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(71) Applicant *(for all designated States except US):* FIRMA LARS BRUUN [SE/SE]; Flottuvevägen 2, S-682 00 Filipstad (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* BRUUN, Lars [SE/SE]; Piludden, S-682 00 Filipstad (SE).

(74) Agent: HYNELL, Magnus; Hynell Patenttjänst AB, Box 2236, S-683 02 Hagfors (SE).

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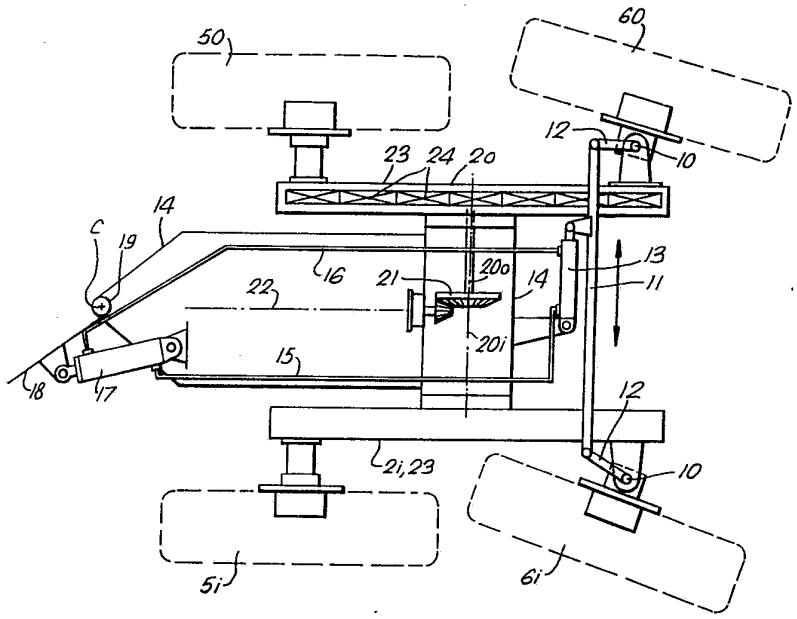
(54) Title: MOTOR VEHICLE WITH ARTICULATED FRAME STEERING

(57) Abstract

The invention relates to an articulated engine driven vehicle having at least a steerable pair of wheels in front of the articulation joint, at least the rear portion of the vehicle having a bogie unit with a drive line (22), a differential gearing (21), and two bogies (2i, 2o), a driven bogie shaft (20i, 20o) between the differential gearing and each bogie, and in each bogie two mechanically interconnected wheels (5i, 6i, 5o, 6o) which are positively driven by the bogie shaft with equal rate of rotation via a mechanical transmission (24) in a bogie frame (23) which can be pivoted relative to a carriage frame about the center of the bogie shaft. One of the wheel pairs in the bogie unit i.e. one wheel in each bogie is steerable but not the other wheel, and means (10, 13, 15, 16) are provided to positively direct, in proportion to the turning angle in the articulation joint, to direct those wheels in each bogie which are located furthermost away from the articulation joint, so that they will set essentially the same turning radii (Ri, Ry) as those wheels at the same side of the vehicle which are located nearest the articulation joint.



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MOTOR VEHICLE WITH ARTICULATED FRAME STEERING.

TECHNICAL FIELD

This invention relates to an articulated engine-driven vehicle having at least a steerable pair of wheels in front of the articulation joint, at least the rear portion of the vehicle having a bogie unit with a drive line, a differential gearing, two bogies, a driven bogie shaft between the differential gearing and each bogie and in each bogie two mechanically interconnected wheels which are driven by the bogie shaft with equal rate of rotation via a mechanical transmission in a bogie frame which can be pivoted relative to a carriage frame of said rear vehicle portion about the center of the bogie shaft.

BRIEF DESCRIPTION OF DRAWINGS

The background of the invention and preferred embodiments of the invention will be described in the following with reference to the accompanying drawings, in which

Fig. 1 is a side view of an articulated working vehicle where the invention advantageously can be applied;

Fig. 2 is a turning radius diagram for a vehicle shown in Fig. 1, conventionelly equipped and conventionally steered;

Fig. 3 is a turning radius diagram of a vehicle shown in Fig. 1, provided with devices according to the invention and steered according to the invention;

Fig. 4 schematically shows a steered bogie according to a first embodiment of the invention;

Fig. 5 schematically shows a steered bogie according to a second embodiment of the invention;

Fig. 6 schematically shows a top view of a bogie unit comprising a steered pair of wheels, the steerable wheels being narrower than those which are not steerable;

Fig. 7 illustrates a hydraulic control system according to a development of the invention;

Fig. 8 is a diagram which schematically illustrates the extra force on top of the dead weight of the vehicle which is applied on one of the wheels as a function of the driving power of the vehicle according to various aspects of the invention; and

Fig. 9 illustrates how the said force varies as the vehicle moves forwards or rearwards under conditions which require varying driving power.

BACKGROUND OF THE INVENTION

In order to ensure that articulated vehicles of the kind which comprises at least one pair of wheels in front of the ariculation joint and at least two rear pair of wheels with bogie mounted driving wheels at the rear of the articulation joint, are guided exactly, it is conventional to locate the center of rotation C of the articulation joint at equal distances from the bogie center B1 of the front portion of the vehicle and the bogie center B2 of the rear vehicle portion, Fig. 1, in the case when the front portion as well as the rear portion of the vehicle are provided with bogies. In the case when the front portion of the vehicle is provided only with a single pair of wheels one has for the same purpose located the axis of rotation of the articulation joint at equal distances between the wheel shaft of the front vehicle portion and the center of the rear bogie. However, in both cases the mechanically driven and mechanically interconnected bogie mounted wheels will skid relative to each other as the vehicle is being turned. This skidding may be extreme, which will be explained with reference to Fig. 2.

The front portion of the vehicle exhibits two parallel bogies 1i och 1o (inner bogie 1i and outer bogie 1o during turning), and the rear portion in the corresponding way exhibits two parallel bogies 2i and 2o. The front bogie pair 1i and 1o has front wheels 3i and 3o, respectively, and rear wheels 4i and 4o, respectively. The two rear bogie pairs 2i and 2o in a corresponding way are provided with front wheels 5i and 5o respectively, and rear wheels 6i and 6o, respectively.

In the prior art one has considered the turning radius of the discribed vehicle as a radius having its center in the point of intersection between the center lines of the front and rear bogie pairs, i. e lines that are perpendicular to the longitudinal axis of the vehicle intersecting the bogie center B1 and B2, respectively, Fig. 1. In Fig. 2, this theoretical turning radius center has been designated Ot. In a conceived case, which concerns an existing working vehicle of the type which is shown in Fig. 1, the distance D was 1700 mm. The turning angle in the particulation joint having a center of rotation C could be max 42°, as far as this specific vehicle was concerned, and the theoretical turning radius Rt in this case was 5600 mm. However, the two wheel pairs 3i and 3o, and 6i and 6o, respectively, which are located furthest away from the center of rotation C of the articulation joint, as a matter of fact have a common turning radius center O1 with a turning radius R1. Correspondingly those wheel pairs 4i and 4o, and 5i and 5o, respectively, which are located nearest to the said center of rotation C, have a common turning radius center O2 with the turning radius R2. In the contemplated case, R1=7300 mm and R2=3900 mm. The wheels which are coupled in tandem, as the wheels 3o and 4o, and the wheels 5o and 6o, respectively, are positively driven through mechanical interconnection which means that they are mechanically propelled with equal rate of rotation. This implies, in the contemplated case, because of the above stated geometrical conditions, a relative skidding of about 87% between the front and rear outer wheels, as between the wheels 3o and 4o, and between the wheels 5o and 6o, respectively. The skidding between the inner wheels arranged in tandem, as between 3i and 4i, and between the wheels 5i and 6i, will

be even greater or about 150% when the distance between the wheels within the wheel pairs is 1750 mm.

