(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 April 2001 (19.04.2001)

PCT

(10) International Publication Number
WO 01/26951 A1

(51) International Patent Classification[7]: B62D 12/00, B60K 6/00

(21) International Application Number: PCT/SE00/01968

(22) International Filing Date: 11 October 2000 (11.10.2000)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
9903644-4 11 October 1999 (11.10.1999) SE

(71) Applicant *(for all designated States except US)*: **VOLVO ARTICULATED HAULERS AB** [SE/SE]; Västra Esplanaden 9 A, S-351 83 Växjö (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **KINGSTON, Tim** [GB/SE]; Lilla Movägen 10, S-632 39 Eskilstuna (SE).

(74) Agents: **HELLBOM, L.** et al.; Albihns Patentbyrå Stockholm AB, P.O. Box 5581, S-114 85 Stockholm (SE).

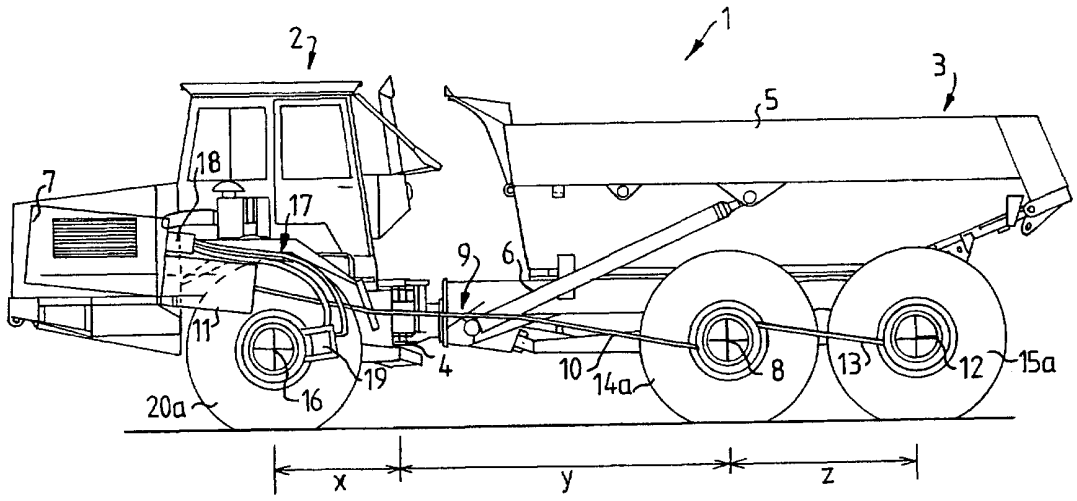
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *With international search report.*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: ARTICULATED HAULER




(57) Abstract: The invention relates to an articulated hauler, such as a dumper, comprising a vehicle part (2) bearing the drive engine, and load-bearing vehicle part (3), which vehicle parts are pivotably interconnected about a vertical pin (4). The load-bearing vehicle part (3) is provided with at least one first wheel axle (8) which is driven by the drive engine (7) via a mechanical transmission (9) and is arranged at a distance from said vertical pin. The vehicle part (2) bearing the drive engine is provided with at least one second wheel axle (16) which is driven by the drive engine. In this connection, the second wheel axle is arranged at a considerably shorter distance from said vertical pin. The second wheel axle (16) on the vehicle part (2) bearing the drive engine is also arranged so as to be driven via a hydrostatic transmission (17).

WO 01/26951 A1

# Articulated hauler

## Technical field

The present invention relates to an articulated hauler, such as a dumper, comprising a vehicle part bearing the drive engine, and a load-bearing vehicle part, which vehicle parts are interconnected in an articulated manner about a vertical pin, the load-bearing vehicle part being provided with at least one wheel axle which is driven by the drive engine via a mechanical transmission and is arranged at a distance from said vertical pin, and the vehicle part bearing the drive engine being provided with at least one wheel axle which is driven by the drive engine and is arranged at a considerably shorter distance from said vertical pin according to the precharacterizing clause of claim 1 below.

## State of the art

It is previously known, in an articulated lorry, such as a dumper, to provide the lorry with drive on all its wheels for the purpose of achieving good passability when driving on soft and/or slippery surfaces.

