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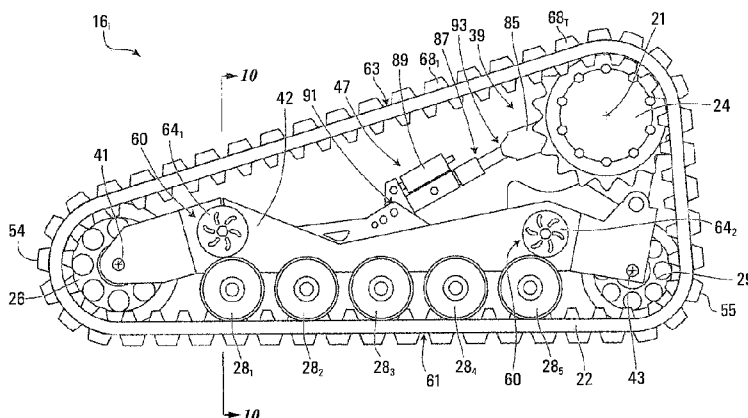


FIG. 3

(57) Abstract: A track system for traction of a vehicle (e.g., a construction vehicle such as a compact track loader). The track system comprises a track comprising a ground- engaging outer side for engaging the ground and an inner side opposite to the ground-engaging outer side. The track system comprises a track-engaging arrangement for driving and guiding the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel for driving the track and a plurality of roller wheels for rolling on the inner side of the track along a bottom run of the track. The track system comprises a frame for supporting components of the track system, including the roller wheels. The frame may be configured to avoid constraining the roller wheels, which may allow the roller wheels to be wider and better distributed loading onto the track. A rolling contact interface between a roller wheel and the inner side of the track may be nonparallel to a widthwise direction of the track.



TRACK SYSTEM FOR TRACTION OF A VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from U.S. Provisional Patent Application 62/117,776 filed on February 18, 2015 and U.S. Provisional Patent Application 62/188,564 filed on July 3, 2015, which are hereby incorporated by reference herein.

FIELD OF THE INVENTION

The invention relates generally to off-road vehicles (e.g., construction vehicles, agricultural vehicles, etc.) and, more particularly, to track systems for providing traction to such vehicles.

BACKGROUND

Certain off-road vehicles may be equipped with track systems which enhance their traction and floatation on soft, slippery and/or irregular grounds (e.g., soil, mud, sand, ice, snow, etc.) on which they operate.

Such track systems include a track which is driven and guided by a track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to drive the track and one or more other wheels to guide and/or transfer loading to the track, such as one or more idler wheels and/or one or more roller wheels.

Interaction between the track-engaging arrangement and the track can create stresses leading to wear or other deleterious effects. For example, roller wheels

may create stresses in certain regions of the track that can cause wear or other deterioration of the track.

For these and other reasons, there is a need for improvements in track systems for traction of vehicles.

SUMMARY OF THE INVENTION

In accordance with a broad aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The frame is free of supporting structure for the roller wheels between the roller wheels and the lateral edges of the track.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel

and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The frame is configured such that at least a majority of each of the roller wheels is exposed when viewing the track system in a widthwise direction of the track system.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The frame extends between laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges. The track system

also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. A ratio of a total width of peripheral surfaces of laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system over a width of the track is at least 0.28.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground and a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, lateral edges, and a plurality of cores at least partially embedded in the elastomeric material. Each core of the plurality of cores extends transversally to a longitudinal direction of the track. A ratio of a length of the core over a width of the track is no more than 0.85.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, lateral edges, and a plurality of cores at least partially embedded in the elastomeric material. Each core of the plurality of cores extends transversally to a longitudinal direction of the track. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The core does not extend beyond outer lateral edges of each of the roller wheels in a widthwise direction of the track system.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The vehicle comprises a frame. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of

the trailing idler wheel. The track system also comprises a mount for resiliently interconnecting the frame of the track system and the frame of the vehicle.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The vehicle comprises a frame. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The track system also comprises a mount for slidably mounting the track system to the frame of the vehicle.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a plurality of roller wheels to roll on a bottom run of the track, and a shaft carrying laterally-adjacent ones of the roller wheels which are adjacent to one another in a widthwise direction of the track such that the shaft and the laterally-adjacent ones of the roller wheels are rotatable together.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels, and a resilient mount between laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system and the frame of the track system. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The

drive wheel comprises a plurality of drive wheel members that are separately mountable into and removable from the track system.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track. The track comprises a ground-engaging outer side for engaging the ground, and an inner side opposite to the ground-engaging outer side. The track comprises elastomeric material and a plurality of cores at least partially embedded in the elastomeric material. Each core of the plurality of cores extends transversally to a longitudinal direction of the track. The track system also comprises a track-engaging arrangement for driving and guiding the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel for driving the track and a plurality of roller wheels for rolling on the inner side of the track along a bottom run of the track. A rolling contact interface between a roller wheel of the plurality of roller wheels and the inner side of the track is nonparallel to a widthwise direction of the track.

In accordance with another aspect, there is provided a track for traction of a vehicle. The track is mountable around a track-engaging arrangement for driving and guiding the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel for drive the track and a plurality of roller wheels for rolling along a bottom run of the track. The track comprises a ground-engaging outer side for engaging the ground, an inner side opposite to the ground-engaging outer side, elastomeric material, and a plurality of cores at least partially embedded in the elastomeric material. Each core of the plurality of cores extends transversally to a longitudinal direction of the track. The inner side comprises a rolling path for a roller wheel of the plurality of roller wheels. The rolling path is nonparallel to a widthwise direction of the track.

In accordance with another aspect, there is provided a roller wheel for a track system for traction of a vehicle. The track system comprises a track. The track

comprises a ground-engaging outer side for engaging the ground, an inner side opposite to the ground-engaging outer side, elastomeric material, and a plurality of cores at least partially embedded in the elastomeric material. Each core of the plurality of cores extends transversally to a longitudinal direction of the track. The track system comprises a drive wheel for driving the track. The roller wheel is configured to roll on the inner side of the track along a bottom run of the track. The roller wheel comprises a first lateral surface and a second lateral surface opposite one another. The roller wheel also comprises a peripheral surface between the first lateral surface and the second lateral surface and configured to roll on the inner side of the track. The peripheral surface is nonparallel to an axis of rotation of the roller wheel.

In accordance with another aspect, there is provided a track system for traction of a vehicle. The track system comprises a track to engage the ground. The track comprises elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges. The track system also comprises a track-engaging arrangement to drive and guide the track around the track-engaging arrangement. The track-engaging arrangement comprises a drive wheel to impart movement to the track, a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, and a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels. A distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel is different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel. The track system comprises a tensioner to maintain the track in tension. The tensioner comprises a piston-cylinder mechanism and a fluidic accumulator that are disposed between the lateral edges of the track.

These and other aspects of the invention will now become apparent to those of ordinary skill in the art upon review of the following description of embodiments of the invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of embodiments of the invention is provided below, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a tracked vehicle in accordance with an embodiment of the invention;

Figure 2 shows a perspective of a track system of the tracked vehicle;

Figure 3 shows a side view of the track system;

Figures 4 and 5 respectively show an inside top view and a cross-sectional view of a track of the track system;

Figure 6 shows a cross-sectional view of a portion of the track system, including a frame and roller wheels of the track system;

Figure 7 shows a cross-sectional view of a portion of the track system, including the frame and an idler wheel of the track system;

Figure 8 shows another cross-sectional view of a portion of the track system;

Figure 9 shows a cross-sectional view of the track;

Figure 10 shows an isometric sectional view of the track system taken along line 10-10 of Figure 2;

Figure 11 shows a cross sectional view of a support installed on the work vehicle;

Figure 12 shows a resilient mount of a mounting arrangement of the track system;

Figure 13 shows a perspective view of a wheel assembly of the track system;

Figure 14 shows a cross-sectional view of the wheel assembly;

Figure 15 shows a top view of the wheel assembly;

Figure 16 shows a connection between the wheel assembly and a frame of the track system;

Figure 17 shows another embodiment of the wheel assembly in which the wheel assembly comprises a suspension;

Figure 18 shows the wheel assembly of Figure 17 installed on the track system;

Figure 19A shows a drive wheel of the track system in accordance with an embodiment in which the drive wheel comprises a plurality of drive wheel members;

Figure 19B shows a front view of the drive wheel of Figure 19A;

Figures 20 to 22 show different embodiments of an idler wheel assembly of the track system;

Figure 23 show a prior art track system in which a camber is implemented and uncompensated;

Figure 24 shows a cross-sectional view of the resilient mount of the mounting arrangement in a first configuration when there is no camber angle implemented;

Figure 25 shows a cross-sectional view of the resilient mount of the mounting arrangement in a second configuration when there is a camber angle implemented;

Figure 26 shows the track system compensating for a camber via the mounting arrangement;

Figure 27 shows a cross-sectional view of a track and a roller wheel in accordance to a variant of the track system; and

Figure 28 shows a detailed view of a rolling contact interface between the roller wheel and the track of the track system of Figure 27.

It is to be expressly understood that the description and drawings are only for the purpose of illustrating certain embodiments of the invention and are an aid for understanding. They are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Figure 1 shows a tracked vehicle 10 in accordance with an embodiment of the invention. In this embodiment, the tracked vehicle 10 is a construction vehicle for performing construction work. More particularly, in this example, the construction vehicle 10 is a compact track loader. For instance, in some embodiments, the compact track loader may have a height V_H of about 80 inches, a width V_W of about 70 inches and a length V_L of about 140 inches, and may weigh around 9000 lbs.

The vehicle 10 comprises a frame 12 supporting a powertrain 19, a pair of track systems 16₁, 16₂ (which can be referred to as “undercarriages”), and an operator cabin 20, from which an operator can control the vehicle 10 to move it on the ground and perform construction work using a work implement 18.

The powertrain 19 comprises a prime mover 14 which is a source of motive power to move the vehicle 10. For example, the prime mover 14 may comprise an internal combustion engine and/or one or more other types of motors (e.g., electric motors, etc.) for generating motive power to move the vehicle 10. The prime mover 14 is in a driving relationship with each of the track systems 16₁, 16₂. That is, power derived from the prime mover 14 is transmitted to each of the track systems 16₁, 16₂ via the powertrain 19 of the vehicle 10.

The work implement 18 is used to perform construction work. In this embodiment where the vehicle 10 is a loader, the work implement 18 is a dozer blade that can be used to push objects and shove soil, debris or other material. In other embodiments, the work implement 18 may take on various other forms, such as a backhoe, a bucket, a fork, a grapple, a scraper pan, an auger, a saw, a ripper, a material handling arm, or any other type of construction working implement.

The operator cabin 20 is where the operator sits and controls the vehicle 10. More particularly, the operator cabin 20 comprises a set of controls that allow the operator to steer the vehicle 10 on the ground and perform construction work using the working implement 18.

The track systems 16₁, 16₂ are drivable by the prime mover 14 and engage the ground to propel the vehicle 10 on the ground. With additional reference to Figure 2, in this embodiment, each track system 16_i comprises a track 22 and a track-engaging arrangement 39 for driving and guiding the track 22 around the track-engaging arrangement 39. In this embodiment, the track-engaging arrangement

39 comprises a frame 42 and a plurality of wheels, which includes a drive wheel 24, a front (leading) idler wheel 26, a rear (trailing) idler wheel 29, and a plurality of roller wheels 28₁-28₁₀. In this example, the track system 16_i also comprises a tensioner 47 for adjusting a tension of the track 22. The track system 16_i has a longitudinal axis 17 defining a longitudinal direction of the track system 16_i. The track system 16_i also has a widthwise direction and a height direction that are normal to its longitudinal direction.

The drive wheel 24 is rotatable by power derived from the prime mover 14 for imparting movement of the track 22 in order to propel the vehicle 10 on the ground. The idler wheels 26, 29 and the roller wheels 28₁-28₁₀ do not convert power supplied by the prime mover 14 to motive force, but rather guide the track 22 and/or maintain it under tension as it is driven by the drive wheel 24. The frame 42 supports components of the track system 16_i, including the idler wheels 26, 29 and the roller wheels 28₁-28₁₀. As the track 22 is driven by the drive wheel 24, the roller wheels 28₁-28₁₀ roll on a bottom run 61 of the track 22 to apply it on the ground for traction.

In this embodiment, the track system 16_i has a generally triangular configuration in which an axis of rotation 21 of the drive wheel 24 is spaced from axes of rotation 41, 43 of the front and rear idler wheels 26, 29. More particularly, in this embodiment, the axis of rotation 21 of the drive wheel 24 is spaced from the axes of rotation 41, 43 of the front and rear idler wheels 26, 29 in the height direction of the track system 16_i and in the longitudinal direction of the track system 16_i. In this example, a distance between the axis of rotation 21 of the drive wheel 24 and the axis of rotation 41 of the front idler wheel 26 is different from a distance between the axis of rotation 21 of the drive wheel 24 and the axis of rotation 43 of the rear idler wheel 29. More specifically, in this example, the distance between the axis of rotation 21 of the drive wheel 24 and the axis of rotation 41 of the front idler wheel 26 is greater than the distance between the axis of rotation 21 of the drive wheel 24 and the axis of rotation 43 of the rear idler wheel 29. Thus, the

axis of rotation 21 of the drive wheel 24 is closer to a given one of the axes of rotation 41, 43 of the front and rear idler wheels 26, 29 in the longitudinal direction of the track system 16_i than to the other one of the axes of rotation 41, 43 of the front and rear idler wheels 26, 29. Specifically, in this case, the axis of rotation 21 of the drive wheel 24 is closer to the axis of rotation 43 of the rear idler wheel 29 in the longitudinal direction of the track system 16_i than to the axis of rotation 41 of the front idler wheel 26. The drive wheel 24 is therefore elevated and asymmetrically disposed longitudinally relative to the front and rear idler wheels 26, 29.

The track 22 engages the ground to provide traction to the vehicle 10. With additional reference to Figures 3 and 4, the track 22 comprises an inner side 25, a ground-engaging outer side 27, and lateral edges 31₁, 31₂. The inner side 25 faces the wheels 24, 26, 29, 28₁-28₁₀ and defines an inner area of the track system 16_i in which these wheels rotate. The ground-engaging outer side 27 engages the ground for traction of the vehicle 10. A top run 63 of the track 22 extends between longitudinal ends 54, 55 of the track system 16_i and over the wheels 24, 26, 29, 28₁-28₁₀, while the bottom run 61 of the track 22 extends between the longitudinal ends 54, 55 of the track system 16_i and under the wheels 24, 26, 29, 28₁-28₁₀. In view of its closed configuration without ends that allows it to be disposed and moved around the track-engaging arrangement 39, the track 22 can be referred to as an "endless" track.

The track 22 has a length defining a longitudinal axis 45 and a width defined by its lateral edges 31₁, 31₂. The track 22 thus has a longitudinal direction (i.e., a direction generally parallel to its longitudinal axis 45) and transversal directions (i.e., directions transverse to its longitudinal axis 45), including a widthwise direction (i.e., a lateral direction generally perpendicular to its longitudinal axis 45). The track 22 also has a thickness which defines a thickness direction thereof.

The inner side 25 of the track 22 contacts the wheels 24, 26, 29, 28₁-28₁₀ as the track 22 is in motion around these wheels. Motion of the track 22 is imparted by the drive wheel 24. More particularly, in this embodiment, the drive wheel 24 is a drive sprocket and the track 22 comprises a plurality of openings 33₁-33_N which cooperate with teeth of the drive wheel 24 in order to drive the track 22. As it is driven, the track 22 contacts the idler wheels 26, 29 and the roller wheels 28₁-28₁₀ which help guide the track 22 and maintain it under tension. For instance, a peripheral surface 75 of each roller wheel 28_i between an outer lateral surface 35 and an inner lateral surface 49 of the roller wheel 28_i is in rolling contact with the inner side 25 of the track 22. More specifically, the inner side 25 comprises rolling paths 30₁, 30₂ (i.e., contact interfaces) on which the wheels 28₁-28₁₀ roll to apply the bottom run 61 of the track 22 onto the ground.

The ground-engaging outer side 27 comprises a tread 40 to enhance traction on the ground. The tread 40 comprises a plurality of traction projections 68₁-68_T distributed on the ground-engaging outer side 27 for enhancing traction on the ground. The tread 40 may have any suitable configuration.

The track 22 is elastomeric, i.e., comprises elastomeric material, to be flexible around the track-engaging arrangement 39. The elastomeric material of the track 22 can include any polymeric material with suitable elasticity. In this embodiment, the elastomeric material of the track 22 includes rubber. Various rubber compounds may be used and, in some cases, different rubber compounds may be present in different areas of the track 22. In other embodiments, the elastomeric material of the track 22 may include another elastomer in addition to or instead of rubber (e.g., polyurethane elastomer).

More particularly, the track 22 comprises an elastomeric body 36 underlying the inner side 25 and the ground-engaging outer side 27. In view of its underlying nature, the body 36 will be referred to as a "carcass". The carcass 36 is elastomeric in that it comprises elastomeric material 38 which allows the carcass

36 to elastically change in shape as the track 22 is in motion around the wheels 24, 26, 29, 28₁-28₁₀. A plurality of cores 44₁-44_N are at least partially embedded in the elastomeric material 38. Also, in this embodiment, a layer of reinforcing cables 37₁-37_M is embedded in the elastomeric material 38. The carcass 36 may comprise one or more additional and/or different components, such as one or more other reinforcements (e.g., one or more layers of reinforcing fabrics), embedded in the elastomeric material 38, in other embodiments.

The reinforcing cables 37₁-37_M extend generally parallel to one another and in the longitudinal direction of the track 22 to enhance strength in tension of the track 22 along its longitudinal direction. In this embodiment, each of the reinforcing cables 37₁-37_M is a cord or wire rope including a plurality of strands or wires. In other embodiments, each of the reinforcing cables 37₁-37_M may be another type of cable and may be made of any suitable material (e.g., metal, plastic, or composite material).

The cores 44₁-44_N are distributed along and extend transversally to the longitudinal direction of the track 22 to impart transverse rigidity to the track 22. The cores 44₁-44_N may also help to drive the track 22 by engagement with the drive wheel 24 and/or guide some of the wheels 24, 26, 29, 28₁-28₁₀ as the track 22 is driven by the drive wheel 24.

Each core 44_i, has a longitudinal axis extending transversally (in this case, perpendicularly) to the longitudinal axis 45 of the track 22. In this embodiment, the core 44_i has a length which is shorter than the width of the track 22 such that it has a first longitudinal end 48₁ and a second longitudinal end 48₂ that are spaced apart from the lateral edges 31₁, 31₂ of the track 22. That is, the first longitudinal end 48₁ of the core 44_i is spaced apart from the first lateral edge 31₁ of the track 22 along the track's widthwise direction, and the second longitudinal end 48₂ of the core 44_i is spaced apart from the second lateral edge 31₂ of the track 22 along the track's widthwise direction.

