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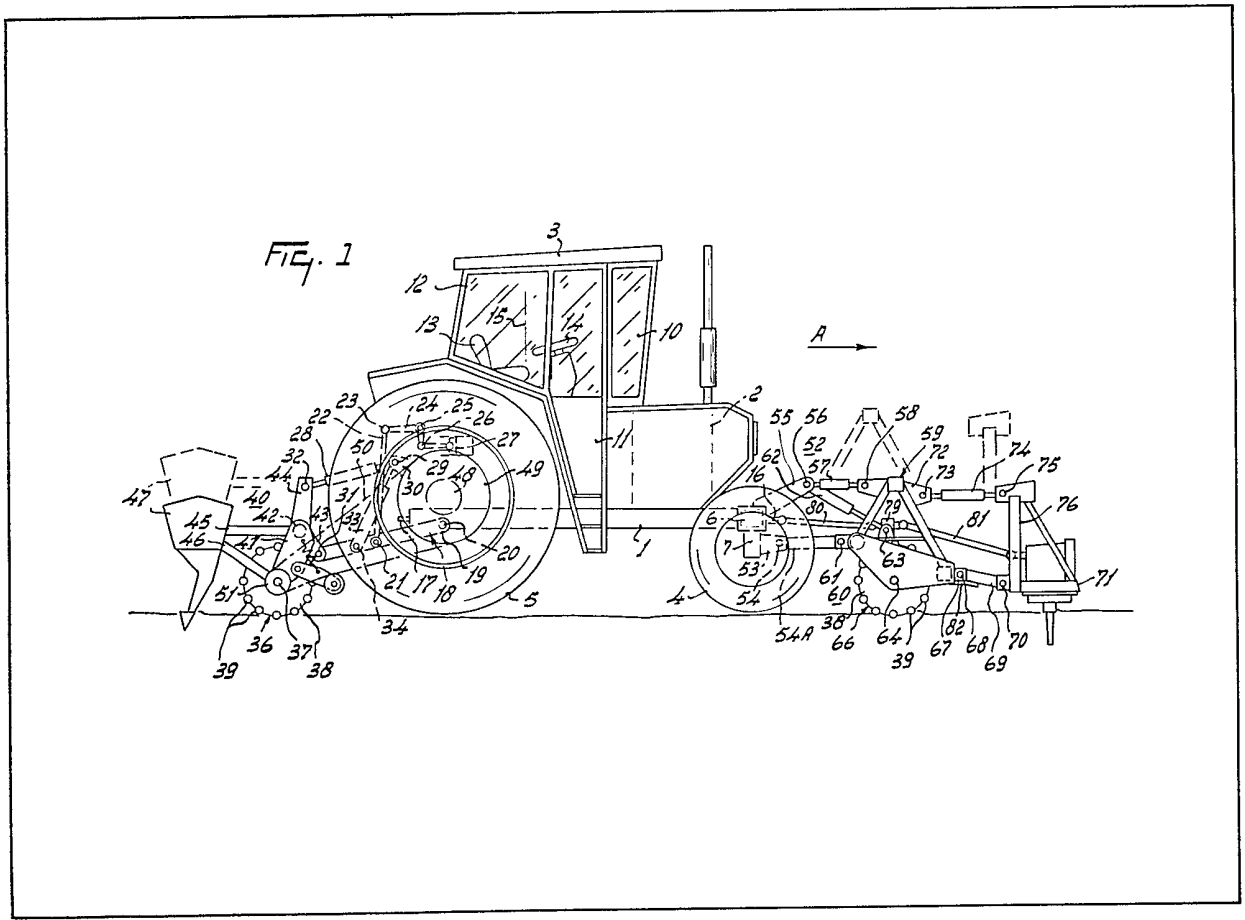
(71) Applicants
C. Van Der Lely NV,
(Netherlands),
10 Weverskade,
Maasland,
The Netherlands.
(72) Inventors
Cornelis van der Lely
(74) Agent and/or Address for Service
Haseltine Lake and Co.,
Hazlitt House,
28 Southampton Buildings,
Chancery Lane,
London WC2A 1AT.

(54) **Agricultural machinery**

(57) A power-driven roller 66 for working the soil is connected to a three point lifting device at the front of a tractor. The roller is drivable from a power take-off shaft 16 of the tractor at a peripheral speed equal to the travel speed of the tractor. A second power-driven roller 36 is mounted at the rear of the tractor, and the front and rear lifting devices 18, 52 include hydraulic rams 62, 33 by means of which the rollers can be pressed downwardly to carry some or all of the weight of the tractor so that the weight is distributed across the full width of the tractor. A rotary harrow 71 is mounted ahead of the front roller, and a seed drill 47 is mounted behind the rear roller.



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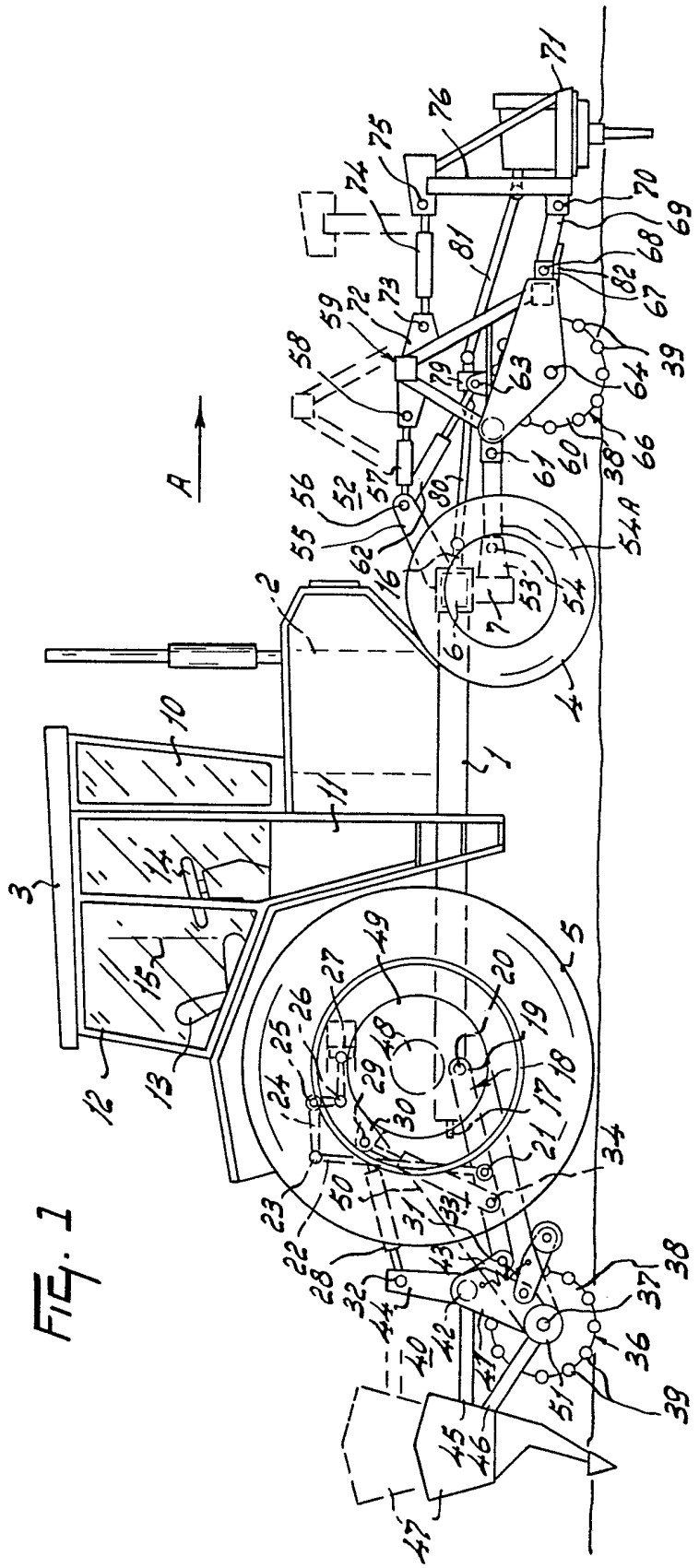

