



(86) Date de dépôt PCT/PCT Filing Date: 1991/08/26

(87) Date publication PCT/PCT Publication Date: 1992/03/19

(45) Date de délivrance/Issue Date: 2003/10/28

(85) Entrée phase nationale/National Entry: 1993/03/01

(86) N° demande PCT/PCT Application No.: AU 1991/000389

(87) N° publication PCT/PCT Publication No.: 1992/004196

(30) Priorité/Priority: 1990/09/03 (PK 2104) AU

(51) Cl.Int.⁵/Int.Cl.⁵ B60G 3/14, B60P 1/28, B60G 9/02,
B60G 7/02, B62D 33/02

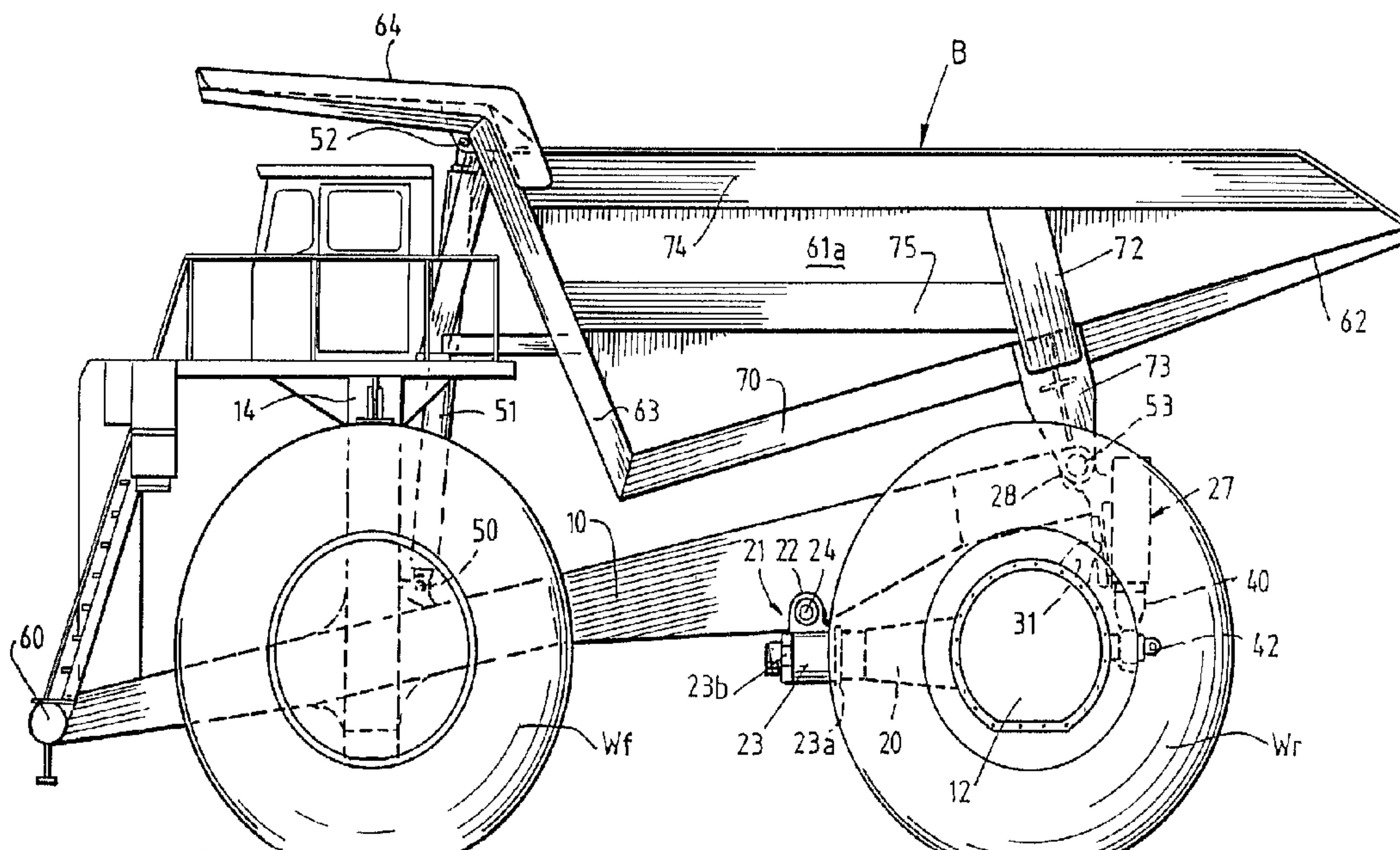
(72) Inventeur/Inventor:
DICKERSON, ALAN WILLIAM, AU

(73) Propriétaire/Owner:
BHP AUSTRALIA COAL PTY LTD., AU

(74) Agent: KIRBY EADES GALE BAKER

(54) Titre : **VEHICULE A DECHARGE ARRIERE**

(54) Title: **REAR DUMPING VEHICLE**



(57) **Abrégé/Abstract:**

A very large rear dumping vehicle of the type used in mining operations, comprising: a main frame, front wheels and rear wheels carried by the main frame, a rear dumping load carrying body pivotally mounted to the main frame at transversely spaced rear supports for pivotal movement about a pivot axis between a tipping position and a lowered position, means for tipping the body about the pivot axis, said body comprising a floor, side walls and a forward end wall defining a load carrying region, whereby said rear dumping load carrying body is supported in said lowered position on said main frame only at the transversely spaced rear pivot locations and at transversely spaced forward support points of the body disposed in the proximity of said end wall; characterised in that said means for tipping the body comprise hydraulic cylinders connected to mounting points of the body disposed in the proximity of said end wall and to mounting points on the main frame which are close to above a line between the centres of the front wheels of the vehicle and in that the floor of the load carrying body comprises longitudinally extending strengthening beams and a single transverse reinforcing beam, said single transverse reinforcing beam being connected to said spaced rear pivot supports.

Abstract

A very large rear dumping vehicle of the type used in mining operations, comprising: a main frame, front wheels and rear wheels carried by the main frame, a rear dumping
5 load carrying body pivotally mounted to the main frame at transversely spaced rear supports for pivotal movement about a pivot axis between a tipping position and a lowered position, means for tipping the body about the pivot axis, said body comprising a floor, side walls and a forward end
10 wall defining a load carrying region, whereby said rear dumping load carrying body is supported in said lowered position on said main frame only at the transversely spaced rear pivot locations and at transversely spaced forward support points of the body disposed in the proximity of
15 said end wall; characterised in that said means for tipping the body comprise hydraulic cylinders connected to mounting points of the body disposed in the proximity of said end wall and to mounting points on the main frame which are close to above a line between the centres of the front
20 wheels of the vehicle and in that the floor of the load carrying body comprises longitudinally extending strengthening beams and a single transverse reinforcing beam, said single transverse reinforcing beam being connected to said spaced rear pivot supports.

