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EP-A1- 1 739 398
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GB-A- 2 304 910
US-A- 5 814 771

Description

The invention relates to a towed large-area distributor.

- 5 Large-area distributors of this type usually have, in accordance with EP 1 739 398 A1 and DE 101 54 733 A1, a storage container, which is configured to receive a material to be distributed. The material to be distributed is distributed by means of a distribution installation preferably uniformly on an area, for instance an area of arable land. These large-area distributors, which are configured as trailers, i.e.
10 to be towed, use a plurality of weighing units for weight detection purposes.

- When loading corresponding mechanical distributors, different machine parameters have to be heeded, for instance so as not to exceed the permitted total weight of the mechanical distributor during filling of the storage container. To
15 this end, printed publication EP 2 275 287 B1 proposes in an agricultural machine which is configured as a loading wagon and which has a weight detection device for detecting the loading state of the machine.

- Besides the loading state of a mechanical distributor, the nose weight which is to
20 be borne by the tow bar of a mechanical distributor constitutes a safety-relevant machine parameter. For the detection of the nose weight on the tow bar, printed publication EP 2 522 775 A2 proposes to equip a distribution trailer with a load-detecting device directly on the drawbar. In addition, printed publication DE 20 2005 017 281 U1 discloses a trailer in which the nose weight of the tow bar is
25 detected by means of a measuring unit between the frame of the trailer and the tow bar.

- Furthermore, US 5 814 771 discloses a load-weighing system for a transporter configured as a semitrailer and having a transport container and a motor tractor in
30 order to take material from one place to another. The transporter here has neither a tow bar nor a distribution installation, by means of which the material situated in the transport container could be distributed in an evenly ejecting manner on an agricultural area. To the transport container is assigned a support frame. The

support frame is connected in the rear region, via connecting elements having weighing cells, to the rear axles, and in the front region, via connecting elements having weighing cells, to the coupling elements of the towing vehicle. By means of the weighing cells, the total weight of the material situated in the transport
5 container can be determined by means of a suitable electrical evaluation installation.

Finally, GB 2 304 910 discloses a load weighing system for a towed transport trailer having a transport container. The transport trailer has a support frame,
10 which is supported on the ground via rear running wheels and on the traction coupling of a towing vehicle via the tow bar disposed on the front end of the support frame. By means of this transport trailer, material can be taken from one place to another. The transporter here has neither a tow bar nor a distribution installation by means of which the material situated in the transport container
15 could be distributed in an evenly ejecting manner on an agricultural area. Disposed between the support frame and the bottom side of the transport container are weighing cells, which are positioned at the respective corners of the transport container at a distance apart. By means of the weighing cells, the total weight of the material situated in the transport container can be determined by
20 means of a suitable electronic evaluation installation.

However, these and other known solutions are complex and/or prone to damage and/or incapable of providing the operator of the mechanical distributor with sufficient information on the state of load of the mechanical distributor.

25

The object of the invention thus consists in providing a towed large-area distributor in which the state of load can be monitored in a simple manner and such that it is not prone to damage.

30 The object is achieved by a large-area distributor according to Claim 1. This distributor according to the invention has a plurality of mutually spaced force transducers, which are specified for detecting the weight force exerted by the storage container on the respective force transducer. In addition, the mechanical

distributor comprises a support frame which supports the storage container, wherein the plurality of force transducers are disposed between the support frame and the storage container. According to the invention, the mechanical distributor has an evaluation installation which, based on the signals of the force transducers,
5 is specified for determining the load at one or a plurality of positions of the mechanical distributor.

The invention makes use of the insight that, in order to determine the state of load at a selected position, the arrangement of a force transducer at this selected
10 position is not absolutely necessary. Rather the detection and/or determination of the load at the one or the plurality of positions of the mechanical distributor is realized by an appropriate calculation, wherein the calculation considers the weight forces detected by the respective force transducers. The calculation can be based, for instance, on an equilibrium of forces and/or an equilibrium of
15 moments. All force transducers are disposed at a distance from the one or the plurality of positions at which the load is determined by the evaluation installation. The towed mechanical distributor is configured, according to the invention, as a large-area distributor. The material to be distributed is constituted, for instance, by spreading material, in particular fertilizer. Also preferred is a
20 towed large-area distributor in which the distribution installation is configured as a centrifugal spreading unit. Preferably, the towed large-area distributor is a single-axle trailer or a tandem-axle trailer, which possesses a tow bar which is capable of carrying load and bears nose weight. Preferably, the towed large-area distributor comprises no plurality of axles disposed at a distance apart, such as,
25 for instance, a front axle and a rear axle.