The above conditions cause a number of unfavourable effects. The most serious ones are that the skidding will cause that the wheels readily will dig themselves down into the ground when driving off-the-road which will cause damages on the ground; that the tyres will wear very quickly; that the fuel consumtion will be increased; and that the propulsion power will be reduced. At the same time the real turning radius of the vehicle will be the radius R1 and not the substantially smaller radius Rt which normally is referred to. This in turn impairs the cross-country mobility of the vehicle.

In principal the same or similar effects are encountered also in the case of such articulated vehicles where the front portion has only one pair of wheels.

BRIEF DISCLOSURE OF THE INVENTION

It is an object of the invention to eliminate or at least to substantially reduce the problems which have been described in the foregoing. More particulary the invention aims at satisfying some or all of the following purposes in connection with vehicles of the type mentioned in the preamble to this specification:

- to eliminate or to considerably reduce the relative skid between the wheels arranged in tandem in the bogies in order to
- reduce damages of the vehicle on the ground or upon road surfacing
- reduce the fuel consumtion,
- reduce the wear of the tyres,
- increase the pull of vehicle, and
- to reduce the effective turning radius of the vehicle, and hence
- to improve the cross-country mobility of the vehicle.

It is also an objective to bring about the above features by comparatively simple means and without any major reconstruction of existing bogie constructions.

These and other objects can be achieved therein that one of the pair of wheels in the bogie unit, said bogie unit comprising two bogies, i.e. that one of the wheels in each bogie can be directed in different direction through the driver's control but not the other wheel in the same bogie, and that means are provided for sensing the turning angle in the articulation joint and for steering that wheel in each bogie which is located furthermost away from the articulation joint in proportion to the turning angle in the articulation joint, so that the said wheels which are located furthermost away from the articulation joint will get essentially the same turning radius as those wheels on the same side of the vehicle which are located nearest to the articulation joint.

The said means for sensing the turning angle in the articulation joint may consist, by way of example, of a hydraulic sensing cylinder for each bogie pair that shall be steered, which sensing cylinder is provided at the side of the articulation joint between the frames of the front part and the rear part. As a sensor, i.e. as a means for registering the turning angle of the articulation joint, there can also be used a dosage device provided to discharge a quantity of oil in proportion to the turning of the steering wheel.

Another conceiveable means for detecting the turning angle is an electrical rheostat or potentiometer provided to register the angle and which can control a servo valve provided to discharge a volume of hydraulic oil in proportion to the reading, i.e. a kind of electro-hydraulic control.

Also the means for steering the wheels which are located furthermost away from the articulation joint, in proportion to the turning angle in the articulation joint, can be designed in a number of ways. For example a tie rod may be provided between the pair of wheels which shall be steered, said tie rod being controlled by a slave cylinder provided to be controlled by said sensing cylinder or corresponding detecting device. Of course also other motion means for acting upon

said tie rod may be conceived, hydraulic as well as mechanical, electro-mechanical etc, as well as combinations of such devices.

The steering function, which is a crucial part of the invention, however, does not only create favourable results but also some new problems. One of these problems is due to the fact that the steerable wheel requires space. However, in existing bogie units there is very little space. In order to increase the available space for the wheel one may consider either to reduce the breadth of the frame of the carriage or to increase the distance between the steerable wheels while at the same time maintain the basic design of the frame of the carriage and of the bogie unit. In the first case the stability of the design is impaired, and in the latter case the wheel track is increased which sometimes also is a disadvantage and in some cases also may be against current rules. According to an embodiment of the present invention these problems may be solved therein that the steerable wheel is made narrower than the non-steerable wheel. Preferably, however, the wheel track of the steerable wheels in the bogie unit, i.e. the distance between the outer sides of the steerable wheeels, is equal to the wheel track of the non-steerable wheels.

However, also the different breadth of the tyres in its turn may cause problems. This particulary concerns cross-country moving working vehicles. By reducing the breadth of the tyre of one of the wheels in each bogie, the pressure of these wheels against the ground will be increased if other conditions are not changed at the same time. Even if the breadth difference is comparatively small, one shall not neglect the risk for permanent damages on wet or otherwise soft grounds. One knows from experience that for example a wheel having a thickness of 700 mm has a load capacity which is approximately twice as good on moss ground as a wheel which has the same diameter but a thickness of 600 mm. This is because the strength of the ground surface layer is not a linear function of the thickness of the tyre. This problem, according to a further development of the invention, may be solved therein that at least an hydraulic, force generating means is provided to perform a torsional moment upon the bogie frame

relative to the carriage frame in such a direction that a certain force is unloaded from the steerable, narrower wheel, said force being related to the difference in thickness between the tyres, said force instead being transferred as an increased load upon the non-steerable wheel which has a thicker/ broader tyre, so that the wheel load capacity of the ground can be used to a larger extent, preferably in an optimal way.

The motion dynamics of the bogie is another problem which does not only concern wheels having different tyre thicknesses but which has more general significance for bogies with wheels which are positively driven by mechanical interconnection. It is well known in the art that that force interplay which is developed between the driving force of the wheels and the friction between the wheels and the ground will generate rearing forces which tend to raise the bogie on either the fore or on the hind wheels. According to another aspect of the invention this tendency can be eliminated or at least reduced therin that at least an hydraulic force generating means is provided to generate a torsional moment on the bogie frame relative to the carriage frame by a force which is proportional to the driving force of the wheels and in such a direction that the said rearing tendency is counter-acted. A measure of the driving force can be obtained by detecting the pressure in the hydrostatic hydraulic system which preferably is used for driving the driving line leading from the engine to the bogie unit.

According to another aspect of the invention, which concerns bogie units in which one of the wheels in each bogie can be steered but not the other wheel, and where the tyre of the steerable wheel is narrower than that of the non-steerable wheel, the above mentioned functions are combined, wherein preferably one and the same hydraulic force generating means is used for developing the torsional moments, although also separate hydraulic force developing means may be considered for these various functions. According to this aspect of the invention the said at least one hydraulic force generating means is provided to develop the torsional moment with a force which is

composed on one hand by a constant component force which is related to the difference in thickness between the two wheels and which acts in such a direction that the steerable narrower wheel is unloaded with a certain force, which force instead is transferred as an increased load on the thicker non-steerable wheel, and on the other hand of variable component force which is proportional to the driving force on the wheels and which acts in such a direction that the said rearing tendency is counter-acted.

Another problem related to articulated vehicles is that they normally are not equipped such that they can be turned when the vehicle is not moving. The difficults are due to the fact that those wheels in the bogie unit or in the bogie units which are located furthermost away from the articualtion joint would have to slide against the ground when turning the vehicle in the articulation joint. It is true that it is known to provide articulated bogie vehicles with devices for unloading those wheels which are located furthermost away from the articulation joint, so that turning can be performed in the articulation joint, but this requires, according to the known art, that the driver makes special provisions. Moreover, the wheels of certain vehicle types are locked when the vehicle is not moving. At least this concerns certain bogie-driven articulated working vehicles.

According to a further development of the invention an improvement is made also with reference to particularly the steerability of bogie-driven articulated vehicles in the non-moving state of the vehicle, which improvement resides in that at least one hydraulic force generating means is provided automatically to develop a torsional moment on the bogie frame relative to the carriage frame when the non-moving vehicle is turned, said torsional moment having such a magnitude and direction that those wheeels which are located furthermost away from the articulation joint are unloaded at least to such an extent that the vehicle can be turned without trouble caused by heavy slide between the wheels and the ground. For this function preferably the same hydraulic force generating means are used in order to, when necessary, to compensate for differences in tyre thicknesses

and/or for counter-acting the said rearing tendency during motion of the vehicle. Preferably, means are also provided for the elimination of the braking action of the wheels when the non-moving vehicle is turned, which braking otherwise automatically would take place when the vehicle is not moving. This concerns at least certain vehicles. As an hydraulic force generating means there can suitably be used a pressure compensated hydraulic cylinder, i.e. an hydraulic cylinder the power of which is independent of the position of the piston in the cylinder, said hydraulic cylinder being provided between the carriage frame and the bogie frame at a distance from the bogie shaft.

