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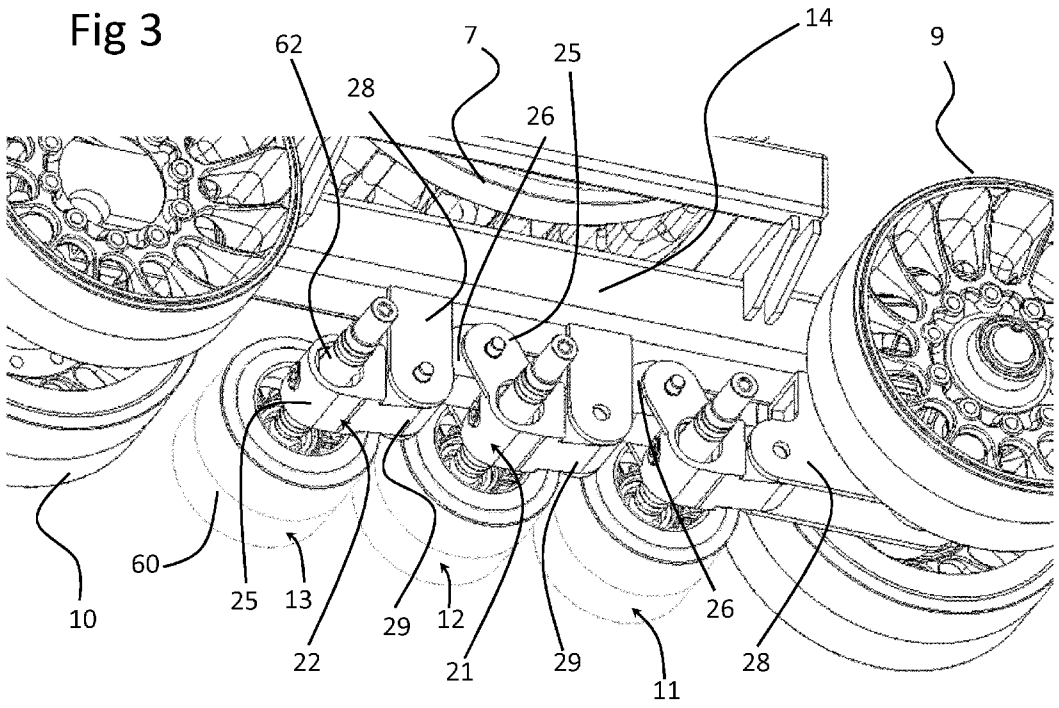
Fig 3




(57) Abstract: A rubber track system (3) comprises a driving wheel (7), an undercarriage beam (14) hinged to a frame (2) of the vehicle, at least one idler wheel (9), at least a first and a second roller wheel (11, 12) attached to the undercarriage beam (14). The vehicle further comprises a first and a second tilting support (20, 21 ) to attach a relative roller wheel (11, 12) to the undercarriage beam (14) and an elastic or visco-elastic connection (23) to join first and second adjacent tilting supports (20, 21) one to the other such that, when a leading roller wheel (11) moves down, a trailing roller wheel (12) is pushed up, and vice-versa, via the elastic or visco-elastic connection (23).

WO 2018/024758 A2

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# TRACK SYSTEM FOR A WORK VEHICLE

The present invention relates to a track system for a tracked work vehicle, such as a construction equipment vehicle or a military tracked vehicle or an agricultural vehicle, e.g. a combined harvester or the like.

## BACKGROUND OF THE INVENTION

A tracked work vehicle is provided with a suspension in order to increase adhesion and traction performances on soft grounds, such as grounds affected by a relatively high degree of humidity or grounds having a relatively high quantity of sand.

A rubber tracked vehicle is preferred to satisfy the need for a relatively high speed on paved streets, e.g. during a travel of the work vehicle to and from a construction site or a cultivated field. Furthermore, a rubber track tends to be relatively less expensive than other tracks.

The suspension is normally an undercarriage suspension and provides highest traction performances when the track adheres the ground. Sometimes the surface layer of the ground is not uniform and bodies made of a hard material are found on or immediately below the surface of the ground, such as rocks, spare metallic construction materials such as tubes or the like.

When encountering such an obstacle, it is important to find a compromise between stiffness and kinematic compliance for the design of the track-supporting idlers, rollers and structure of the suspension. Otherwise the track, in particular the rubber track, may undergo excessive wear. In particular it is important that the rollers are sufficiently constrained to provide proper support to the track when the ground is uniformly soft and are mobile enough to retract only in the near surroundings of a hard body on the ground surface. In both instances the scope is to keep or improve traction performances and, at the same time, lower the wear of the track.

## SUMMARY OF THE INVENTION

The scope of the present invention is achieved by providing a rubber track system for a work vehicle with a first and a second tilting supports to attach a relative roller wheel or idler wheel to an undercarriage beam and with an elastic or visco-elastic connection to join first and second adjacent tilting supports one to the other such that, when a leading

wheel moves down, a trailing wheel is pushed up, and vice-versa, via the elastic or visco-elastic connection.

According to the invention, an existing tracked vehicle is retrofittable by providing a first and a second tilting supports to attach a relative roller wheel or idler wheel to an undercarriage beam and with an elastic or visco-elastic connection to join first and second adjacent tilting supports one to the other such that, when a leading wheel moves down, a trailing wheel is pushed up, and vice-versa, via the elastic or visco-elastic connection.

Additional features of the invention are disclosed in the dependent claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, the latter will further be disclosed with reference to the accompanying figures in which:

- Figure 1 shows a work vehicle that can be equipped with the present invention;
- Figures 2a and 2b show respective sketches of the principle underlying present invention;
- Figure 3 is a partial enlarged perspective view with elements hidden for clarity's sake, of a track system according to a first embodiment of the present invention;
- Figure 4 is a partial section view of figure 3 along a plane perpendicular to axes of idler wheels;
- Figure 5 is an enlarged partial side view of a second embodiment of the present invention;
- Figure 6 is a partial perspective view of figure 5 with elements hidden for clarity's sake;
- Figure 7 is a partial section view along a plane perpendicular to axes of idler wheels of a third embodiment of the present invention;
- Figure 8 is a partial perspective view of a fourth embodiment of the present invention;

- Figure 9 is a side view of figure 8; and

- Figure 10 is a partial lateral view of a fifth embodiment of the present invention

DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 refers, as a whole, to a work vehicle 1 comprising a frame 2 and at least two rubber tracked, preferably four, track systems 3 attached to frame 2.

Frame 2 can be a rigid frame and in this case the vehicle may be provided with steering wheels (not shown); or a hinged frame having a front part 4, a rear part 5 hinged to front part 4 about axis A and a steering unit (not shown), preferably a hydraulic steering unit comprising linear actuators, to control the relative angular position of front part 4 with respect to rear part 5 about axis A.

Track system 3 comprises a rubber track 6, a drive wheel 7 extending from a differential (not shown) for driving track 6 and an undercarriage 8 pivoting with respect to frame 2. Undercarriage 8 comprises a front idler wheel 9, a rear idler wheel 10 about which track 6 is wrapped, roller wheels 11, 12, and 13 for guiding track 6, all of which are supported by an undercarriage beam 14, which extends fore-and-aft, and to which wheels 11, 12, 13, 9 and 10 are coupled. While the "front idler wheel," "rear idler wheel," “roller wheel” are singular terms, a plurality of wheels may be provided at each relative position in side-to-side orientation, such as in this embodiment. Advantageously, in order to provide a better contact surface with rubber track 6, at least wheels 11, 12, 13, 9 and 10 are twin wheels, i.e. each wheel comprises two wheels coupled side-to-side.

In particular, undercarriage beam 14 is connected to frame 2 in order to tilt in a plane parallel to axis A and oriented fore-and-aft when vehicle 1 travels along a straight path. Preferably, undercarriage beam 14 is hinged to frame 2 in order to tilt for a maximum of 15 degrees with respect to a neutral position shown in figure 1. Instead, drive wheel 7 is fixed to frame 2.