This large-area distributor according to the invention has a bearing axle, on which at least two running wheels are disposed, and a nose-weight bearing tow bar. The evaluation installation is specified for determining the axle load of the bearing
30 axle and preferably for considering the position of the bearing axle when determining the axle load of the bearing axle. The distance of the bearing axle from the respective force transducers in the longitudinal direction of the towed large-area distributor is herein considered.

Preferably, one or more force transducer(s) is or are disposed in front of the bearing axle in the direction of travel. In addition, one or two or more force transducer(s) is or are disposed behind the bearing axle in the direction of travel.

- 5 Preferably, all force transducers are disposed at a distance from the bearing axle.

The towed large-area distributor according to the invention has a tow bar for coupling the mechanical distributor to a motor tractor, wherein the evaluation installation is specified for determining the nose weight on the tow bar and for
10 considering the position of the tow bar when determining the nose weight on the tow bar. Preferably, the distance of the coupling point of the tow bar from the respective force transducers and/or from the bearing axle in the longitudinal direction of the mechanical distributor is herein considered. Preferably, all force transducers are disposed at a distance from the tow bar.

15

Finally, the towed large-area distributor according to the invention has a display installation which is specified for displaying the load determined at the one or the plurality of positions of the towed large-area distributor, in particular the axle load of the bearing axle and/or the nose weight on the tow bar, to a user of the
20 towed large-area distributor. To this end, the display installation is preferably connected in a signal-conducting manner to the evaluation installation. For increased convenience, it is advantageous that the signal-conducting connection between the display installation and the evaluation installation is of wireless configuration, so that the evaluation installation can be disposed directly on, in
25 particular fastened to, the towed large-area distributor, and the display installation can be disposed in the cab of the motor tractor of the towed large-area distributor. The display installation can be configured, for instance, as a display or touch screen. Alternatively or additionally, the evaluation installation can provide the determined load at the one or the plurality of positions of an interface via which
30 the motor tractor of the towed large-area distributor can access the determined load at the one or the plurality of positions of the towed large-area distributor and can call up this load.

In a particularly preferred embodiment of the towed large-area distributor according to the invention, the evaluation installation is specified for considering the arrangement and/or the position of the plurality of force transducers when determining the load at the one or the plurality of of the towed large-area distributor. In particular, the evaluation installation considers the distance of the one or the plurality of positions of the mechanical distributor from the respective force transducers, in particular in the longitudinal direction of the towed large-area distributor, when determining the load at the one or the plurality of positions of the towed large-area distributor. Alternatively or additionally, the evaluation installation can also consider the distance of the one or the plurality of positions of the towed large-area distributor from the respective force transducers transversely to the longitudinal direction of the towed large-area distributor.

Preferably, the evaluation installation has a memory, in which the following relationship is stored:

$$F_{St} = \frac{F_1 * a + F_2 * b}{c}$$

wherein F_1 denotes the forces acting on the one or the plurality of force transducers disposed in front of the bearing axle in the direction of travel, and a denotes the distance from the bearing axle of the one or the plurality of force transducers disposed in front of the bearing axle in the direction of travel, and wherein F_2 denotes the forces acting on the one or the plurality of force transducers disposed behind the bearing axle in the direction of travel, and b denotes the distance from the bearing axle of the one or the plurality of force transducers disposed behind the bearing axle in the direction of travel. In addition, F_{St} denotes the nose weight, stemming from the loading of the storage container, on the tow bar, and c denotes the of the coupling point of the tow bar from the bearing axle of the towed large-area distributor. Hence the above-referenced equation is based on an equilibrium of moments about the bearing axle. Analogously, by virtue of an equilibrium of moments about the coupling

point of the tow bar, the axle load stemming from the loading of the storage container and acting on the bearing axle can be detected.

Preferably, in the memory of the evaluation installation is stored the following
5 relationship based on an equilibrium of forces in the vertical direction:

$$F_A = F_1 + F_2 - F_{St}$$

Based on the nose weight, stemming from the loading of the storage container, on
10 the tow bar, the axle load acting on the bearing axle can thus be determined. In addition, based on the axle load, stemming from the loading of the storage container and acting on the bearing axle load, the nose weight, stemming from the loading of the storage container, on the tow bar can be determined.

