

United States Patent

Murata et al.

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[45] Aug. 1, 1972

[54] SELF-DRIVEN CARRIAGE

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Jan. 24, 1969 Japan.....44/5863

[52] U.S. Cl.180/23, 180/42, 180/45,
180/89, 280/43.23, 280/91, 280/124 R,
180/79.2 R

[51] Int. Cl.B62d 7/04, B62d 61/10

[58] Field of Search ...180/23, 24, 22, 45; 280/43.23,
280/91

[56]

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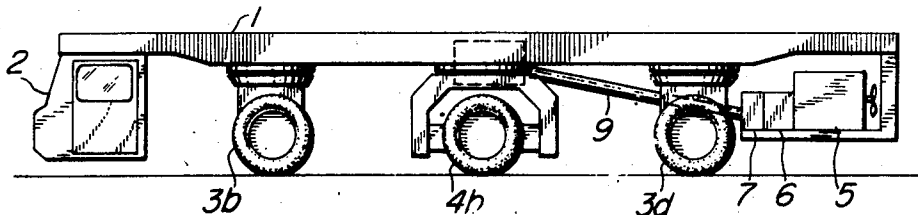
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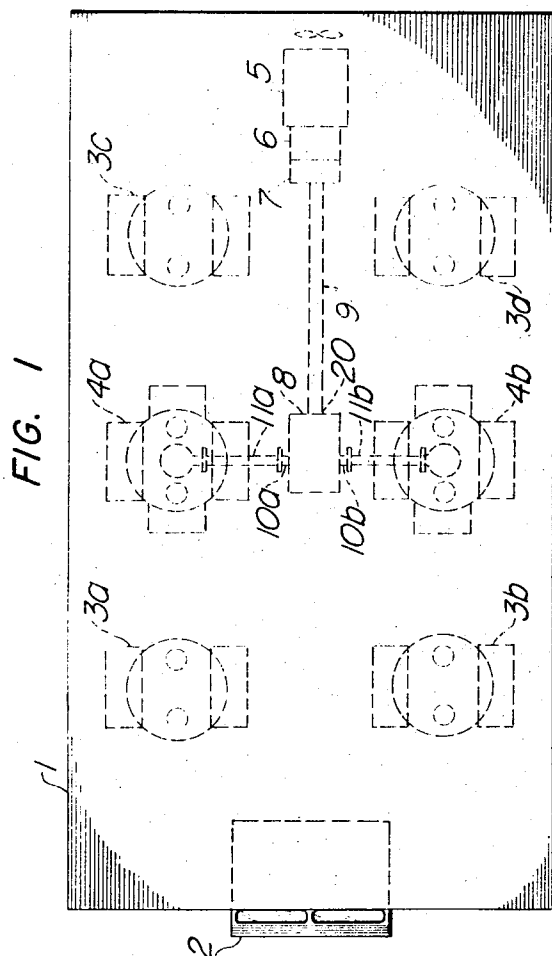
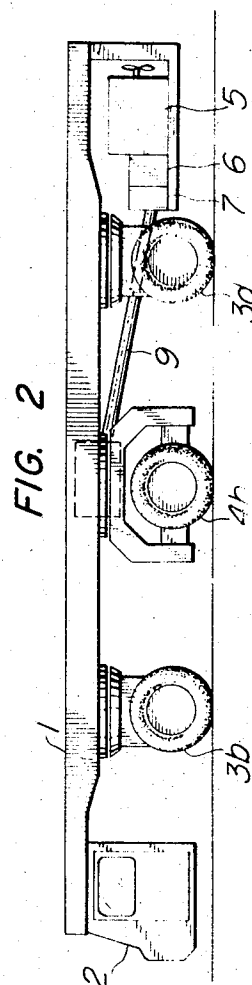
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ABSTRACT

Two pairs of driven wheel units and a pair of driving wheel units are rotatably mounted on the underside of a loading bed at the front, rear and the intermediate positions of the bed, each wheel unit including at least a pair of wheels mounted on an axle which is pivotally mounted to the loading bed and operatively rotated by a hydraulic mechanism. A travel mode designating mechanism is operatively associated with the hydraulic mechanism so as to set the respective wheel units in a desired direction individually providing for travelling of the carriage in longitudinal, transverse or gyratory movement and for steering of the individual wheel units during travelling of the carriage.

20 Claims, 26 Drawing Figures





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FIG. 3

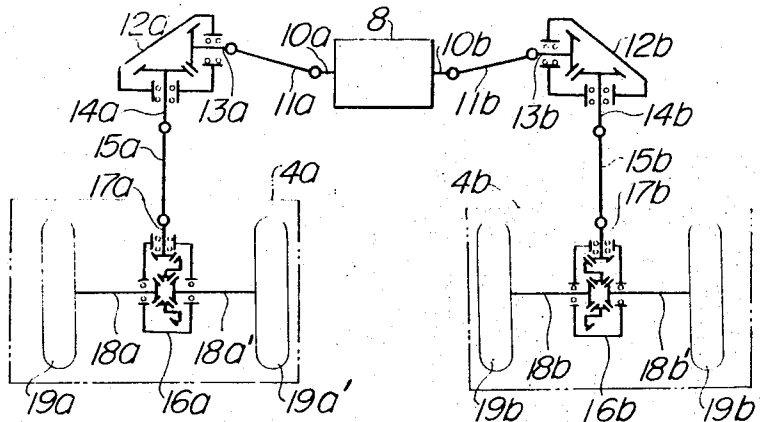


FIG. 4

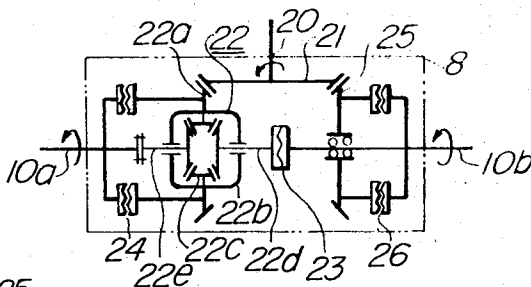
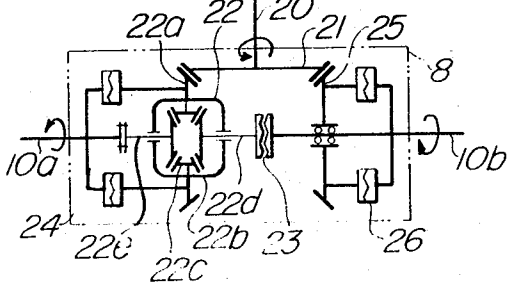


FIG. 5



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FIG. 6

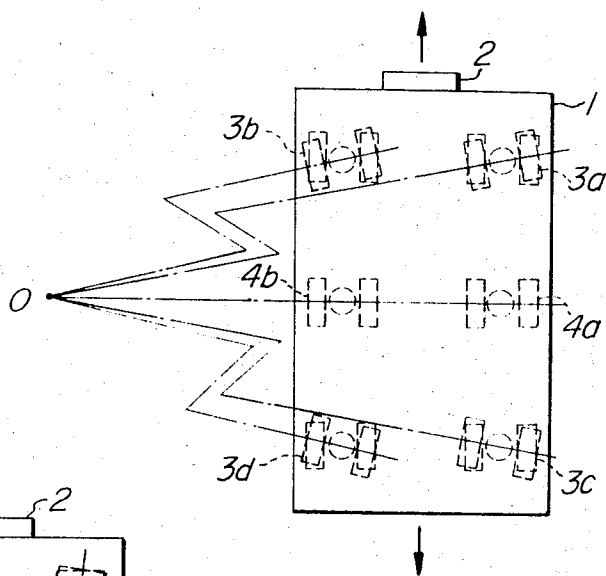


FIG. 7

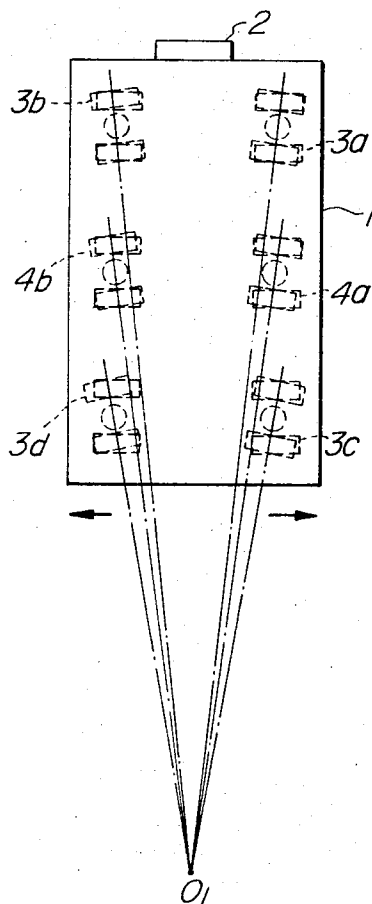
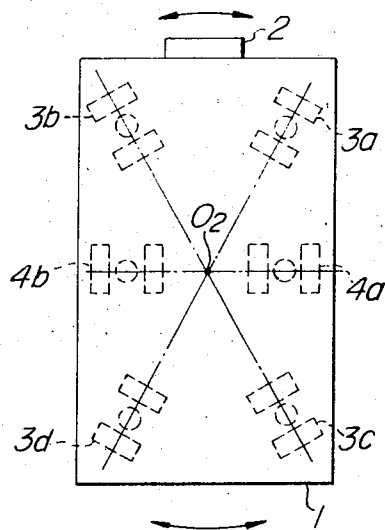


