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WEBSTER et al.

(54) **HYBRID COMBINATION OF RUBBER TRACK WITH ROAD WHEELS FOR A VEHICLE**

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B62D 55/14 (2006.01)

(52) **U.S. Cl.** **305/129**

(57) **ABSTRACT**

Described is a belt used in conjunction with road wheels device and method of supporting weight of hybrid tire tracking-laying vehicles more safely and efficiently at highway speeds. The supporting device includes belts **004**, road tires **002**, track tires **003**, tensioning tires **015**, and supporting frame and axles. The road tires **002** are located outside beside the belt **004** with a larger diameter than the belt **004**. The outside road tires work to laterally guide the belt **004** and to prevent the rubber belt **004** from track-throwing. The tensioning tires **015** running inside the belt **004** along the wheel runways **027**, are guided by the belt guide horns **020**. In this proposed device, the belt **004** can remain sufficiently taut to prevent the guide horns **020** from slipping over the track tires **003** and road tires **002**. The designed hybrid belt with tires can remove debris such as mud and sand, and prevent track-throwing even during turning maneuvers.

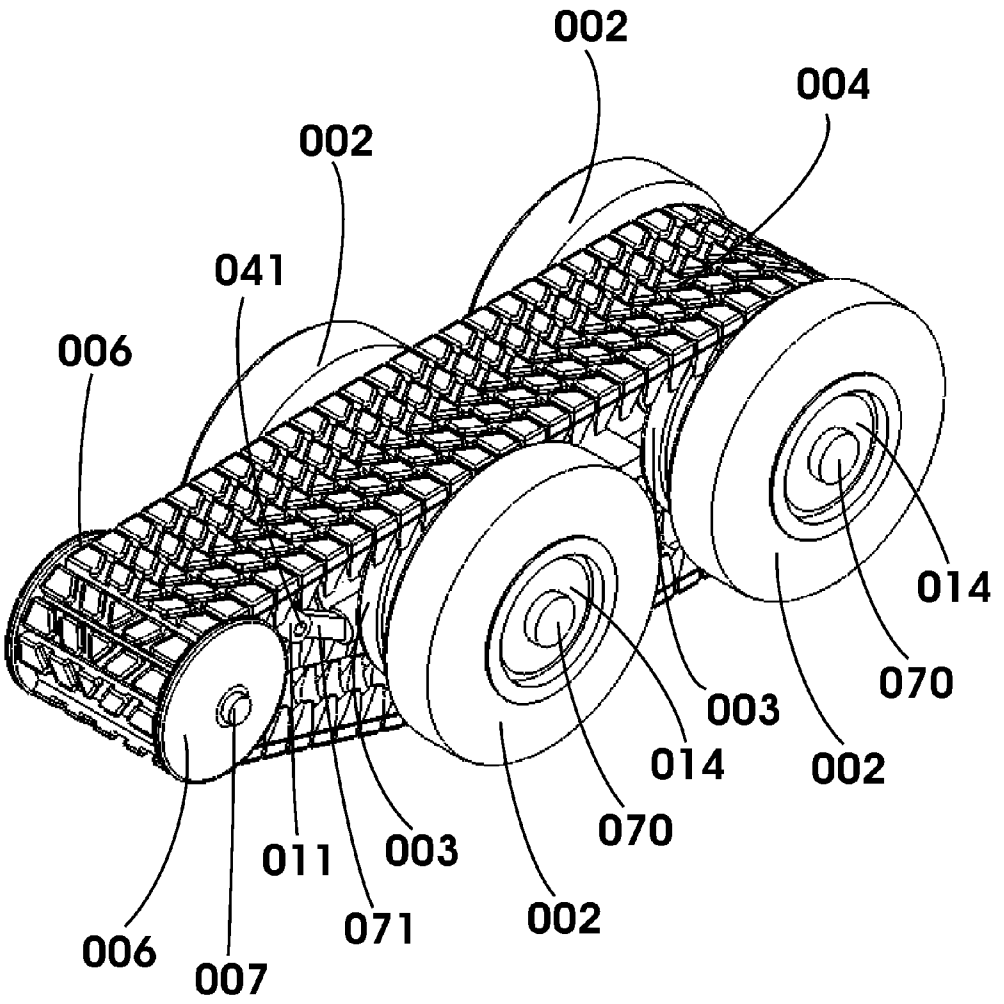

Fig 1

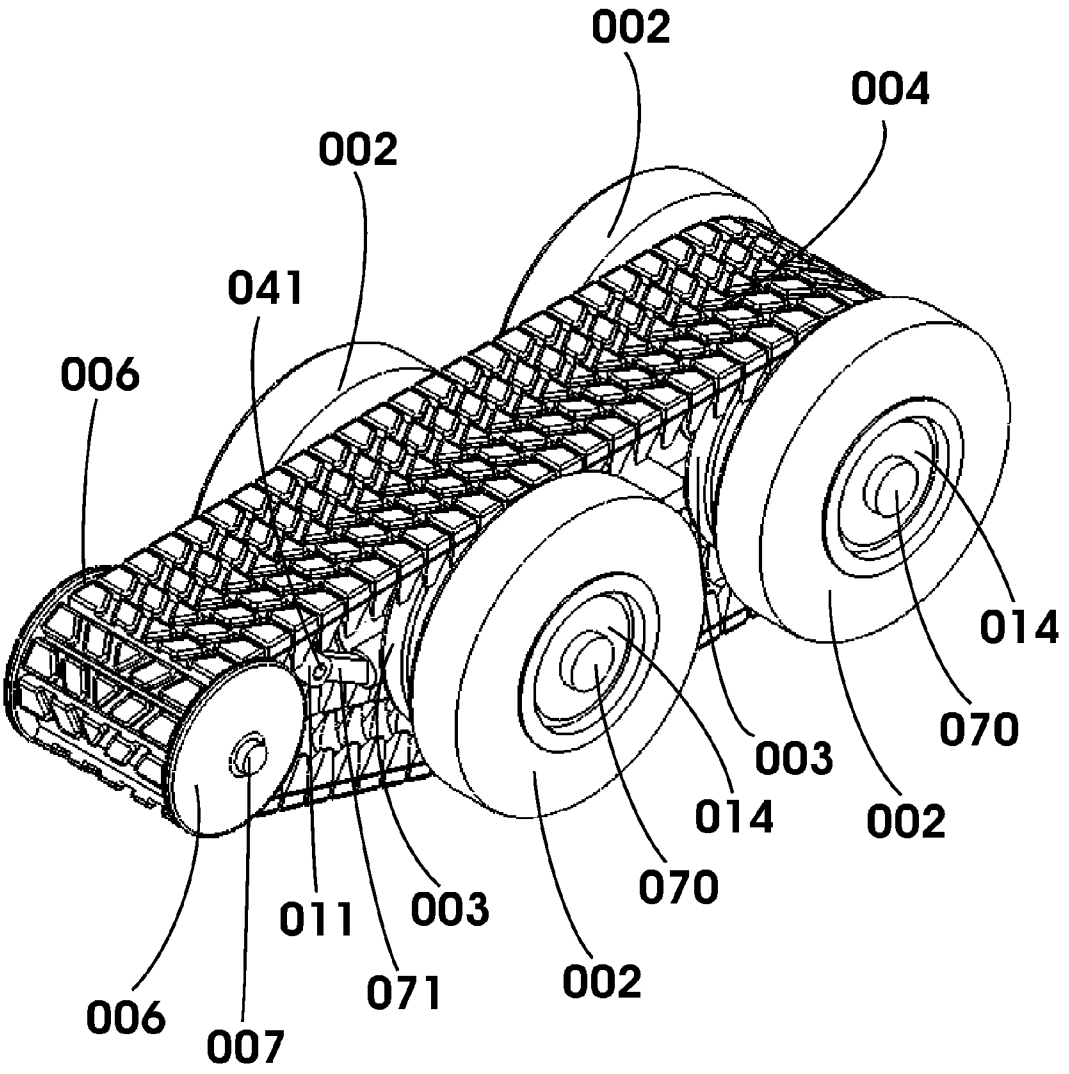
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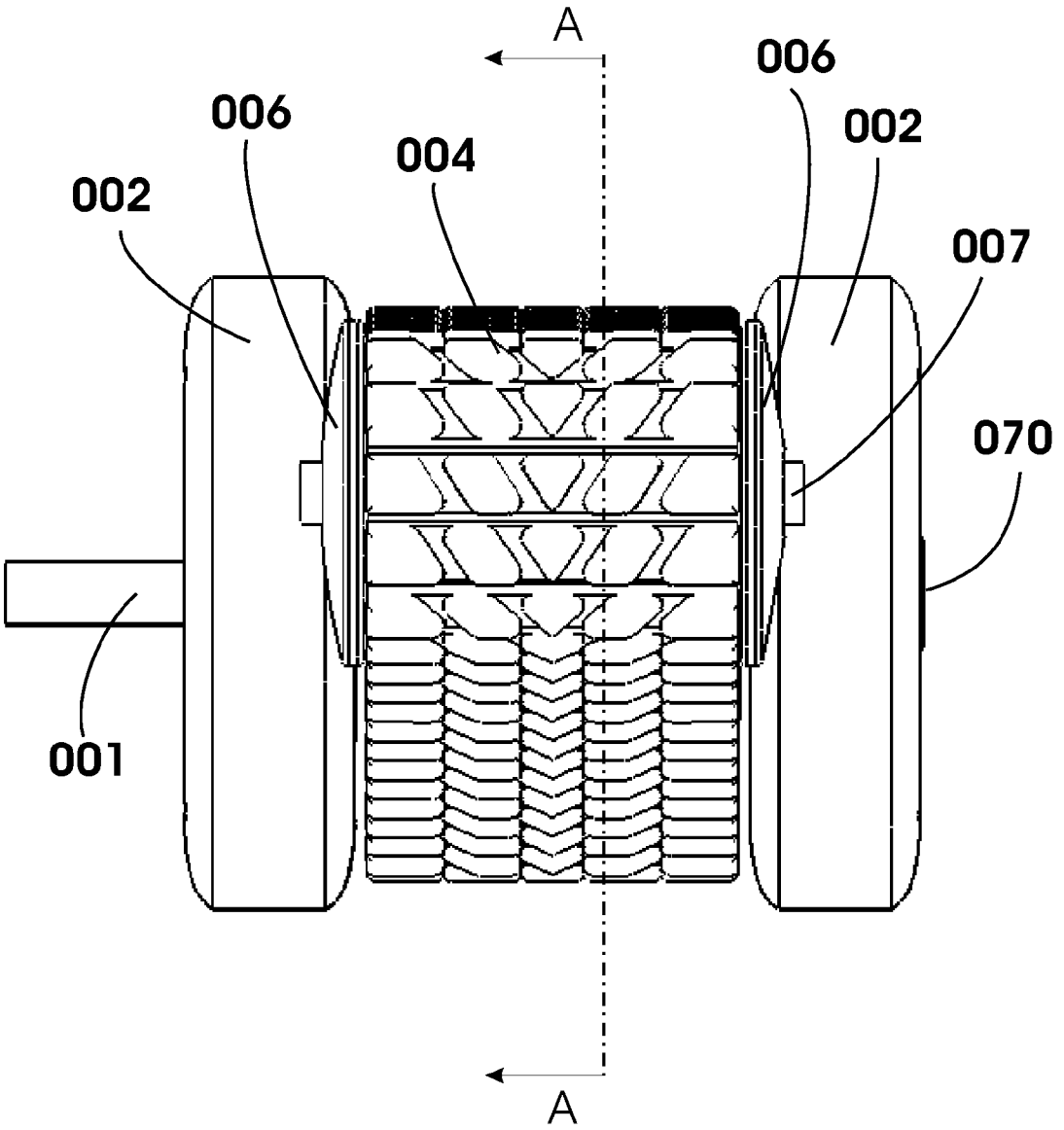
Fig 2



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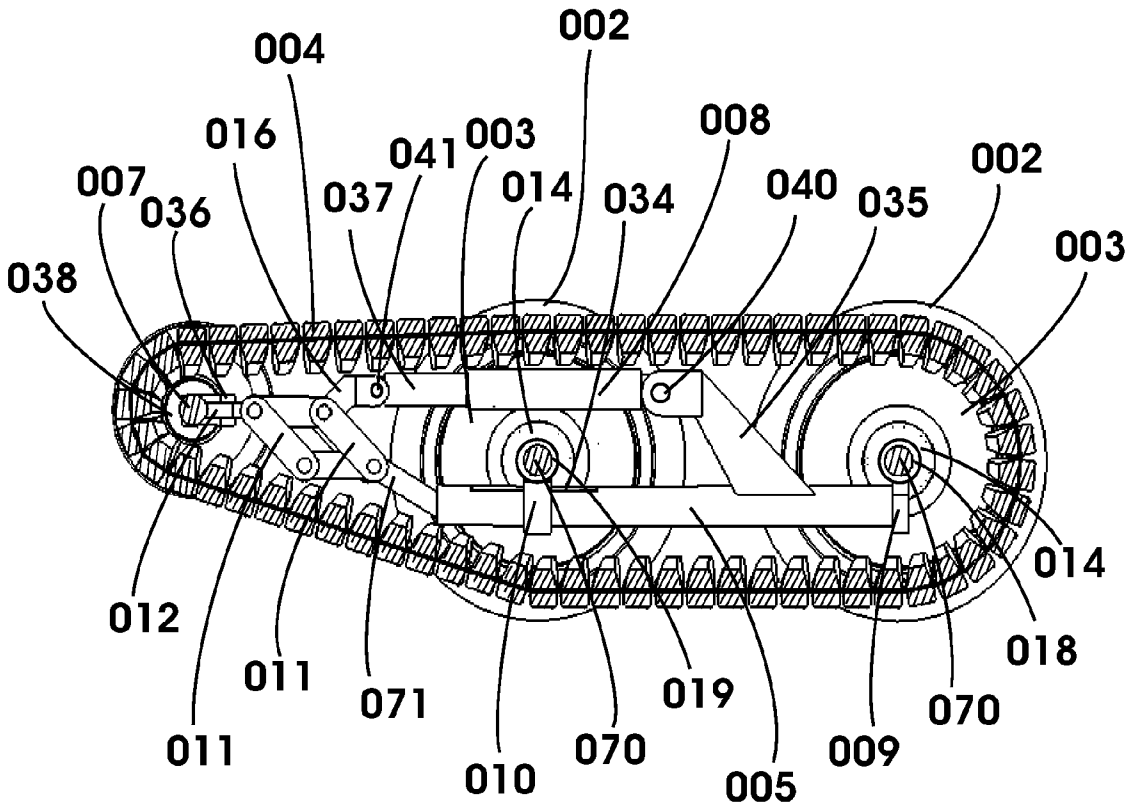
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A - A

Fig 4

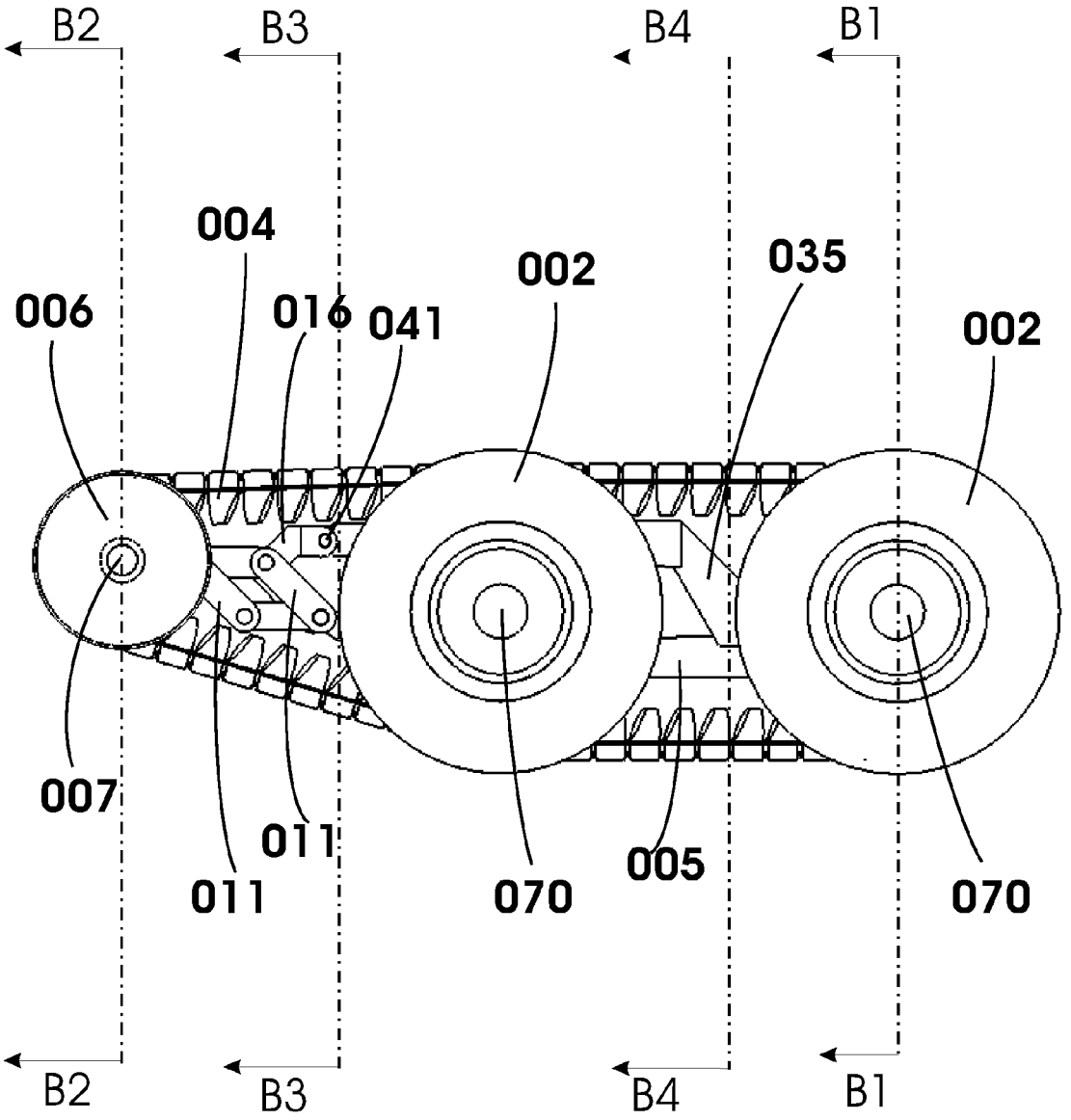
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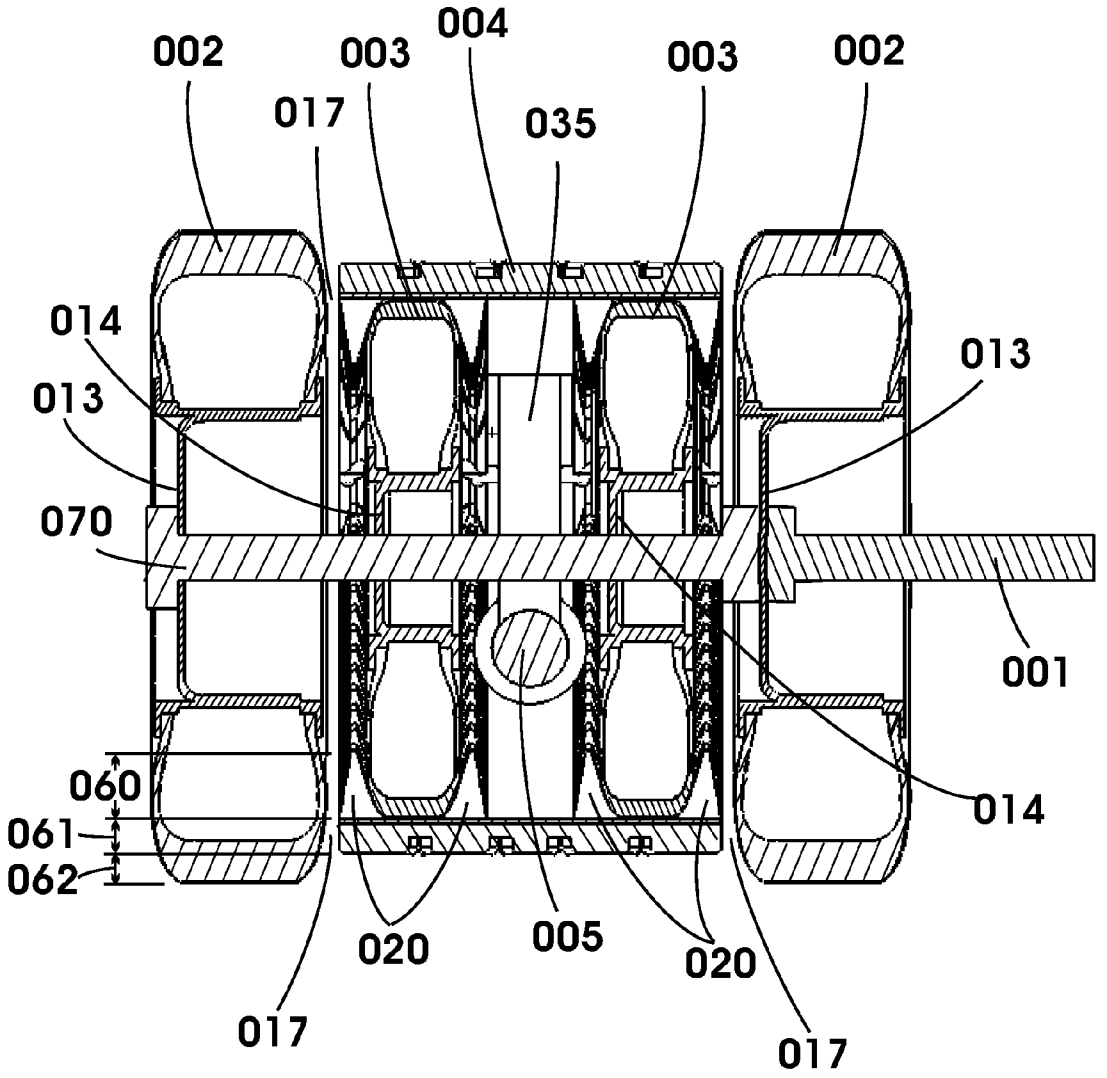
Fig 5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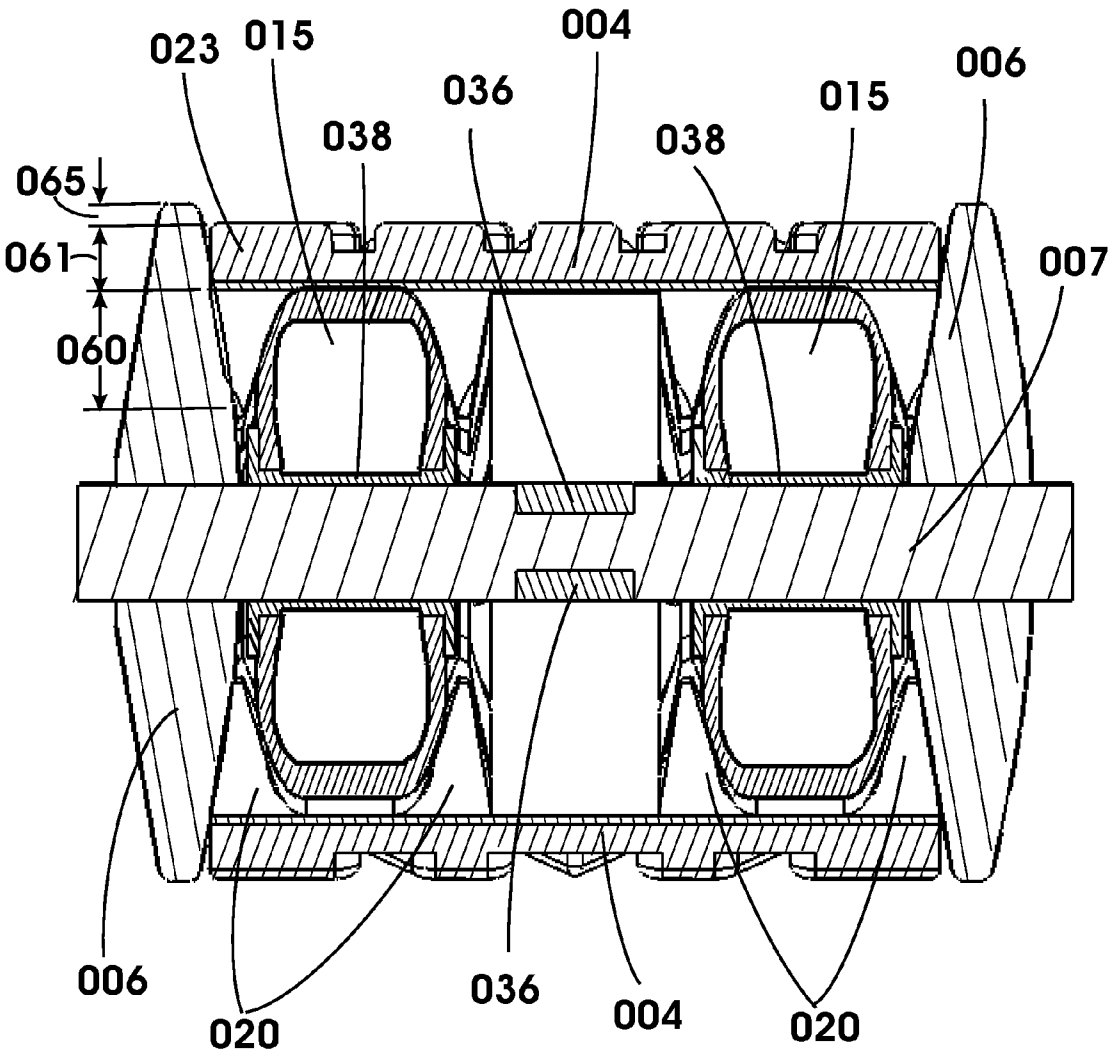
B1 - B1