- 1 -

REAR DUMPING VEHICLEField of the Invention

This invention relates to very large trucks of the type used in mining operations.

5 Background of the Invention

There is much commonality between currently available large mining trucks made by different manufacturers and the following observations are generally applicable regardless of the truck manufacturer:

- 10 - The empty vehicle weight is a high proportion of the maximum gross vehicle weight. Typically the ratio of payload to empty vehicle weight is only about 1.4:1. This means that much of the cost of operating such trucks is related to moving the empty vehicle weight rather than the payload.
- 15 - The total width of the four rear tires is large compared to the total width of the truck. Typically 65% of the total width of a truck is taken up by the four rear tires. With present designs of truck this leads to a very narrow main frame for the truck and very high bending loads on the rear axle and rear wheel support systems. The narrow main frame causes shortage of space for maintenance of some components, high stress changes during cornering manoeuvres, the need for vertically stiff rear suspension springs and design restrictions on the body. The net effect is high weight and cost for the main frame, the rear axle, the rear wheel support assemblies and the body.
- 20 - The travel of the rear suspension system of a fully loaded truck is very limited compared to the scale of the truck. Typically the maximum travel in the
- 25
- 30

- 2 -

compression direction of the rear axle relative to the main frame is only of the order of 50 mm when loaded. This limited travel is a result of the need to achieve adequate roll stiffeners from the two narrowly spaced rear spring units.

5

- The main frames of these trucks are complex welded steel structures that are heavy (e.g. 16.5 tonnes for the main frame of a truck with a payload rating of 172 tonnes), expensive to design, develop and manufacture, and prone to fatigue cracking.

10

- The main load carrying member (the body) of the trucks is a very strong and generally stiff member. This strength and stiffness is a consequence of the need for the body to withstand the shock loads applied during loading of large rocks by large excavators.

15

- The body is generally supported from the main frame of the truck at numerous points. For example at the rear pivot points, at two, four, six or eight points along the underside of the body and in some trucks also at forward extensions of the body which contact the main frame at points which are close to being above the line of the front wheels. This system of supporting the stiff body causes high variation of stress levels in the main frame of the truck and the body as the truck traverses over uneven ground. This feature causes fatigue problems, high design and fabricating costs and the need for considerable expenditure to limit the unevenness of the ground on which the trucks travel.

20

25

30

- The body is tipped (hoisted) by hydraulic cylinders which react against the main frame of the truck at points near to midway between the front and rear

- 3 -

wheels. This causes very large bending loads to be applied to the main frame of the truck and requires that the main frame be very massive at the mid sections. It can also cause large stress changes in the body.

- The dual rear tires are rotationally locked together. During short radius turning manoeuvres (frequent occurrences in typical mining operations), this causes severe scrubbing type wear of the tires due to the differential travel distance effect. Relative scrubbing between the two tires of a dual set is considered to contribute significantly to total wear of rear tires on large mining trucks.
- The combination of four wide tires on a solid beam axle type rear axle causes large variations in individual tire loads as the trucks traverse uneven ground conditions. This arrangement also means that it is necessary to take considerable care in matching tire outside diameters and inflation pressures to minimise the unevenness in tire loads on level ground conditions.
- In general with currently available truck designs, the transfer of forces between the body and the ground is through a very indirect path which involves high bending loads in the body, the main frame of the truck, the rear axle housing and the rear wheel support systems (the final drives or the wheel motor housings). Furthermore these bending loads fluctuate greatly as the truck travels over uneven ground and during cornering.

A typical very large mining truck is shown in Figure 1 of the drawings of International Patent Publication

- 4 -

No. WO 90/09907, and it will be noted that the frame structure is quite substantial and this results from the frame being required to bear the load supported by the body of the truck by contact between the body and the upper
5 surfaces of the frame, and by virtue of the body hoisting rams being connected to the frames as shown. The substantial size of the rear axle is also apparent.

While many truck frame design improvements have been suggested over the years, no one design has successfully
10 addressed more than a few of the difficulties which have been outlined above. For example, United States Patent No. 3,704,040 Davis et al discloses a frame arrangement in which the front and rear wheel pairs are centrally supported, the independent frame members arrangement which
15 is described as addressing many of the problems created by uneven terrain is extremely complex and consequently expensive and heavy. This patent and the related United States Patent No. 3,773,348 also disclose a rear suspension arrangement suitable for use with centrally supported rear
20 wheel pairs. Centrally supported rear wheel pairs provide the potential to overcome some of the problems inherent in currently available large mining trucks, but to date no successful method of exploiting this potential has been established.

25 In addition to the above, most truck body designs have remained essentially unchanged for many years, being characterised by extremely heavy structures reinforced by means of relatively closely spaced transverse beams assisted by limited longitudinal beams, thereby resulting
30 in a body structure of extremely high weight.

Similarly, most conventional truck bodies have a sloping floor and vertical longitudinal sides arranged at a

- 5 -

constant width spacing. In one departure from this approach, a body having a flat floor and vertical sides which are wider apart at the rear of the body than at the front of the body was designed. Although in this arrangement, the wear on the sides of the body is reduced, the flat body floor is not compatible with most truck main frame designs and it increases the height of the centre of gravity of the truck unless the overall width and/or length of the truck is increased.

10 A very large rear dumping vehicle of the type used in mining operations comprising: a main frame, front wheels (W_f) and rear wheels (W_r) carried by the main frame (10, 11), a rear dumping load carrying body (B) pivotally mounted to the main frame at transversely spaced rear supports (73) for pivotal movement about a pivot axis between a tipping position and a lowered position, means for tipping the body about the pivot axis, said body comprising a floor (62), side walls (61, 61A) and a forward end wall (63) defining a load carrying region, whereby said rear dumping load carrying body is supported in said lowered position on said main frame only at the transversely spaced rear pivot locations and at transversely spaced forward support points of the body disposed in the proximity of said end wall, is known from JP 62-034828.

This document however does not address a number of the problems discussed above, in particular the desire to reduce the weight of the body without compromising the payload capacity or the fatigue life of the truck.

- 6 -

Summary of the Invention

It is an object of the present invention to provide an improved configuration for a very large vehicle which addresses these problems.

5 According to the present invention there is provided a very large rear dumping vehicle of the type used in mining operations, comprising: a main frame, front wheels and rear wheels carried by the main frame, a rear dumping load carrying body pivotally mounted to the main frame at
10 transversely spaced rear supports for pivotal movement about a pivot axis between a tipping position and a lowered position, means for tipping the body about the pivot axis, said body comprising a floor, side walls and a forward end wall defining a load carrying region, whereby said rear
15 dumping load carrying body is supported in said lowered position on said main frame only at the transversely spaced rear pivot locations and at transversely spaced forward support points of the body disposed in the proximity of said end wall; characterised in that said means for tipping
20 the body comprise hydraulic cylinders connected to mounting points of the body disposed in the proximity of said end wall and to mounting points on the main frame which are close to above a line between the centres of the front wheels of the vehicle and in that the floor of the load
25 carrying body comprises longitudinally extending strengthening beams and a single transverse reinforcing beam, said single transverse reinforcing beam being connected to said spaced rear pivot supports.