FIG. 8



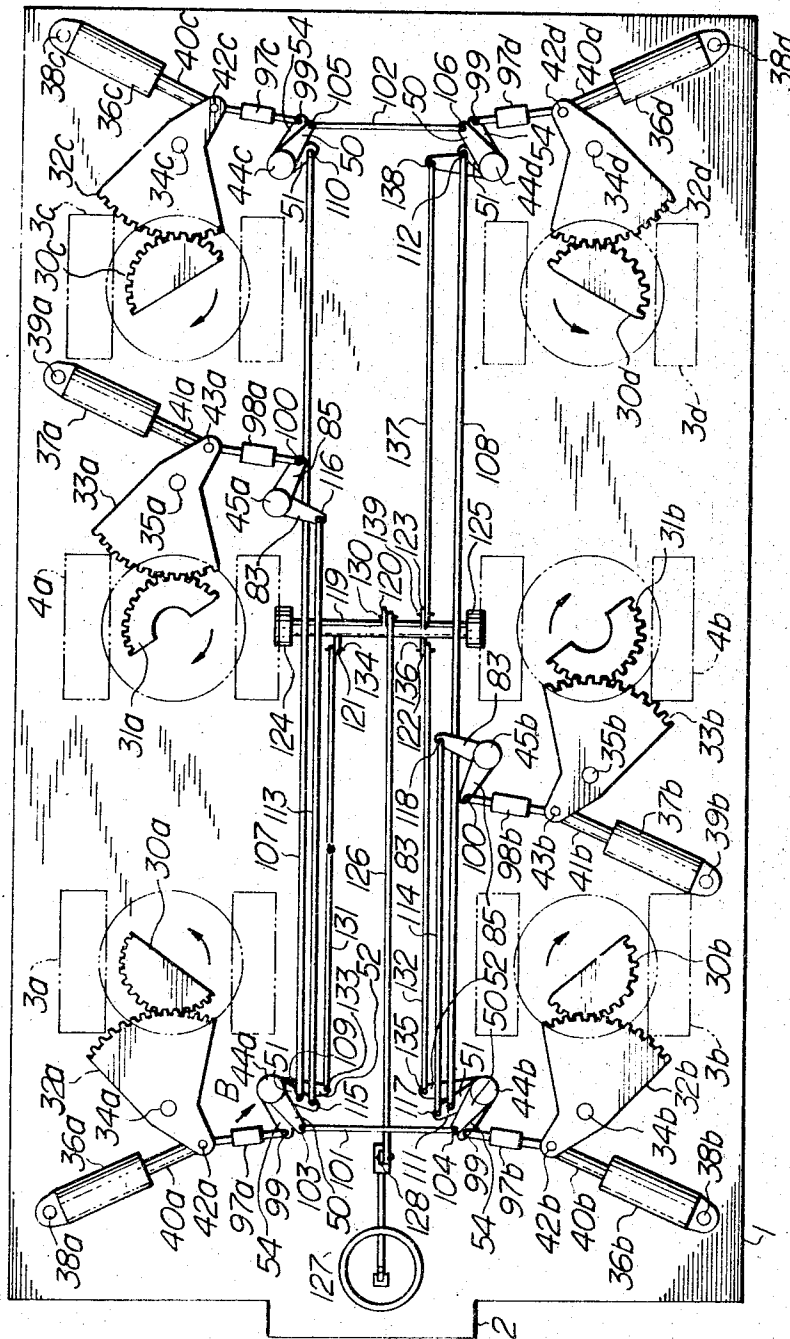
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FIG. 9



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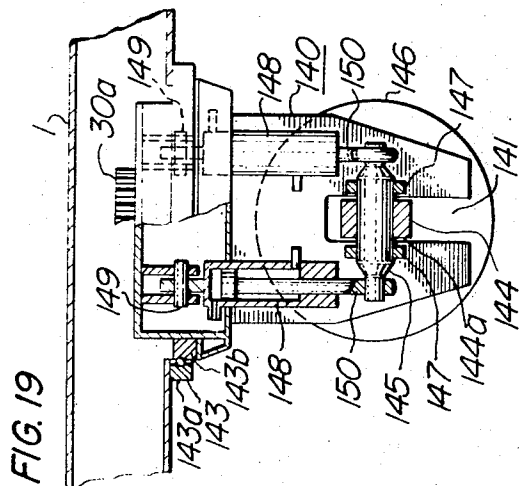


FIG. 19

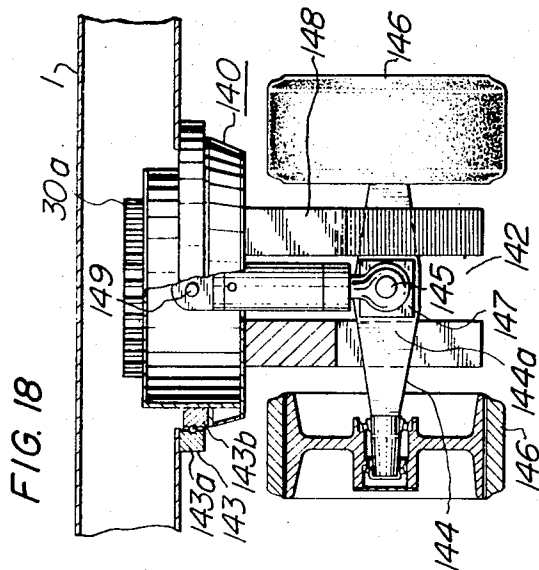


FIG. 18

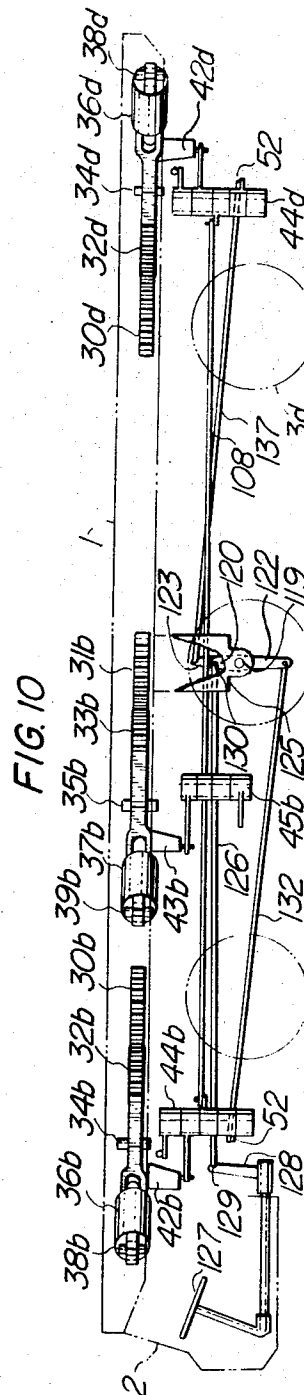


FIG. 10

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FIG. 11

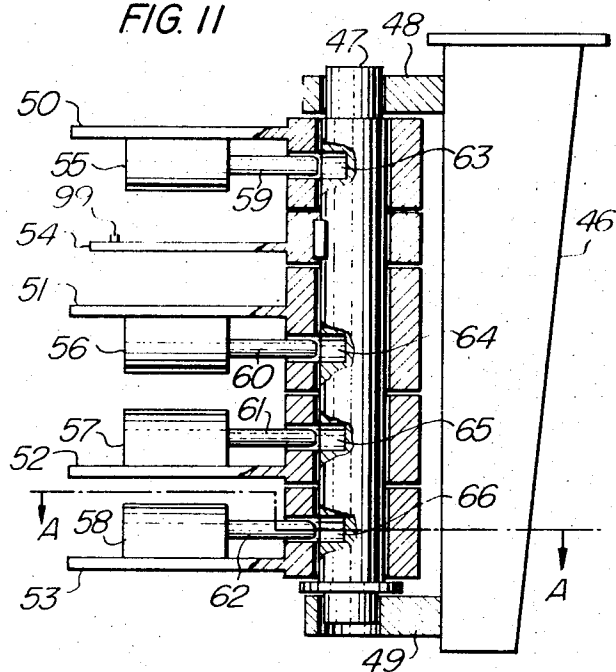
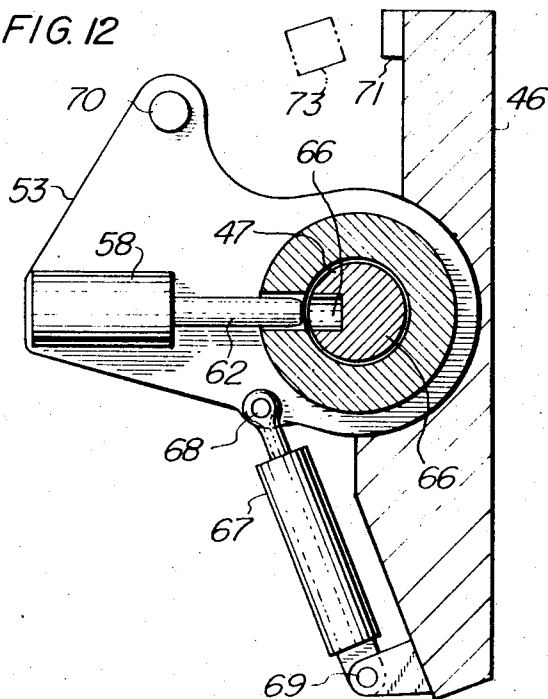