Each track system 3 further comprise tilting supports 20, 21, 22 to connect a respective roller wheel 11, 12, 13 to undercarriage beam 14 in order to provide one or more degrees of freedom to such rollers with respect to beam 14. Preferably tilting supports 20, 21, 22 are rigid rockers.

In addition track system 3 comprises at least one elastic or visco-elastic connection 23 to connect two adjacent tilting supports in such a way that an upwards motion of a leading roller, e.g. during climbing on an obstacle 24 (figure 2), applies a downwards action on the adjacent trailing roller and vice versa, such action being transmitted through the elastic or visco-elastic connection. In view of such desired effect, there is a specific ratio between connections 23 and rollers, i.e. given N rollers there are N-1 connections 23.

Preferably, the elastic or visco-elastic connection is preloaded in order to increase the tension of the track after mounting of the latter about drive wheel 7 and idler wheels 9, 10. Furthermore, the connection can be either passive, i.e. including a spring and a damper that are pre-set during assembly or by the user before a specific mission of vehicle 1, or active, i.e. including actuators to change the stiffness and/or the damping of the connection when vehicle 1 is working.

Preferably, the connection is visco-elastic and comprises inserts, e.g. a pack of discs, or bushings of a rubber material possibly reinforced either by particles or fibres or by one or more woven or non-woven layers. Rubber inserts or bushings are loaded to transfer the target action by either compression or shear or a combination of the two.

According to the functional sketch of figure 2, each tilting support 20, 21, 22 comprises a first end portion 25 carrying a relative roller 11, 12, 13 and a second end portion 26 projecting on an opposite side of the first end portion with respect to a hinge 27 for connection of the tilting support to undercarriage beam 14. In order to transfer the desired action from a leading roller to a trailing roller and vice versa, elastic or visco-elastic connection 23 is located between second end portion 26 of a tilting support and first end portion 25 of an adjacent tilting support. Rubber connection 23 may either attach to first end portion 25 at an opposite side of hinge 27 with respect to the relative roller (as shown in figure 2) or attach to end portion 25 on the same side of hinge 27 with respect to the relative roller. It is possible that the tilting support attached to the last or first roller is not provided with second end portion 26, as shown in figure 2.

According to a first constructive embodiment of the invention (figure 3), tilting supports 20, 21, 22 are located below the undercarriage beam 14 and hinges 27 for connection with tilting supports are defined by stirrups 28 extending from beam 14 towards the ground opposite to driving wheel 7. In particular, tilting supports 20, 21, 22 are hinged

one to the other. To do so, first and second end portions 25, 26 define an angle between 90° and 180° and hinge 27 is located in a vertex portion 29 of tilting support 20, 21, 22 formed between first and second end portions 25, 26. Angle between first and second end portions 25, 26 of the same tilting support 20, 21, 22 can be measured between lines converging in hinge 27 from the roller axis and the hinge for connection with the adjacent tilting support (dash-dotted lines in figure 4).

Furthermore the elastic or visco-elastic connection 23 is located below undercarriage beam 14 and comprises a rubber bushing mounted in hinge 31 for connection between two adjacent tilting supports 20, 21, 22. Preferably, the shape of tilting supports 20, 21, 22 and the position of hinges 27 and 31 is such to provide a kinematically fixed configuration. This means that, if the rubber bushing 23 were substituted by a rigid body, rollers 11, 12, 13 and tilting supports 20, 21, 22 could not move one with respect to the other. In such a condition, the provision of rubber bushings 23 in hinges 31 and optionally also in hinges 27 provides, by means of compression of the bushings depending on the obstacles encountered by track 6, relatives degrees of freedom between tilting supports 20, 21, 22 and, accordingly, between rollers 11, 12, 13. Such configuration therefore provides kinematic liability only in view of the fact that rubber bushings 23 are deformable. This results in a relatively stiff configuration of the suspension, i.e. the combination of tilting supports and elastic or visco-elastic connection.

The embodiment of figures 5 and 6 differs from that of figures 3 and 4 in that connection 23 is purely elastic and at least in part faces lateral sides 35 of undercarriage beam 14. Furthermore connection 23 is articulated so that tilting supports 20, 21, 22 are kinematically liable because of the combination of an articulation and an elastic element. This provides a configuration that is less stiff with respect to that of figures 3 and 4. In particular, the articulation of connection 23 is such that, in order to obtain the desired effect that a leading roller moving down lifts up via connection 23 a trailing roller and vice versa, connection is between second end portions 26 of respective adjacent tilting supports.

In greater detail elastic connection 23 comprises, for each tilting support 20, 21, 22, a rocker 36 hinged to side 35; and a link 37 for connection to the second end portion 26. Rocker 36 and link 37 define an articulated joint. In order to provide a proper preload on rollers 11, 12, 13, in particular a pre-load such to tension track 6, elastic connection 23

comprises a spring 38, preferably a coiled spring, to apply a load on the articulated joint comprising rocker 36 and link 37. In particular spring 38 connects articulated joints transmitting loads to adjacent rollers. According to embodiment of figure 4 springs are attached to the articulated joint in order to be tensioned and not compressed.

As shown in figure 5, each rocker 36 comprises end portions 39, 40 opposite with respect to hinge 41. End portion 39 is attached to second end portion 26 via link 37 and end portion 40 is attached to the articulated joint of the adjacent roller via spring 38.

In view of the increased level of liability for the tilting of rollers 11, 12, 13, the embodiment of figure 5 comprises, for each tilting support 20, 21, 22 or connection 23, a relative stop 42 defining by abutment the closest position of a relative roller to undercarriage beam 14. Stop 42 is preferably carried on first end portion 25 by the relative tilting support 20, 21, 22.

Alternative embodiment of figure 7 is similar to that of figures 5 and 6, with the only difference that connection 23 is constituted of an elastic or visco-elastic link 45 to connect second end portion 25 and first end portion 25 of adjacent tilting supports. Link 45 is mounted below undercarriage beam 14 and is hinged between adjacent tilting supports. Link 45 can be, for example, a compression spring optionally with a friction damping device.

Further embodiment of figures 8 and 9 is similar to that of figure 7, with the only difference that connection 23 is a rubber block 50, preferably a reinforced rubber block, defining a deformable spacer between adjacent tilting supports 20, 21, 22. Rubber block 50 is compressed when adjacent tilting supports rotate in opposite angular directions. In order to provide proper absorption and/or load resistance, rubber block 50 shall have suitable dimensions and, to this regard, angular position between first and second end portions 25, 26 is comprised between 135° and 90°.

Rubber block 50 is located below undercarriage beam 14 and is preferably carried by the relevant tilting support 20, 21, 22. Conveniently rubber block 50 is interference fitted between second end portion 26 and first end portion 25 of adjacent tilting supports in order to provide, after mounting, a tensioning action on track 6. Rubber block 50 is preferably attached to one of the adjacent tilting supports and abuts without being attached to the other of the adjacent tilting supports.

As a preferable common feature to all embodiments discussed in the present application, rollers 11, 12, 13 comprise a first and a second wheel 60, 61 rigidly connected one to the other by a shaft 62. Each shaft 62 is pivotably attached to first end portion 25 of the relative tilting support in order to provide a rotational degree of freedom about and axis that is co-planar to a mid-plane of track 6 and/or of shaft 62.

Preferably (figure 4), pivoting axis of shaft 62 is defined by a pin 63, in particular a screwable pin, attached in a dedicated seat within first end portion 25. Shaft 62 is attached to pin 63. In order to restore a neutral position, i.e. a position wherein shaft 62 is substantially parallel to axes of drive wheel 7 and idler wheels 9, 10, a resilient element 64 acts on shaft 62. Preferably resilient element is housed at least in part or wholly within first end portion 25. According to one embodiment, resilient element 64 comprises rubber bushings, or a pack of rubber discs or the like and is coaxial to shaft 62.