In this text "bogie" means two tandem mounted wheels at a distance from each other which is less than two meters. Further "steering" of a wheel means directing a wheel at a certain angle relative to the neutral position of the wheel.

DESCRIPTION OF PREFERRED EMBODIMENTS

The turning radius diagram which is shown in Fig. 3, as well as the turning radius diagram in Fig. 2, relates to a vehicle of the type which is shown in Fig. 1. The two diagrams in Fig. 2 and Fig. 3 therefore are comparable. For corresponding parts the same reference numerals have been used in Fig. 3 and in Fig. 2.

The difference in comparison with a conventionally designed vehicle, which has a turning radius diagram according to Fig. 2, is that in accordance with the invention those wheel pairs 3i and 3o, and 6i and 6o, respectively, which are located furthermost away from the center of rotation C in the articulation joint are directed in proportion to the turning angle a in the articulation joint. More particularly, the wheels 3i and 3o, and 6i and 6o, respectively, are directed such that there turning radii Ri and Ry, respectively, will have their foot-points in the center of rotation O2' of the wheel pairs 4i, 4o, and 5i, 5o. If the turning angle a=35° in the chosen example, the turning radii R2' for those outer wheels 3o and 6o, which are located furthermost away from the center of rotation C of the articulation joint will get a length Ry=4800 mm. At the same turning angle a=35°, the outer

wheels 4o and 2o, which are located nearest the center of rotation C will have turning radii R2'=4650 mm. The difference in other words will be very small and will cause a skidding between the outer wheels of only 3.2% which is negligible. The skidding between the inner wheels, i.e. between the wheels 3i and 4i, and between 5i and 6i, respectively, will be somewhat larger or about 10%, which shall be compared with about 150% without the direction of the wheels according to the invention.

Fig. 4 schematically illustrates how the invention can be reduced to practice. Each of those wheels 3i, 3o, 6i and 6o, Fig. 3, which are located furthermost away from the rotation center C of the articulation joint is provided with a pivoted joint 10 of principal the same type as is provided on steered driving wheels on motor cars. Between the said wheels, as between the wheels 6i and 6o, Fig. 4, a tie rod 11 is provided according to conventional principles, the steering arms 12 of the tie rod being provided to turn the pivoted axle in the pivoted joints 10 in a manner per se. The motions of the tie rod 11 is brought about by means of a slave cylinder 13 which is coupled between the vehicle frame 14 and the tie rod 11. Hydraulic oil is fed to the slave cylinder 13 via two hydraulic conduits 15 and 16 from a master cylinder 17, which is coupled between the frame 18 of the front carriage and the frame 14 of the rear carriage at the side of the articulation joint, the center of rotation of which has been designated C.

The bogies 2i and 2o in other respects are conventionally designed, which means that each of them is provided with a bogie shaft 20i and 20o, respectively, which is coupled to a drive line 22 via a differential gearing 21. Further, there are provided in each bogie frame 23 a series of gears 24 which transmits the propulsion force from the bogie shaft 20i and 20o, respectively, positively to the respective wheel in the two tandem mounted wheel pairs, so that the wheel in a manner per se will be positively driven with equal rate of rotation. These parts of the system in other words are conventionally designed. For those who want a more detailed description of the principles of this design,

reference may be made e.g. to Terrängmaskinen, part 1, issued 1978 by Forskningsstiftelsen Skogsarbeten, page 145-149.

An equipment equal to the one which has been described with reference to Fig.4 is provided also for directing those wheels 3i, 3o in the front part of the vehicle, which are located furthermost away from the said center of rotation C. Thus a separate master cylinder is provided for the slave cylinder in the front portion, which master cylinder may be mounted above or beneath the shown master cylinder 17 at the same distance from the center of rotation C as the master cylinder 17.

It has above been mentioned in the brief description of the invention that as a conceivable means for detecting the turning angle and the direction of the steered wheels, respectively, there can be used an electric rheostat or potentiometer provided to discharge a volume of hudraulic oil in proportion to the reading, i.e. a kind of electro-hydraulic control. In the following an embodiment of the invention which is based on this principle of control will be explained more in detail with reference to Fig. 5.

Each of those wheels 3i, 3o and 6i, 6o, which are located furthermost away from the center of rotation C of the articulation joint, is provided with a conventional pivoted joint 10 of in principle the same type as on driven, steered wheels on motor cars. A steering arm is coupled to each pivoted joint and an hydraulic cylinder 13i and 13o, respectively, is connected between the outer end of the steering arm 12 and a pivoted axle connected to the bogie frame for directing the wheels 6i and 6o by control from said means for detecting the turning angle a in the articulation joint, which means will be described in the following. Further an electrical position detector 11i, 11o is connected to each steering cylinder 13i, 13o, which position detector is provided to detect the turning position of the steering cylinders. By this detection also the direction of the wheels 6i, 6o is detected, since there is a functional correlation between the turning position of the steering cylinders 13i, 13o and the direction of the wheels 6i, 6o. The position detecting devices 11i, 11o can consist e.g. of rotary

potentiometers. As an alternative there can instead be provided straight-line potentiometers for detecting the motion in the axial direction of the piston belonging to each steering cylinder 13i, 13o.

A rotary potentiometer 17 is provided in connection to the articulation joint 19 of the vehicle for detecting the turning angle a in the articulation joint. This potentiometer is mounted coaxial with the center of rotation C, such that a first part of the potentiometer is connected to the carriage frame 18 of the front portion of the vehicle while the second part of the potentiometer 17 which is rotatable relative to the first part is connected to the frame 14 of the rear portion of the vehicle or on parts which are firmly connected to the front frame and the rear frame, respectively.

The rotary potentiometer 19 is connected via an electrical conduit 25 to an electrical control voltage amplifier 26. Also the two electrical position detectors 11i, 11o of the steering cylinders 13i, 13o are connected to the electrical control voltage amplifier 26 via conduits 27i, 27o. The electrical control voltage amplifier 26 in its turn is via a conduit 28 provided to control a hydraulic unit 29. Hydraulic conduits 30i and 31i are provided between the hydraulic unit 29 and the steering cylinder 13i and hydraulic conduits 30o and 31o are provided between the hydraulic unit 29 and the steering cylinder 13o for manoeuvring the respective steering cylinder.

The described equipment works in the following way. When the vehicle is turned, which is brought about in a manner per se by turning in the articulation joint 19 by means of hydraulic cylinders which are not shown in the drawings, the rotary potentiometer 17 will detect a turning motion which is transmitted via the conduit 25 to the electrical control voltage amplifier 26. At the same time there is an input to the control voltage amplifier 26 in the form of signals via conduits 27i, 27o from the position detectors 11i, 11o which issue information about the positions of the steering cylinders 13i, 13o and accordingly also information about the direction of the wheels 6i and 6o. When there is a turning in the articulation joint 19 such that the

turning angle a is changed, there is achieved a signal to the hydraulic unit 29 via conduit 28 after comparison between and amplification of the signals from the rotary potentiometer 17 and the rotary potentiometers 11i, 11o, so that the steering cylinders 13i, 13o are manoeuvred via the hydraulic conduits 30i. 31i, 30o, 31o resulting in a steering of the wheels 6i, 6o so that their turning radii Ri and Ry, respectively, will have their footpoints on the turning center 02' of the wheel pairs 4i, 4o and 5i, 5o, as has been explained in connection with the first embodiment.

Instead of a rotary potentiometer 17 there can also be used a straight-line potentiometer 17', which also is shown in Fig. 5. This optional device is provided at the side of the center of rotation C and at a distance from said center between the frames 18 and 14 of the front and rear carriages. For example it can be provided inside and be integrated with one of those hydraulic cylinders which are used for turning the vehicle in the articulation joint.

According to the embodiment shown in Fig. 6 the steered wheel 6i' and 6o' on each bogie 2i, 20 is narrower than the other wheel 5i'and 5o', respectively, which is not steerable.

