the location of each compactor assembly. This allows the drive to immediately identify soft areas for additional compaction. The hubs 42 rotate whereby each foot 32 in turn penetrates the ground to provide a set of separate, discrete indentations 51 in the ground. Because the machine 1 is being driven, the feet 33 have a relatively clean exit from the indentations and do not tend to lift soil as they are exiting from the indentations. It will thus be appreciated that the compactors 20 compact locally at discrete locations to provide discrete indentations in the ground. It has been found that this is particularly effective at avoiding displacement of the soil, which is a problem with prior art compactors which provide an overall blanket compaction of the ground. It has been found that the machine of the invention is particularly effective at avoiding soil displacement where the soil has a high moisture content. Another aspect of this localised type of compaction is that water in the soil tends to come to the surface within the indentations (indicated by the numeral 51 in Fig. 5(a)) and therefore a good deal of the water tends to run off and drain away and on hot days it is also evaporated to some extent.

Another very important aspect of compaction in this manner is that the machine 1 effectively provides five different compactors, each of which operates over a very small surface area. Accordingly, where small pockets of the ground are particularly soft, they are individually compacted to the correct level. The maximum level of compaction is set by the hydraulic pressure in the rams 45 and this pressure urges the compactors 20 downwardly against the reaction force of the ground. It could be said that the rams 39 and 45 distribute the available downward force provided by the ballast 10 to six different assemblies of compactors at the required level for each compactor. For example, the pair of compactors 20 at one side of the machine 1 may be required to press down against a reaction force of 20 bar, whereas the compactors on the other side may be required to

counter a reaction force of 10 bar.

Another important aspect of the invention is that the driver in the cab 3 is provided with feedback as to the reaction force or resistance provided at each of the pairs of compactors 20. In this embodiment, the control panel 23 includes a set of dials, each of which indicates the hydraulic pressure in each of the hydraulic circuits and this provides a measure of the ground resistance or reaction force. In this way, the ground may be compacted in a much more controlled manner in which the operator knows which areas require more compaction and the relevant information can be provided to the engineers on-site. It is envisaged that the data may be recorded electronically or on a hard copy for later analysis.

The next step of compaction is to apply a layer 55 of a fine, dry aggregate over the ground after it has been compacted in one pass. The aggregate 55 may be of the type known as "804" but may be of any type which is dry so that it helps in reducing the overall moisture content of the ground and is fine so that there are no voids created in the ground. As shown in Fig. 5(c), the next stage is a second pass of compaction using the machine 1. It is not necessary that the feet of the compactors are in registry with the original position and the overall effect is that the aggregate 55 is impregnated into the ground. Impregnation of the aggregate 55 is particularly effective because it is deposited into relatively deep indentations 51 in the ground so that there is access to a low level in the ground. The steps shown in Figs. 5(b) and 5(c) are then repeated until the desired level of compaction is achieved. After this has been achieved, a layer of stones 60 is applied over the ground and then this is rolled in a conventional manner to provide the base. A very important advantage which arises from the invention is the fact that because ground compaction is so uniform, a much smaller amount of stone is required and this saves on a huge amount of expense and also on time.

Referring now to Fig. 7, an arrangement is shown whereby alternative pairs of compactors 20 are operated in one pass according to the ground conditions for the pass. It will be appreciated that any desired configuration of compactors 20 may be operated. This provides a large degree of versatility in operation of the machine.

Regarding the side compactor 21, this may be operated in much the same way as the rear compactors 20, with the rear compactors 20 in an upper inoperative position. This may provide for additional compaction for road preparation, or it may alternatively be used for verge compaction at a roadside verge. In this embodiment, the ballast 10 is slid forwardly, as indicated by the arrow A in Fig. 1, to a forward position at which it provides more effective ballast for the ram 39 of the side compactor 31. In this mode of operation, the machine 1 provides for efficient road widening by compacting the roadside verge in a simple manner to provide a very strong foundation, upon which relatively little stone is

required before application of the surface dressing.

It is envisaged that the machine 1 may include a side compactor only without any rear compactors and may therefore be regarded as a dedicated roadside verge compactor. Equally, there may be no side compactor and rear compactors only. However, where the machine 1 does include both rear and side compactors as shown in the drawings, the side compactor may be used for general ground compaction for road preparation.

It will be appreciated that the invention uses very simple mechanical features to provide compaction over very small areas according to the required compaction force. This ensures that the ground is uniformly prepared before further work is carried out. It will also be appreciated that the invention provides for feedback of a good deal of information regarding the ground conditions to the driver so that the appropriate decisions can be made. Another very important feature of the invention is the fact that the machine compacts ground having a high moisture content in a very effective manner by helping to remove water and allowing for very effective impregnation of a fine and dry aggregate to reduce the overall moisture content.