There is described in the following and claimed in the
30 European Application Publication No. EP-A-545996 a suspension system for a very large vehicle, the very large vehicle comprising a substantially rigid main frame having

- 7 -

a forward section carrying front wheels and a rear section, said rear section being substantially rigidly attached to said front section and including spaced frame members each associated with a wheel mounting hub, each hub
5 independently supporting a pair of rear wheels on either side of the hub and said suspension system comprising a forward attachment means for said hub pivotally mounted on said frame members to allow limited rotation of said hub about a longitudinal and a transverse axis relative to each
10 frame member, and a vertically compliant suspension means limiting rotation of said hub about said transverse axis, said suspension means being rigidly attached to said frame member to prevent lateral movement of said hub in the transverse plane relative to said frame member and being
15 actively coupled to said hub in a manner which allows longitudinal movement of said hub relative to said suspension means as the hub rotates about said transverse axis and to permit rotation of said hub about said longitudinal axis.

20 The main frame forward section may be narrow and extend between said front wheels, said rear section being wider than said front section, said spaced frame members including elongate frame portions which extend gradually inwardly from said wider rear section to said narrower
25 front section such that the transition between said front and rear section is gradual rather than abrupt.

In the load carrying body of the rear dumping vehicle in accordance with the invention, the floor is reinforced by strengthening beams a substantial majority of which
30 extend longitudinally of the body. The body is reinforced by only one substantial strengthening beam extending transversely of the vehicle, in the region of a pivot

- 8 -

attachment means for pivoting the body with respect to the frame. The body preferably also has longitudinal strengthening beams in the side walls, and the traverse beam also preferably extending to said side walls.

5 By providing the principle reinforcement of the body by means of longitudinally extending strengthening beams, the necessary body strength can be achieved with significant reductions in the weight and the manufacturing cost of the body.

10 The body is preferably pivotally mounted on the main frame of the truck such that pivotal movement of said body is about an axis which lies within the profile of the rear wheel pairs. The body is supported only at the pivot points and at two points near the front of the body, these
15 forward supports lying close to above the line between the centres of the front wheels of the truck. The hydraulic cylinders used for tipping the body about its pivot points preferably react onto the main frame of the truck at two points which are also close to above the line between the
20 centres of the front wheels of the truck. By these means the body is prevented from exerting large bending moments in the main longitudinal members of the main frame of the truck. The forward body supports may include a positive location system between the body and the main frame of the
25 truck so that the body can provide a significant proportion of the strength that is required between the front and rear wheels when it is in the 'down' position.

The use of rear wheel mounting hubs positioned between each pair of wheels suits the use of electric motor systems
30 to drive the rear wheels. The use of such motors has the inherent advantage of enabling the problems associated with a solid rear axle to be easily overcome thereby reducing

the weight of the rear wheel supporting systems, improving load sharing between the rear tires and reducing the rear tire wear effects of such axles. However, mechanical drive systems may be utilized with acceptable results.

5 Advantages may be taken of the rear wheel mounting arrangement to incline one or both of the wheels which are mounted on the hub at an angle other than vertical so as to improve the stability of the vehicle during cornering manoeuvres and when operating on cross (transverse) slopes.
10 The location of the rear wheel mounting hubs between each pair of wheels allows independent rotation of each wheel thereby avoiding tire wear caused by short radius turning.

In an embodiment of the invention, said floor slopes downwardly in the forward longitudinal direction of said
15 body, said side walls sloping inwardly towards said floor, and said floor increasing in width towards the rear longitudinal direction of said body.

A truck body having the above combination of features has the necessary low centre of gravity and the sloping
20 side walls and the increasing width of the body floor facilitates easier discharge of a load while minimizing wear on the sides of the body.

Brief Description of Drawings

The foregoing and other features, objects and
25 advantages of the present invention will become more apparent from the following description of the preferred embodiment and the accompanying drawings in which:

Figure 1 is a side elevation of a truck incorporating an embodiment of the invention;

30 Figure 2 is a side elevation similar to Figure 1 with the truck body elevated;

- 10 -

Figure 3 is a rear end elevation of the truck of Figure 1 showing details of the rear suspension and partly illustrating the improved truck body construction;

Figure 4 is a fragmentary sectional end elevation with parts removed to show the extent of transverse rotation of one of the two rear wheel mounting hubs in one direction;

Figure 5 is a fragmentary plan view of the truck frame with the body removed;

Figure 6 is an enlarged sectional side elevation of one rear wheel mounting and suspension; and

Figure 7 is a plan view of the truck body showing its improved construction.

Description of Preferred Embodiments

Referring to Figures 1 to 5 of the drawings, the truck frame comprises a pair of relatively light longitudinal members 10 and 11 suspending rear wheel mounting hubs 12 and 13 towards their rear ends. The longitudinal members 10 and 11 are connected at their forward ends by a substantial cross member 14, such as a mounting collar which generally includes mounting points for the front suspension (not shown) for the front wheels (W_f), at the front by a bumper 60 and at the rear, forwarding of the rear wheels, by a cross member 60a, which forms part of the support means for the rear wheel mounting hubs 12 and 13, as will be described further below. The front suspension may take the form described in greater detail in International Patent Publication No. WO 90/09907, or in any other suitable form.

As shown in Figures 3, 4 and 5, the wheel mounting hubs 12 and 13 support drive means for the rear wheels (W_r), such as electric traction motors 16, 17, 18 and 19, which are in turn connected to the rear wheels W_r , with

- 11 -

each wheel being mounted one on either side of the hubs 12 and 13. The location of the rear wheel mounting hubs 12 and 13 between each pair of rear wheels (W_r) allows independent rotation of each wheel thereby avoiding tire wear caused by short radius turning.

The rear suspension system includes rear wheel mounting hubs 12 and 13 mounted to the longitudinal frame members 10 and 11 by means of hollow forwarding extending attachment members 20 which are attached to pivotal mounting 21 which are in turn pivotally secured to a cross member 60a which is rigidly secured to the frame members 10 and 11. The attachment members 20 and the rear wheel mounting hubs 12 and 13 may be formed separately or as an integral unit, and the hollow attachment members 20 operate to convey cooling air to the motors 16 to 19 attached to the hubs 12 and 13.