A pressure compensated hydraulic cylinder 35 is provided between the carriage frame 14 and each bogie frame. A mounting bracket on the carriage frame has been designated 36.

The hydraulic system for manoeuvring the hydraulic cylinders 36 is shown in Fig. 7. The main engine of the vehicle, usually a Diesel enginge 37, powers a hydrostatic pump 38 which feeds an hydrostatic motor 41 via a pair of hydraulic main conduits 39, 40. The hydrostatic motor 41 powers the driving line 22 to the bogie unit via a gear box 42. The driving force on the wheels is directly proportional to the hydrostatic pressure, which is detected through a pair of pressure detecting conduits 43, 44 via a shuttle valve 45. Numeral 46 designates a unit e.g. a strain gauge, which emits an electrical voltage, current or other electrical signal proportional to the

hydrostatic pressure. This signal is transmitted to an electronic unit, which usually is called drive amplifier and which comprises a micro processor. The drive amplifier 47 also can receive input in a form of electrical signals from a unit 48, which gives information about in which direction the vehicle is moving or if it is at rest, and also from a unit 49, which emits an electrical proportional pressure detecting signal from the steering of the vehicle, and also from a unit 50 for compensating for the difference of tyre thickness.

From the drive amplifier 47, signals can be transmitted to a brake control unit 51, which can release the locking of the wheels if the articulated vehicle shall be turned in the articulation joint when the vehicle is at rest, and also to a proportionally acting directional valve (electro hydraulic valve) which controls the flow of hydraulic oil to the hydraulic cylinders 35 via the conduits 53, 54 from the hydraulic constant pressure system which schematically has been indicated by 56.

The equipment which has been described above with reference to Fig. 6-7 works in the following way. In order to compensate for the differences in tyre thicknesses of the wheels, an additional force, according to one of the aspects of the invention, will be applied on the thicker wheels 5i', 5o' in order to increase the pressure of these wheels against the ground, wherein the narrower wheels 6i', 6o' will be unloaded to a corresponding degree. When the hydraulic cylinder 35 is located as shown in the drawing, the cylinders thus shall expand, so that the bogie frame 23 is turned in such a direction about the center of the bogie shaft 20i, 20y that the broader wheel 5i' and 5o', respectively, will be pressed down towards the ground, wherein the narrower wheels 6i' and 6o' will be unloaded to a corresponding degree. This result is achieved by means of the unit 50 via the drive amplifier 47 and the direction valve 52. Preferably, the force which the hydraulic cylinders 35 apply upon each bogie frame 23 is so great that the load is distributed between the thicker and narrower wheels in such a way that the effective pressure against the ground from each wheel will be equally great for certain ground conditions. When

determining the effective ground pressure, consideration is taken to the load carrying capacity of the kind of ground in each case, according to certain convertion factors. It should be understood that the distribution of the pressure between thicker and narrower wheels can be adjusted in consideration of the ground conditions through adjustment of the compensation unit 50 which for this purpose is adjustable, so that the load carrying capacity of each type of ground can be used optimally or at least to a very high degree. In the diagrams in Fig. 8 and Fig. 9, Pk is the additional, adjustably constant force which has been applied on the thicker wheel 5i' and 5o', respectively, in order to compensate for the tyre thickness difference.

When the vehicle moves, the driving force varies depending on accelerations, retardations and also upon the terrain conditions. The power interplay which is developed between the driving force acting on the bogie and the propulsion force of the wheels acting on the ground will create rearing forces which tend to raise the bogie on either the fore or the hind wheel. These forces are proportional to the driving force of the vehicle. As has been mentioned in the foregoing an embodiment of the invention aims at counter-acting these rearing forces. Therefore the hydrostatic pressure which powers the hydrostatic motor 41 is detected, said pressure being directly proportional to the driving force. The hydraulic cylinder 35 between the carriage frame 14 and each bogie frame 23 is actuated via the drive amplifier 47, the directional valve 52 and the hydraulic conduits 54 and 55 so that a torsional moment is applied to the bogie frame 23 relative to the carriage frame 14 with a magnitude which is proportional to the driving force acting on the wheels and in such a direction that the said rearing tendency is counter-acted. The additional force which is applied on the thicker wheels 5i', 5o' (when the vehicle is moving forwards) is schematically illustrated by the lower inclined line in Fig. 8. Preferably, this variable power Pv is superposed on top of the adjustably, constant force Pk applied to the broader wheel in order to compensate for the thickness difference. Fig. 9 also schematically shows how the force which is applied on the broader wheel 5i', 5o'

varies as the vehicle is moving forwards and during a distance also rearwards. It should be understood that that variable force is applied on that wheel which tends to rear while the other wheel in the bogie is unloaded to a corresponding degree. It depends on the design of the force transmission in the bogie from case to case which wheel is loaded with an extra force and which wheel is unloaded.

When the vehicle is at rest, the brakes are automatically activated. In order that the vehicle nevertheless shall be able to be turned by turning about the articulation joint, two functions are automatically performed according to an embodiment of the invention when the driver turns the steering wheel. In response to a signal from unit 49 (the steering) and from the unit 48 which indicates that the vehicle is at rest the brake control 51 will be influensed so that the locking of the wheels is released. At the same time the valve 52 is influensed so that the hydraulic cylinders 35 are activated to perform a torsional moment on the bogie frame 23 about the center of the bogie shaft 20i, 20o, so that those wheels which are located nearest the articulation joint are pressed down towards the ground and those wheels which are located furthermost away from the articulation joint are raised from the ground to such an extent that the turning of the vehicle can be performed without the wheels 6i', 6o' significantly sliding against the ground.

CLAIMS

1. An articulated engine driven vehicle having at least a steerable pair of wheels in front of the articulation joint, at least the rear portion of the vehicle having a bogie unit with a drive line (22), a differential gearing (21), and two bogies (2i, 2o), a driven bogie shaft (20i, 20o) between the differential gearing and each bogie, and in each bogie two mechanically interconnected wheels (5i, 6i,5o, 6o) which are positively driven by the bogie shaft with equal rate of rotation via a mechanical transmission (24) in a bogie frame (23) which can be pivoted relative to a carriage frame about the center of the bogie shaft, c h a r a c t e r i z e d in that one of the pair of wheels in the bogie unit, i.e. one of the wheels in each bogie, is steerable but not the other wheel, and that means (10, 13, 15, 16) are provided to positively direct those wheels in each bogie which are located further most away from the articulation joint in proportion to the turning angle in the articulation joint, so that said steerable wheels will have essentially the same turning radii (Ri, Ry) as those wheels on the same side of the vehicle which are located nearest the articulation joint.

2. A vehicle according to claim 1, c h a r a c t e r i z e d by means for detecting the turning angle (a) in the articulation joint for steering the positively steerable wheels in the bogie unit.

3. A vehicle according to claim 2, c h a r a c t e r i z e d in that said means for detecting the turning angle in the articulation joint comprises an electrical voltage transmitter (17) provided to transmit a voltage proportional to the turning angle.

4. A vehicle according to claim 3, c h a r a c t e r i z e d in that the electrical voltage transmitter consists of a rotary potentiometer (17) provided in the articulation joint.

5. A vehicle according to claim 3, c h a r a c t e r i z e d in that said voltage transmitter for the detection of the turning angle in the articulation joint comprises a straight line potentiometer (17')

provided at the side of the articulation joint between the frames (18, 14) of the front carriage and of the rear carriage.

6. A vehicle according to any of claims 3-5, c h a r a c t e r i z e d in that each of those bogie wheels which is located furthermost away from the articulation joint is provided with an hydraulic steering cylinder, and that a hydraulic unit (29) is provided for manoeuvring said steering cylinders in response to signals from said voltage transmitter.

7. A vehicle according to claim 6, c h a r a c t e r i z e d in that each of said steering cylinders (13i, 13o) is provided with an electrical position detector (11i, 11o).