The invention is not limited to the embodiments hereinbefore described. For example, it is envisaged that instead of the feet being mounted on arms about a hub, they could be mounted at the end of a reciprocating rod which is driven in a reciprocating manner by a drive ram or other drive means. The important point is that weight from a ballast is distributed according to the requirements of the ground at the feet. It is also envisaged that a pneumatic drive, or alternatively a mechanical spring arrangement could be used to apply a downward force from the ballast to the feet. The machine need not necessarily have compactors with feet. For example, rollers could be used, possibly with protruding rims or ridges.

Claims

1. A ground compacting machine (1) comprising a chassis (2), a ballast (10) supported on the chassis, and a compactor assembly (19) having at least one compactor (20) mounted on the chassis (2) by a compactor drive (39, 45) to transmit the weight of the ballast to the compactor assembly, characterised in that the compactor drive comprises a control means (23) for monitoring the compacting force of the compactor assembly to indicate ground resistance.
2. A machine as claimed in claim 1, wherein there are a plurality of compactor assemblies (19, 21) transversely arranged across the machine (1) with respect to the direction of travel.

3. A machine as claimed in claim 2, wherein there are a plurality of compactor assemblies (19) mounted at the rear of the machine (1).

4. A machine as claimed in any preceding claim, wherein the compactor drive (39, 45) comprises a fluid drive and the control means comprises means for sensing fluid pressure.

5. A machine as claimed in claim 4, wherein the fluid drive is an hydraulic drive (39, 45) and the control means comprises an hydraulic pressure indicator (23).

6. A machine as claimed in any preceding claim, wherein each compactor comprises a rotatable hub (30, 42) carrying a plurality of compacting feet (32).

7. A machine as claimed in claim 6, wherein each compacting foot is disc-shaped and is mounted on a radially arranged arm (31).

8. A machine as claimed in claim 7, wherein the foot (32) is mounted on the radially arranged arm so that the leading edge of the foot (32) is further away from the hub (30, 42) than the trailing edge.

9. A machine as claimed in any preceding claim, wherein the compactor assembly (19) includes a vibrator means (47).

10. A machine as claimed in any preceding claim, wherein there are a plurality of compactor assemblies (19) mounted at the rear of the machine and a compactor assembly (21) mounted transversely of the machine at a location forwardly of those at the rear, and the machine further comprises means (11) for moving the ballast (10) to different operative positions on the chassis (2).

11. A ground compacting machine comprising a chassis (2), a ballast (10) supported on the chassis and a compactor assembly (19, 21) having at least one compactor (20, 21) mounted on the chassis by a compactor drive (39, 45) to transmit the weight of the ballast (10) to the compactor assembly, characterised in that:-

the compactor drive comprises a control means (23) for monitoring the compacting force of the compactor assembly to indicate ground resistance;

there are a plurality of compactor assemblies (19) transversely arranged across the machine with respect to the direction of travel; and

each compactor comprises a rotatable hub (30,

42) carrying a plurality of compacting feet (32).

12. A method of compacting the ground, the method comprising the steps of:-

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urging a compactor (20, 21) against the ground;
and

continuously monitoring the compacting force
as the compactor is applied to the ground (50). 10

13. A method of compacting the ground over a base area using a compacting machine, the method comprising:

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compacting in any one pass of the machine discrete individual areas (51) of the base while leaving other areas uncompacted in that pass;
and

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monitoring the compacting force at the individual areas.