FIG. 12



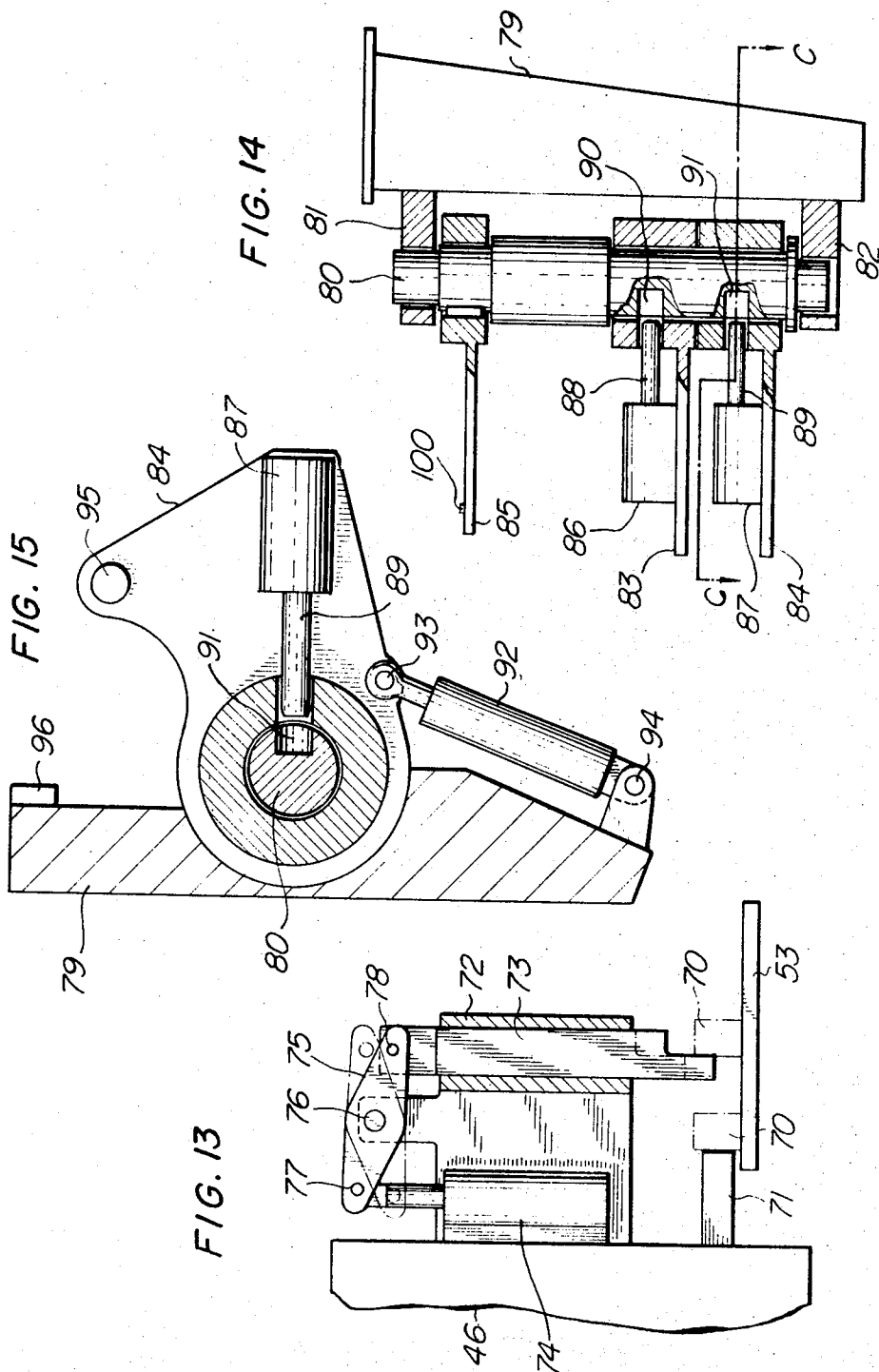
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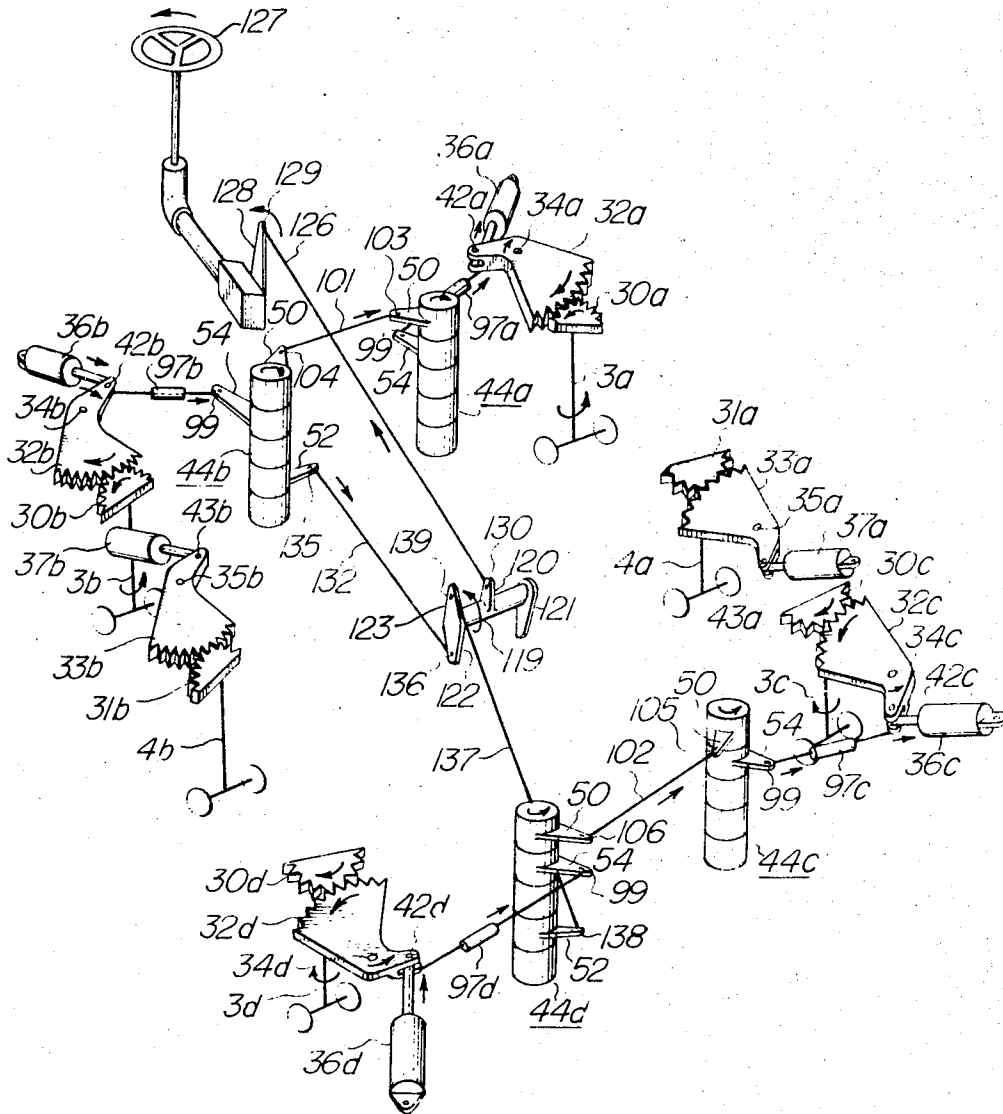
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FIG. 16



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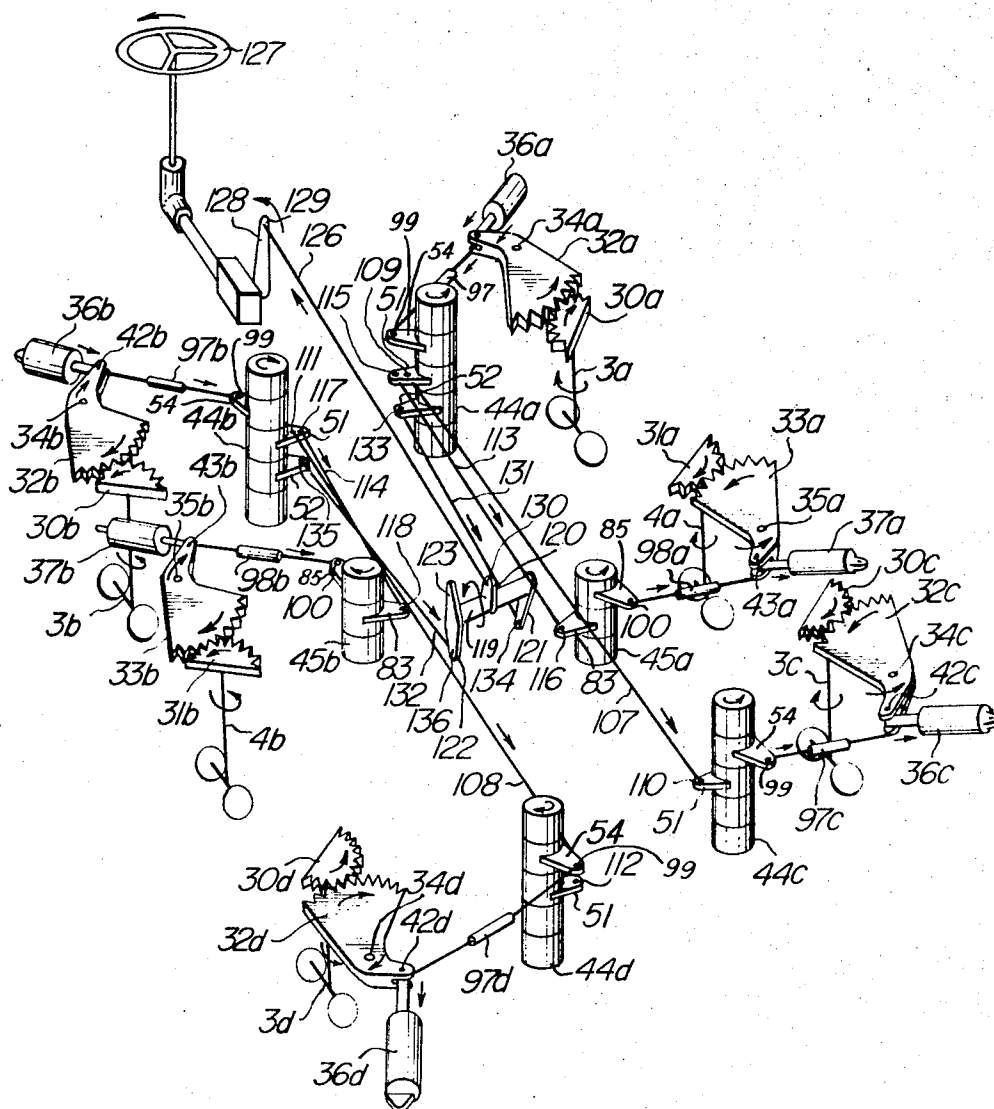
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FIG. 17



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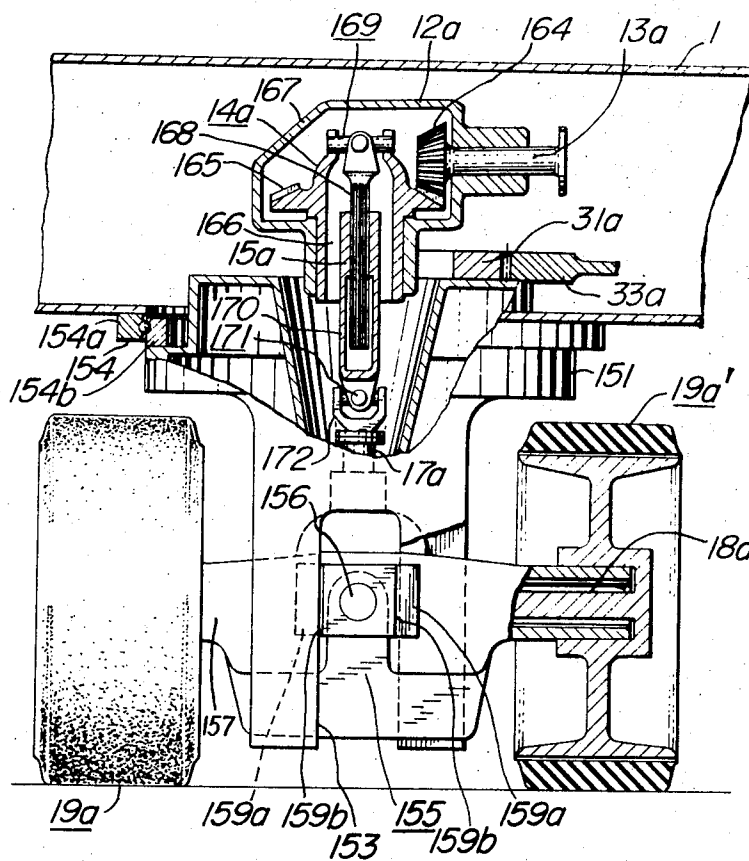
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FIG. 20