More particularly, in this embodiment, each core 44_i comprises a pair of wings 50₁, 50₂ (i.e., extensions) and a wheel guide 52.

The wings 50₁, 50₂ are elongated along the longitudinal axis of the core 44_i to impart transverse rigidity to the track 22. Each of the wings 50₁, 50₂ has a top surface oriented towards the inner side 25 of the track 22 and a bottom surface oriented towards the ground-engaging outer side 27 of the track 22. In this embodiment, each of the wings 50₁, 50₂ has a tapered shape whereby its top surface converges longitudinally outwardly towards its bottom surface. The wings 50₁, 50₂ may have various other shapes in other embodiments.

The wheel guide 52 is located between the pair of wings 50₁, 50₂ and serves to guide some of the wheels 24, 26, 29, 28₁-28₁₀ as the track 22 is driven by the drive wheel 24. More particularly, in this embodiment, the wheel guide 52 comprises a pair of guide projections 56₁, 56₂ that project on the inner side 25 of the track 22. Each guide projection 56_i comprises a top end, a base, and a pair of wheel-facing sides opposite one another and extending from its base to its top end. The wheel guide 52 may be configured in various other ways in other embodiments (e.g., it may comprise only one guide projection or more than two (2) guide projections).

In this embodiment, the core 44_i, including its wings 50₁, 50₂ and wheel guide 52, is made of metallic material. For instance, in some embodiments, the core 44_i may be made of steel formed into shape by casting. The core 44_i may have various other shapes, may comprise various other components, may be made of various other rigid materials (e.g., polymers, ceramics, composites, etc.), and/or may be made using various other processes (e.g., forging, welding, fastening, etc.) in other embodiments.

The track system 16_i may have various features to facilitate its use and/or enhance its performance and/or that of the vehicle 10 in various embodiments, examples of which will now be discussed.

I. Widthwise extent of the frame and other components of the track system

In some embodiments, the frame 42 of the track system 16_i may be designed to minimize a restriction on a size of the roller wheels 28₁-28₁₀ and/or other components of the track system 16_i.

For example, in this embodiment, as shown in Figure 6, the frame 42 of the track system 16_i is configured to avoid confining the roller wheels 28₁-28₁₀ laterally outwardly, i.e., towards the lateral edges 31₁, 31₂ of the track 22. This may allow the roller wheels 28₁-28₁₀ to be wider and thus better distributed loading onto the track 22.

More particularly, in this embodiment, the frame 42 of the track system 16_i is free of supporting structure between the roller wheels 28₁-28₁₀ and the lateral edges 31₁, 31₂ of the track 22. That is, there is no supporting structure for the roller wheels 28₁-28₁₀ located between the roller wheels 28₁-28₁₀ and the lateral edges 31₁, 31₂ of the track 22. Rather, there is nothing from the track system 16_i between the roller wheels 28₁-28₁₀ and the lateral edges 31₁, 31₂ of the track 22. The frame 42 therefore does not overlap with the roller wheels 28₁-28₁₀ in the height direction of the track system 16_i between the roller wheels 28₁-28₁₀ and the lateral edges 31₁, 31₂ of the track 22. As a result, at least a majority of, and in this case an entirety, of each of the roller wheels 28₁-28₁₀ is exposed when viewing the track system 16_i in the widthwise direction of the track system 16_i.

In this embodiment, the frame 42 extends in a space 67 between laterally-adjacent ones of the roller wheels 28₁-28₁₀ that are adjacent to one another in the

widthwise direction of the track system 16_i. The frame 42 thus supports the laterally-adjacent ones of the roller wheels 28₁-28₁₀ from in between them.

More particularly, in this embodiment, the frame 42 is generally centered in the widthwise direction of the track system 16_i relative to a wheel-assembly of the roller wheels 28₁-28₁₀. As used here, the expression "wheel-assembly" refers to at least two wheels 28_i, 28_j of the wheels 28₁-28₁₀ that are transversally mounted and rotate about a common axis (e.g., wheels 28₁ and 28₆).

In order to minimize a restriction of the size of the wheels 28₁-28₁₀ (e.g., a width W_R of the peripheral surface 75 of the wheels 28₁-28₁₀ with the track 22), in this embodiment, a widthwise extent W_F of the frame 42 of the track system 16_i (i.e., an extent of the frame 42 taken along the widthwise direction of the track system 16_i) is made smaller than a distance W_o measured between the outer lateral edges 35 of the wheels 28_i, 28_j of a wheel-assembly (the outer lateral edge 35 of each of the wheels 28_i, 28_j is the edge that is closest to either of the lateral edges 31₁, 31₂ of the track 22). More specifically yet, in this embodiment, the widthwise extent W_F of the frame 42 is made smaller than a distance W_i measured between the inner lateral edges 49 of the wheels 28_i, 28_j of a wheel-assembly. This makes it possible to locate the frame 42 between the wheels 28_i, 28_j, such as to reduce the overall height of the track assembly 16_i and at the same time make it possible to use wheels 28₁-28₁₀ of a larger width to better support a ground engaging run of the track 22.

Since the width W_R of the peripheral surface 75 of the wheels 28₁-28₁₀ in contact with the track 22 is not restricted by the frame 42, a total width W_{RT} of the peripheral surfaces 75 of the wheels 28₁-28₁₀ of a lateral wheel-assembly may be increased ($W_{RT} = N \times W_R$, where N is the number of wheels that are part of the wheel-assembly). For instance, in some cases, a ratio W_{RT}/W_T of the total width W_{RT} of the peripheral surfaces 75 of the wheels 28₁-28₁₀ of a wheel-assembly over the width W_T of the track 22 may be at least 0.28, in some cases at least

0.3, in some cases at least 0.35, in some cases at least 0.4, in some cases at least 0.45 and in some cases even more than 0.45 (e.g., 0.47, 0.5). For example, in some cases, the ratio W_{RT}/W_T of the total width W_{RT} of the peripheral surfaces 75 of the wheels 28₁-28₁₀ of a wheel-assembly over the width W_T of the track 22 may be between 0.28 to 0.3, in some cases between 0.3 to 0.35, in some cases between 0.35 to 0.4, in some cases between 0.4 to 0.45 and in some cases even more than 0.45 (e.g., 0.47, 0.5 or more). This greater total width W_{RT} of the wheels 28_i, 28_j of the wheel-assembly may reduce wear of the track 22. For instance, the wheels 28₁-28₁₀ may apply pressure over a greater area and thus reduce a stress subjected on the track 22.

For similar reasons, a width W_D of a contact surface of the drive wheel 24 with the track 22 may also be increased. For instance, in some cases, a ratio W_D/W_T of the width W_D of the contact surface of the drive wheel 24 with the track 22 over the width W_T of the track 22 may be at least 0.15, in some cases at least 0.17, in some cases at least 0.19, and in some cases even more (e.g., 0.20, 0.21, 0.22 or more). This greater width of the contact surface of the drive wheel 24 may reduce wear of the track 22. For instance, a contact surface between the teeth of the drive wheel 24 and the track 22 is wider. This enables the teeth of the drive wheel 24 to apply pressure on the track 22 over a greater area and thus reduce a stress subjected on the track 22 and its cores 44₁-44_N.

Since the width W_R of the peripheral surface 75 of the wheels 28₁-28₁₀ in contact with the track 22 can be increased, in this embodiment, a length L_C of a cores 44_i measured between the first and second longitudinal ends 48₁, 48₂ of the core 44_i may be made smaller since the transverse rigidity of the track 22 may not need to be as great owing to the improved lateral load distribution by the implementation of wheels 28₁-28₁₀ with a wider peripheral surface 75. For instance, a ratio L_C/W_T between the length L_C of the core 44_i and the width W_T of the track 22 may be no more than 0.85, in some cases no more than 0.75, in some cases no more than 0.65, in some cases between no more than 0.60 and in some cases even less

than 0.60 (e.g., 0.58, 0.55). This can cause a reduction in a weight of the cores 44_i and consequently of the track 22 which may in turn improve a performance of the track system 16_i .

The length L_C of the core 44_i may be reduced by decreasing a length of the wings $50_1, 50_2$ of the core 44_i . In this embodiment, the core 44_i is symmetrical in the widthwise direction of the track 22 about a centerline 23 of the core 44_i such that each wing $50_1, 50_2$ has a same length L_W . In some cases, a ratio L_W/L_C of the length L_W of the wings $50_1, 50_2$ over the length L_C of the core 44_i may be no more than 0.30, in some cases no more than 0.27, in some cases no more than 0.25, in some cases no more than 0.22, in some cases no more than 0.20 and in some cases even less than 0.20 (e.g., 0.19, 0.18).

More particularly, in this embodiment, as shown in Figure 8, the longitudinal ends $48_1, 48_2$ of the cores 44_1-44_N do not extend beyond the respective outer lateral edge 35 of each of the wheels $28_i, 28_j$ of a wheel-assembly in the widthwise direction of the track system 16_i . In this example, the longitudinal ends $48_1, 48_2$ of the cores 44_1-44_N are generally aligned (i.e., coplanar) with the respective outer lateral edge 35 of each of the wheels $28_i, 28_j$ of a wheel-assembly in the widthwise direction of the track system 16_i . For instance, a plane 65_1 normal to the widthwise direction of the track system 16_i and coincident with the first longitudinal end 48_1 of a core 44_i is also generally coincident with the outer lateral edge 35 of a wheel 28_j of a wheel-assembly, while simultaneously, a plane 65_2 normal to the to the widthwise direction of the track system 16_i and coincident with the second longitudinal end 48_2 of the core 44_i is also generally coincident with the outer lateral edge 35 of a wheel 28_i of the wheel-assembly.

In some embodiments, the track system 16_i may be designed such that the outer lateral edges 35 of the wheels $28_i, 28_j$ of a wheel-assembly extend in a widthwise direction of the track system 16_i beyond the first and second longitudinal ends $48_1, 48_2$ of the cores 44_1-44_N . For example, the distance W_o measured between

outer lateral edges 35 of the wheels 28_i, 28_j of a wheel-assembly may be greater than the length L_C between the first and second longitudinal ends 48₁, 48₂ of the cores 44₁-44_N. This may help reduce upward flexing of the track 22 when a lateral end portion of the track 22 travels over and/or impacts an obstacle and may thus generally reduce wear of the track 22. For instance, such flexing of the track 22 can cause a portion 51 of the elastomeric material 38 of the track 22 between the lateral edge 31₁ and the cores 44₁-44_N to be more susceptible to tearing.

Furthermore, a distance L_G between the guide projections 56₁, 56₂ of the wheel guide 52 may be increased since the wheel guide 52, much like the wheels 28₁-28₁₀, is not restricted laterally by the frame 42 of the track system 16_i. For instance, in some embodiments, a ratio L_G/W_T of the distance L_G measured between the guide projections 56₁, 56₂ of the wheel guide 52 over the width W_T of the track 22 may be at least 0.19, in some cases at least 0.22, in some cases at least 0.25, in some cases at least 0.27, and in some cases even more (e.g., 0.30, 0.31 or more).

A distance S_W measured between a lateral edge 31_i of the track 22 and an adjacent outer lateral edge of a wheel 28_i of a wheel-assembly may thus be decreased. For instance, a ratio S_W/W_T of a distance S_W measured between a lateral edge 31_i of the track 22 and an adjacent outer lateral edge of a wheel 28_i of a wheel-assembly over the width W_T of the track 22 may be no more than 0.19, in some cases no more than 0.15, in some cases no more than 0.10, in some cases no more than 0.05, and in some cases even less (e.g., 0.04 or less).

II. Ease of installation of the track system and enhanced suspension

In some embodiments, the track system 16_i may be designed to facilitate the mounting of the track system 16_i onto the vehicle 10 and to enhance a suspension of the track system 16_i.

For example, in some embodiments, as shown in Figures 3 and 10, the track system 16_i comprises a mounting arrangement 60 for mounting the track system 16_i to the vehicle 10. As will be described further below, in this embodiment, the mounting arrangement 60 also implements a “suspension” of the track system 16_i and may thus be referred to as a suspension of the track system 16_i. In this example, the mounting arrangement 60 comprises a pair of mounts 64₁, 64₂ connected to the frame 42 of the track system 16_i, each mount 64_i being configured to interact with a support 66. The mounting arrangement 60 may comprise a single mount or more than two mounts in other embodiments (e.g., three, four or more mounts).

The support 66 is configured to establish a connection between the track system 16_i and the frame 12 of the vehicle 10. In this embodiment, the support 66 is provided as part of the frame 12 of the vehicle 10. That is, a manufacturer of the vehicle 10 provides the support 66 as a standard part of the frame 12 of the vehicle 10. In other embodiments, the support 66 may instead be provided with the track system 16_i such that the support 66 is first installed onto the frame 12 of the vehicle 10 in order to install the track system 16_i.

With additional reference to Figure 11, the support 66 comprises a base 68 and a support arm 70. In this embodiment, the base 68 comprises a bracket portion 72 and a projected portion 74. The bracket portion 72 is configured to be fastened to the frame 12 of the vehicle 10 in any suitable way (e.g., bolts, welding, etc.) while the projected portion 74 is configured to receive the support arm 70. For instance, the projected portion 74 may comprise an opening in which the support arm 70 is received via a bushing 76. The support arm 70 comprises a fastening element 71 for mating with a complementary fastening element. In this embodiment, the fastening element 71 comprises a threaded hole.

In other embodiments, the support 66 may be made as a single component. For example, the base 68 and the support arm 70 may be manufactured (e.g., cast) as a single component.

Each mount 64_i of the mounting arrangement 60 is configured to engage a corresponding support 66. Moreover, in this embodiment, as will be elaborated further below, each mount 64_i is resilient to at least partially absorb impacts or other vibrations within the track system 16_i. As shown in Figure 12, the mount 64_i comprises a housing 82 and a resilient material 84 for providing compliance to the mount 64_i. The housing 82 extends in the widthwise direction of the track system 16_i from a first end 86 to a second end 88 and comprises inner and outer walls 90, 92. The resilient material 84 is at least partially contained within the housing 82 and has a shape similar to the housing 82 (i.e. a cylindrical shape).

In this embodiment, the mount 64_i is configured to slidably engage the support arm 70 of the support 66. For instance, a diameter of the inner wall 86 of the housing 82 may be dimensioned such that the mount 64_i can slidably engage the support arm 70. The sliding engagement of the mount 64_i on the support arm 70 is stopped by an abutment of the first end 86 of the housing 82 with an outer surface 78 of the of the base 68 of the support 66.

The mount 64_i further comprises a locking member 96 for securing the mount in engagement with the support 66. The locking member 96 is disposed on an outboard side of the track system 16_i (i.e., a side of the track system 16_i that faces away from the vehicle 10) and comprises an opening 98 for receiving a fastener (e.g., a bolt). More particularly, as shown in Figure 11, a fastener is inserted into the opening 98 and engages the fastening element 71 (i.e., the threaded hole) of the support arm 70 such as to secure the mount 64_i to the support 66.

In some embodiments, the mounting arrangement 60 of the track system 16_i may be configured to compensate for and/or otherwise adapt to a misalignment at a connection between the track system 16_i and the vehicle 10. For instance, the track system 16_i may be configured to compensate for and/or otherwise adapt to a camber (i.e., a camber angle), that is implemented at the connection between the track system 16_i and the vehicle 10. The track system 16_i may be configured to compensate for and/or otherwise adapt to the misalignment to enhance its traction and/or other aspects of its performance and/or use.

To this end, in this embodiment, the mount 64_i is a “resilient” mount 64_i that is deformable (i.e., changeable in configuration). More particularly, the mount 64_i is operable to deform from a first configuration to a second configuration in response to a load and recover the first configuration in response to removal of the load. As mentioned above, the resilient material 84 of the mount 64_i provides compliance to the mount 64_i. Although, the resilient material 84 of the mount 64_i is shaped cylindrically in this embodiment, the resilient material 84 may be shaped in any suitable way in other embodiments. For instance, in some embodiments, the resilient material 84 may be rectangular (e.g., a pad) or may have a V-shape.

More specifically, the resilient material 84 of the mount 64_i is more flexible and/or softer than a material of the housing 82.

For example, in some embodiments, a ratio of a modulus of elasticity of the resilient material 84 over a modulus of elasticity of the material of the housing 82 may be no more than 0.3, in some cases no more than 0.2, in some cases no more than 0.1, in some cases no more than 0.05, and in some cases even less. This ratio may have any other suitable value in other embodiments. For instance, in some embodiments, the modulus of elasticity of the resilient material 84 may be no more than 0.4 GPa, in some cases no more than 0.2 GPa, in some cases no more than 0.05 GPa, and in some cases even less.

The modulus of elasticity of the resilient material 84 may have any other suitable value in other embodiments.

As another example, in some embodiments, a ratio of a hardness of the resilient material 84 over a hardness of the material of the housing 82 may be no more than 0.5, in some cases no more than 0.4, in some cases no more than 0.3, in some cases no more than 0.2, in some cases no more than 0.1, and in some cases even less. This ratio may have any other suitable value in other embodiments. For instance, in some embodiments, the hardness of the resilient material 84 may be no more than 50 Shore D in some cases no more than 20 Shore D in some cases no more than 1 Shore D (60 Shore A) and in some cases even less. The hardness of the resilient material 84 may have any other suitable value in other embodiments.

In this embodiment, the resilient material 84 is elastomeric material. More particularly, in this embodiment, the elastomeric material 84 comprises rubber. The elastomeric material 84 may comprise any other suitable elastomer (e.g., ethylene-vinyl acetate (EVA), polyurethane) in other embodiments. The resilient material 84 may be any other suitable material providing suitable compliance in other embodiments (e.g., a gel or other fluid).

In some cases, as shown in Figure 23, this may address issues with a conventional track system 16_i' in which the camber implemented at the connection between the vehicle and the track system 16_i' results in uneven contact of its track 22' with the ground due to only certain ones of its wheels 28₁'-28₁₀' bearing some load while other ones of its wheels 28₁'-28₁₀' are off the ground and unloaded, thereby causing the track's contact patch 58' to extend over a very limited part of the track's width. Such a scenario may also cause uneven wear of the track 22' as the wheels 28₁'-28₁₀' and apply more pressure

on one side of the track 22' than the other which can result in severe wear on one side of the track 22'.