8. A vehicle according to any of claims 3-7, c h a r a c t e r i z e d in that an electrical control voltage amplifier is provided between said voltage transmitter (17) and said hydraulic unit (29), and that said electrical position detectors (11i, 11o) are feed-back-coupled to said control voltage amplifier (26)

9. A vehicle according to claim 1, c h a r a c t e r i z e d in that the steerable wheel (6i', 6o') is narrower than the non-steerable wheel in each bogie.

10. A vehicle according to claim 9, c h a r a c t e r i z e d in that at least an hydraulic force generating means (35) is provided to apply a torsional moment on each bogie frame relative to the carriage frame, and that said force generating means is provided to develop the torsional moment in such direction that the steerable narrower wheel is unloaded with a certain force which is correlated to the difference in thickness between the wheels, which force instead is transferred as an increased load on the thicker, non-steerable wheel.

11. A vehicle according to any of claims 1-10, c h a r a c t e r i-z e d in that at least an hydraulic force generating means (35) is provided to perform a torsional moment on the bogie frame relative to the carriage frame, and that said hydraulic force generating means

(35) is provided to develop said torsional moment with a magnitude which is proportional to the driving force acting on the wheels and in such direction that any rearing tendency of the bogie is counter-acted.

12. A vehicle according to claim 11, c h a r a c t e r i z e d in that said hydraulic force generating means (35) is provided to develop said torsional moment by a force which is composed by a constant component force which is correlated to the difference in thickness between the two wheels and which acts in such a direction that the steerable, narrower wheel is unloaded with a certain force which instead is transferred as an increased load on the thicker, non-steerable wheel, and by a variable component force which is proportional to the driving force acting on the wheels and which acts in such a direction that the said rearing tendency is counter-acted.

13. A vehicle according to any of claims 1-12, c h a r a c t e r i z e d by at least an hydraulic force generating means (35) is provided automatically to develop a torsional moment on the bogie frame relative to the carriage frame when a vehicle at stand still is turned in the articulation joint, said torsional moment having such magnitude and direction that those wheels which are located furtermost away from the articulation joint are unloaded at least to such an extent that the vehicle can be turned without problem because of heavy sliding between the wheels and the ground.

14. A vehicle according to claim 13, c h a r a c t e r i z e d in that means also are provided in order, when the vehicle is turned in the articulation joint, automatically to release the braking of the wheels of the vehicle which normally are braked when the vehicle is at rest.

15. A vehicle according to any of claims 10-14, c h a r a c t e r i z e d in that said at least one hydraulic force generating means consists of a pressure compensated hydraulic cylinder provided between the carriage frame and the bogie frame at a distance from the bogie shaft.

Fig.1.

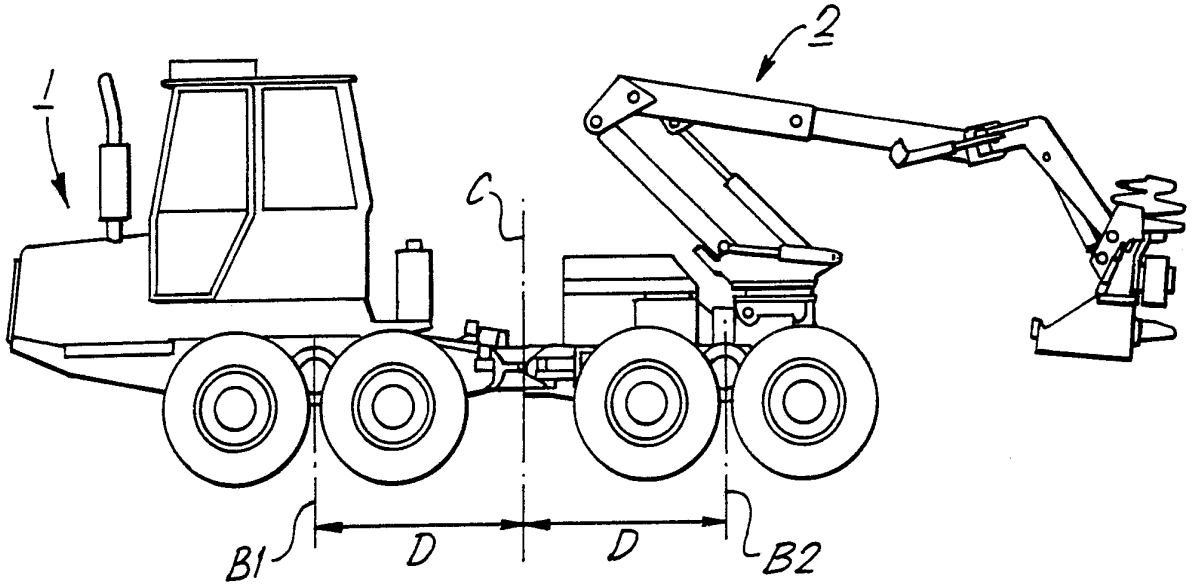


Fig. 2.