FIG. 1

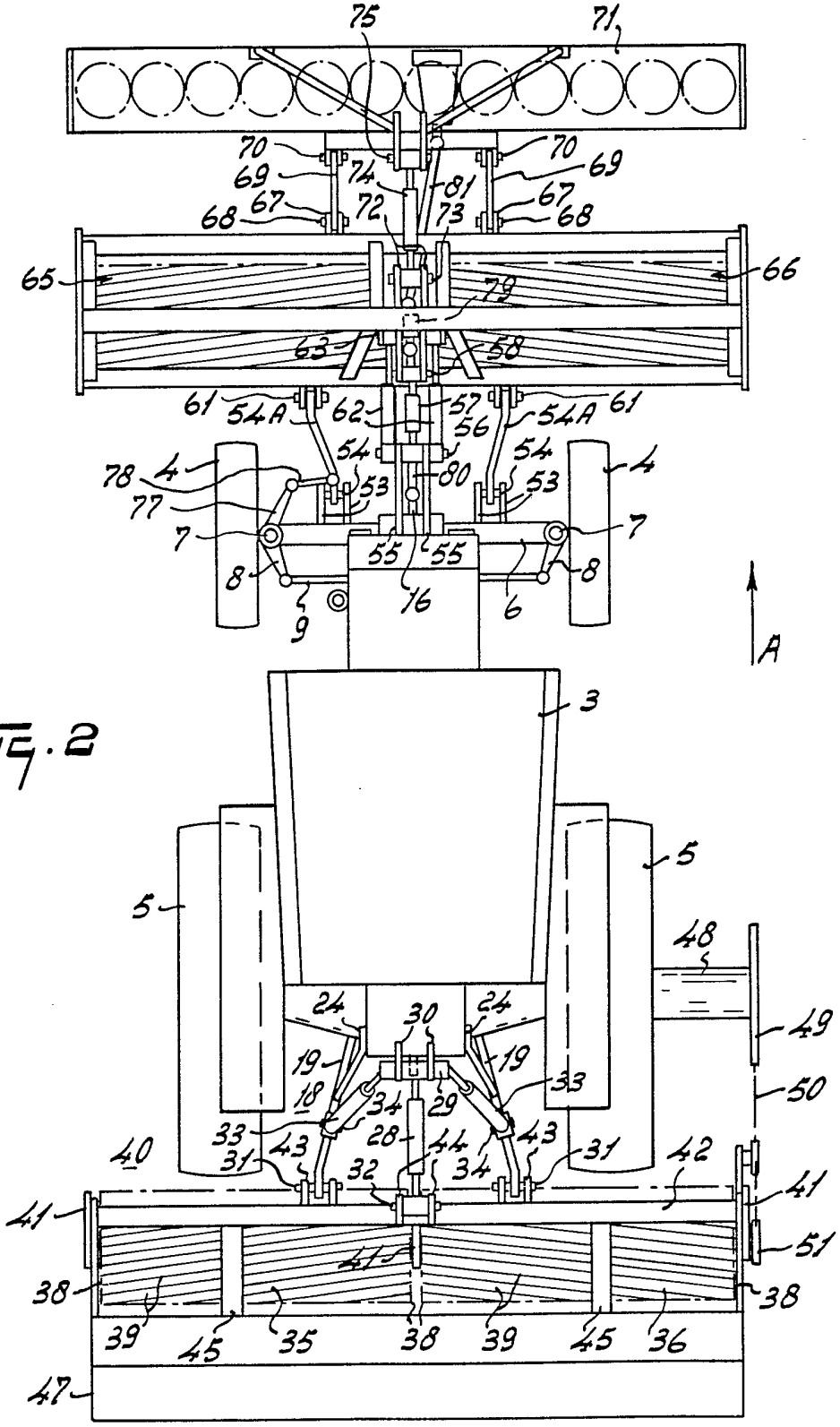
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FIG. 2

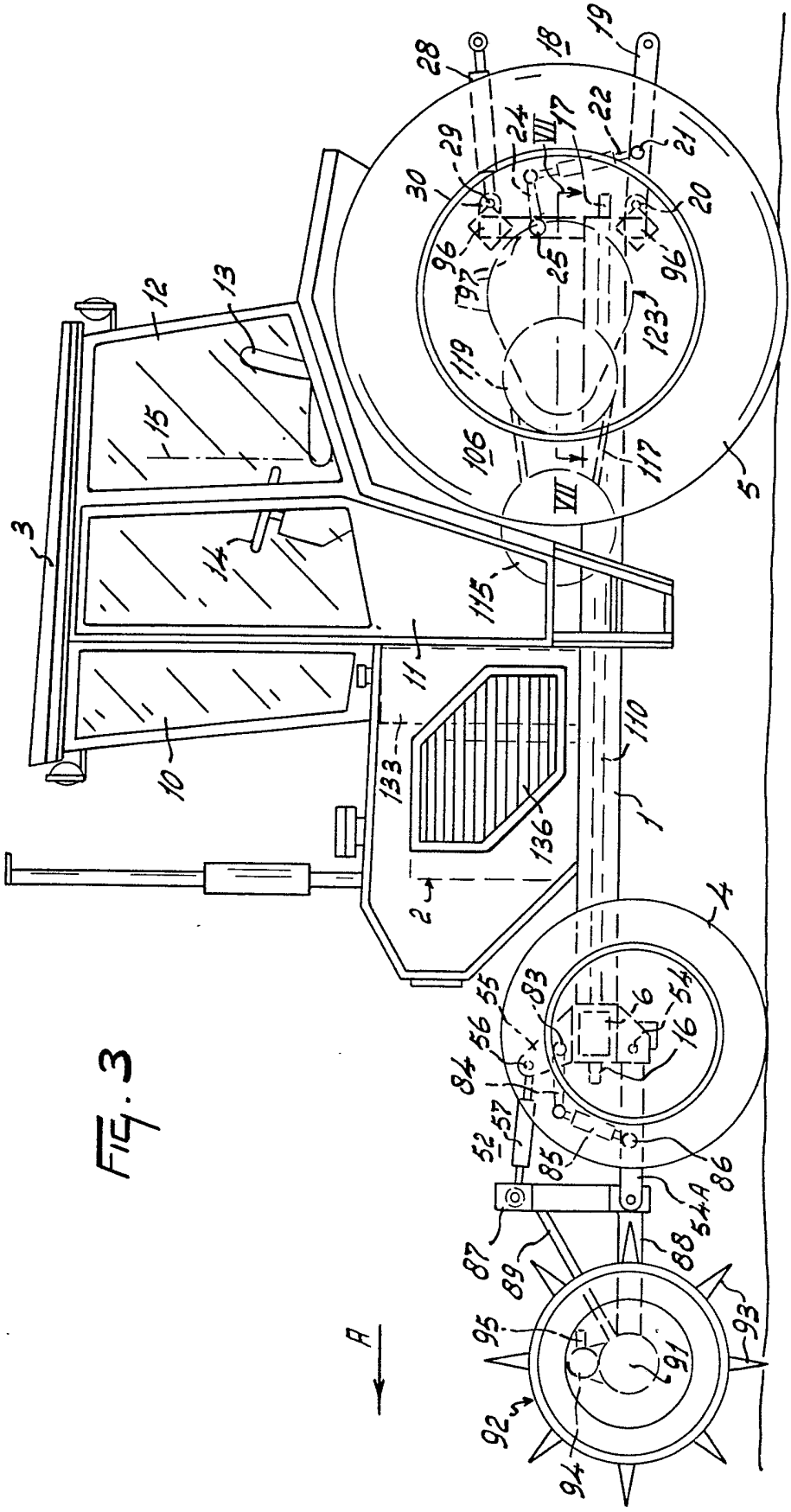
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FIG. 3