It is preferable that elastic or visco-elastic connection 23 is designed such that, when travelling on a paved street, at least front idler wheel 9, preferably also idler wheel 10, are lifted from the paved surface. Without a prejudice to the stability of the work vehicle, this decreases wear on rubber track 6.

Figure 10 shows a further embodiment of the present invention wherein front idler wheel 9 is tilting with respect to undercarriage beam 14 and is attached to roller wheel 11 via connection 23 in order to obtain the desired effect that if leading idler wheel 9 moves down, the trailing roller wheel 11 moves up via connection 23 and vice versa.

In particular, a tilting support 70 is connected via hinge 71 to undercarriage beam 14 and carries front idler wheel 9. Tilting support 70 also carries a controllable tensioning apparatus 72, known in the art, to control the position of idler wheel 9 with respect to undercarriage beam 14. Preferably tensioning apparatus 72 comprises a pivoting link 73 connected to idler wheel 9 so that the latter is movable with respect to tilting support 70, and a tensioner or an actuator, preferably an hydraulic actuator, attached to idler wheel 9 or link 73 in order to apply a force and, thus, adjust the tension of track 6.

In order to obtain the desired effect cited in preceding passages of the description, second end portion 26 of tilting support 20 is attached to tilting support 70 via link 45.

The advantages of a track system according to the present invention are the following.

The provision of tilting supports connected one to the other by elastic or visco-elastic connections provides the combined effect of increasing effectiveness to overcome obstacles and, at the same time, reduce the wear of the track. Indeed a controlled compliance of the rollers is such to avoid tension peaks within the track when the ground is rough or non-homogeneous.

Embodiments where the connection 23 comprises an articulated joint and elastic or visco-elastic elements are hinged on the lateral side of undercarriage beam provide a layout that is efficient to reduce the distance between undercarriage beam 14 and rollers 11, 12, 13.

Embodiments where connections 23 are located below undercarriage beam 14 provide the lowest possible impact on undercarriage beam.

It is clear that changes and variations are applicable to the work vehicle according to the present invention without departing from the scope of protection as defined in the attached claims.

For example, track 6 can be arranged along a triangular path, as shown e.g. in figure 1, or along other paths. This may increase or reduce the number of idler wheels with respect to the embodiments discussed in the preceding paragraphs.

When at least three rollers are provided to guide track 6, two rollers may be attached to a single rigid and tilting support such as e.g. a walking beam, in order to rigidly tilt one with respect to the other when track 6 runs on an obstacle 24.

It is possible to retrofit existing work vehicles with a kit comprising at least the undercarriage beam (14), tilting supports 20, 21, 22 and connection 23.

CLAIMS

1. Track system (3) for a work vehicle, comprising a driving wheel (7), an undercarriage beam (14) hinged to a frame (2) of the vehicle, at least one idler wheel (9), at least a first and a second roller wheels (11, 12) attached to the undercarriage beam (14) and a rubber track (6) wound about at least driving wheel (7), idler wheel (9), first and second roller wheels (11, 12), comprising a first and a second tilting support (20, 21) to attach a relative roller wheel (11, 12) or idler wheel (9) to the undercarriage beam (14) and an elastic or visco-elastic connection (23) to join first and second adjacent tilting supports (20, 21) one to the other such that, when a leading wheel (11) moves down, a trailing wheel (12) is pushed up, and vice-versa, via the elastic or visco-elastic connection (23); and wherein at least a tilting support (20, 21) is below the undercarriage beam (14) characterized in that the connection (23) comprises at least one of a link (37, 45) and rocker (36) and wherein for each tilting support (20, 21) the at least one of a link (37, 45) and rocker (36) define an articulated joint wherein the connection (23) applies a load on the articulated joint and the connection (23) transmits loads to adjacent rollers (9, 10, 11).

2. Track system according to claim 1, wherein adjacent tilting supports (20, 21) and connection (23) define a kinematic structure that is configured to displace at least the leading and the trailing roller wheels (11, 12) because of the sole deformation of connection (23) or because connection (23) is articulated.

3. Track system according to claims 1 or 2, wherein at least one roller wheel comprises a first and a second wheels (60, 61), and a shaft (62) to connect first and second wheels (60, 61), the shaft being pivotally attached to a relevant tilting support (20, 21, 22).

4. Track system according to claim 3, wherein a spring (63) is provided to restore a neutral position of the shaft (62) such that the shaft is substantially parallel to axes of the idler wheel and/or the driving wheel (9, 7).

5. Track system according to any of the preceding claims, wherein connection (23) comprises a rubber bushing mounted at a hinge point (31) connecting the adjacent pivoting supports (20, 21), said busing being below the undercarriage beam (14).

6. Track system according to claim 5, wherein a further rubber bushing is mounted at a further hinge point (27) connecting the tilting support (20, 21) to the undercarriage beam (14).

7. Track system according to claim 1, wherein the rocker (36) and the link (37) are hinged one to the other and the rocker (36) faces a lateral side (35) of the undercarriage beam (14).

8. Track system according to claim 1, wherein the link (45) is hinged between the adjacent tilting supports (20, 21) and is located below the undercarriage beam (14).

9. Track system according claim 1, wherein tilting supports comprise a tensioning apparatus (73) for the idler wheel (9) and the link (45) is hinged to transfer a load between the idler wheel (9) and a roller wheel (11).

10. Track system according to any of claims 1 to 4, wherein connection (23) is a rubber block (50) carried on one of the adjacent tilting supports (20, 21) and abutting on the other of the adjacent tilting supports (20, 21).

11. Track system according to any of the preceding claims, wherein the elastic or visco-elastic connection (23) is pre-loaded in order to tension the track (6).