As shown in Figure 26, the mount 64_i of the mounting arrangement 60 is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch 58 of the track 22 with the ground extends over at least a substantial part of the width of the track 22 (i.e., over all or a substantial part of the width W_T of the track 22). That is, in some embodiments, the mount 64_i may be configured such that, even with the camber implemented, when the ground is horizontal, the contact patch 58 of the track 22 with the ground may extend over at least 30%, in some cases at least 40%, in some cases at least 50%, in some cases at least 60%, in some cases at least 70%, in some cases at least 80%, in some cases at least 90% and in some cases even more of the width of the track 22. Thus, in some examples of implementation, the mount 64_i may be configured such that, even with the camber implemented, when the ground is horizontal, the contact patch 58 of the track 22 with the ground extends over at least a majority of the width W_T of the track 22, and in some cases all or nearly all of the width W_T of the track 22.

The mounting arrangement 60 may be configured in various other ways in other embodiments.

III. Modularity and reduced complexity of the wheel assemblies

In some embodiments, certain ones of the wheels 28₁-28₁₀ of the track system 16_i may be grouped together to form modular subassemblies of the track system 16_i. This may help to reduce an amount of components involved in manufacturing the wheels 28₁-28₁₀ and consequently to reduce production costs of the track system 16_i.

For example, in some embodiments, with additional reference to Figures 2 and 13 to 16, the track system 16_i may comprise a plurality of wheel assemblies 100₁-100₅. Each wheel assembly 100_i comprises two wheels 28_i, 28_j that are laterally-adjacent (i.e., mounted transversally and rolling about a common axis), a housing 102 for securing the wheel assembly 100_i to the frame 42 of the track system 16_i, and a shaft 104 defining an axle of the two wheels 28_i, 28_j.

The shaft 104 extends within the housing 102 and is journaled in the housing 102. To this end, bushings 108₁, 108₂ are disposed at a contact interface between the shaft 104 and the housing 102 to seal the clearance between the housing 102 and the shaft 104. In some embodiments, the bushings 108₁, 108₂ may instead be substituted by bearings (for high speed applications for example).

The housing 102 comprises a lubricant reservoir 110 configured for lubricating the contact interface between the shaft 104 and the housing 102 as well as the bushings 108₁, 108₂. To this end, the housing 102 comprises a plurality of passageways 111₁-111_c that interconnect the lubricant reservoir 110 to the contact interface between the shaft 104 and the housing 102. The plurality of conduits 111₁-111_c also interconnects the lubricant reservoir 110 to the bushings 108₁, 108₂. A sealable opening 112 of the housing 102 provides access to the lubricant reservoir 110 such that the user may fill the lubricant reservoir 110 with an appropriate lubricant (e.g., oil).

The wheels 28_i, 28_j are mounted to the shaft 104 such that the wheels 28_i, 28_j are rotatable together with the shaft 104 about an axis of rotation 106. In other words, an angular rotation of the shaft 104 causes an identical angular rotation of the wheels 28_i, 28_j. For instance, in this embodiment, the wheels 28_i, 28_j are mounted to the shaft 104 via a press-fit. Alternatively, the wheels 28_i, 28_j may be mounted to the shaft 104 in any other suitable way. In addition, in this embodiment, a retaining ring 114, such as a C-clip, is disposed at each end portion of the shaft 104 to prevent the wheels 28_i, 28_j from being disengaged

from the shaft 104. The shaft 104 may comprise a groove for holding captive the retaining ring 114 therein.

The wheel assembly 100_i is secured to the frame 42 of the track system 16_i via the housing 102. As shown in Figures 15 and 16, the housing 102 comprises a plurality of holes 116₁-116_H formed on mounting pads for receiving a fastener 118 therein. For example, the fastener 118 may traverse a hole 116_i and securely engage the frame 42 of the track system 16_i via a threaded feature of the frame 42.

The wheel assembly 100_i may be configured in various other ways, as described below.

For instance, with additional reference to Figure 17, in some embodiments, the wheel assembly 100_i may comprise a suspension 120 for absorbing impacts undergone by the wheel assembly 100_i.

In this embodiment, the suspension 120 comprises first and second suspension members 122, 124. The first suspension member 122 comprises an arm structure 126 protruding upwardly from the housing 102 of the wheel assembly 100_i. An end portion 128 of the arm structure 126 is shaped cylindrically and extends in a widthwise direction of the wheel assembly 100_i (i.e., in a direction generally parallel to the axis of rotation 106 of the shaft 104). A mount 130 is provided at the end portion 128 of the arm structure 126 and is configured to engage a support shaft of the track system 16_i (not shown). The mount 130 is configured to at least partially absorb impacts and/or other vibrations at the wheel assembly 100_i. To this end, in this embodiment, the mount 130 is a "resilient" mount 130 that is deformable (i.e., changeable in configuration). More particularly, the mount 130 is operable to deform from a first configuration to a second configuration in response to a load and recover the first configuration in response to removal of the load. In this embodiment, the mount 130 comprises a

housing 132 and a resilient material 134 for providing compliance to the mount 130. The resilient material 134 is at least partially contained within the housing 132.

In this embodiment, the resilient material 134 is elastomeric material, such as rubber. The elastomeric material 134 may comprise any other suitable elastomer (e.g., ethylene-vinyl acetate (EVA), polyurethane) in other embodiments. The resilient material 134 may be any other suitable material providing suitable compliance in other embodiments (e.g., a gel or other fluid).

The second suspension member 124 comprises a support plate 136 and a resilient pad 138. More specifically, the support plate 136 is secured to the resilient pad 138 while the resilient pad 138 is fixed to the housing 102 of the wheel assembly 100_i in any suitable way (e.g., fasteners, adhesives, etc.). The support plate 136 comprises a plurality of holes 140₁-140_H for receiving a fastener therein to secure the wheel assembly 100_i to the frame 42 of the track system 16_j.

In this embodiment, the resilient pad 138 comprises resilient material similar to the resilient material 134 of the first suspension member 122. In other embodiments, the resilient material of the resilient pad 134 may have different properties than the resilient material 134 of the first suspension member 122.

Together, the first and second suspension members 122, 124 are operable to absorb impacts at the wheel assembly 100_i in any given direction.

In some embodiments, the first and second suspension members 122, 124 of the suspension 120 may be implemented separately. That is, in some cases, the suspension 120 may comprise only one of the first suspension member 122 and the second suspension member 124.

IV. Ease of installation of the drive wheel

In some embodiments, the drive wheel 24 may be designed such as to facilitate its installation onto the track system 16_i.

For example, in this embodiment, as shown in Figure 19, the drive wheel 24 comprises a plurality of drive wheel members 160₁-160_P separate from one another and which together form the drive wheel 24. This may facilitate the installation of the drive wheel 24 onto the track system 16_i. For instance, since each drive wheel portion 160_i of the plurality of drive wheel portions 160₁-160_P is smaller than the resultant drive wheel 24, handling of the drive wheel portion 160_i may be easier than handling of the drive wheel 24 since the drive wheel portion 160_i is not as bulky and/or does not weigh as much as the drive wheel 24.

Each drive wheel portion 160_i is configured to be fastened to a drive hub of the track system 16_i. The drive hub of the track system 16_i is connected to the powertrain of the vehicle 10 (e.g., via a drive axle of the vehicle 10) such that the drive hub of the track system 16_i is driven by the powertrain of the vehicle 10. More specifically, each drive wheel portion 160_i comprises a plurality of holes 162₁-162_H for receiving a fastening member (e.g., a threaded stud) therein. For example, the drive hub of the track system 16_i may comprise a plurality of fastening members which the plurality of holes 162₁-162_H of the drive wheel portion 160_i can engage. A complementary fastening member (e.g., a nut) may then engage the fastening member of the drive hub to secure the drive wheel portion 160_i to the drive hub of the track system 16_i. The drive wheel portion 160_i may be fastened to the drive hub of the track system 16_i in any other suitable way in other embodiments.

This design of the drive wheel 24 may also facilitate a method used to install the drive wheel 24 onto the track system 16_i. For example, this may allow the drive wheel 24 to be installed onto the track system 16_i after the track 22 has been

disposed about the wheels 28₁-28₁₀. More specifically, a first drive wheel portion 160₁ can be installed at a “free portion” of the drive hub of the track system 16_i, i.e., a portion of the drive hub that, where the drive wheel portion 160₁ does not engage the track 22 when installed. The power train of the vehicle 10 is then actuated to cause the drive hub of the track system 16_i to turn by 1/3 of a turn (or 1/4 of a turn if there are four drive wheel portions instead of three for example), the drive hub rotates such that the two remaining drive wheel portions 160₂, 160₃ can be installed onto the drive hub at a free portion of the drive hub.

V. Configuration of the idler wheels

The front and rear idler wheels 26, 29 of the track system 16_i may be configured in various ways.

In this embodiment, as shown in Figure 20, an idler wheel assembly 200 is provided comprising the idler wheel 26. The idler wheel assembly 200 may be referred to as a “single idler” assembly since it comprises only one idler wheel. The idler wheel assembly 200 further comprises a shaft 202, a housing 204 and a mounting member 206. In this embodiment, the idler wheel 26 is symmetrical in a widthwise direction of the idler wheel assembly 200 (i.e., in a direction parallel to the widthwise direction of the track system 16_i).

The shaft 202 is configured to be fixedly secured to a structural member that is connected to the frame 42 of the track system 16_i. More specifically, the shaft 202 extends in the widthwise direction of the idler wheel assembly 200 and comprises an engagement feature 210 (e.g., a threaded hole) at each end portion of the shaft 202 for receiving therein a fastener that connects the shaft 202 to the structural member connected to the frame 42. The shaft 202 defines a rotation axis 203 of the idler wheel assembly 200.

The mounting member 206 is configured to securely receive the idler wheel 26. For instance, the idler wheel 26 is connected to the mounting member 206 in any suitable way (e.g., via a pressure fit). The mounting member 206 is also configured to be rotatably mounted to the shaft 202.

The housing 204 connects the mounting member 206 to the shaft 202. More specifically, the housing 204 comprises a plurality of housing portions 205₁, 205₂ that are fixedly secured to the shaft 202 (e.g., via a press-fit). Each housing portion 205_i is connected to an end of the mounting member 206 via a bushing 208. Alternatively, a bearing can be used.

As such, the shaft 202 and the housing 204 are fixed (i.e., remain stationary) while the mounting member 206 and the idler wheel 26 rotate about the rolling axis 203. Moreover, the mounting member 206 may comprise one or more lubrication conduits for feeding lubricant to the contact interface between the mounting member 206 and the shaft 202.

The idler wheel 26 is configured to interact with the wheel guide 52 of a core 44_i of the track 22. For instance, the idler wheel 26 is dimensioned to fit between the guide projections 56₁, 56₂ of the wheel guide 52.

This design of the idler wheel assembly 200 may help reduce a pressure exerted on the rolling paths 30₁, 30₂ of the track 22.

In some embodiments, as shown in Figure 21, the idler wheel assembly 200 may comprise a pair of idler wheels 226₁, 226₂ mounted on the shaft 202 such that the idler wheels 226₁, 226₂ have a common rotation axis 203. The idler wheels 226₁, 226₂ are different from the idler wheel 26 in that each idler wheel 226_i is asymmetrical in the widthwise direction of the idler wheel assembly 200. The idler wheel assembly 200 may be referred to as a “double flange” idler wheel assembly since it comprises two idler wheels. In such an embodiment, the idler

wheels 226₁, 226₂ engage the track 22 at a position outside of the wheel guide 52 and its guide projections 56₁, 56₂ (i.e., between the guide projection 56₁ and the first longitudinal end 48₁ of a core 44_i and between the guide projection 56₂ and the second longitudinal end 48₂ of the core 44_i). This design of the idler wheel assembly 200 may help reduce vibrations induced by the engagement of the of idler wheel assembly 200 with the track 22.

In yet other embodiments, as shown in Figure 22, the idler wheel assembly 200 may comprise a pair of idler wheels 226₁, 226₂ and an idler wheel 26 mounted between the pair of idler wheels 226₁, 226₂. All three of the idler wheels 226₁ are mounted on the shaft 202. Each of the outer idler wheels 226₁, 226₂ is asymmetrical in the widthwise direction of the idler wheel assembly 200 whereas the central idler 26 wheel is symmetrical in the widthwise direction of the idler wheel assembly 200. In such embodiments, the central idler wheel 26 may engage a central portion of the track 22 between the guide projections 56₁, 56₂ of the wheel guide 52. This may improve a pressure distribution on the track 22 such as to reduce wear of the track 22. This design of the idler wheel assembly 200 may help reduce vibrations induced by the engagement of the of idler wheel assembly 200 with the track 22.

As shown in Figures 3 and 7, in this embodiment, the front and rear idler wheels 26, 29 are mounted between the frame 42 while the frame 42 is located between laterally-adjacent ones of the roller wheels 28₁-28₁₀. That is, in this embodiment, the idler wheel assembly 200 is bounded by the frame 42 in the widthwise direction of the track system 16_i such that a width W_{ID} of the idler wheel assembly 200 (measured between outermost lateral edges 77 of the wheel(s) of the idler wheel assembly 200) is smaller than the widthwise extent W_F of the frame 42 measured at a position of the idler wheel assembly 200. It will be appreciated that the widthwise extent W_F of the frame 42 at a position of the roller wheels 28₁-28₁₀ may be different from the widthwise extent W_F of the frame 42 at the position of the idler wheel assembly 200 (i.e., the widthwise extent W_F of the frame 42 may

vary in the longitudinal direction of the track system 16_i). A similar relationship may be applied between an idler wheel assembly comprising the rear idler wheel 29 and the frame 42.

The idler wheel assembly 200 may be configured in various other ways in other embodiments.

In a variant, the track 22 and the roller wheels 28₁-28₁₀ may be configured to reduce a stress generated at a base of the wheel guide 52 of the cores 44₁-44_N (i.e., at a portion of the wheel guide 52 nearest to the wings 50₁, 50₂ of a core 44_i). This may be useful to reduce wear of the track 22.

For instance, with additional reference to Figures 26 and 27, a rolling contact interface *CI* between a roller wheel 28_i and the inner side 25 of the track 22 may be configured to be nonparallel to the widthwise direction of the track 22. More particularly, the rolling contact interface *CI* between the peripheral surface 75 of the roller wheel 28_i and a corresponding rolling path 30_i of the inner side 25 of the track 22 may be configured to define an oblique angle α relative to a horizontal plane P_H extending in the widthwise direction of the track 22. The angle α may take on various values in various embodiments. For example, in some embodiments, the angle α may be at least 1°, in some cases at least 2°, in some cases at least 3°, in some cases at least 4°, and in some cases even more (e.g., 6°).

Furthermore, the orientation of the rolling contact interface *CI* may be based on a configuration of the wings 50₁, 50₂ of the cores 44₁-44_N of the track 22. For instance, the rolling contact interface *CI* may be oriented in accordance to an orientation of a top surface 80 of a wing 50_i facing towards the inner side 25 of the track 22. In this example, the top surface 80 of the wing 50_i is nonparallel to the widthwise direction of the track 22. More specifically, the top surface 80 of the wing 50_i defines an oblique angle λ with the horizontal plane P_H which extends in

the widthwise direction of the track 22. The angle λ may take on various values in various embodiments. For example, in some embodiments, the angle λ may be at least 1° , in some cases at least 2° , in some cases at least 3° , in some cases at least 4° , and in some cases even more (e.g., 6°).

Thus, in this example, the peripheral surface 75 of the roller wheel 28_i is nonparallel to the widthwise direction of the track 22. That is, the peripheral surface 75 of the roller wheel 28_i defines an oblique angle α_r with the horizontal plane P_H . Moreover, the rolling surface 30_i of the inner side 25 of the track 22 is also nonparallel to the widthwise direction of the track 22. That is, the rolling surface 30_i of the inner side 25 of the track 22 defines an oblique angle α_t with the horizontal plane P_H . In this case, the angle α_t corresponds to the angle α_r such that the angle α of the rolling contact interface CI corresponds to the angles α_t , α_r (i.e., $\alpha_t = \alpha_r = \alpha$). In other words, in this example, the peripheral surface 75 of the roller wheel 28_i and the rolling surface 30_i of the inner side 25 of the track 22 are parallel to one another. In other cases, the angle α_t defined by the rolling surface 33_i of the track 22 may be different from the angle α_r defined by the wheel 28_i. For example, in some embodiments, a ratio of the angle α_r to the angle α_t may be between 0.8 and 1.2, in some cases between 0.9 and 1.1, and in some cases between 0.95 and 1.05. In cases where the angles α_t , α_r are different, the angle α of the rolling contact interface CI corresponds to an average of the angles α_t , α_r .

The angle α_r defined by the peripheral surface 75 of the roller wheel 28_i and the angle λ defined by the top surface 80 of the wing 50_i of the core 44_i may approximate one another. For instance, in some cases, a ratio of the angle α_r defined by the peripheral surface 75 of the roller wheel 28_i and the angle λ defined by the top surface 80 of the wing 50_i of the core 44_i may be between 0.8 and 1.2, in some cases between 0.9 and 1.1 and in some cases between 0.95 and 1.05. For example, the peripheral surface 75 of the roller wheel 28_i and the top surface 80 of the wing 50_i of the core 44_i may be substantially parallel.

Moreover, the angle α_t defined by the rolling path 30_i of the inner side 25 of the track 22 and the angle λ defined by the top surface 80 of the wing 50_i of the core 44_i may approximate one another. For instance, in some cases, a ratio of the angle α_t defined by the rolling path 30_i of the inner side 25 of the track 22 and the angle λ defined by the top surface 80 of the wing 50_i of the core 44_i may be between 0.8 and 1.2, in some cases between 0.9 and 1.1 and in some cases between 0.95 and 1.05. For example, the rolling path 30_i of the inner side 25 of the track 22 and the top surface 80 of the wing 50_i of the core 44_i may be substantially parallel.

Thus, the peripheral surface 75 of the roller wheel 28_i, the top surface 80 of the wing 50_i of the core 44_i, and the rolling path 30_i of the inner side 25 of the track 22 may be substantially parallel.

In this example, the roller wheel 28_i tapers in a direction generally parallel to the axis of rotation 106 of the roller wheel 28_i such that its peripheral surface 75 is nonparallel to the axis of rotation 106 of the roller wheel 28_i. More specifically, in this example, the roller wheel 28_i tapers such that its outermost diameter is greater at an outboard side of the roller wheel 28_i (i.e., a side closest to a lateral edge 31_i of the track 22) than at an inboard side of the roller wheel 28_i (i.e., a side furthest to a lateral edge 31_i of the track 22). For example, the peripheral surface 75 of the roller wheel 28_i tapers in a direction parallel to the axis of rotation 106 of the roller wheel 28_i such that an outboard side of the peripheral surface 75 is closer to the ground-engaging outer side 27 of the track 22 than an inboard side of the peripheral surface 75. For instance, the peripheral surface 75 of the roller wheel 28_i defines an oblique angle ω relative to the axis of rotation 106 of the roller wheel 28_i. For example, in some embodiments, the angle ω between the peripheral surface 75 of the roller wheel 28_i and the axis of rotation of the roller wheel 28_i may be at least 1°, in some cases at least 2°, in some

cases at least 3°, in some cases at least 4°, and in some cases even more (e.g., 6°).