15 Preferably, in the memory of the evaluation installation, that axle load of the mechanical distributor that, in the unladen state of the towed large-area distributor, acts on the bearing axle (hereinafter: $F_{A,leer}$), and/or the nose weight on the tow bar of the mechanical distributor in the unladen state of the mechanical distributor (hereinafter: $F_{St,leer}$), is/are stored. Based on the nose weight, stemming
20 from the loading of the mechanical distributor, on the tow bar, and the axle load, stemming from the loading of the mechanical distributor and acting on the bearing axle, the total nose weight (hereinafter: $F_{St,Gesamt}$) on the tow bar, and/or the total axle load acting on the bearing axle (hereinafter: $F_{A,Gesamt}$), can thus be determined as follows:

25

$$F_{St,Gesamt} = F_{St} + F_{St,leer}$$

$$F_{A,Gesamt} = F_A + F_{A,leer}$$

30 Based on the referenced calculation formula, the operator of the mechanical distributor is at all times capable of calling up the current axle load of the bearing axle and/or the current nose weight on the tow bar.

In another preferred embodiment of the mechanical distributor according to the invention, the plurality of force transducers comprise at least three mutually spaced force transducers, or the plurality of force transducers are exactly four mutually spaced force transducers. Because at least three mutually spaced force transducers are present, the storage container can be fully supported, so that a detection of all forces transmitted from the storage container to the support frame can be realized. Through the use of exactly four mutually spaced force transducers, the storage container can be evenly supported, whereby force transducers of same design, and thus force transducers which have a matching force detection range, can be used. As a result, the total costs of a towed large-area distributor fall.

In another preferred embodiment of the towed large-area distributor according to the invention, at least some of the plurality of force transducers are disposed at a distance apart in the direction of travel. In particular, a first force transducer pair are disposed at a distance from a second force transducer pair.

In a further advantageous refinement of the towed large-area distributor according to the invention, at least some of the plurality of force transducers are disposed at a distance apart transversely to the direction of travel. In particular, the force transducers of a force transducer pair are respectively disposed at a distance apart, transversely to the direction of travel, wherein the respective force transducers of a force transducer pair have the same distance from the longitudinal axis of the towed large-area distributor. As a result of the mutual spacing of force transducers transversely to the direction of travel, on the one hand a homogeneous distribution of force amongst all the force transducers can be attained, and on the other hand the effects of transverse accelerations of the mechanical distributor upon the state of load of the mechanical distributor can be monitored. In this way, changes in the state of load during cornering manoeuvres or prolonged tilt are considered when determining the load at the one or the plurality of positions of the mechanical distributor.

In a further preferred embodiment 2. of the towed large-area distributor of the invention, the support frame is the chassis frame of the towed large-area distributor. Alternatively, the support frame can be mounted on the chassis frame of the towed large-area distributor. In order to improve the operating characteristics of corresponding towed large-area distributors, multi-frame constructions are also employed, for instance in order to realize a mobility of the storage container and/or in order to decouple the storage container from the chassis frame of the towed large-area distributor. The plurality of force transducers can be arranged between the support frame and the storage container in such a way that the plurality of force transducers respectively touch the support frame and/or the storage container. Alternatively, the plurality of force transducers can also be arranged between the support frame and the storage container in such a way that one or a plurality of intermediate elements are disposed between the force transducers and the support frame and/or between the force transducers and the storage container.

Further details of the invention can be gleaned from the description of the figures and from the drawings, wherein:

Fig. 1 shows an illustrative embodiment of the towed large-area distributor according to the invention, in a side view;

Fig. 2 shows the large-area distributor represented in Fig. 1, without storage container, in a top view; and

25

Fig. 3 shows parts of a towed large-area distributor according to the invention in a schematic representation.

Fig. 1 shows a towed mechanical distributor 10, configured as a large-area distributor, having a storage container 12, a distribution installation 14, a support frame 18, a tow bar 20 and a bearing axle 22.

30

The storage container 12 is specified for receiving material to be distributed. The material to be distributed can here, for instance, be a granular spreading material, such as fertilizer. The storage container 12 is formed of a metal or a metal alloy. For instance, the storage container 12 can be formed of steel plate and have a
5 container capacity between 5,000 litres and 10,000 litres.