In this connection, the drive line of said lorry comprises a front wheel axle, arranged in a front vehicle part, with a differential which, via a propeller shaft, is driven, via a distribution gearbox, by a gearbox arranged in the drive engine of the lorry. The distribution gearbox is also arranged so as, via a second propeller shaft, to transmit the torque of the drive engine to the differential of a rear wheel axle arranged in a rear vehicle part. In the event that the lorry is provided with a second rear wheel axle, the torque of the drive engine is transmitted between the first rear wheel axle and the differential of the second rear wheel axle via a further propeller shaft arranged between the wheel axles. The function of said differentials is to make it possible for the wheels on one and the same axle to cover distances of different length, for example when cornering and negotiating obstacles. As long as the wheels have a good grip, this works well, but if the grip of one of the wheels on a wheel axle becomes worse, it starts to slip, and the power of the drive engine is then led out to the slipping wheel. It is therefore the grip of the slipping wheel which is decisive for the combined driving power of the two wheels. Against this background, a differential lock is

usually arranged so as to lock the differential, the wheels then being made to rotate at the same speed.

In accordance with the known art, a longitudinal differential is also arranged between the front wheel axle of the front vehicle part and the rear wheel axle of the rear vehicle part in order, in a corresponding manner to the differentials described above, to make it possible for the wheels on the front and, respectively, the rear wheel axle to cover distances of different length, for example when cornering or negotiating obstacles. As long as all the wheels have a good grip, this works well, but if the grip of the wheels on one wheel axle, usually the front wheel axle in the case of a loaded vehicle, becomes worse, they start to slip, and the power of the drive engine is then led out to the slipping wheels. Said longitudinal differential is therefore also provided with a differential lock arranged so as to lock the differential, all the wheels then being made to rotate at the same speed.

The above-mentioned differential locks are operated by the driver of the lorry who is therefore responsible for both engaging and disengaging the locks. As lorries of the above-mentioned type are often used on sites with very varied surfaces, for example mud and asphalt alternately, frequent engagement and disengagement of the differential locks is required in order to avoid increased wear/stress on the transmission of the lorry.

A particularly marked problem in articulated lorries, such as a dumper, with a front vehicle part connected pivotably, about a vertical pin, to a rear vehicle part, the rear vehicle part being provided with a wheel axle arranged at a distance from said vertical pin, and the front vehicle part being provided with a front wheel axle which is arranged at a considerably shorter distance from said vertical pin, is that, during cornering, the wheels on the wheel axles run on considerably different turning radii. If the lorry is driven through a curve, in particular when loaded and/or on a surface with good grip, with the longitudinal differential lock engaged, the transmission is subjected to great restrained torques because the wheels on the front wheel axle try to rotate at a higher speed than the wheels on the rear wheel axle. In addition to the stresses on the transmission, this also results in increased tyre wear and an impaired driving feeling when the lorry is understeered, that is to say tries to go straight on during cornering.

**Disclosure of the invention**

One object of the invention is to eliminate the above-mentioned problems by producing an articulated lorry in which great restrained torques, associated with cornering, in the transmission of the lorry are avoided.

This object is achieved by the invention described in Patent Claim 1. The subsequent patent claims describe preferred embodiments of the invention.

The invention therefore relates to an articulated lorry, such as a dumper, comprising a vehicle part bearing the drive engine, and a load-bearing vehicle part, which vehicle parts are pivotably interconnected about a vertical pin. The load-bearing vehicle part is provided with at least one first wheel axle which is driven by the drive engine via a mechanical transmission and is arranged at a distance from said vertical pin, and the vehicle part bearing the drive engine is provided with at least one second wheel axle which is driven by the drive engine. In this connection, the second wheel axle is arranged at a considerably shorter distance from said vertical pin. The second wheel axle on the vehicle part bearing the drive engine is also arranged so as to be driven via a hydrostatic transmission. By virtue of the fact that the first wheel axle on the load-bearing vehicle part is driven by the drive engine via a mechanical transmission, the driving torque of the drive engine is transmitted to those wheels which, when the vehicle is loaded, can be expected to have the best grip, at the same time as part of the driving torque of the drive engine can be transmitted to the second wheel axle, even during cornering, without great restrained torques arising.

According to a preferred embodiment of the invention, the hydrostatic transmission comprises a hydraulic pump which is driven by the drive engine and is coupled to a hydraulic motor arranged for driving the second wheel axle, the hydraulic motor being arranged at the differential of the second wheel axle. By arranging the hydraulic motor at the differential of the wheel axle, only one hydraulic motor is required for driving both wheels of the wheel axle, which contributes to both weight-saving and simplified installation as relatively little space is required.