Each pivotal mounting 21 includes a top transverse journal 22 and a bottom longitudinal journal 23 which allow two rotational degrees of freedom for the hubs 12 and 13. The transverse journal 22 engages spindle sections on the ends of a shaft 24 (Figure 5) which forms part of the rear cross member 60a for the frame members 10 and 11, which, as shown in Figures 1 and 2, are of increased depth in this region to allow the cross member 61 to penetrate the side plates of the frame members 10 and 11, to which the cross member 60a is rigidly secured in some suitable manner. Each lower journal 23 receives the end portion of one of the attachment members 20, within which journal 23 this end portion is free to rotate, the end portion of the attachment member 20 being restrained within the journal by a flange 23a formed on the attachment member 20 and a nut

- 12 -

23b engaging the end portion of the attachment member 20, as shown most clearly in Figure 6 of the drawings.

The frame members 10 and 11 also carry a mounting member 26 for vertically compliant suspension means or spring unit 27, the mounting member 26 also having an integrally formed journal 28 which receives pivot pins 29 about which the body B of the truck pivots. The spring unit 27 includes a cylinder housing 41 rigidly attached to the mounting means 26 and receiving a piston unit 40 which is fixed to the mounting hubs 12, 13 by a rearward extension 42. The spring effect may be obtained by the compression of a gas within the cylinder or by other suitable means.

The mounting means 26 has downwardly extending rigid flanges 30 which are adapted to be engaged by a projection 31 extending from each hub 12, 13 at a position closely adjacent the flanges 30 whereby transverse rotation of the hubs 12 and 13 is limited.

Rotation of the attachment member 20 and its connected hub 12, 13 in the other direction is confined by the cylinder of the spring means 27 to be along the axis of the cylinder 27, and the attachment point of the piston 40 to the rearward extension 42 is allowed by a spherical sliding bearing 45 between the piston 40 and the rearward extension 42.

The above described coupling and spring unit for the rear wheel mounting hubs 12 and 13 allows the hubs 12 and 13 to pivot about both longitudinal and transverse axes to facilitate greater flexibility in the movement of each hub 12, 13 with respect to the frame and truck body B. One such movement is illustrated in Figure 4 of the drawings.

- 13 -

While the above described suspension system is suitable for trucks having frames of the type described above, or of the type otherwise described in International Patent Publication No. WO 90/09907, it should be appreciated that the suspension system is equally applicable to other forms of truck having independent rear axles supported in a different manner to that described above.

Referring additionally to Figure 7 of the drawings, the truck body B according to a particularly preferred embodiment comprises side walls 61a and 61, a floor 62, a front wall 63 and a forwardly extending cabin-protecting extension 64. The truck body B has a number of novel features, including that the main reinforcing beams under the floor 62, front wall 63 and extension 64 extend longitudinally of the body, as shown at 65 to 70, and only one transverse reinforcing beam 72, located close to or on a line between brackets 73 formed to receive the pivot pin 29 engaging the journal 28, as previously described. Two additional beams 74, 75 and 76, 77 extend along each side 61a and 61 as shown most clearly in Figure 3 of the drawings. Similarly, the cabin cover 64 will be seen to have the smallest strengthening beams as shown in Figure 1. The transverse beam 72 extends the full width of the floor 62, and preferably extends up the sides 61a, 61 of the body as shown.

As mentioned earlier in this specification, conventional truck body designs rely on numerous transverse beams, and generally only two longitudinal beams running above the main frame of the truck or along the sides of the body floor. The principal advantages of the new body design described above include a significant reduction in

- 14 -

the body weight, and a significant reduction in the manufacturing cost of the body, the body still having sufficient strength to allow it to be supported only at the front and at the body pivots, thereby allowing the weight and cost of the main frame of the truck to be reduced as described in greater detail in International Patent Publication No. WO 90/09907.

In addition to the above, the floor 62 and the sides 61a and 61 are sloped in the manner shown in Figures 1, 3, 4 and 7 of the drawings whereby the width of the floor 62 of the body B increases from the front of the body to the rear of the body, as shown most clearly in Figure 7 of the drawings. The advantage of this design feature is that wear on the sides of the body is reduced, because when the body is raised to the tipping position as shown in Figure 2, the load slides into a widening space, rather than being confined to a constant width as for a conventional body design. Furthermore, the weight of the body can be reduced and there is no increase of the overall width of the truck.

As described in our earlier international patent application referred to above, the body is elevated by a pair of extendible rams 51 carried by mounting points 50 on the frame cross member 14 and at 52 on the truck body B.

It will be appreciated that the truck body features described in greater detail above are equally applicable to trucks of designs other than the design described in greater detail above.

Details of the attachment of the traction motors 16 to 19, the front wheel assemblies, the engine and the construction of the truck ancillaries including the driver's cab has not been included in this specification since each of these items can be of relatively standard

- 15 -

construction and is within the existing knowledge of a person of skill in the art. It will, however, be noted that the rear axles are independent short axles with one tire on either side. Whilst the three cross members 14, 60
5 and 60a provide substantial strength and rigidity between the two main longitudinal members of the main frame, the transverse spacing of the frame members 10 and 11 is also maintained to a significant extent by the direct attachment of the body B to the longitudinal frame members at the
10 pivot mounts 73. This use of the inherent strength of the body B enables a further reduction in the frame strength, weight and cost.

- 16 -

Claims:

1. A very large rear dumping vehicle of the type used in mining operations, comprising: a main frame, front wheels and rear wheels carried by the main frame, a rear dumping
5 load carrying body pivotally mounted to the main frame at transversely spaced rear supports for pivotal movement about a pivot axis between a tipping position and a lowered position, means for tipping the body about the pivot axis, said body comprising a floor, side walls and a forward end
10 wall defining a load carrying region, whereby said rear dumping load carrying body is supported in said lowered position on said main frame only at the transversely spaced rear pivot locations and at transversely spaced forward support points of the body disposed in the proximity of
15 said end wall; characterised in that said means for tipping the body comprise hydraulic cylinders connected to mounting points of the body disposed in the proximity of said end wall and to mounting points on the main frame which are between the front wheels of the vehicle and in that the
20 floor of the load carrying body comprises longitudinally extending strengthening beams and a single transverse reinforcing beam; said single transverse reinforcing beam being connected to said spaced rear pivot supports.

2. A vehicle according to claim 1, wherein the
25 transversely spaced rear supports of said body on said vehicle are between or above rear wheels of the vehicle.