The distribution installation 14 is specified for distributing the material situated in the storage container 12. The distribution installation 14 is configured as a centrifugal spreading unit and has a spreading disc 16, which accelerates the
10 material to be distributed and preferably ejects it evenly onto an area, such as an area of arable land. The spreading disc 16 is connected to a mechanical spreading disc drive, which is designed, for instance, for p.t.o. shaft speeds between 500 revolutions per minute and 1,000 revolutions per minute.

15 The support frame 18 bears the storage container 12 and is connected to the tow bar 20. The support frame 18 is at the same time the chassis frame of the mechanical distributor 10, wherein the support frame 18 can be designed, for instance, for payloads between 5 and 10 tonnes. The tow bar 20 serves to couple the mechanical distributor 10 to a motor tractor. The tow bar 20 supports the
20 mechanical distributor 10 against the coupling system of the motor tractor, so that a nose weight F_{St} acts on the tow bar 20. The tow bar 20 can be a component part of a spring-loaded and/or height-adjustable drawbar system. Depending on the motor tractor which is utilized, the tow bar 20 can be configured as a top hitch with towing eye, as a bottom hitch with towing eye, or as a steering drawbar with
25 spherical head.

On the bearing axle 22 are disposed two running wheels 24a, 24b. The running wheels 24a, 24b support the mechanical distributor 10 against the ground, so that an axle load F_A acts on the bearing axle 22. The running wheels 24a, 24b can be
30 configured and arranged, for instance, such that wheel tracks can be realized between 1.50 metres and 2.50 metres.

Between the support frame 18 and the storage container 12 are disposed, in total, four mutually spaced force transducers 26a, 26c (the force transducers 26b, 26d are concealed). The force transducers 26a-26d are specified for detecting the weight force exerted by the storage container 12 on the respective force
5 transducer 26a-26d.

All force transducers 26a-26d are disposed at a distance from the tow bar 20 and the bearing axle 22. A first force transducer pair 26a (the second force transducer 26b of the first force transducer pair is concealed) is disposed in front of the
10 bearing axle 22 in the direction of travel. The force transducers 26a, 26b of the first force transducer pair have a distance a from the bearing axle 22. Acting on the first force transducer pair is, in total, the force F_1 induced by the storage container 12. A second force transducer pair 26c (the second force transducer 26d of the second force transducer pair is concealed) is disposed behind the bearing
15 axle 22 in the direction of travel. The force transducers 26c, 26d of the second force transducer pair have a distance b from the bearing axle. The coupling point of the tow bar 20 has a distance c from the bearing axle. Acting on the second force transducer pair is, in total, the force F_2 induced by the storage container 12.

20 As represented in Fig. 2, the force transducers 26a, 26b of the first force transducer pair and the force transducers 26c, 26d of the second force transducer pair are respectively disposed at a distance apart transversely to the direction of travel. The force transducers 26a, 26c are disposed on a first longitudinal strut 28a of the support frame 18, the force transducers 26b, 26d being disposed on a
25 second longitudinal strut 28b of the support frame 18. The longitudinal struts 28a, 28b are connected via a transverse strut 30 to a drawbar fastening 32.

The four force transducers 26a-26d are connected in a signal-conducting manner to an evaluation installation 34, wherein the evaluation installation 34, based on
30 the signals of the force transducers 26a-26d, is specified for determining, the load at at least two positions of the mechanical distributor 10. The first position at which the evaluation installation 34 defines the load is the coupling point of the tow bar 20. The evaluation installation 34 is thus specified for determining the

nose weight F_{St} on the tow bar 20. The second position at which the evaluation installation 34 defines the load is the bearing axle 22. The evaluation installation 34 is thus specified for determining the axle load F_A acting on the bearing axle 22.

5

The determination of the nose weight F_{St} on the tow bar 20 and the axle load F_A acting on the bearing axle 22 is realized by a calculation. In a memory of the evaluation installation 34, the distances a , b of the respective force transducers 26a-26d from the bearing axle 22, and the distance c of the coupling point of the tow bar 20 from the bearing axle 22 are stored, so that the evaluation installation 34, in the detection of the nose weight F_{St} , on the tow bar 20 and of the axle load F_A acting on the bearing axle 22, can consider the positions of the force transducers 26a-26d.