According to another preferred embodiment of the invention, the hydraulic pump is coupled to other hydraulic components arranged on the lorry. This results in both weight-saving and simplified installation by virtue of the fact that fewer hydraulic pumps have to be accommodated in the space which is available in connection with the drive engine of the lorry.

According to another preferred embodiment of the invention, the hydraulic pump is coupled to tipping cylinders arranged for tipping a container arranged on the load-bearing vehicle part. This makes it possible for the whole of the oil flow delivered by the hydraulic pump to be used for propulsion when the lorry is driven. When the lorry is stationary, in connection with tipping, the whole oil flow is then available for the tipping cylinders.

According to another preferred embodiment of the invention, a coupling is arranged between the hydraulic motor and the second wheel axle for selective coupling of the hydraulic motor to the second wheel axle. This makes it possible to uncouple the driving wheels on the hydrostatically driven second wheel axle, for example when driving on roads, which means reduced transmission losses and thus reduced fuel consumption.

According to another preferred embodiment of the invention, the coupling is a toothed coupling which is preferably pneumatically operated between a coupled position and an uncoupled position. In this way, a robust coupling is obtained, which can be engaged and disengaged during lorry trips without being damaged.

According to another preferred embodiment of the invention, a detector is arranged so as to detect a driving situation in which said coupling is adapted so as to uncouple the hydraulic motor from the second wheel axle. By automating the engagement and disengagement of the drive to the second wheel axle depending on the current driving situation, unnecessary driving with the drive engaged is avoided, which leads to reduced fuel consumption and to reduced wear on the hydrostatic transmission. In this context, said detector is connected to an electronic control unit which engages or disengages the drive on the second wheel axle depending on the detected driving situation.

According to another preferred embodiment of the invention, a driving situation is the speed of the lorry, the hydraulic motor being arranged so as to be uncoupled from the second wheel axle when a predetermined speed is exceeded. Another driving situation is the current gear in the gearbox of the lorry. The above driving situations can be used as indicators that the lorry is being driven under such conditions that drive of the second wheel axle is not required.

Further preferred embodiments and advantages of the invention can be understood by means of the patent claims and description below.

**Description of the Figures**

The invention will be described below with reference to preferred exemplary embodiments and the appended figures, in which

Figure 1 shows a side view of an articulated lorry according to the present invention;

Figure 2 shows a view from above, partly in cross section, of an articulated lorry according to the present invention, where the part bearing the drive engine is pivoted relative to the load-bearing vehicle part in connection with cornering;

Figure 3 shows a simplified diagram of the hydraulic/mechanical/electronic connections of a hydrostatic transmission according to the present invention, and

Figure 4 shows, finally, a toothed coupling.

**Detailed description of a preferred embodiment**

Figure 1 shows a side view of an articulated or articulated frame-steered lorry 1, what is known as a dumper, according to the present invention, which, in a known manner, has a front vehicle part 2 bearing the drive engine and a rear, load-bearing vehicle part 3 which is connected to the front vehicle part 2 via a vertical articulation pin 4. The load-bearing vehicle part 3 is also provided with a tippable container 5 which can be raised/tipped by hydraulic cylinders 6.

The front and rear vehicle parts 2 and 3 are also interconnected in an articulated manner about a horizontal pivot pin (not shown) so that the

vehicle parts 2, 3 can be rotated in relation to one another about a longitudinal axis of the lorry 1.

To steer the lorry 1, when it is being driven, the front vehicle part 2 is made to pivot about the vertical articulation pin 4 by means of a pair of hydraulic cylinders (not shown), each of which is arranged on its own side of the articulation pin 4.

The driving torque delivered by the drive engine 7 is transmitted, according to the present invention, to the first wheel axle 8, which is arranged on the load-bearing vehicle part 3, via a mechanical transmission 9 comprising a first propeller shaft 10 which is arranged between the gearbox 11 of the vehicle 1 and the differential of the first wheel axle 8. Arranged between the first wheel axle 8 and an additional wheel axle 12 arranged on the load-bearing vehicle part 3 is a second propeller shaft 13 for transmitting the driving torque delivered by the drive engine 7. Each of the wheel axles 8, 13 is provided with wheels 14a, 14b, 15a, 15b.