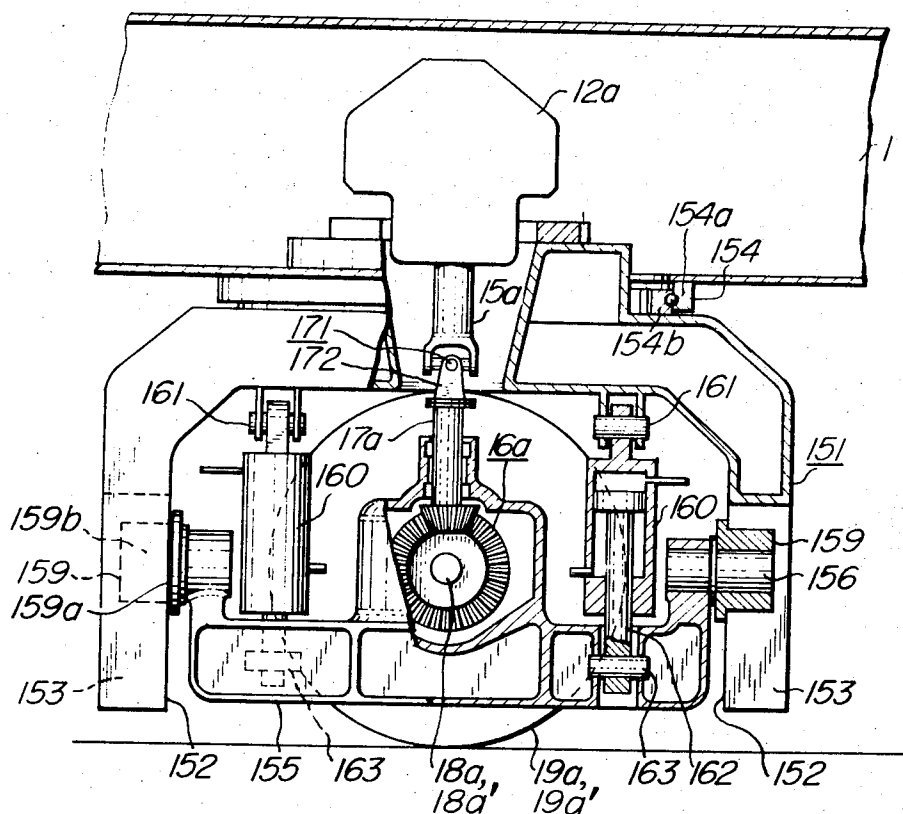
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FIG. 21



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FIG. 22

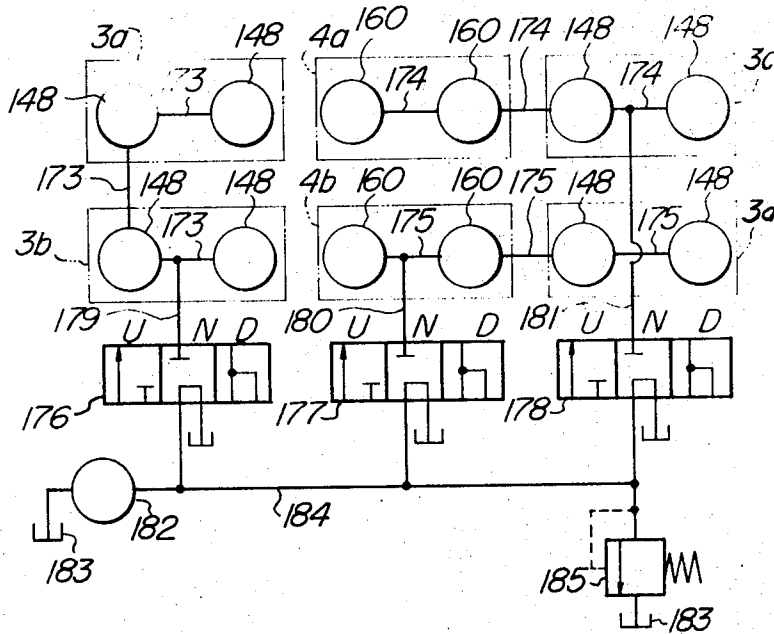
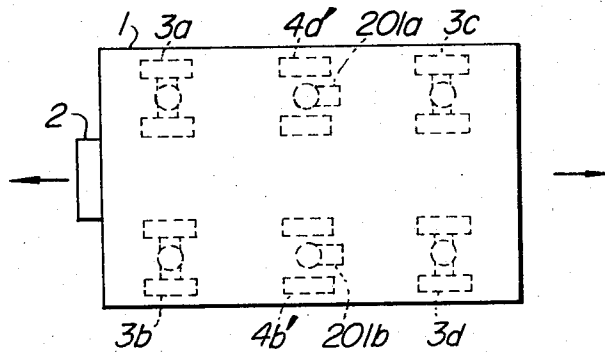


FIG. 23



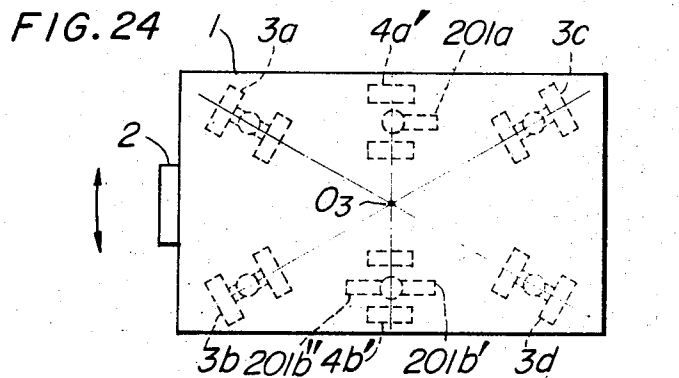
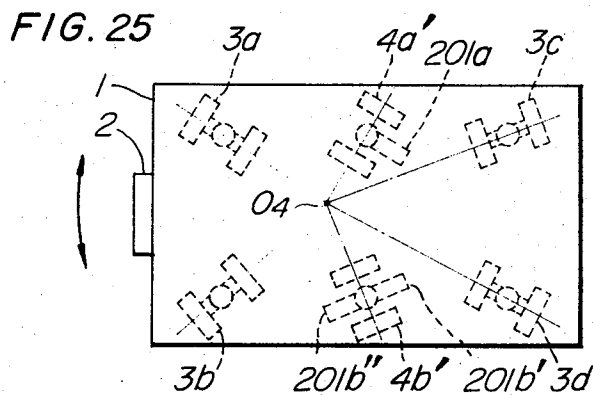
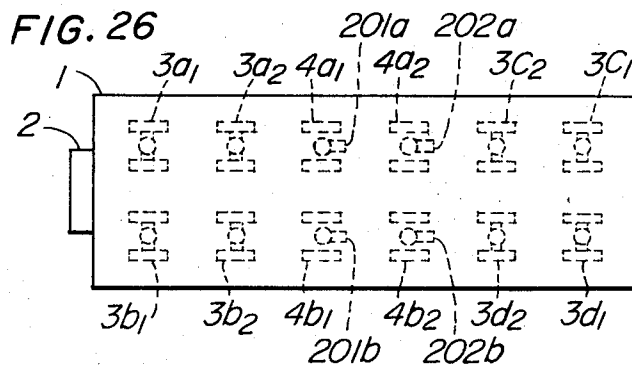
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SELF-DRIVEN CARRIAGE

The present invention relates to a self-driven carriage adapted for use in the transportation of articles of large size and heavy weight.

The vehicles which have heretofore been used at a dockyard or the like for the transportation of large size, heavy weight articles, such as ship blocks, are generally of the trolley or trailer type, so that there have been a number of problems, such as that the maneuvering of the vehicles in a narrow loading or unloading site is difficult, that the working efficiency is poor and that a crane or the like facility is required for loading and unloading of such heavy articles.

The major object of the present invention is to provide a self-driven carriage capable of moving in both the longitudinal and transverse directions as required by the condition of the path of transportation.

Another object of the present invention is to provide a self-driven carriage capable of gyration at the spot where it is located.

Still another object of the invention is to provide a self-driven carriage equipped with a jack mechanism for loading and unloading heavy articles.

These and other objects, features and advantages of the invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIGS. 1 to 22 inclusive show an embodiment of the self-driven carriage according to the present invention, in which:

FIG. 1 is a plan view of the self-driven carriage;

FIG. 2 is a side view of the self-driven carriage;

FIG. 3 is a plan view of a power transmitting mechanism;

FIGS. 4 and 5 are views for explaining the different operations of a gear mechanism employed in the present invention, respectively;

FIGS. 6 to 8 inclusive are views respectively showing the positions of driven wheel units and driving wheel units during travelling of the self-driven carriage, in which FIG. 6 is a view showing the positions of said wheels during travelling of the self-driven carriage in a longitudinal direction, FIG. 7 is a view showing the positions of the same during travelling of the self-driven carriage in a transverse direction, and FIG. 8 is a view showing the positions of the same during gyration of the carriage;

FIGS. 9 to 17 inclusive are views of a steering mechanism of the self-driven carriage respectively, in which FIG. 9 is a plan view of the steering mechanism, FIG. 10 is a side view of the same, FIG. 11 is a sectional view of travel mode designating means for the driven wheel units, FIG. 12 is a sectional view taken on the line A—A of FIG. 11, FIG. 13 is a sectional view of a stopper as viewed in the direction of arrow B in FIG. 9, by which the position of the driven wheel is set for gyration of the carriage, FIG. 14 is a sectional view of travel mode designating means for the driving wheel units, FIG. 15 is a sectional view taken on the line C—C of FIG. 14, FIG. 16 is an overall illustrative view of a steering mechanism for travelling in a longitudinal direction, and FIG. 17 is an overall illustrative view of a steering mechanism for travelling in a transverse direction;

FIG. 18 is a sectional front view of the driven wheel unit;

FIG. 19 is a sectional side view of the driven wheel unit;

FIG. 20 is a sectional front view of the driving wheel unit;

FIG. 21 is a sectional side view of the driving wheel unit;

FIG. 22 is a hydraulic circuit diagram of a hydraulic balancing mechanism and a hydraulic jack mechanism;

FIGS. 23 to 26 inclusive are another embodiment of the self-driven carriage according to the present invention, in which:

FIG. 23 is a plan view of the self-driven carriage;

FIGS. 24 and 25 are plan views respectively showing the positions of the driven wheel units and the driving wheel units during gyration of the carriage; and

FIG. 26 is a plan view showing a modification of the carriage shown in FIG. 23.