12. Method of retrofitting a work vehicle with a track system (3) according to claim 1.

13. Method according to claim 13, wherein first and second roller wheels (11, 12) are twin wheels.

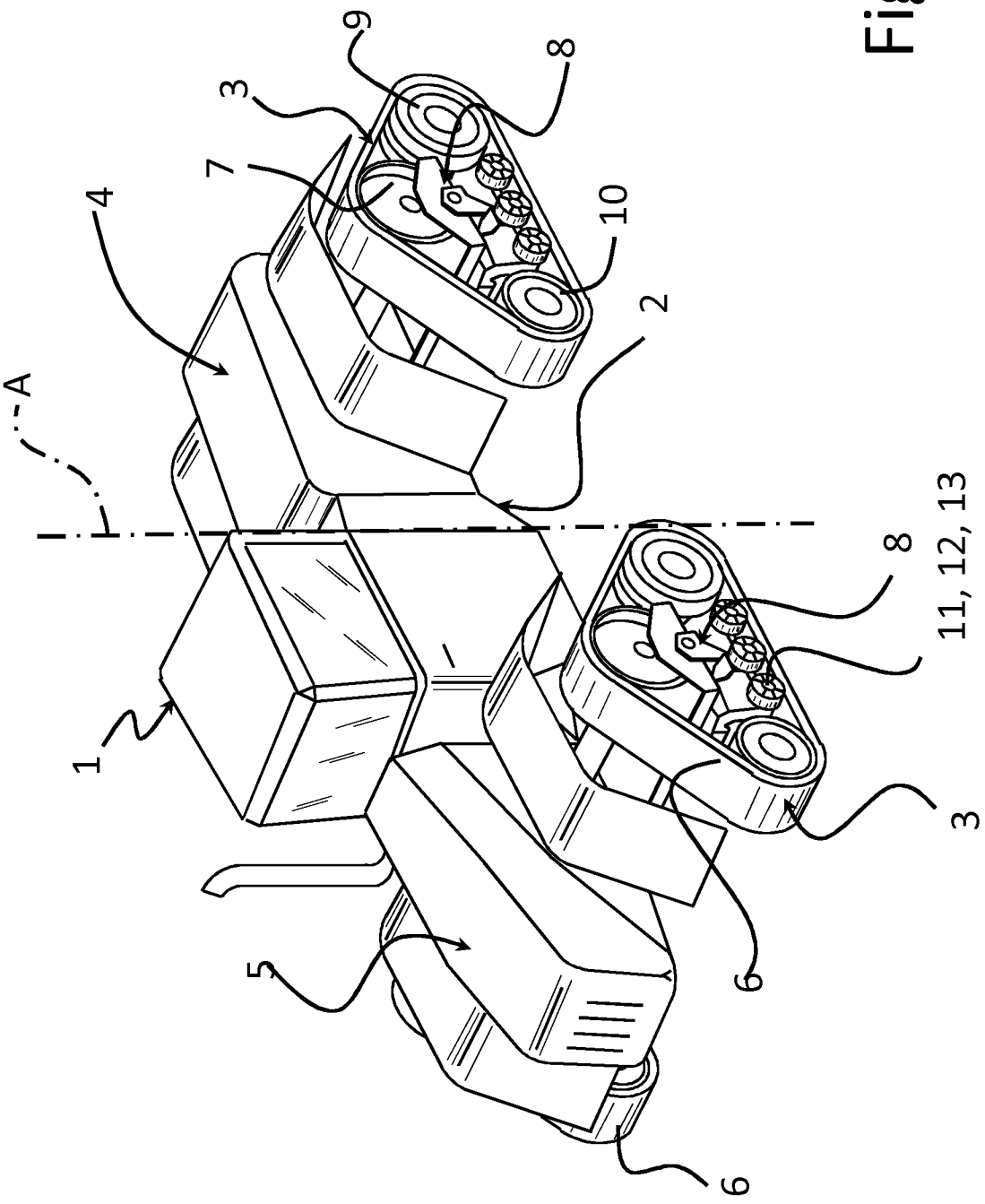


Fig 1

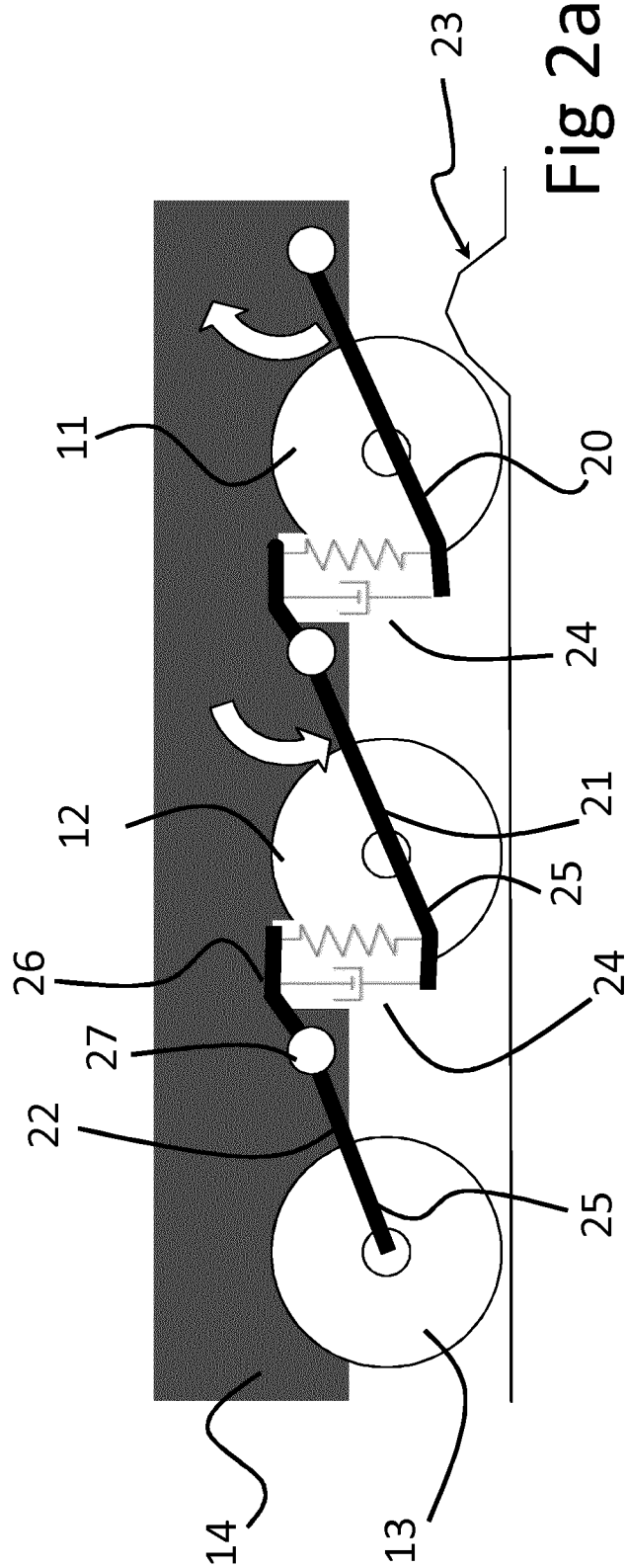
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Fig 2a

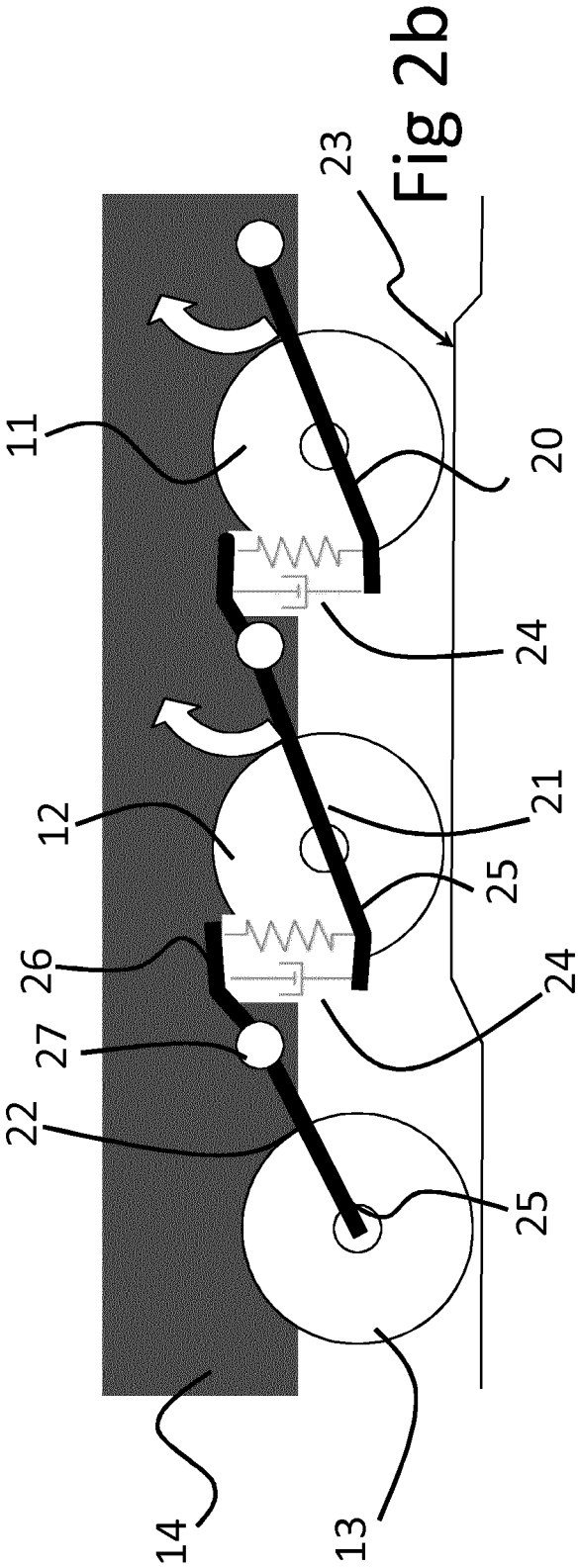
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Fig 2b