The driving torque delivered by the drive engine 7 is also transmitted to the second wheel axle 16, which is arranged on the vehicle part 2 bearing the drive engine, via a hydrostatic transmission 17 which comprises a hydraulic pump 18 which is arranged on and driven by the drive engine 7 and is coupled to a hydraulic motor 19 which is adapted so as to drive the second wheel axle 16. The second wheel axle 16 is provided with wheels 20a, 20b.

An important feature of the lorry 1 according to the present invention relative to other vehicle types is the distance between the individual wheel axles 8, 13, 16 and the vertical pin 4 about which the vehicle parts 2, 3 are pivotable in relation to one another. The distance Y between the first wheel axle 8 and said vertical pin 4 is considerably greater than the distance X between the second wheel axle 16 and said vertical pin 4. The greatest distance Y+Z to the vertical pin 4 is from the additional wheel axle 12 arranged on the load-bearing vehicle part 3. This results in the first wheel axle 8 and the second wheel axle 16 having considerably different turning radii in connection with cornering, as will be described below. The ratio X/Y is 0.15 to 0.5, preferably 0.35.

Figure 2 shows a view from above, partly in cross section, of an articulated lorry 1, what is known as a dumper, according to the present invention, where the vehicle part 2 bearing the drive engine is pivoted, about the vertical pin 4, relative to the load-bearing vehicle part 3 in connection with cornering. In this context, the wheel axles 8, 13 on the load-bearing vehicle part 3 follow the turning radius R1 while the second wheel axle 16 arranged on the vehicle part 2 bearing the drive engine follows the turning radius R2. By virtue of the fact that the turning radius R2 is considerably greater than the turning radius R1, the wheels 20a, 20b on the second wheel axle 16 must, in connection with cornering, cover a greater distance than the wheels 14a, 14b, 15a, 15b on the wheel axles 8, 13 arranged on the load-bearing vehicle part 3.

With reference to Figure 3, a simplified hydraulic/mechanical/electronic connection diagram for a hydrostatic transmission 17 is described below. In this context, said transmission comprises a hydraulic pump 18, with variable displacement, which is driven by the drive engine 7 and is coupled, via a reverse valve 21, to a hydraulic motor 19 with variable displacement. The function of the reverse valve 21 is to change the direction of the oil flow through the hydraulic motor 19 in order to make it possible to drive the lorry 1 both forwards and backwards. After the oil has passed through the hydraulic motor 19, it is led back to a tank 22, to which the suction side 23 of the hydraulic pump is coupled.

The second wheel axle 16 is provided with a lockable differential 24 arranged in association with an angle gear 25 which, via an intermediate transmission 26 (the function of which is, by reduction, to adapt the speed of the hydraulic motor 19 to a lower speed suitable for the second wheel axle 16) and a coupling 27, is coupled to the hydraulic motor 19. By virtue of the fact that the coupling 27 is arranged between the hydraulic motor 19 and the second wheel axle 16, the wheel axle 16 can be uncoupled when it is not required for propulsion of the lorry 1. Engagement and disengagement are effected by a pneumatic operating arrangement (not shown) which is in turn controlled by an electronic control unit 28 which controls said coupling 27 on the basis of a driving situation, such as vehicle speed and gear, detected by detectors 29, 30. In the embodiment shown, the coupling 27 is arranged so as to uncouple the second wheel axle 16 when the vehicle 1 is driven at

speeds in excess of 20 km/h. The second wheel axle 16 can also be uncoupled manually by the driver of the vehicle 1 reversing a switch 31 arranged in the cab of the vehicle. When the second wheel axle 16 is uncoupled from the hydraulic motor 19, the lorry 1 is propelled via only said mechanical transmission 9 which is connected to an output shaft 32 of the drive engine 7.

By virtue of the fact that the reverse valve 21, hydraulic motor 19, intermediate transmission 26, coupling 27, angle gear 25 and differential 24 are integrated in a drive unit 33, very compact and therefore space-saving installation is obtained.

By virtue of the fact that a dividing valve 34 is arranged on the pressure side 35 of the hydraulic pump 18, upstream of the hydraulic motor 19, the hydraulic pump 18 also constitutes a source of power for said tipping cylinders 6 in connection with tipping of the container 5.