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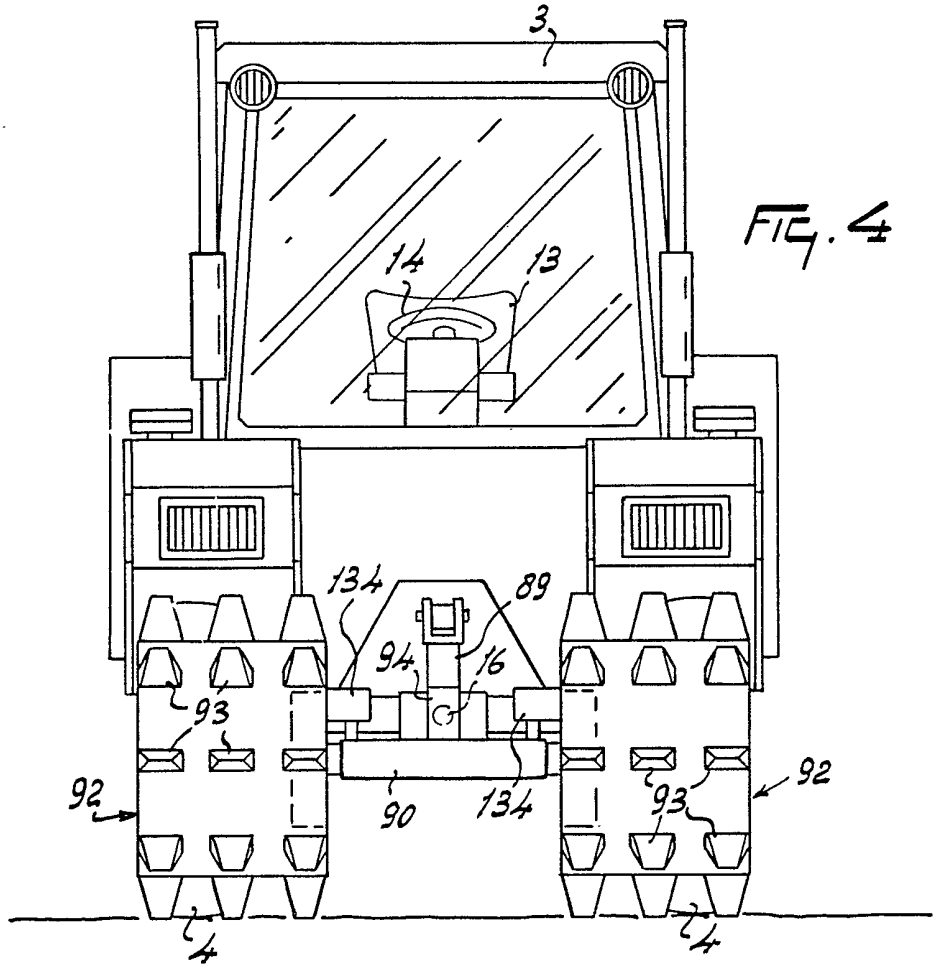

FIG. 4

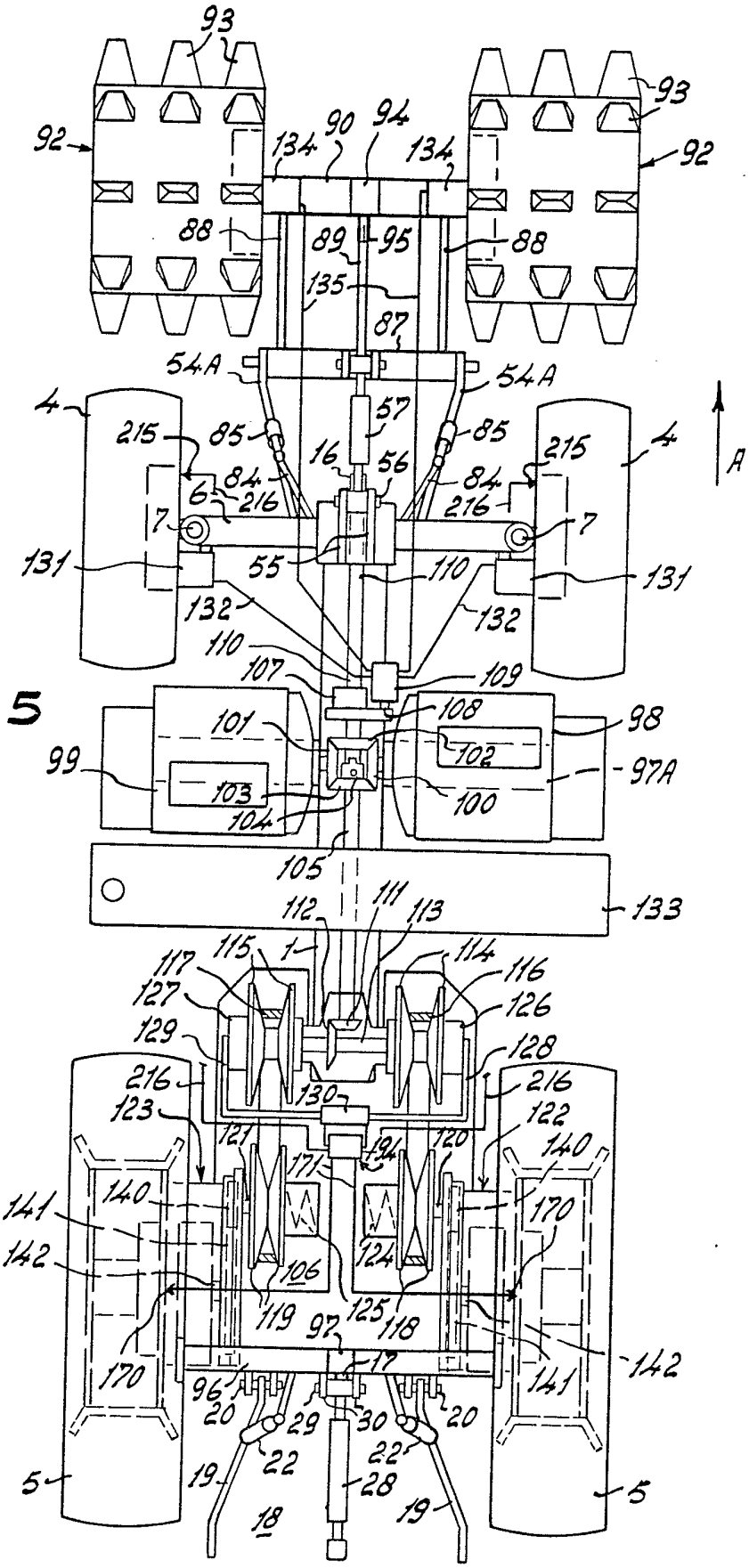
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FIG. 5

SPECIFICATION

A power-driven roller

This invention relates to a power-driven roller for working the soil.