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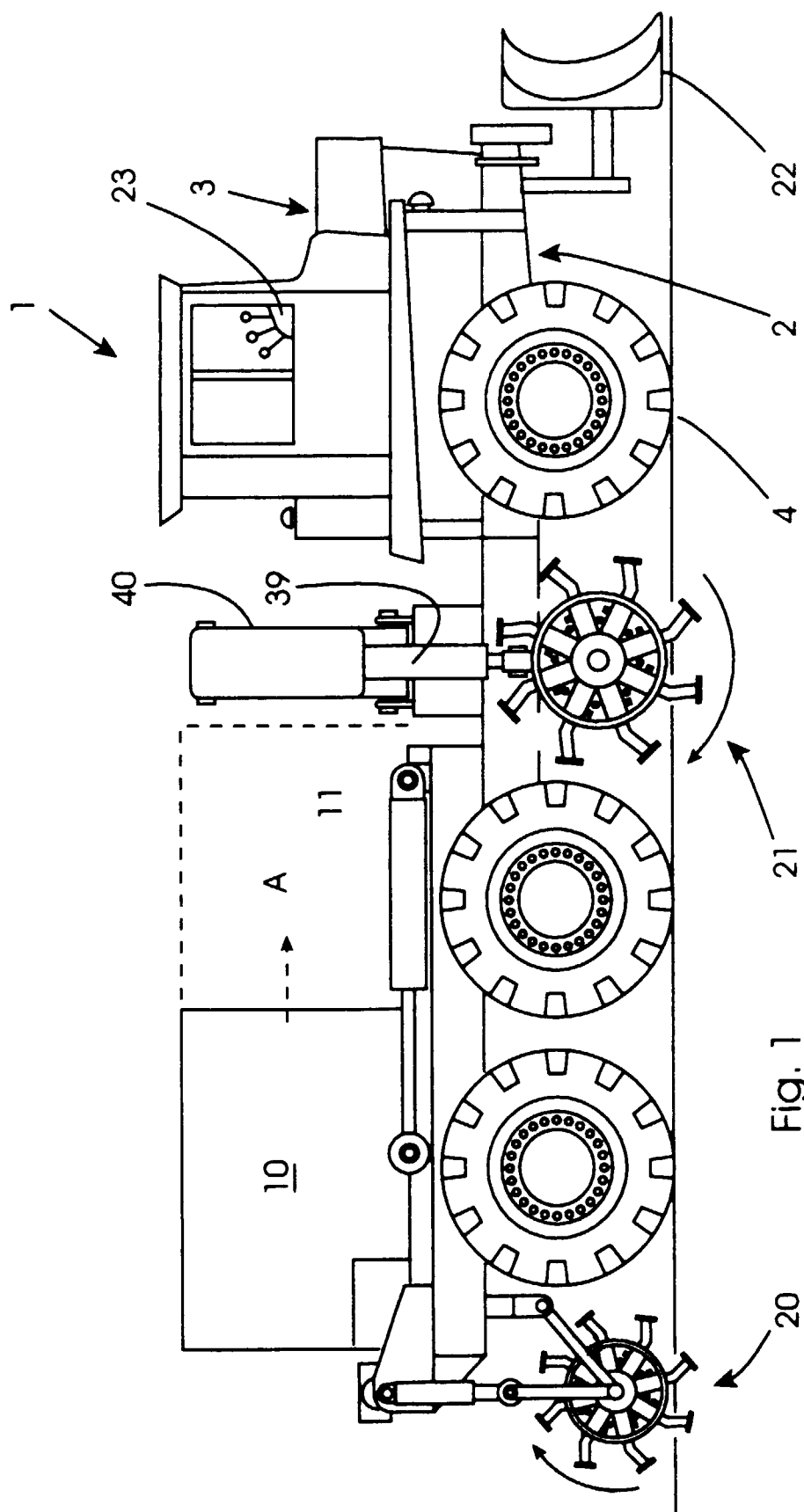
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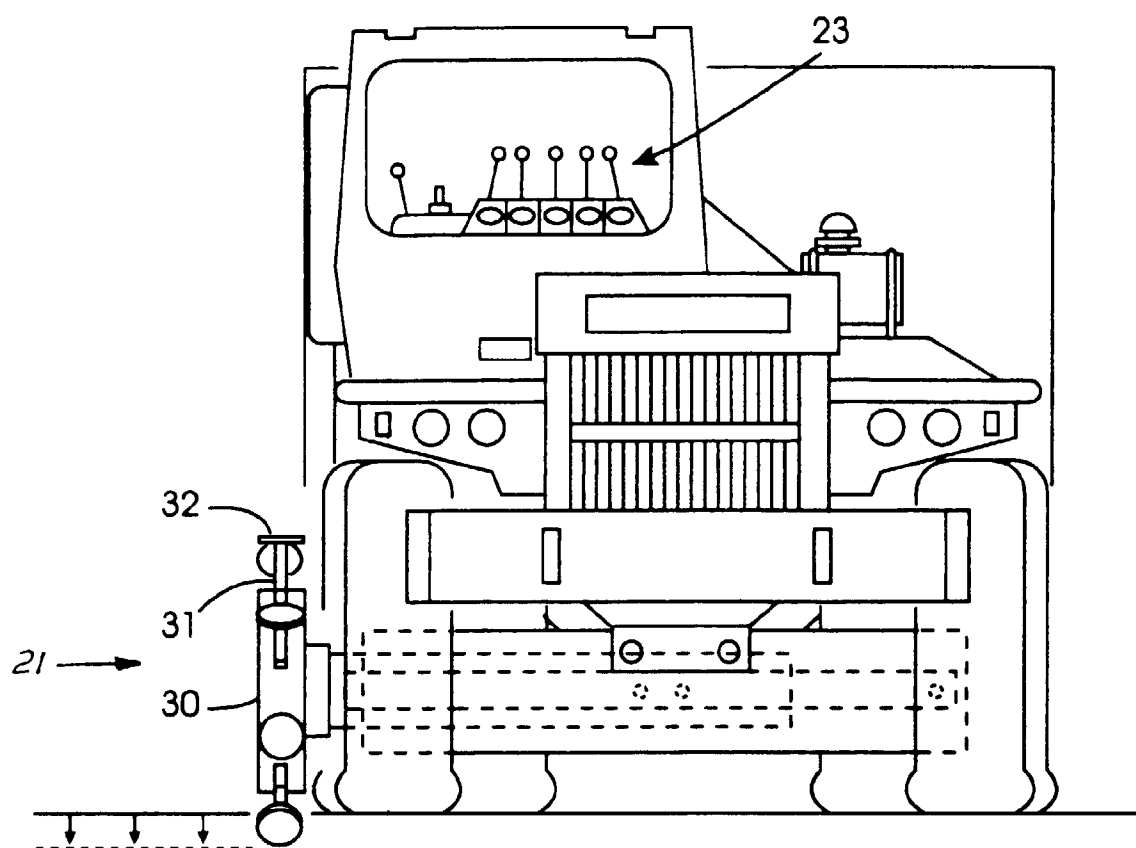