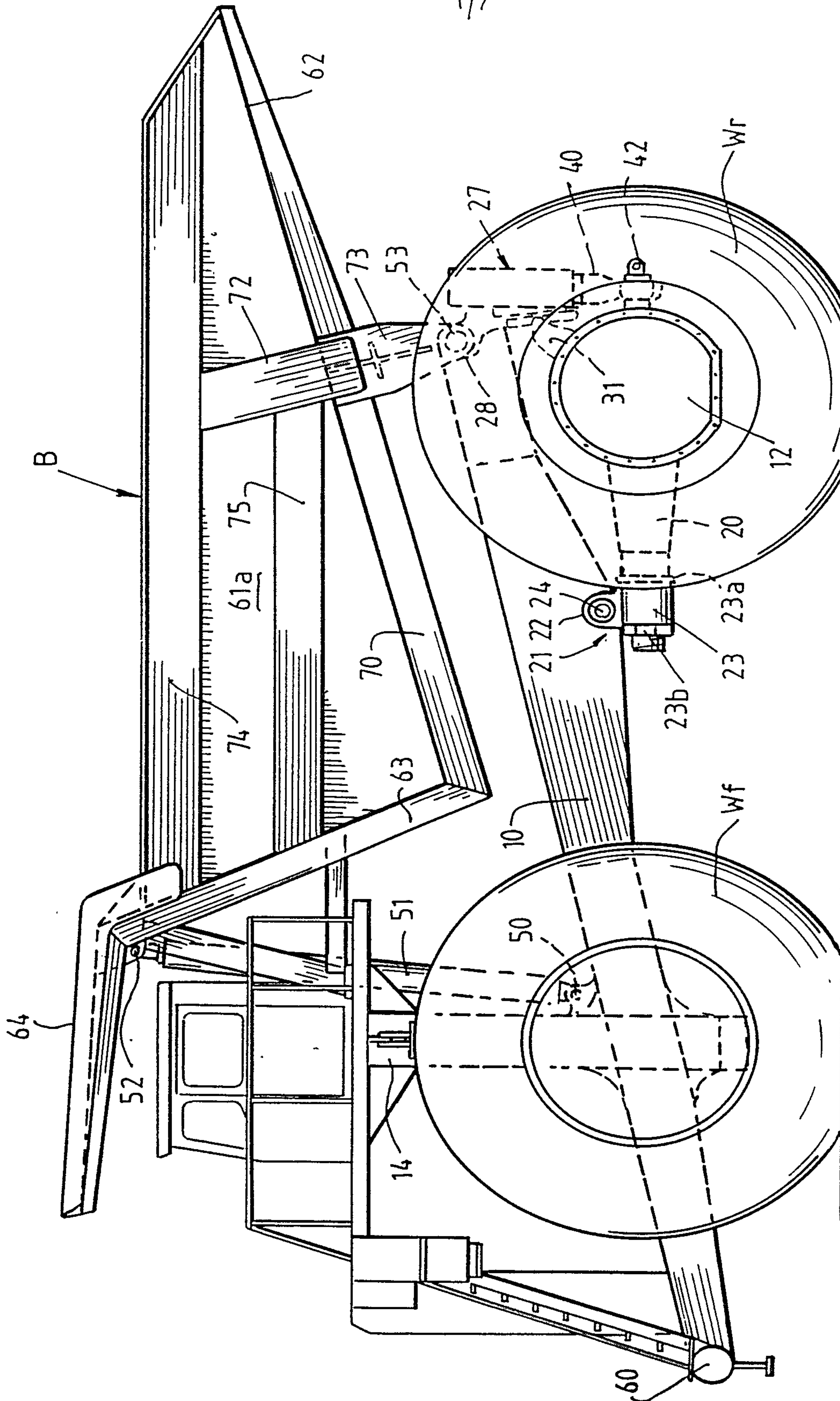
3. A vehicle according to claim 1 or 2, wherein the transverse strengthening beam is integrally formed with the transversely spaced rear supports.

- 17 -

4. A vehicle according to any one of claims 1, 2 or 3
wherein said floor slopes downwardly in a forward
longitudinal direction of said body, said side walls
sloping inwardly towards said floor and said floor
5 increasing in width towards a rear longitudinal direction
of said body.