According to the present invention, there is provided a power-driven roller for working the soil, the roller having connecting means for connecting the roller to a tractor, the connecting means being provided at the rear of the roller, with respect to the normal intended direction of operative travel of the roller.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a side view of a tractor;

Figure 2 is a plan view of the tractor shown in Figure 1;

Figure 3 is a side view of another tractor;

Figure 4 is a front view of the tractor shown in Figure 3; and

Figure 5 is a plan view of the tractor shown in Figures 3 and 4, the superstructure of the tractor being omitted.

The tractor shown in Figures 1 and 2 comprises a frame 1 on which are mounted a driving engine 2 and a driver's cab 3. The frame 1 is supported by steerable front wheels 4 and drivable rear wheels 5, which can be coupled with the engine 2 by a torque converter (not shown) and a clutch. The front wheels 4 are mounted on a front axle 6, which is pivotable with respect to the frame 1 about a horizontal pivotal axis lying in the longitudinal central plane of the tractor and extending in the direction of travel indicated by an arrow A. The front wheels 4 are pivotable relatively to the axle 6 about upwardly extending king pins 7, which are secured respectively near the two ends of the front axle 6. The wheels 4 are rigidly secured to track arms 8, which extend from the wheels rearwardly and inwardly. The ends of the track arms away from the wheels are pivotally coupled to a track 9, which extends substantially parallel to the front axle 6 and which can be displaced from the cab 3 for steering the front wheels 4. Viewed on plan, the front end of the engine 2 is located near the front axle 6. With respect to the direction of travel A, the cab 3 is located mainly behind the engine 2 and comprises a front portion 10 having an internal height which is great enough to allow a person who is at least 1.80 ms high to stand upright. An entrace door 11 of the cab 3 has the same height. The rear portion of the cab 3 accommodates a driver's seat 13, a steering wheel 14 and other control levers and pedals for steering and otherwise controlling the tractor and any implements hitched to it. The seat 13, the steering wheel 14 and at least some of the other controls are arranged on a console, which is pivotable about a substantially vertical axis 15 with respect to the rest of the tractor.

The console, and the seat, steering wheel and other controls on it can be fixed in place with respect to the frame 1 in two positions about the axis 15 differing by 180°. In one of these positions, the driver faces in the direction opposite the direction A. As seen from the side (Figure 1), the console is located above the front part of the rear wheels 6.

The tractor has a front power take-off shaft 16 and a rear power take-off shaft 17, which are driven by the engine 2 with a speed proportional to that of the engine 2. In this embodiment provision is made for the power take-off shafts 16 and 17 to be driven at a speed which is proportional to that of the driven rear wheels 5. For this purpose a change-over gear box (not shown) is provided, which has two input shafts, one of which is coupled with the engine 2 by a driver-controlled clutch and the other of which is coupled, also by a clutch, with the output shaft on the torque converter.

At the rear, the tractor has a three-point lifting device 18 having two lower lifting arms 19 attached to the frame 1 for pivotal movement about pivotal shafts 20. Substantially midway along their length, the lower lifting arms 19 have pivotal shafts 21, to which upwardly extending pull rods 22 are fastened, the top ends of which are pivotably coupled by shafts 23 to bell cranks 24, which are pivotable about pivotal shafts 25 with respect to the frame 1. The ends of the bell cranks 24 away from the shafts 23 are connected by pivotal shafts 26 to the piston rods of hydraulic rams 27, which are pivotably mounted on the frame 1. The hydraulic rams 27 can be actuated by the driver so that the pull rods 22 can turn the lower lifting arms 19 upwards. Otherwise, by opening a hydraulic connection, the driver can cause the hydraulic fluid to flow out of the hydraulic rams 27 to allow the lower lifting arms 19 to turn downwards under the effect of gravity acting, for example on an attached machine. The lifting device 18 comprises furthermore an upper arm 28, the length of which is adjustable and which is pivotably connected by a pivotal shaft 29 to lugs 30 which are fixed to the frame 1. The machine or the tool is hitched to the outermost ends of the lifting arms 19 and 28 by pins 31 and 32 respectively.

In addition to the components of the three-point lifting device 18 described above, there are provided two hydraulic rams 33, which are disposed symmetrically with respect to the central vertical longitudinal plane of the tractor and the top ends of which are pivotably connected by the pivotal shaft 29 to the lugs 30. The lower ends of the hydraulic rams 33 are pivotably connected by horizontal pivotal shafts 34 to the respective lower lifting arms 19 concerned. The orientation of the rams 33 is such that in the side elevation of Figure 1 a line of connection between the shafts 29 and 34 is in this embodiment at an angle of about 15 to 30° to the vertical, the rams 33 being inclined to the rear from top to bottom. The two hydraulic rams 33 can be actuated from the driver's seat 13 so that their lengths are increased under pressure so that the lower lifting arms 19 are forcibly pressed down. The hydraulic rams 33 are provided in addition to the hydraulic three-point lifting device 18 already provided on the tractor. It is furthermore also possible for the rams 27 to be double-acting and for the linkage 21 to 26 to be constructed in a manner such that the rams 27 can

press the lower lifting arms 19 forcibly downwards.

A rotary support for the tractor is connected to the lifting device 18 by the pins 31 and 32. This rotary support comprises in this embodiment two rollers 35 and 36 having the same dimensions as each other, and having aligned rotary shafts 37. The rollers 35 and 36 are arranged end-to-end and cover a width which may be 20% to 50% larger than the overall width of the tractor itself. The rollers 35 and 36 are disposed symmetrically one on each side of the central vertical longitudinal plane of the tractor. As an alternative, a single roller or more than two rollers end-to-end may be arranged to cover the width covered by the rollers 35 and 36. If more than one roller is used, the rollers may both be rigidly secured to a common rotary shaft 37, as in the embodiment shown, but embodiments are possible, in which each roller is driven independently about its own rotary shaft 37.

Each of the rollers 35 and 36 has near each end an end plate 38 supported by the rotary shaft 37. Each end plate 38 supports at its periphery a great number of rods or tubes 39 which extend helically around the rotary shaft 37, these rods or tubes 39 together providing a substantially cylindrical outer surface for each roller 35, 36. This cylindrical outer surface may, as an alternative, be formed by flat strips extending helically or axially, the faces of which constitute the outer surface of the rollers.

The rollers 35, 36 are supported by the rotary shaft 37 in a frame 40 having at its two outer ends side plates 41 the top edges of which are interconnected by a supporting beam 42 extending transversely of the direction A. The supporting beam 42 is provided with downwardly extending lugs 43, through which pass the pins 31 at the rear ends of the lower lifting arms 19. Midway along the length of the supporting beam 42 there is a pair of lugs 44 for receiving the pins 42 to connect the top arm 28 of the lifting device 18 to the supporting beam 42. The frame 40 of the rotary support is provided with rearwardly projecting carriers 45 and 46, by means of which a machine or tool, in this embodiment a seed drill 47, is fastened to the frame 40. In this embodiment the seed drill 47 covers the whole width of the frame 40.

In this embodiment one of the wheel axles of the drivable wheels 5 of the tractor is extended by a length of tubing 48, the outer ends of which carries a chain sprocket 49 which is drivably connected by a chain 50 with a further chain sprocket 51 rigidly secured to the rotary shaft 37. The diameters of the sprockets 49 and 51 are selected so that the rollers 35 and 36 are driven by the engine 2 with a peripheral speed which is equal to that of the rear wheels 5. As an alternative, the rollers 35 and 36 may be driven by means of the power take-off shaft 17, when the latter is coupled by the aforesaid change-over gear box with the output shaft of the toque converter of the tractor.