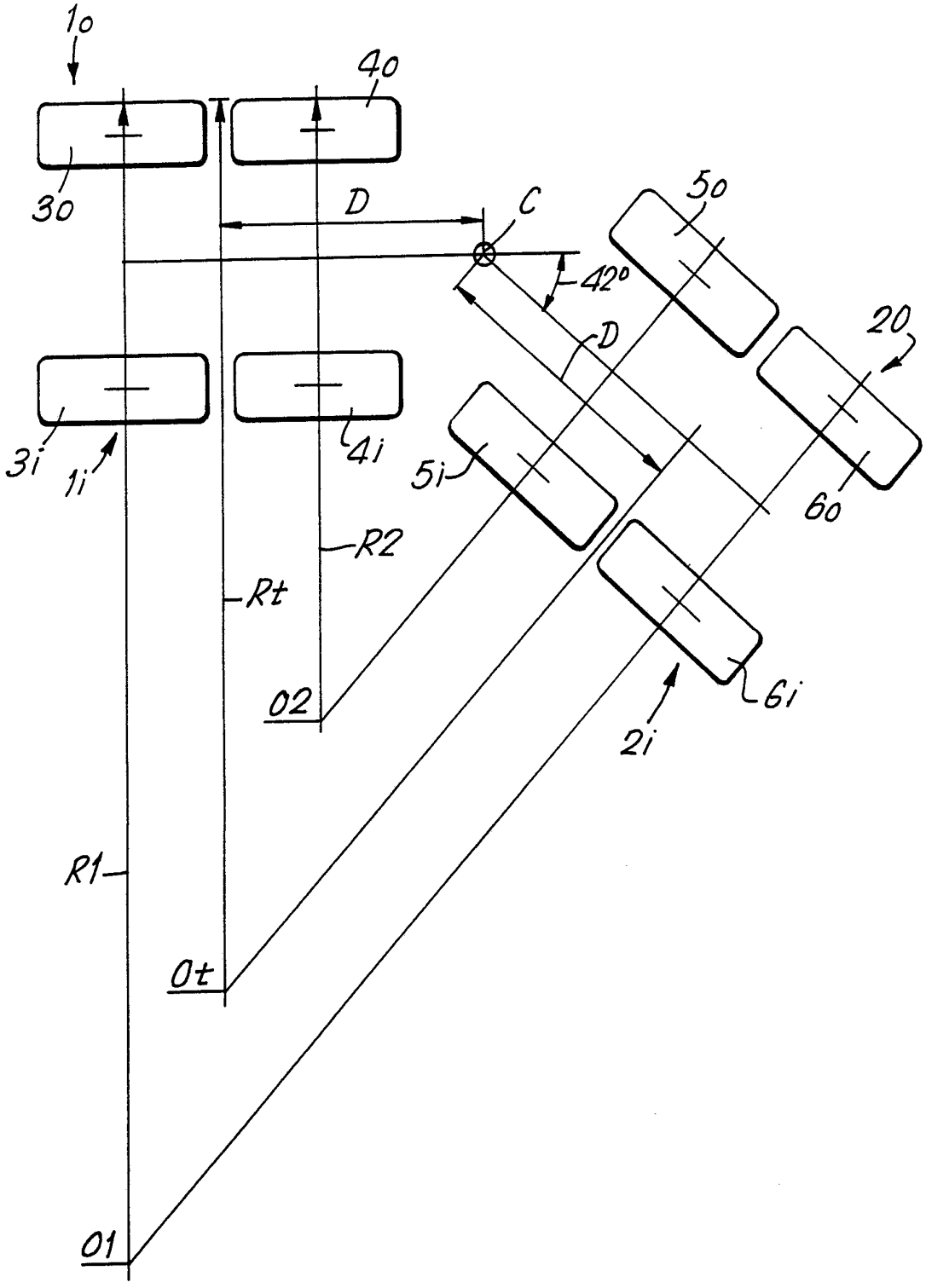
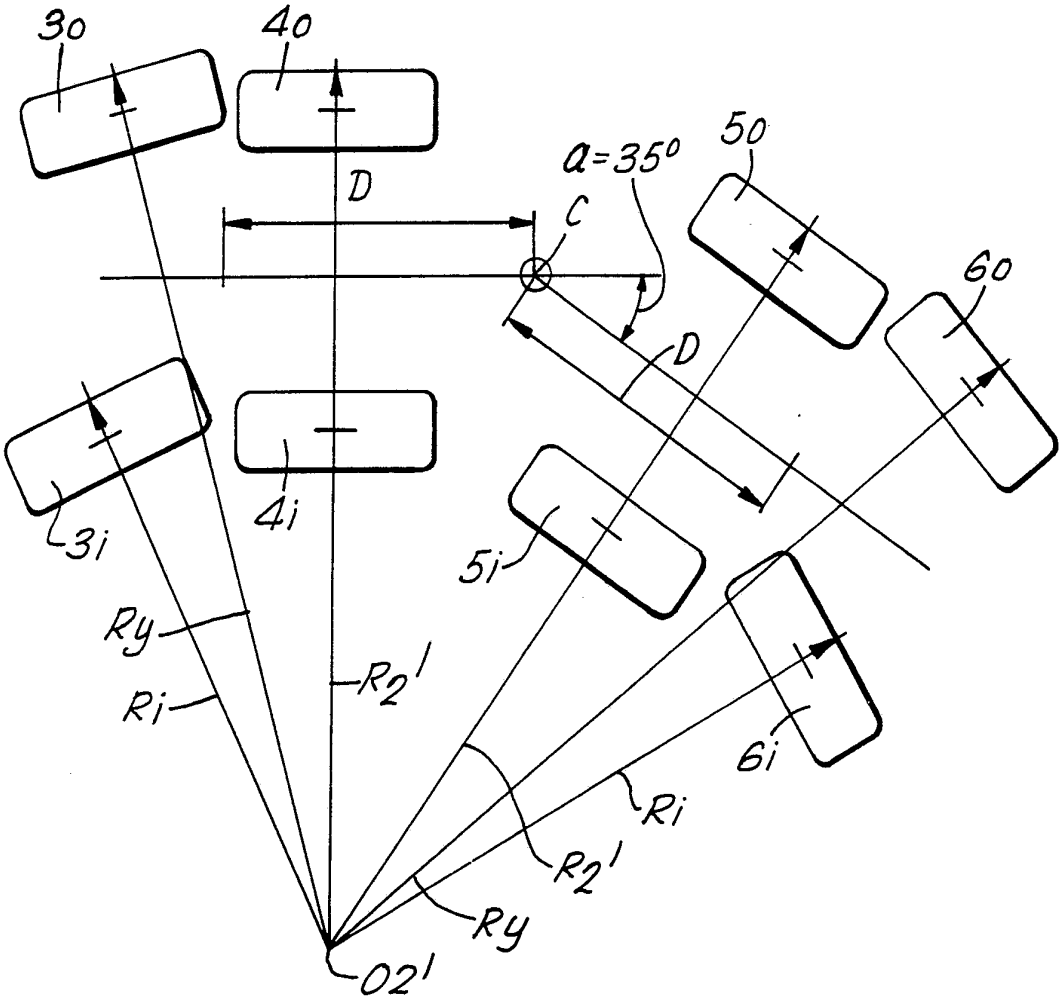


Fig.3.



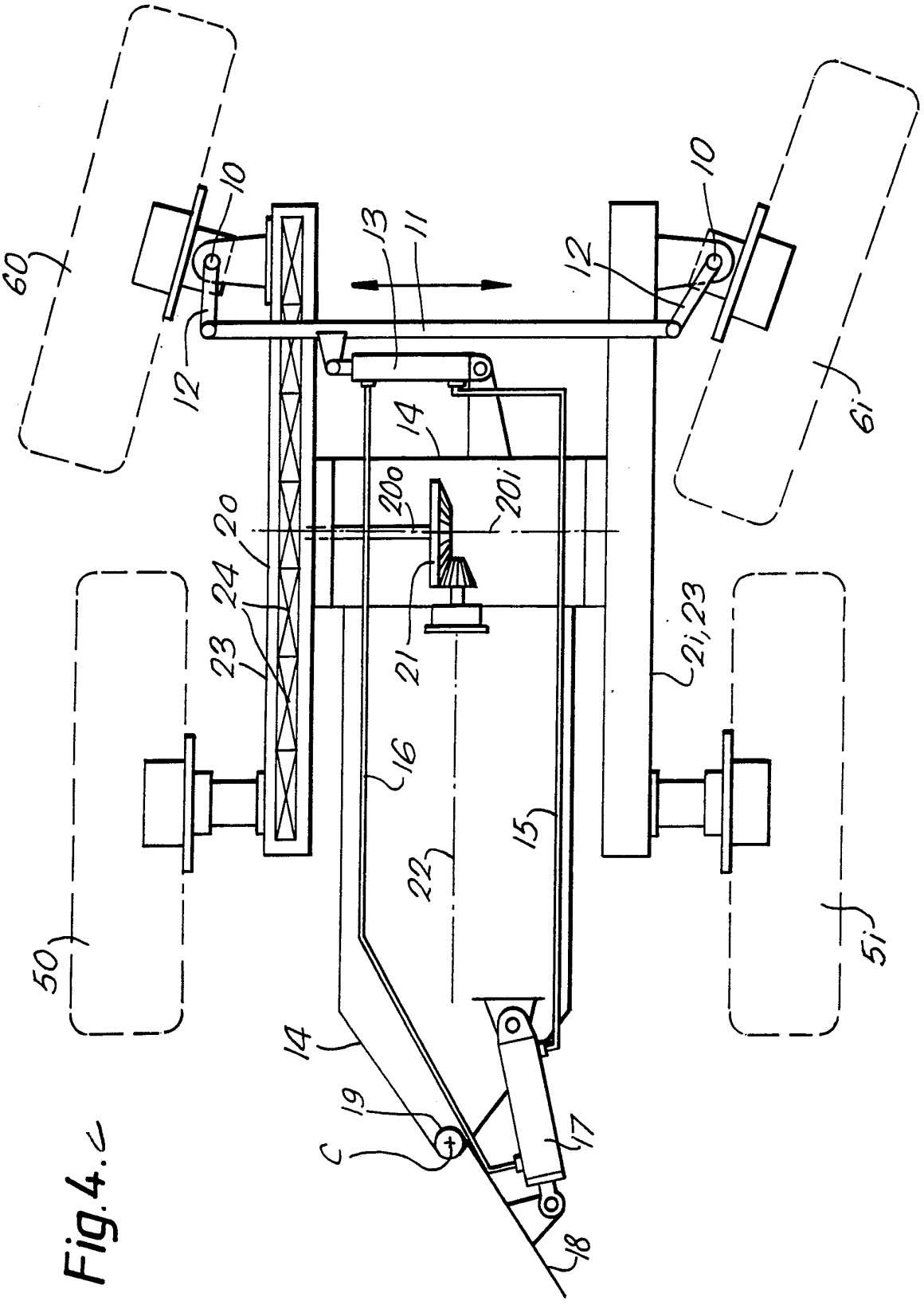
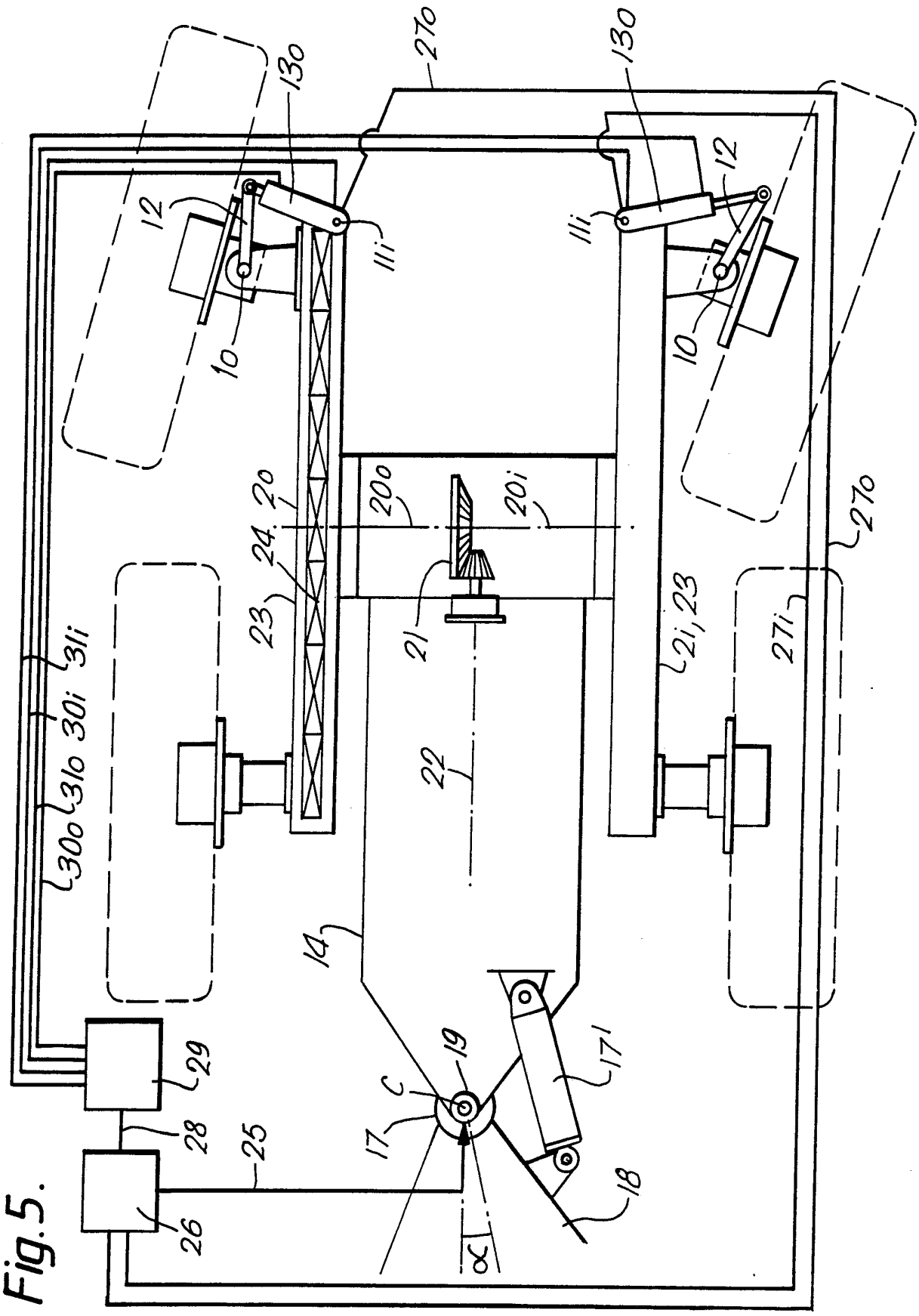