The tensioner 47 of the track system 16_i maintains the track 22 in tension. In this example, the tensioner 68 is connected between the frame 42 and a cam plate 85 of the track system 16_i that rotatably supports the drive wheel 24. The tensioner 47 thus urges the frame 42, and the idler wheels XXXX supported by the frame 47, away from the drive wheel 24 to maintain the track 22 in tension.

More particularly, in this embodiment, the tensioner 47 is a fluidic (i.e., fluid-based) tensioner, i.e., a hydraulic or pneumatic tensioner, which comprises a piston-cylinder mechanism 87 connected to a fluidic accumulator 89. The fluidic accumulator 89 is configured to receive a fluid (e.g., liquid, gas) and, in this embodiment, is integrated with the track system 16_i. In particular, the fluidic accumulator 89 is contained within an envelope defined by the track 22 of the track system 16_i such that the fluidic accumulator 89 is disposed between the lateral edges 31₁, 31₂ of the track 22.

The piston-cylinder mechanism 87 has a first end portion 91 connected to the frame 42 and a second end portion 93 connected to the cam plate 85. In this example, the second end portion 93 of the piston-cylinder mechanism 87 is connected to the cam plate 85 at a location below the axis of rotation 21 of the drive wheel 24 and above the axis of rotation 43 of the rear idler wheel 29. Moreover, the first end portion 91 of the piston-cylinder mechanism 87 is connected to the frame 42 approximately at a midpoint of the track system 16_i in the longitudinal direction of the track system 16_i. The position of the piston-cylinder mechanism 87 may provide a greater clearance between the piston-cylinder mechanism 87 and the inner side 25 of the track 22.

A piston of the piston-cylinder mechanism 87 is movable relative to a cylinder of the piston-cylinder mechanism 87 between an extended position and a retracted

position. Pressure of a fluid inside the piston-cylinder mechanism 87 urges the piston towards its extended position. As a result, the piston pushes on the cam plate 85 which biases the drive wheel 24 mounted thereon away from the front idler wheel 26, thereby maintaining the track 22 in tension. The tensioner 47 allows tension in the track 22 to be manually adjusted to a desired level before use and remains active during use to maintain the tension in the track 22 at the desired level.

The tensioner 47 may be constructed in various other ways and/or using various other materials in other embodiments. For example, in some embodiments, the tensioner 47 may comprise a coil spring or any other elastic object that deforms under stress and recovers its original configuration when the stress is released.

Although it is configured in a certain way in this embodiment, each track system 16_i of the vehicle 10, including its track 22, may be configured in various other ways in other embodiments.

For example, the track 22 may interact with the drive wheel 24 in other ways in other embodiments in order to be moved. For instance, in some embodiments, the inner side 25 of the track 22 may comprise a plurality of drive lugs that interact with the drive wheel 24 in order to cause the track 22 to be driven (i.e., the track system 16_i may implement a “positive drive” system), or may frictionally engage the drive wheel 24 to cause the track 22 to be driven (i.e., the track system 16_i may implement a “friction drive” system).

Each track system 16_i may comprise different and/or additional components in other embodiments. For example, in some embodiments, the track system 16_i may comprise a front drive wheel (e.g., the idler wheel 26 may be replaced by a drive wheel) instead of or in addition to the drive wheel 24. As another example, in some embodiments, the track system 16_i may comprise more or less wheels

such as the wheels 28₁-28₁₀. As yet another example, rather than have a generally triangular configuration as in this embodiment, in other embodiments, the track system 16_i may have various other configurations (e.g., a generally linear configuration).

While in the embodiment considered above the vehicle 10 is a compact track loader, in other embodiments, the vehicle 10 may be any other type of construction vehicle (e.g., a bulldozer, a backhoe loader, an excavator, etc.) for performing construction work. In other examples, the vehicle 10 may be any other suitable type of tracked vehicle (e.g., an agricultural vehicle, a forestry vehicle, an all-terrain vehicle (ATV)) or any other vehicle operable off paved roads. Although operable off paved roads, the vehicle 10 may also be operable on paved roads in some cases. Also, while in the embodiment considered above the vehicle 10 is driven by a human operator in the vehicle 10, in other embodiments, the vehicle 10 may be an unmanned ground vehicle (e.g., a teleoperated or autonomous unmanned ground vehicle).

In some examples of implementation, any feature of any embodiment described herein may be used in combination with any feature of any other embodiment described herein.

Certain additional elements that may be needed for operation of some embodiments have not been described or illustrated as they are assumed to be within the purview of those of ordinary skill in the art. Moreover, certain embodiments may be free of, may lack and/or may function without any element that is not specifically disclosed herein.

Although various embodiments and examples have been presented, this was for the purpose of describing, but not limiting, the invention. Various modifications and enhancements will become apparent to those of ordinary skill in the art and are within the scope of the invention, which is defined by the appended claims.

CLAIMS

1. A track system for traction of a vehicle, the track system comprising:
 - a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges; and
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels, the frame being free of supporting structure for the roller wheels between the roller wheels and the lateral edges of the track.
2. The track system of claim 1, wherein the frame extends between laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system.
3. The track system of claim 1, wherein a widthwise extent of the frame of in the widthwise direction of the track system is less than a distance between outer lateral edges of laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system.

4. The track system of claim 3, wherein the widthwise extent of the frame is less than a distance between inner lateral edges of the laterally-adjacent ones of the roller wheels.
5. The track system of claim 1, wherein a ratio of a total width of peripheral surfaces of laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system over a width of the track is at least 0.28.
6. The track system of claim 5, wherein the ratio of the total width of the peripheral surfaces of the laterally-adjacent ones of the roller wheels over the width of the track is at least 0.35.
7. The track system of claim 5, wherein the ratio of the total width of the peripheral surfaces of the laterally-adjacent ones of the roller wheels over the width of the track is at least 0.45.
8. The track system of claim 1, wherein a ratio of a width of a contact surface of the drive wheel with the track over a width of the track is at least 0.15.
9. The track system of claim 8, wherein a ratio of the width of the contact surface of the drive wheel with the track over the width of the track is at least 0.18.
10. The track system of claim 1, wherein the track comprises a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track.
11. The track system of claim 10, wherein a ratio of a length of the core over a width of the track is no more than 0.85.

12. The track system of claim 11, wherein the ratio of the length of the core over the width of the track is no more than 0.75.
13. The track system of claim 11, wherein the ratio of the length of the core over the width of the track is no more than 0.65.
14. The track system of claim 10, wherein the core does not extend beyond outer lateral edges of each of the roller wheels in a widthwise direction of the track system.
15. The track system of claim 14, wherein longitudinal ends of the core are generally aligned with respective ones of the outer lateral edges of each of the roller wheels in the widthwise direction of the track system.
16. The track system of claim 14, wherein a distance between the outer lateral edges of each of the roller wheels in the widthwise direction of the track system is greater than a length of the core.
17. The track system of claim 10, wherein the core comprises a wheel guide comprising a pair of guide projections projecting toward the inner side of the track and a ratio of a distance between the guide projections in the widthwise direction of the track over a width of the track is at least 0.19.
18. The track system of claim 17, wherein the ratio of the distance between the guide projections in the widthwise direction of the track over the width of the track is at least 0.25.
19. The track system of claim 1, wherein the frame extends between the leading idler wheel and the lateral edges of the track and between the trailing idler wheel and the lateral edges of the track.
20. A vehicle comprising the track system of claim 1.

21. The vehicle of claim 20, wherein the vehicle is a construction vehicle.
22. The vehicle of claim 21, wherein the construction vehicle is a compact track loader.
23. A track system for traction of a vehicle, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges; and
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels, the frame being configured such that at least a majority of each of the roller wheels is exposed when viewing the track system in a widthwise direction of the track system.
24. A track system for traction of a vehicle, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges; and
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;

- a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
- a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
- a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels, the frame extending between laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system.

25. A track system for traction of a vehicle, the track system comprising:

- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges; and
- a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, a ratio of a total width of peripheral surfaces of laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system over a width of the track is at least 0.28; and
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels.

26. A track system for traction of a vehicle, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, lateral edges, and a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track, a ratio of a length of the core over a width of the track being no more than 0.85; and
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels.
27. A track system for traction of a vehicle, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, lateral edges, and a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track; and
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;

- a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
- a plurality of roller wheels between the leading idler wheel and the trailing idler wheel, the core not extending beyond outer lateral edges of each of the roller wheels in a widthwise direction of the track system; and
- a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels.

28. A track system for traction of a vehicle, the vehicle comprising a frame, the track system comprising:

- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side;
- a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels;

and

- a mount for resiliently interconnecting the frame of the track system and the frame of the vehicle.
29. The track system of claim 28, wherein the mount comprises a resilient material.
 30. The track system of claim 29, wherein the resilient material is an elastomeric material.
 31. The track system of claim 29, wherein the mount comprises a housing and the resilient material is disposed within the housing.
 32. The track system of claim 31, wherein the resilient material is more flexible than a material of the housing.
 33. The track system of claim 31, wherein a ratio of a modulus of elasticity of the resilient material over a modulus of elasticity of the material of the housing is no more than 0.3.
 34. The track system of claim 31, wherein the ratio of a modulus of elasticity of the resilient material over the modulus of elasticity of the material of the housing is no more than 0.1.
 35. The track system of claim 29, wherein a modulus of elasticity of the resilient material is no more than 0.4 GPa.
 36. The track system of claim 35, wherein a modulus of elasticity of the resilient material is no more than 0.2 GPa.
 37. The track system of claim 31, wherein the resilient material is softer than a material of the housing.
 38. The track system of claim 37, wherein a ratio of a hardness of the resilient material over a hardness of the material of the housing is no more than 0.5.

39. The track system of claim 38, wherein the ratio of the hardness of the resilient material over the hardness of the material of the housing is no more than 0.2.
40. The track system of claim 29, wherein a hardness of the resilient material is no more than 50 Shore D.
41. The track system of claim 40, wherein a hardness of the resilient material is no more than 1 Shore D.
42. The track system of claim 31, wherein the housing is generally cylindrical.
43. The track system of claim 28, wherein the mount is configured to slidably mount the track system to the frame of the vehicle.
44. The track system of claim 33, comprising a support arm for connection to the frame of the vehicle and the mount comprises an opening to slidably receive the support arm.
45. The track system of claim 34, wherein the mount comprises a locking member to secure the mount to the support arm.
46. The track system of claim 28, wherein the vehicle implemented a camber and the mount is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch of the track with the ground extends over at least 30% of a width of the track.
47. The track system of claim 28, wherein the vehicle implemented a camber and the mount is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch of the track with the ground extends over at least 40% of a width of the track.

48. The track system of claim 28, wherein the vehicle implemented a camber and the mount is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch of the track with the ground extends over at least a majority of a width of the track.
49. The track system of claim 28, wherein the vehicle implemented a camber and the mount is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch of the track with the ground extends over at least 70% of a width of the track.
50. The track system of claim 28, wherein the vehicle implemented a camber and the mount is configured such that, even with the camber implemented, when the ground is horizontal, a contact patch of the track with the ground extends over at least 90% of a width of the track.
51. A track system for traction of a vehicle, the vehicle comprising a frame, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side;
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and

- a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels;

and

- a mount for slidably mounting the track system to the frame of the vehicle.

52. A track system for traction of a vehicle, the track system comprising:

- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side;
- a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a plurality of roller wheels to roll on a bottom run of the track; and
 - a shaft carrying laterally-adjacent ones of the roller wheels which are adjacent to one another in a widthwise direction of the track such that the shaft and the laterally-adjacent ones of the roller wheels are rotatable together.

53. The track system of claim 52, wherein the track-engaging arrangement comprises a housing and the shaft is journaled in the housing.

54. The track system of claim 53, comprising a lubricant reservoir to lubricate a contact interface between the shaft and the housing.

55. The track system of claim 54, wherein the housing comprises a plurality of passageways interconnecting the lubricant reservoir to the contact interface between the shaft and the housing.

56. The track system of claim 52, wherein the laterally-adjacent ones of the roller wheels are press-fitted onto the shaft.

57. A track system for traction of a vehicle, the track system comprising:

- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side;
- a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel;
 - a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels; and
 - a resilient mount between laterally-adjacent ones of the roller wheels that are adjacent to one another in a widthwise direction of the track system and the frame of the track system.

58. The track system of claim 57, wherein the resilient mount comprises a resilient material.

59. The track system of claim 58, wherein the resilient material is an elastomeric material.

60. A track system for traction of a vehicle, the track system comprising:

- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, and an inner side opposite to the ground-engaging outer side;
- a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:

- a drive wheel to impart movement to the track, the drive wheel comprising a plurality of drive wheel members that are separately mountable into and removable from the track system;
- a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
- a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and
- a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels.

61. A track system for traction of a vehicle, the track system comprising:

- a track comprising a ground-engaging outer side for engaging the ground and an inner side opposite to the ground-engaging outer side, the track comprising:
 - elastomeric material; and
 - a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track;and
- a track-engaging arrangement for driving and guiding the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel for driving the track; and
 - a plurality of roller wheels for rolling on the inner side of the track along a bottom run of the track,

wherein a rolling contact interface between a roller wheel of the plurality of roller wheels and the inner side of the track is nonparallel to a widthwise direction of the track.

62. The track system of claim 61, wherein the roller wheel comprises a peripheral surface in rolling contact with the inner side of the track and nonparallel to the widthwise direction of the track.
63. The track system of claim 62, wherein the peripheral surface of the roller wheel defines an oblique angle relative to the widthwise direction of the track.
64. The track system of claim 62, wherein the core comprises a pair of wings and a wheel guide projecting on the inner side of the track and disposed between the pair of wings in the widthwise direction of the track, and each wing of the pair of wings of the core comprises a top surface facing towards the inner side of the track and nonparallel to the widthwise direction of the track.
65. The track system of claim 64, wherein the peripheral surface of the roller wheel defines an oblique angle relative to the widthwise direction of the track and the top surface of the wing of the core defines an oblique angle relative to the widthwise direction of the track.
66. The track system of claim 65, wherein a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core is between 0.8 and 1.2.
67. The track system of claim 65, wherein a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core is between 0.9 and 1.1.
68. The track system of claim 65, wherein a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core is between 0.95 and 1.05.

69. The track system of claim 64, wherein the peripheral surface of the roller wheel and the top surface of the wing of the core are substantially parallel.
70. The track system of claim 61, wherein the rolling contact interface defines an oblique angle relative to the widthwise direction of the track.
71. The track system of claim 70, wherein the oblique angle defined by the rolling contact interface is at least 1° .
72. The track system of claim 70, wherein the oblique angle defined by the rolling contact interface is at least 2° .
73. The track system of claim 70, wherein the oblique angle defined by the rolling contact interface is at least 3° .
74. The track system of claim 64, wherein the inner side of the track comprises a rolling path for the roller wheel, the rolling path of the inner side of the track being nonparallel to the widthwise direction of the track.
75. The track system of claim 74, wherein the peripheral surface of the roller wheel defines an oblique angle relative to the widthwise direction of the track, the top surface of the wing of the core defines an oblique angle relative to the widthwise direction of the track, and the rolling path of the inner side of the track defines an oblique angle relative to the widthwise direction of the track.
76. The track system of claim 75, wherein each of: a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core; a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the rolling path of the inner side of the track; and a ratio of the oblique angle defined by the rolling path of the inner side of the track and the

oblique angle defined by the top surface of the wing of the core is between 0.8 and 1.2.

77. The track system of claim 75, wherein each of: a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core; a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the rolling path of the inner side of the track; and a ratio of the oblique angle defined by the rolling path of the inner side of the track and the oblique angle defined by the top surface of the wing of the core is between 0.9 and 1.1.
78. The track system of claim 75, wherein each of: a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the top surface of the wing of the core; a ratio of the oblique angle defined by the peripheral surface of the roller wheel and the oblique angle defined by the rolling path of the inner side of the track; and a ratio of the oblique angle defined by the rolling path of the inner side of the track and the oblique angle defined by the top surface of the wing of the core is between 0.95 and 1.05.
79. The track system of claim 75, wherein the peripheral surface of the roller wheel, the top surface of the wing of the core, and the rolling path of the inner side of the track are substantially parallel.
80. The track system of claim 61, wherein the roller wheel tapers in a direction generally parallel to an axis of rotation of the roller wheel.
81. A track for traction of a vehicle, the track being mountable around a track-engaging arrangement for driving and guiding the track around the track-engaging arrangement, the track-engaging arrangement comprising: a drive

wheel for driving the track; and a plurality of roller wheels for rolling along a bottom run of the track; the track comprising:

- a ground-engaging outer side for engaging the ground;
- an inner side opposite to the ground-engaging outer side, the inner side comprising a rolling path for a roller wheel of the plurality of roller wheels, the rolling path being nonparallel to a widthwise direction of the track;
- elastomeric material; and
- a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track.

82. The track of claim 81, wherein each core comprises a pair of wings and a wheel guide projecting on the inner side of the track and disposed between the pair of wings in the widthwise direction of the track, and each wing of the pair of wings of the core comprises a top surface facing towards the inner side of the track and nonparallel to the widthwise direction of the track.

83. The track of claim 82, wherein the top surface of the wing of the core defines an oblique angle relative to the widthwise direction of the track and the rolling path of the inner side of the track defines an oblique angle relative to the widthwise direction of the track.

84. The track of claim 83, wherein a ratio of the oblique angle defined by the rolling path of the inner side of the track and the oblique angle defined by the top surface of the wing of the core is between 0.8 and 1.2.

85. The track of claim 83, wherein a ratio of the oblique angle defined by the rolling path of the inner side of the track and the oblique angle defined by the top surface of the wing of the core is between 0.9 and 1.1.

86. The track of claim 83, wherein a ratio of the oblique angle defined by the rolling path of the inner side of the track and the oblique angle defined by the top surface of the wing of the core is between 0.95 and 1.05.
87. The track of claim 83, wherein the oblique angle defined by the rolling path of the inner side of the track is at least 1°.
88. The track of claim 83, wherein the oblique angle defined by the rolling path of the inner side of the track is at least 2°.
89. The track of claim 83, wherein the oblique angle defined by the rolling path of the inner side of the track is at least 3°.
90. The track of claim 83, wherein rolling path of the inner side of the track and the top surface of the wing of the core are substantially parallel.
91. A roller wheel for a track system for traction of a vehicle, the track system comprising a track comprising: a ground-engaging outer side for engaging the ground; an inner side opposite to the ground-engaging outer side, elastomeric material; and a plurality of cores at least partially embedded in the elastomeric material, each core of the plurality of cores extending transversally to a longitudinal direction of the track, the track system comprising a drive wheel for driving the track, the roller wheel being configured to roll on the inner side of the track along a bottom run of the track, the roller wheel comprising:
- a first lateral surface and a second lateral surface opposite one another; and
 - a peripheral surface between the first lateral surface and the second lateral surface and configured to roll on the inner side of the track, the peripheral surface being nonparallel to an axis of rotation of the roller wheel.