Figure 4 shows a toothed coupling intended to be arranged between the hydraulic motor 19 and the differential 24 of the second wheel axle 16. By virtue of the fact that the coupling 27 is in the form of a toothed coupling, no torque whatsoever is transmitted during driving with the coupling in the uncoupled position. Said toothed coupling comprises an input shaft 34, connected to the intermediate transmission 26, with an input drive wheel 35 provided with coupling teeth 36 which are intended to interact with corresponding coupling teeth 37 on an output drive wheel 38. The output drive wheel 38 is arranged displaceably along a splined joint 40, arranged on an output shaft 39, by means of said pneumatic operating arrangement.

The invention is not limited to embodiments shown in the drawings and described above, but can be varied freely within the scope of the patent claims below. For example, said coupling can be in the form of a plate coupling instead of the toothed coupling described above. Furthermore, other/additional hydraulic components, such as a crane, can be coupled to the hydraulic pump.

## Claims

1. Articulated lorry (1), such as a dumper, comprising a vehicle part (2) bearing the drive engine, and a load-bearing vehicle part (3), which vehicle parts (2, 3) are interconnected in an articulated manner about a vertical pin (4), the load-bearing vehicle part (3) being provided with at least one first wheel axle (8) which is driven by the drive engine (7) via a mechanical transmission (9) and is arranged at a distance (Y) from said vertical pin (4), and the vehicle part (2) bearing the drive engine being provided with at least one second wheel axle (16) which is driven by the drive engine and is arranged at a considerably shorter distance (X) from said vertical pin (4), **characterized** in that the second wheel axle (16) on the vehicle part (2) bearing the drive engine is arranged so as to be driven via a hydrostatic transmission (17).

2. Articulated lorry (1) according to claim 1, **characterized** in that said hydrostatic transmission (17) comprises a hydraulic pump (18) which is driven by the drive engine (7) and is coupled to a hydraulic motor (19) arranged for driving the second wheel axle (16), the hydraulic motor (19) being arranged in association with the differential (24) of the second wheel axle (16).

3. Articulated lorry (1) according to claim 2, **characterized** in that said hydraulic pump (18) is coupled to other hydraulic components arranged on the lorry (1).

4. Articulated lorry (1) according to claim 3, **characterized** in that said hydraulic components comprise tipping cylinders (6) arranged for tipping a container (5) arranged on the load-bearing vehicle part (3).

5. Articulated lorry (1) according to claim 2, **characterized** in that a coupling (27) is arranged between the hydraulic motor (19) and the second wheel axle (16) for selective coupling of the hydraulic motor (19) to the second wheel axle (16).

6. Articulated lorry (1) according to claim 5, **characterized** in that said coupling (27) is a toothed coupling.

7. Articulated lorry (1) according to claim 6, **characterized** in that said toothed coupling is pneumatically operated between a coupled position and an uncoupled position.

8. Articulated lorry according to any one of claims 5 to 7, **characterized** in that a detector (29, 30, 31) is arranged so as to detect a driving situation in which said coupling (27) is adapted so as to uncouple the hydraulic motor (19) from the second wheel axle (16).

9. Articulated lorry (1) according to claim 8, **characterized** in that said driving situation is the speed of the lorry (1), the hydraulic motor (19) being arranged so as to be uncoupled from the second wheel axle (16) when a predetermined speed is exceeded.

10. Articulated lorry (1) according to either of claims 8 and 9, **characterized** in that said driving situation is the current gear in the gearbox (11) of the lorry (1), the hydraulic motor (19) being arranged so as to be uncoupled from the second wheel axle (16) when a predetermined gear is detected.