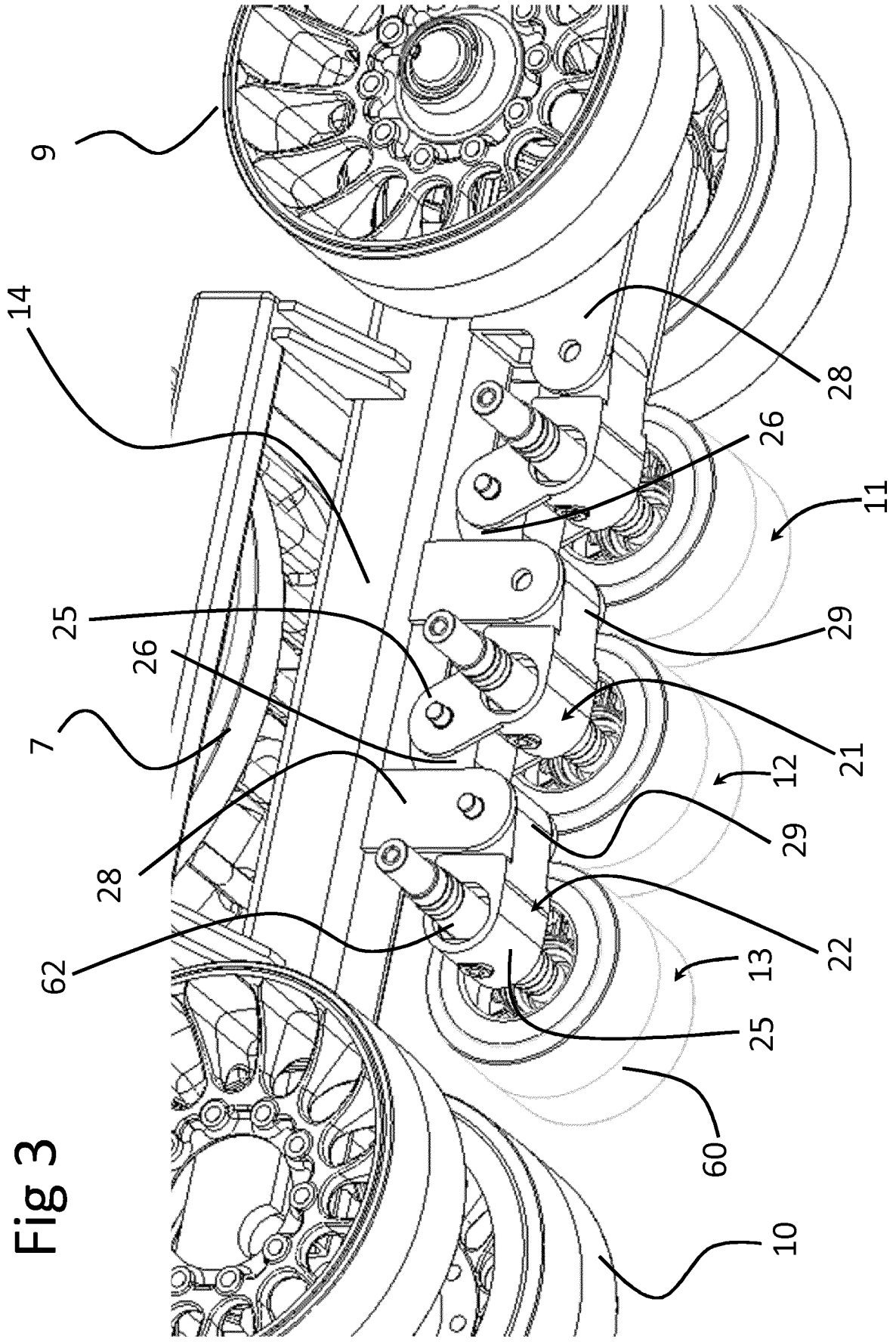


Fig 3

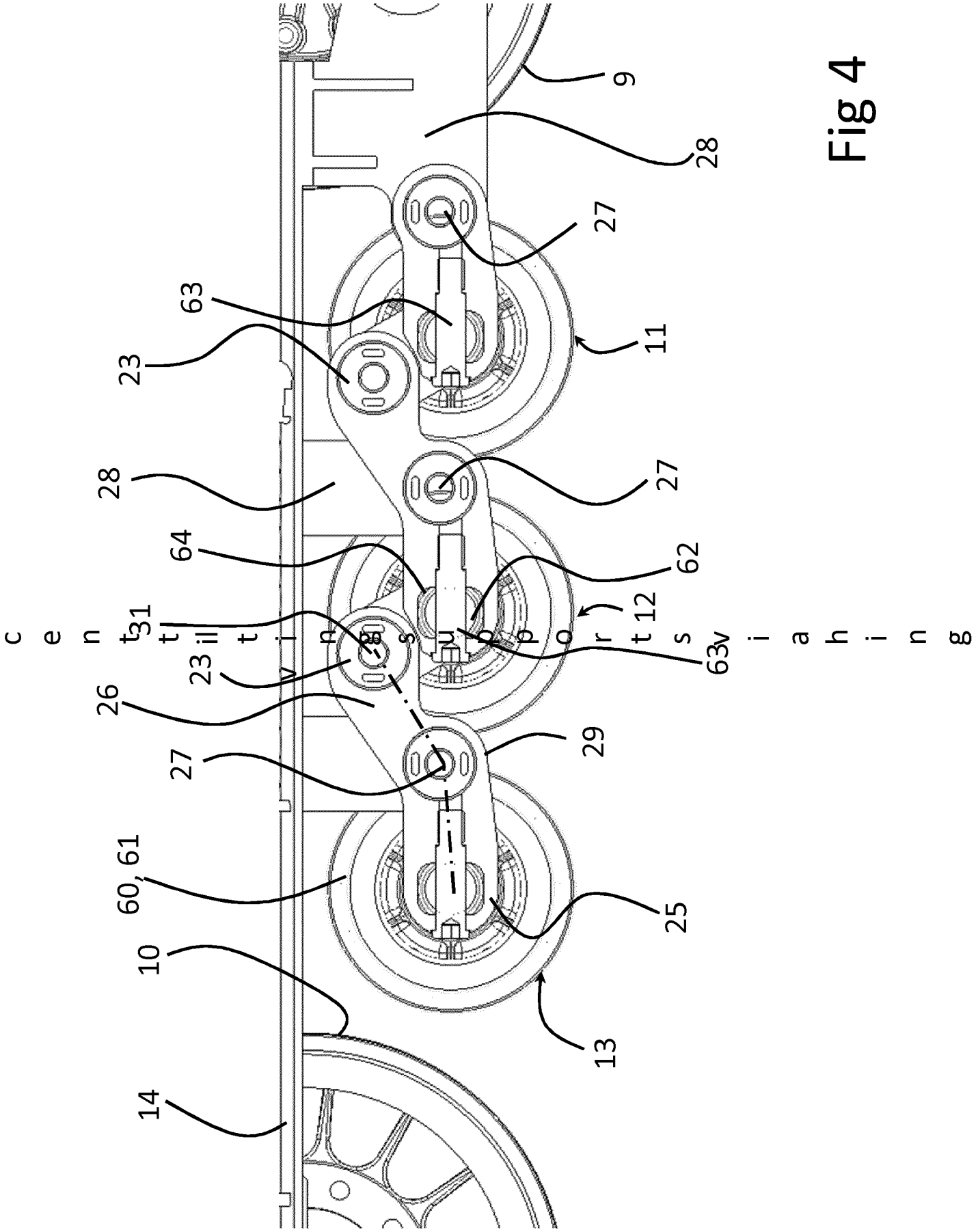


Fig 4