Fig 6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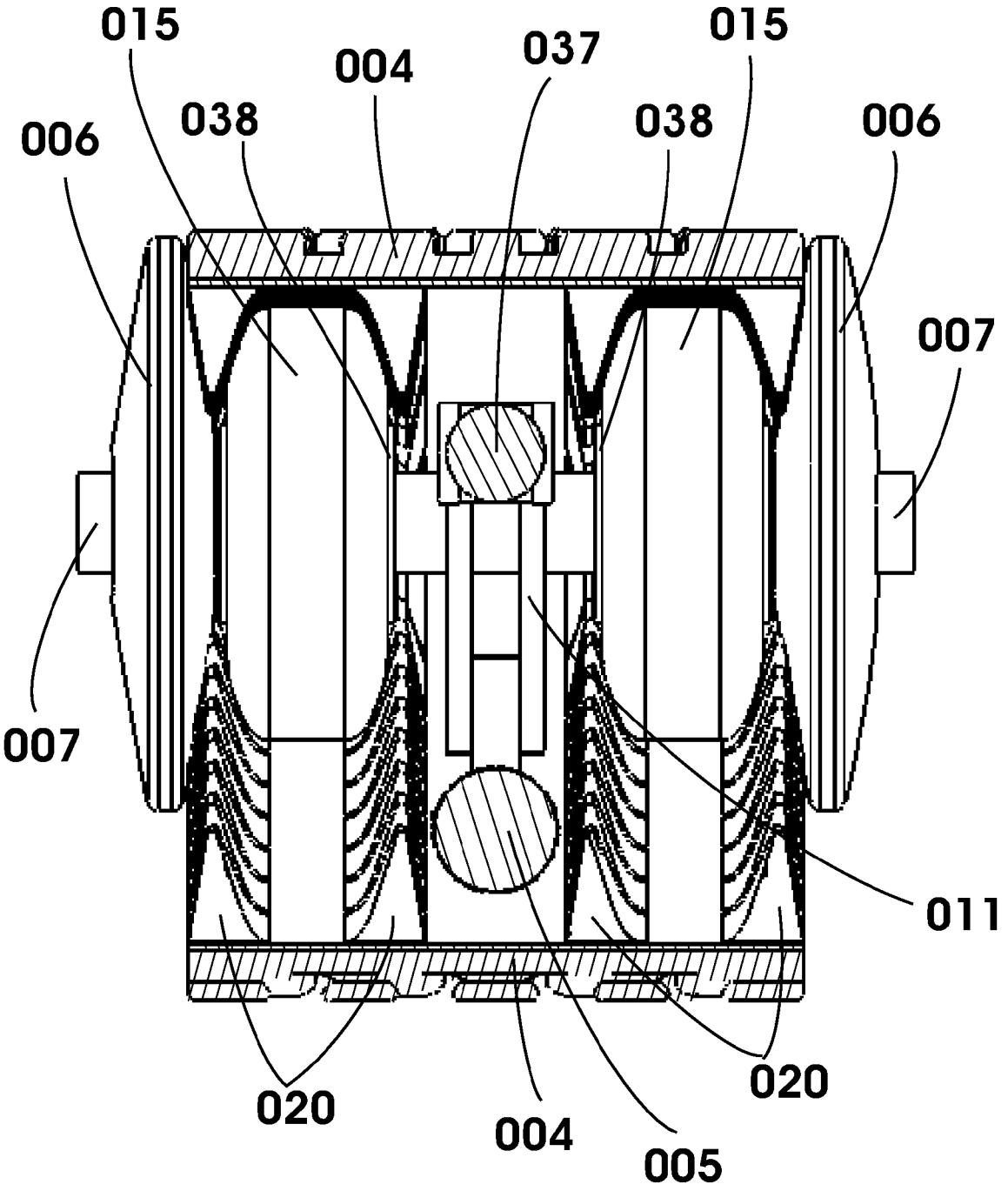
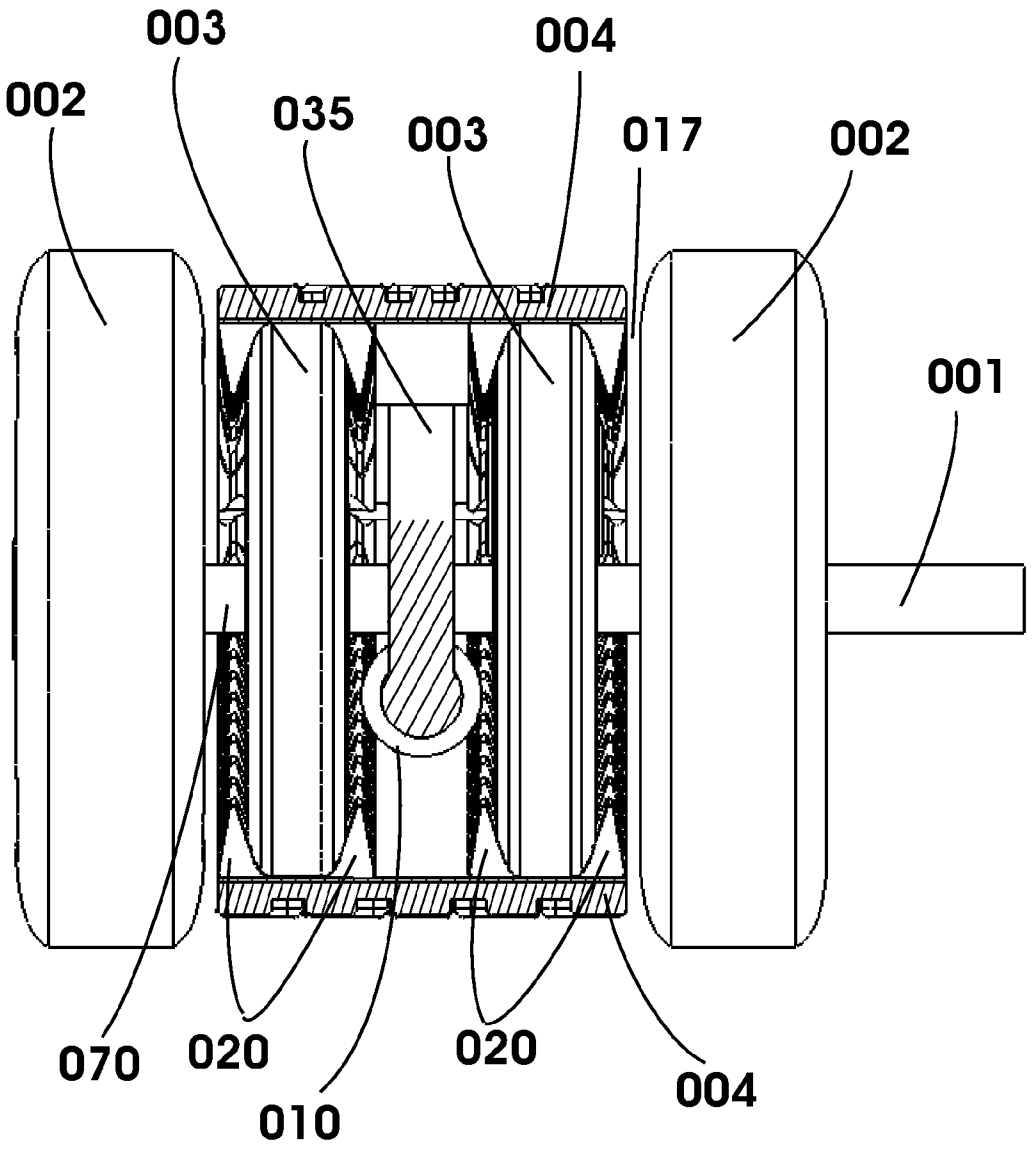
B2 - B2

Fig 7



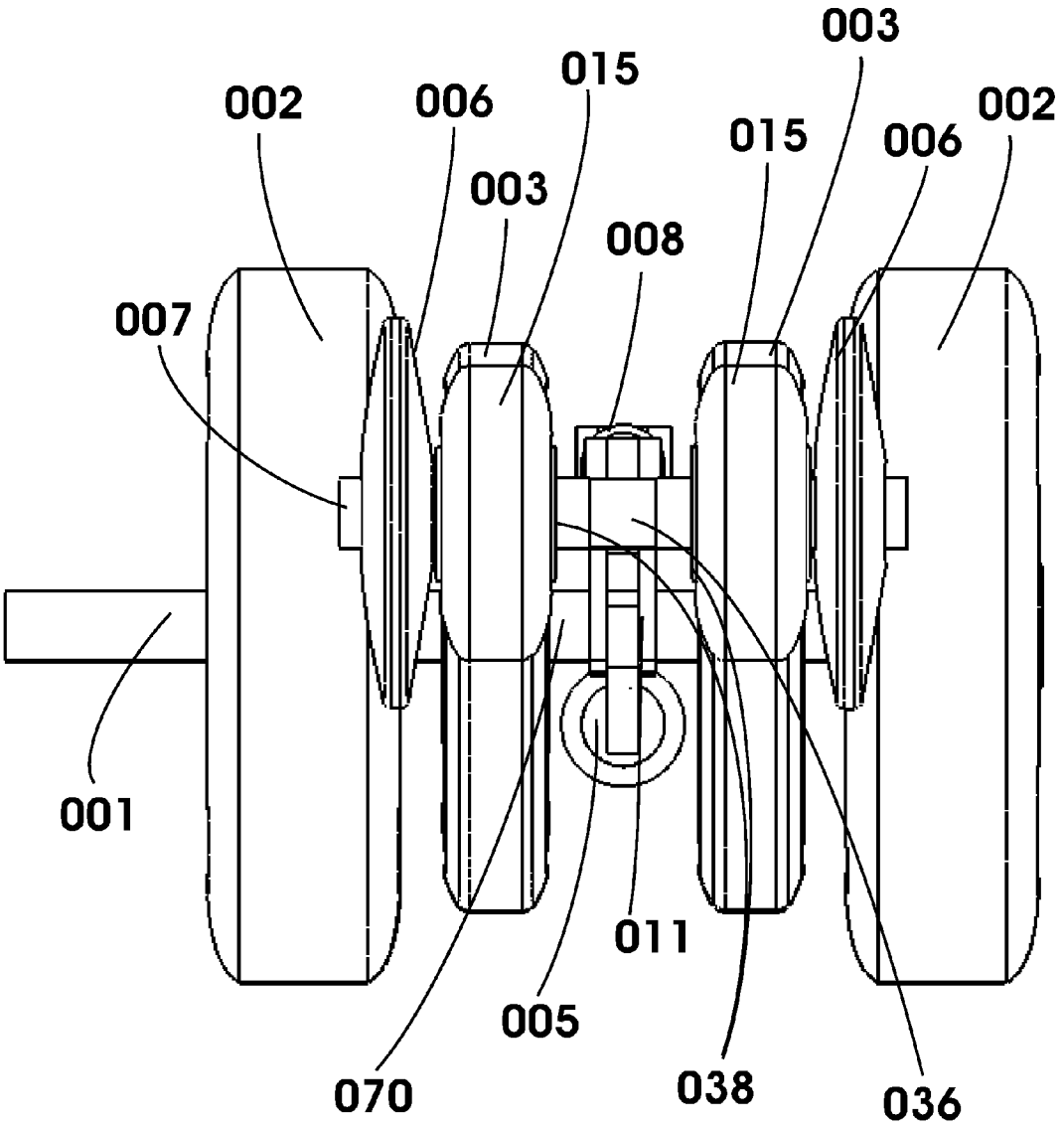
B3 - B3

Fig 8



B4 - B4

Fig 9



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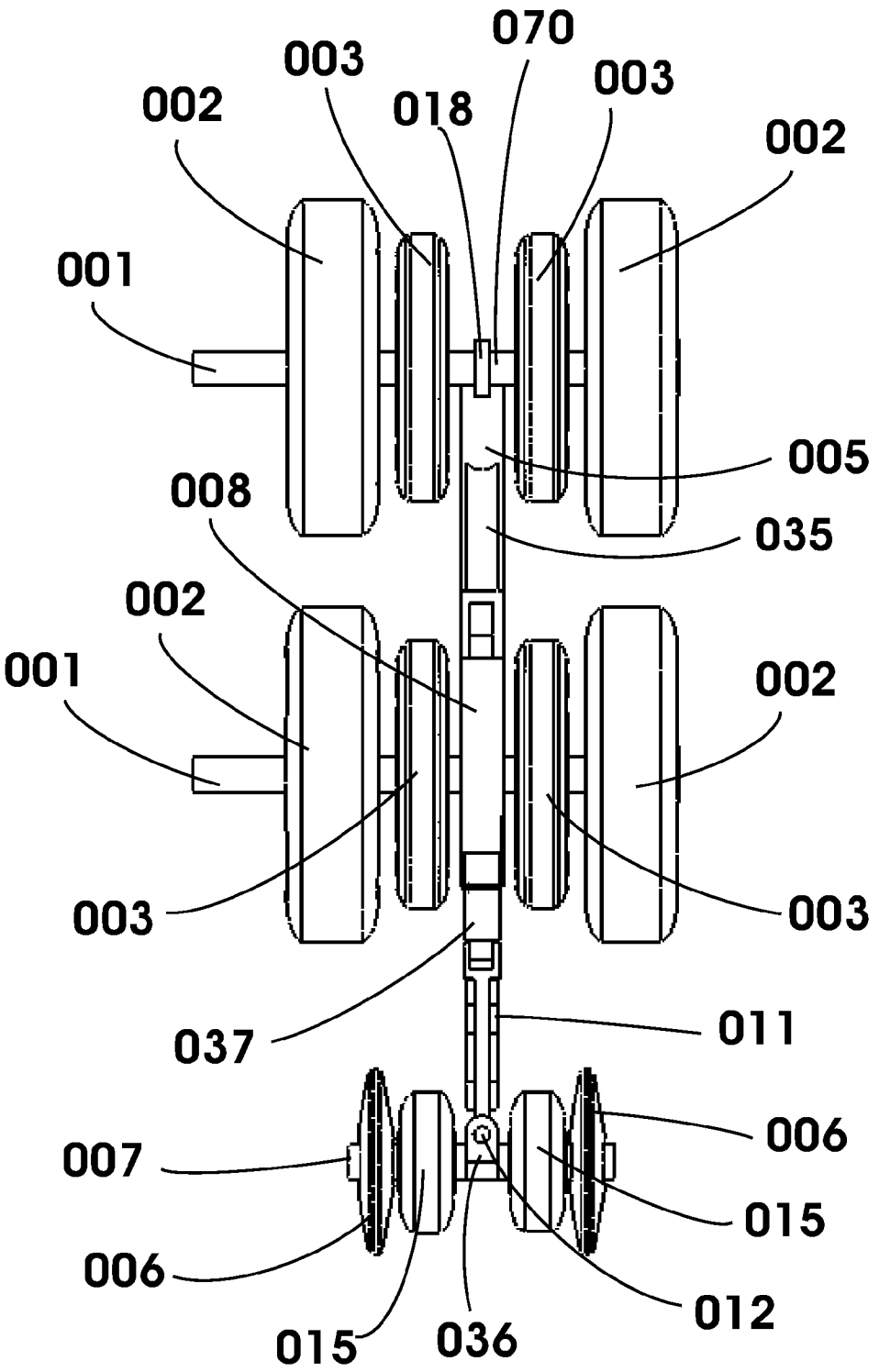
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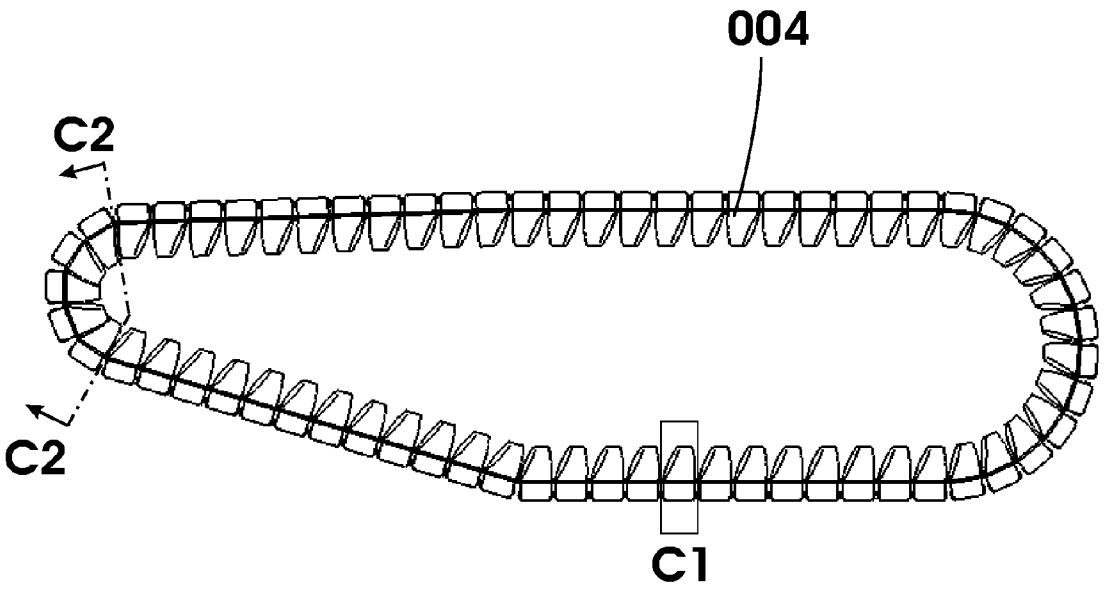
Fig 11



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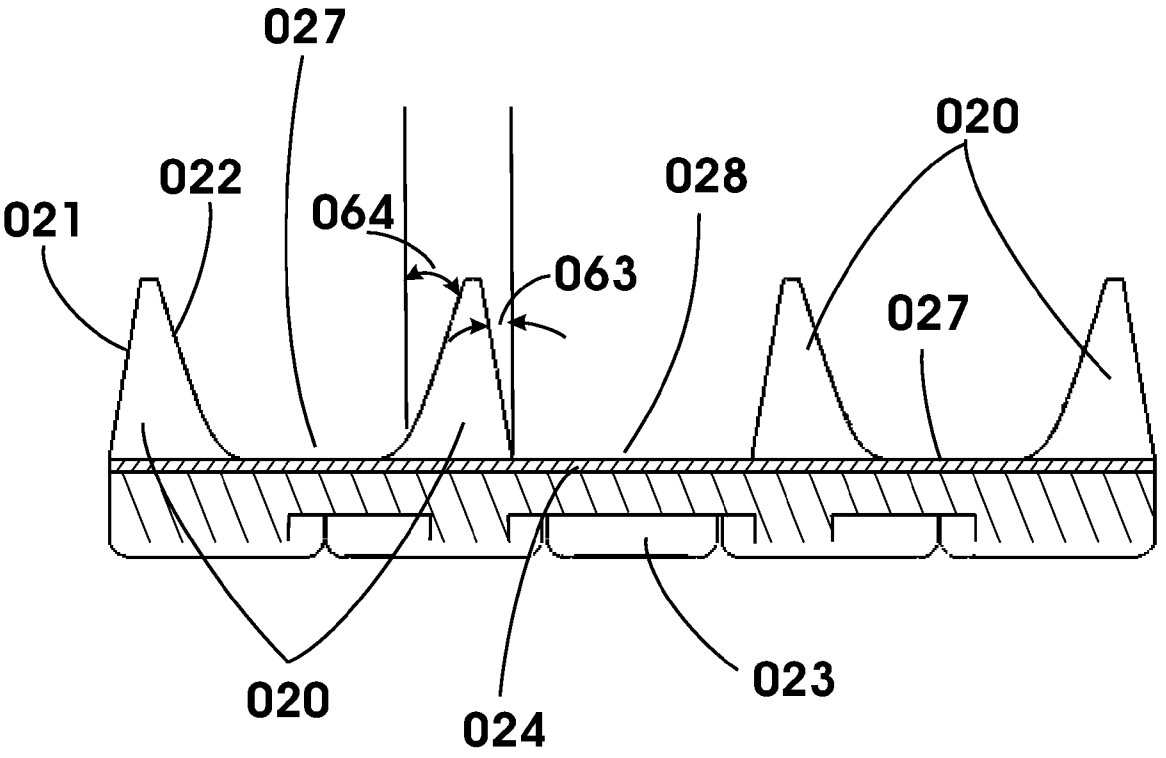