Fig. 2

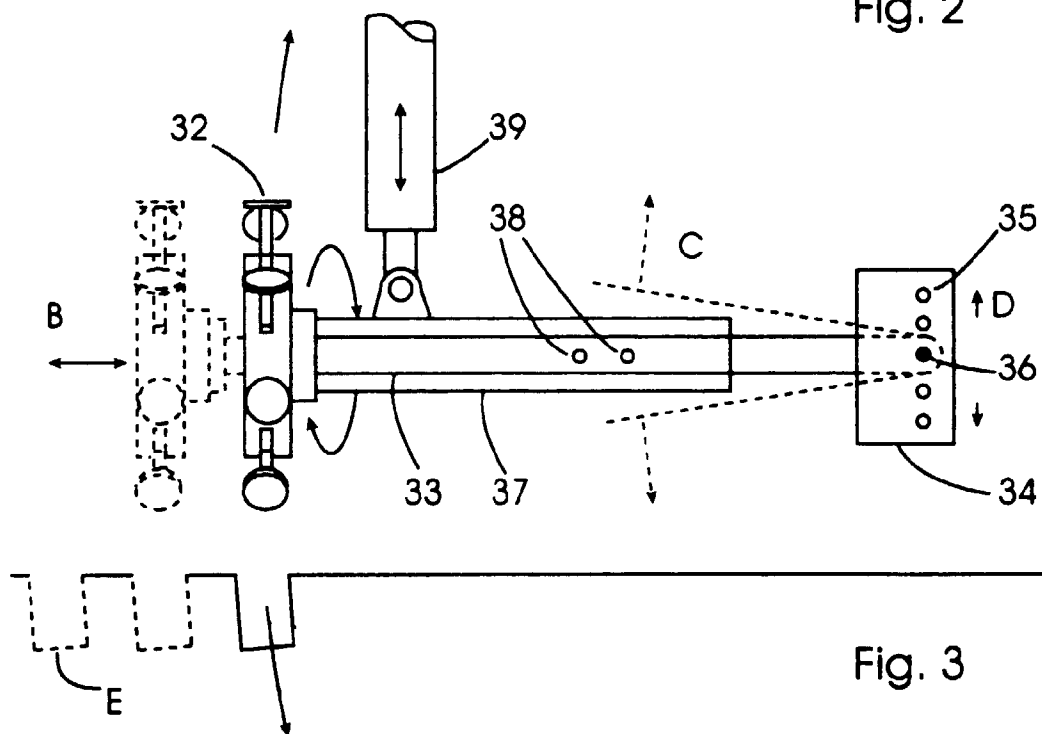


Fig. 3

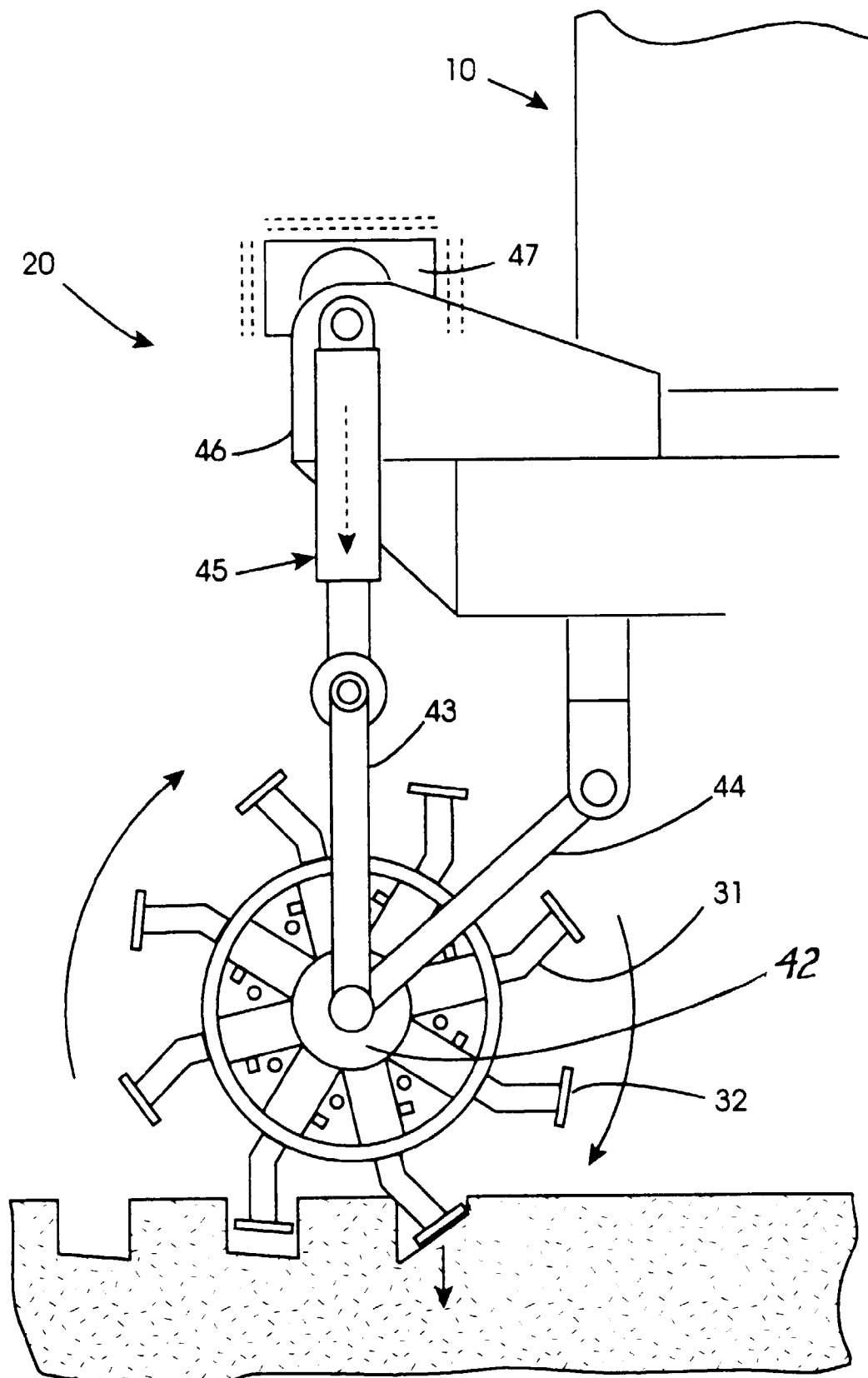