In an analogous manner a rotary support for the tractor is hitched to a three-point lifting device 52 at the front of the tractor. In this embodiment the lifting device 52 is secured only to the front axle 6, but this lifting device may, as an alternative, be secured directly to the frame 1 of the tractor. The front axle 6 is provided with two pairs of lugs 53 projecting forwardly. Lower, lifting arms 54A are pivotably connected to the pairs of lugs 53 by aligned pivotal shafts 54. At the centre the top face of the front axle 6 is provided with a pair of lugs 55 which are inclined forwardly from bottom to top. A top arm 57 of the lifting device is pivotally supported at the front ends of the lugs 55 by a pivotal shaft 56, which extends, like each of the pivotal shafts 54, horizontally and transversely of the direction A. The length of the top arm 57 is variable. The leading end of the top arm 57 is pivotably connected to a frame 59 by a pivotal shaft 58. The frame 59 is part of a rotary support 60 carried by the lifting device 52. The lower lifting arms 54A are pivotably connected to the frame 59 at their front ends by pivotal shafts 61. As seen from the side, the lower lifting arms 54A and the top lifting arm 57 are substantially parallel to one another and are substantially horizontal in a normal operational position of the support 60. A double-acting hydraulic ram 62 is supported at one end by the pivotal shaft 56 and the other end is pivotably connected to the frame 59 by a pivotal shaft 63. In this embodiment the hydraulic ram 62 is a double-acting ram.

The pivotal shafts 54, 56, 58, 61 and 63 are all parallel to one another and extend horizontally and transversely of the direction A. As seen from the side (Figure 1), the pivotal shafts 53, 56, 58 and 61 are located at the corners of a quadrilateral which, as shown, is almost a parallelogram. The pivotal shafts 58, 61 and 63 are all fastened to the rigid frame 59 of the rotary support 60 and are thus disposed at the corners of a rigid triangle regardless of the lengths of the hydraulic rams 62.

In the frame 59 is journalled a substantially horizontal rotary shaft 64, which is parallel to the rotary shaft 37 when the tractor is travelling in a straight line. Rotatable rollers 65 and 66 are mounted on the rotary shaft 64. The rollers 65 and 66 are arranged end-to-end. They have the same dimensions as the rollers 35 and 36 and are constructed in a similar manner. The width covered by the pair of rollers 65 and 66 is equal to that covered by the rollers 35 and 36. The rollers 65 and 66 are in front of the front wheels 4, whereas the rollers 35 and 36 are behind the rear wheels 5.

Because it is mounted on the front axle 6, the support 60 is freely pivotable with respect to the frame 1 of the tractor about the same horizontal pivotal axis located in the central vertical plane of the tractor as the front axle 6 is pivotable about.

The front of the frame 59 is provided with two pairs of lugs 67 carrying aligned pivotal shafts 68 which pivotably connect arms 69 to the frame 59. These arms 69 project forwardly from the frame 59 and are inclined slightly downwardly from back to front when in an operational position. The front ends of the carrier arms 69 are pivotally connected by aligned pivotal shafts 70 with a machine or tool which, in this case, is a rotary harrow 71. Near the top of the frame 59 there is a pair of ears 72 supporting a pivotal shaft 73 which pivotably connected an adjustable length rod 74 to the frame 59. The front end of the rod 74 is pivotably connected by a pivotal shaft 75 to the top fastening point of a

trestle 76 carrying the machine 71.

About one or both of the king pins 7 is pivotable a lever 77, which, like the track arm 8, is rigidly secured to the adjacent wheel 4. The lever 77 extends forwardly away from the king pin 7 in the direction towards the adjacent lower lifting arm 54A. The lever 77 is connected by a control link 78 with the adjacent lower lifting arm 54A, this control link 78 being pivotally connected both to the lever 77 and to the lower lifting arm 54A. The pivotal connection between the control link 78 and the lower lifting arm 54A is in front of the pivotal shaft 54.

It should be noted that the rollers 65 and 66 of Figures 1 and 2 are rotatable independently of one another about the rotary shaft 64. In an alternative construction, the rollers 65 and 66 may be driven by the power take-off shaft 16, when the latter is coupled with the output shaft of the torque converter of the tractor. In this case there is provided a change-over gear box in a manner not shown, the input shaft of which is coupled by means of an auxiliary shaft with the power take-off shaft 16 and the output shaft of which is drivably connected through a gear transmission with the rotary shaft 64, to which the rollers 65 and 66 are then rigidly secured.

However, in the embodiment shown the frame 59 of the support 60 has fastened to it a bearing housing 79, through which passes an auxiliary shaft 80. The shaft 80 is connected at one end by a universal coupling with the power take-off shaft 16 and at the other end by a further universal coupling to a second auxiliary shaft 81. The second auxiliary shaft 81 is connected by a third universal coupling to the input shaft of the machine 71. In this way the machine 71 can be driven from the power take-off shaft 16.

In agricultural work the tracks made in the ground by the tractor wheels may often be undesirable. If, for example, a field is first harrowed before manure, fertilizer or seed is applied, the pressure of the tractor wheels on the harrowed soil locally packs the soil so that the soil structure obtained by harrowing, and in particular the distribution of capillaries, is adversely affected. After the growth of the plants this adverse effect becomes manifest. In order to obviate this disadvantage the pressure of the tractor constructed in the form shown in Figures 1 and 2 on the ground is reduced to such a low value that the underlying soil structure, particularly in the region of the plant roots, is maintained wholly or substantially wholly in the form obtained by harrowing. This applies not only to harrowing but also to soil treatments by means of other soil cultivating machines. It can thus be ensured that the seeds can germinate and grow in a soil structure which is not, or is only slightly, affected by the weight of the tractor.

From his seat 13 the driver can lift the rotary support at the front and/or at the rear of the tractor together with the tool (the rotary harrow 71 or the speed drill) by means of the hydraulic ram 27, which is normal tractor equipment and acts through the bell cranks 24, the pull rods 22 and the lower lifting arms 19 and the top arm 28, or by means of the double-acting hydraulic ram 62, by means of which the foremost support 60 and the machine 71 are movable relatively to the front axle 6. When a hydraulic communication in the hydraulic feed of the ram 27 is opened, the rear support and the seed drill drop to the ground under their own weight, whereas the front support and the machine 71 can be lowered to the ground by extending the rams 62 by hydraulic pressure. However, the hydraulic ram 27 which is standard equipment is not able to exert downwards pressure on the rear support 35, 36 and on the machine 47. For this purpose the two hydraulic rams 33 are provided, which can be actuated from the driver's seat to force the lower lifting arms 19 downwardly about the pivotal shafts 20 so that, in a first instance, part of the tractor weight is taken by the rollers 35, 36. In the same manner the hydraulic rams 62 can be extended by hydraulic pressure so that the roller 65, 66 also support, in a first instance, part of the tractor weight. Thus the pressure applied by the tractor wheels 4 and 5 to the ground is reduced so that compression of the soil by the wheels 4 and 5 and the consequent deterioration of the structure is reduced because, for a given weight, the pressure exerted by the combination of the rollers 35, 36 and 65, 66 and the wheels 4, 5 is an order of magnitude lower than the pressure exerted by the wheels 4 and 5 when they provide the sole support of the tractor.

In order to improve further this advantageous effect of the reduced ground pressure, the pressure in the rams 33 and 62 can be increased by the driver to an extent such that the full weight of the tractor, the supports and the machines is taken by the rollers 35, 36 and 65, 66 so that the tractor wheels 4 and 5 no longer exert any significant pressure on the ground and may even be lifted clear of the ground. The overall weight is then distributed along the long rollers and the ground pressure is then reduced to such a low value that deterioration of the soil structure in the region of plant roots is avoided.