10

15 The calculation of the nose weight F_{St} on the tow bar 20 is realized firstly on the basis of the below-stated equilibrium of moments about the bearing axle:

$$\sum M_A = F_{St} * c - F_1 * a + F_2 * b = 0$$

20 Following rearrangement of the equation, the nose weight F_{St} on the tow bar 20, stemming from the weight force of the storage container s , can be determined:

$$F_{St} = \frac{F_1 * a + F_2 * b}{c}$$

25 In the memory of the evaluation installation 34 is additionally stored the nose weight $F_{St,leer}$ on the tow bar 20 in the unladen state of the towed large-area distributor 10, that the total nose weight $F_{St,Gesamt}$ on the tow bar 20 in the laden state of the towed large-area distributor 10 is obtained from the following relationship:

30

$$F_{St,Gesamt} = F_{St} + F_{St,leer}$$

The calculation of the axle load F_A on the bearing axle 22, stemming from the weight force of the storage container 12, is realized on the basis of the below-stated equilibrium of forces:

$$F_A = F_1 + F_2 - F_{St}$$

In the memory of the evaluation installation 34 is additionally stored the axle load $F_{A,leer}$, acting on the bearing axle 22, in the unladen state of the mechanical distributor 10, so that the total axle load $F_{A,Gesamt}$ acting on the bearing axle 22, in the laden state of the mechanical distributor 10, is obtained from the following relationship:

$$F_{A,Gesamt} = F_A + F_{A,leer}$$

Fig. 3 shows that the force transducers 26a-26d are connected via the signal lines 40a-40d to the evaluation installation 34. A first display installation 36a, which is disposed directly on the evaluation installation 34, and a second display installation 36b, which is connected via the wireless signal line 42 to the evaluation installation 34, are respectively specified for displaying the determined nose weight on the tow bar 20, and the determined axle load acting on the bearing axle 22, to a user of the mechanical distributor 10.

The display installations 36a, 36b are respectively configured as displays, wherein the first display installation 36a is readable from the direct environment of the mechanical distributor 10, and the display installation 36b can be positioned, for instance, within the cab of the motor tractor.

In addition, the evaluation installation 34 is connected via the signal line 44 to an interface 38, via which the signals of the force transducers 26a-26d, the determined nose weight on the tow bar 20, and/or the determined axle load acting on the bearing axle 22 can be passed on to the control system of the motor tractor.

Reference symbol list

	10	mechanical distributor
	12	storage container
5	14	distribution installation
	16	spreading disc
	18	support frame
	20	tow bar
	22	bearing axle
10	24a, 24b	running wheels
	26a-26d	force transducers
	28a, 28b	longitudinal struts
	30	transverse strut
	32	drawbar fastening
15	34	evaluation installation
	36a, 36b	display installations
	38	interface
	40a-40d	signal lines
	42	signal line
20	44	signal line
	a, b, c	distances

PATENTKRAV

1. Trukket storareal distributionsmaskine (10) med en opbevaringsbeholder (12), en trækstang (20) og mindst en bæreaksel (22),