92. The roller wheel of claim 91, wherein the peripheral surface of the roller wheel defines an oblique angle relative to the axis of rotation of the roller wheel.
93. The roller wheel of claim 92, wherein the oblique angle defined by the peripheral surface of the roller wheel is at least 1°.
94. The roller wheel of claim 92, wherein the oblique angle defined by the peripheral surface of the roller wheel is at least 2°.
95. The roller wheel of claim 92, wherein the oblique angle defined by the peripheral surface of the roller wheel is at least 3°.
96. The roller wheel of claim 91, wherein the roller wheel tapers in a direction generally parallel to the axis of rotation of the roller wheel.
97. A track system for traction of a vehicle, the track system comprising:
- a track to engage the ground, the track comprising elastomeric material, a ground-engaging outer side, an inner side opposite to the ground-engaging outer side, and lateral edges;
 - a track-engaging arrangement to drive and guide the track around the track-engaging arrangement, the track-engaging arrangement comprising:
 - a drive wheel to impart movement to the track;
 - a leading idler wheel and a trailing idler wheel spaced apart in a longitudinal direction of the track system, a distance between an axis of rotation of the drive wheel and an axis of rotation of the leading idler wheel being different from a distance between the axis of rotation of the drive wheel and an axis of rotation of the trailing idler wheel;
 - a plurality of roller wheels between the leading idler wheel and the trailing idler wheel; and

- a frame supporting the leading idler wheel, the trailing idler wheel, and the roller wheels;
- and
- a tensioner to maintain the track in tension, the tensioner comprising a piston-cylinder mechanism and a fluidic accumulator that are disposed between the lateral edges of the track.

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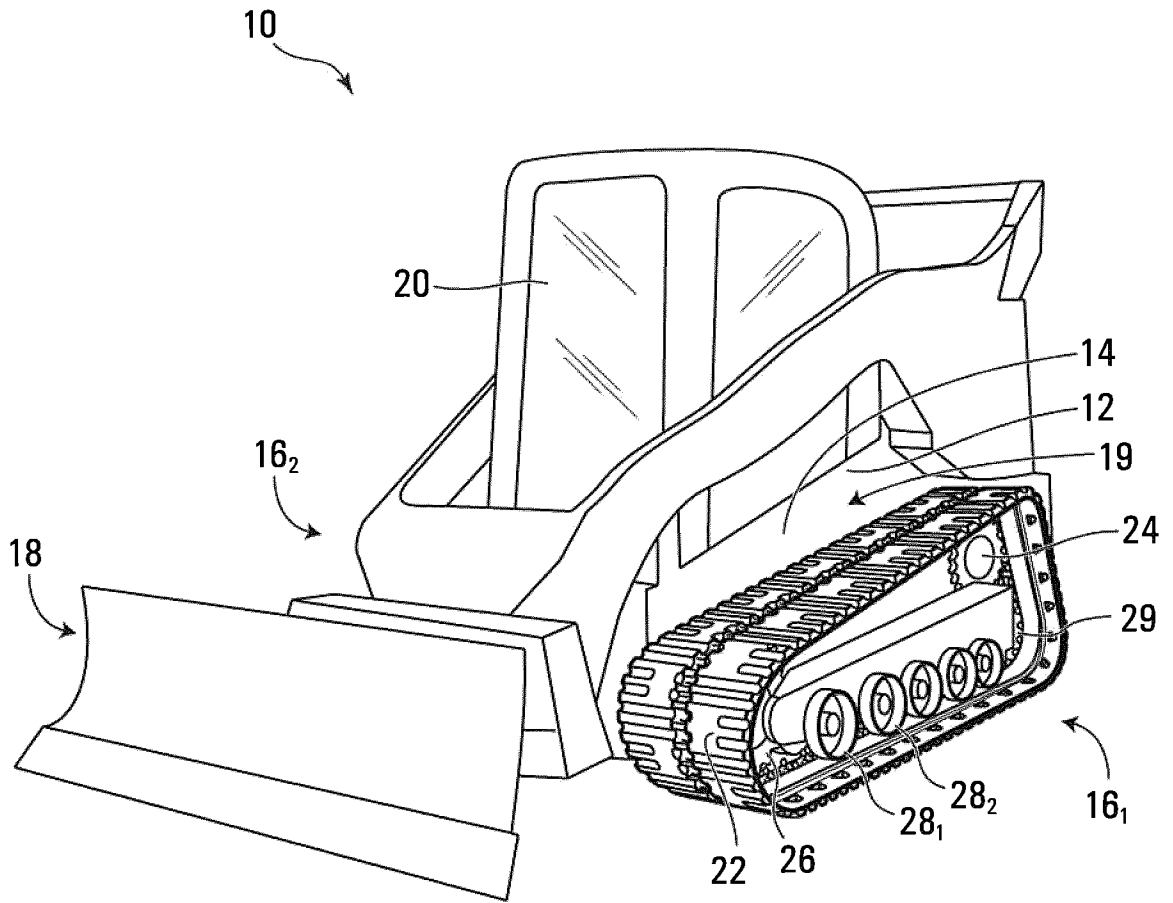


FIG. 1

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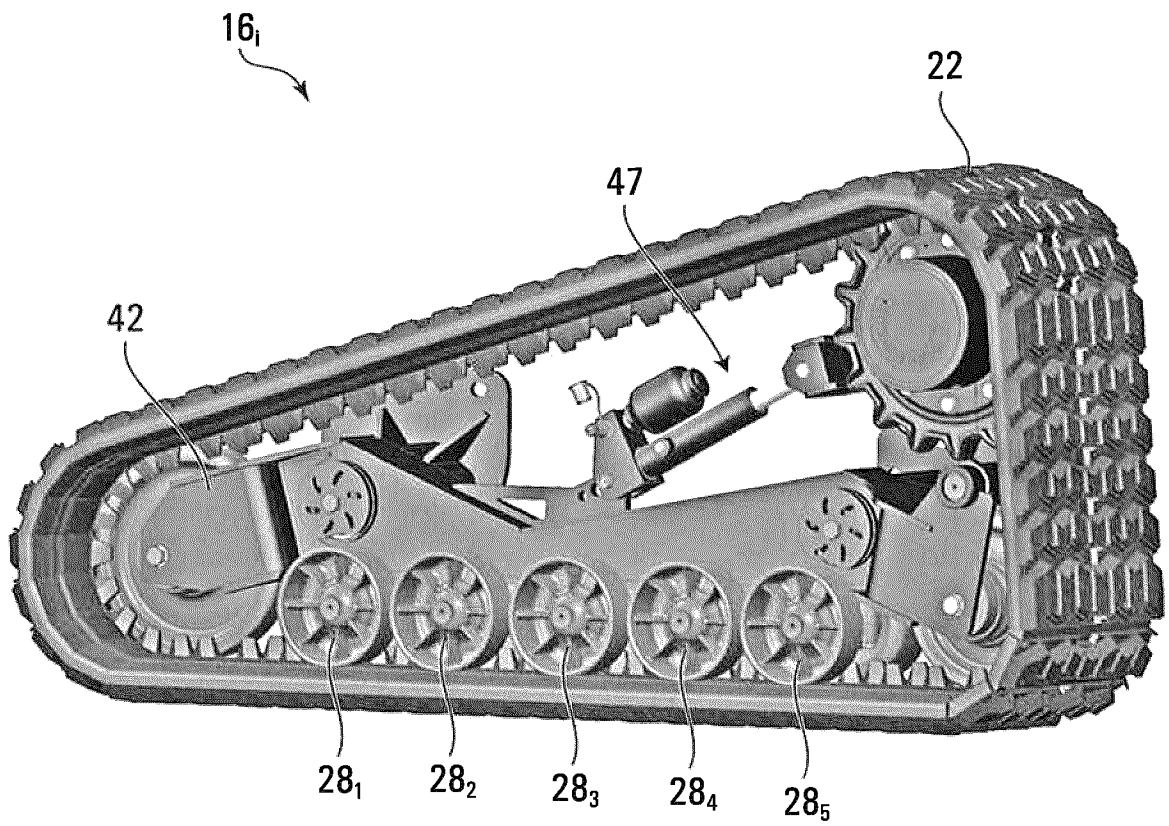


FIG. 2

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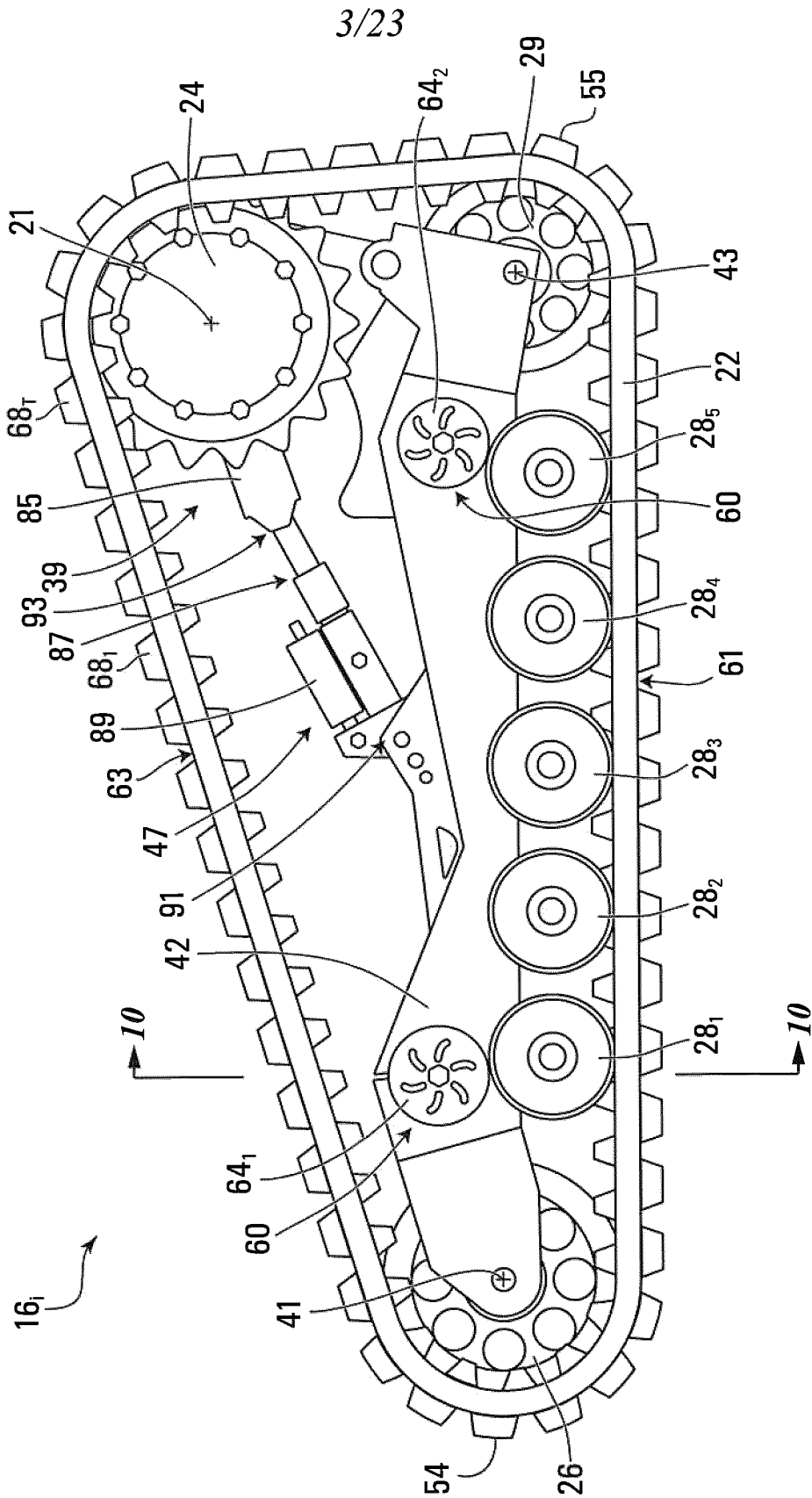


FIG. 3

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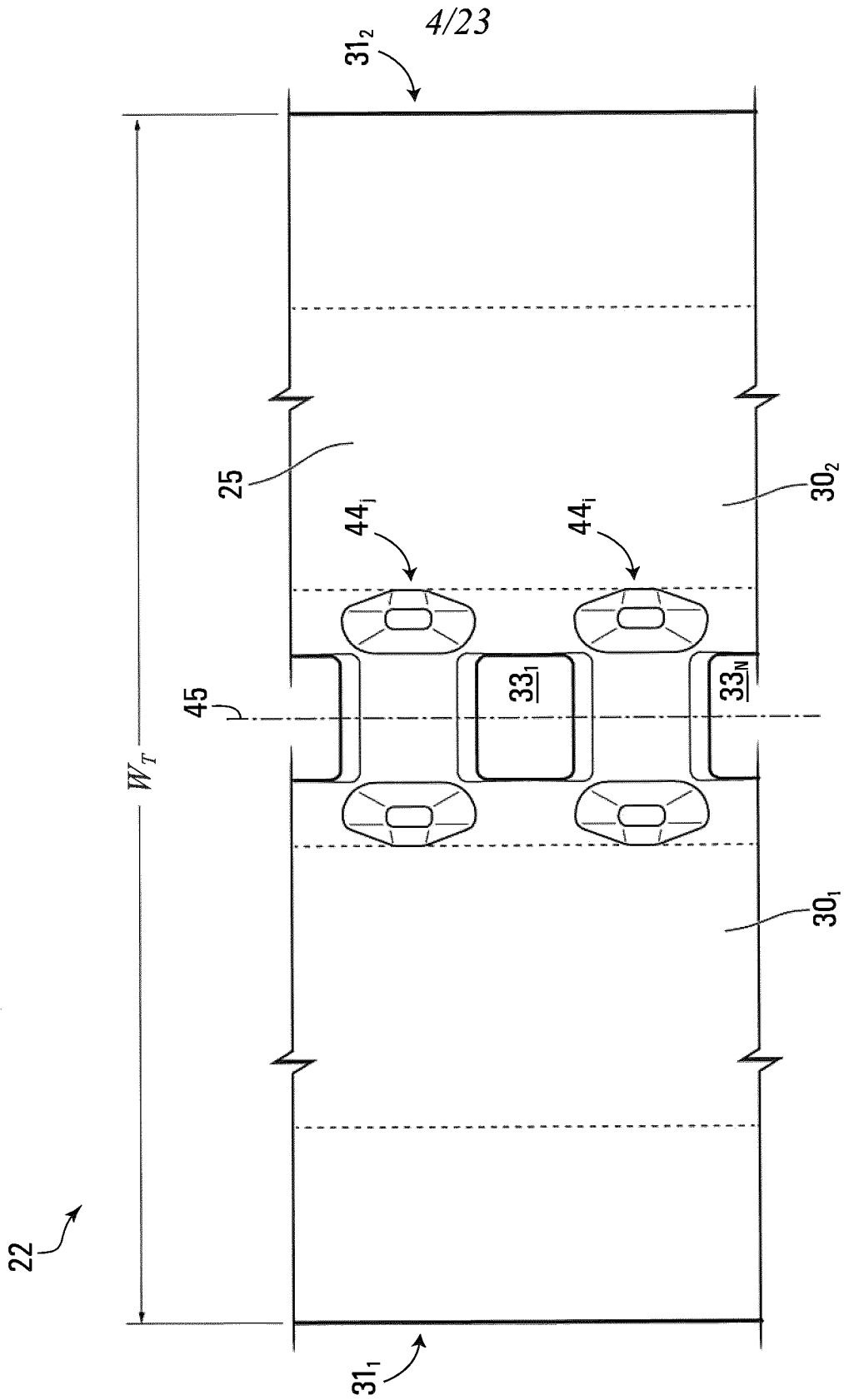


FIG. 4

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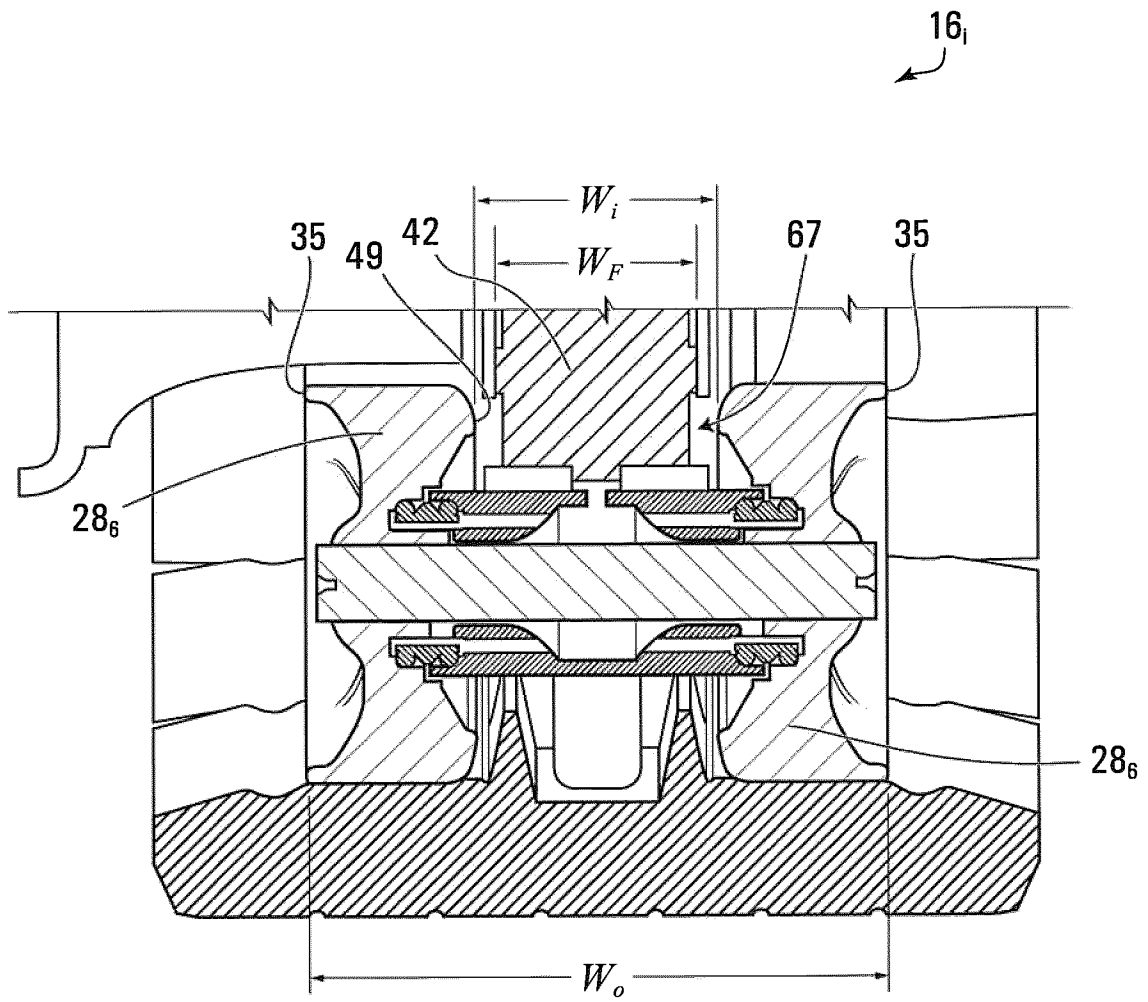