The height of the equipment 47 and 71 above the ground is determined by the positions of this equipment with respect to the rollers 35, 36 and 65, 66 respectively. Despite the fact that the support 60 moves with respect to the tractor when the tractor is lifted, the orientation of the frame 59 of the support 60 does not change significantly, since the pivotal shafts 54, 56, 58 and 61 are located, as viewed from the side, at the corners of what is substantially a parallelogram so that the attached machine also maintains its initial orientation. This is important for machines whose orientation with respect to the ground influences the quality of the treatment, as in the case of a rotary harrow 71. It should be noted that beneath each of the two carrier arms 69 of the harrow 71 there is a stop 82 positioned for abutment with the carrier arms 69 loaded by the weight of the tool 71. This stop 82 is rigidly fastened to the frame 59 of the support 60 and prevents the tool 71 from shifting too far downwards relative to the support 60, when, for example, the support 60 is lifted by means of the hydraulic ram 62.

When the driver wants to make a turn, the track rod 9 is displaced approximately parallel to itself so

that the track arms 8 and hence also the front wheels 4 turn about the king pins 7. At the same time the lever 77 is turned about the respective king pin 7. The control link 78 connecting the lever 77 to the adjacent lower lifting arm 54A causes this lower lifting arm to turn about the associated pivotal shaft 54. This is permitted because the lower lifting arm 54A is mounted on the pivotal shaft 54 by a ball-and-socket joint. Therefore, when the front wheels 4 turn about the shafts 7 the rotary support 60 of the tractor will turn likewise so that the support 60 guides the tractor round the bend regardless of whether or not the front wheels 4 are in contact with the ground. The machine 71 coupled to the front of the support 60 is turned at the same time and steered through the bend. During operation, the assembly of the support 60 and the machine 71 is pivotable with respect to the tractor frame about the pivotal axis about which the front axle 6 is pivotable so that the support 60 and the machine 71 can follow unevennesses of the ground independently of the rear roller 35, 36.

The torque converter which transmits power between the engine 2 and the driven wheels 5 comprises at least one variable belt transmission and, in addition, a stepwise change-speed gearbox, which is arranged between the variable belt transmission and the axle of the wheels 5. The construction of this torque converter can correspond with that described with reference to the following embodiments. With the elements of the torque converter disposed as will be described, an advantageous load of the belt transmission is obtained with differently adjusted transmission ratios of the stepwise change-speed gearbox so that for each transmission ratio set in the change-speed gearbox (for example, to provide a range of low speeds for exerting high tractive power and a range of higher speeds for actuating light machines or for road travel) the pulley speed of the belt transmission can be adjusted steplessly to transmit maximum torque and/or power.

The tractor can be used in either direction of travel so that, depending upon the circumstances, the driven rotary support can be disposed at the front or at the rear of the tractor, with respect to the actual travel direction, and also in front of or behind the implement. Apart from the nature of the implement (it is sometimes preferable to employ implements hitched to the front of the tractor) the necessity that the driver is able to supervise the job must also be a consideration. Depending, therefore, on whether or not the driven rotary support and the implement to be used is to be at the front or at the rear of the tractor, the driver's seat and the steering wheel and other controls mounted on the console can be turned about the pivotal axis 15 to face the driver in the direction A or in the opposite direction.

Figures 3 and 4 show another tractor construction having a rotary support, which in this case may serve in addition as a non-skid device. Parts whose functions correspond with those of the parts shown in Figures 1 and 2 are designated by the same reference numerals. As in the preceding embodiment the front power take-off shaft 16 is coaxial with the pivot axis about which the front axle 6 is pivotable with respect to the frame 1.

The construction of the front lifting device 52 of the tractor shown in Figures 3 to 5 slightly differs from that of the preceding embodiment. The interior of the hollow front axle 6, which is pivotable about the shaft 16 with respect to the rest of the tractor, accommodates one or more hydraulic devices capable of turning two pivotal shafts 83 disposed above the front axle 6 one on each side of the central longitudinal plane or symmetry of the tractor. A lever 84 is rigidly secured to each shaft 83. The end of each lever 84 away from the pivotal shaft 83 is pivotally coupled to a connecting element 85, the lower end of which is connected by a pivotal shaft 86 with a lower lifting arm 54A. The connecting element 85, in this embodiment, is a double acting hydraulic ram actuable from the driver's seat independently of the hydraulic device in the front axle 6.

A trestle 87 is hitched to the front ends of the lower lifting arms 54A and the top arm 57. This trestle 87 has the shape of an inverted V, as viewed in the direction of travel A. Near the places where it is hitched to the lifting arms 54A this trestle 87 has two forwardly projecting, substantially horizontal carrier arms 88 secured to it, and near the place where it is hitched to the top arm 57, there is secured a rod 89 which is inclined downwardly from back to front. The carrier arms 88 and the rod 89 support at their front ends a sleeve 90, in which is journalled a rotary shaft 91 extending parallel to the front axle 6. Rotary members 92 in the form of wheels or drums are mounted on the portions of the rotary shaft 91 projecting from the ends of the sleeve 90. In the embodiment illustrated the width of each of these rotary members 92 is substantially equal to the distance between the lowermost point of the trestle 87 and the lateral boundary of the tractor, but this width may be larger. The diameter of each rotary member 92 is about 50 to 90% of the diameter of the adjacent tractor wheel 4. The rotary members 92 are disposed symmetrically about the central longitudinal plane of the tractor. The outer circumference of each of the rotary members 92 is constituted by cylindrical sheet material provided with a plurality of rows (in this embodiment there are eight rows), of pointed projections 93, which extend radially outwardly. Each row of projections comprises, for example, three projections 93. As seen from the side, each projection 93 is tapered, and a seen in a tangential direction, each extension 93 looks, in outline, like a truncated cone, so that when a projection 93 has penetrated into the ground, a large driving contact surface is obtained between each projection 93 and the ground.

The sleeve 90 is provided with a gearbox 94 having an input stub shaft 95 projecting towards the power take-off shaft 16. The input stub shaft 95 can be drivably connected by an auxiliary shaft to the power take-off shaft 16, in which case the auxiliary shaft would pass through the V-shaped trestle 87. The pinion transmission in the gearbox 94 provides a speed difference between the power take-off shaft 16 and the rotary shaft 91, the rotary shaft 91 is provided near the gearbox 94 with a pinion which is in mesh with the pinion transmission in the gearbox

94.

The rotary support comprising the elements 92 and the associated frame parts 87, 88 and 89 and the driving elements 94 and 95 may also be fastened to the rear lifting device 18, the drive then being applied by the power take-off shaft 17. In this way the tractor can be provided at the front as well as at the rear with a rotary support as in the preceding embodiment. In this embodiment both supports are drivable. The support at the front can be lifted by means of the hydraulic device accommodated in the hollow front axle 6, which device can cause the levers 84 and the connecting elements 85 to turn, while the support at the back can be raised by turning the pivotal shafts 25 and the associated levers 24 as well as the pull rods 22. The pull rods 22 may be replaced by separately actuable double-acting hydraulic rams controlled from the driver's coat so that when the rotary supports have been lowered to the ground, they can be forced downwards by the energization of the hydraulic ram 22 and of the double-acting ram 85, so that the pressure of the tractor wheels 4 and 5 on the ground can be reduced or eliminated at the driver's option as is described for the first embodiment.