2090698

1/7



III. 1.

SUBSTITUTE SHEET

2090698

2/7

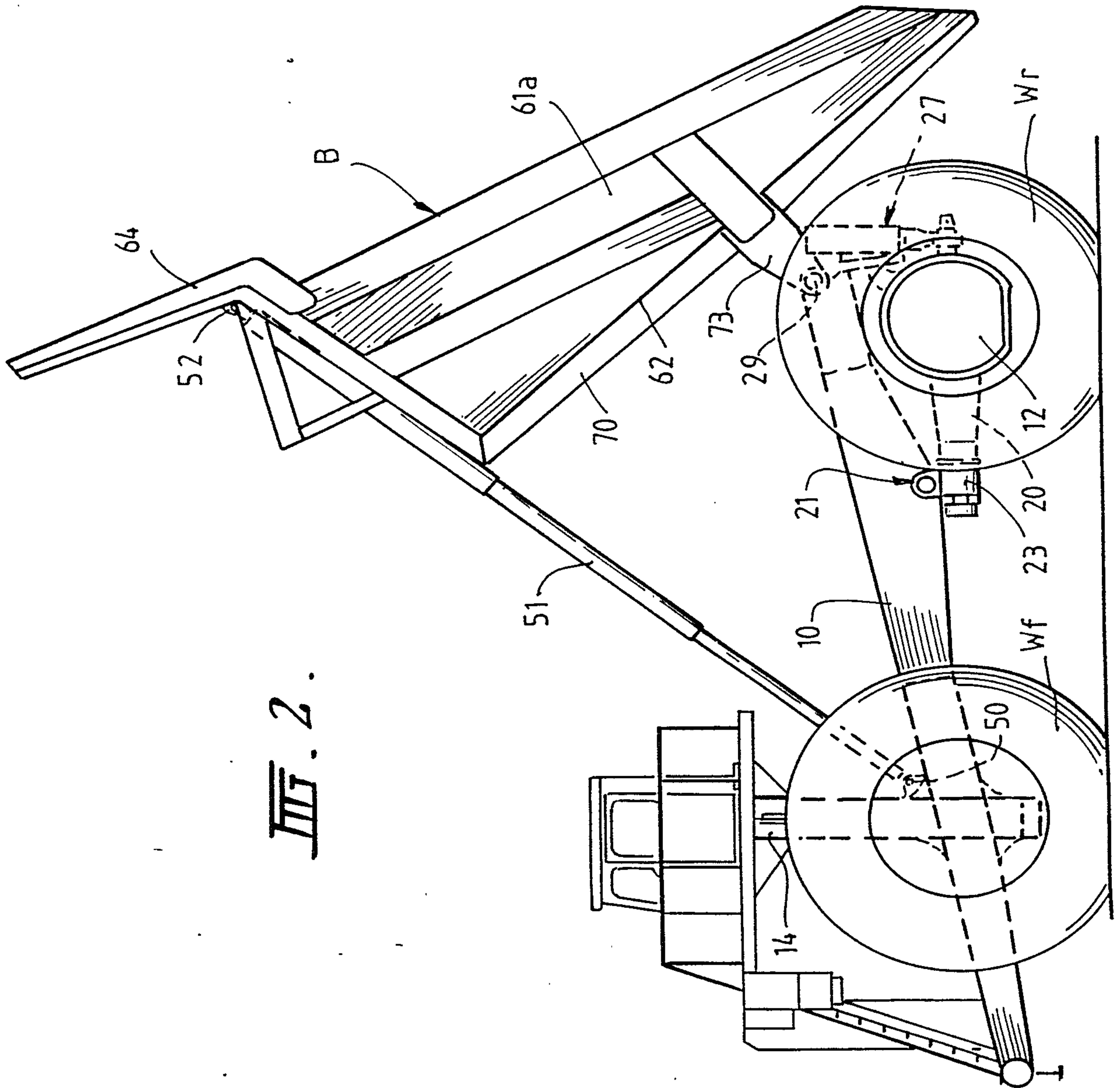


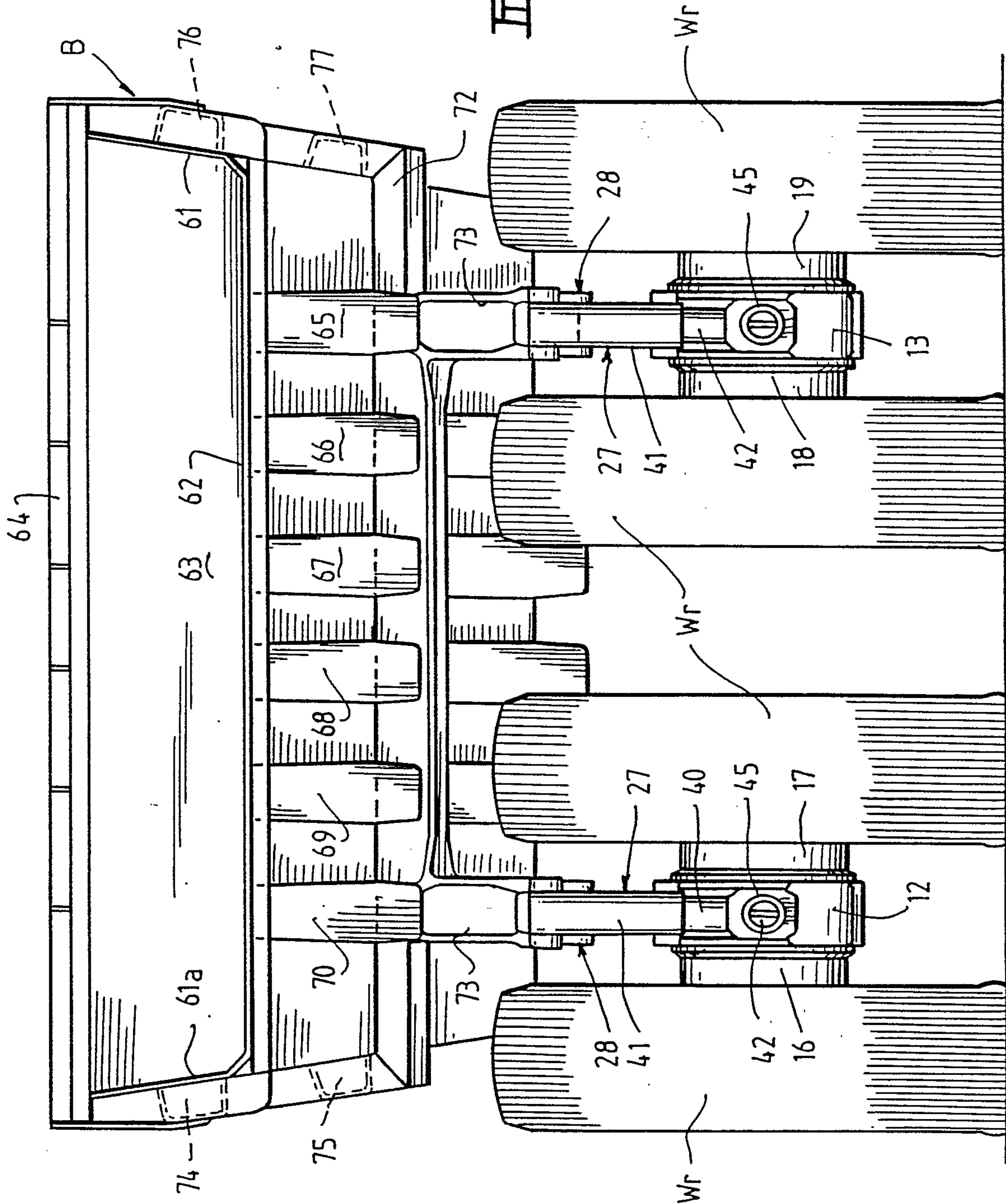
FIG. 2.