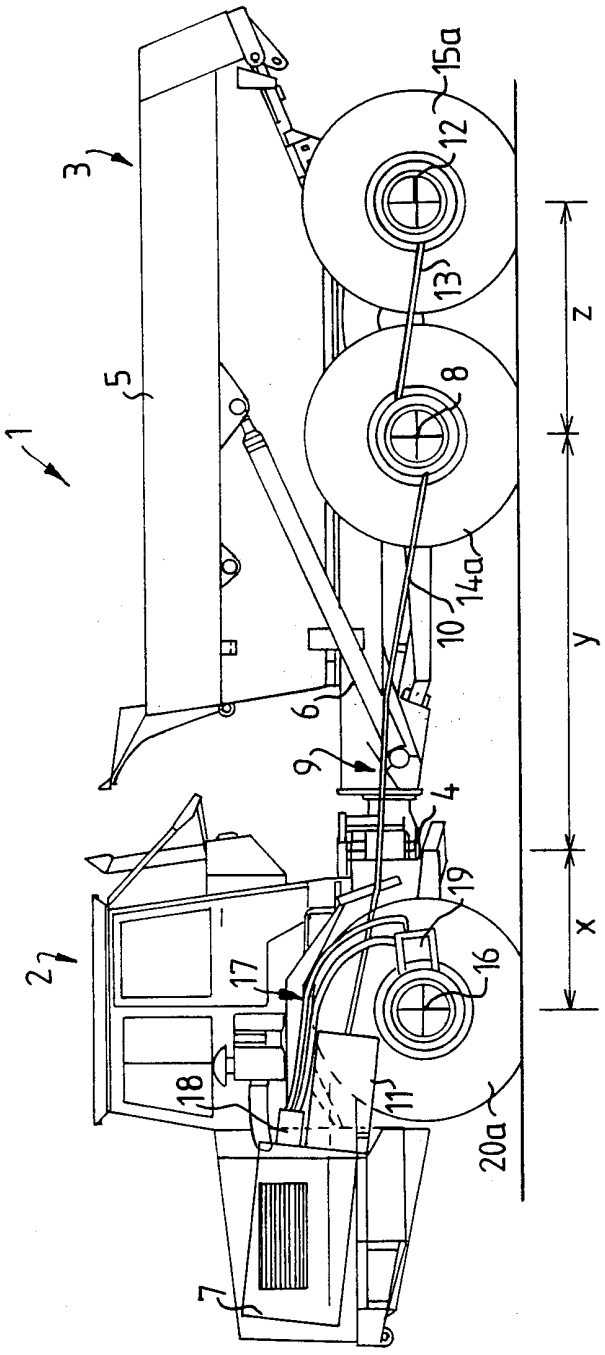



FIG.1

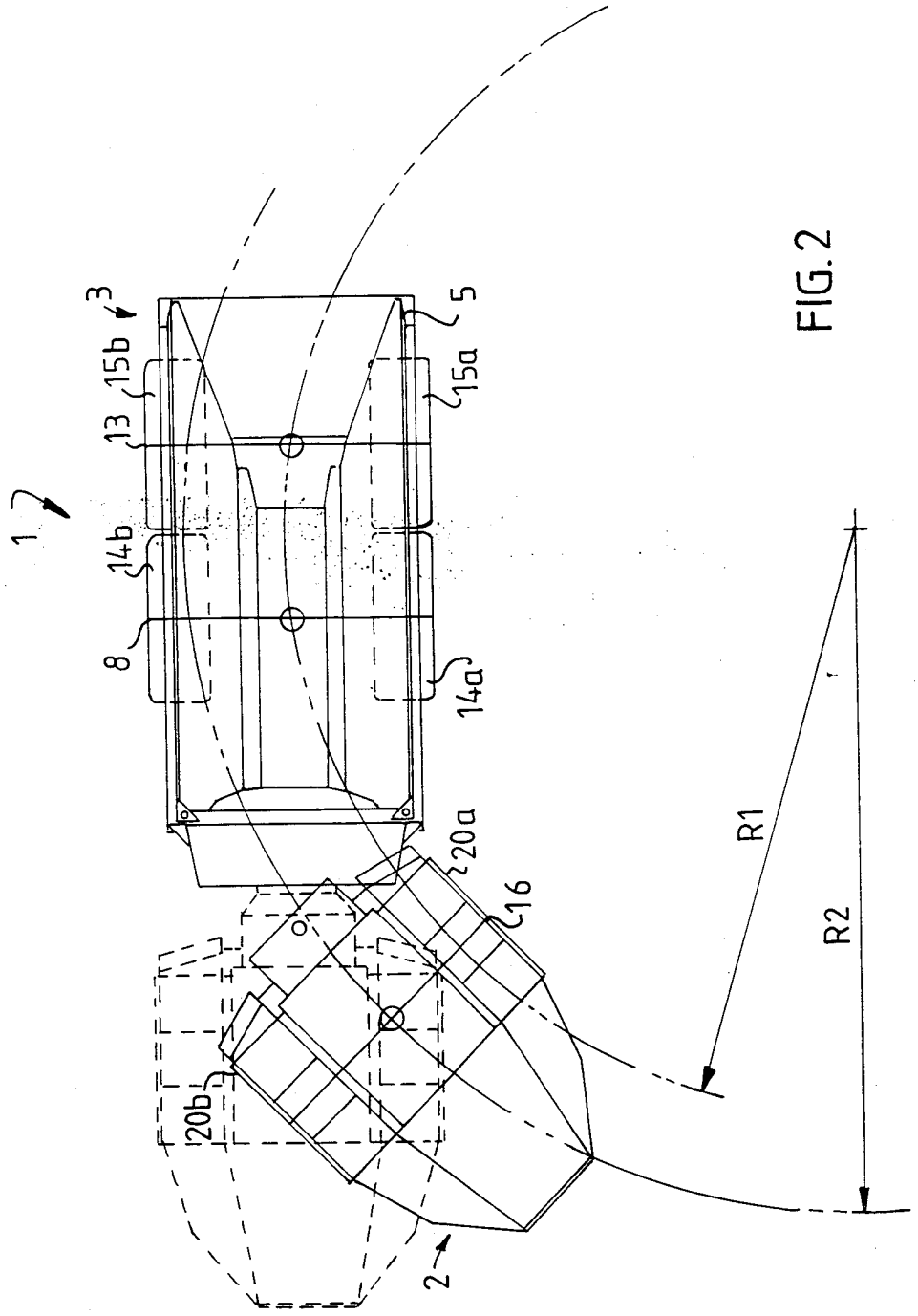



FIG.2

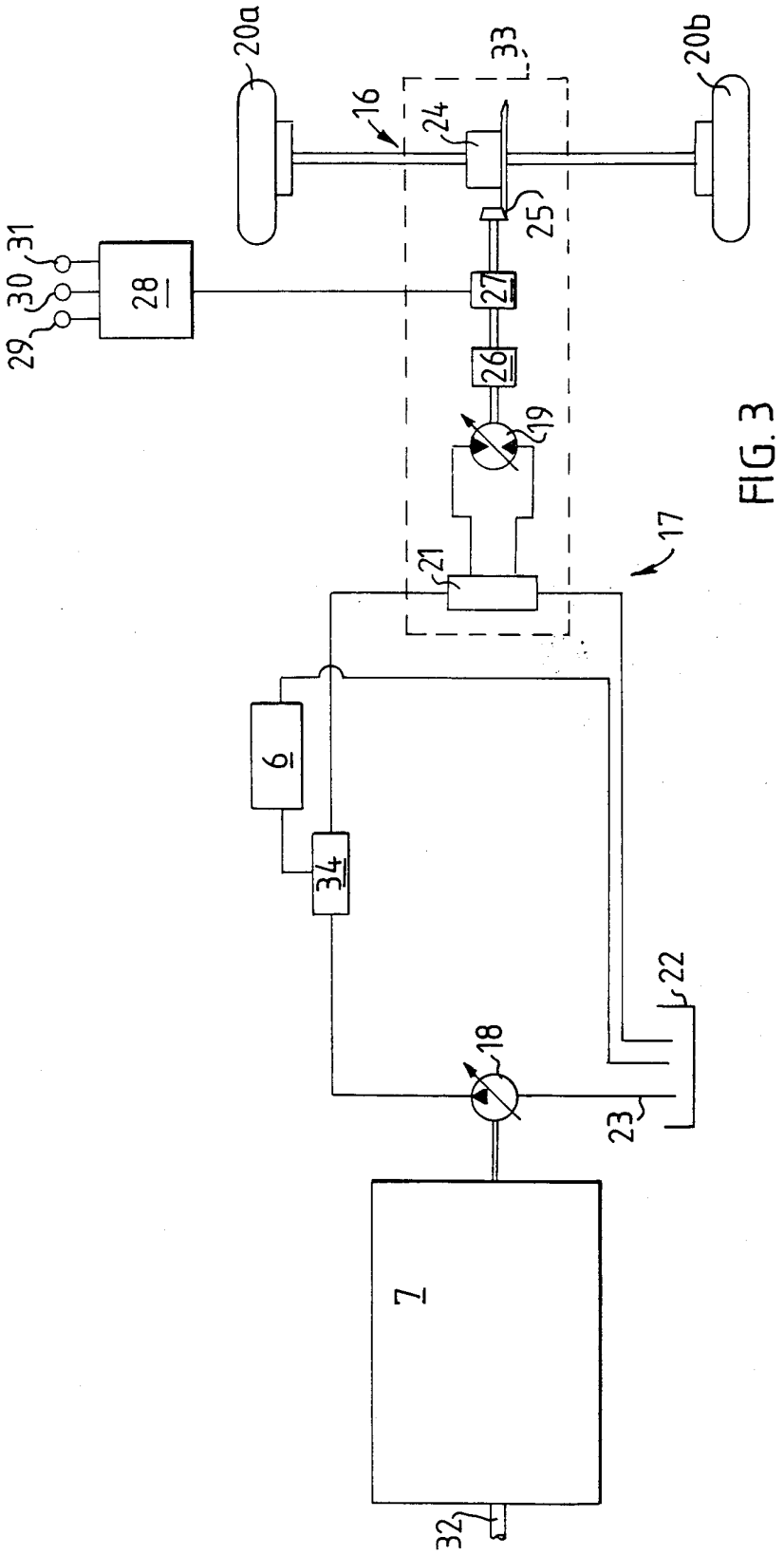



FIG. 3

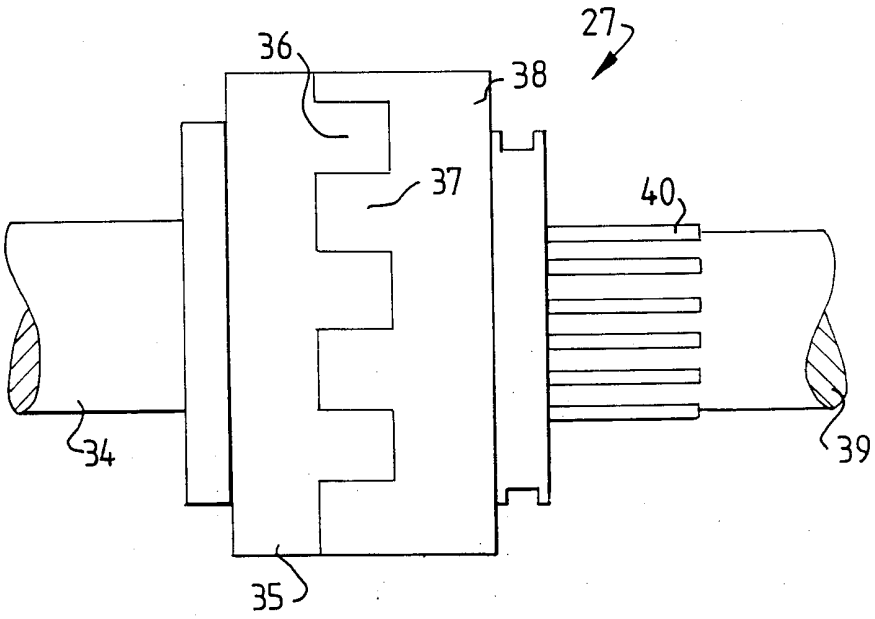



FIG.4

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/01968

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B62D 12/00, B60K 6/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B62D, B60K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5167292 A (MOIROUX ET AL), 1 December 1992 (01.12.92) -- | 1 |