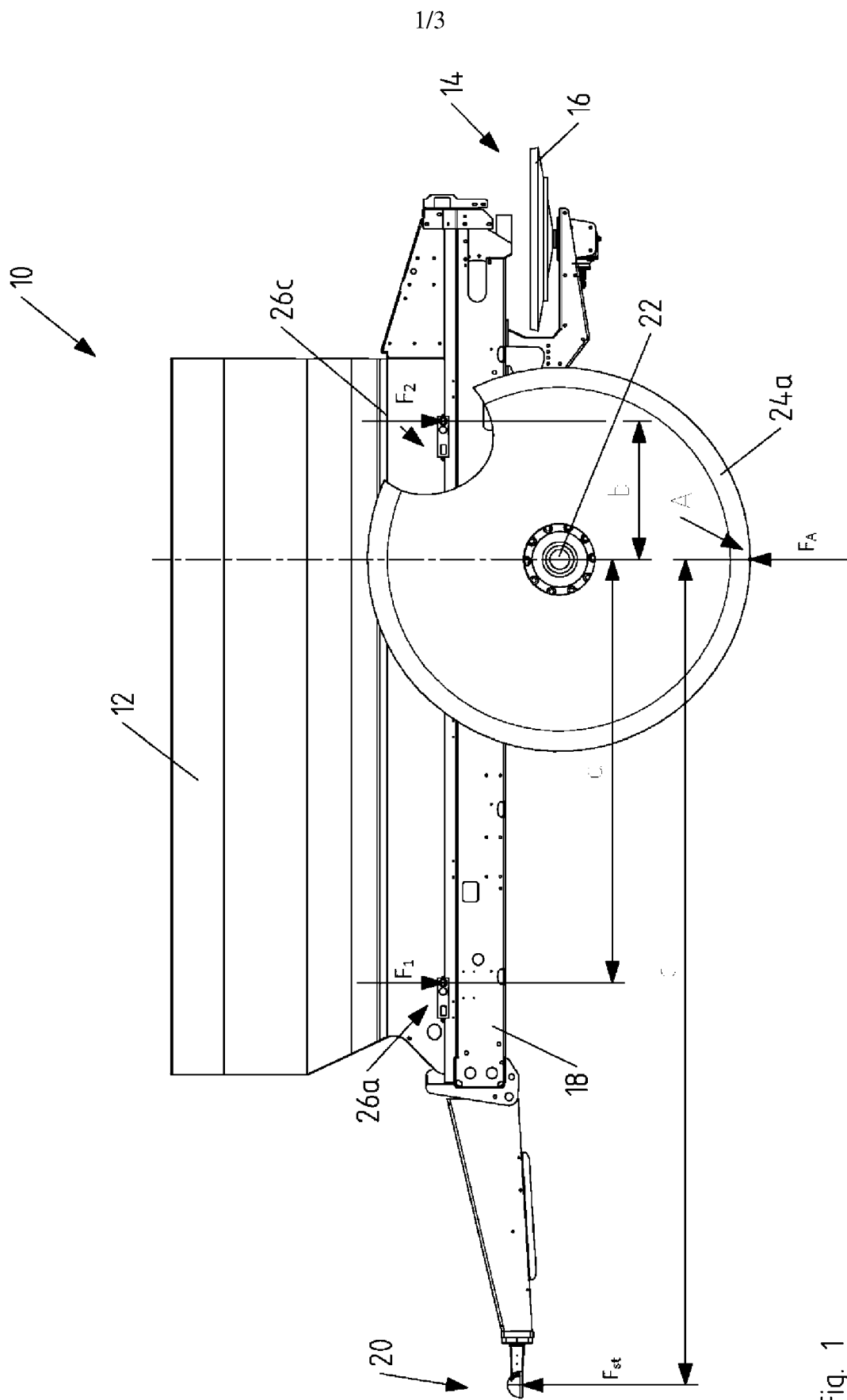
- 5 - hvor opbevaringsbeholderen (12) er specificeret til at modtage materiale, der skal distribueres;
- hvor distributionsaggregatet (14) er specificeret til at distribuere materialet placeret i opbevaringsbeholderen (12) ensartet på landbrugsland;
- hvor er tilvejebragt en flerhed af krafttransducere (26a-26d), der er således-
- 10 - placeret indbyrdes adskilte, nævnte krafttransducere (26a-26d) er specificeret til at detektere vægtekraften udøves af opbevaringsbeholderen (12) på de respektive krafttransducere (26a-26d); og
- en bæreramme (18), der understøtter opbevaringsbeholderen (12),

kendetegnet ved, at

- 15 - flerheden af krafttransducere (26a-26d) er anbragt mellem bærerammen (18) og opbevaringsbeholderen (12);
- hvor der er tilvejebragt en evalueringsindretning (34), der på basis af signallerne fra krafttransducerne (26a-26d) er specificeret til at bestemme belastning i en eller flere positioner af distributionsmaskinen (10);
- 20 - hvor mindst to kørehjul (24a, 24b) er monteret på bæreakslen (22);
- hvor trækstangen er konfigureret som en næse-vægt-bærende trækstang (20);
- hvor evalueringsindretningen (34) yderligere er specificeret til bestemmelse akselbelastningen af bæreakslen (22) og fortrinsvis til at tage hensyn til placeringen af bæreakslen (22), når akselbelastningen af bæreakslen (22) bestemmes;
- 25 - hvor trækstangen (20) er udformet til kobling af den trukne storareal distributionsmaskine (10) til en motoriseret traktor;
- hvor evalueringsindretningen (34) yderligere er specificeret til at bestemme næsevægten på trækstangen (20) og fortrinsvis til at tage hensyn til positionen af trækstangen (20), når bestemmelse af næsevægten af trækstangen (20);
- 30 - hvor er tilvejebragt en displayindretning (36a, 36b), der er specificeret til at vise vægtbelastning i et eller en flerhed af positioner af den mekaniske distri-

butionsmaskine (10) fortrinsvis akslebelastningen af bæreakslen (22) og/eller næsevægten på trækstangen (20) for en bruger af den trukne storareal distributionsmaskine (10).