60
10
13
11
12
10
12
6i
14
20o
20i
20
24
23
21
21i,23
16
15
22
50
5i
14
19
C
17
18

Fig. 4.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130
130
12
12
111
111
10
10
20
200
20i
24
23
23
21
21i, 23
270
27i
311
30i
310
300
22
14
29
19
17
17
28
25
26
18
α

Fig.5.

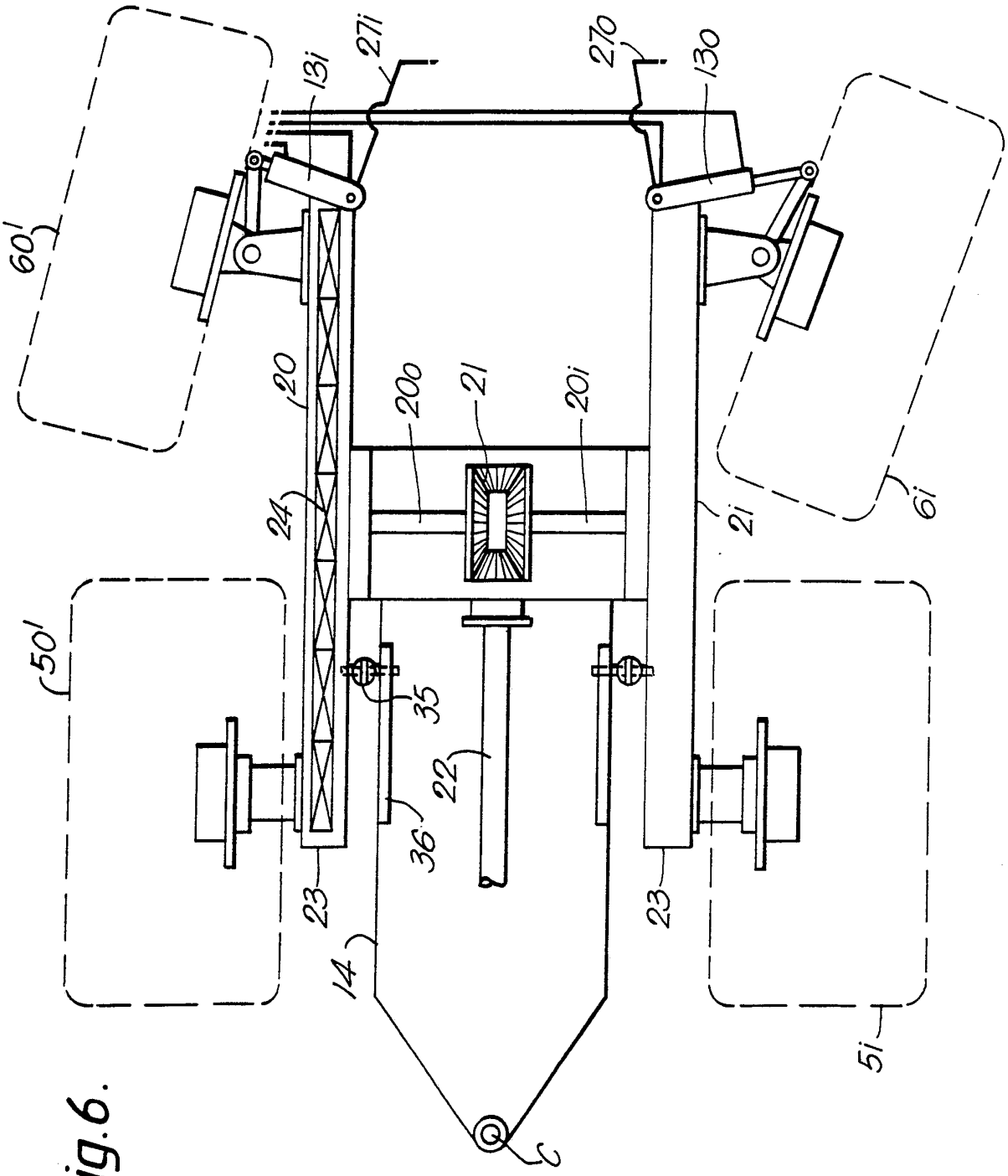


Fig.6.

Fig.7.