FIG. 6

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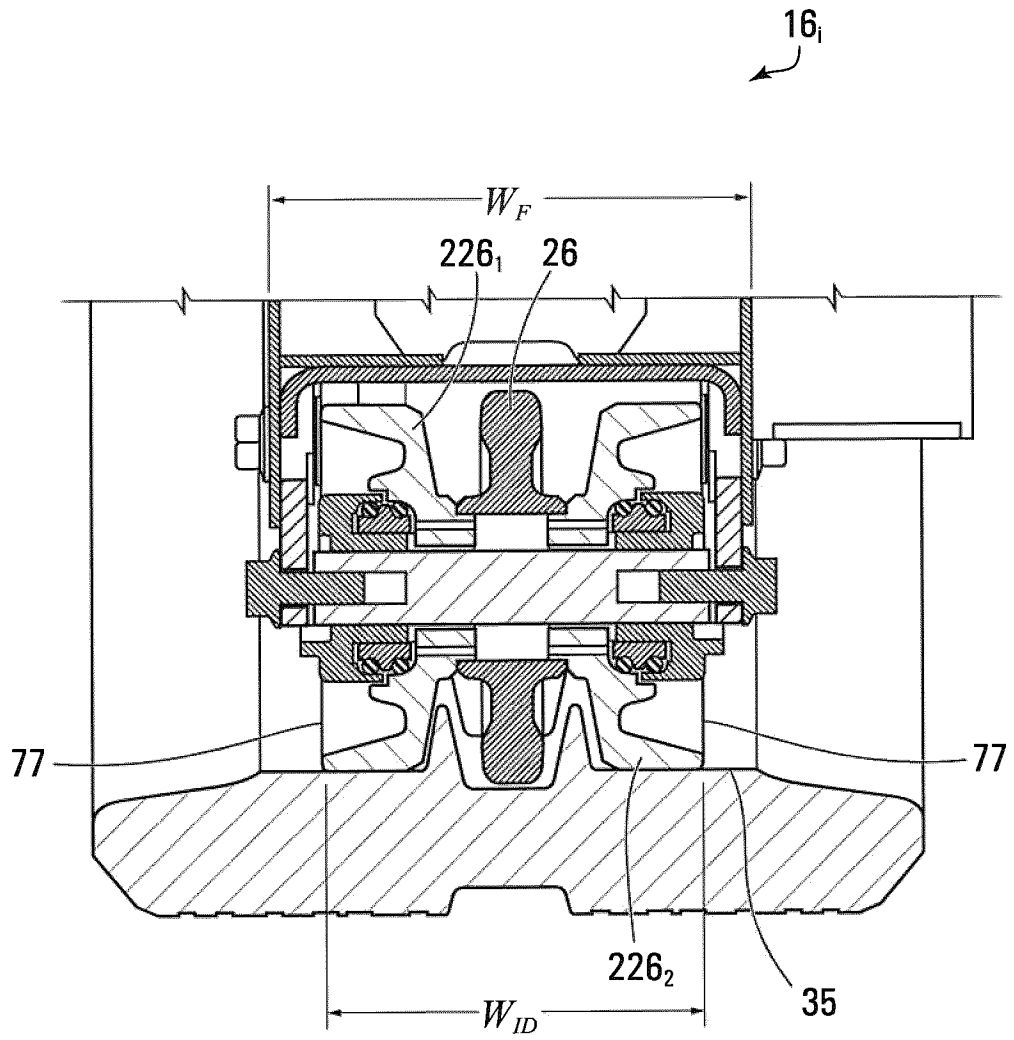


FIG. 7

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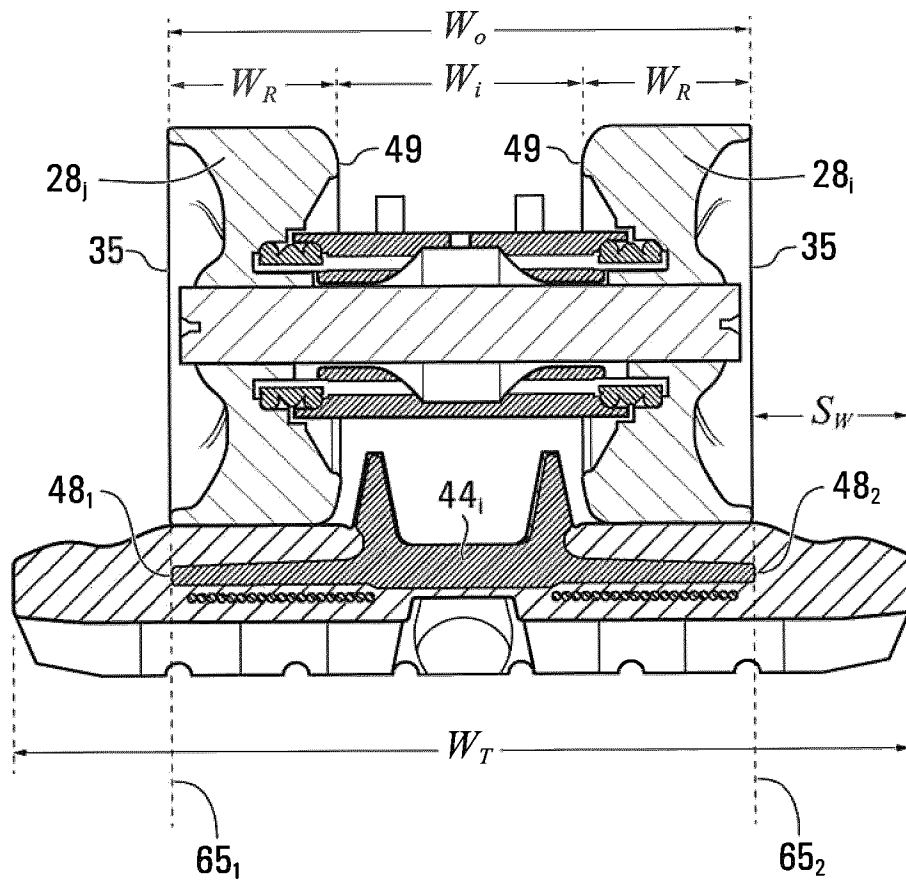


FIG. 8

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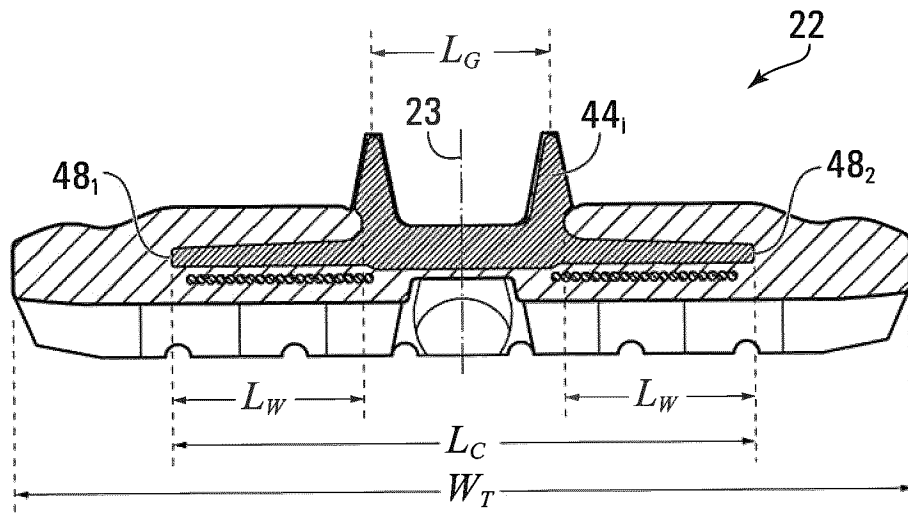


FIG. 9

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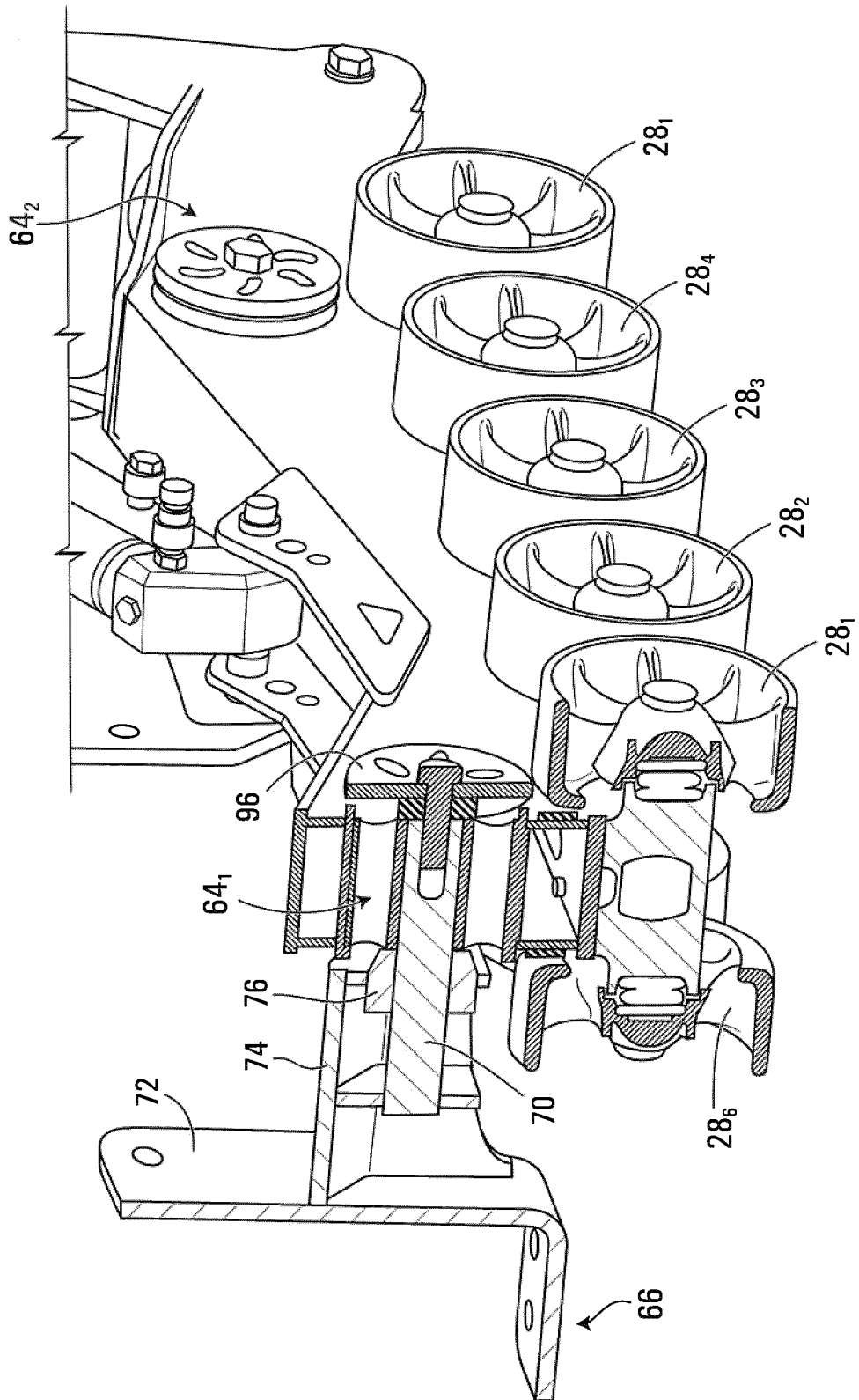


FIG. 10

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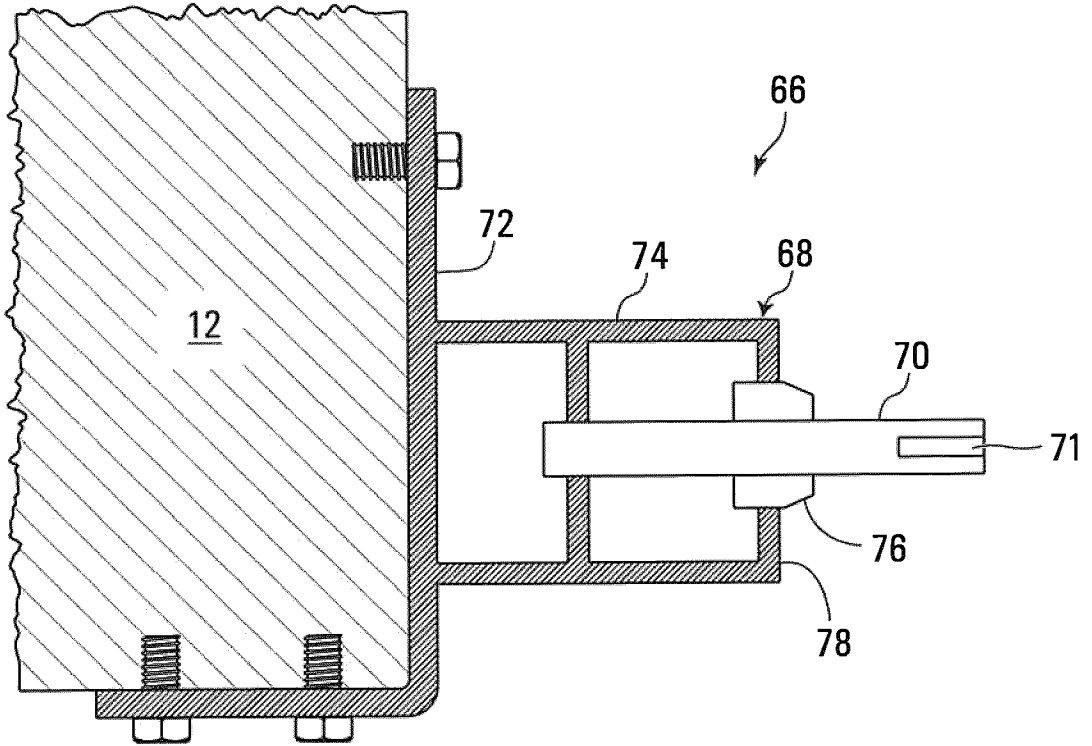


FIG. 11

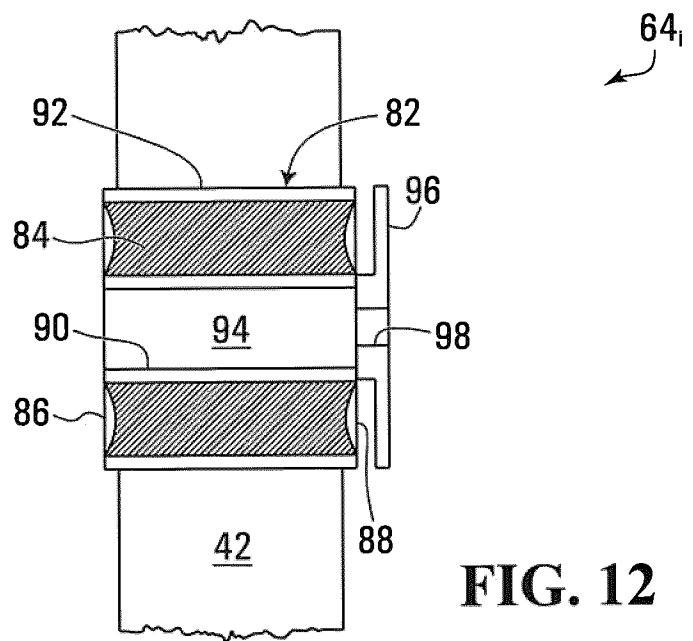


FIG. 12

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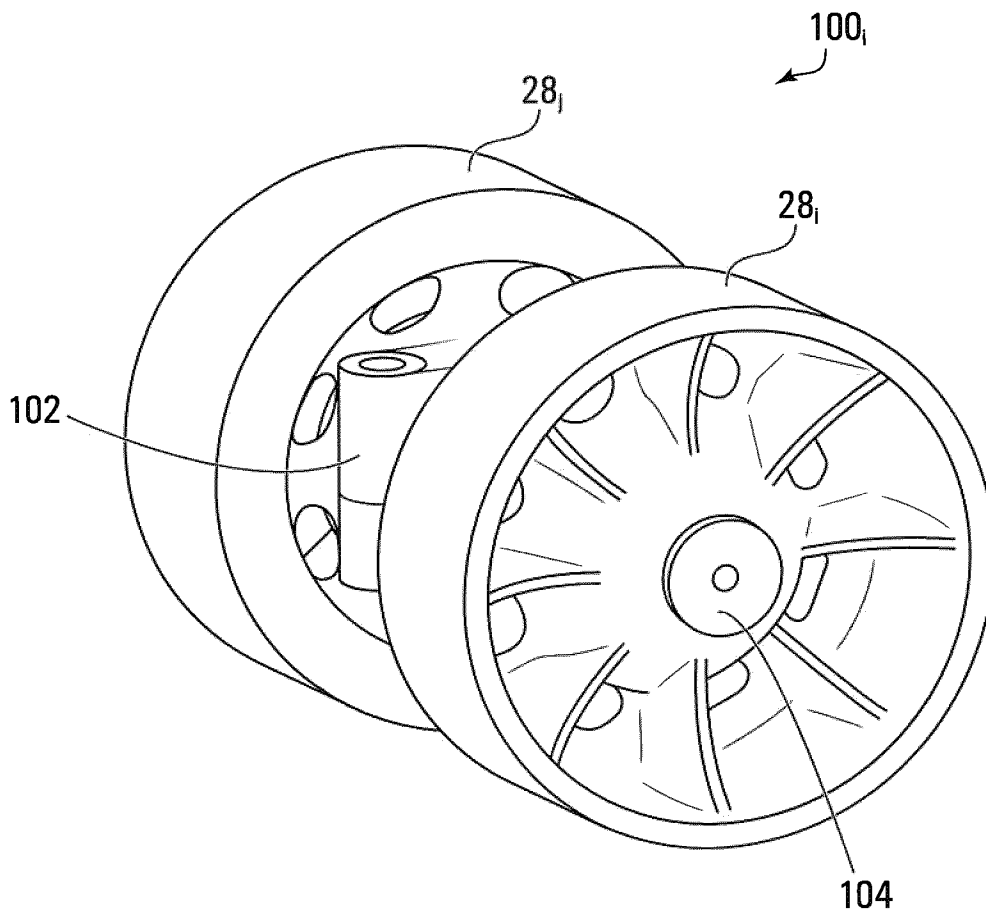