Fig. 4

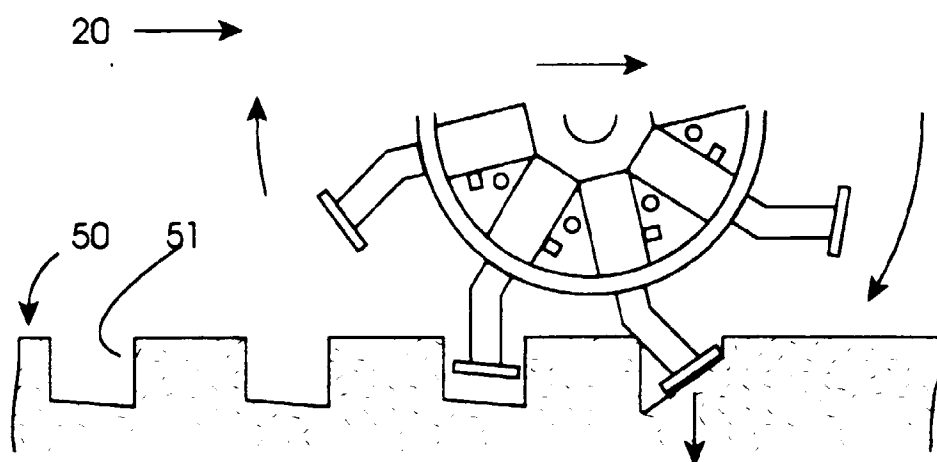


Fig. 5(a)

