

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO VEHICLE SUSPENSION SYSTEMS

(71) We, CATERPILLAR TRACTOR Co., a corporation organized and existing under the laws of the State of California, United States of America, of 100 N.E. Adams Street, Peoria, State of Illinois 61602, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to vehicle suspension systems, and more particularly to a suspension system which provides for proper movement of the elements thereof for smooth and efficient operation of the vehicle.

Vehicles of the track-type generally comprise a plurality of supporting track rollers rotatably fixed on track frames disposed on the sides of the vehicle. Rotatable members are generally fixed to the end portions of the track frames, and these idlers, along with the track rollers, engage endless tracks. See, for example, U.S. Patent No. 3,435,908 to Sunderlin et al, U.S. Patent No. 3,595,333 to Barbee, and U.S. Patent No. 3,332,725 to Reinsma, all assigned to us.

In some cases, i.e., in the disclosures of Reinsma and Barbee, recoil means are associated with the front rotatable members of the vehicle. However, it has been found that in such relatively rigid systems, with little or no real suspension movement, good contact between the track chains and the ground is not maintained when the vehicle is negotiating relatively rough terrain. It would, therefore, be desirable to provide for proper suspension movement of the track rollers and rotatable members, meanwhile still providing proper carrying of the track frames, so that better track chain-ground engagement can be achieved over rough terrain.

Vehicles which generally incorporate means for allowing such suspension movement are shown in U.S. Patent No. 3,063,510 to Hunger et al, and U.S. Patent No. 3,254,738 to Larsen, both assigned to us. While these systems have been found relatively effective in operation, it should be noted that they are relatively complicated in design. It will be understood, of course, that it is always desirable to simplify the design of such a suspension system, meanwhile aiming for the most efficient manner of operation for proper traction, and also for maximum smoothness of operation.

Thus, the prior art suspension systems have generally incorporated relatively solidly mounted idlers and track rollers, or a relatively soft suspension through intermediate, coiled springs or hydraulic cushioning of these elements. The former system provides a rigid platform on flat surfaces, but lacks adaptability to uneven terrain as well as not providing any relief for peak shock loads transmitted through the suspension. The latter, while generally permitting relief from shock loads and high speed vehicle travel, is excessively soft so that the suspension system is not stable with respect to the variable loading of implements attached to the vehicle such as a bulldozer blade or ripper.

According to this invention there is provided a suspension assembly comprising a track frame adapted to be mounted to a vehicle frame, a first crank member pivotally mounted on the track frame, the first crank member having first and second legs extending from its pivot point, a first rotatable member mounted on the first leg of the first crank member, a first roller means mounted on the second leg of the first crank member, and a track chain encompassing and in contact with the first rotatable member and first roller means, 90

the first crank member being disposed so that one end of the track frame is supported at the pivot point of the first crank member by the first rotatable member and first roller means, wherein the pivot point of the first crank member is positioned so as in use to be above the line of action of the force applied to the first crank member as a result of track chain forces acting on the first rotatable member and first roller means, whereby the first crank member is urged by said force to pivot the first rotatable member downwardly and the first roller means upwardly.

Thus this invention makes it possible to provide, in a track-type vehicle, a suspension system which provides that the tracks thereof maintain a high degree of contact with the ground, even when the vehicle is driven over relatively rough terrain.

The invention also makes it possible to provide, in a track-type vehicle, such a suspension system which also provides for maximum smoothness of operation of the vehicle and which is simple in design.

Furthermore, this invention makes it possible to provide a track-type vehicle suspension system having improved adaptability to relatively fast traveling modes of operation over uneven terrain as well as to relatively slow speed working modes of operation involving the variable loading of vehicle-mounted implements.

The invention will best be understood from the following description with reference to the accompanying drawings, in which:

Figure 1 is a side elevation of a vehicle incorporating a suspension system in accordance with the invention;

Fig. 2 is a side elevation of the track chain and suspension combination, with portions broken away;

Fig. 3 is a view similar to that of Fig. 2, showing the action of the elements of the suspension system; and

Figs. 4 and 5 are fragmentary views of the forward portion of the suspension system, showing the action of the elements as the vehicle is driven over various terrains.