FIG. 13

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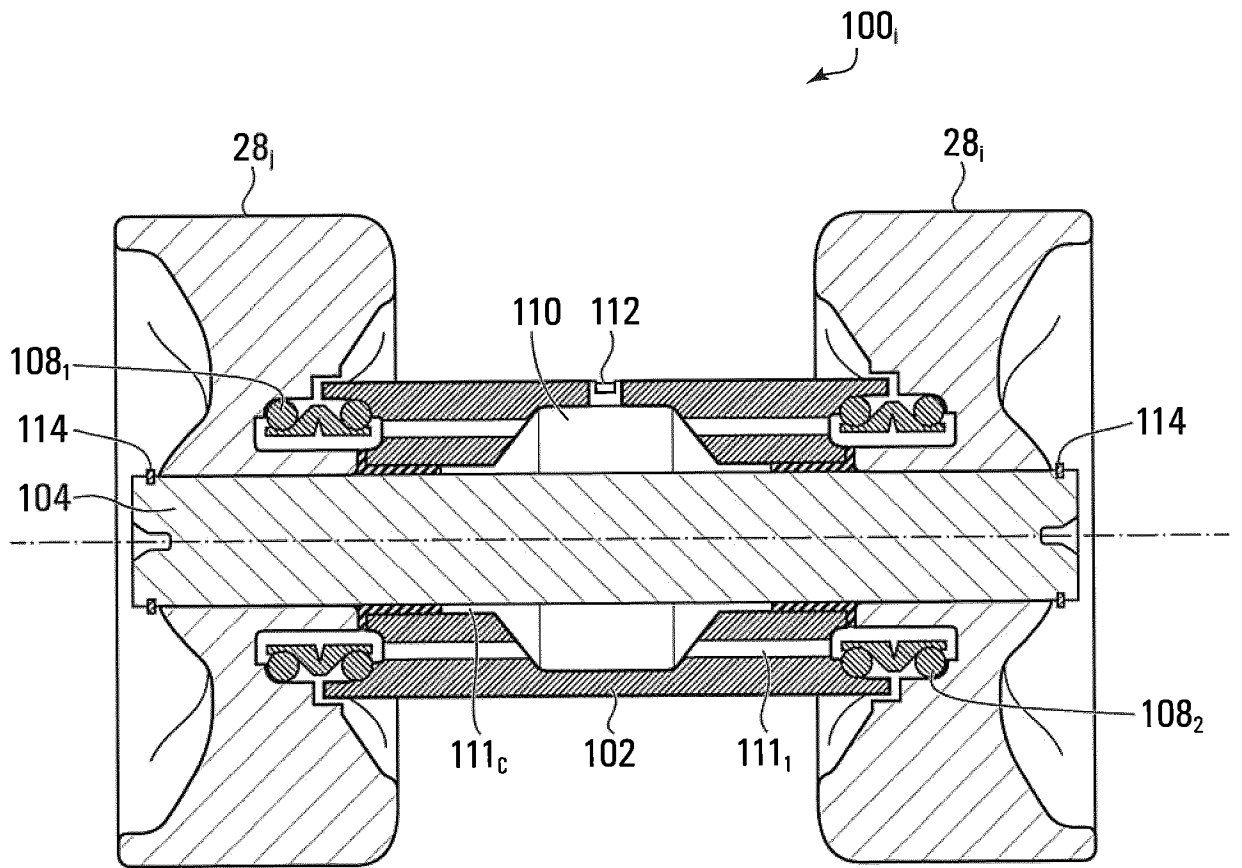


FIG. 14

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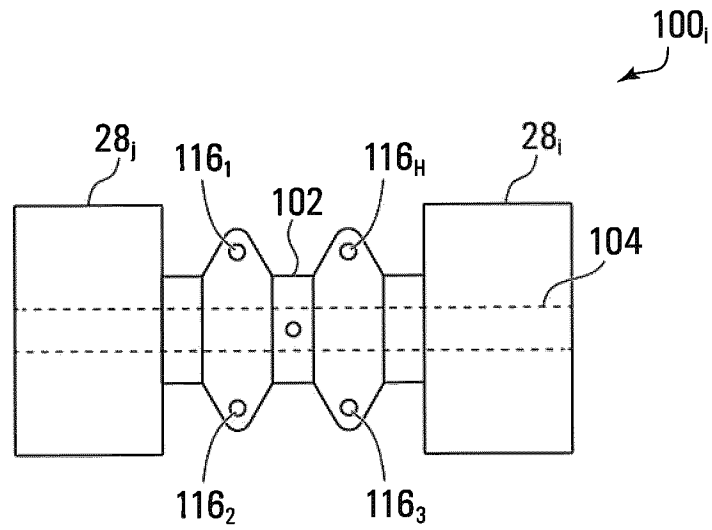


FIG. 15

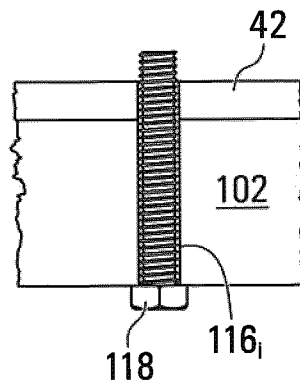


FIG. 16

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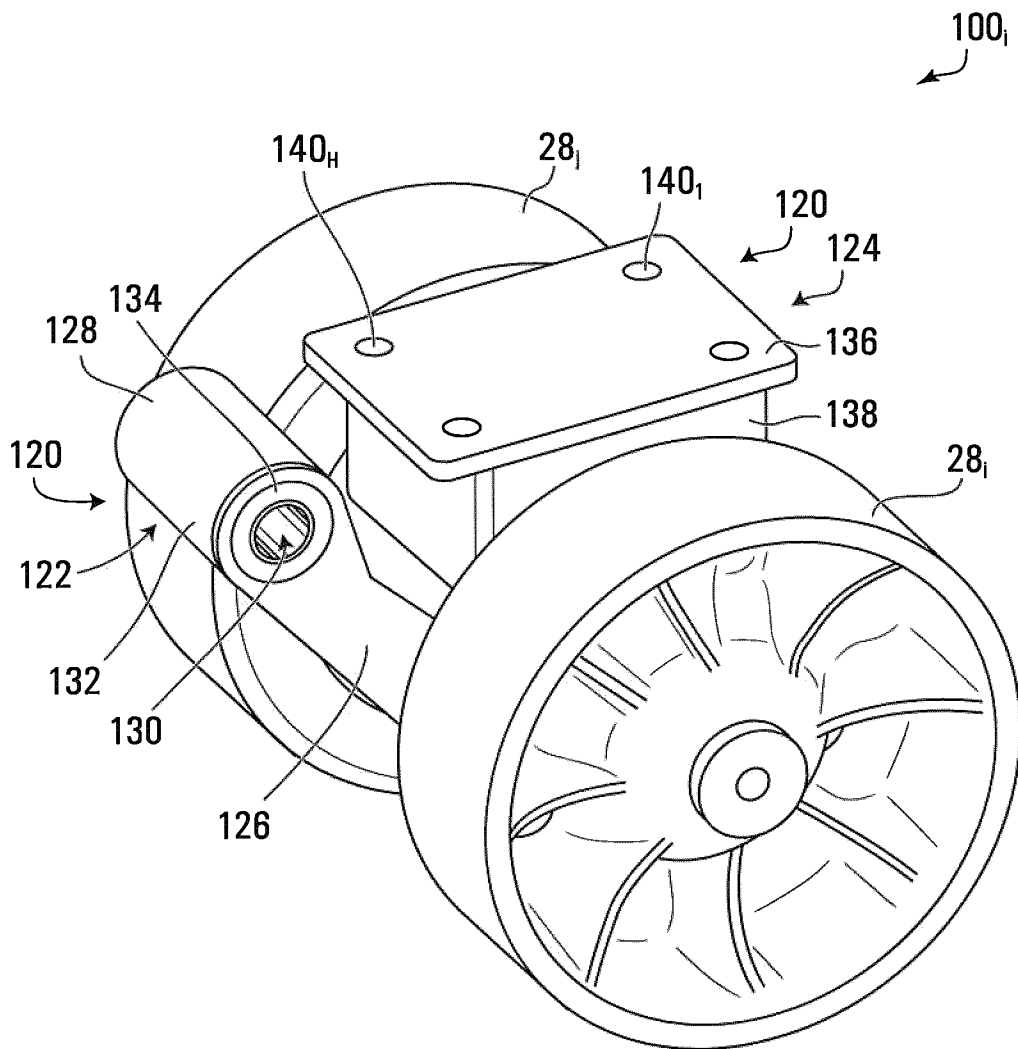


FIG. 17

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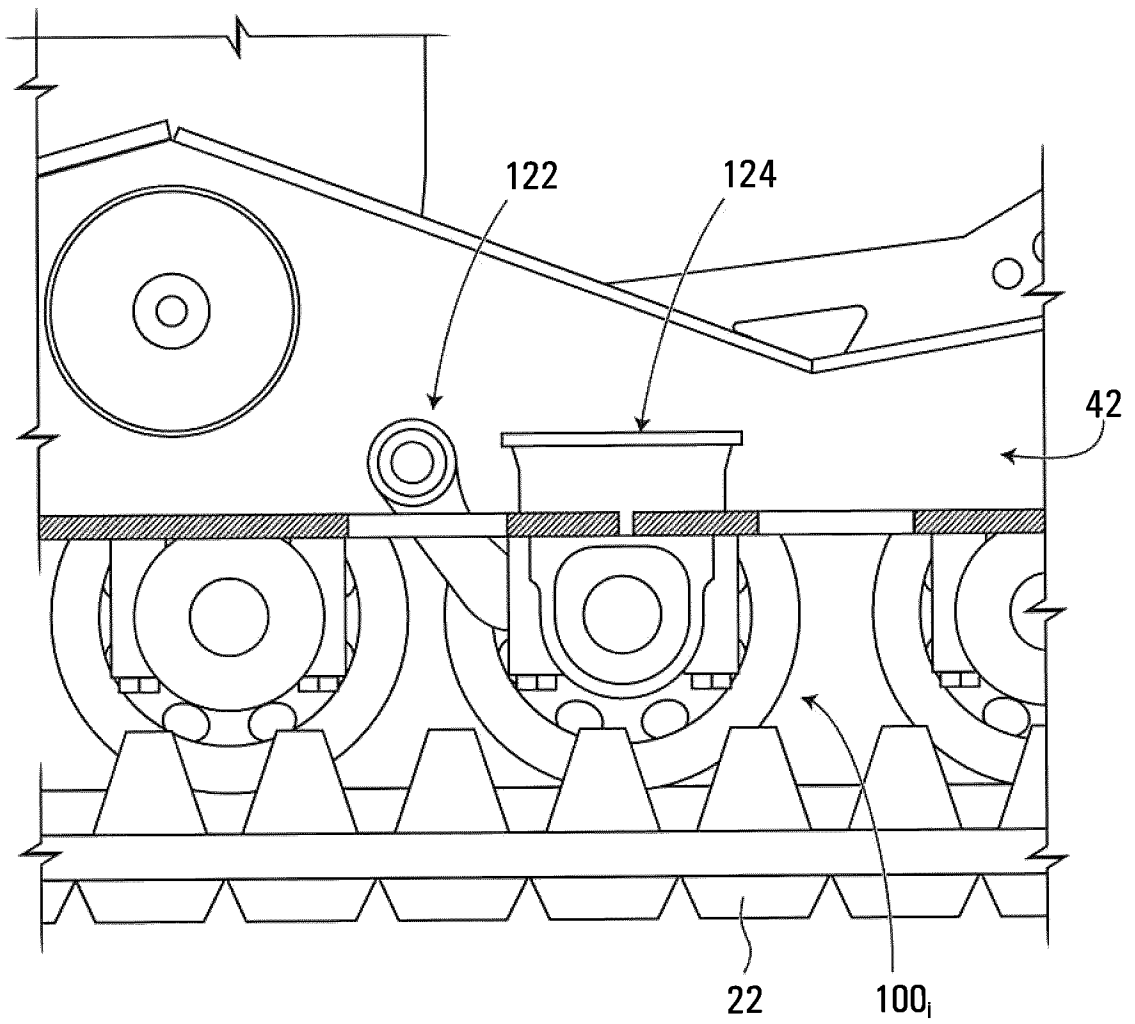


FIG. 18

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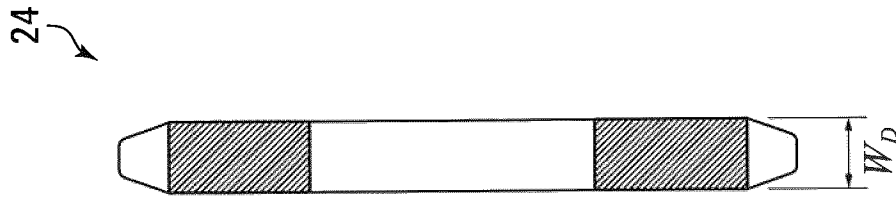


FIG. 19B

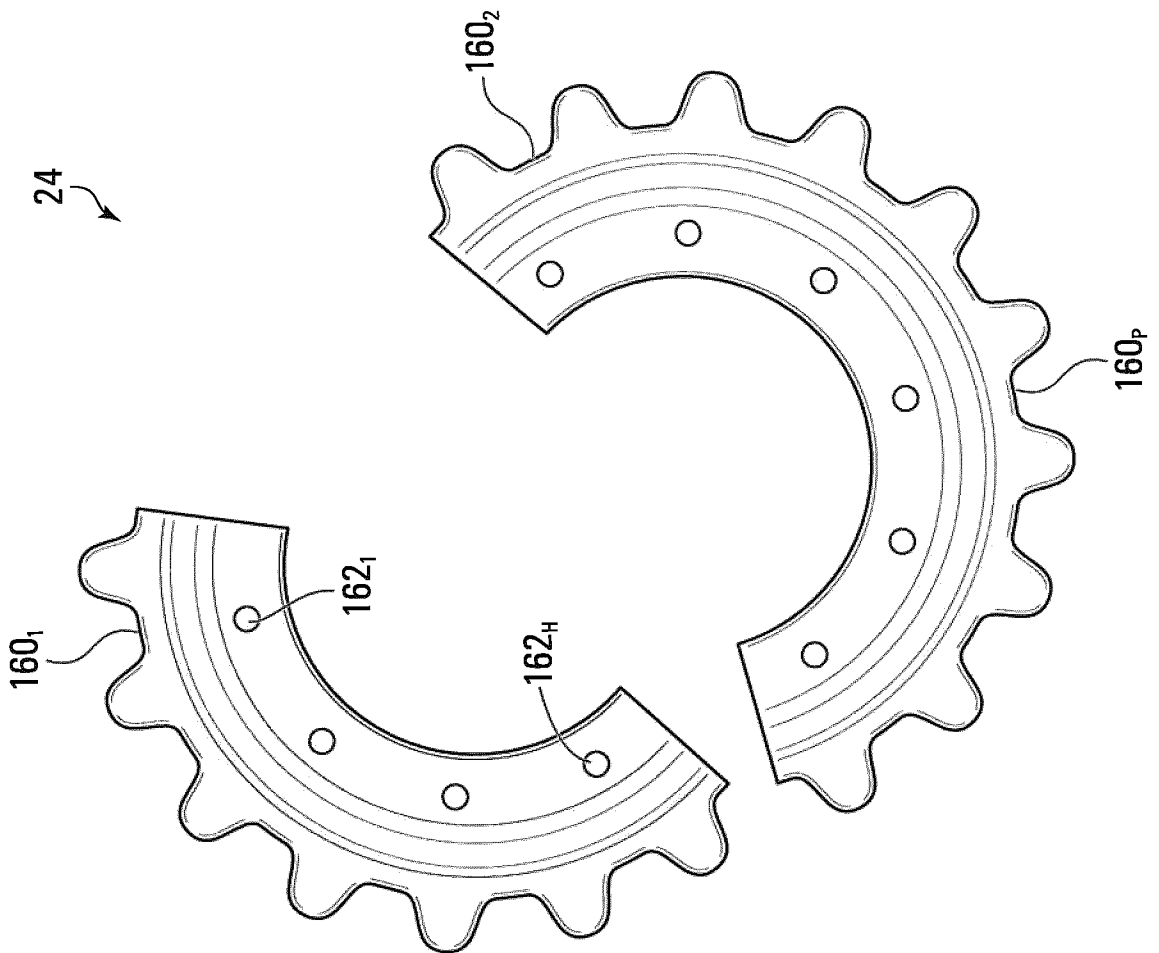


FIG. 19A

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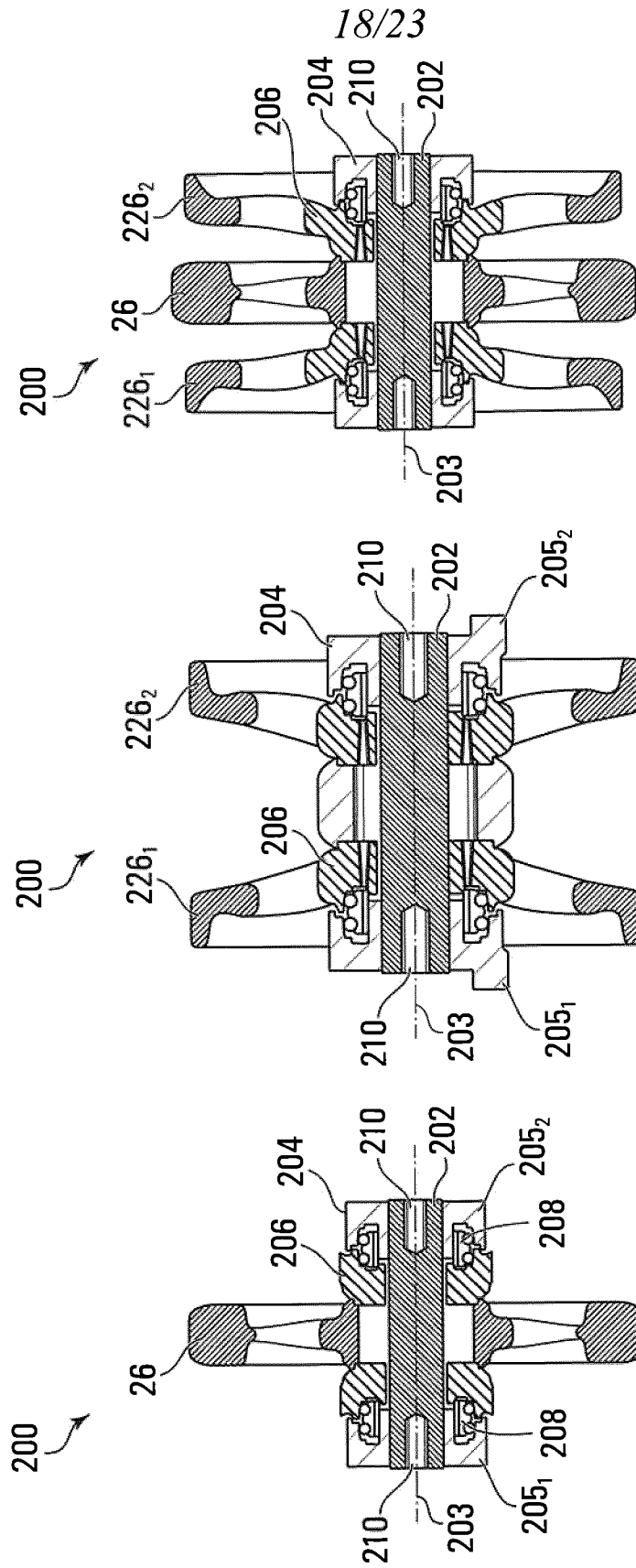