An embodiment of the present invention will be described with reference to FIGS. 1 to 22. Referring to FIGS. 1 to 3, reference numeral 1 designates a loading bed; 2 an operator's cabin fixedly secured to the underside of the front end of the loading bed 1; 3a, 3b a pair of driven wheel units pivotably mounted on the underside of the front portion of the loading bed 1, the pivotal positions of the respective wheel units 3a and 3b being located in transversely symmetrical relation with respect to the longitudinal axis of the carriage; 3c and 3d another pair of driven wheel units pivotably mounted on the underside of the rear portion of the loading bed 1 in transversely symmetrical relation; 4a, 4b a pair of driving wheel units pivotably mounted on the underside of the intermediate portion of the loading bed 1 in transversely symmetrical relation; 5 an engine fixedly mounted on the underside of the rear end of the loading bed 1; 6 a transmission; 7 a reversing mechanism; 8 a gear mechanism, fixedly mounted on the underside of the loading bed 1 between the driving wheel units 4a and 4b; and 9 a propeller shaft through which the drive force of the engine 5 is transmitted to the gear mechanism 8. The output shafts 10a, 10b of the differential gear mechanism 8 are operatively connected to input shafts 13a, 13b of bevel gear mechanisms 12a, 12b through propeller shafts 11a, 11b respectively, which bevel gear mechanisms are fixedly mounted on the underside of the loading bed 1. Output shafts 14a, 14b of the bevel gear mechanisms 12a, 12b are operatively connected to input shafts 17a, 17b of differential gear mechanisms 16a, 16b through propeller shafts 15a, 15b respectively, which differential gear mechanisms are provided on the respective driving wheel units 4a, 4b, and output shafts or axles 18a, 18a' and 18b, 18b' of the differential gear mechanisms 16a, 16b are operatively connected to driving wheels 19a, 19a' and 19b, 19b' respectively to transmit a driving force.

Details of the gear mechanism 8 will be described with reference to FIGS. 4 and 5. In FIGS. 4 and 5, reference numeral 20 designates an input shaft which connects the propeller shaft 9 to reduction bevel gear 21. A differential gear mechanism 22 comprises a casing 22b having a driven reduction bevel gear 22a intermeshing with the reduction bevel gear 21, a plurality of differential bevel gears 22c and differential shafts 22d, 22e. The differential shaft 22d is connected to the output shaft 10b through a clutch 23, whereas the differential shaft 22e is directly connected with the output shaft 10a. Reference numeral 24 designates a clutch by which the driven reduction bevel gear 22a and the out-

put shaft 10a are engaged with or disengaged from each other, 25 a reversing bevel gear intermeshing with the reduction bevel gear 21 and rotatably mounted on the output shaft 10b, and 26 a clutch by which the reversing bevel gear 25 and the output shaft 10b are engaged with or disengaged from each other.

The gear mechanism 8 acts as a differential means when the state shown in FIG. 4 upon releasing the engagement between the driven reduction bevel gear 22a and the output shaft 10a by opening or disengaging the clutch 24 and simultaneously releasing the engagement between the reversing bevel gear 25 and the output shaft 10b by opening or disengaging the clutch 26, and acts as a reversing means when shifted from the state shown in FIG. 4 to the state shown in FIG. 5 upon releasing the engagement between the differential shaft 22d and the output shaft 10b by operating the clutch 23 and simultaneously engaging the reversing bevel gear 25 to the shaft 10a and 10b by closing the clutches 24 and 26, respectively.

Now, the different travel modes of the self-driven carriage of the invention constructed as described above will be explained with reference to FIGS. 6 to 8. FIG. 6 shows the state of the carriage for travelling in a longitudinal direction wherein the all wheels 3a, 3b, 3c, 3d, 4a, and 4b are set in their first home positions directing their axes perpendicular to the longitudinal direction of the carriage. In this longitudinal travelling mode, the gear mechanism 8 with is placed in the position shown in FIG. 4 and the driven wheel units 3a, 3b, 3c, 3d are steered by steering a handle 127 in such a manner that the extensions of the axes of the respective driven wheels may intersect at the center 0 of rotation (as will be described in detail later), whereby the carriage can travel smoothly either forwardly or backwardly according to the switch of the reversing mechanism 7 along a straight or a curved path in response to steering the driven wheels from their first home position. FIG. 7 shows the state of the carriage for travelling in a transverse direction. In this transverse travelling mode, the driven wheel units 3a, 3b, 3c, 3d and the driving wheel units 4a, 4b are rotated 90° into their second home positions shown in FIG. 8 from the first home positions shown in FIG. 7 and the differential gear mechanism 8 is still placed in the position shown in FIG. 4 and thereafter said driven wheel units 3a, 3b, 3c, 3d and the driving wheel units 4a, 4b are steered so that the extensions of the axes of the respective wheels may intersect at the center 0₁ of rotation (as will be described in detail later), whereby the carriage can travel smoothly either rightwardly or leftwardly according to the switching of the reversing mechanism 7 along a straight or a curved path. On the other hand, FIG. 8 shows the state of the carriage for gyratory movement. In this gyratory mode, the driving wheel units 4a, 4b are set in a longitudinal direction of the loading bed 1, same as in the case of travelling in a forward or backward direction while the driven wheel units 3a, 3b, 3c, 3d are set in their third home positions so that the extensions of axes of the respective wheel units 3a—3d and 4a—4b concentrate at central point 0₂ (the center of gyration) with each other, and further the gear mechanism 8 is placed in the position shown in FIG. 5, whereby the self-driven carriage can gyrate smoothly around the center of gyration 0₂ either

clockwise or counterclockwise according to the switching of the reversing mechanism 7.

The construction of the steering mechanism of the self-driven carriage according to the invention will be described hereunder with reference to FIG. 9 to 7. Reference numerals 30a, 30b, 30c, 30d and 31a, 31b designate sector gears respectively fixed on top of the driven wheel units 3a, 3b, 3c, 3d and driving wheel units 4a, 4b, 32a, 32b, 32c, 32d and 33a, 33b sector gears intermeshing with said sector gears 30a, 30b, 30c, 30d and 31a, 31b and pivotally secured to the loading bed 1 by means of pins 34a, 34b, 34c, 34d and 35a, 35b respectively; and 36a, 36b, 36c, 36d and 37a, 37b hydraulic cylinders for rotating the respective sector gears 32a, 32b, 32c, 32d and 33a, 33b. These hydraulic cylinders are pivotally mounted on the loading bed 1 at one end thereof by pins 38a, 38b, 38c, 38d and 39a, 39b respectively and have piston rods 40a, 40b, 40c, 40d and 41a, 41b the outer ends of which are connected with the sector gears 32a, 32b, 32c, 32d and 33a, 33b by pins 42a—42d and 43a—43b respectively.

The arrangement is made such that then the hydraulic cylinders 36a, 36b, 36c, 36d and 37a, 37b are actuated, the driven wheel units 3a, 3b, 3c, 3d and the driving wheel units 4a, 4b can be rotated through an angle of about 180° through the sector gears 30a, 30b, 30c, 30d and 31a, 31b and the sector gears 32a, 32b, 32c, 32d and 33a, 33b respectively which are in meshing engagement with each other. This mesh engagement should be so designed that the angle of rotation of the intermeshing sector gears includes a shifting angle of 90° for the shifting of the carriage from the longitudinal travelling direction to the transverse travelling direction or vice versa and steering tolerance angles of about 45° in each of clockwise and counterclockwise directions for steering of the carriage during travelling in a longitudinal and a transverse directions. Reference numerals 44a, 44b, 44c, 44d and 45a, 45b designate travel mode designating mechanisms for the driven wheel units and the driving wheel units respectively which are mounted on the underside of the loading bed 1 for cooperation with the respective hydraulic cylinders 36a, 36b, 36c, 36d and 37a, 37b, and details of these travel mode designating mechanisms will be explained with reference to FIGS. 11 to 15. FIGS. 11 to 13 show the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d, in which reference numeral 46 designates a bracket fixed to the underside of the loading bed 1, 47 a shaft having the upper and lower ends thereof supported by the bracket 46 through bearings 48, 49 respectively, 50 a longitudinal travel mode designating lever, 51 a transverse travel mode designating lever, 52 a steering lever, 53 a gyratory travel mode designating lever, all of said levers being pivotally mounted on the shaft 47. Reference numeral 54 designates a valve control lever fixedly mounted on the shaft 47; 55, 56, 57, 58 hydraulic cylinders fixed on the longitudinal travel mode designating lever 50, the transverse travel mode designating lever 51, the steering lever 52 and the gyratory travel mode designating lever 53 respectively; 59, 60, 61, 62 piston rods of the respective hydraulic cylinders 55, 56, 57, 58; and 63, 64, 65, 66 holes bored in the shaft 47 corresponding to the respective piston rods 59, 60, 61, 62. The arrangement is such that when the hydraulic cylin-

ders 55, 56, 57, 58 are actuated, the piston rods 59, 60, 61, 62 of the respective hydraulic cylinders are received in the holes 63, 64, 65, 66 respectively. However, only the travel mode designating mechanism 44c for the driven wheel unit 30c is not provided with the steering lever 52, the hydraulic cylinder 57 and the hole 65. A hydraulic cylinder 67 has one end pivotally connected to the gyration mode designating lever 53 by a pin 68 and the other end supported on the bracket 46 through a pin 69. A pin 70 is fixed on the gyration mode designating lever 53 and a stopper 71 is fixed on the bracket 46 for engagement with said pin 70. When the hydraulic cylinder 67 is actuated, the gyration mode designating lever 53 is pivotally moved around the shaft 47 until the pin 70 engages with the stopper 71, whereby said gyration mode designating lever 53 is set in a transverse travelling position of the carriage. A stopper guide 72 is fixed on the bracket 46 at an appropriate position in order not to interfere the rotational movements of levers 50, 51, 52, 53 and 54 and a stopper 73 is in this case vertically movably mounted in said stopper guide 72. A hydraulic cylinder 74 is fixed on the bracket 46 and a lever 75 is pivotally connected to the stopper guide 72 by a pin 76. One end of the lever 75 is connected to the piston rod of the hydraulic cylinder 74 and the other end thereof is connected to the stopper 73 by a pin 78, so that said lever 75 is teetered incident to the operation of the hydraulic cylinder 74. As shown in FIG. 13, the stopper 73 in its lowered position acts as a stopper for the pin 70 of the gyration mode designating lever 53 to set said gyration mode designating lever in a gyratory travelling position of the carriage.

FIGS. 14 and 15 show the travel mode designating mechanism for the driving wheel units, which comprises: a bracket 79 fixed on the underside of the loading bed 1; a shaft 80 having the upper and lower ends thereof supported by the bracket 79 through bearings 81, 82 respectively; a transverse travel mode designating lever 83; a gyration mode designating lever 84 which are pivotally mounted on the shaft 80; a valve control lever 85 fixedly mounted on the shaft 80; hydraulic cylinders 86, 87 fixed respectively on the transverse travel mode designating lever 83 and the gyration mode designating lever 84 and having piston rods 88, 89 respectively which piston rods are received in corresponding holes 90, 91 formed in the shaft 80 upon actuation of said hydraulic cylinders 86, 87; a hydraulic cylinder 92 having one end pivotally connected to the gyration mode designating lever 84 by a pin 93 and the other end supported on the bracket 79 through a pin 94; a pin 95 fixed on the gyration mode designating lever 84 and a stopper 96 fixed on the bracket 79 for engagement with the pin 95. When the hydraulic cylinder 92 is actuated, the gyration mode designating lever 84 is pivotally moved about the shaft 80 and the pin 95 is brought into abutment against the stopper 96, whereby said gyration mode designating lever 84 is set in a transverse travelling position of the carriage.