Shown generally in Fig. 1 is a vehicle 10 having a vehicle frame 12. A track frame 14 includes one end 16, the forward end thereof, and the other end 18, the rearward end thereof, and is pivotally mounted between forward end 16 and rearward end 18 adjacent the rearward end 18 to the vehicle frame 12 by means of pin 20. A crank member 22 is pivotally mounted at point 24 between the crank member ends to end 16 of track frame 14. The crank member 22 has a leg 26 which extends generally forward away from end 18 of track frame 14, and a leg 28 which extends generally

rearward toward the end 18. A rotatable member 30, in this embodiment an idler, is rotatably mounted on leg 26. Roller means 32 are mounted on the leg 28. Such roller means 32 comprise a bogey 34 pivotally mounted to the leg 28 and having track rollers 36 mounted thereon. Crank member 38 is pivotally mounted at point 40 between the crank member ends to end 18 of track frame 14. This crank member 38 has a leg 42 which extends generally rearwardly away from end 16 and a leg 44 which extends generally forwardly toward frame end 16. A rotatable member 46, in this embodiment also an idler, is rotatably mounted on the leg 42. Roller means 48 are mounted on the leg 44, and comprise a bogey 50 pivotally mounted to the leg 44 and having track rollers 52 mounted thereon.

A track chain 54 encompasses and is in contact with idlers 30, 46, and track rollers 36, 52, and a drive sprocket 56 mounted on vehicle frame 12 and positioned above and between the idlers 30, 46. The end 16 of track frame 14 is supported at pivot point 24 by the idler 30 and track rollers 36, which contact the ground-engaged track portion as shown. These elements define a support triangle for positive support of the end 16 without the use of springs or the like within the support triangle. This is to be because pivot point 24 is above the ground-engaging track chain portion and between the points where the idler 30 engages the track and the point where the roller means 32 engage the track, providing great stability.

The end 18 of track frame 14 is supported by idler 46 and track rollers 52 in like manner.

With the crank members 22, 38 being pivotable about the pivot points 24, 40, respectively, it will be understood that movement of the type shown in Figs. 4 and 5 can be achieved. An important feature of this invention is the relationship of the pivot point 24 and the "lines of action" 58, 58a shown. Such "lines of action" 58, 58a represent the resultant loading of the forces placed by the track chain 54 on the idler 30 and roller means 32. These are shown in Figs. 4 and 5, and the direction thereof depends on the attitude of crank member 22. It will be noted that pivot point 24 is chosen as above the lines of action 58, 58a so that the crank member 22 is urged by such line of action to pivot leg 26 and idler 30 downwardly and leg 28 and roller means 32 upwardly. Upon such rotation, stop means 60 comprising resilient rubber pads 62, 64 of spherical shape mounted to the end 16 and leg 28 come into play, providing positive placement of the crank member 22 when

rotated in this direction. It should also be noted that pivot point 24 is in close proximity to the lines of action 58, 58a, and to the bisector of the track chain 54 wrap angle on the idler so as to provide a minimum change in track chain 54 length, and to allow a relatively great amount of suspension travel, i.e., up and down travel of the idler 30 and roller means 32.

- 10 Stop means 66 are associated with the crank member 22 and end 16 to limit rotative movement of the crank member 22 which moves roller means 32 downwardly and idler 30 upwardly. Such stop means 66
15 comprise a stop member 68 formed on end 16 and a stop member 70 formed on leg 26 and adapted to contact stop member 68 upon such pivoting. Thus, positive stop means are provided for limiting rotative
20 movement of crank member 22 in either direction.

It will be understood that crank member 38 and end 18 have similar stop pads and stop members associated therewith and
25 operates in an identical manner, with leg 42 corresponding to leg 26, and leg 44 corresponding to leg 28.

- A link member 72 is pivotally fixed at one end to the track frame 14 adjacent the
30 idler 30 and inwardly of end 16. A link member 74 is pivotally fixed at one end to the track frame 14 adjacent the idler 46 and inwardly of the end 18. These link members 72, 74 extend generally toward
35 each other from the respective link member-track frame pivot points thereof and have their extended ends in close proximity to each other. Roller assemblies 76, 78 are mounted on the link members 72, 74 respectively, and comprise bogies 80, 82
40 pivotally mounted to the link members 72, 74. Track rollers 74 are mounted on bogey 80, and track rollers 86 are mounted on bogey 82. The track chain 54 encompasses
45 and is in contact with the roller assemblies 76, 78, being in engagement with track rollers 84 and 86.

It will be seen that the link members 72, 74 and rollers 84, 86 associated therewith
50 are pivotable upwardly and downwardly relative to the track frame 14 independently of each other.