The elements 92 hitched to the front and/or rear lifting devices of the tractor are also effective as non-skid devices. The elements 92 can be pressed to the ground by the hydraulic rams 22 and 85, as the case may be, with enough force to cause the projections 93 to penetrate the ground, while the wheels 4 and 5 continue to bear on the ground with almost the full wheel pressure. The projections 93 provide a firm grip on the ground so that an appreciable part of the driving torque provided by the driving engine 2 is transferred through the non-skid arrangement to the ground and therefore, the torque to be transferred by the wheels 4 and 5 may be lower when the elements are driven by the power take-off shafts 16 and 17. By fastening the supports or non-skid devices 92 to the front and rear lifting devices the tractor can be employed on slack or yielding soil whilst the pressure of the tractor can be reduced to avoid deterioration of the soil structure by compaction. In the latter case the elements 92 may, if desired, be pressed against the ground with considerably heavier force than in the first case. Consequently, despite the attached heavy machines, a comparatively low ground pressure can be ensured. The non-skid device 92 has a simple structure and can be readily detached. When the non-skid device 92 is raised from the ground, its weight increases the pressure of the wheels 4 and 5 on the ground, which is advantageous under normal soil conditions for producing heaving tractive forces.

A drive arrangement which can be used with either of the tractors of Figures 1 to 4 is shown schematically in Figure 5. The frame 1 comprises a central, hollow frame beam extending away from its junction with the front axle 6 to behind the axles of the wheels 5. Near its rear end, the frame beam 1, which is located in the central vertical longitudinal plane of the tractor, is rigidly secured to a beam 96 which extends transversely of the direction A and carries the lower lifting arms 19 and a vertical supporting beam 97 located in the central longitudinal vertical plane of the tractor. The top arm 28 of the lifting device 18 is attached to the beam 97 by the pivotal shaft 29.

At a position behind the rear most points of the front wheels 4 and in front of the rear wheels 5, a hollow beam 97A is secured to the central, hollow frame beam 1. This beam 97 supports driving engines 98 and 99 which are arranged so that their output shafts are aligned with and project towards one another, the output ends of the engines facing one another. In this embodiment the output shafts are at right angles to the central vertical plane of the tractor, but they may be inclined to that plane. The engines 98 and 99 are disposed one on each side of the central vertical plane of the tractor. The adjacent ends of the output shafts of the engines are provided with bevel gear wheels 100 and 101 respectively, both of which mesh with bevel gear wheels 102 and 103 located one on each side of a vertical plane containing the axes of the output shafts of the engines 98 and 99. The axis of the bevel gear wheels 102, 103 are aligned with one another and are parallel to and above the centreline of the hollow frame beam 1. Between the bevel gear wheels 102 and 103 there is a coupling piece 104, which is splined to, and therefore axially slidable along, a drive shaft 105 of a variable transmission 106 of the tractor. Axial displacement of the coupling piece 104 along the drive shaft 105 causes the shaft 105 to engage either the bevel gear wheel 102 or the bevel gear wheel 103 so that the drive shaft 105 can be rotated in either direction by one or both of the engines 98 and 99. The gear wheels 102 and 103, if they are not rotationally coupled with the shaft 105 by the coupling piece 104, are, therefore, freely rotatable about the shaft 105 (over-running). The shaft 105 projects forwardly beyond the gear wheel 102 and constitutes an input shaft of a gear box 107. The gear box 107 has two output shafts 108 and 110. The output shaft 108 drives a hydraulic pump 109 and the output shaft 110, which is accommodated in the hollow beam 1 and projects beyond the front end of the hollow beam 1, constitutes a power take-off shaft 16, as well as constituting the pivotal shaft about which the front axle 6 is pivotable with respect to the frame beam 1. The portion of the drive shaft 105 located behind the gear wheel 103 drives by means of two bevel gear wheels 111 and 112 a horizontal shaft 113 extending at right angles to the vertical central plane of the tractor. The shaft 113 has near each end a pulley 114 or 115 respectively, these pulleys being disposed symmetrically one on each side of the vertical central plane of the tractor. The pulleys 114 and 115 are drivably connected by drive bolts 116 and 117 respectively with pulleys 118 and 119 respectively, each of which is mounted on a shaft 120 and 121 respectively. The shafts 120 and 121 constitute input shafts of stepwise change-speed gearboxes 122 and 123 respectively (Figure 5), the output shafts of which drive the rear wheels 5 of the tractor. The gearboxes 122 and 123 are both adjustable from the driver seat in a manner such that the same speed of the shafts 120 and 121, two ranges of speeds of the wheels 5 can be provided.

The inboard flange of each pulley 118 and 119 is biased by a spring 124 and 125 respectively towards the other flange of the pulley concerned, and so the associated belt 116 or 117 respectively is clamped between the conical faces of the flanges.

The outboard flange of each pulley 114 and 115 can be urged by means of hydraulic means in a housing 126 or 127 respectively towards the inboard flange of the respective pulley. These hydraulic means are known *per se* and are supplied with hydraulic fluid through hydraulic conduits 128 and 129 respectively, both of which lead from a control valve 130, which can be adjusted by the driver or by a control device.

The drive shaft 105 is coupled through one or more pinions (located in the hollow beam 1) drivably engaging the pinion 101 with the rear power take-off shaft 17; which extends to the rear inside the hollow beam 1.

In this embodiment the front wheels 4 are driven by hydraulic motors 131 mounted on the front axle 6, the output shafts of which drive, via a gear transmission a ring gear which is rigidly secured to the wheel rim. The hydraulic pump 109 is connected to the hydraulic motors 131 by two pairs of lines 132.

A fuel tank 133 is arranged behind the two endings 98 and 99 and between the pairs of wheels 4 and 5. The tank 133 is thus located between the two engines and driver's seat 13. Viewed on plan, the fuel tank is elongate and its length is at right angles to the central vertical plane of the tractor. The tank covers the whole width of the tractor. Seen from the side, the fuel tank 133 is substantially the same height as the engines 98 and 99. This has the advantage that the noise produced by the engines will not readily penetrate into the cab owing to the screening effect of the fuel tank and its contents.

As stated above, the elements 92 can be driven from the power take-off shaft 16 by means of an auxiliary shaft and the gearbox 94. Figure 5 shows an alternative drive in which each of the elements 92 can be driven by a hydraulic motor 134, the housing of which is fastened to the sleeve 90. The hydraulic motors 134 communicate through pairs of hydraulic lines 135 with the pump 109.

Inlets 136 for air intended for cooling the two engines 98 and 99 are provided (see Figure 3) in the sides of the engine cover of the tractor. These air inlets 136 in the sheet cover are larger than the radiator of the engine concerned located behind them.

The stepwise change-speed gearbox 123 (Figure 5) is shown in section in Figure 7. The other gearbox 22 is the mirror-image of this one. The output shaft 121 of the pulley 119 is supported in a housing 137 of the gearbox 123 by bearings 138 and 139. The bearings 138 and 139 are spaced apart by a comparatively large distance because of the load applied to the shaft 121 by the belt 117. The shaft 121 is drivably connected by means of two meshing pinions 140 and 141 with a shaft 142 which is parallel to the shaft 121. The transmission ratio between the pinions 140 and 141 is such that the shaft 142 rotates more slowly than the shaft 121. An internally toothed annulus 143 is rigidly secured to the shaft 142. The teeth are near the outer periphery of the annulus 143, and they mesh with the teeth of a plurality of planet wheels 144, which are mounted on shafts journalled in the planet carrier 145 and in a supporting ring 146. The planet carrier 145 is splined to an auxiliary shaft 147 which is coaxial with the shaft 142. The planet wheels 144 mesh with a sun wheel 148 which is keyed to a sleeve 149. The sleeve 149 is freely rotatable about the auxiliary shaft 147. A ring 150 is bolted to the sun wheel 148, the outer periphery of this ring being provided with teeth 151. A second ring 152 is mounted on bearings 153 on a spigot portion of the sun wheel 148. The ring 152 has the same diameter as the ring 150 and is also provided with teeth 154 on its outer periphery. The ring 152 serves as a further planet carrier, and rotatably supports shafts of planet wheels 155. These shafts are also supported by a supporting ring 156A. The planet wheels 155 mesh with teeth on the outer periphery of the sleeve 149, which thus serves as a sun wheel. The planet wheels 155 also mesh with internal teeth at the outer periphery of an annulus 156, which is splined to the auxiliary shaft 147. The outboard end of the auxiliary shaft 147 is splined to a sun wheel 157 surrounding the shaft and meshing with planet wheels 158. The planet wheels 158 also mesh with internal teeth provided in an end portion of the housing 137. The planet wheels 158 are supported on shafts mounted in a planet carrier 159, which is splined to a wheel axle 160 which is coaxial with the shafts 142 and 147. The shaft 160 is provided with one of the wheels 5.