- 5 2. Trukket storareal distributionsmaskine (10) ifølge krav 1, **kendetegnet ved**, at evalueringsindretningen (34) er specificeret til at overveje arrangementet og/eller positionerne af flerheden af krafttransducere (26a-26d), når bestemmelse af belastningen i den ene eller i flerheden af positioner af den trukne storareal distributionsmaskine (10).
- 10 3. Trukket storareal distributionsmaskine (10) ifølge ethvert af de foregående krav, **kendetegnet ved**, at flerheden af krafttransducere (26a-26d) omfatter mindst tre indbyrdes adskilte krafttransducere (26a-26d) eller specifikt fire indbyrdes adskilte krafttransducere (26a-26d).
- 15 4. Trukket storareal distributionsmaskine (10) ifølge ethvert af de foregående krav, **kendetegnet ved**, at mindst nogle af flerheden af krafttransducere (26a-26d) er således placeret, at de er indbyrdes adskilte i kørselsretningen.
- 20 5. Trukket storareal distributionsmaskine (10) ifølge ethvert af de foregående krav, **kendetegnet ved**, at mindst nogle af flerheden af krafttransducere (26a-26d) er således placeret, at de er indbyrdes adskilte på tværs af kørselsretningen.
- 25 6. Trukket storareal distributionsmaskine (10) ifølge ethvert af de foregående krav, **kendetegnet ved**, at bærerammen (18) er chassisrammen af den trukne storareal distributionsmaskine (10) eller er monteret på chassisrammen af den trukne storareal distributionsmaskine (10).