Control valves 97a, 97b, 97c, 97d and 98a, 98b each have one end connected to pins 42a, 42b, 42c, 42d and 43a, 43b and the other end connected to the valve control levers 54 and 85 through pins 99 and 100 respectively, and are operated by the pivotal movement of

said valve control levers 54 and 85, to operate the hydraulic cylinders 36a, 36b, 36c, 36d and 37a, 37b respectively. The longitudinal travel mode designating levers 50 of two pairs of the driven wheel travel mode designating mechanisms 44a, 44b and 44c, 44d are operatively connected with each other by tie rods 101 and 102 respectively by means of pins 103, 104 and 105, 106. Likewise, the transverse travel mode designating levers 51 of two pairs of the driven wheel travel mode designating mechanisms 44a, 44c and 44b, 44d are operatively connected with each other by tie rods 107 and 108 respectively by means of pins 109, 110 and 111, 112. The transverse travel mode designating levers 51 of the driven wheel travel mode designating mechanisms 44a and 44b, and the transverse travel mode designating levers 83 of the driving wheel travel mode designating mechanisms 45a, 45b, are operatively connected with each other by tie rods 113 and 114 respectively by means of pins 115, 116 and 117, 118. Levers 120, 121, 122, 123 are fixedly mounted on an intermediate shaft 119 which is rotatably supported by brackets 124, 125 fixed on the underside of the central portion of the loading bed 1. The lever 120 is connected with a lever 128 by a tie rod 126 by means of pins 129, 130. The lever 128 is moved by a steering handle 127. The levers 121 and 122 are connected with the steering levers 52 of the driven wheel travel mode designating mechanisms 44a and 44b by tie rods 131 and 132 respectively by means of pins 133, 134 and 135, 136. The lever 123 is connected with the steering lever 52 of the driven wheel travel mode designating mechanism 44d by a tie rod 137 by means of pins 138 and 139.

Now, the operation of the steering mechanism will be explained hereunder. First of all the steering operation in the longitudinal travelling of the carriage will be explained in referring to mainly FIG. 16. In the longitudinal travel mode, all the wheels should have been directed in their first home positions shown in FIG. 6. Thereafter the hydraulic cylinders 55 of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d should be actuated to engage the piston rods 59 of said respective hydraulic cylinders in the holes 63, in the state shown in FIG. 6, thus the longitudinal travel mode designating levers 50 of the respective driven wheel travel mode designating mechanisms are engaged with the shafts 47 respectively. At the same time, the hydraulic cylinders 57 of the driven wheel travel mode designating mechanisms 44b, 44d should only be actuated to engage the piston rods 61 of the respective hydraulic cylinders in the holes 65 and thereby to engage the steering levers 52 of the mechanisms 44b and 44d with the shafts 47. Consequently, once the steering handle 127 is operated, for example, turned counterclockwise to turn the carriage to the left as designated by an arrow in FIG. 16, whereupon the rotation of the steering handle 127 is transmitted to the intermediate shaft 119 through the lever 128, the tie rod 126 and the lever 120, the steering levers 52 of the driven wheel travel mode designating mechanisms 44b and 44d are rotated through the levers 122 and 123, and the tie rods 132 and 137 respectively, so that the shafts 47 of the driven wheel travel mode designating mechanisms 44b, 44d are thus rotated. The rotations of the shaft 47 of the

mechanisms 44b and 44d, cause on one hand rotations of the levers 54 of the mechanisms 44b and 44d, so that the control valves 97b and 97d are actuated. This causes actuations of the hydraulic cylinders 36b and 36d. The sector gears 32b and 32d are thus rotated around the pins 34b and 34d by the cylinders 36b and 36d, and therefore the driven wheel units 3b and 3d are steered through counterclockwise the sector gears 30b and 30d in meshing engagement with said sector gears 32b and 32d respectively. On the other hand, the rotation of the shafts 47 of the driven wheel travel mode designating mechanisms 44b and 44d is transmitted to the longitudinal travel mode designating levers 50 of the driven wheel travel mode designating mechanisms 44a and 44c through the longitudinal travel mode designating levers 50 of the mechanisms 44b and 44d, and the tie rods 101 and 102, so that the driven wheel units 3a and 3c are also steered counterclockwise, by the same operation as described above, via the shafts 47, the valve control levers 54, the control valves 97a and 97c, the hydraulic cylinders 36a and 36c, and the sector gears 32a, 30a and 32c, 30c respectively.

The above-described steering mechanism is constructed such that the imaginary extensions of the axes of the wheels of the respective driven wheel units 3a, 3b, 3c, 3d intersect at the point 0 on the imaginary extensions of the axes of the wheels of the respective driving wheel units 4a, 4b during the steering operation as shown in FIG. 5.

Next, the steering operation as shown in FIG. 5 in the transverse travelling of the carriage will be explained in referring to mainly FIG. 17. In this case, all the wheels should have been directed in their second home positions as shown in FIG. 7 and the hydraulic cylinders 56 and 86 of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d and the driving wheel travel mode designating mechanisms 45a, 45b should be actuated to engage the piston rods 60 and 88 of the respective hydraulic cylinders in the holes 64 and 90 and thereby to engage the transverse travel mode designating levers 51 and 83 with the shafts 47 and 80 respectively. At the same time, the hydraulic cylinders 57 of the driven wheel travel mode designating mechanisms 44a, 44b should be actuated to engage the piston rods 61 of the respective hydraulic cylinders in the holes 65 and thereby to engage the steering levers 52 with the shafts 47. When the steering handle 127 is rotated counterclockwise to turn the carriage to the left as shown by an arrow, the rotation of said steering handle 127 is transmitted to the intermediate shaft 119 through the lever 128, the tie rod 126 and the lever 120, and as a result the shafts 47 are rotated via the levers 121 and 122, the tie rods 131 and 132 and the steering levers 52 of the driven wheel travel mode designating mechanisms 44a and 44b respectively, so that the control valves 97a and 97b are actuated via the respective valve control levers 54, thereby actuating the hydraulic cylinders 36a and 36b associated therewith. The sector gears 32a and 32b are rotated around the pins 34a and 34b and thus the driven wheel units 3a and 3b are steered in reverse relation to each other through the sector gears 30a and 30b intermeshing with said sector gears 32a and 32b respectively. At the same time, the rotation of the shafts 47 of the driven wheel travel mode designating mechanisms 44a

and 44b is transmitted to the transverse travel mode designating levers 51 of the driven wheel travel mode designating mechanisms 44c and 44d via the transverse travel mode designating levers 51 and the tie rods 107 and 108 and thus the driven wheel unit 3c is steered in the same rotational direction as that of 3a, and unit 3d is steered in the same rotational direction as that of 3b, by the same operation as described above, via the shafts 47, the valve control levers 54, the control valves 97c and 97d, the hydraulic cylinders 36c and 36d, and the sector gears 32c, 30c and 32d, 30d respectively. Furthermore, the rotation of the shafts 47 of the driven wheel travel mode designating mechanisms 44a and 44b is transmitted to the transverse travel mode designating levers 83 of the driving wheel travel mode designating mechanisms 45a and 45b through the transverse travel mode designating levers 51 and the tie rods 113 and 114, and thus the driving wheel units unit 4a is steered in the same rotational direction as those of 3a and 3c, and 4b is steered simultaneously in the same rotational direction as those of 3b and 3d via the shafts 80, the valve control levers 85, the control valves 98a and 98b, the hydraulic cylinders 37a and 37b, and the sector gears 33a, 31a and 33b, 31b.

The steering mechanism described above is constructed such that the imaginary extensions of the wheel axes of the driven wheel units 3a, 3b, 3c, 3d and the driving wheel units 4a, 4b intersect at the center of gyration, 0₁, during the steering operation as shown in FIG. 7.

Shifting of the carriage from the longitudinal travel mode to the transverse travel mode will be explained. First of all, steering handle 127 is steered to reset all of the wheels into their home positions, so that the wheel axes of all the wheels are in parallel with each other and directed to the transverse direction of the carriage shown in FIG. 6. Thereafter, all of the piston rods engaging the respective shafts 47 and 80 are disengaged therefrom. Then the hydraulic cylinders 58 and 87 of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d and the driving wheel travel mode designating mechanisms 45a, 45b are actuated in the state shown in FIG. 6, whereby the piston rods 62 and 89 of the respective hydraulic cylinders are received in the corresponding holes 66 and 91, and thus the gyration mode designating levers 53 and 84 are engaged with the shafts 47 and 80 respectively. Thereafter, the hydraulic cylinders 67 and 92 of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d and the driving wheel travel mode designating mechanisms 45a, 45b are actuated to rotate the shafts 47 and 80 through the gyration mode designating levers 53 and 84 respectively since these layers are always fixed to the shafts. When the shafts 47 and 80 are thus rotated, the control valves 97a, 97b, 97c, 97d and 98a, 98b are actuated via the respective valve control levers 54 and 85, and accordingly the hydraulic cylinders 36a, 36b, 36c, 36d and 37a, 37b are actuated, so that the driven wheel units 3a, 3b, 3c, 3d the driving wheel units 4a, 4b are rotated in the directions of arrows shown in FIG. 9, via the sector gears 32a, 30a; 32b, 30b; 32c, 30c; 32d, 30d and 33a, 31a; 33b, 31b respectively. The rotation of the wheel units is stopped by the engagement of the pins 70 and 95 with the stoppers 71 and 96 respectively, when said respective wheel units have been rotated through

an angle of 90°, and thus the carriage is shifted from the home position of the longitudinal travel mode into the home position of the transverse travel mode shown in FIG. 7. Thereafter, the hydraulic cylinders 58 and 87 are reset to disengage the piston rods 62 and 89 of the respective hydraulic cylinders from the corresponding holes 66 and 91, and thereby to release the gyration mode designating levers 53 and 84 from engagement with the associated shafts 47 and 80, whereby, the shifting of the travel mode of the carriage is completed.

Shifting of the carriage from the transverse travel mode to the longitudinal travel mode can be effected by operating the respective mechanisms in a sequence reverse to that described above.