C1 - C1

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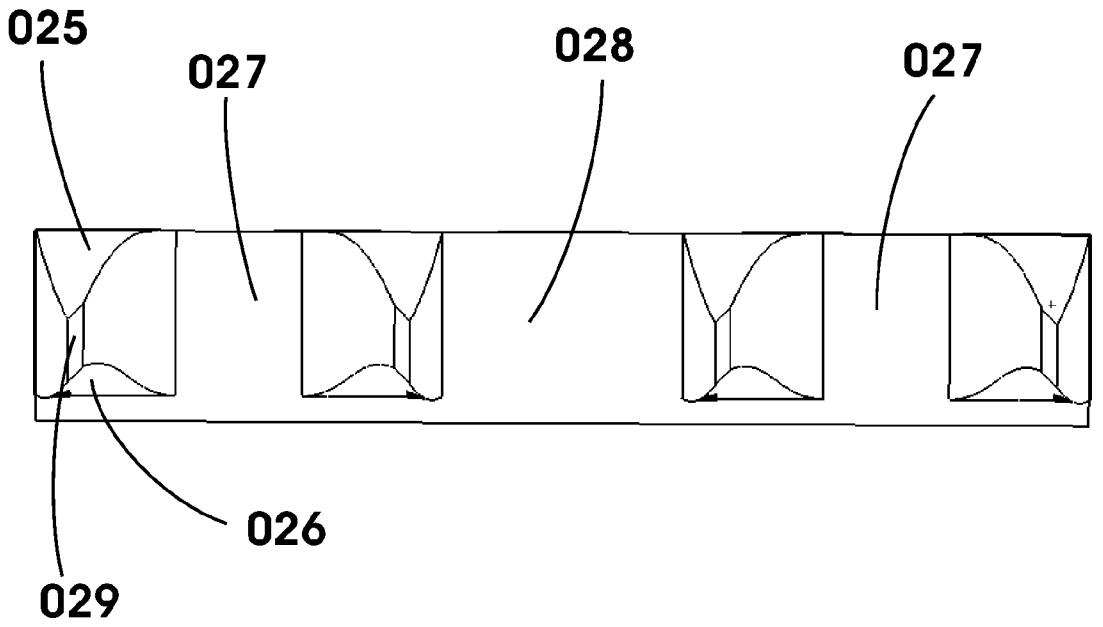

C1 - C1

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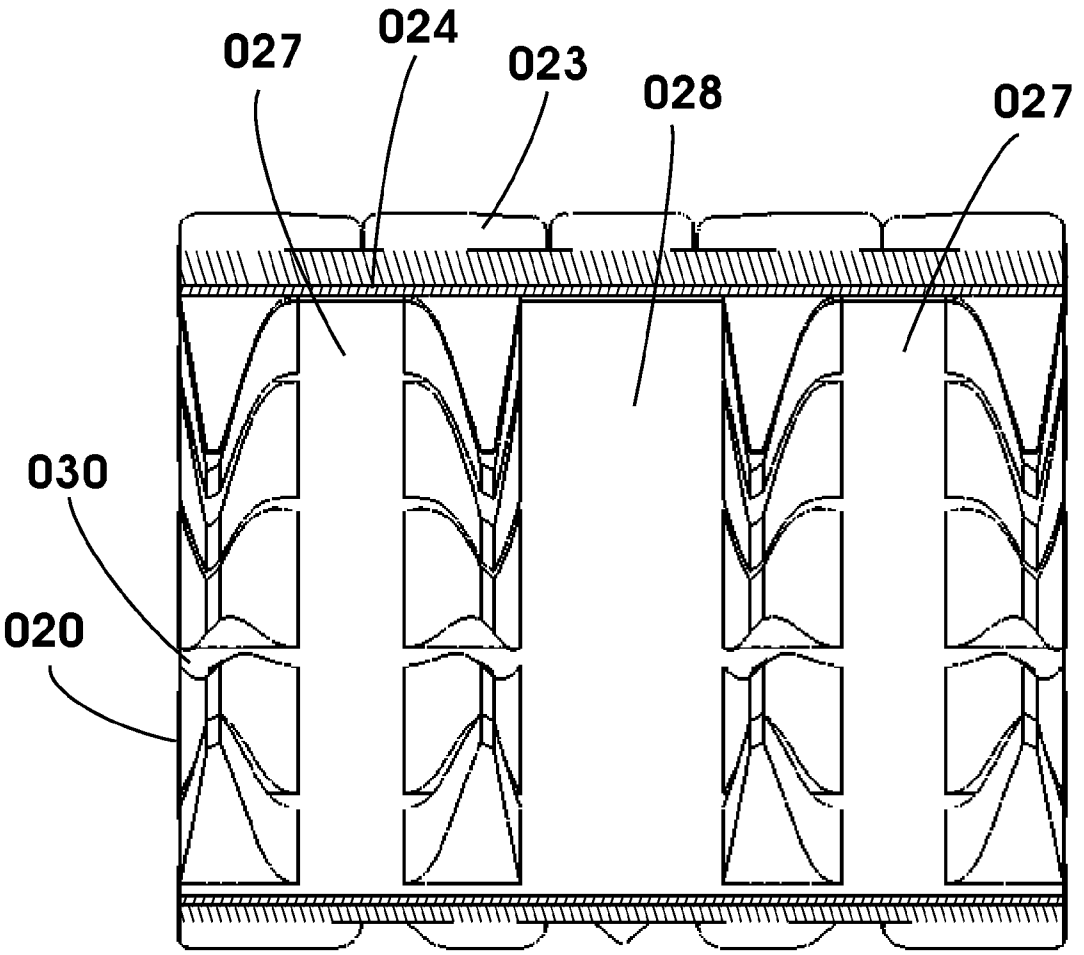

C2 - C2

Fig 15

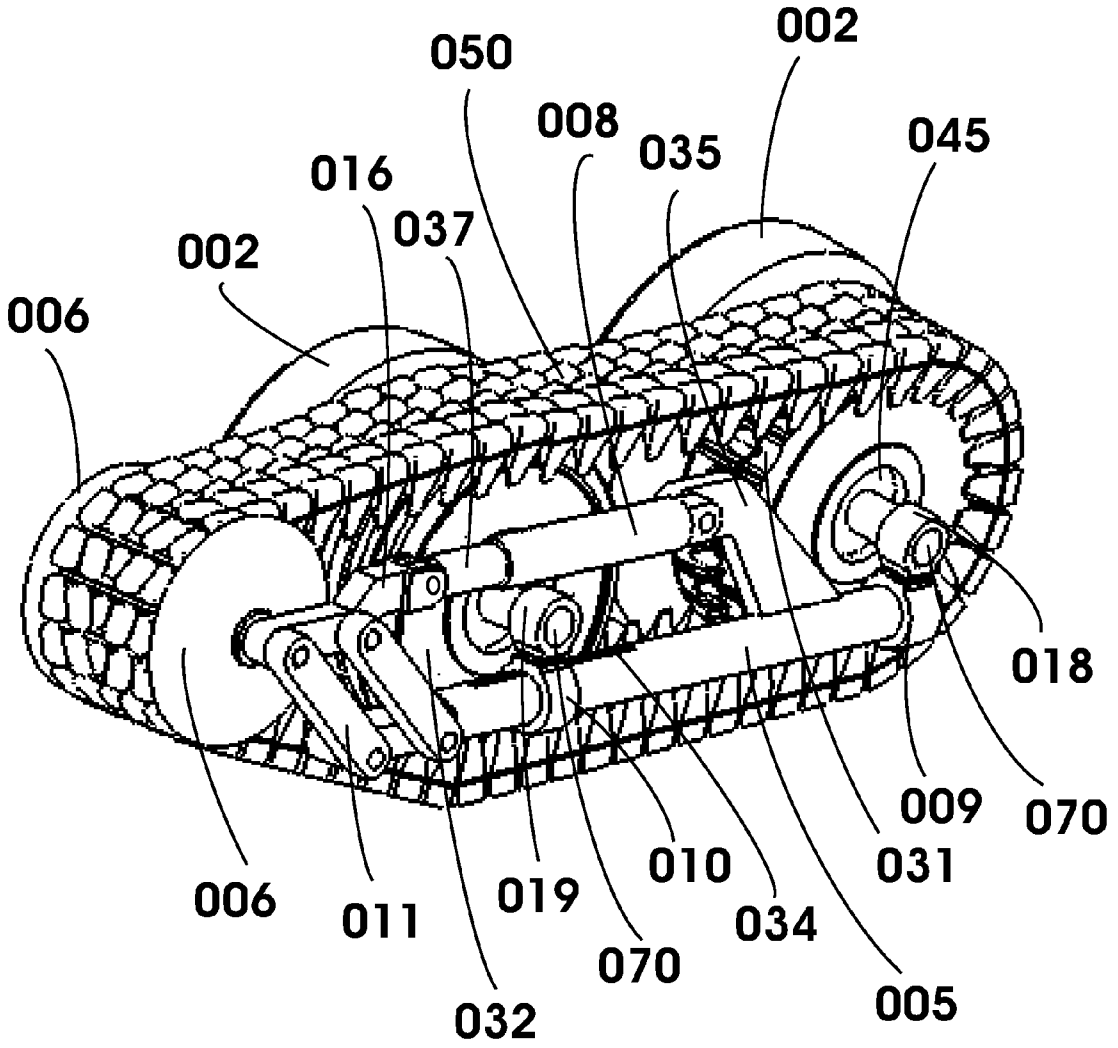
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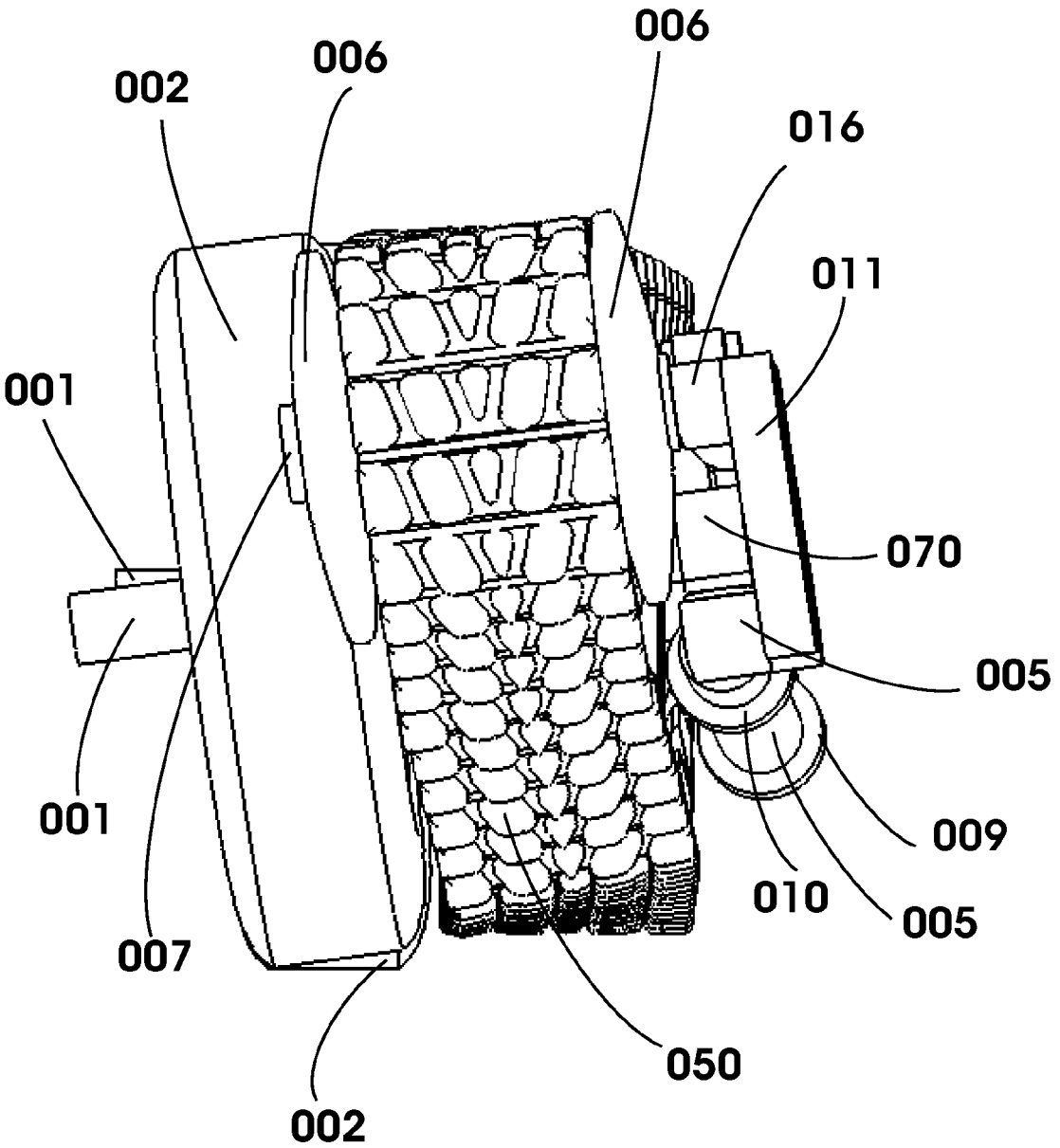
Fig 16



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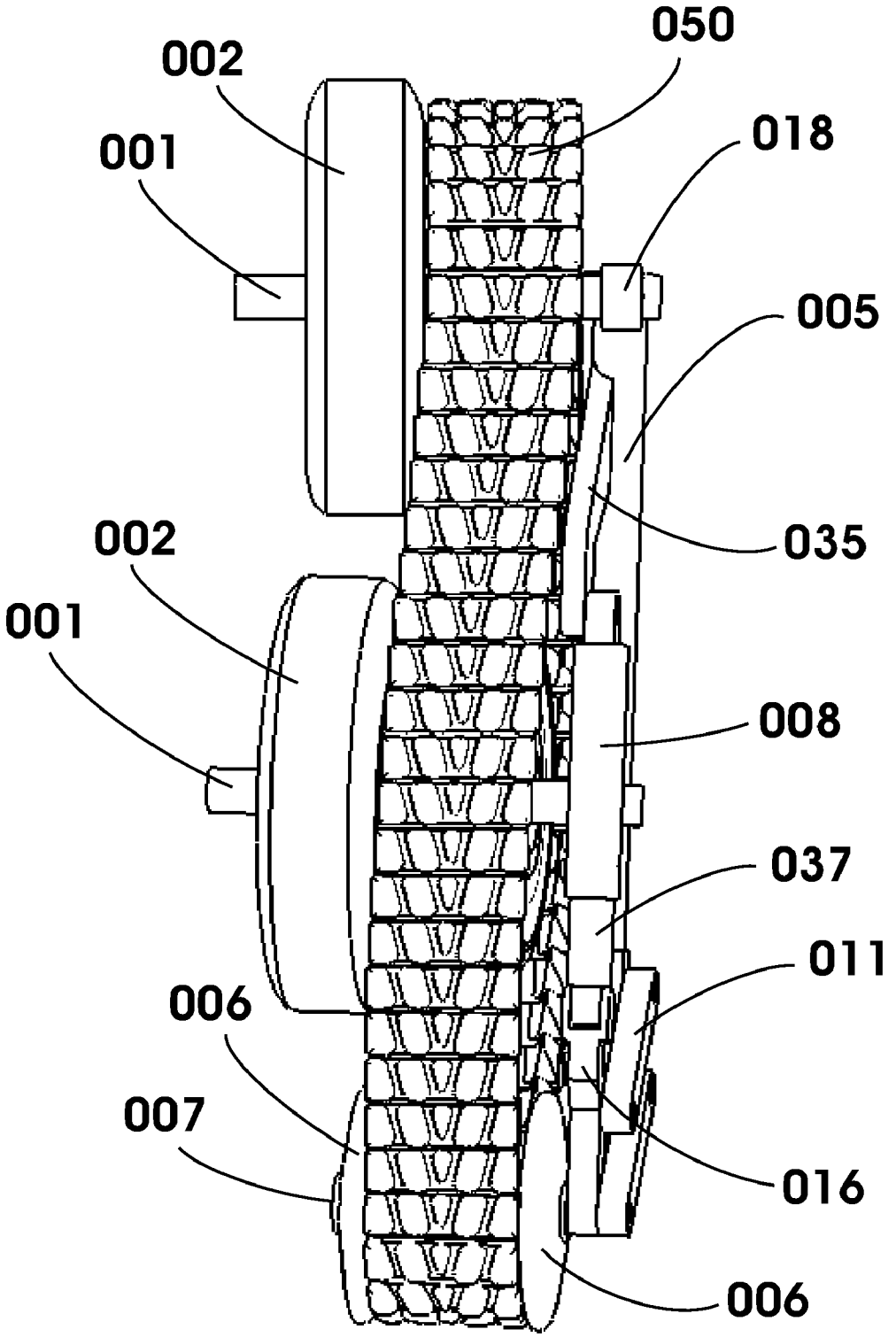

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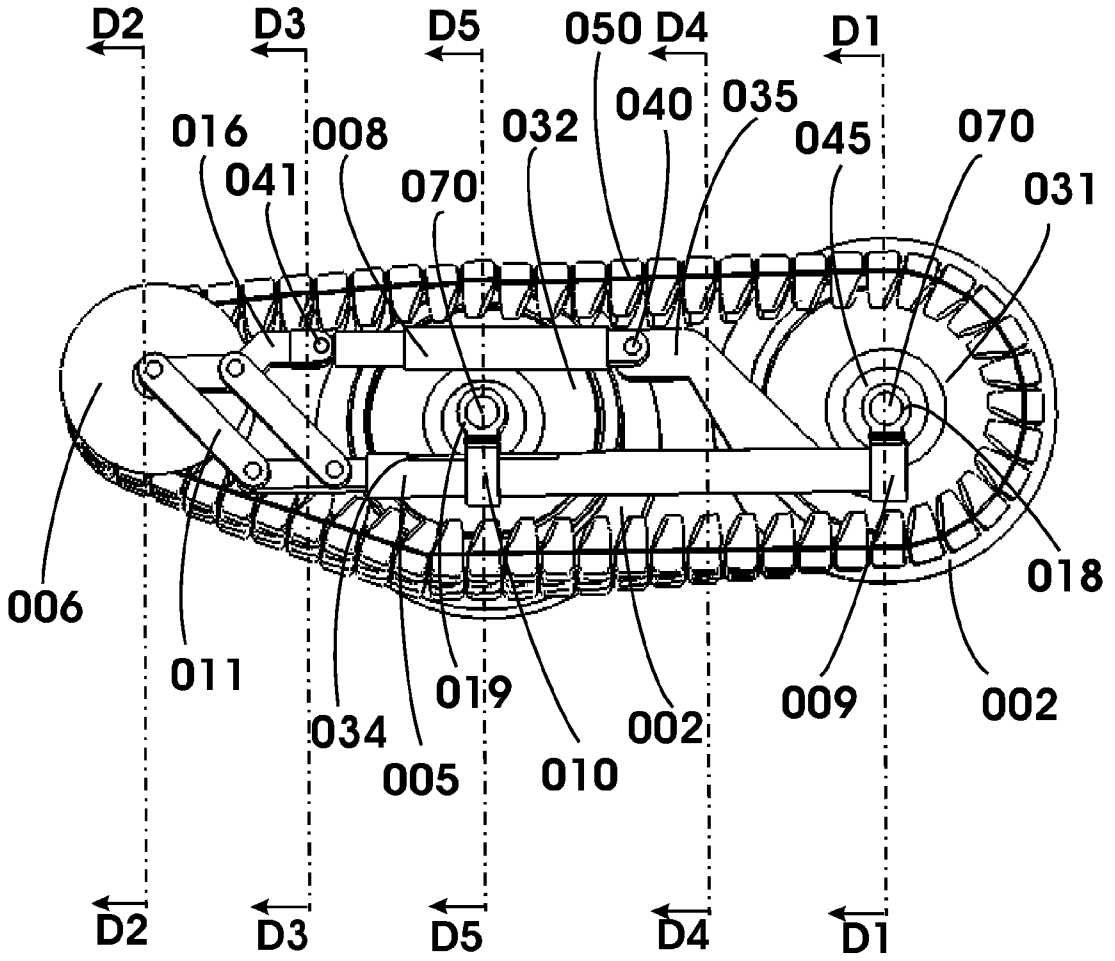
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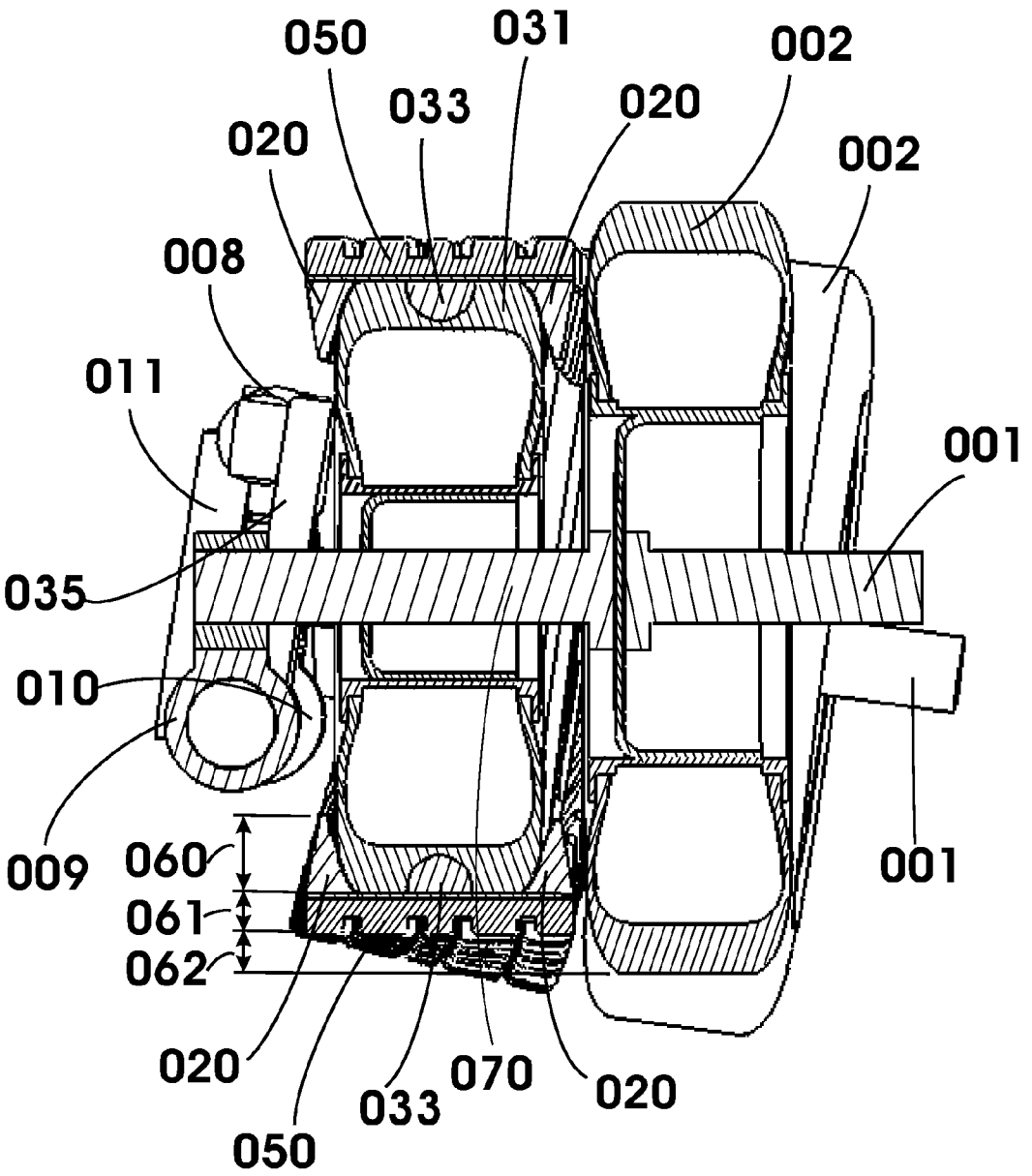
Fig 19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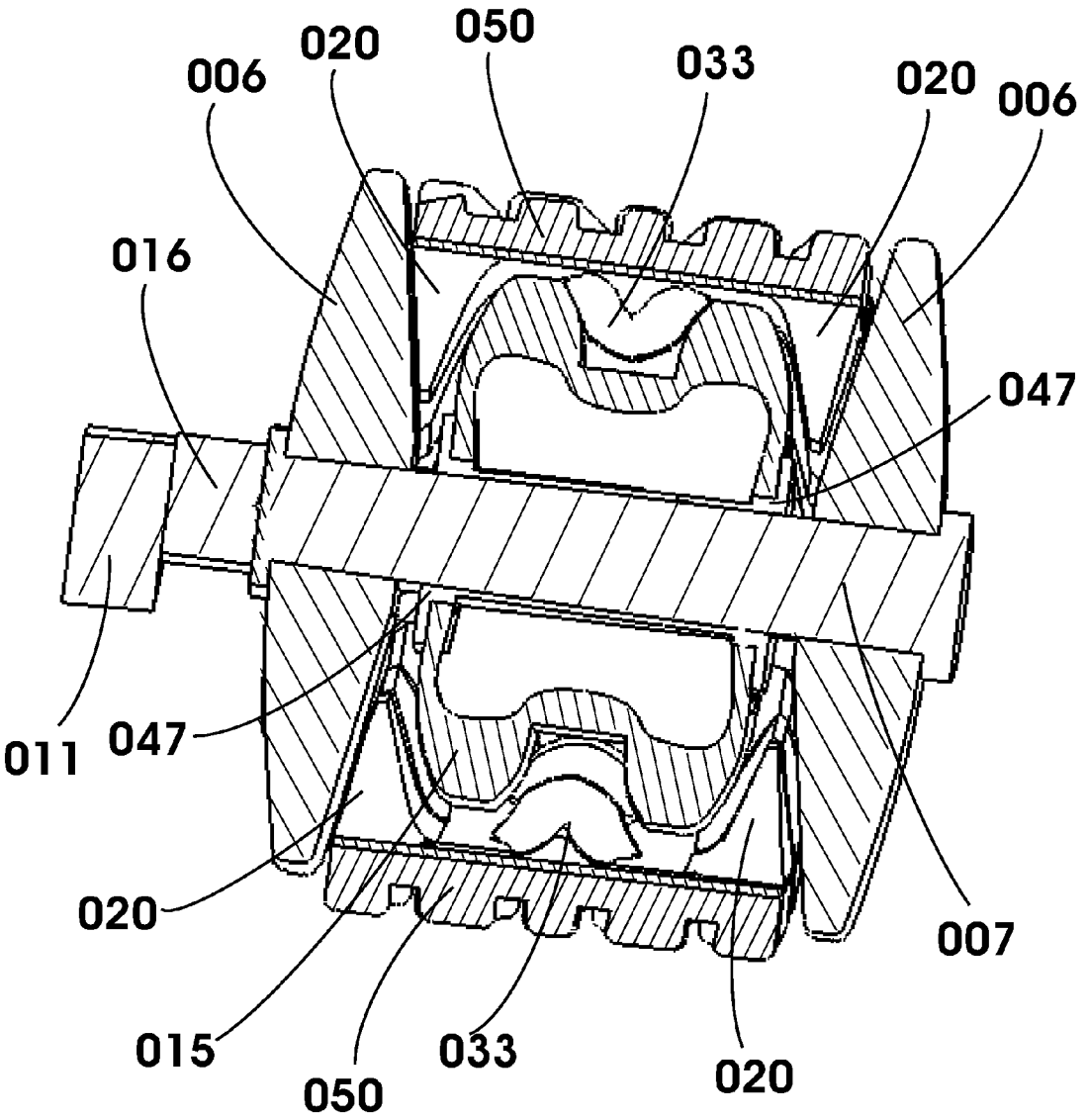
D1 - D1