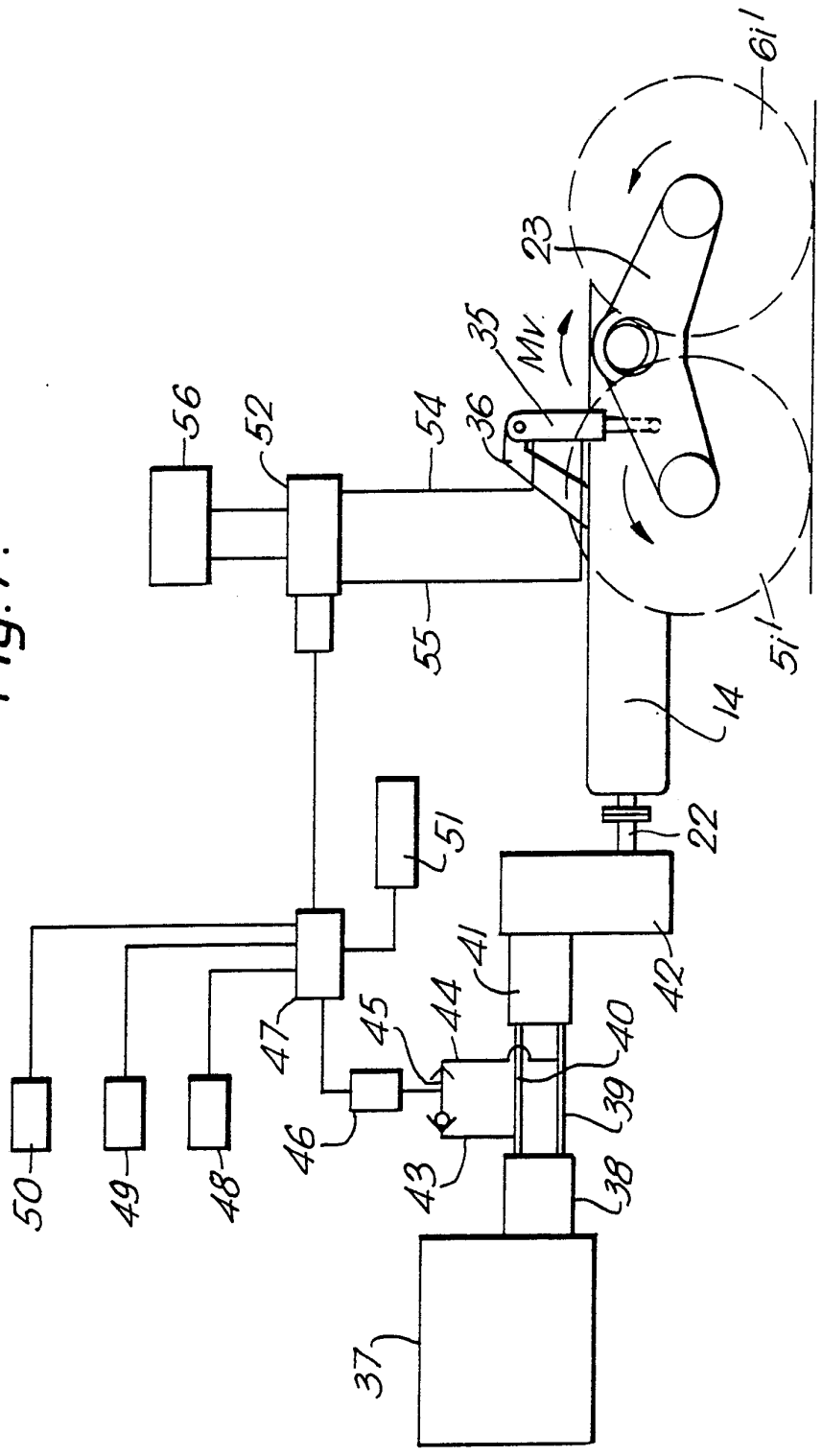

6i'
23
35
Mv.
36
56
52
54
55
5i'
14
22
51
41
42
44
40
45
47
39
46
43
38
50
49
48
37

Fig.8.

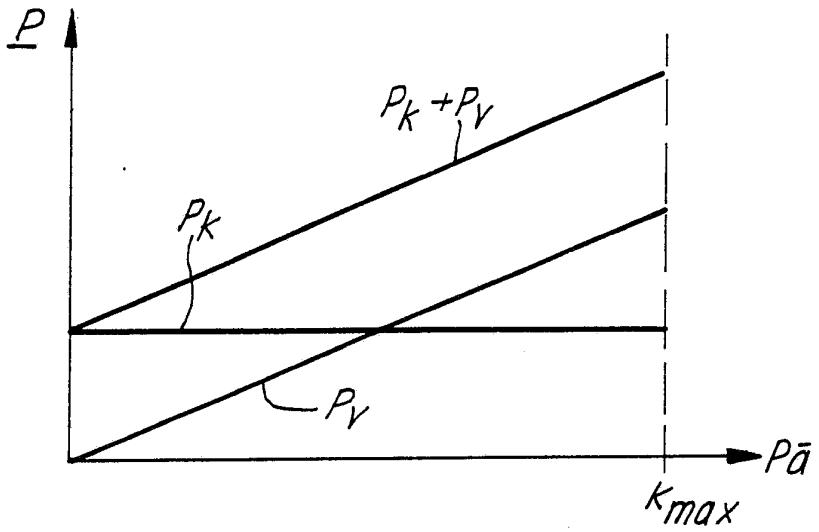
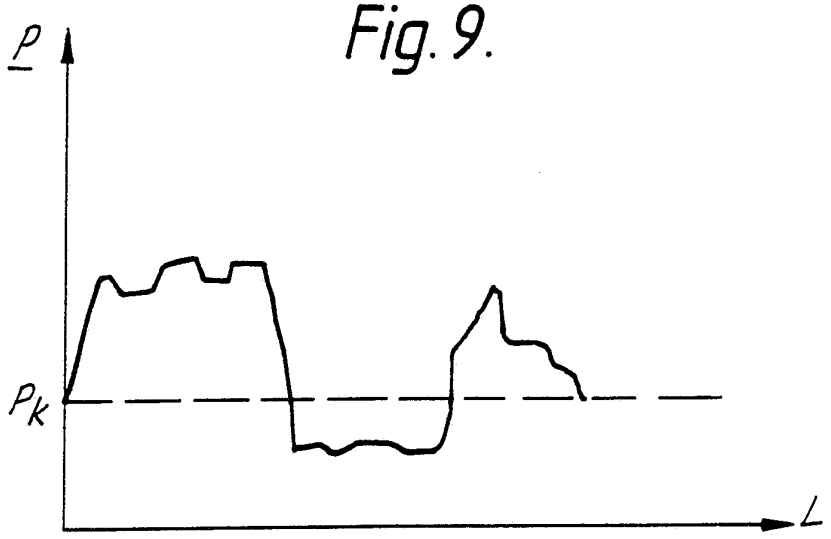


Fig.9.



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00882

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 62 D 12/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 62 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	DE, C1, 3616457 (SCHULTZ, RAINER M.) 26 November 1987, see figures 1,2 --	1
A	EP, A1, 0092952 (SIR RUPERT EDWARD MANN & LADY MARY ROSE MANN) 2 November 1983, see page 8, line 7 - line 12; figure 2 --	1
A	US, A, 1541965 (L.F. JORDAN) 16 June 1925, see figure 1 --	1
A	US, A, 1571748 (G.W.WILSON) 2 February 1926, see the whole document --	1

* Special categories of cited documents: [10]

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26th March 1991	1991 -04- 05
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Kenneth Gustafsson

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4696486 (MARTIN L. RUHTER) 29 September 1987, see the whole document --	2-5
A	US, A, 2791286 (F.S. BASTER) 7 May 1957, see figure 4 --	9
A	WO, A1, 8704128 (HERLOF OLOF) 16 July 1987, see page 2, line 24 - line 29; figures 3,5,7 --	10-13, 15
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 90/00882

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 91-02-28
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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		US-A-	4768601	88-09-06
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		US-A-	4858447	89-08-22
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