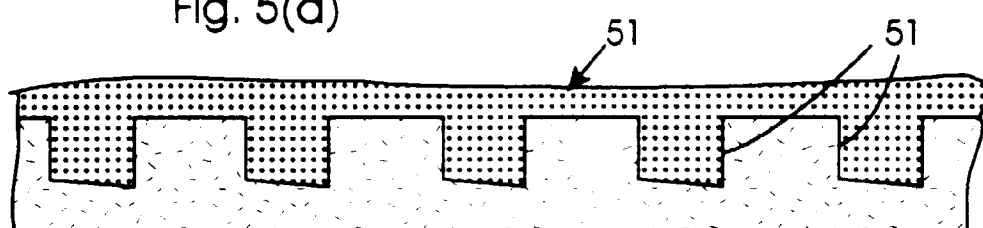


Fig. 5(b)

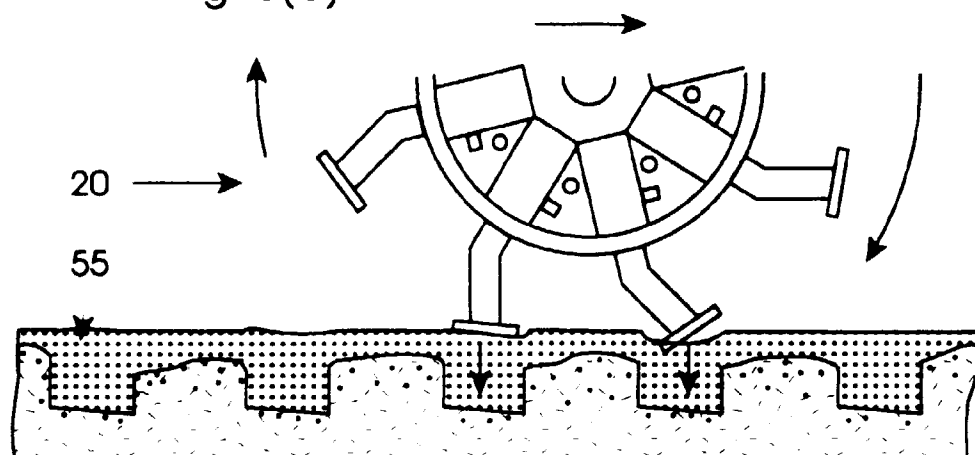


Fig. 5(c)

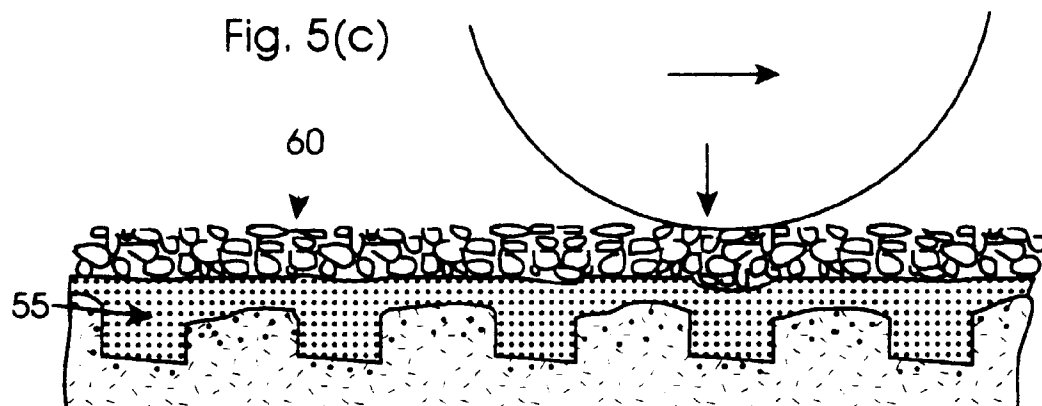


Fig. 5(d)