Fig 20



D2 - D2

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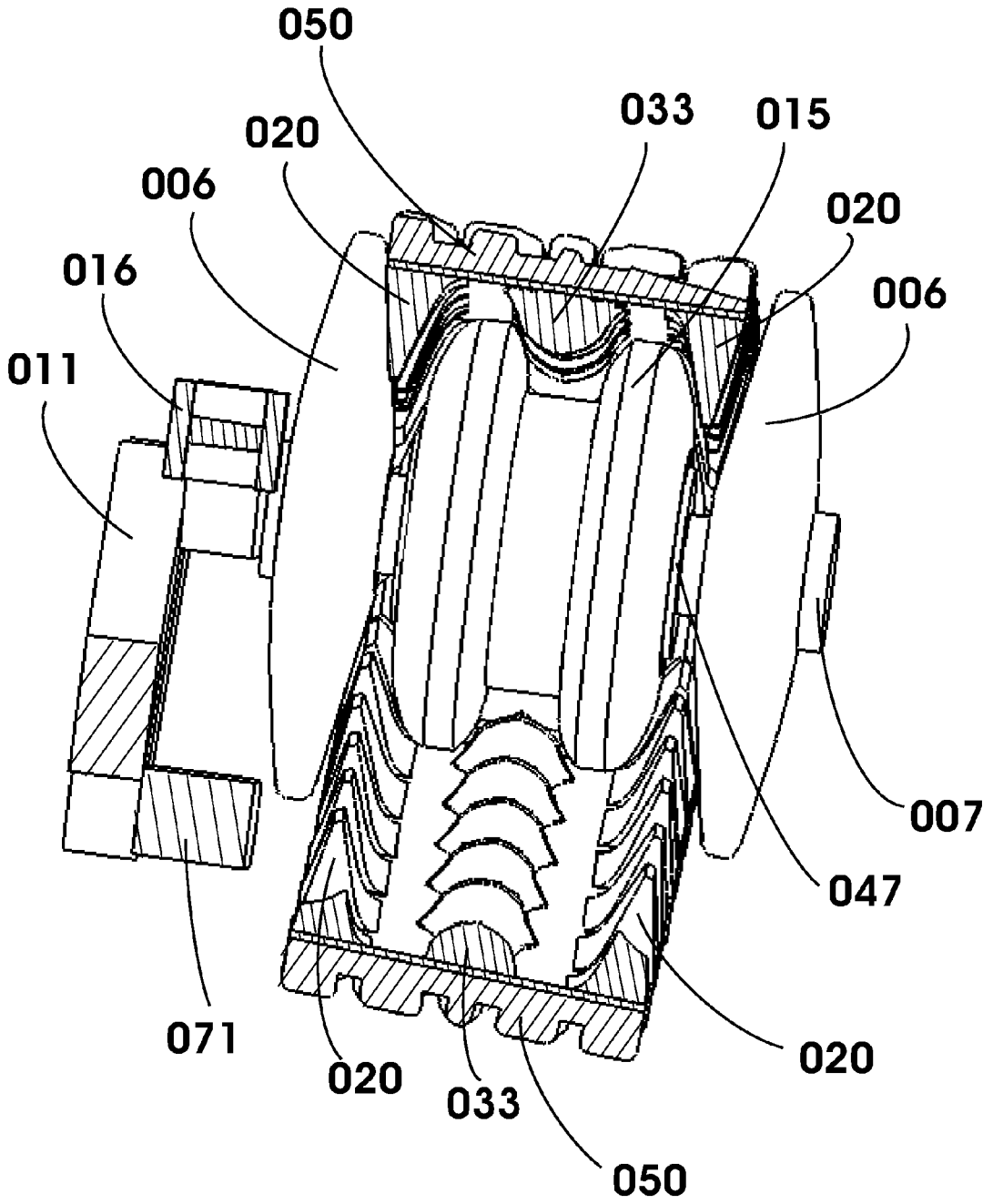

D3 - D3

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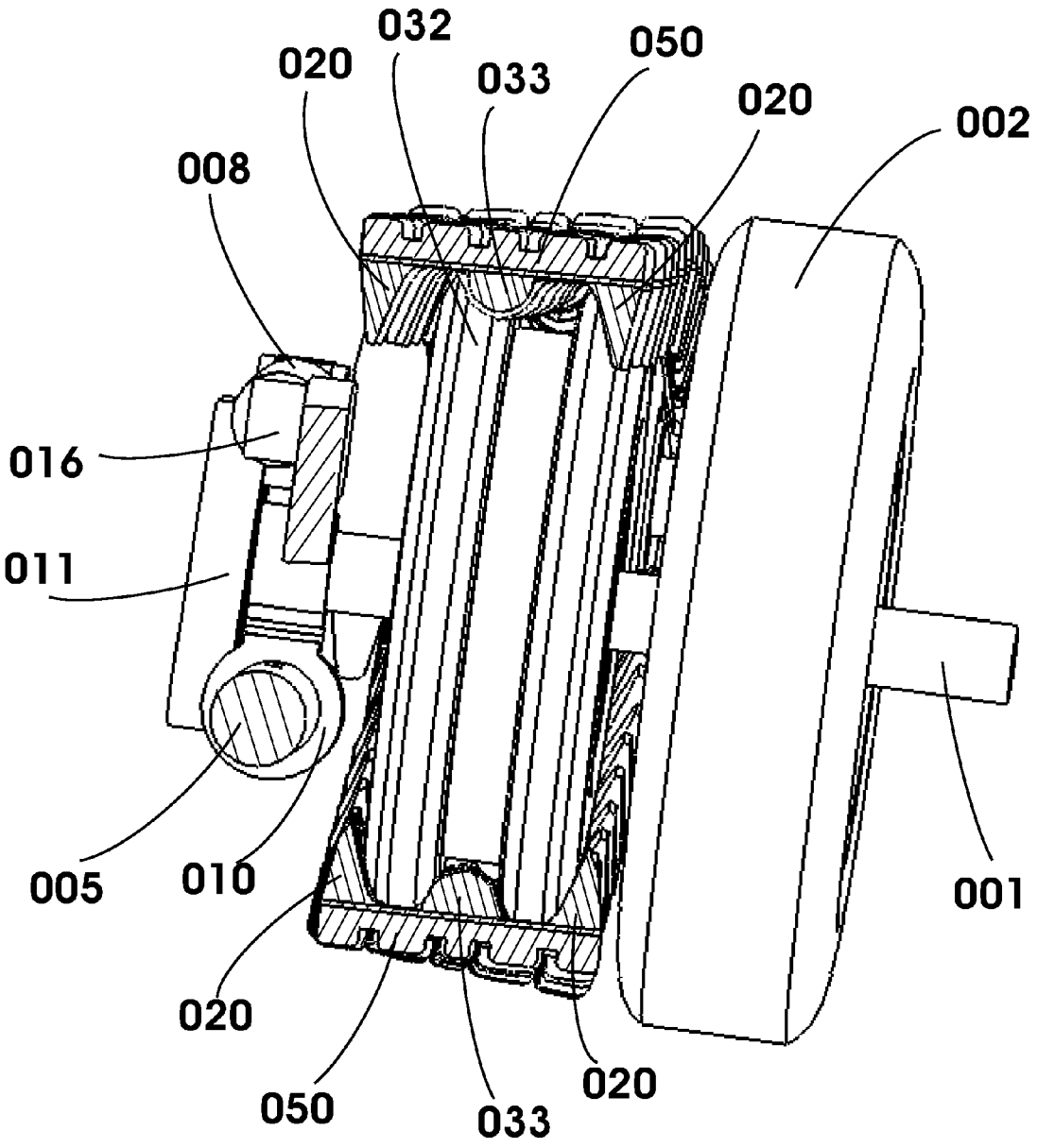

D4 - D4

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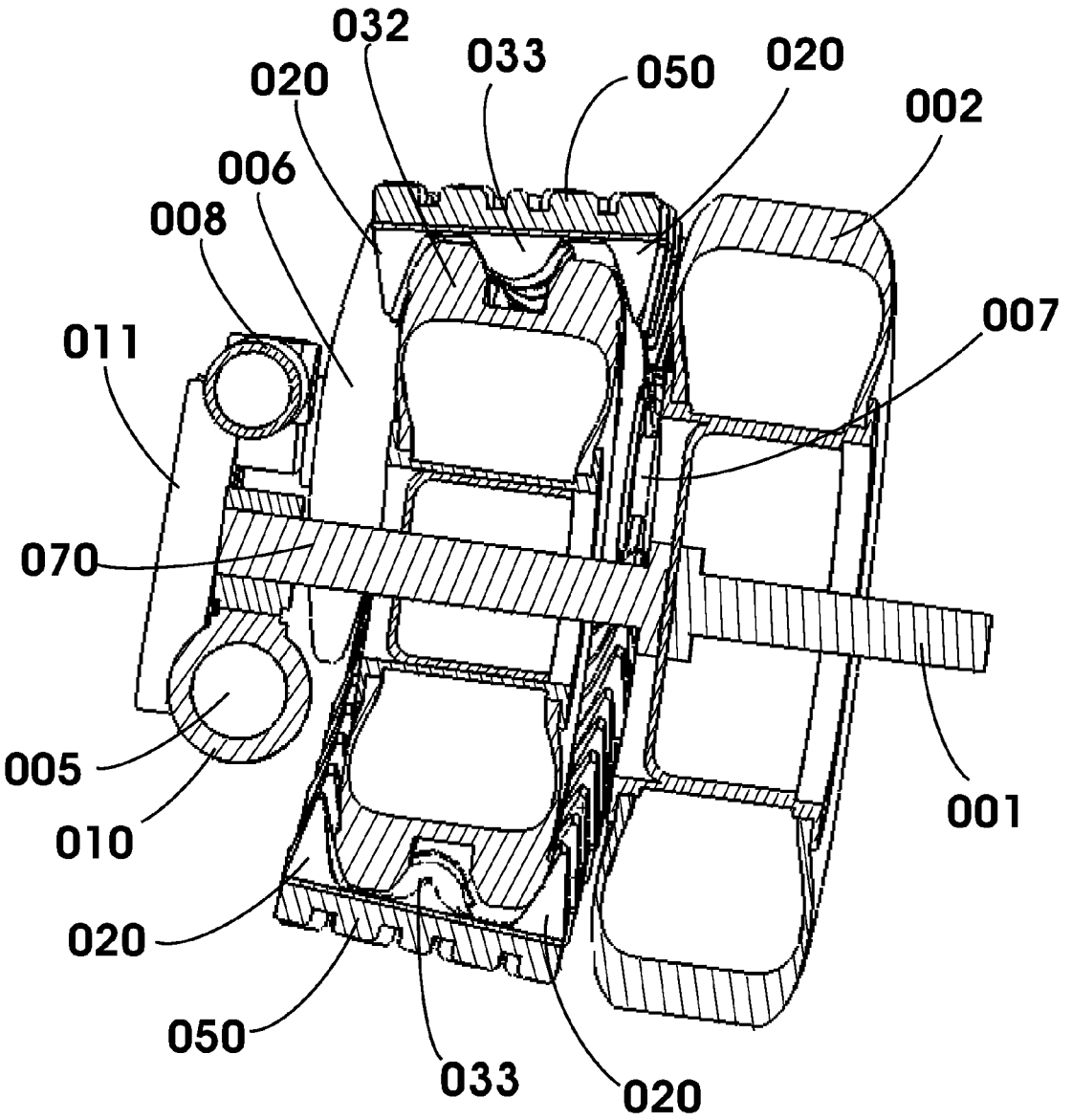
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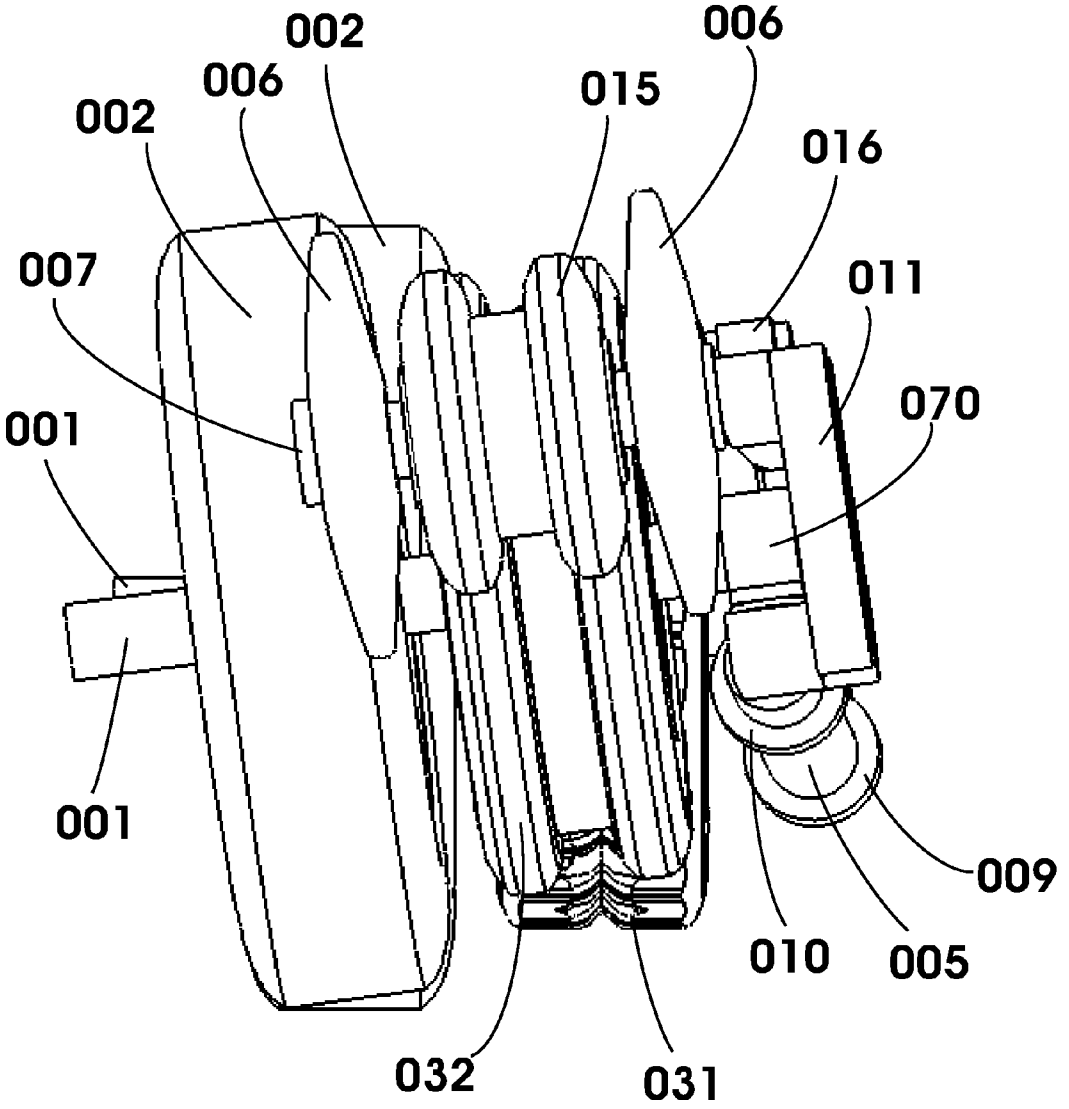
D5 - D5