- Stop means 98 (see Fig. 2) are associated with the link member 72 and the track
55 frame 14. Such stop means 98 comprise resilient rubber pads 100, 102 of spherical shape mounted on the track frame 14 and link member 72, respectively, and positioned to contact each other upon upward pivoting of the link member 72, to
60 limit such pivoting. Stop means 104 are associated with the link member 74 and track frame 14. Such stop means 104 also comprise resilient rubber pads 106, 108 of
65 spherical shape mounted on the track

frame 14 and link member 74 respectively, and positioned to contact each other upon upward pivoting of the link member 74, to limit such pivoting.

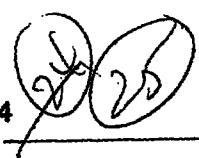
With the vehicle 10 in its normal, non-
70 loaded situation, the vehicle weight is supported by crank member 22 (through the resilient pads 62, 64), crank member 38 (through the resilient pads associated there-
75 with), link member 72 (through the resilient pads 100, 102), and link member 74 (through the resilient pads 106, 108), and of course like structure associated with a track on the other side of the vehicle 10. In such unloaded positions, the idlers 30,
80 46 are normally carried in a slightly raised position, and are lowered only upon application of load. Under such load, because of the generally equal length of legs 26, 28, and legs 42, 44, the load on a crank mem-
85 ber is divided roughly equally between the idler and the bogey associated therewith.

Figs. 4 and 5 show clearly the operation of the suspension assembly. As the tractor chain 54 rolls over a combined dip and
90 bump, leg 26 is pivoted upwardly and leg 28 is pivoted downwardly. Through such pivoting, proper contact between the forward portion of the track 54 and the ground is maintained. In addition, because
95 of the dip, link member 72 pivots downwardly away from track frame 14, and is no longer a load-carrying member. However, it should be noted that with the downward travel of link member 72, track
100 chain 54 has maintained good contact with the ground and the rollers 84 are still in guiding engagement with the track chain 54. In addition, link member 72 is properly
105 positioned to move into a load-bearing position as the bump approaches the area thereof.

Fig. 5 shows a bump in a different position relative to the track chain 54. In such
110 situation, both crank member 22 and link member 72 have been pivoted to bring their respective resilient stop means into play. These stop means now transfer load to the track frame 14, the resiliency of the
115 stop means meanwhile allowing proper track chain-ground contact to be maintained as shown.

The rear portion of the suspension assembly, of course, operates in a like man-
120 ner.

In such operation, it is to be understood that a stable platform effect is maintained in combination with proper suspension
125 movement. If the vehicle 10 is tilted forwardly by the loading of the implement mounted thereon for example, it will pivot generally about pivot point 24, and it will be seen that link member 22 pivots relative to track frame 14 so that idler 30 comes
130 into play as a load bearing member. In

4  this state, idler 30 and track rollers 36 support the load of the front end 16 through a gradually decreasing loading of the resilient members 62, 64 and gradually increasing direct mechanical loading of the controlling pivot point 24. In this way, a proper platform is maintained.

10 The rearward portion of the vehicle 10 operates in the same manner when the vehicle 10 is tilted rearwardly.

Such stable platform is maintained under all situation, as for example when the vehicle 10 is driven over a bump. In such case, with the idlers unloaded, the bump will be absorbed by the resilient means associated with link members 72, 74 and crank members 22, 38, i.e., the bump will be enveloped, with the stable platform being maintained. However, as soon as an idler is brought into play as a load bearing member, it along with the track rollers associated therewith is included to define such platform. Thus, while proper suspension travel is achieved, a stable vehicle platform exists under all conditions.

25 With the idler 30 and track rollers 36 being mounted on the same crank member 22, the entire front crank member 22 and structure associated therewith can be made to retract together if a recoil system is included in the apparatus. In such a recoil system, end 16 would be separate from end 18, and would be movable toward and away from end 18. With such a recoil system, a very stable end 16 support structure is provided, since the idler 30 and rollers 36 recoil (end 16 moves rearwardly) and move forwardly together.

40 The disclosed suspension system has proved extremely effective in providing smooth operation even over extremely rough terrain, and has proved quite superior in this regard to the prior designs tested. This is because of the novel crank member and link member system, the particular pivot points chosen, the stop means, and positions of the idlers, bogies, and track rollers, along with all associated structure, as described above. Because of such smooth operation, work can be carried out more rapidly with greater safety and less operator fatigue. In addition, it will be seen that such suspension system is extremely simple in design.