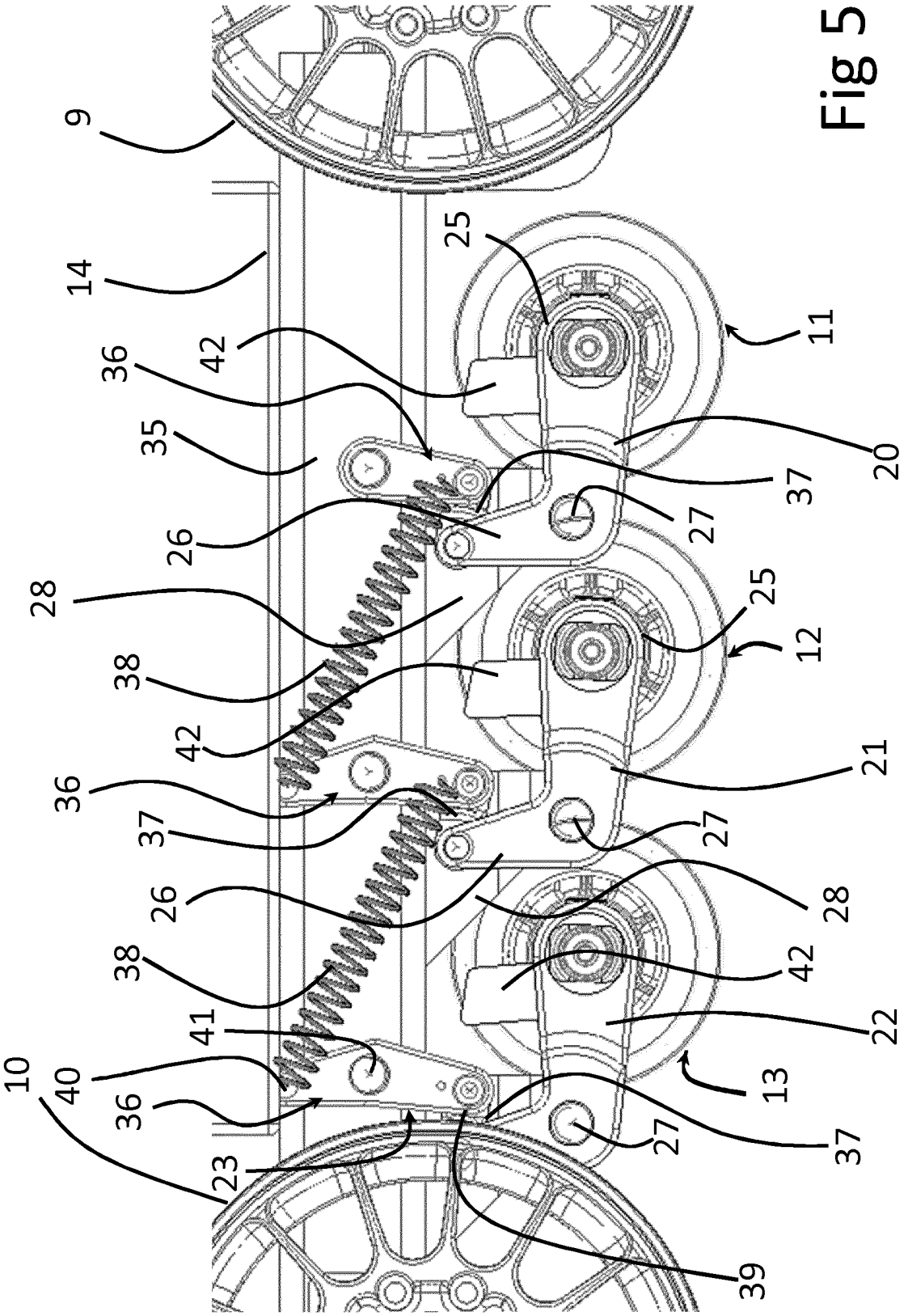
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Fig 5