Fig 24



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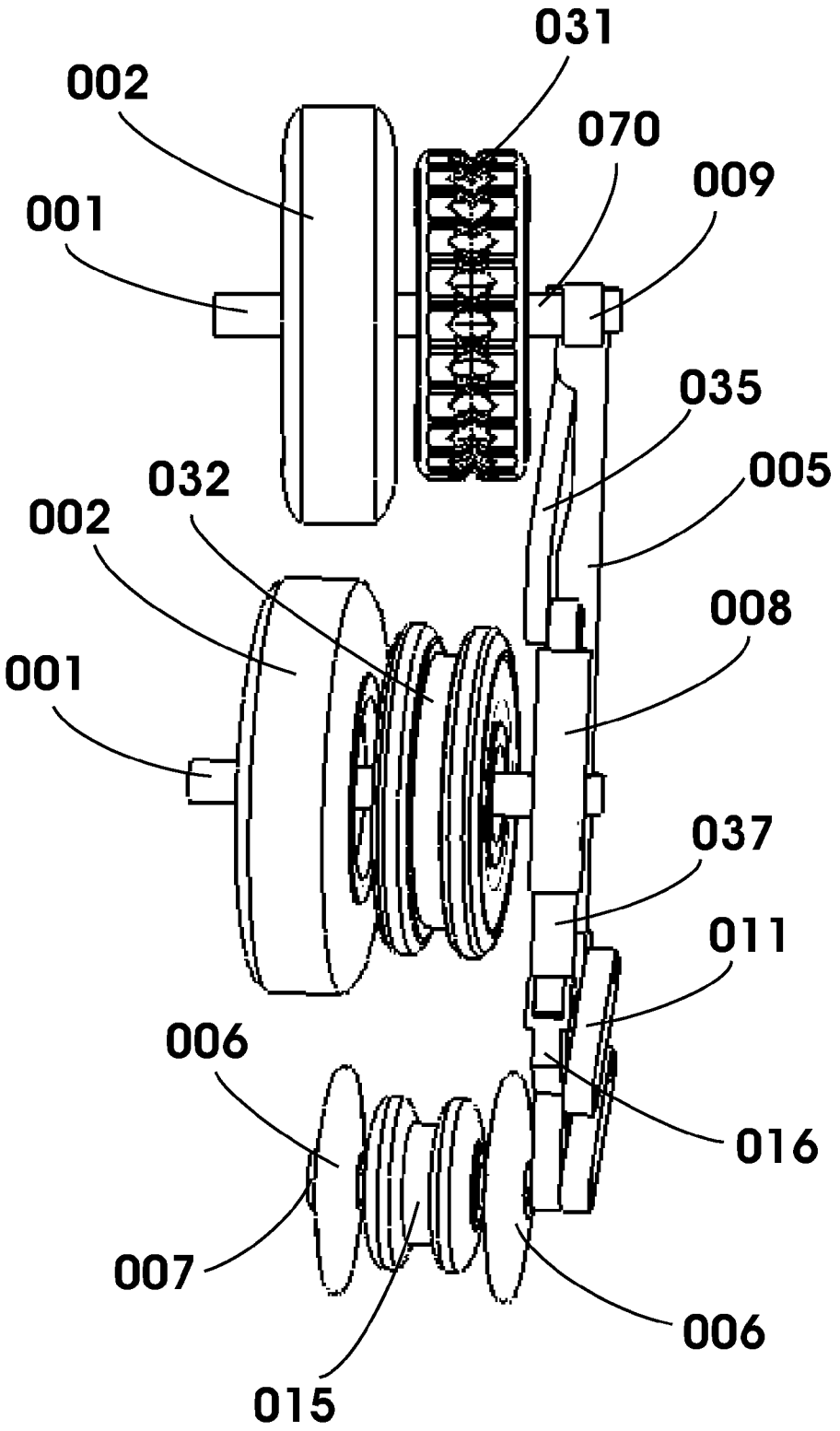
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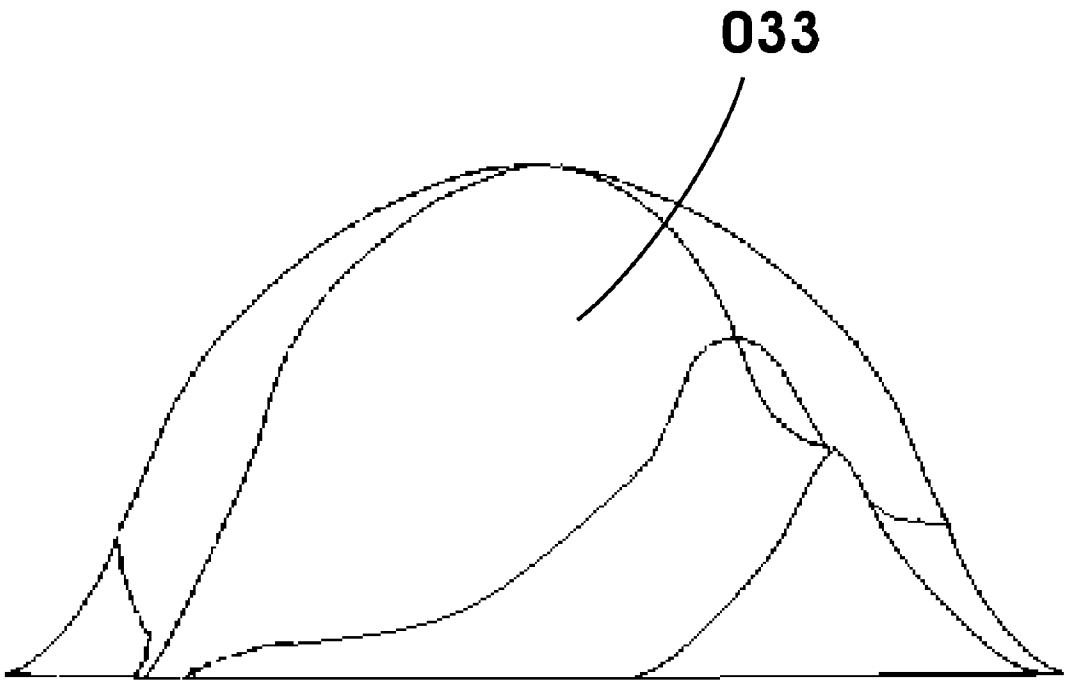
Fig 26



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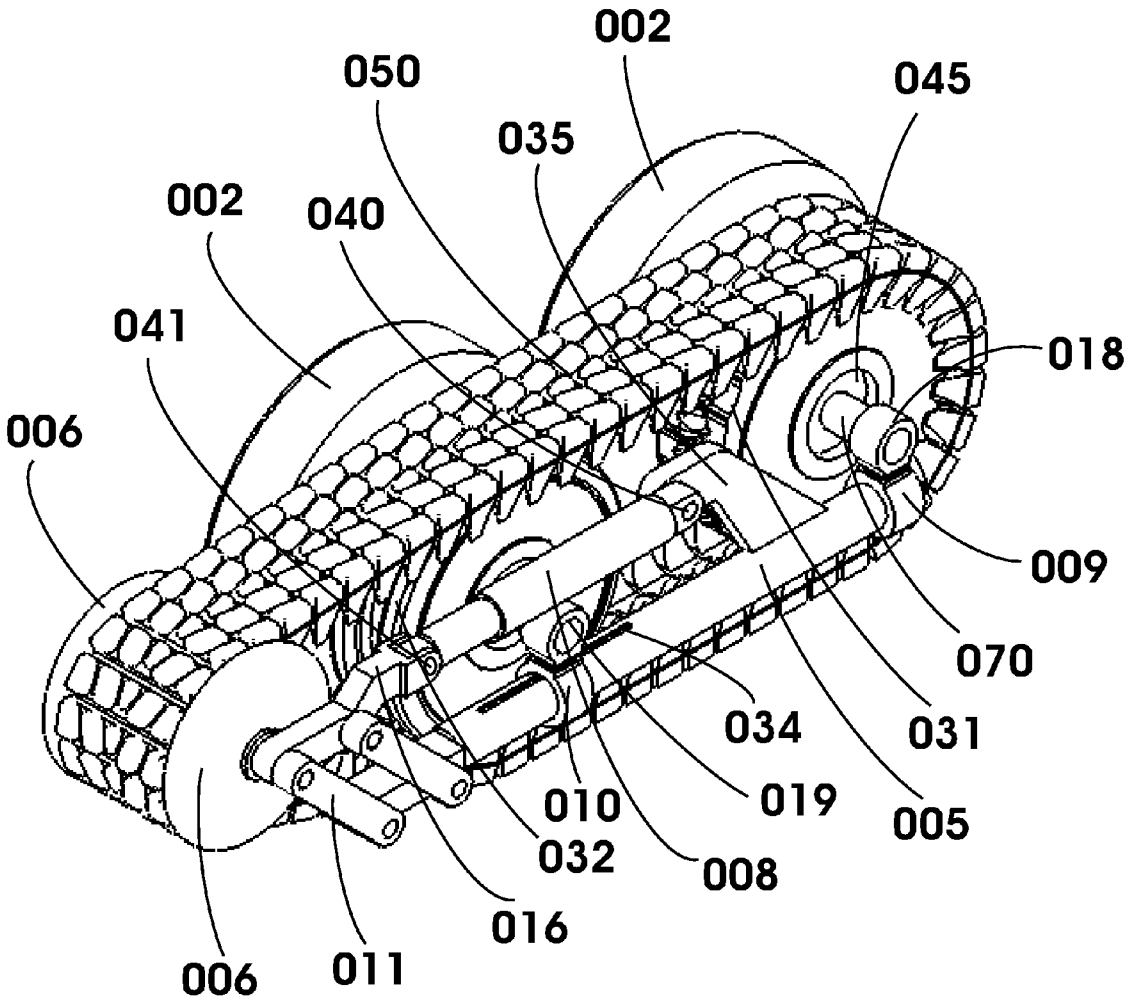
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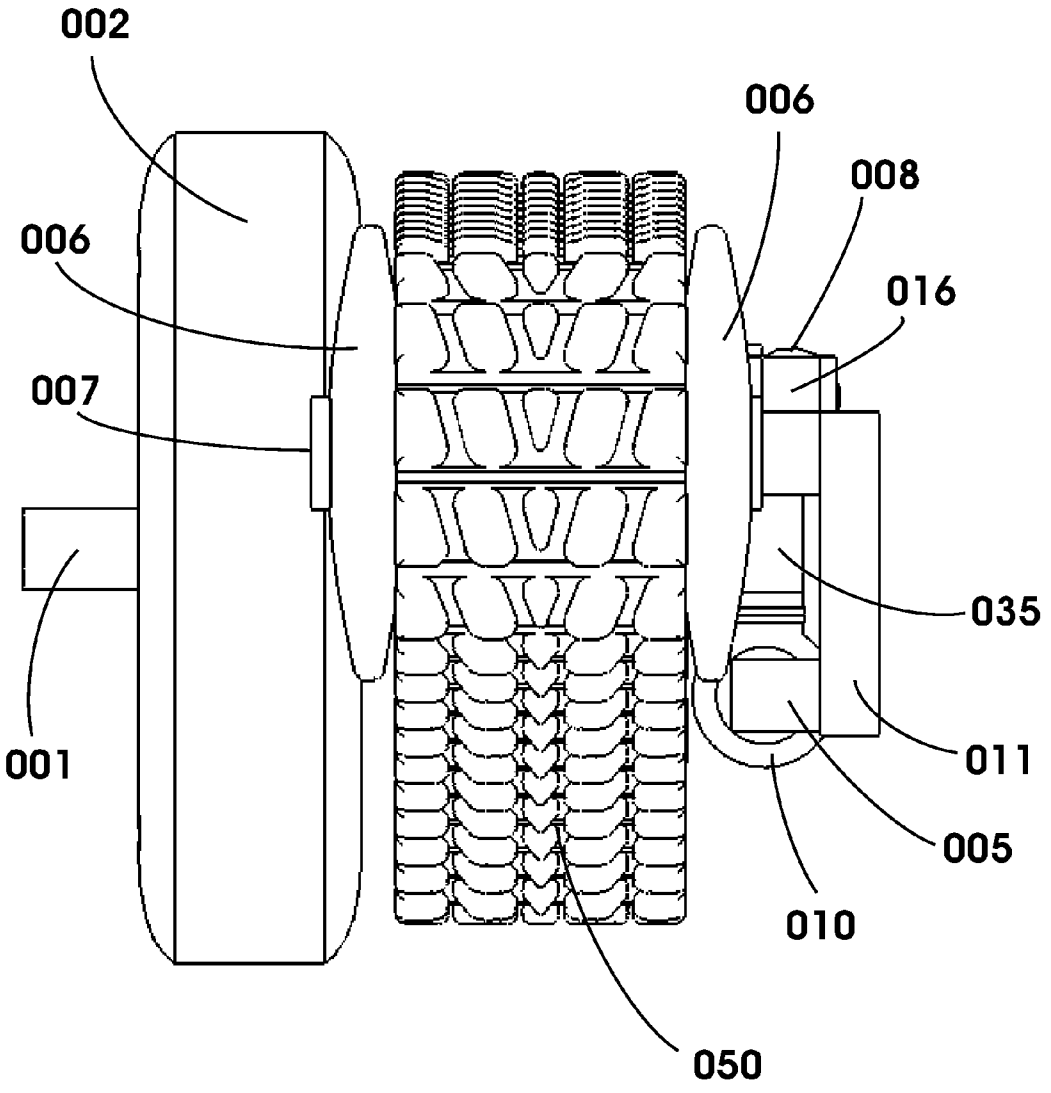
Fig 28



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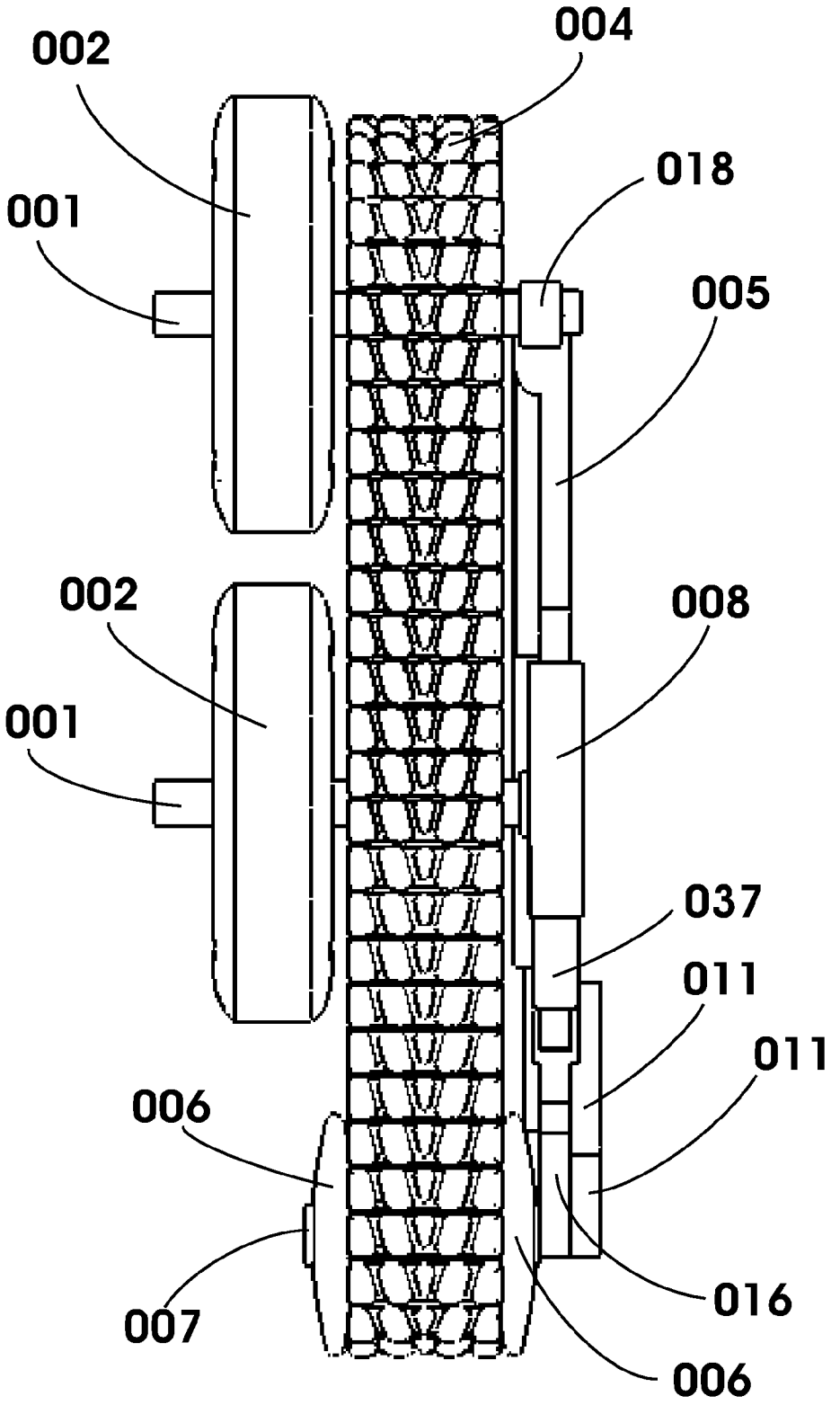

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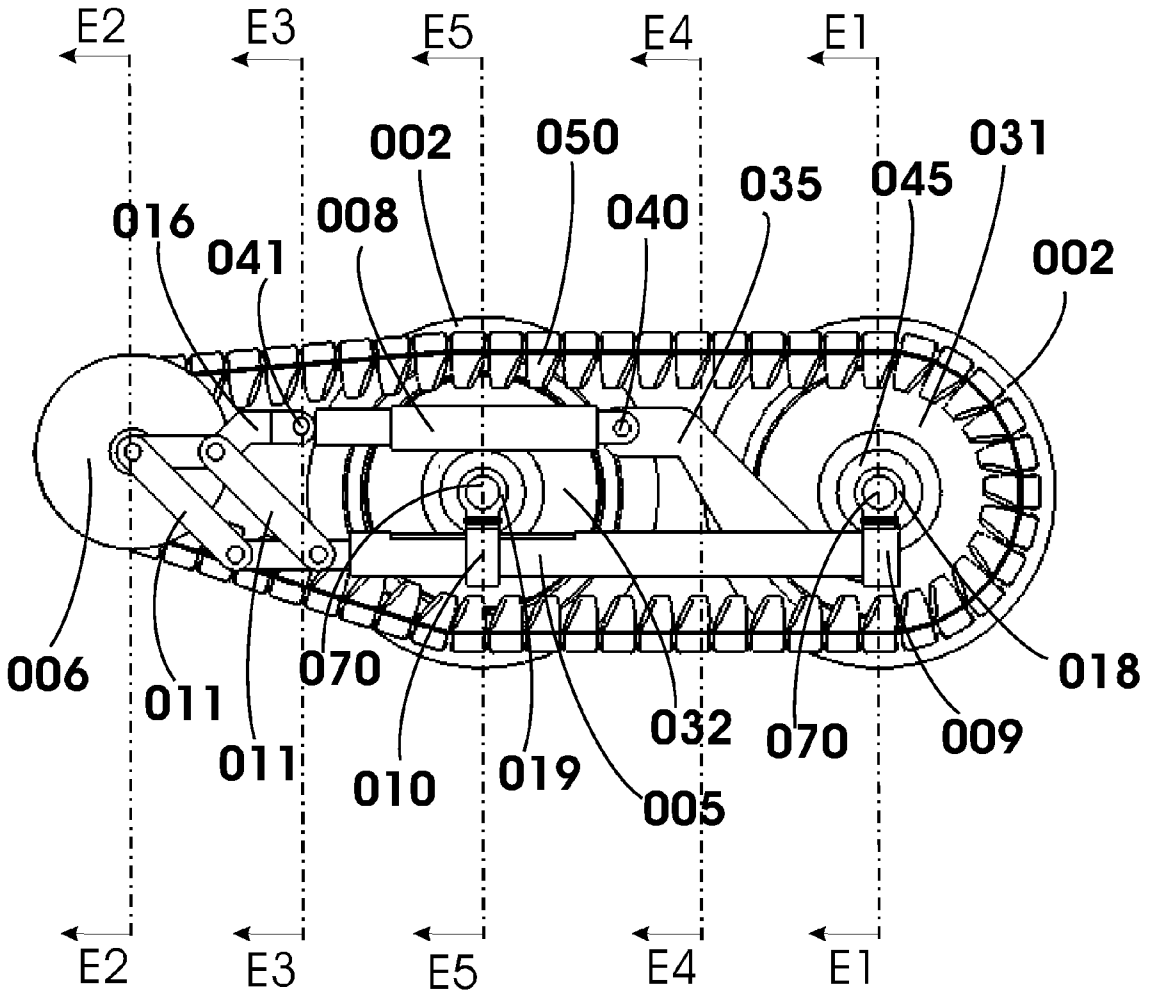
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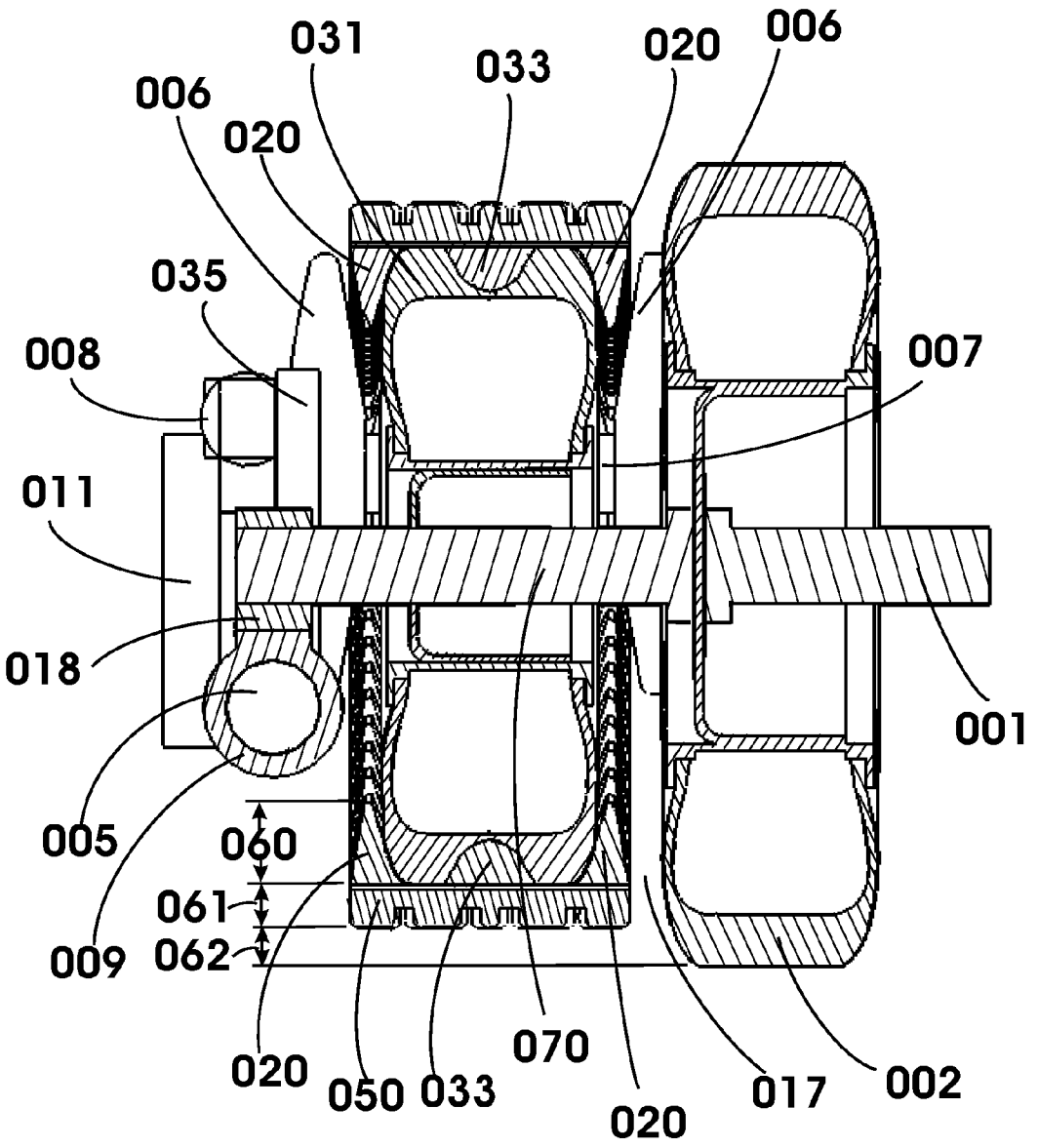
Fig 31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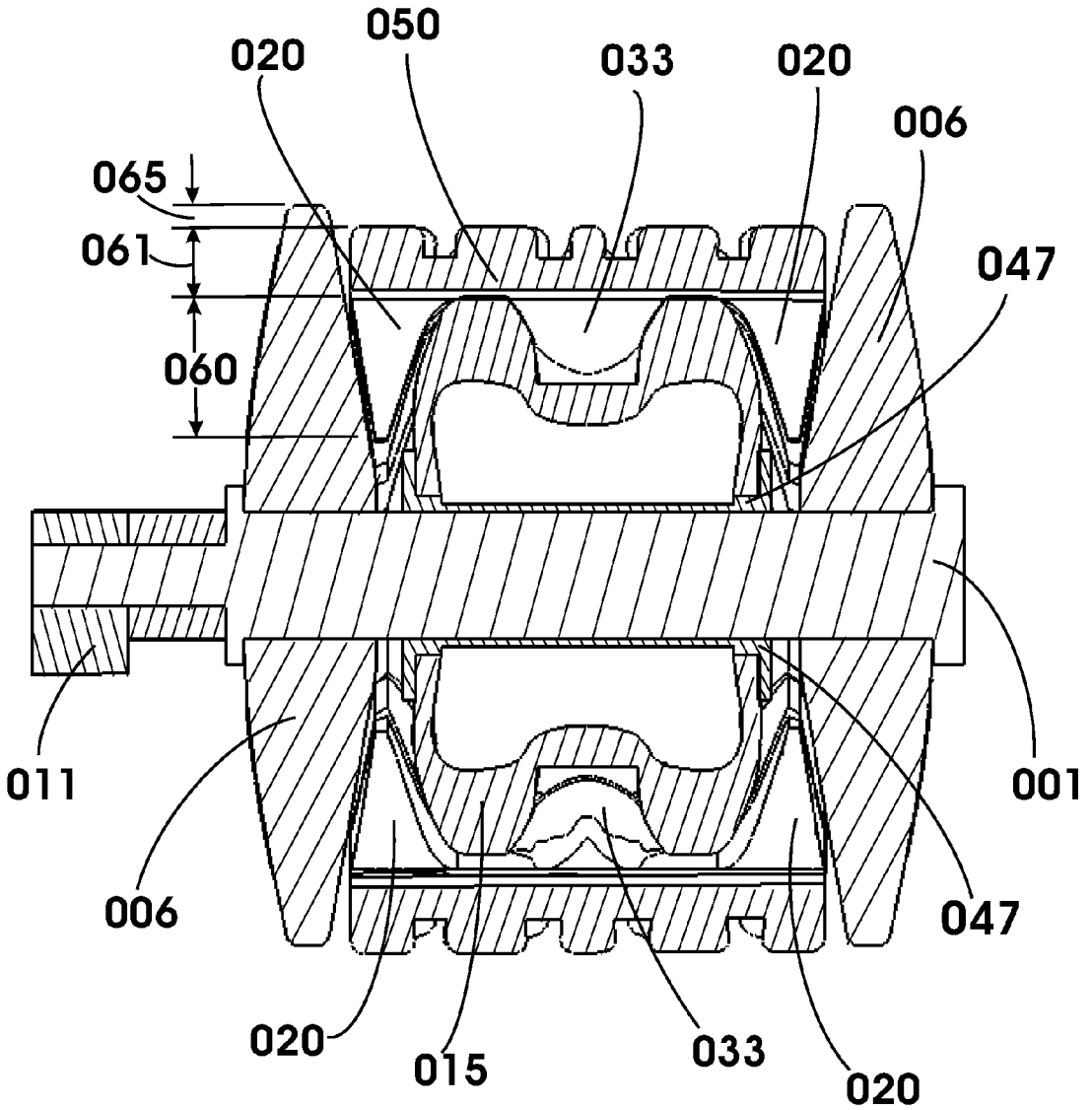
E1 - E1