| A | DE 2450573 A1 (METALLGESELLSCHAFT AG), 6 May 1976 (06.05.76) -- -------- | 1 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 12 January 2001 | 18 -01- 2001 |
| Name and mailing address of the ISA<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br>Göran Carlström/js<br>Telephone No. +46 8 782 25 00 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

04/12/00

International application No.
PCT/SE 00/01968

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5167292 A | 01/12/92 | AT 70007 T | 15/12/91 |
| | | AU 626544 B | 06/08/92 |
| | | AU 3412789 A | 16/10/89 |
| | | CA 1325578 A | 28/12/93 |
| | | DE 68900507 D | 00/00/00 |
| | | EP 0407436 A,B | 16/01/91 |
| | | SE 0407436 T3 | |
| | | FR 2629171 A,B | 29/09/89 |
| | | JP 3503394 T | 01/08/91 |
| | | WO 8909144 A | 05/10/89 |
| DE 2450273 A1 | 06/05/76 | AR 202849 A | 24/07/75 |
| | | BR 7408814 D | 00/00/00 |
| | | DE 7435347 U | 07/04/77 |
| | | FR 2248602 A,B | 16/05/75 |
| | | GB 1469931 A | 06/04/77 |
| | | JP 50106166 A | 21/08/75 |
| | | NL 7413863 A | 25/04/75 |
| | | SU 572229 A | 05/09/77 |
| | | US 3971904 A | 27/07/76 |