The carriage can be shifted from the longitudinal travel mode to the gyration mode in the following manner: Namely, after all the wheels have been set in either the longitudinal or transverse mode home positions, only the hydraulic cylinders of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d are actuated to insert the piston rods 62 of the respective hydraulic cylinders into the corresponding holes 66, whereby the gyration mode designating levers 53 of only the mechanisms 44a-44d are engaged with the shafts 47. Then, the hydraulic cylinders 74 are actuated to move the stoppers 73 downwardly as shown in FIG. 13. Thereafter, the hydraulic cylinders 67 of the driven wheel travel mode designating mechanisms 44a, 44b, 44c, 44d are actuated to rotate the shafts 47 through the gyration mode designating levers 53. As the shafts 47 are rotated, the control valves 97a, 97b, 97c, 97d are actuated via the respective valve control levers 54 since they are always fixed to the shafts 47, so that the hydraulic cylinders 36a, 36b, 36c, 36d are actuated, causing the driven wheel units 3a, 3b, 3c, 3d to rotate in the direction of arrows in FIG. 9 via the sector gears 32a, 30a; 32b, 30b; 32c, 30c; 32d, 30d. The rotation of the driven wheel units 3a, 3b, 3c, 3d is stopped by the engagement of the pins 70 with the corresponding stoppers 73 and the stopping angle is so designed as the imaginary extensions of the wheel axes of said respective driven wheel units may be set in a direction to pass the center of gyration 0, shown in FIG. 8. Thus, the carriage is shifted into the state of FIG. 9.

Shifting of the carriage from the gyration mode to the longitudinal travel mode is effected by operating the respective mechanisms in a sequence reverse to that described above. During the drive in the gyration travel mode, the piston rods are retained in the engaged state with the shaft.

Details of the driven wheel unit 3a will be described with reference to FIGS. 18 and 19. A support member 140 having a transverse guide groove 141 and a longitudinal guide groove 142 formed in the lower portion and the sector gear 30a secured to the top end thereof is rotatably connected to the underside of the loading bed 1 through a swivel bearing 143. An outer race 143a of the swivel bearing 143 is fixed to the underside of the loading bed 1, while an inner race 143b thereof is fixed on the support member 140. An axle 144 is vertically movable in the guide groove 141 with sliding surfaces 144a thereof in sliding engagement with said guide groove and has a shaft 145 perpendicularly extending through the central portion thereof. The driven wheels 146 are mounted at the opposite ends of the axle 144.

Slide blocks 147 are slidably mounted on the shaft 145 with the axle 144 interposed therebetween, for vertical sliding movement in the guide groove 142. A pair of hydraulic cylinders 148 are pivotally connected to the upper portion of the support member 140 at one end thereof by pins 149 and the lower ends of piston rods 150 of said hydraulic cylinders are pivotally connected to the opposite ends of the shaft 145 respectively. Thus, it will be seen that by feeding or discharging pressure oil into or from the hydraulic cylinders 148, said mechanism acts as a hydraulic jack for lifting or lowering the loading bed 1, with the sliding surfaces 144a of the axle 144 being guided by the guide groove 141 and the slide blocks 147 by the guide groove 142, whereas by stopping the feeding or discharging the pressure oil, the mechanism acts as a hydraulic suspension mechanism for the loading bed. The other driven wheel units 3b, 3c, 3d have the same construction as that of 3a described above.

Details of the driving wheel unit 4a is shown in FIGS. 20 and 21. Namely, the driving wheel unit 4a includes a U-shaped support member 151 rotatably connected to the underside of the loading bed 1 through a swivel bearing 154, said support member 151 being formed at the lower portion thereof with transverse guide surfaces 152 and a longitudinal grooves 153, and having the sector gear 31a fixed to the top end thereof. An outer race 154a of the swivel bearing 154 is fixed to the underside of the loading bed 1, while an inner race 154b thereof is fixedly mounted on the support member 151. A suspension beam 155 is provided with the differential gear mechanism 16a at the center thereof and having supporting arms 157 at the front and rear ends thereof, each provided with a pin 156 fixed thereto. An axle 18a having the driving wheels 19a, 19a' mounted at the opposite ends thereof is supported on the suspension beam 155. Rotatably mounted on each of the pins 156 is a slide block 159 which has a surface 159a in engagement with the guide surface 152 and a surface 159b in engagement with the guide groove 153. A pair of hydraulic cylinders 160 are pivotally connected at one end to the upper portion of the support shaft 151 by pins 161 and the lower ends of piston rods 162 of the respective hydraulic cylinders 160 are connected to the suspension beam 155 by pins 163 respectively. The cylinders act as a hydraulic jack for lifting or lowering the loading bed 1, with the slide blocks 159 being guided by the guide surfaces 152 and the guide grooves 153, when pressure oil is fed into or discharged from the hydraulic cylinders 160, and act as a hydraulic suspension mechanism for the loading bed 1 when the feed or discharge of the pressure oil is stopped. The output shaft 14a is provided with an air space 166 therein and a bevel gear 165 intermeshing with a bevel gear 164 which is fixed on the input shaft 13a, and is rotatably supported on a casing 167. A propeller shaft 15a is connected to the top end of the output shaft 14a through a spline shaft 168 and a universal cross joint 169, and to the input shaft 17a through a spline yoke 170 engaging the spline shaft 168, a universal cross joint 171 and a flange 172, and is swingable in the air space 166 in the output shaft 14a. With such construction, the driving force can be transmitted through the propeller shaft 15a, irrespective of whether the loading bed 1 is moved upward or

downward by the jacking action of the hydraulic cylinders 160, due to elongation or contraction of said propeller shaft. The driving wheel unit 4b has the same construction as that of the driving wheel unit 4a described above.

Now, the construction of the hydraulic balancing mechanism and the hydraulic jack mechanism will be explained with reference to FIG. 22. The hydraulic cylinders 148 of the driven wheel units 3a, 3b; the hydraulic cylinders 160 and 148 of the driving wheel unit 4a and the driven wheel unit 3c; and the hydraulic cylinders 160 and 148 of the driving wheel unit 4b and the driven wheel unit 3d; are communicated with each other through communication lines 173, 174, 175 and divided into three blocks to form a three-point suspension mechanism as a whole. The hydraulic cylinders 148, 160 in each block are simultaneously shifted to a hydraulic pressure balancing position N, to a hydraulic jack elevating positions U or to a hydraulic jack lowering position D by change-over valves 176, 177, 178 provided each for each block and communicated with said respective blocks by communication lines 179, 180, 181. Hydraulic oil is supplied to the respective change-over valves 176, 177, 178 from an oil tank 183 through a communication line 184 by a hydraulic pump 182. A relief valve 185 is provided to protect the hydraulic circuit by releasing the oil into the oil tank 183 when the oil pressure in the communication line 184 has reached above a predetermined level. With the arrangement described, when the change-over valves 176, 177, 178 are in the hydraulic pressure balancing position N, the communication lines 179, 180, 181 for the respective blocks are closed, so that even when the hydraulic cylinders 148, 160 in the respective blocks are stretched or contracted during travelling of the carriage on a rough road surface, the oil in the hydraulic cylinders flows into each other freely within each block and thus the respective hydraulic cylinders are always subjected to the same load. Therefore, the three blocks of hydraulic cylinder, each performing the above-described function, form a three-point suspension system which follows closely the surface condition of the road on which the carrier travels. Now, when the change-over valves 176, 177, 178 are in the hydraulic jack elevating position U, the respective hydraulic cylinders 148, 160 are communicated with the hydraulic pump 182, so that hydraulic oil is fed with pressure into said respective hydraulic cylinders through the communication lines 184, 179, 180, 181, resulting in elevating the loading bed 1. On the other hand, when the change-over valves 176, 177, 178 are in the hydraulic jack lowering position D, the respective hydraulic cylinders 148, 160 are communicated with the oil tank 183, so that the oil in said respective hydraulic cylinders is discharged into the oil tank 183 and, therefore, the loading bed 1 is lowered.

In use of the carriage according to the present invention, it is driven into below a load to be carried, mounted on a support frame structure, with its loading bed 1 in the lowered position and then the change-over valves 176, 177, 178 are shifted to the hydraulic jack elevating position U to elevate the loading bed, whereby the load is automatically loaded on said loading bed. Thereafter, the change-over valves 176, 177, 178 are shifted to the hydraulic pressure balancing

position N and the load is maintained in the lifted state on the carriage and carried to a desired spot. When the carriage has reached the desired unloading spot, the change-over valves 176, 177, 178 are shifted to the hydraulic jack lowering position to lower the loading bed 1, whereby the load on the loading bed is automatically mounted on a supporting frame structure at said spot.

Another embodiment of the carriage according to the present invention is shown in FIGS. 23 to 27. According to this embodiment, the driving wheel units 4a', 4b' are each provided with an independent drive source 201a or 201b which can drive reversibly, and for the travelling of the carriage in a longitudinal direction, the driving wheel units 4a', 4b' are directed in the same direction, as shown in FIG. 23, and the respective drive sources 210a, 201b are driven in the same direction. When the carriage is desired to be gyrated on the spot, the driving wheel units 4a', 4b' are held in the same position as in the case of longitudinal travelling namely the source 201b is referred as 201b' and the driven wheel units 3a, 3b, 3c, 3d are rotated such that the extensions of the wheel axes of the respective driven wheel units are set in a direction to pass the central point (the center of gyration) 0₃ of the line connecting the centers of the driving wheel units with each other, as shown in FIG. 25, but the driving wheel units 4a' and 4b' are driven in opposite directions to each other, whereby the carriage makes a gyratory movement in either a clockwise or counterclockwise direction around the center of gyration 0₃. FIG. 25 shows a different type of the wheel unit arrangement for gyratory movement of the carriage. In this case, the driven wheel units 3a, 3b, 3c, 3d and the driving wheel units 4a', 4b' are rotated such that the extensions of the wheel axes of the respective wheel units intersect at an optional point (the center of gyration) 0₄ and then the driving wheel units 4a' and 4b' are driven in opposite directions to each other, whereby the carriage makes a gyratory movement around said optional center of gyration 0₄. Gyration of the carriage can alternatively be attained by driving the driving wheel units 4a', 4b' in the same direction after either one of said driving wheel units has been turned around through an angle of 180° as indicated by the chain lines in FIGS. 25 and 26 in which the source 201b is referred as 201b'.

In FIG. 26 there is shown a modification of the carriage of this invention shown in FIG. 23. In this form of the carriage, there are provided two pairs of driven wheel units 3a₁, 3b₁ and 3a₂, 3b₂ at the front portions of the loading bed 1, also two pairs of driven wheel units 3c₂, 3d₂ and 3c₁, 3d₁ at the rear positions and two pairs of driving wheel units 4a₁, 4b₁ and 4a₂, 4b₂, with independent drive sources 210a, 201b, 202a, 202b respectively at the intermediate positions between the front and rear positions of the loading bed.