Fig 32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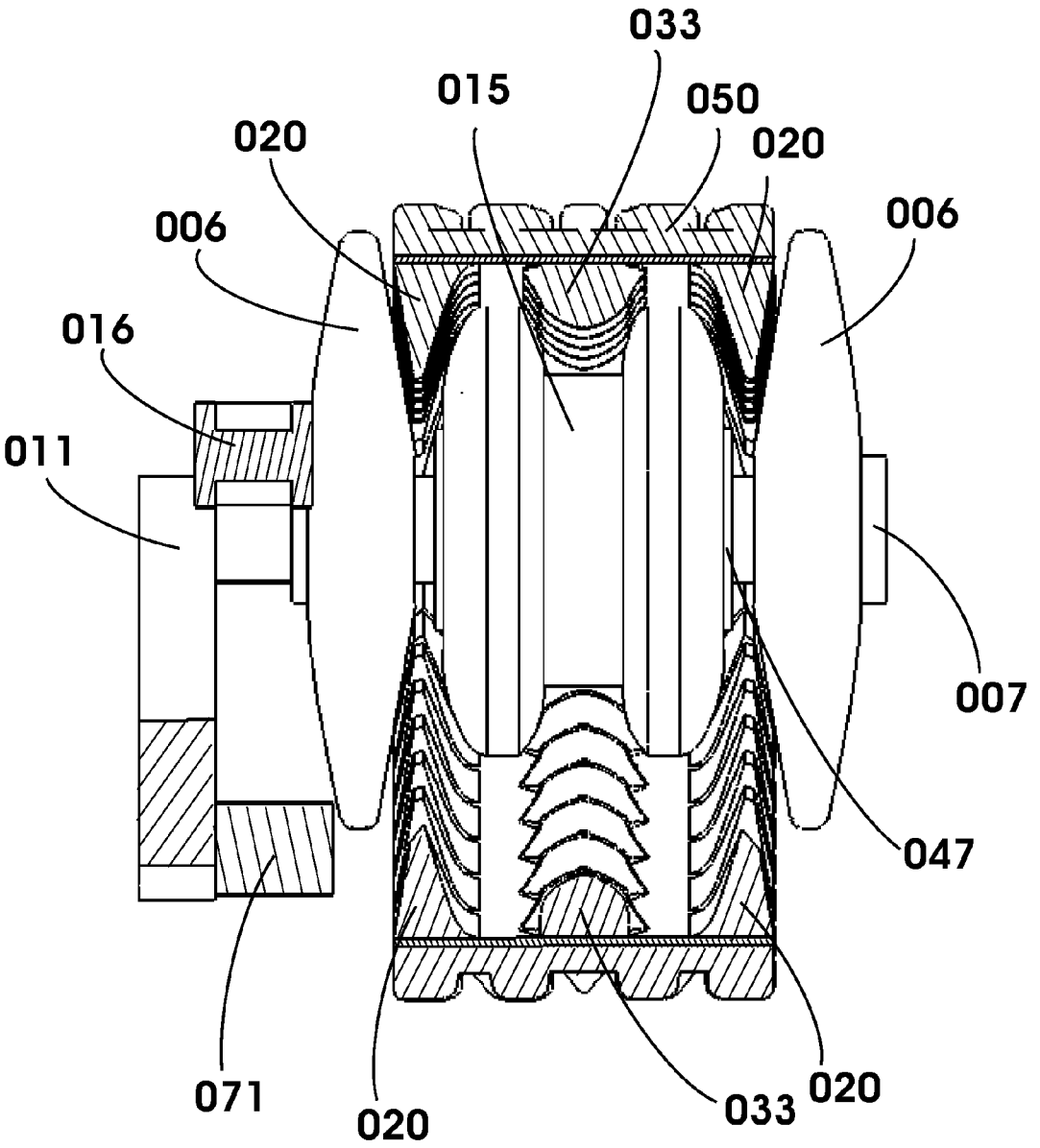
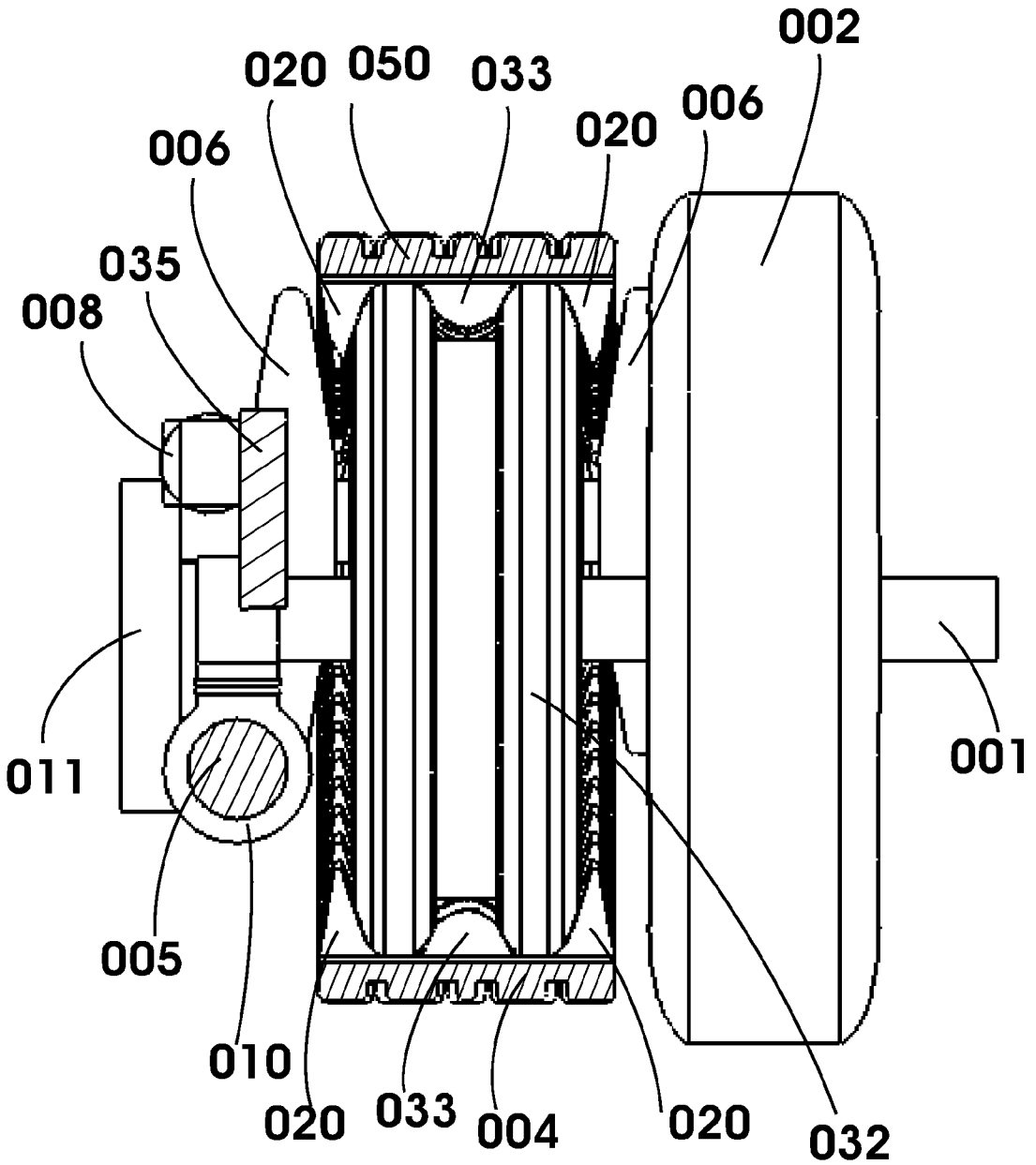
E2 - E2

Fig 33



E3 - E3

Fig 34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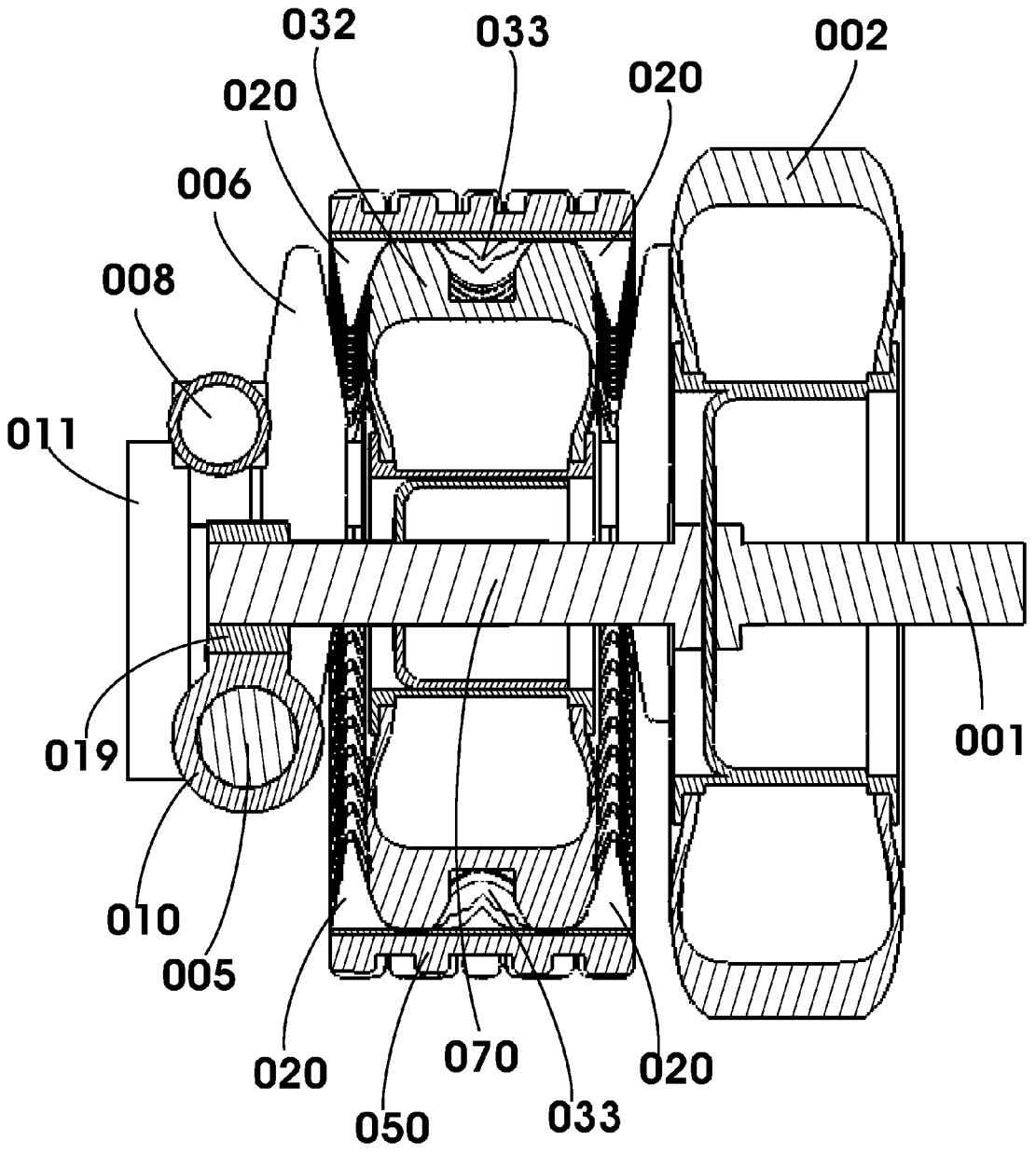
E4 - E4

Fig 35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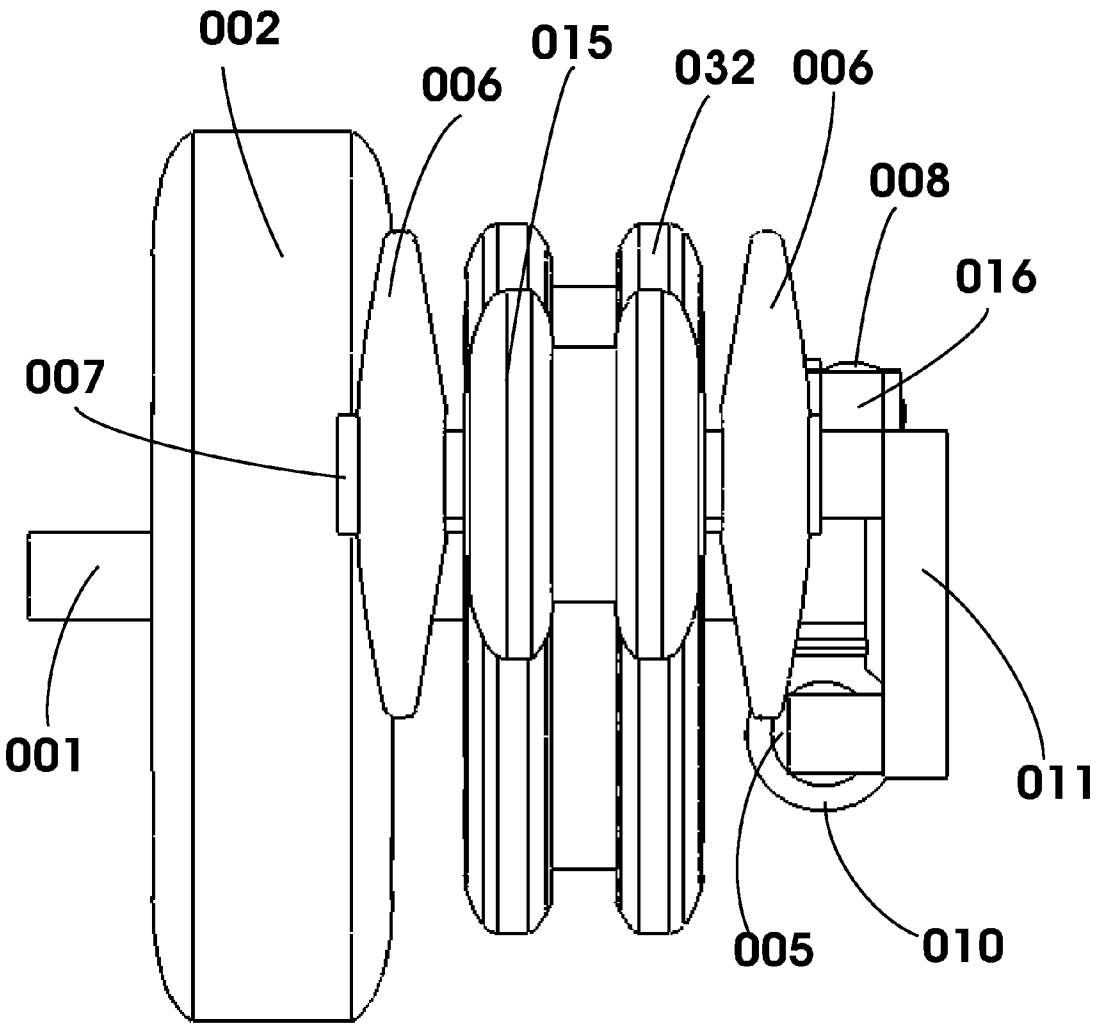
E5 - E5

Fig 36



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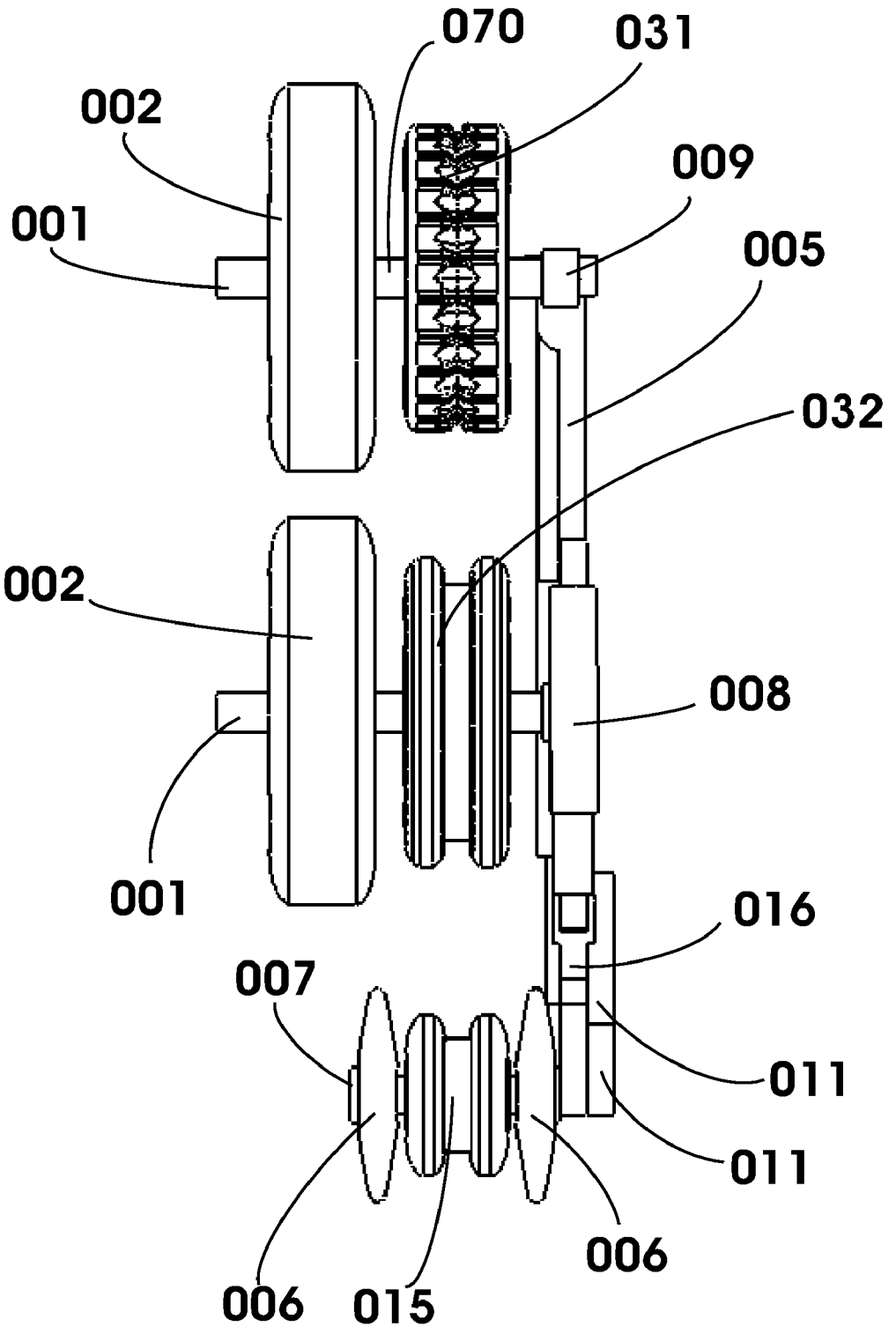
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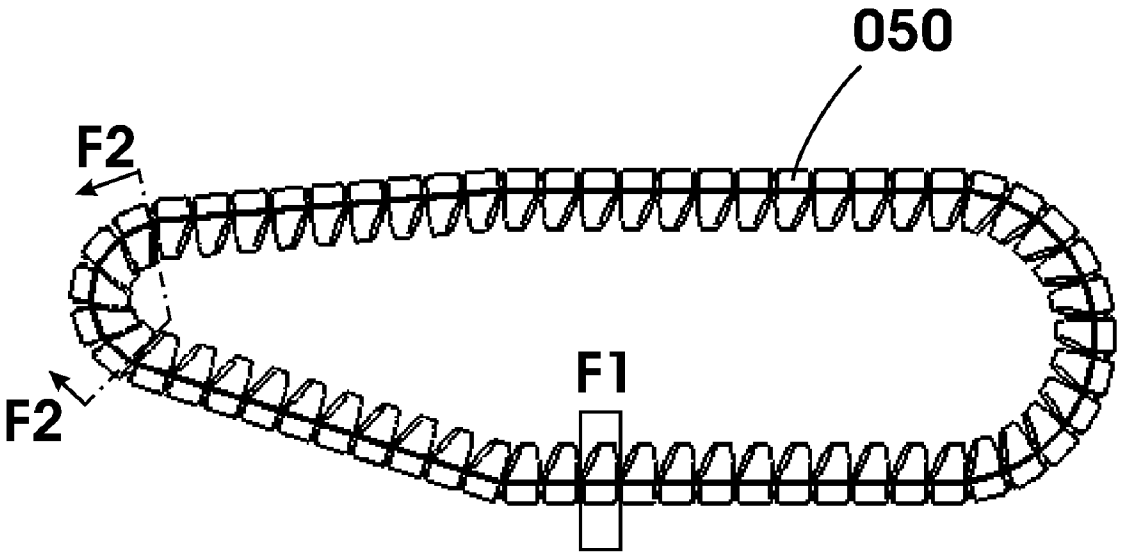
Fig 38