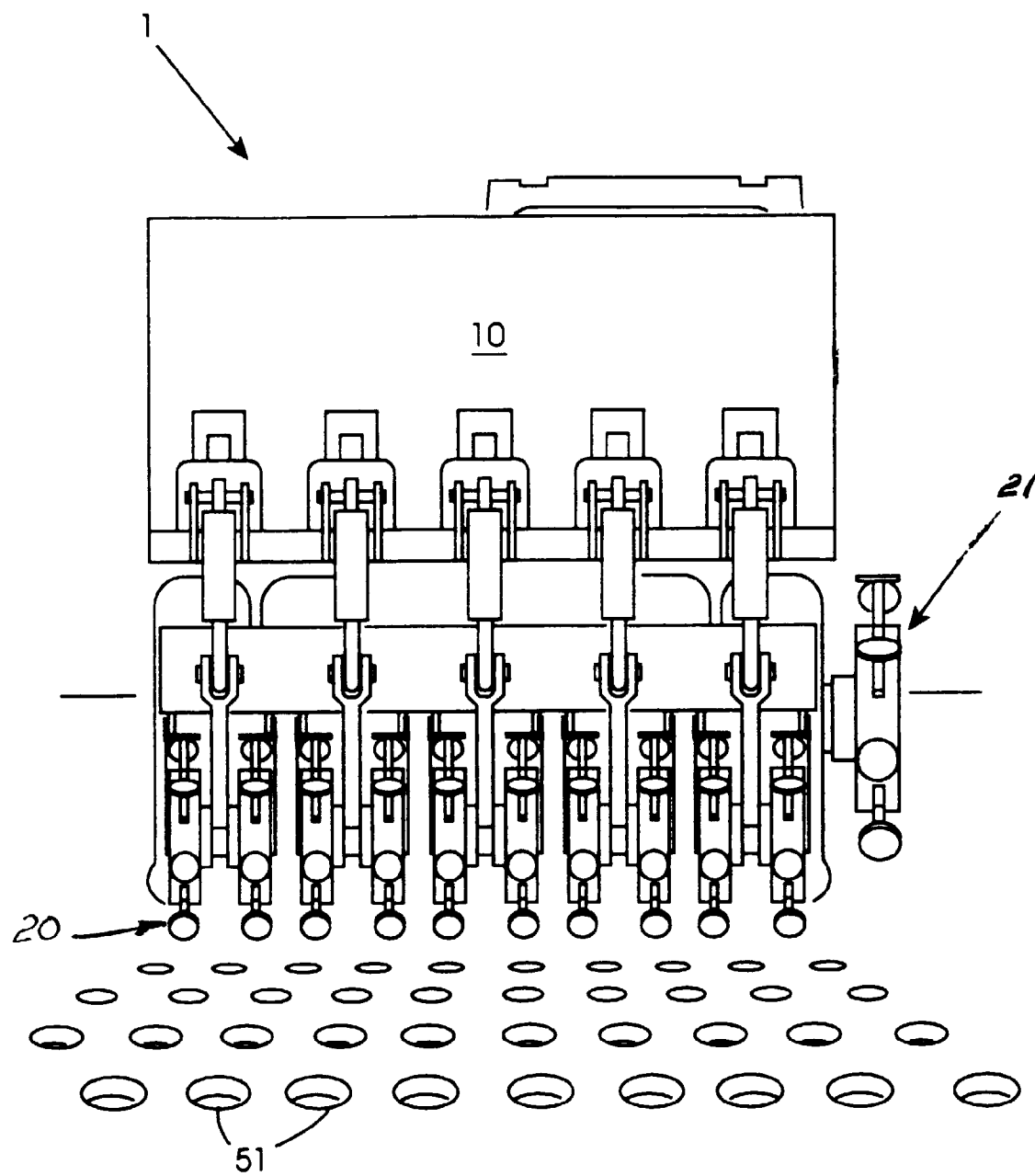


Fig. 6

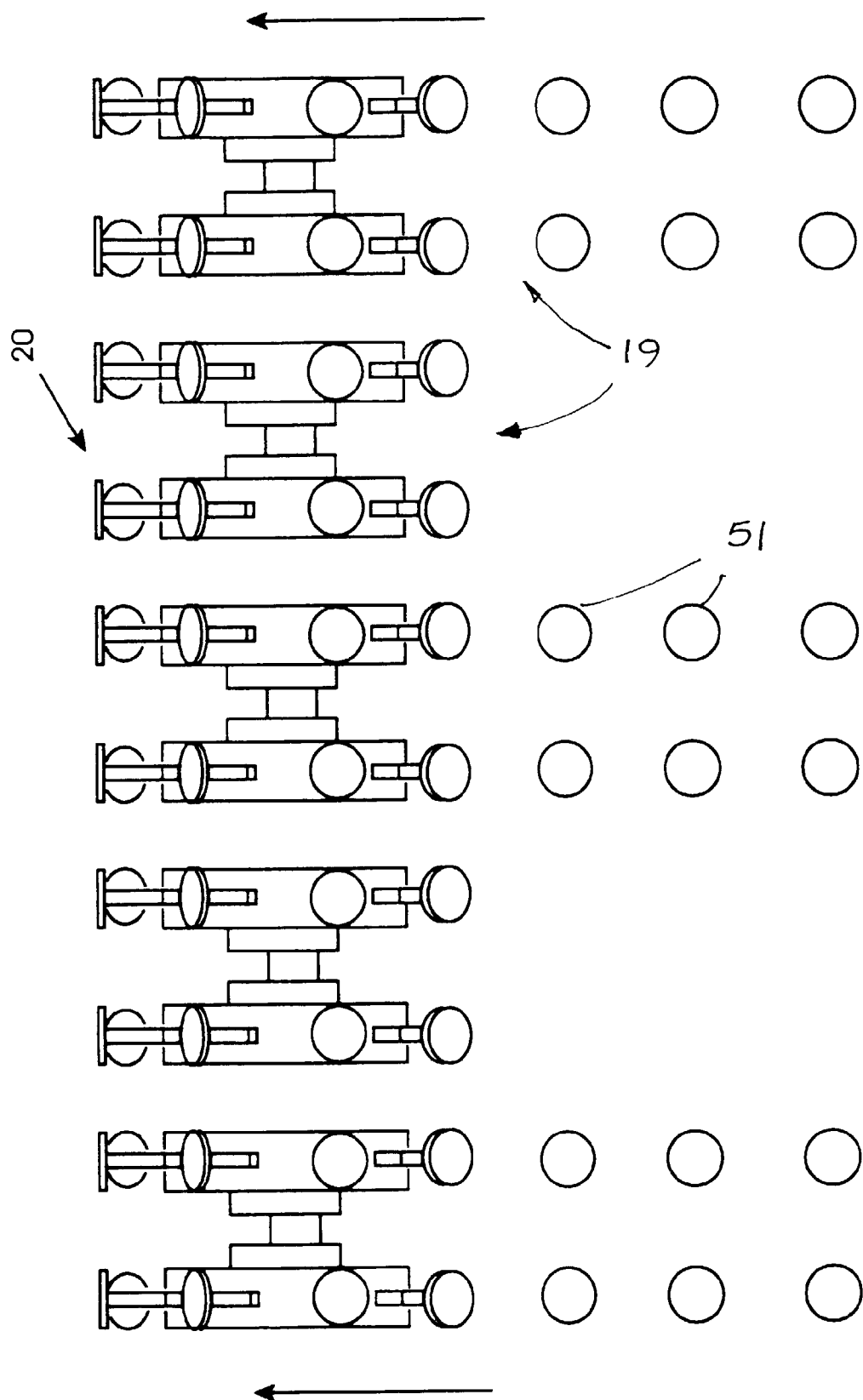


Fig. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 96 65 0001

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 459 062 (CATERPILLAR PAVING PROD) 4 December 1991	1,9,12	E02D3/026 E01C19/28
Y	* page 4, line 50 - page 5, line 49; figures 1-3 *	2,3,6-8, 11,13	
A	---	4,5	
X	US-A-3 797 954 (HARRIS J) 19 March 1974	1	
A	* the whole document *	2-5	

D,Y	US-A-3 146 686 (GRACE ET AL.) 1 September 1964	2,3,11	
A	* column 1, line 55 - column 4, line 2; figures 1-5 *	1,12,13	

Y	US-A-3 067 658 (PALMITER) 11 December 1962	6-8,13	
A	* column 1, line 72 - column 4, line 18; figures 1-8 *	1-3,11, 12	

A	GB-A-1 146 339 (BALDWIN-LIMA-HAMILTON) 26 March 1969	1-3,6,7, 11-13	
	* page 1, line 86 - page 2, line 57; figures 1-5 *		

A	JOURNAL OF TERRAMECHANICS, vol. 29, no. 1, January 1992 OXFORD,GB, pages 35-55, XP 000278239 HIROAKI FUJII 'problems between soil and construction machinery with special reference to field compaction' -----	1	E02D E01C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 11 April 1996	Examiner Tellefsen, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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