As described hereinabove, the carriage according to the present invention is provided with a mechanism for rotating the driven wheel units and the driving wheel units about their own vertical axes so that all of the wheels may be directed in a longitudinal direction or a transverse direction of the carriage, a steering mechanism for steering the respective wheels during travelling of the carriage in the longitudinal direction or a transverse direction, and a mechanism for rotating

all wheels about their own vertical axes so that the extensions of the wheel axes may be set in a direction to pass one fixed point. Therefore, it is possible to drive the carriage in a longitudinal direction or a transverse direction according to the condition of the road on which it is travelling, or to gyrate at the same spot where it rests, and hence the carriage of this invention is highly adapted for maneuvering in a narrow place, such as a narrow loading and unloading cite. Moreover, since the carriage of this invention is provided with a mechanism for jacking-up the loading bed, it is capable of loading or unloading the load at a loading or unloading cite without using a crane or the like facility.

Furthermore, since the carriage is provided with a hydraulic pressure balancing mechanism by which the loading bed is supported at three points, the carriage quickly follows the roughness of the road surface and travels on the road with stability.

What is claimed is:

1. A self-driven carriage comprising:
a loading bed;

at least four driven wheel units pivotally mounted to said loading bed of said carriage, at least two of said units being positioned at the front sides of said bed in symmetrical relation to each other with respect to the longitudinal center line of said bed and at least two of said units being positioned at the rear sides of said bed in symmetrical relation to each other with respect to the longitudinal center line of said bed, each of said driven wheel units including an axle, a mounting means supporting said axle pivotally mounted to said bed so as to permit the rotation thereof about a pivotal center of each said unit, at least one pair of driven wheels rotatably mounted on said axle at the opposite ends thereof in symmetrical relation to each other with respect to the pivotal center, and a rotating mechanism to pivotally rotate said mounting means;

at least two driving wheel units pivotally mounted to said bed and positioned at an intermediate position between said front and said rear sides of said bed in symmetrical relation to each other with respect to the longitudinal center line of said bed, each of said driving wheel units including an axle, a mounting means supporting said axle pivotally mounted to said bed so as to permit the rotation thereof about a pivotal center of each said driving wheel unit, at least one pair of driving wheels rotatably mounted on said axle at the opposite ends thereof in symmetrical relation to each other with respect to the pivotal center, and a rotating mechanism for pivotally rotating said mounting means;

means for transmitting drive force to said driving wheels of said driving wheel units;

a travel mode designating mechanism including a longitudinal travel mode designating link mechanism which temporarily connects said respective driven and driving wheel units with said corresponding rotating mechanism so as to allow the wheels of all of said wheel units to be oriented in a longitudinal direction parallel to the longitudinal axis of said bed; a transverse travel mode designating link mechanism which temporarily

connects said respective driven and driving wheel units with said corresponding rotating mechanisms so as to orient the wheels of all of said wheel units in a transverse direction perpendicular to the longitudinal axis of said bed; and selection means for selectively actuating said longitudinal and transverse travel mode designating link mechanisms whereby said carriage possesses a longitudinal and a transverse travel mode;

manual steering means adapted to permit the coordinated steering of the carriage; and

longitudinal traveling steering means operatively associated between said manual steering means and said driven wheel units when said longitudinal travel mode designating link mechanism is actuated, said longitudinal traveling steering means adapted to permit the steering of the wheels of only said driven wheel units during traveling of the carriage in the longitudinal direction in such a manner that the imaginary extensions of the respective wheel axles of all said wheel units intersect each other in a center point of curvature of the carriage.

2. A self-driven carriage as defined in claim 1, in which said longitudinal traveling steering means is so designed as to set the driving wheels always in the longitudinal direction of the carriage and steer only the driven wheels of the front and rear driven wheel units in such a manner that the axles of the front driven wheel units and those of the rear driven wheel units are rotated in reverse rotating directions to each other, whereby imaginary extensions of the axles of the respective driven wheel units intersect in imaginary extensions of the axles of the respective driving wheel units.

3. A self-driven carriage as defined in claim 1, which further comprises transverse traveling steering means operatively associated between said manual steering means and all of said driven and driving wheel units when said transverse travel mode designating link mechanism is actuated, said transverse traveling steering means adapted to permit the steering of all of the wheels of said driven and driving wheel units during traveling of the carriage in the transverse direction, which is so designed as to rotate the wheel axles of the driven and driving wheel units positioned at one side of said bed with respect to the longitudinal axis of said bed and the axles of the driven and driving wheel units positioned at the other one side of said bed with respect to the longitudinal axis of said bed in reverse directions to each other in such a manner that imaginary extensions of all the wheel axles intersect each other in a center point of curvature of the carriage.

4. A self-driven carriage as defined in claim 1, in which the driving power transmitting mechanism for the driving wheel units is provided with a spline mechanism, so that the loading bed may be held in an elevated position by said jack-constituting hydraulic pressure balancing mechanism during travelling of the carriage.

5. A self-driven carriage as defined in claim 1, in which said travel mode designating mechanism further includes a gyration mode designating link mechanism which is adapted to set all the wheels in such directions that imaginary extensions of the wheel axles of all said

units intersect with each other at the center of gyration of the carriage, said selection means further adapted to selectively actuate said gyration mode designating link mechanism.

6. A self-driven carriage as defined in claim 5, in which the respective driven wheel units are positioned in symmetrical relation to each other with respect to a point of symmetry located in the vicinity of the center of the carriage and said gyration mode designating link mechanism is so designed as to set all of the driving wheels always in the longitudinal direction of the carriage and to set all of the driven wheels in such directions that imaginary extensions of the axles of all said units intersect with each other in said point of symmetry.

7. A self-driven carriage as defined in claim 5, in which said drive force transmitting means operatively drives the driving wheel units in opposite directions to each other during the gyration of the carriage.

8. A self-driven carriage as defined in claim 5, in which said drive force transmitting means comprises individual driving power transmitting mechanisms provided each for the respective driving wheel units.

9. A self-driven carriage as defined in claim 8, in which said driving power transmitting mechanism is of such construction that the direction of rotation of the driving wheel can be reversible.

10. A self-driven carriage as defined in claim 8, in which each said driving power transmitting mechanism is provided with an independent drive source.

11. A self-driven carriage as defined in claim 10, in which said driving sources of the respective driving wheel units rotate the associated driving wheels in the same direction during the travelling of the carriage in a longitudinal or transverse direction, but in opposite directions to each other during the gyration of the carriage.

12. A self-driven carriage as defined in claim 1, which further comprises a hydraulic pressure balancing mechanism for providing hydraulic pressure balance within each of three groups of wheel units consisting of a first group comprising the front driven wheel units, a second group comprising one of the rear driven wheel units and one of the driving wheel unit, and a third group comprising the rest of the wheel units, so as to constitute a three-point suspension system.

13. A self-driven carriage as defined in claim 12, which further comprises a pump means for cooperation with said hydraulic pressure balancing mechanism, whereby said hydraulic pressure balancing mechanism acts as a jack.

14. A self-driven carriage comprising:
a loading bed;

at least six wheel units rotatably connected to said loading bed and including at least two driven wheel units positioned at the front sides of said loading bed, at least two driven wheel units positioned at the rear sides of said loading bed and at least two driving wheel units positioned between the front and rear pairs of said driven wheel units, each of said wheel units being rotatable about a vertical axis to said loading bed through 180° and having an axle rotatable therewith and at least two wheels rotatably mounted on said axle;
means for transmitting a drive force to said driving wheels of said driving wheel units;

a travel mode designating mechanism including engageable longitudinal, transverse and gyration travel mode means for setting the carriage in longitudinal, transverse and gyration travel modes, respectively;

rotating means, positioned adjacent each of said wheel units and operably associated with said travel mode designating mechanism, for rotating said wheel units to orient said wheels in a longitudinal travel mode, a transverse travel mode at an angular difference of 90° from said longitudinal travel mode or a gyration travel mode intermediate said longitudinal and said transverse travel modes; and

a manually actuable steering means for the coordinated steering of said wheels in such a manner that, when said longitudinal travel mode means is engaged, said driven wheel units positioned at the front side of said loading bed and said driven wheel units positioned at the rear side of said bed are rotated in the reverse directions to each other but said driving wheel units are set to be oriented in a longitudinal direction of said bed so that the imaginary extensions of all of said axles of said driven wheel units intersect together at a point on imaginary transverse extensions of the axles of said driving wheel units and

that, when said transverse travel mode means is engaged, a set of said driven and driving wheel units positioned at one side with respect to a longitudinal axis of said bed and another set of said driven and driving wheel units positioned at the other side with respect to the longitudinal axis of said bed are rotated in the reverse directions to each other so that the imaginary extensions of all said axles of said driven and driving wheel units intersect together at a point in the longitudinal axis of said loading bed,

whereby said carriage is steered in both of the longitudinal and transverse travel modes.

15. A self-driven carriage as defined in claim 14, wherein the respective driving wheel units are driven by a single engine whose power is transmitted through a transmission mechanism which selectively drives the respective driving wheel units in the desired relative directions.

16. A self-driven carriage as defined in claim 14, wherein the respective driving wheel units are respectively driven by individual power sources which are reversibly operable.

17. A self-driven carriage as defined in claim 14, which further comprises:

control valve means which activate and control said rotating means; and

wherein said travel mode designating mechanism which sets said carriage in one of said longitudinal transverse and gyration travel modes is adapted to temporarily engage one of said travel mode means with said control valve means to actuate said rotating means so that said wheel units are set in the corresponding one of said travel modes; and

said steering means includes a steering handle and a steering link mechanism operatively engaging said steering handle and said control valve means, said steering link mechanism adapted to regulate said control valve means so that, when said longitudinal

17

travel mode means is engaged, the front and rear pairs of said driven wheel units are rotated in reverse directions with respect to each other, and when said transverse travel mode means is engaged, the right and left side sets of said driven and driving wheel units are rotated in reverse directions with respect to each other.

18. A self-driven carriage as defined in claim 17, wherein said travel mode designating mechanism is adapted to operatively engage said gyration travel mode means to set all of said wheels in such directions that the imaginary inward extensions of said wheel axes intersect with each other at a center point to thereby set said carriage in said gyration travel mode.

19. A self-driving carriage as defined in claim 18,

18

wherein said driving wheel of the respective driving wheel units are driven in opposite directions to each other, thereby gyrating said carriage.

20. A self-driven carriage as defined in claim 17, wherein said travel mode designating mechanism is adapted to operatively engage said gyration travel mode means to set said wheel axles of said driving wheel units in a transverse direction of said carriage and said wheel axles of all said driven wheel units in such directions that their imaginary inward extensions intersect together at a center point on the imaginary inward extensions of said wheel axles of said driving wheel units to thereby set said carriage in said gyration travel mode.

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