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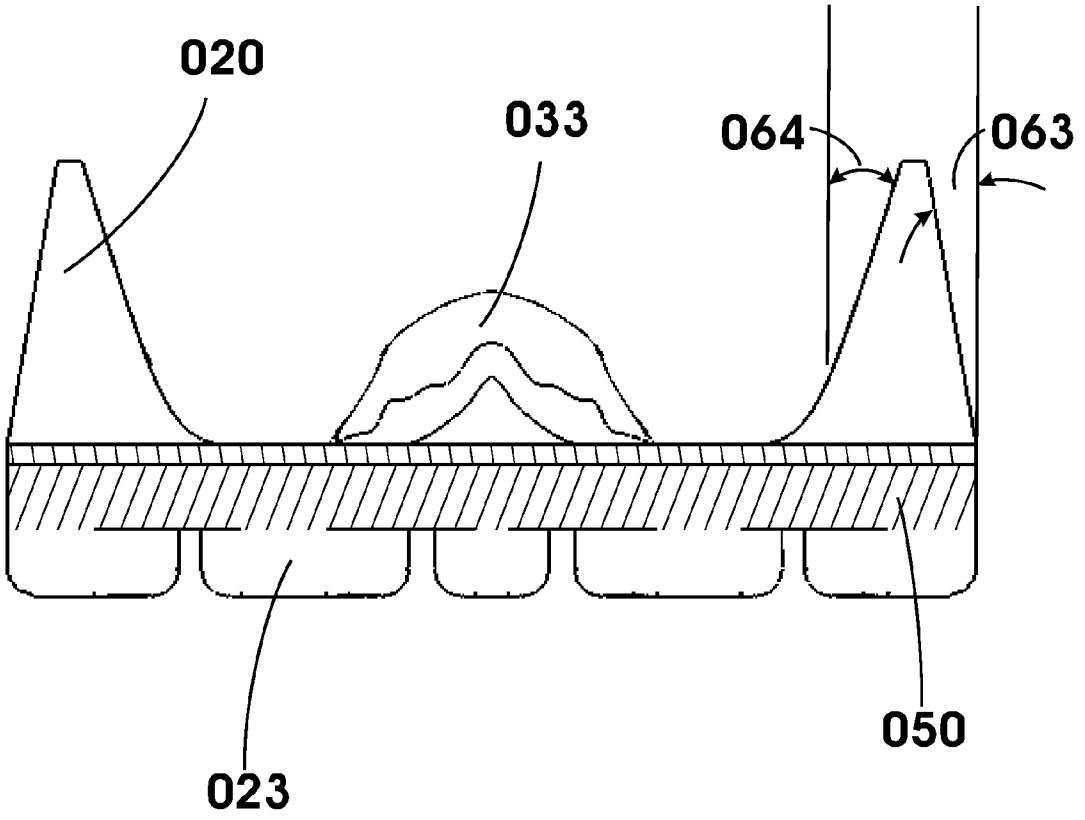
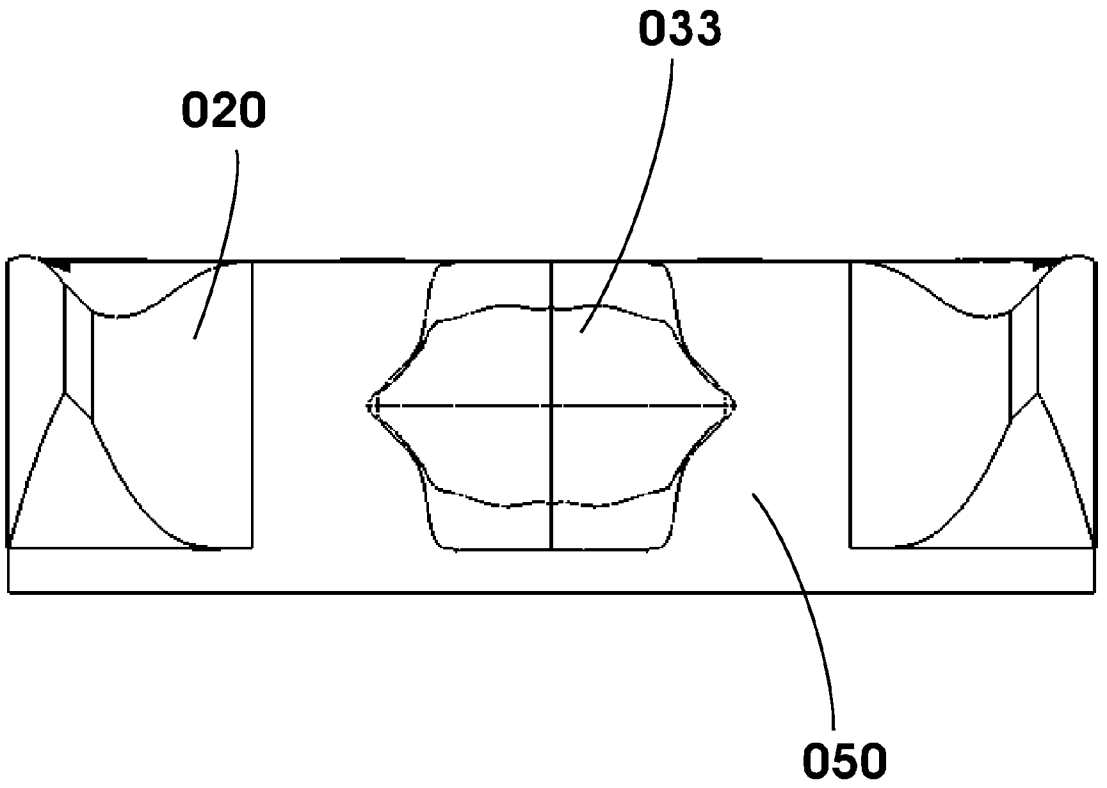


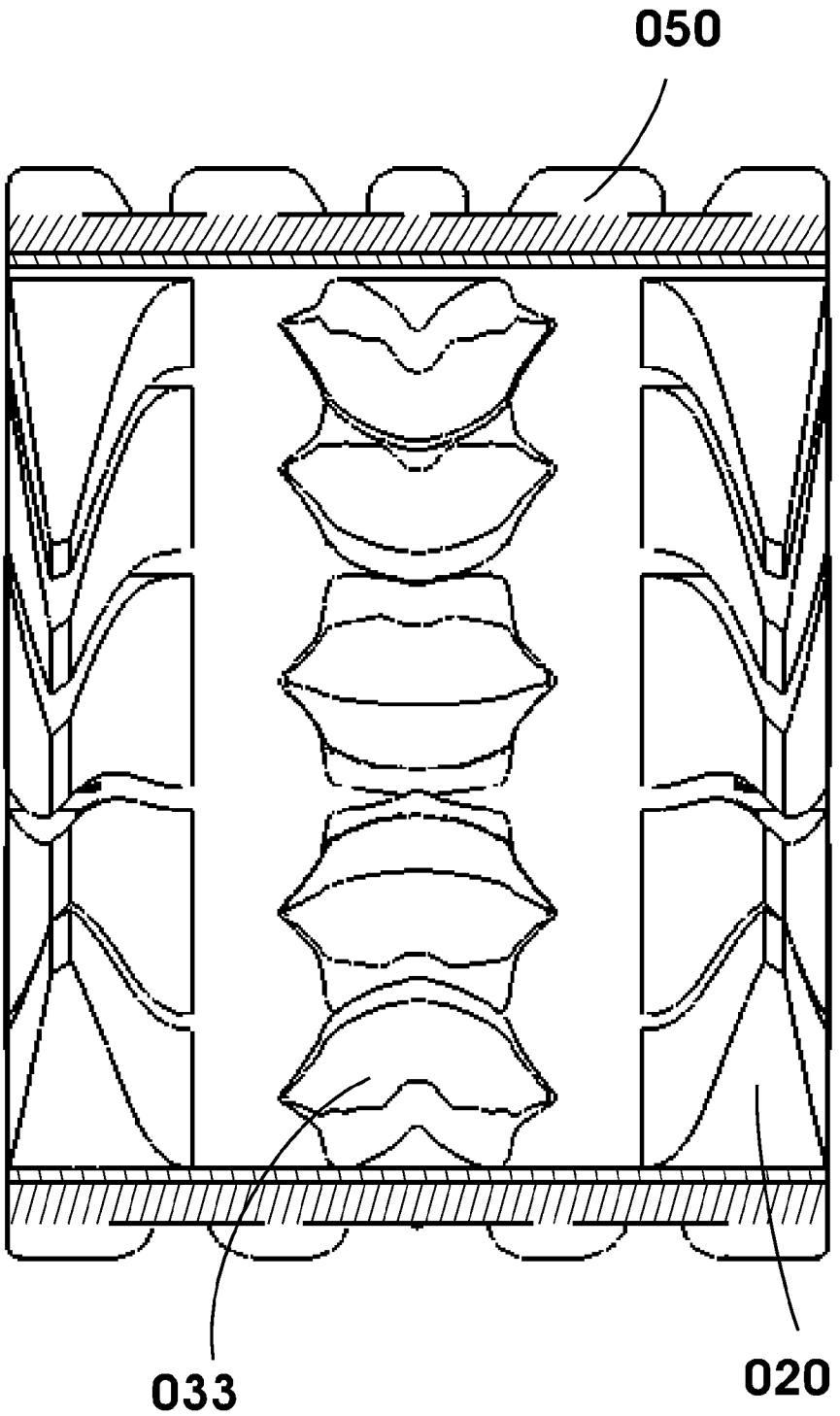
F1 - F1

Fig 40



F1 - F1

Fig 41



F2 - F2

HYBRID COMBINATION OF RUBBER TRACK WITH ROAD WHEELS FOR A VEHICLE

BACKGROUND

[0001] 1. Field of Invention

[0002] This invention relates to a hybrid combination of tracks in conjunction with road wheels for vehicles.

[0003] 2. Description of Prior Art

[0004] Numerous types of vehicles are frequently used in terrain in which it is difficult for pneumatic tires to operate. Amphibious vehicles, military tanks, construction equipment, tractors, and recreational vehicles may be required to operate on terrains that are very soft and/or debris covered, such as sand, mud, rocks, tree branches, and building debris. Pneumatic tires are not very capable of efficient operation on the above mentioned soft and/or debris covered surfaces, as they tend to burrow into the surface rather than riding across the surface and climbing over debris.

[0005] Belt vehicles have been developed for use on terrains in which pneumatic tire vehicles are impractical. For example, see U.S. Pat. Nos. 3,361,488 (Ohm et al), 3,688,858 (Jesperson), 3,734,577 (Snellman), and 3,955,855 (Massieon et al). In many types of terrain, these vehicles provide improved performance relative to the performance of a pneumatic tire vehicle. Still difficulties are encountered with existing belt vehicles.

[0006] Originally, such tracks were made of a plurality of metal links or shoes pivotally attached to each other to form an belt, which is very heavy and causes serious damage to surfaces on which it runs. Metal links are also noisy, an uncomfortable ride for passengers, and require significantly more maintenance when operated at high speeds. For example, see U.S. Pat. Nos. 2,823,082 (Bauer) and 4,530,546 (Meisel, Jr.). Heavy off-road only vehicles and construction equipment that travel at low speeds may still use metal tracks.

[0007] A need has developed for a low maintenance form of vehicle appropriate for both normal road use and off-road use. There is a significant need for a vehicle capable of rapid responses to armed conflicts and natural emergencies. Also, a load carrying vehicle that is both on road and off road would be useful in many areas, such as construction, agriculture, and undeveloped regions without extensive road infrastructure. Most load carrying off-road vehicles presently have very large wheels or very cumbersome tracks, which are heavy, slow moving, prone to coming off in debris, inappropriate for use on roads at normal highway speeds, and which wear excessively when used on hard surfaces.

[0008] Rubber belts have become popular for construction and low soil compaction farming equipment that must travel or operate on road surfaces. With the combination of rubber technology and a tremendous amount of trial and error, various types of rubber tracks are now available. For example, see U.S. Pat. Nos. 5,279,378 (Graiwey et al) and 6,267,458 (Hansen et al). Most equipment is operated on the job site only and is transported between sites by trucks or trailers. To eliminate the inconvenience of transporting the vehicle between job sites, a vehicle that can operate on both public roads at normal speeds and off road is required.

[0009] A number of hybrid steel tracks with rubber pads have been proposed where the links or shoes are made of metal that is provided with a rubber cover or insert. For example, see U.S. Pat. Nos. 2,359,586 (Sayler), 2,369,130 (Benson), 2,409,502 (Leguillon et al), 3,148,921 (Batur et al), 4,109,971 (Black et al), 4,359,248 (Kortering), and 4,588,233 (DenBensten). While these hybrid tracks reduce noise and greatly reduce road damage, they are still relatively slow moving, prone to coming off in debris, worn excessively when used on hard surfaces, and inappropriate for use on roads at normal highway speeds. Hybrid steel tracks with rubber pads are more complex than rubber tracks and require more maintenance. However, they are capable of carrying extreme loads.

[0010] Rubber tracks are generally capable of higher speeds than either steel or hybrid tracks. However, no track vehicle can match the high speed at which pneumatic tire vehicles can comfortably operate. All tracked vehicles are prone to coming off in debris and wear excessively when used on hard surfaces.

[0011] Some of the problems encountered in using such an endless rubber track in practice are maintaining adequate uniform tension on the rubber track as it twists to accommodate even a small amount of misalignment, keeping the rubber track lateral and aligned with each track wheel when there is even a small amount of misalignment, keeping the rubber track in lateral alignment with the track wheels when it is subjected to large lateral loads occurring during turning maneuvers or on steep inclines, as well as debris wedging between the rubber track and the track wheels affecting alignment and the ability to drive the rubber track.

[0012] Throwing a track is the most dangerous and catastrophic problem that can occur during the operation of rubber tracks. As travel velocity increases the energy, the resulting danger posed by throwing a track increases with the velocity squared. At road traffic speeds, sudden maneuvers, such as sudden lane changes could result in throwing a track. An unbalanced track or slack in the rubber track and the resulting flapping set upper limits on the safe travel speed. Travel speeds are finally limited by friction heating of the rubber track.

[0013] 3. Description of Related Art

[0014] [Note: As used herein, the term rubber relates to any elastic and primarily non-metallic materials, such as rubber, elastomer, or combinations thereof used in the manufacture of belts].

[0015] Most rubber tracks are formed around a basic carcass or belt. The carcass includes an endless belt-shaped rubber-like elastic member, a number of core bars (usually of metal) embedded therein, aligned in the longitudinal direction thereof, and extending in the traverse directions thereof. It also includes high tension strength cords embedded in the endless elastic member to surround the core bars circumferentially outward. For example, see U.S. Pat. Nos. 4,904,030 (Ono), 5,295,741 (Togashi et al), 5,511,869 (Edwards et al), and 6,241,327 (Gleasman).

[0016] Some have suggested the construction of endless rubber tracks using a plurality of interconnected polymeric modules. For example, see U.S. Pat. Nos. 4,861,120 (Edwards et al) and 5,005,922 (Edwards et al).

[0017] Terrain contacting lugs are formed integral with the exterior surface of this basic belt element. Known rubber tracks have large lugs in a variety of well-known orientations, such as those formed generally perpendicular to the track axis, at an angle to the track axis, or in a chevron or modified-chevron design. These latter specialized tracks also include interior lugs or horns for maintaining the track in alignment as it travels over the circumferences of the rubber tires. These lugs are located either in the center of the interior surface of

the track (for fitting between the tires of dual wheels) or in two aligned rows near the outside edges of the track (for receiving a single tire there between). For example, see U.S. Pat. Nos. 5,447,365 (Muramastsu et al), and 5,540,489 (Muramatsu et al).

[0018] Endless rubber tracks have been adapted to existing high-speed military steel track laying vehicles to improve efficiency at higher road speeds. For example, see U.S. Pat. No. 2,357,140 (Soucy et al).

OBJECTS AND ADVANTAGES

[0019] Spring rubber or pneumatic road tires **002** slightly larger in diameter than the endless rubber belt **004** are located beside the belt to laterally guide the endless rubber belt **004** and minimize track-throwing occurrences. Spring rubber or pneumatic tires absorb rough road shocks from stones and pot holes that might break solid wheels of similar strength. The side located road tires **002** act as large guides. However, unlike existing tracks, the guide horns **020** are not prone to grabbing loose debris and wedging the debris between the rubber belt **004** and the track tires **003**. Loose debris wedged between rubber belt **004** and the track tires **003** can easily lift the rubber belt **004** off the track tires **003**. The side shoulder of the road tire **002** is protected from track friction wear by a small gap present between the road tire **002** and the endless rubber belt **004** at full road tire **002** inflation and track the outside guide horns **020**, which are designed to spread any lateral load against the tire over a large area. When the inflation of road tires **002** is sufficiently reduced, the track outside the guide horns **020** is designed to operate like a V-belt gripping both the track tires **003** and the road tires **002**. Interior 3D curvilinear belt drive teeth **033** may be used to eliminate endless rubber belt slippage on track drive wheel. The 3D curvilinear drive teeth **033** allow much larger track wheel misalignments than conventional drive horns. However, in most applications, the tight endless rubber belt **004** on the track drive tire **031** should provide more than enough traction to prevent excessive slippage of the rubber belt **004**. Slight rubber belt **004** slippage substantially reduces drive train shock forces. Eliminating the drive teeth **033** allows track drive wheels to dig through any debris that may have accumulated inside the endless rubber belt **004**. As a result, debris, such as sticks and stones, cleans itself away much easier. The road tires **002** located beside the endless rubber belt **004** also protect the rubber belt **004** by clearing material away from the track while turning in soft soils or loose debris. On smooth hard surfaces, if fully inflated, the road tires **002** would lift the endless rubber belt **004** off the surface. The endless rubber belt **004** can be lifted off hard road surfaces during high speed travel, dramatically reducing wear and rolling friction. Higher road speeds with reduced power consumption are achieved by disengaging the rubber belt **004** during high speed operation. The rubber belt **004** would then be engaged when required by brakes between the track tires **003** and road tires **002**. A tensioning idler is composed of tensioning track guides **006**, tensioning shaft **007**, and dual tensioning tires **015**. Retracting the tensioning idler in combination with the slight ground clearance provided by the road tires **002** on hard surfaces can allow the rubber belt **004** to be removed and replaced without the use of vehicle jacks.

[0020] The outside road tires **002** prevent the rubber belt **004** from track-throwing even when the track tires **003** are misaligned. The optional interior 3D curvilinear drive teeth **033** and the track outside guide horns **020** are practically immune to realistic amounts of misalignment. With a pattern belt canvas, which allows for an amount of belt shear, the proposed hybrid tire rubber belt systems can be adapted to vehicles with a suspension not specifically designed for rubber belts. In such an application, a pivotable tensioning idler dynamically maintains uniform tension across the width of the rubber belt **004**. The angular misalignment between tandem solid axis **001** is further reduced by a hydraulic linkage between them, which enables the hybrid tire and rubber belt system to be used on many existing tire vehicles.

SUMMARY

[0021] In accordance with the present invention, a belt is used in conjunction with road wheels to support weight of hybrid wheel track-laying vehicles. This is an improved design that allows a belt to be driven more efficiently and safely at highway speeds, diminishes the possibility of mud, sand, or other debris dislodging the track during turning maneuvers, and reduces belt wear when this invention is used on hard surfaces.

DRAWING FIGURES

[0022] FIG. **1** is an isometric view of rubber belt assembly for dual track tires.

[0023] FIG. **2** is a front view of rubber belt assembly for dual track tires showing the position of cutting plane A-A.

[0024] FIG. **3** is a cross section of rubber belt assembly for dual track tires at cutting plane A-A.

[0025] FIG. **4** is a side view of rubber belt assembly for dual track tires showing the position of cutting planes B**1**-B**1**, B**2**-B**2**, B**3**-B**3**, and B**4**-B**4**.

[0026] FIG. **5** is an end view of rubber belt assembly for dual track tires at cutting plane B**1**-B**1**.

[0027] FIG. **6** is an end view of rubber belt assembly for dual track tires at cutting plane B**2**-B**2**.

[0028] FIG. **7** is an end view of rubber belt assembly for dual track tires at cutting plane B**3**-B**3**.

[0029] FIG. **8** is an end view of rubber belt assembly for dual track tires at cutting plane B**4**-B**4**.

[0030] FIG. **9** is a front view of rubber belt frame for dual track tires with rubber belt removed.

[0031] FIG. **10** is a top view of rubber belt frame for dual track tires with rubber belt removed.

[0032] FIG. **11** is a side view with dual tire rubber belt for over dual track tires showing the positions of cutting plane C**2**-C**2** and cut object C**1**-C**1**.

[0033] FIG. **12** is a front view of one single rubber belt unit at cut object C**1**-C**1**.

[0034] FIG. **13** is a top view of one single rubber belt unit at cut object C**1**-C**1**.

[0035] FIG. **14** is a rear view of one set of rubber belt unit at cutting plane C**2**-C**2**.

[0036] FIG. **15** is an isometric view of rubber belt assembly for single track tire twisted 8 degrees.

[0037] FIG. **16** is a front view of rubber belt assembly for single track tire twisted 8 degrees.

[0038] FIG. **17** is a top view of rubber belt assembly for single track tire side twisted 8 degrees.

[0039] FIG. **18** is a side view of rubber belt assembly showing the positions of cutting planes D**1**-D**1**, D**2**-D**2**, D**3**-D**3**, D**4**-D**4**, and D**5**-D**5**.

[0040] FIG. **19** is an end view of rubber belt assembly for single track tire at cutting plane D**1**-D**1**.

[0041] FIG. **20** is an end view of rubber belt assembly for single track tire at cutting plane D**2**-D**2**.
[0042] FIG. **21** is an end view of rubber belt assembly for single track tire at cutting plane D**3**-D**3**.
[0043] FIG. **22** is an end view of rubber belt assembly for single track tire at cutting plane D**4**-D**4**.
[0044] FIG. **23** is an end view of rubber belt assembly for single track tire at cutting plane D**5**-D**5**.
[0045] FIG. **24** is a front view of rubber belt assembly for single track tire with rubber belt removed twisted 8 degrees.
[0046] FIG. **25** is a top view of rubber belt assembly for single track tire with rubber belt removed twisted 8 degrees.
[0047] FIG. **26** is an isometric view of belt tooth.
[0048] FIG. **27** is an isometric view of rubber belt assembly for single track tire.
[0049] FIG. **28** is a front view of rubber belt assembly for single track tire.
[0050] FIG. **29** is a top view of rubber belt assembly for single track tire.
[0051] FIG. **30** is a side view of rubber belt assembly for single track tire showing the positions of all cutting planes E**1**-E**1**, E**2**-E**2**, E**3**-E**3**, E**4**-E**4**, and E**5**-E**5**.
[0052] FIG. **31** is an end view of rubber belt assembly for single track tire at cutting plane E**1**-E**1**.
[0053] FIG. **32** is an end view of rubber belt assembly for single track tire at cutting plane E**2**-E**2**.
[0054] FIG. **33** is an end view of rubber belt assembly for single track tire at cutting plane E**3**-E**3**.
[0055] FIG. **34** is an end view of rubber belt assembly for single track tire at cutting plane E**4**-E**4**.
[0056] FIG. **35** is an end view of rubber belt assembly for single track tire at cutting plane E**5**-E**5**.
[0057] FIG. **36** is a front view of rubber belt frame for single track tire with rubber belt removed.
[0058] FIG. **37** is a top view of rubber belt frame for single track tire with rubber belt removed.
[0059] FIG. **38** is a side view of rubber belt showing the positions of cutting plains F**1**-F**1** and F**2**-F**2**.
[0060] FIG. **39** is the end view of a rubber belt unit at cutting plane F**1**-F**1** looking along the length of the rubber belt.
[0061] FIG. **40** is the inside view of rubber belt unit at cutting plane F**1**-F**1**.
[0062] FIG. **41** is the inside view of rubber belt bending at cutting plane F**2**-F**2**.