FIG. 22

FIG. 21

FIG. 20

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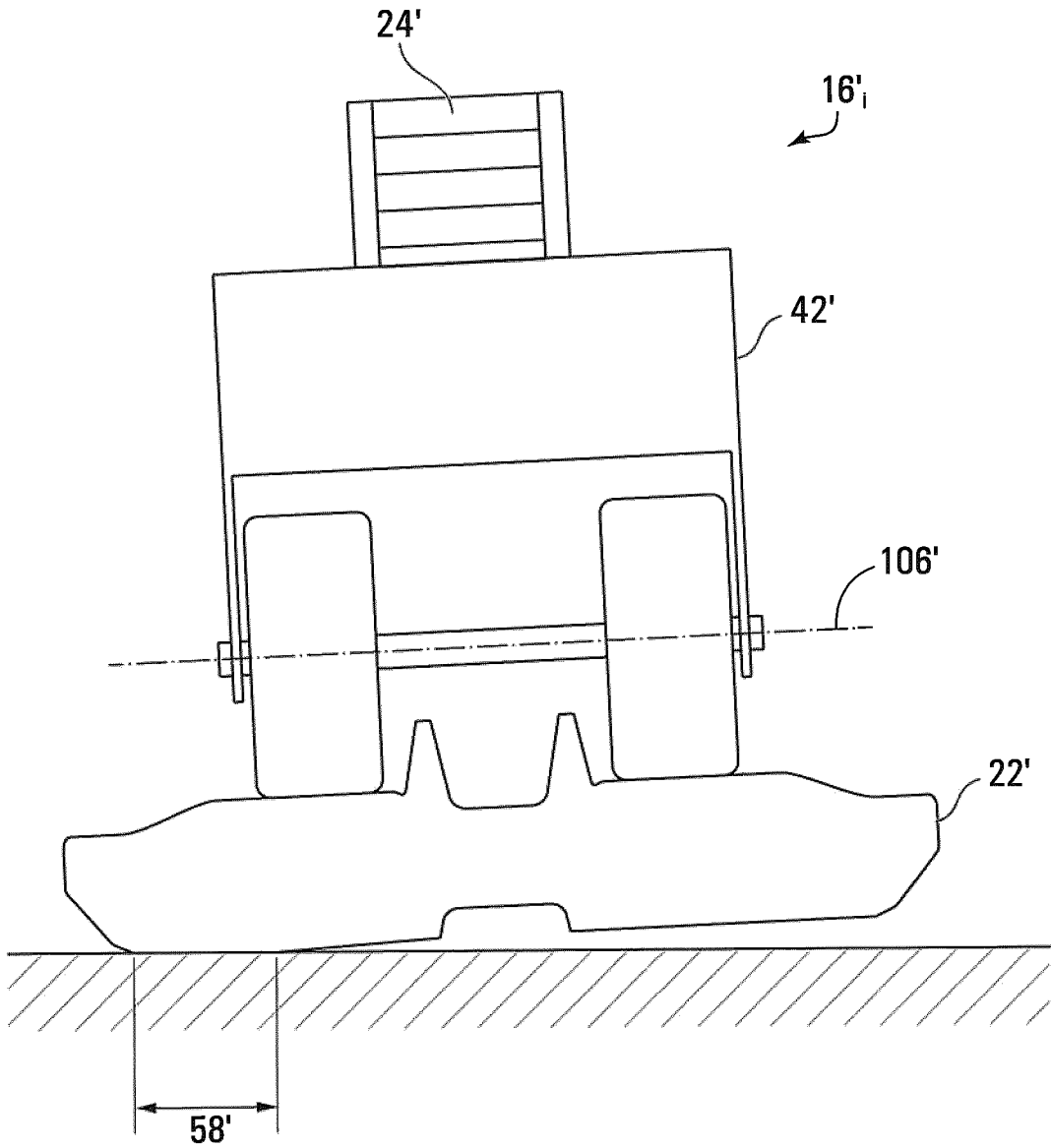


FIG. 23
Prior Art

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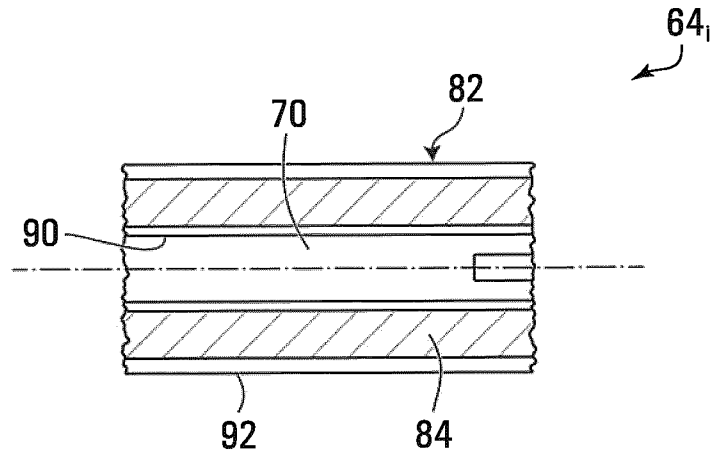


FIG. 24

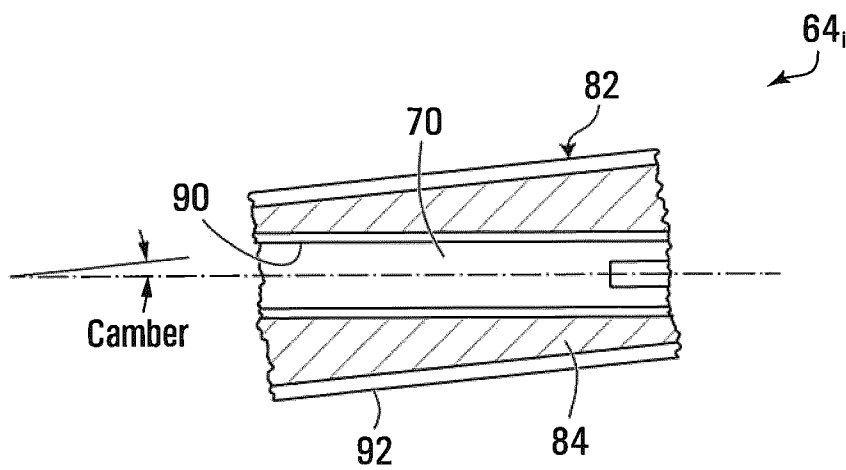


FIG. 25

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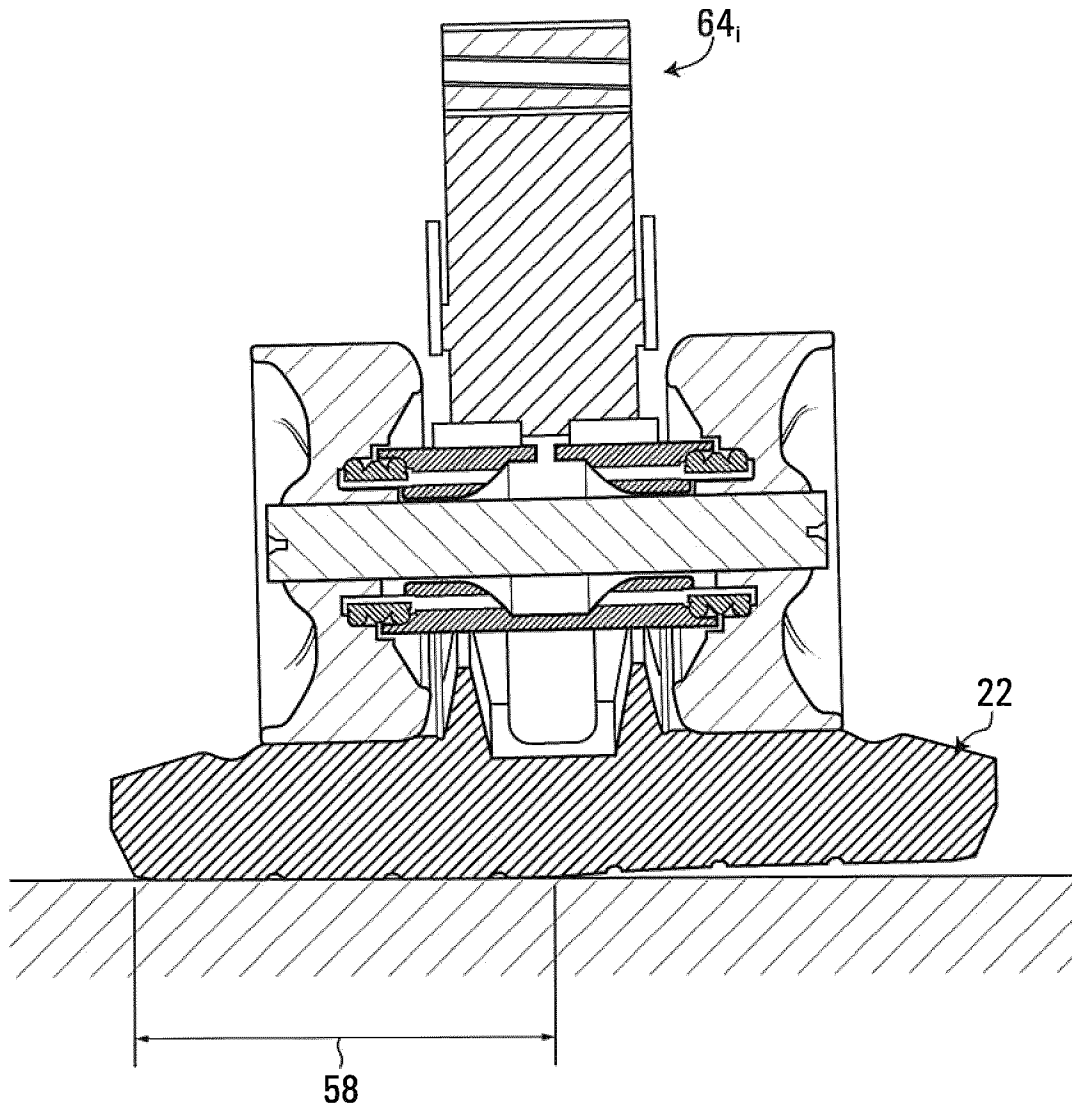


FIG. 26

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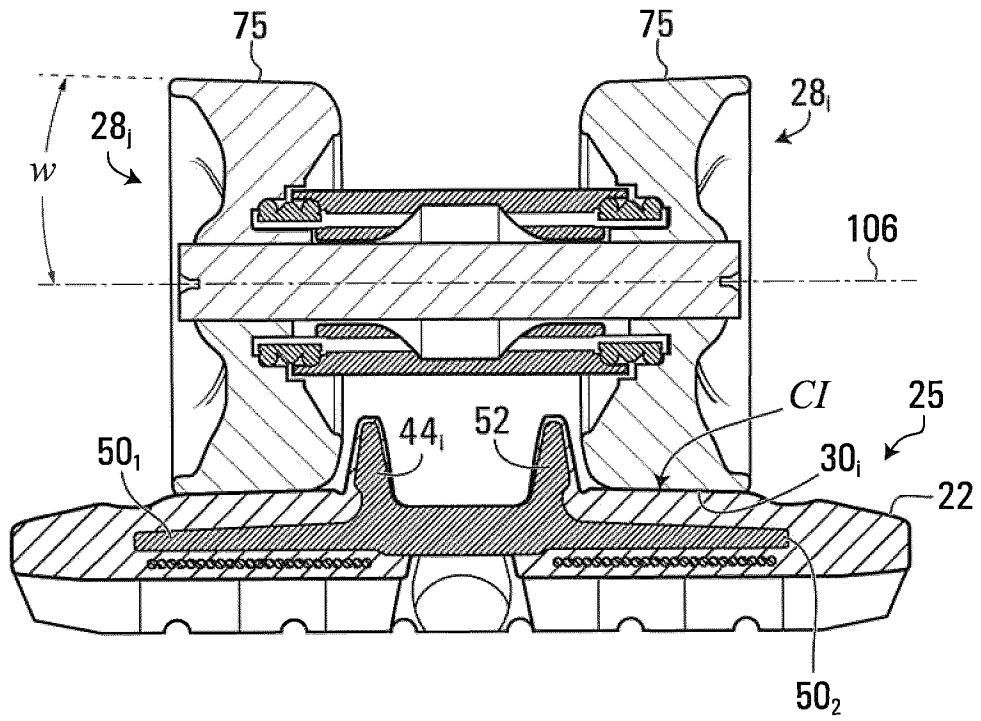


FIG. 27

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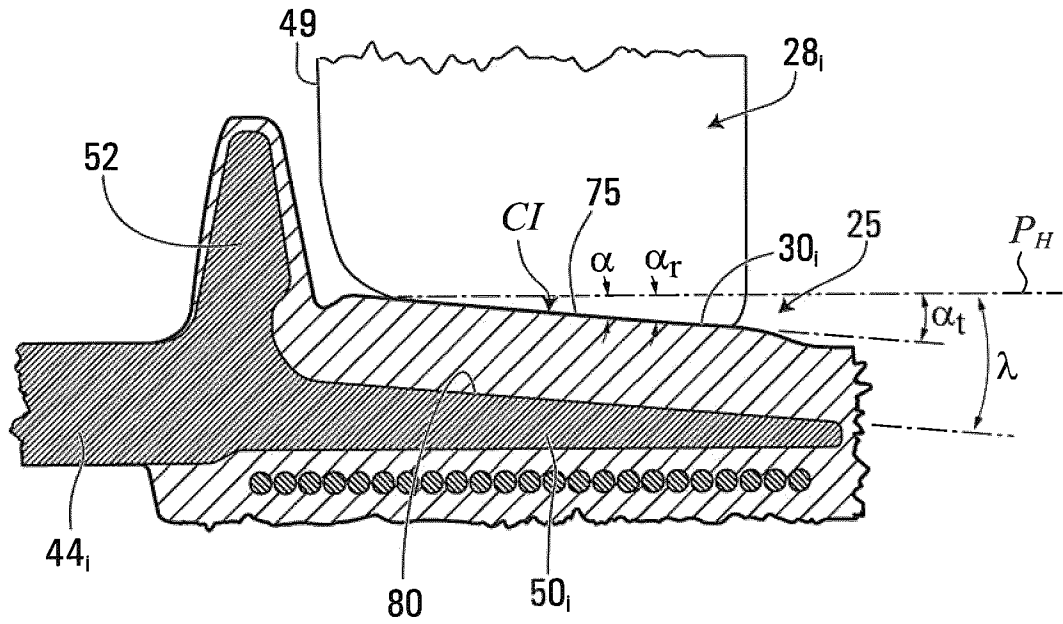


FIG. 28

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2016/050148A. CLASSIFICATION OF SUBJECT MATTER
IPC: **B62D 55/08** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(2006.01): B62D 55/08; B62D 55/14

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

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

Databases: Canadian Patent Database (CPD), Questel Orbit
keywords: angle, slant, incline

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP2001146182A (MAKOTO, T. et al.) 29 May 2001 (29-05-2001) *Fig. 1 and 2*	1, 10, 17 – 23, 25, 28, 29, 51, 52, 57, 58, 60 – 65, 69, 70, 80, 91, 92, 96 and 97
Y		2 – 9, 11 – 16, 24, 26 – 27, 30 – 50, 53 – 56, 59, 67, 68, 71 – 79, 90 and 93 – 95
Y	WO9816419A1 (NAGORKA, J.) 23 April 1998 (23-04-1998) *Fig. 1 and 3*	2 – 4, 14, 15, 24 and 27
Y	US1506431A (KEGRESSE, A.) 26 August 1924 (26-08-1924) *Fig. 4*	74, 75 and 81- 83

Further documents are listed in the continuation of Box C.

See patent family annex.

* “A” “E” “L” “O” “P”	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier application or patent but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	“T” “X” “Y” “&”	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art document member of the same patent family
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Date of the actual completion of the international search
25 April 2016 (25-04-2016)Date of mailing of the international search report
11 May 2016 (11-05-2016)Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 819-953-2476Authorized officer

Adeeb Zarifa (819) 639-7925

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2016/050148

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
JP2001146182A	29 May 2001 (29-05-2001)	None	
WO9816419A1	23 April 1998 (23-04-1998)	WO9816419A1 AU4543697A AUPO302096D0 DE19782050T1 GB9908453D0 GB2333273A	23 April 1998 (23-04-1998) 11 May 1998 (11-05-1998) 07 November 1996 (07-11-1996) 14 October 1999 (14-10-1999) 09 June 1999 (09-06-1999) 21 July 1999 (21-07-1999)
US1506431A	26 August 1924 (26-08-1924)	US1506431A DE396431C DE396432C DE404453C FR25242E FR523157A GB168331A	26 August 1924 (26-08-1924) 05 June 1924 (05-06-1924) 06 June 1924 (06-06-1924) 20 October 1924 (20-10-1924) 08 January 1923 (08-01-1923) 13 August 1921 (13-08-1921) 27 July 1922 (27-07-1922)