2090698

PCT/AU 91/00389
RECEIVED 10 FEB 1992

3/7

FIG. 3

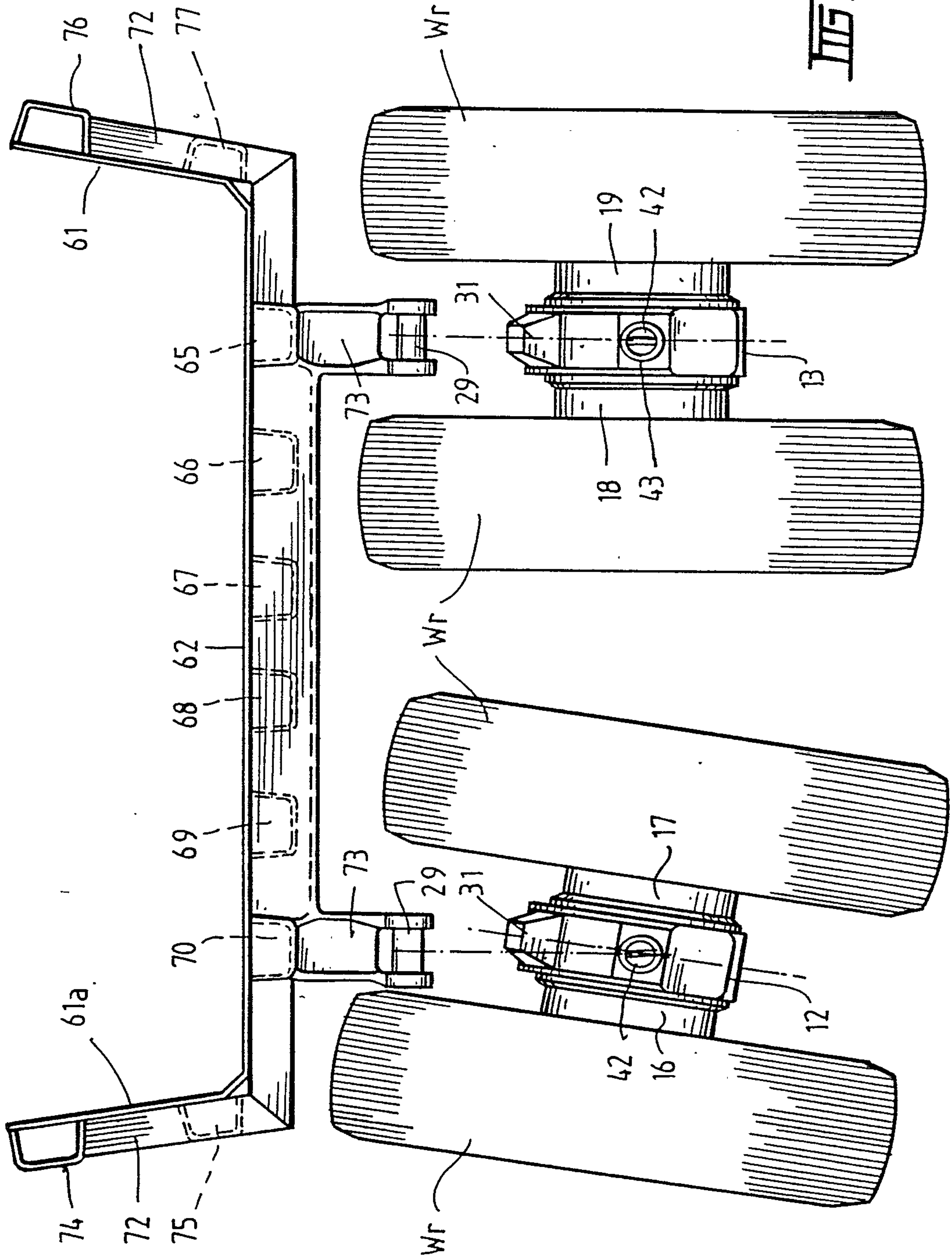


SUBSTITUTE SHEET

2090698

4/7

Fig. 4.



SUBSTITUTE SHEET

2090698

PCT/AU 91/00389
RECEIVED 10 FEB 1992

5/1

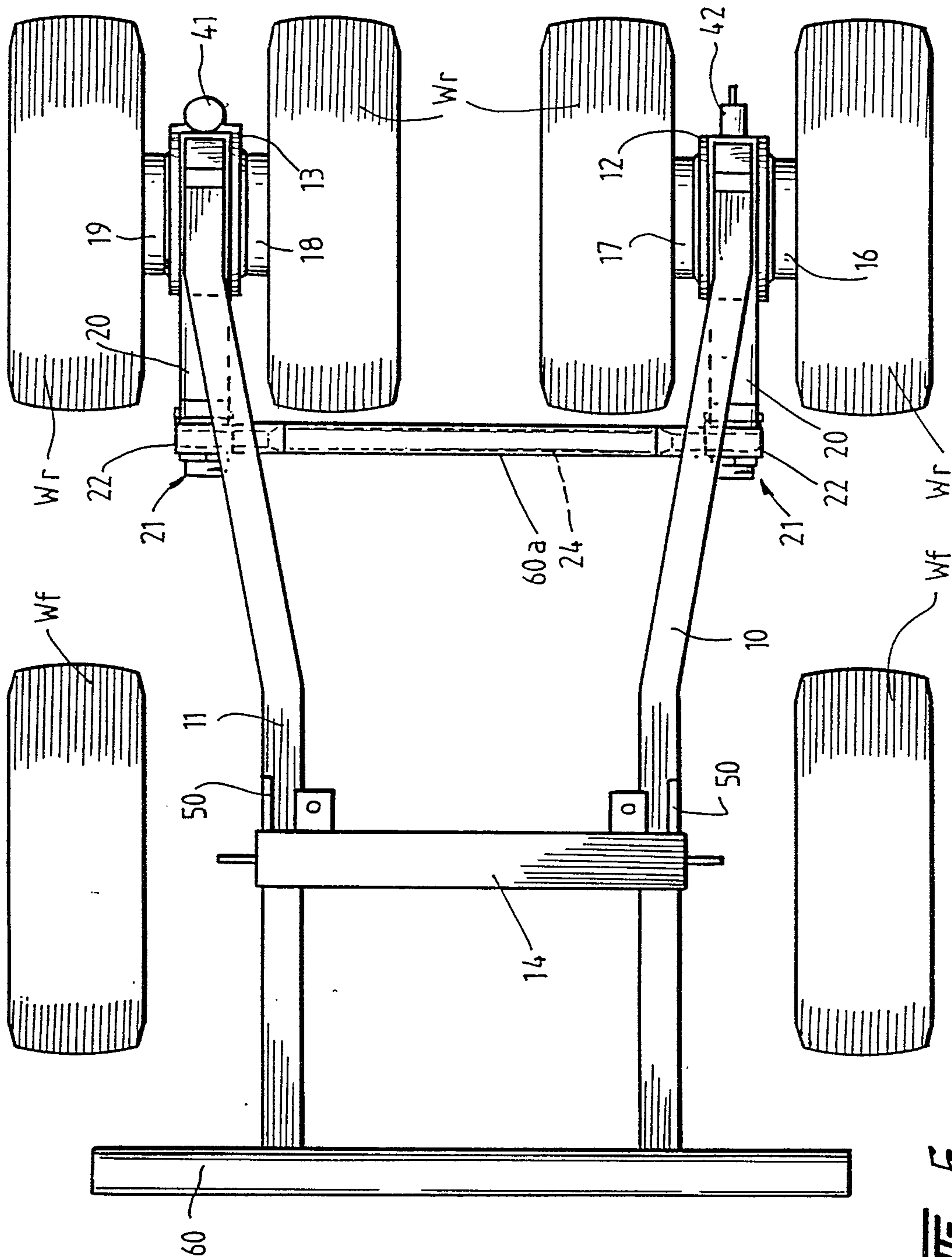


Fig. 5.