55 WHAT WE CLAIM IS:—

1. A suspension assembly comprising a track frame adapted to be mounted to a vehicle frame, a first crank member pivotally mounted on the track frame, the first crank member having first and second legs extending from its pivot point, a first rotatable member mounted on the first leg of the first crank member, a first roller means mounted on the second leg of the first crank member, and a track chain en-

compassing and in contact with the first rotatable member and first roller means, the first crank member being disposed so that one end of the track frame is supported at the pivot point of the first crank member by the first rotatable member and first roller means, wherein the pivot point of the first crank member is positioned so as in use to be above the line of action of the force applied to the first crank member as a result of track chain forces acting on the first rotatable member and first roller means, whereby the first crank member is urged by said force to pivot the first rotatable member downwardly and the first roller means upwardly.

2. A suspension assembly as claimed in claim 1 wherein the pivot point of the first crank member is positioned so as in use to be in close proximity to the line of action of the force applied to the first crank member.

3. A suspension assembly as claimed in claim 1 or claim 2 and including a stop for limiting pivotal movement of the first crank member in one direction in response to said force applied to the first crank member.

4. A suspension assembly as claimed in claim 3 and including an additional stop for limiting pivotal movement of the first crank member in the other direction.

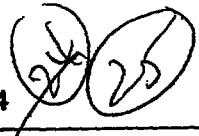
5. A suspension assembly as claimed in claim 3 or claim 4 wherein the or each stop comprises a resilient pad mounted on the first crank member or the track frame and arranged to be compressed to limit pivotal movement of the first crank member.

6. A suspension assembly as claimed in any of the preceding claims wherein the first rotatable member is an idler.

7. A suspension assembly as claimed in any of the preceding claims wherein the first roller means comprises a bogie pivotally mounted on the second leg of the first crank member and track rollers mounted on the bogie and engaging the track chain.

8. A suspension assembly as claimed in any of the preceding claims and further comprising a second crank member pivotally mounted on the track frame, the second crank member having first and second legs extending from its pivot point, a second rotatable member mounted on the first leg of the second crank member, and a second roller means mounted on the second leg of the second crank member, the arrangement being such that the first legs of the first and second crank members extend generally away from each other and the track chain also encompasses and is in contact with the second rotatable member and the second roller means, the second



4  this state, idler 30 and track rollers 36 support the load of the front end 16 through a gradually decreasing loading of the resilient members 62, 64 and gradually increasing
5 direct mechanical loading of the controlling pivot point 24. In this way, a proper platform is maintained.

10 The rearward portion of the vehicle 10 operates in the same manner when the vehicle 10 is tilted rearwardly.

Such stable platform is maintained under all situation, as for example when the vehicle 10 is driven over a bump. In such case, with the idlers unloaded, the bump
15 will be absorbed by the resilient means associated with link members 72, 74 and crank members 22, 38, i.e., the bump will be enveloped, with the stable platform being maintained. However, as soon as an
20 idler is brought into play as a load bearing member, it along with the track rollers associated therewith is included to define such platform. Thus, while proper suspension travel is achieved, a stable vehicle
25 platform exists under all conditions.

With the idler 30 and track rollers 36 being mounted on the same crank member 22, the entire front crank member 22 and structure associated therewith can be made
30 to retract together if a recoil system is included in the apparatus. In such a recoil system, end 16 would be separate from end 18, and would be movable toward and away from end 18. With such a recoil
35 system, a very stable end 16 support structure is provided, since the idler 30 and rollers 36 recoil (end 16 moves rearwardly) and move forwardly together.

The disclosed suspension system has
40 proved extremely effective in providing smooth operation even over extremely rough terrain, and has proved quite superior in this regard to the prior designs tested. This is because of the novel crank
45 member and link member system, the particular pivot points chosen, the stop means, and positions of the idlers, bogies, and track rollers, along with all associated structure, as described above. Because of
50 such smooth operation, work can be carried out more rapidly with greater safety and less operator fatigue. In addition, it will be seen that such suspension system is extremely simple in design.

55 WHAT WE CLAIM IS:—

1. A suspension assembly comprising a track frame adapted to be mounted to a vehicle frame, a first crank member pivotally mounted on the track frame, the
60 first crank member having first and second legs extending from its pivot point, a first rotatable member mounted on the first leg of the first crank member, a first roller means mounted on the second leg of the
65 first crank member, and a track chain en-

compassing and in contact with the first rotatable member and first roller means, the first crank member being disposed so that one end of the track frame is supported at the pivot point of the first crank member by the first rotatable member and first roller means, wherein the pivot point of the first crank member is positioned so as in use to be above the line of action of the force applied to the first crank member as a result of track chain forces acting on the first rotatable member and first roller means, whereby the first crank member is urged by said force to pivot the first rotatable member downwardly and the first
70 roller means upwardly.