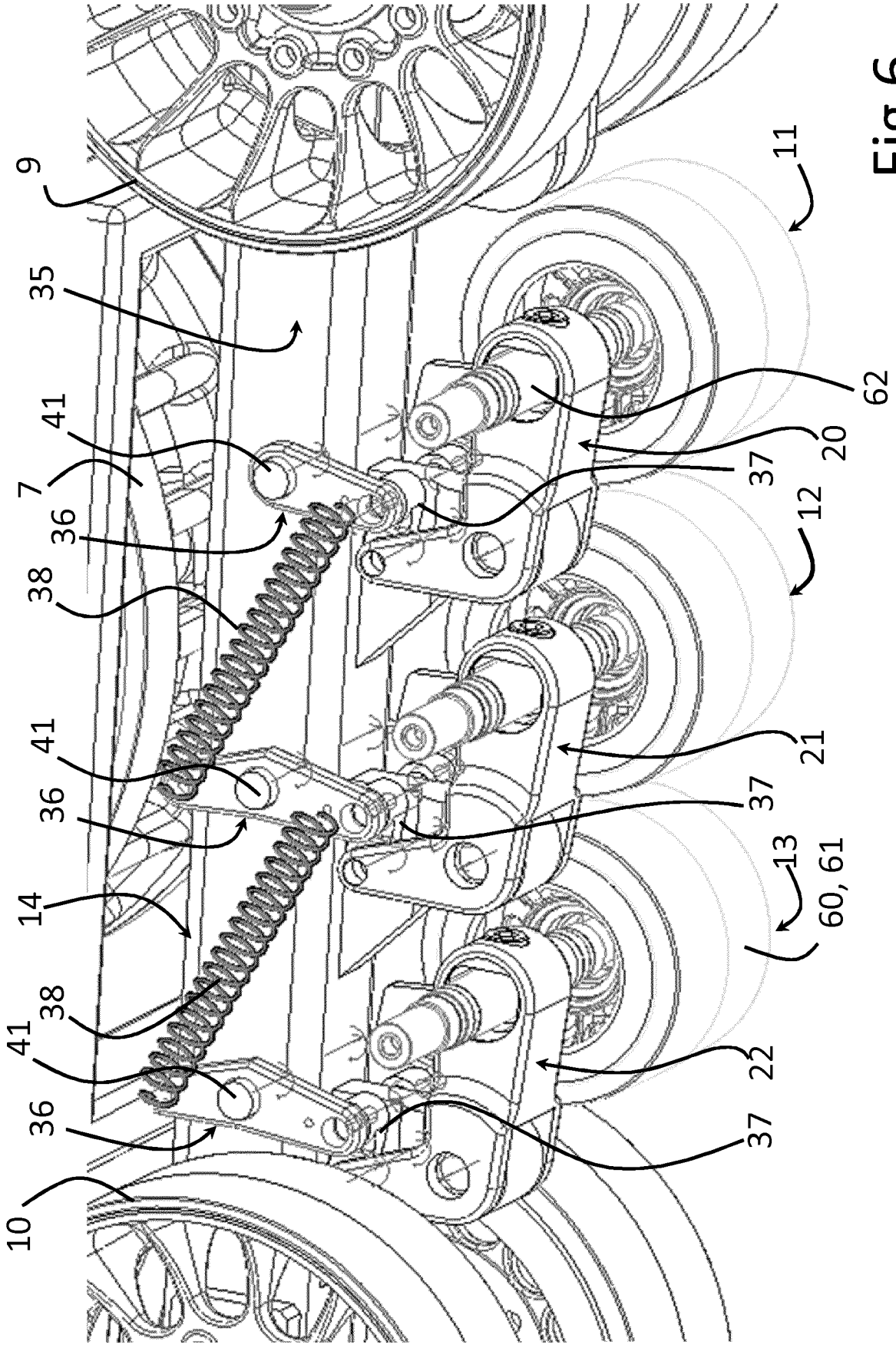


Fig 6

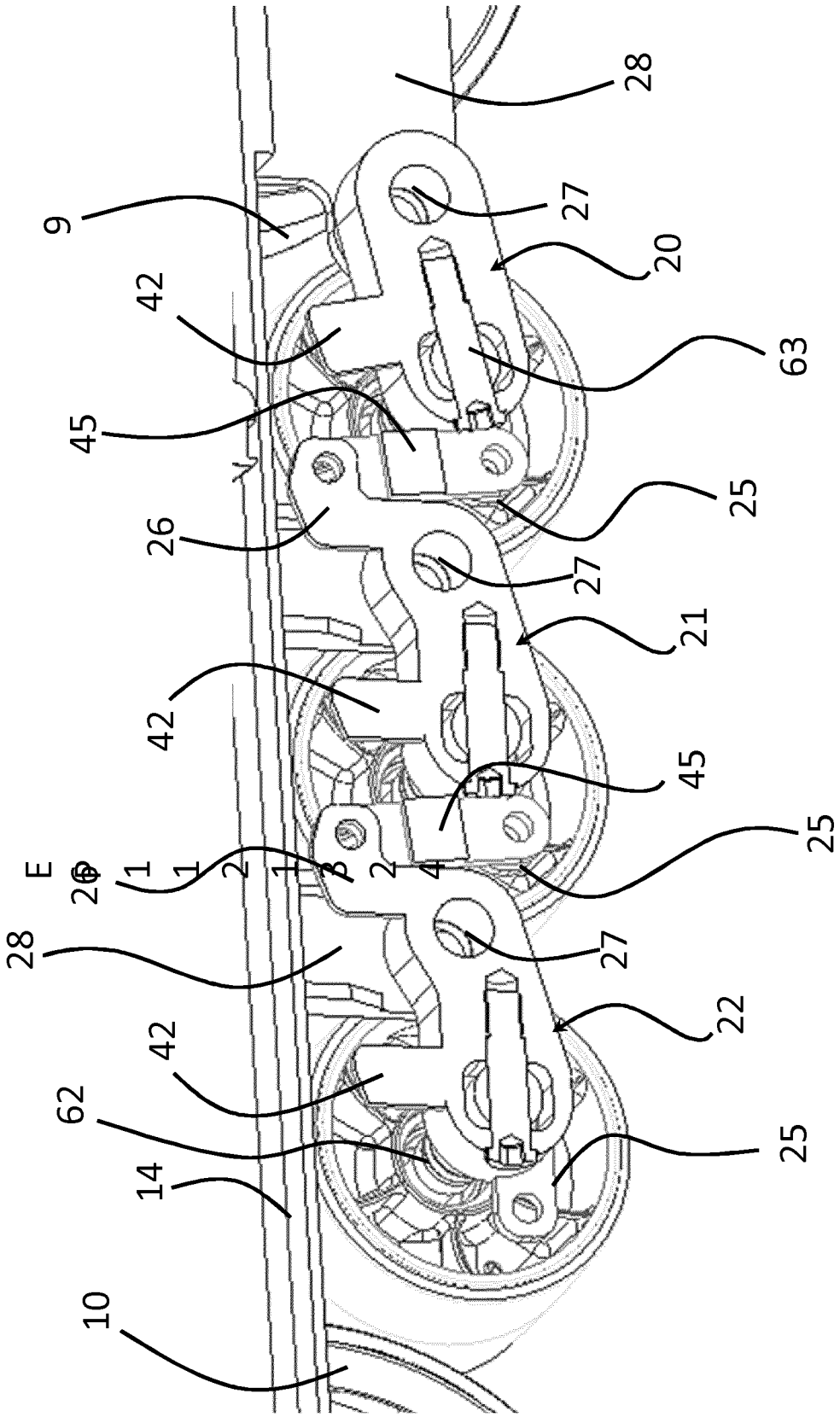


Fig 7

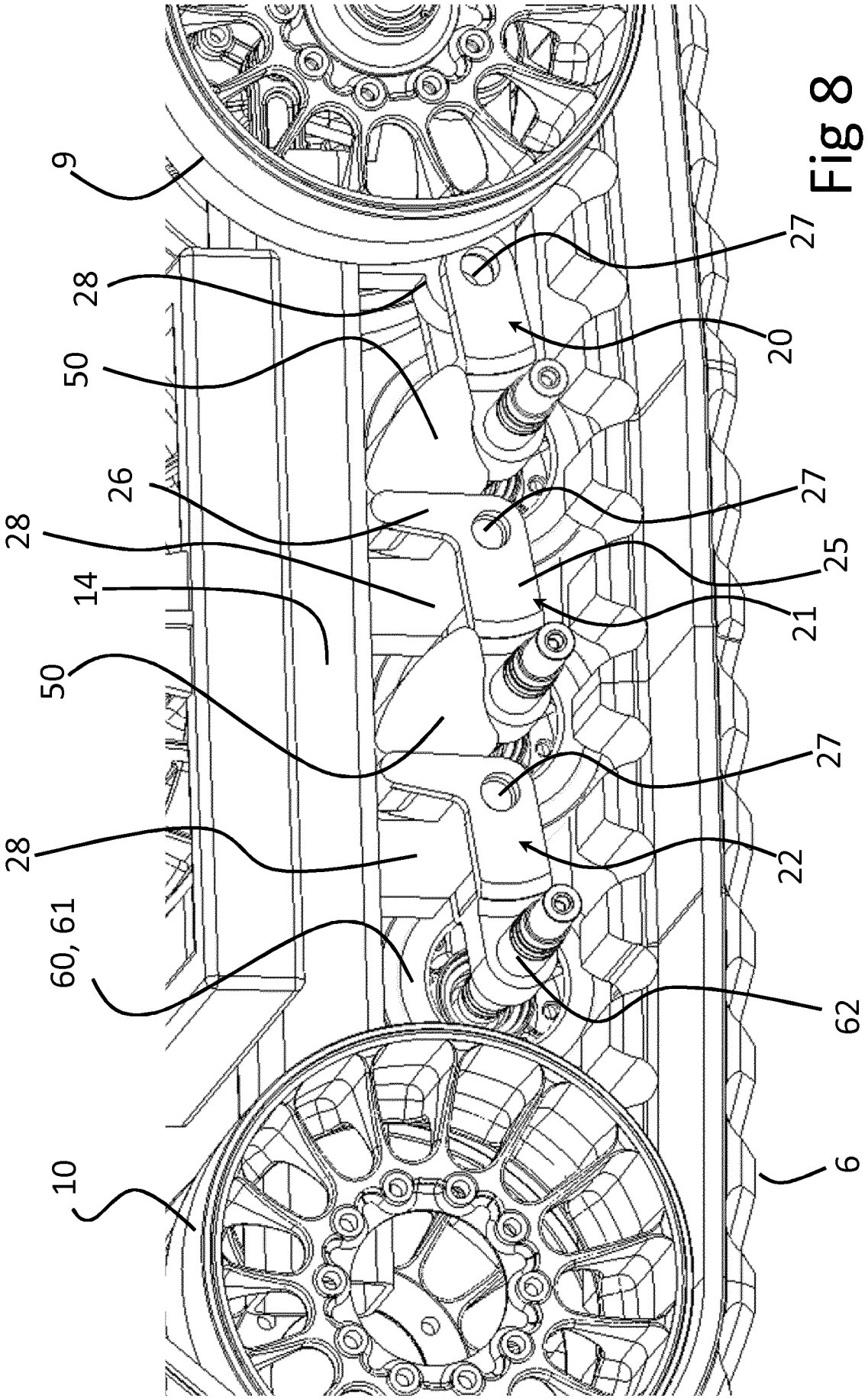