SUBSTITUTE SHEET

2090698

6/7

PCT/AU 91 / 00389
RECEIVED 10 FEB 1992

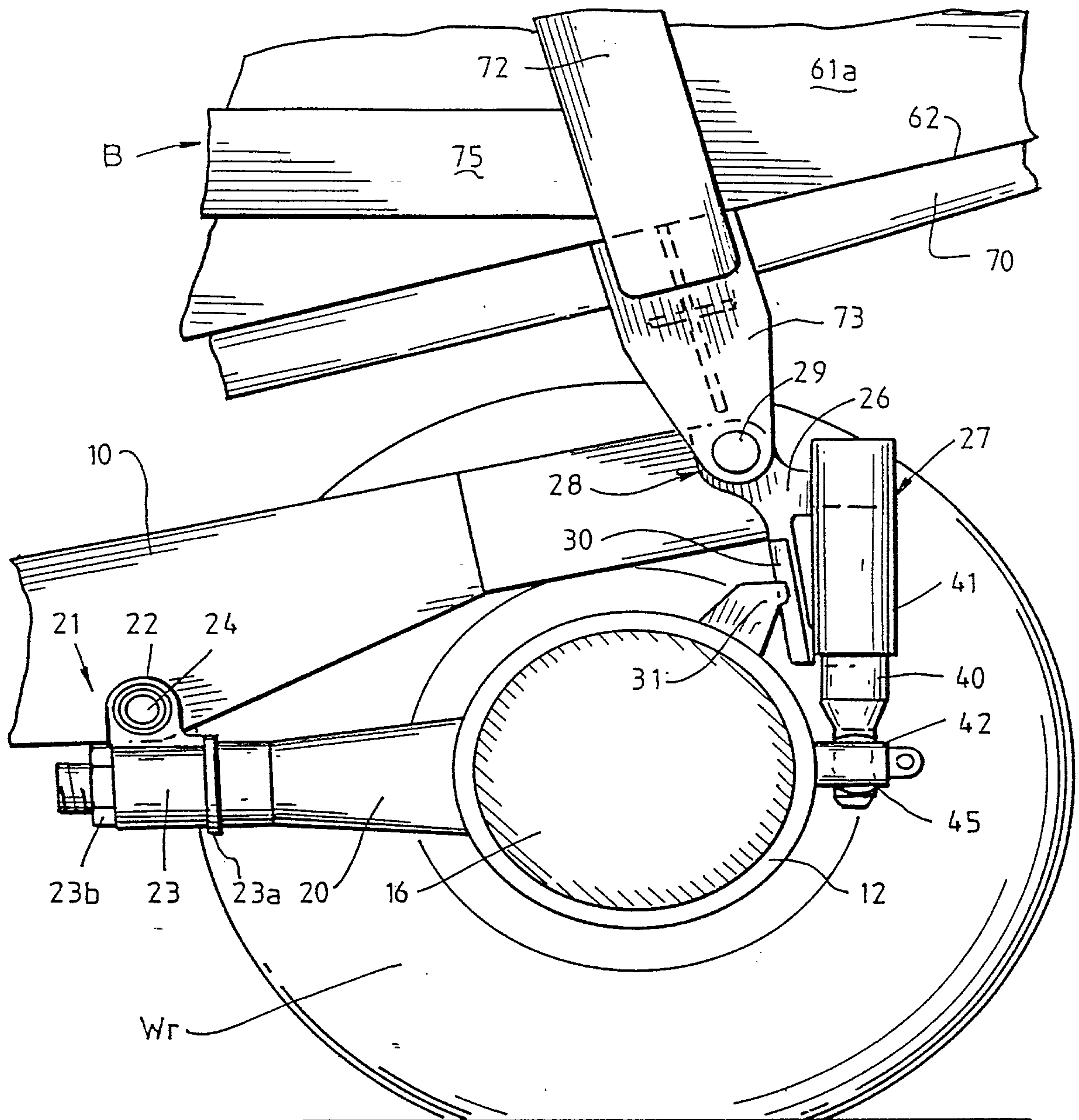


FIG. 6.

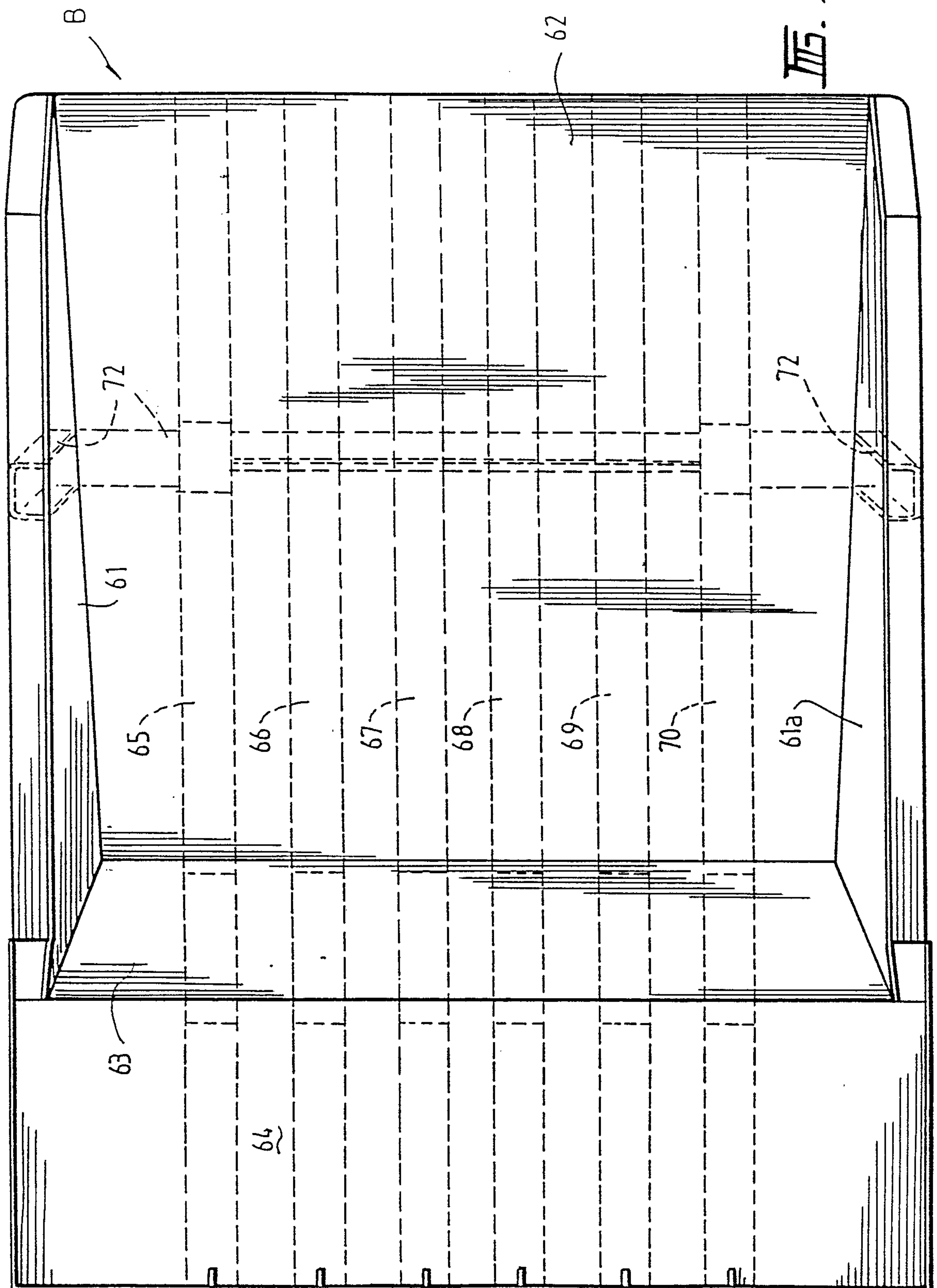
SUBSTITUTE SHEET

2090698

PCT/AU 91/00389
RECEIVED 10 FEB 1992

7/7

Fig. 7.



SUBSTITUTE SHEET