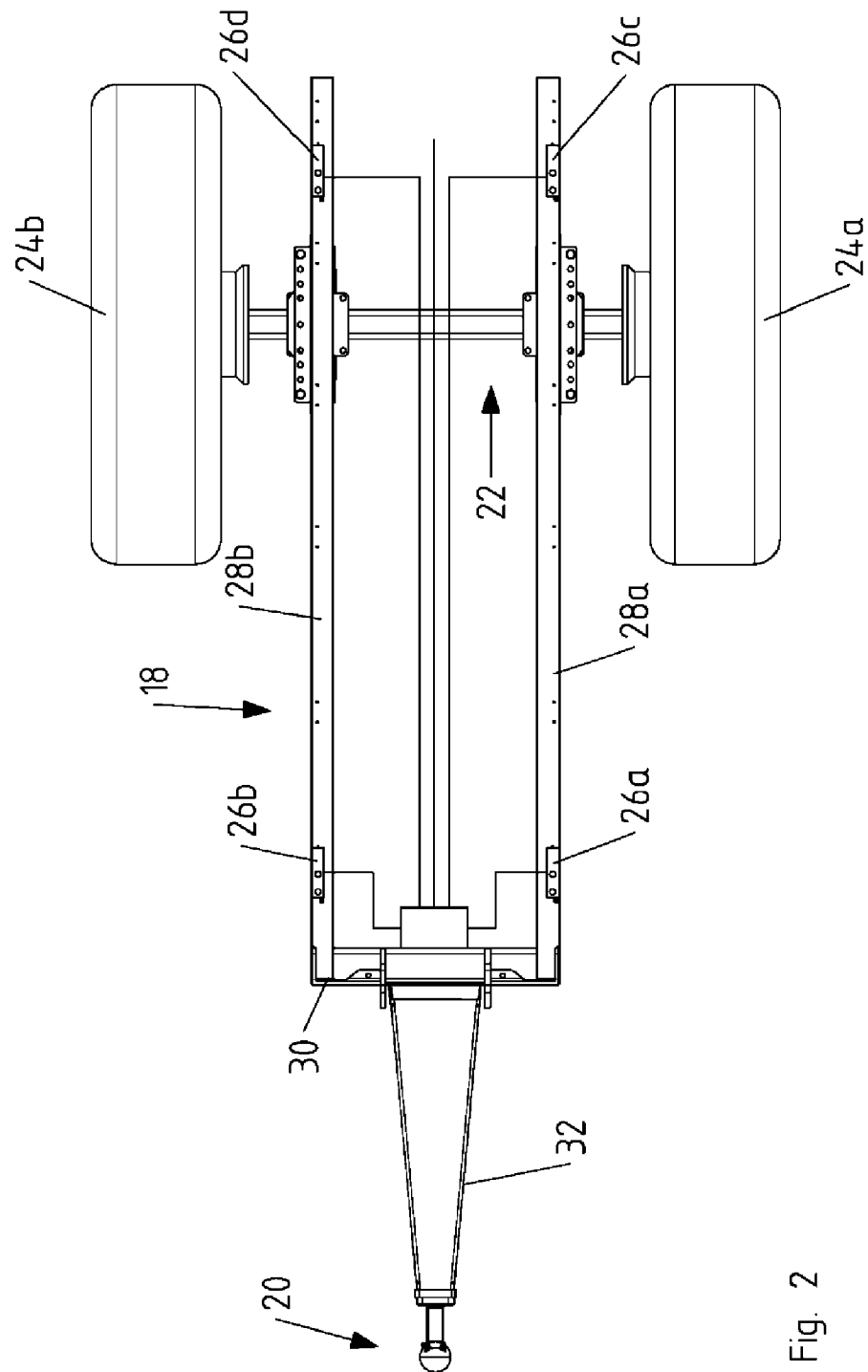


Fig. 2

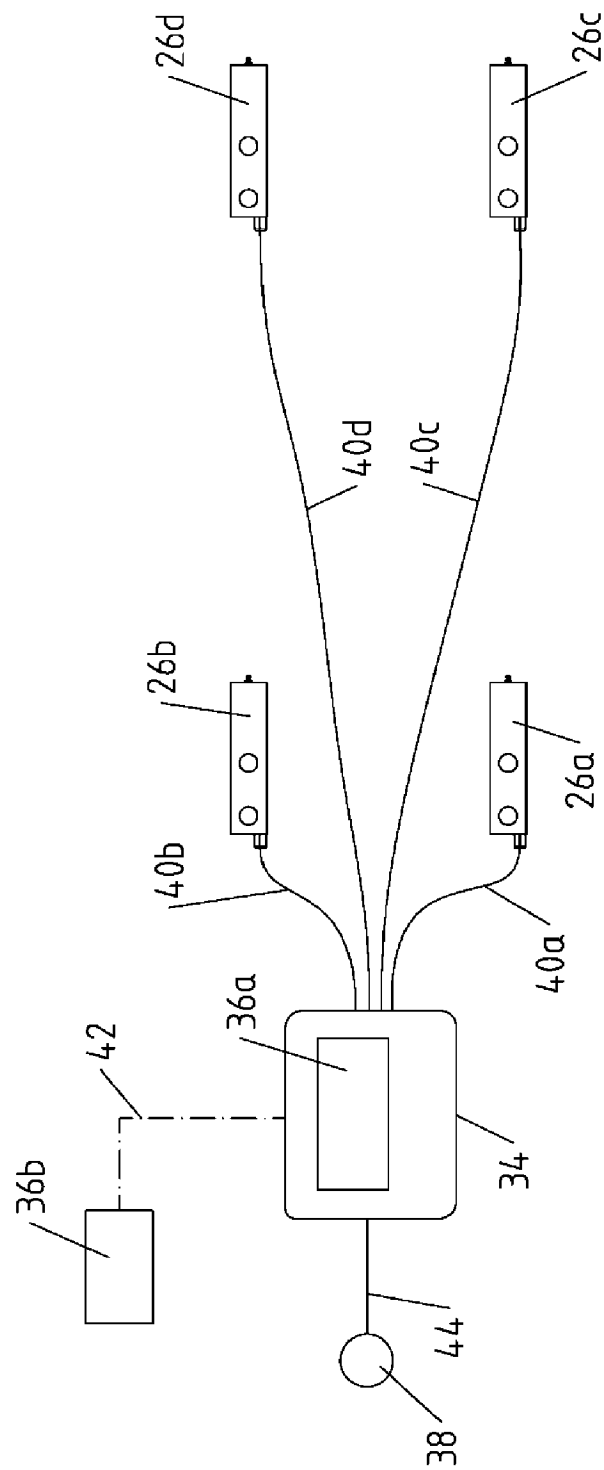


Fig. 3