2. A suspension assembly as claimed in claim 1 wherein the pivot point of the first crank member is positioned so as in use to be in close proximity to the line of action
85 of the force applied to the first crank member.

3. A suspension assembly as claimed in claim 1 or claim 2 and including a stop for limiting pivotal movement of the first
90 crank member in one direction in response to said force applied to the first crank member.

4. A suspension assembly as claimed in claim 3 and including an additional stop
95 for limiting pivotal movement of the first crank member in the other direction.

5. A suspension assembly as claimed in claim 3 or claim 4 wherein the or each stop comprises a resilient pad mounted on the first crank member or the track frame and arranged to be compressed to limit pivotal movement of the first crank member.

6. A suspension assembly as claimed in
105 any of the preceding claims wherein the first rotatable member is an idler.

7. A suspension assembly as claimed in any of the preceding claims wherein the first roller means comprises a bogie
110 pivotally mounted on the second leg of the first crank member and track rollers mounted on the bogie and engaging the track chain.

8. A suspension assembly as claimed in
115 any of the preceding claims and further comprising a second crank member pivotally mounted on the track frame, the second crank member having first and second legs extending from its pivot point, a second rotatable member mounted on the first leg of the second crank member, and a second roller means mounted on the second leg of the second crank member, the arrangement being such that the first
120 legs of the first and second crank members extend generally away from each other and the track chain also encompasses and is in contact with the second rotatable member and the second roller means, the second
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25 26

crank member being disposed so that the other end of the track frame is supported at the pivot point of the second crank member by the second rotatable member and second roller means.

9. A suspension assembly as claimed in claim 8 wherein the pivot point of the second crank member is positioned so as in use to be above the line of action of the force applied to the second crank member as a result of track chain forces acting on the second rotatable member and the second roller means, whereby the second crank member is urged by said force to pivot the second rotatable member downwardly and the second roller means upwardly.

10. A suspension assembly as claimed in claim 9 wherein the pivot point of the second crank member is positioned so as in use to be in close proximity to the line of action of the force applied to the second crank member.

11. A suspension assembly as claimed in claim 9 or claim 10 and including a stop for limiting pivotal movement of the second crank member in one direction in response to said force applied to the second crank member.

12. A suspension assembly as claimed in claim 11 and including an additional stop for limiting pivotal movement of the second crank member in the other direction.

13. A suspension assembly as claimed in claim 11 or claim 12 wherein the or each stop comprises a resilient pad mounted on the second crank member or the track frame and arranged to be compressed to limit pivotal movement of the second crank member.

14. A suspension assembly as claimed in any of claims 8 to 13 wherein the second rotatable member is an idler.

15. A suspension assembly as claimed in any of claims 8 to 14 wherein the second roller means comprises a bogie pivotally mounted on the second leg of the second crank member and track rollers mounted on the bogie and engaging the track chain.

16. A suspension assembly as claimed in any of the preceding claims and further comprising a first link member pivotally mounted on the track frame inwardly of said one end thereof, a first roller assembly mounted on the first link member, a second link member pivotally mounted on

the track frame inwardly of the other end thereof, and a second roller assembly mounted on the second link member, the arrangement being such that the track chain encompasses and is in contact with the first and second roller assemblies.

17. A suspension assembly as claimed in claim 16 wherein each of the first and second roller assemblies comprises a bogie, which is pivotally mounted on the respective link member, having track rollers mounted thereon, the arrangement being such that these track rollers are in contact with the portion of the track chain running between and under the first and second rotatable members.

18. A suspension assembly as claimed in claim 16 or 17 wherein the first and second link members extend generally towards each other from their pivotal mountings on the track frame so that the first and second roller assemblies are in relatively close proximity to each other and are pivotable independently of each other upwardly and downwardly relative to the track frame.

19. A suspension assembly as claimed in claim 18 and including a stop for limiting upward pivotal movement of the first link member and for supporting part of the vehicle weight when operative.

20. A suspension assembly as claimed in claim 19 wherein each of the stops for limiting upward pivotal movement of the link members comprises a resilient pad mounted on the respective link member or the track frame and arranged to be compressed to limit said upward pivotal movement.

21. A suspension assembly substantially as herein described with reference to the accompanying drawings.

22. A vehicle comprising a vehicle frame and at least one suspension assembly as claimed in any of the preceding claims the track frame of which is pivotally mounted to the vehicle frame at a point intermediate the ends of the track frame.

23. A vehicle, including a suspension assembly, substantially as herein described with reference to the accompanying drawings.

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