In operation, the tractor can be powered by both of the two engines 98 and 99, or by only one of them. There are advantages in providing a tractor with more than one engine of comparatively low power rather than with a single large engine. One is that, should one of the engines become defective, the tractor can continue to operate normally with the other engine, if the circumstances do not require high power, or the tractor can reach a repair shop under its own power. A further advantage is that certain jobs require the power of only one engine so that the tractor will operate more economically for these jobs. A third advantage is that it is generally cheaper to provide, for example, two engines of comparatively low power than one large engine having twice the power of one of the smaller engines, because smaller engines tend to be produced in larger quantities than large ones and are, therefore, appreciably cheaper. In this embodiment each of the engines 98 and 99 has a power of about 70 HP. Owing to the back-to-back disposition of the engines 98 and 99 a simple pinion coupling with the main shaft 105 is sufficient, in which each engine drives one of the pinions 100 and 101 respectively, which in turn, dependent upon the position of the coupling piece 104 connecting one or the other of the pinions 102 or 103 with the shaft 105, drives the shaft 105 through the pinion 102 or 103. By moving the coupling piece 104 along the shaft 105 the direction of travel of the tractor can be changed simply. On the sides of the engines 98 and 99 facing the shaft there are provided coupling members (not shown) for connecting or disconnecting the engines

to or from the pinions 100 and 101 respectively. These coupling members as well as the coupling piece 104 can be operated from the driver's seat 13. If the direction of travel is changed by displacement of the coupling piece 104, the driver's seat 13 together with the steering wheel and other controls can be turned about the axis 15 so that the driver can face in the actual direction of travel.

The shaft 105 is connected by the gearbox 107 to drive the hydraulic pump 109 as well as the power take-off shaft 16 and hence, if the above-mentioned auxiliary shaft is provided, the two elements 92.

The hydraulic pump 109 pressurises fluid to drive the hydraulic motors 131 which drive the front wheels 4.

The front axle 6, with the front wheels 4 and the two elements 92, is freely pivotable about the shaft 16 with respect to the rest of the tractor so that the front wheels and the elements 92 can follow unevennesses of the ground independently of the ground conditions at the rear wheels 5. This precaution helps to keep the driven front wheels 4 and the elements 92 always on the ground so that, if wheel tracks have to be avoided, the elements 92 have a uniform low ground pressure, while the extensions 93 of the two elements 92 penetrate into the ground in an identical manner in order to ensure a good grip and a consequent high driving torque for the tractor. These advantages apply equally to an identical rotatable support which may be hitched to the rear lifting device 18.

The drive shaft 105 provides the input to the transmission 106, which comprises the variable pulley drives and a planetary change-speed arrangement. The shaft 105 directly drives the two front pulleys 114 and 115 through the bevel pinions 111 and 112. The rear pulleys 118 and 119 are driven by the belts 116 and 117. The transmission ratio between the front and the rear pulleys is determined by the positions of the belts with respect to the pulleys. This position is established by the hydraulic devices arranged in the housings 126 and 127 respectively, which can be supplied with pressurised fluid through the conduits 128 and 129 from the control valve 130. The springs 124 and 125 urge the inner flanges of the rear pulley towards the associated fixed flanges which are fastened to the shafts 120 and 121 respectively and so ensure that the belts 116 and 117 have the required tension for transmitting torque to the planetary gear arrangements 122 and 123 respectively.

The output shafts 120 and 121 of the rear pulleys constitute input shafts for the planetary gear arrangements which transmit drive to the wheels 5 and are discussed in greater detail in our co-pending patent application No. 8007976 (Serial No. 2 046 683).

Whilst various features of the tractors that have been described, and that are illustrated in the drawings, will be set forth in the following claims as inventive features, it is to be noted that the invention is not necessarily limited to these features and that it encompasses all of the features that have been described both individually and in various combinations.

CLAIMS

1. A power-driven roller for working the soil, the roller having connecting means for connecting the roller to a tractor, the connecting means being provided at the rear of the roller, with respect to the normal intended direction of operative travel of the roller.

2. A power-driven roller as claimed in claim 1, when connected to a tractor, in which the roller is driven by a power take-off shaft of the tractor at a speed proportional to that of driven wheels of the tractor.

3. A power-driven roller as claimed in claim 1, when connected to a tractor, or in claim 2, in which the roller extends over substantially the entire width of the tractor.

4. A power-driven roller as claimed in any one of the preceding claims, which is bounded at or near its outer periphery by a plurality of elongate elements.

5. A power-driven roller as claimed in claim 4, in which at least some of the elongate elements are tubular.

6. A power-driven roller as claimed in claim 4 or 5, in which at least some of the elongate elements comprise flat strips.

7. A power-driven roller as claimed in claim 1 or 2, which comprises a cylindrical wall at or near its outer periphery.

8. A power-driven roller as claimed in claim 7, in which the cylindrical wall is provided with outwardly extending projections.

9. A power-driven roller as claimed in claim 8, in which the projections are tapered as viewed in a direction perpendicular to the axis of the roller.

New claims or amendments to claims filed on 13.7.83
Superseded claims 1 - 9
New or amended claims:-

1. Agricultural machinery comprising a tractor, a rotary support and a drivable implement, the tractor having an engine provided with a change-speed transmission, and a three-point lifting device at the front of the tractor, with reference to the intended direction of normal operative travel of the tractor, the rotary support having first coupling means by which the roller is attached to the lifting device of the tractor, and being drivable directly from the output of the change-speed transmission at a peripheral speed substantially equal to the travel speed of the tractor, the implement being disposed ahead of the roller, with respect to the intended direction of normal operative travel of the tractor, and being coupled to second coupling means of the roller.

2. Agricultural machinery as claimed in claim 1, in which the rotary support extends over substantially the entire width of the tractor.

3. Agricultural machinery as claimed in claim 1 or 2, in which the rotary support comprises a roller which is bounded at or near its outer periphery by a plurality of elongate elements.

4. Agricultural machinery as claimed in claim 3, in which at least some of the elongate elements are

tubular.

5. Agricultural machinery as claimed in claim 3 or 4, in which at least some of the elongate elements comprise flat strips.

6. Agricultural machinery as claimed in any one of the preceding claims, in which, in operation, the rotary support determines the level of the implement with respect to the ground.

7. Agricultural machinery as claimed in any one of the preceding claims, in which the implement is vertically fixed with respect to the rotary support during operation.

8. Agricultural machinery as claimed in any one of claims 1 to 6, in which the implement is movable at least in a vertical direction with respect to the rotary support during operation.

9. Agricultural machinery as claimed in claim 5, in which the rotary support has a stop for supporting the implement.

10. Agricultural machinery as claimed in any one of the preceding claims, in which the rotary support is displaceable at least in a vertical direction parallel to itself with respect to the tractor.

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