Fig 8

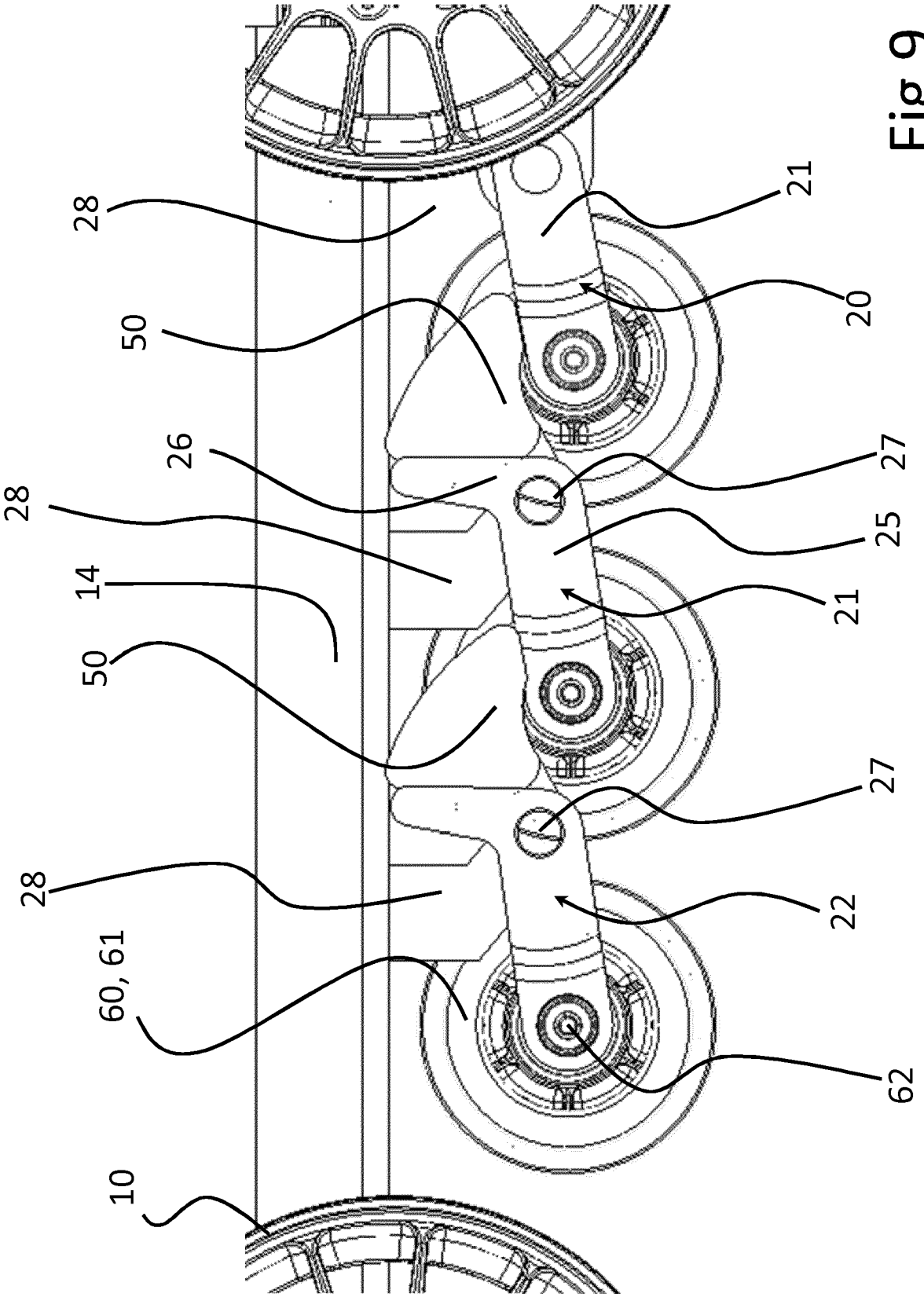


Fig 9

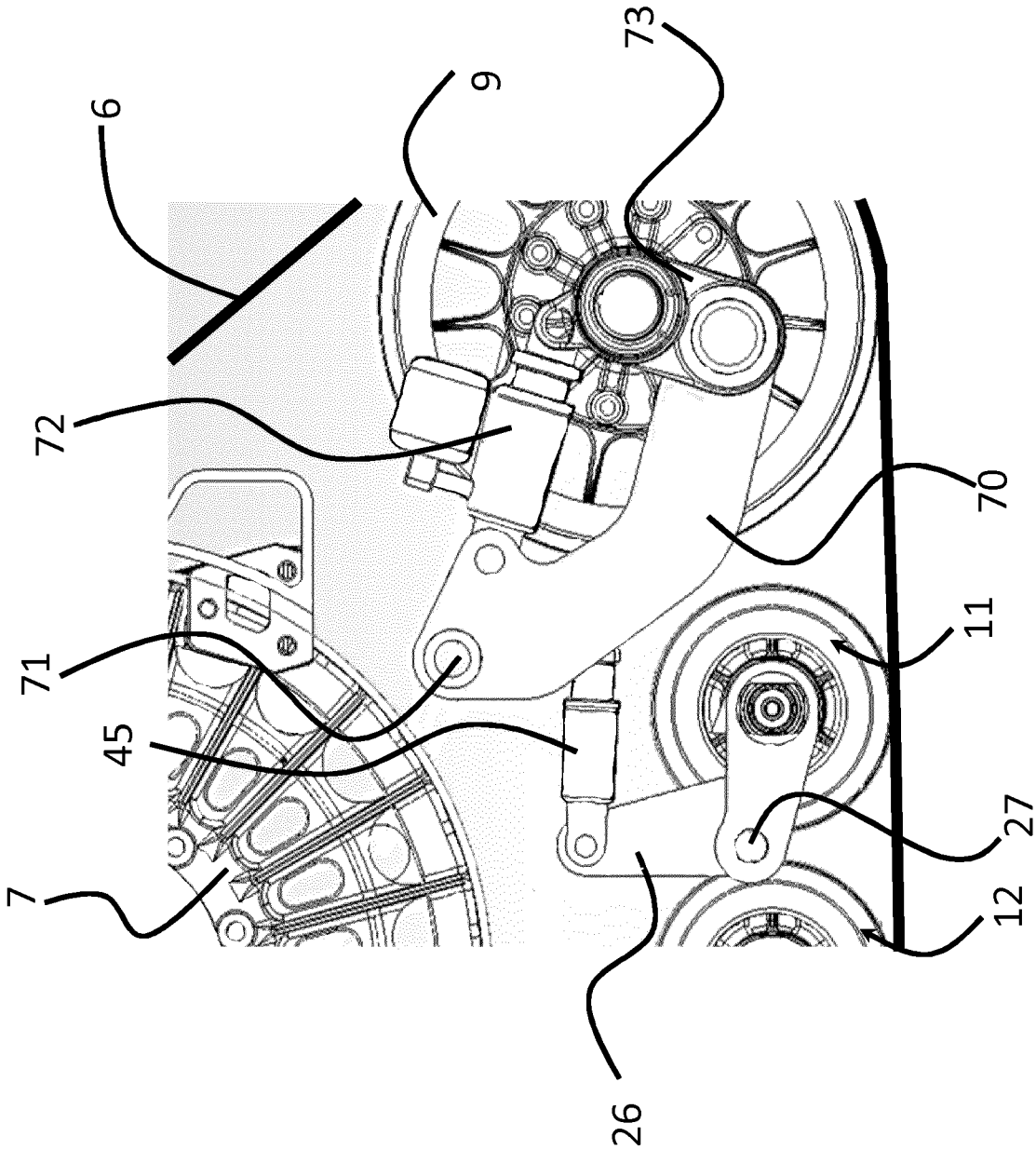


Fig 10