REFERENCE CHARACTERS IN DRAWINGS

[0063] **001** axle shaft
[0064] **002** road tires
[0065] **003** dual track tires
[0066] **004** dual tire rubber belt
[0067] **005** rear track frame
[0068] **006** tensioning track guide
[0069] **007** tensioning shaft
[0070] **008** track hydro-pneumatic cylinder
[0071] **009** track frame pivot joint
[0072] **010** track frame slide joint
[0073] **011** track frame parallelogram
[0074] **012** track frame tensioning pivot joint
[0075] **013** road wheel rim
[0076] **014** dual track wheel rim
[0077] **015** dual tensioning tires
[0078] **016** track hydro-pneumatic push rod
[0079] **017** gap between road tire and rubber belt
[0080] **018** rear axle joint
[0081] **019** front axle joint
[0082] **020** rubber belt guide horns
[0083] **021** rubber belt guide horns outer edge
[0084] **022** rubber belt guide horns inner edge
[0085] **023** rubber belt tread
[0086] **024** belt
[0087] **025** rubber belt guide horns front
[0088] **026** rubber belt guide horns back
[0089] **027** rubber belt wheel runway
[0090] **028** rubber belt center runway
[0091] **029** vertex of rubber belt guide horn
[0092] **030** rubber belt guide horn gap
[0093] **031** single drive track tire
[0094] **032** single track tire
[0095] **033** drive tooth
[0096] **034** key way
[0097] **035** track frame arm
[0098] **036** tensioning pivot joint
[0099] **037** track hydro-pneumatic piston
[0100] **038** dual tensioning wheel rim
[0101] **040** cylinder rear hinge joint
[0102] **041** cylinder front hinge joint
[0103] **045** single track wheel rim
[0104] **047** single tensioning wheel rim
[0105] **050** single tire rubber belt
[0106] **060** rubber belt guide horn height
[0107] **061** rubber belt tread depth
[0108] **062** rubber belt road clearance
[0109] **063** angle from vertical of the rubber belt guide horns outer edge **021**
[0110] **064** angle from vertical of the rubber belt guide horns inner edge **022**
[0111] **065** rubber belt tensioning guide clearance depth
[0112] **070** axle extension
[0113] **071** front track frame

DESCRIPTION

[0114] During high speed road travel, the road tires are better suited for high speed operation. To reduce rubber belt **004** wear, rolling resistance and heat build up, the rubber belt **004** may be disengaged during road usage. To allow the rubber belt **004** to be disengaged for road travel, one or more of the axles shafts **001** needs to be driven. The axle shafts **001** are equipped with suspension for road and off road travel.
[0115] The complete dual tire hybrid rubber belt assembly is shown in FIGS. **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9** and **10**. The dual tire rubber belt **004** used on the dual tire hybrid rubber belt assembly is shown in FIGS. **11**, **12**, **13**, and **14**.
[0116] FIG. **1** shows an isometric view of the complete dual tire hybrid rubber belt assembly. FIG. **10** is the top view of dual tire hybrid rubber belt assembly with the dual tire rubber belt **004** removed from the complete assembly shown in FIG. **1**. FIG. **9** is the front view of the dual tire hybrid rubber belt assembly with the dual tire rubber belt **004** removed. With the dual tire rubber belt **004** removed, the internal components are clearly visible in FIG. **10**. FIG. **2** shows the front view of the complete dual tire hybrid rubber belt assembly. A cutting plane A-A, is shown in FIG. **2**. The cutting plane A-A looking inwards towards the vehicle body, is taken between the outside track tire **003** and the track frame **005**. FIG. **3** shows the side view of the complete dual tire hybrid rubber belt assembly taken along the cutting plane A-A. FIG. **4** shows the outside view of the complete dual tire hybrid rubber belt

assembly. Cutting planes B1-B1, B2-B2, B3-B3 and B4-B4 are shown in FIG. **4**. Cutting plane B1-B1 is taken through the rear axle shaft **001** looking forward to the front. FIG. **5** shows the rear view of the complete dual tire hybrid rubber belt assembly taken along the cutting plane B1-B1. Cutting plane B2-B2 is taken through the front tensioning shaft **007** looking forward to the front. FIG. **6** shows the rear view of the complete dual tire hybrid rubber belt assembly taken along the cutting plane B2-B2. Cutting plane B3-B3 is taken through just in front of the front road tires **002** looking forward to the front. FIG. **7** shows the rear view of the complete dual tire hybrid rubber belt assembly taken along the cutting plane B3-B3. Cutting plane B4-B4 is taken through just in front of the rear road tires **002** looking forward to the front. FIG. **8** shows the rear view of the complete dual tire hybrid rubber belt assembly taken along the cutting plane B4-B4.

Frame Construction

[0117] The complete dual tire hybrid rubber belt assembly shown in FIGS. **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9** and **10** is assembled as follows.

[0118] As shown in FIG. **10**, the rear axle joint **018** is mounted on the rear axle shaft extension **070** and the front joint **019** shown in FIG. **3** is mounted on the front axle shaft extension **070** so that they are aligned to each other. As shown in FIG. **3**, the track frame pivot joint **009** is attached to the rear axle joint **018**. The track frame slide joint **010** is attached to the front axle joint **019**. The track frame **005** is fixed at the track frame pivot joint **009** so that it goes through the track frame slide joint **010** with the key-way **034** facing upwards. A key is placed on the key-way **034** to prevent the track frame **005** from twisting.

[0119] As shown in FIG. **3**, the track frame arm **035** is attached to top of rear track frame **005** between the track frame pivot joint **009** and the track frame sliding joint **010**. The hydro-pneumatic cylinder **008** is attached to the track frame arm **035** by cylinder rear hinge joint **040**. The front of the hydro-pneumatic piston **037** is attached to the hydro-pneumatic push rod **016** by the cylinder front hinge joint **041**. The hydro-pneumatic push rod **016** is connected to the tensioning shaft **007** by the tensioning pivot joint **036**. The front track frame **071** is bolted onto the rear track frame **005** in front of the front axle extension **070**. The hydro-pneumatic push rod **037** is connected to the front track frame **071** by the track parallelogram **011**.

[0120] As shown in FIG. **5**, the rear dual track wheel rims **014** are mounted on the rear axle shaft extension **070** both sides of the rear track frame **005**. The rear dual track wheel rims **014** are mounted by either bolted directly onto the rear axle shaft extension **070** or bolted to a brake assembly which is in turn bolted onto the rear axle shaft extension **070**.

[0121] The front dual track wheel rims **014** are mounted on the front axle shaft extension **070** both sides of the rear track frame **005** which is aligned with the rear dual track wheel rims **014**. The front dual track wheel rims **014** are mounted by either bolted directly onto the front axle shaft extension **070** or bolted to a brake assembly which is in turn bolted onto the front axle shaft extension **070**. The front dual track tires **003** are mounted onto the front dual track wheel rims **014**. The rear dual track tires **003** are mounted onto the rear dual track wheel rims **014**.

[0122] As shown in FIG. **5**, the inside rear road wheel rim **013** is bolted onto the rear axle shaft **001**. The rear axle extension **070** is bolted through the inside rear road wheel rim **013** onto the rear axle shaft **001**. The inside front road wheel rim **013** is bolted onto the front axle shaft **001** and is aligned with the inside rear road wheel rim **013**. The front axle extension **070** is bolted through the inside front road wheel rim **013** onto the front axle shaft **001**. The outside rear road wheel rim **013** is bolted onto the rear axle shaft extension **070**. The outside front road wheel rim **013** is bolted onto the front axle shaft extension **070** and is aligned with the outside rear road wheel rim **013**. The front and rear road wheel rims **013** are located on both sides of the front and dual track tires **003**. The road tires **002** are mounted on all road wheel rims **013**.

[0123] As shown in FIG. **6**, the tensioning wheel rims **038** are mounted on the tensioning shaft **007** so that they are aligned with the front and rear dual track tires **003**. The tensioning tires **015** are mounted onto the tensioning wheel rims **038**. The tensioning guide **006** are mounted on the tensioning shaft **007**, outside of the tensioning tires **015**. The idle guides **006** align with the dual tire rubber belt **004** so that the dual tire rubber belt **004** runs between them.

Track Construction

[0124] FIG. **11** shows the dual tire rubber belt **004**. Cutting planes C1-C1 and C2-C2 are shown on FIG. **11**. The cutting plane C1-C1 cuts around one single rubber belt unit. FIG. **12** shows the front view of a single rubber belt unit taken along the cutting plane C1-C1. FIG. **13** shows the top view of a single rubber belt unit taken along the cutting plane C1-C1. Cutting plane C2-C2 is taken at the edge where the dual tire rubber belt **004** bends around the tensioning tires **015** looking forward to the front. FIG. **14** shows the rear view of the dual tire rubber belt **004** taken along the cutting plane C2-C2.

[0125] The dual tire rubber belt **004** is constructed as continuous belt with repeated patterned units. The length of the unrepeated patterned unit is called a rubber belt unit. The backbone of the rubber belt **004** is a belt **024**. The belt **024** includes an endless belt-shaped rubber-like elastic member, a canvas radially aligned high tension strength cords, and may include a number of core bars embedded therein and aligned laterally across the belt side to side. The radial canvas allows some shear motion within the rubber belt without buckling. The rubber belt tread **023**, shown below the rubber belt **004** in FIG. **12**, is attached outside the backbone of the rubber belt **004**. The rubber belt tread **023** is made of abrasion resistance rubber suitable for road and off road usage with a raised tread pattern. The rubber belt tread **023** has a tread depth **061** as shown in FIG. **6**. The raised pattern of the rubber belt tread **023** is chosen as a compromise of specific needs. Some of the many specific needs include a deep open self cleaning pattern for soft soils and a dense wear resistance pattern for high speed road usage. The rubber belt tread **023** protects the backbone of the rubber belt **004** from damage and grips the travel surface.

[0126] The dual track tires **003** run inside the dual tire rubber belt **004** along the rubber belt wheel runways **027**. The rubber belt **004** is driven from the rear dual track tires **003** and perhaps also from the front dual track tires **003**. The dual track tires **003** are prevented from spinning within the dual rubber belt **004** by static friction. The inside surface of the rubber belt **004** may have a shallow rib pattern to increase grip between the dual track tires **003** and the rubber belt **004**. The shallow rib pattern is designed to reduce the dual track tires **003** from hydroplaning on the inner surface of the rubber belt **004**. Rows of rubber belt guide horns **020**, shown above the rubber belt **004** in FIG. **12**, are attached inside the backbone of the

rubber belt **004**. Each track tire **003** runs along the rubber belt wheel runway **027** between two rows of rubber belt guide horns **020**. In the center between the two rows of rubber belt guide horns **020** the rubber belt center runway **028** is unused. This rubber belt center runway **028** is not filled with rubber belt guide horns **020** because they are not needed and they would unnecessarily increase the rubber belt **004** weight. The track tires **003** are guided by the rubber belt guide horn inner edges **022**. The guide horn inner edges **022** viewed from the end form a spline shape which allows the track tires **003** to pivot through a small angle without being pushed away from the rubber belt **004**.

[0127] In FIG. **19**, the angle of the track tires **031** pivot equals the axle shaft **001** pivot, which occurs as the vehicle travels over uneven terrain. Increasing the allowed track tire **031** pivot angle will increase the angle **064** of the guide horn inner edge **022** from vertical. The angle **064** is shown in FIG. **39**. When large lateral forces are applied to the rubber belt **004**, a large angle **064** of the guide horn inner edge **022** from vertical will cause the single track tires **031** to lifting off rubber belt **004** rather than laterally retaining them. As a result, only a few degrees of track tire **031** pivot are allowable.

[0128] The road tires **002** are located outside rubber belt **004** as shown in FIG. **5** and FIG. **8**. When the road tires **002** are fully inflated, the tires side walls will not swell outwards significantly under the vehicle's weight. As a result when the road tires **002** are fully inflated there is a small gap **017** between the rubber belt guide horns **020** and the side walls of the road tires **002**. The inflated road tires **002** also lifts the rubber belt **004** off the flat hard road surfaces creating a clearance **062** between the rubber belt **004** and the road surface. The small gap **017** between the rubber belt guide horns **020** and the side walls of the road tires **002** allows the rubber belt **004** to be disengaged traveling on flat hard road surfaces. When the road tires **002** are partially deflated, they will settle and lower the rubber belt **004** until it comes in contact with the ground surface. As the partially deflated road tires **002** settle under the vehicle weight, the bottom side walls of the road tires **002** will swell outwards eliminating the gap **017** between the road tires **002** and the rubber belt **004**. The rubber belt guide horns outer edge **021** spreads the lateral load against the road tire **002** over a large side wall area. As shown in FIG. **12**, the angle **064** of the guide horns inner edge **022** from vertical is designed to maximize the surface area in contact with road tires **002**, provide lateral retention of the rubber belt **004**, and direct the rubber belt **004** away from the road ties as the rubber belt **004** is pushed upwards towards the axle. In most situations a small angle **064** of the guide horns inner edge **022** from vertical, approximately 10 degrees is a good compromise.

[0129] The road tire **002** and the track tire **003** together form a V-belt pulley for the outer rubber belt guide horns **020**. The larger diameter road tires **002** acts as a very deep pulley guide sidewall. When there is an excessive amount of debris between the dual track tires **003** and the rubber belt **004** or the rubber belt **004** is excessively twisted, the rubber belt guide horns **020** may slip off the dual track tires **003**. Even in these extreme cases, the rubber belt **004** is prevented from being thrown by the larger diameter road tires **002**. The larger diameter road tires form large flanges as shown in FIG. **5** and FIG. **8**, which confines the rubber belt **004**. Without the road tires **002** functioning as large flanges, the rubber belt **004** would be thrown when the rubber belt **004** is lifted away from the dual track tires **003**. With road tires **002** functioning as large flanges, the rubber belt **004** needs to lift away from the track tires **003** by the guide horn height **060** plus the tread depth **061** plus the track road clearance **062**. The road tires **002** also provide a greater surface area to resist rubber lateral forces of the rubber belt **004** on the dual track tires **003** by the amount of the tread depth **061**. A further benefit of the road tires **002** located on both sides of the rubber belt **004** is that the rubber belt **004** will be guided between the road tires **002** as they push against the guide horns outer edges **021**. As a result, the rubber belt **004** can have less tension than the equivalent ground pressure without a concern of the rubber belt **004** climbing off the dual track tires **003**.

[0130] On soft soils or in loose debris, the road tires **002** sink down so that the rubber belt **004** comes in solid contact with the soft surface. As a result, the road tires **002** only sink into the soft surface by a small amount before the weight of the vehicle is supported by the high flotation rubber belt **004**. Without the additional flotation provided by the rubber belt **004**, the road tires **002** would sink beyond the point where they can climb out from the hole created by sinking. Also without the additional traction provided by the rubber belt **004**, the road tires **002** would spin and dig deep holes in soft surfaces. The continuous rubber belt **004** can also bridge over loose debris such as boulders and fallen tree branches. The relatively smooth road tires **002** have a larger diameter than the rubber belt **004** and as a result the road tires **002** will push loose debris away from the guide horns **020**. Debris should be kept away from the guide horns **020**, which can grab debris in the guide horn gaps **030**. The depressions the road tires **002** create on both sides of the rubber belt **004** act as gutters for the rubber belt **004** to dump debris.

[0131] The shock to both the road tires **002** and the dual track tires **003** from stones and pot holes can be extreme. In order to withstand the shock, the road tires **002** are assumed to be standard pneumatic tires, but they may be spring rubber. Similarly, the dual track tires **003** are assumed to be standard pneumatic or spring rubber tires. In either case, the road tires **002** and the dual track tires **003** are able to safely absorb shocks that might break a similar strength solid wheels.

[0132] The reduced footprint of only the road tires **002** on hard surfaces greatly reduces the turning force required to skid steer the hybrid rubber belt vehicle. The road tires **002** also push loose debris away from the rubber belt **004** as the vehicle turns. This is particularly important at the front and rear dual track tires **003**. Debris entering the rubber belt **004** at the front or rear dual track tires **003** is pinched in between the guide horn gaps **030** as the rubber belt wraps around the dual track tires **003**. By the road tires pushing loose debris away from the rubber belt **004**, the danger of debris wedged between the guide horns **020** and lifting the rubber belt off the dual track tires **003** is avoided.

[0133] The top inside view of the rubber belt **004** is shown in FIG. **13** and FIG. **14**. The front and back of each guide horn **020** forms an angled shape. In prior art designs, the front and back surfaces **025** and **026** of the rubber belt guide horns **020** may be perpendicular to the rubber belt **004** side. In this design, the front and back surfaces **025** and **026** of the guide horns **020** may be twisted in parallel as shown in FIG. **13** and FIG. **14**. When the front and back surfaces **025** and **026** of the guide horns **020** are twisted in parallel, there is smaller straight through guide horn gap **030** in between the guide horns **020**. The smaller straight through rubber belt guide horn gap **030** provides greater lateral support to the rubber belt **004** and makes it more difficult for debris to enter. Also if the rubber belt is forced to bend in a sharper angle than the

wedge shape of the guide horns **020** was designed for, the twisted front and back surfaces of the guide horns **020** allow the rubber belt guide horns **020** to displace each other sideways rather than preventing the sharp bend angle. The guide horns **020** fit together end to end as shown in FIG. **14**.

Tensioning Idlers Construction

[0134] The dual tensioning tires **015** run inside the dual tire rubber belt **004** along the wheel runways **027**. Each tensioning tire **015** runs along the wheel run way **027** between two rows of guide horns **020**. The dual tensioning tires **015** are guided by the rubber belt guide horn inner edges **022**. The guide horn inner edges **022** viewed from the end form a spline shape which allows the tensioning tires **015** to pivot through a small angle without being pushed away from the rubber belt **004**. The pivot angle of the dual tensioning tires **015** is dependent on the twisting amount of the rubber belt **004**. The tensioning pivot joint **036** prevents the rubber belt **004** from lifting off one side of the dual tensioning tires **015** as the rubber belt **004** twists. The twisting of the rubber belt **004** is caused by the difference in pivot angles between the front and rear axle shafts **001**.

[0135] The tensioning track guides **006** are located outside rubber belt **004** as shown in FIG. **6** and FIG. **7**. The outer guide horns **020** are held by the tensioning track guide **006** on the outside and the tensioning tire **015** on the inside. Together the tensioning track guide **006** and the tensioning tire **015** form a V-belt pulley for the outer guide horns **020**. The amount of the tensioning track guides **006** extend beyond the rubber belt tread **023** is the rubber belt tensioning guide clearance depth **065**. The guide horns outer edge **021** spreads the lateral load against the tensioning track guides **006** over a large area. The side wall slope of the tensioning track guides **006** is designed to maximize the surface area in contact with the guide horns outer edge **021**. This provides lateral retention of the rubber belt **004**, and centers the rubber belt **004** between the tensioning track guides **006** by the rubber belt **004** tension.

[0136] The continuous rubber belt **004** can also bridge over loose debris such as boulders and fallen tree branches. The smooth tensioning track guides **006** have a larger diameter than the rubber belt **004** surrounding the dual tensioning tires **015** and as a result they will push loose debris away from the guide horns **020**. Debris should be kept away from the guide horns **020** because the guide horns can grab debris in the rubber belt guide horn gaps **030**. The depressions the tensioning track guides **006** create on both sides of the rubber belt **004** act as gutters for the rubber belt **004** to dump debris.

[0137] The shock to both the tensioning track guides **006** and the dual tensioning tires **015** from stones can be extreme. To withstand shock from stones, the tensioning track guides **006** are assumed to be standard pneumatic or spring rubber tires. Similarly the dual tensioning tires **015** are assumed to be standard pneumatic or spring rubber tires. In either case the tensioning track guides **006** and the dual tensioning tires **015** are able to safely absorb shocks that might break a similar strength solid wheels.

[0138] The tensioning track guides **006** also push loose debris away from the rubber belt **004** as the vehicle turns. This is particularly important at the front and rear. Debris entering the rubber belt **004** at the front dual tensioning tires **015** is pinched in between the guide horn gaps **030** as the rubber belt **004** wraps around the dual tensioning tires **015**. By the tensioning track guides **006** pushing loose debris away from the rubber belt **004**, the danger of debris wedged between the guide horns **020** and lifting the rubber belt **004** off the dual tensioning tires **015** is avoided.

Frame Operation

[0139] The suspension used by the hybrid rubber belt vehicle is not limited to track laying vehicle suspension. Track laying vehicle suspension has the advantage of not introducing axle shaft **001** vertical misalignment while traveling over rough terrine. Hybrid rubber belt vehicles with typical wheeled vehicle suspension such as solid axle, wishbone, McPherson strut and variations of these suspension types will sustain axle shaft **001** vertical misalignment while traveling over rough terrine. The hybrid rubber belt assembly is designed to accommodate a small amounts of axle shaft **001** vertical misalignment.

[0140] Typical wheeled vehicle suspension will cause the axle shafts **001** to tilt inwards as the road tires **002** and dual track tires **003** rise over bumps. Similarly the axle shafts **001** will tilt outwards as the road tires **002** and dual track tires **003** fall into depressions. The geometry of the suspension will cause the rubber belt **004** to twist. For the rubber belt **004** to accommodate twisting without buckling, the radial canvas embedded into the belt **024** allows an amount of lateral and longitudinal shear.

[0141] Separately raising the front axle shaft **001** or lowering the rear axle shaft **001** will cause top rear of the rubber belt **004** to twist outwards and the bottom rear of the rubber belt **004** to twist inwards. As the hybrid rubber belt vehicle travels forward, the rubber belt **004** needs to move inward along the top between the rear and front dual track tires **003** and moves outward along the bottom between the front and rear dual track tires **003**. The outer edge of the rubber belt **004** also tightens as the front and rear axle shafts **001** move up and down separately. Some of the slackness along the inside edge of the rubber belt **004** will be taken up by the tensioning shaft **007** pivoting outwards on the tensioning pivot joint **036**. The elastomer construction of the rubber belt's belt prevents the pivoting of the tensioning shaft **007** from taking up the inside edge slackness around the full length of the rubber belt **004**. As a result the rubber belt **004** is forced to fit tightly around the outer dual track tire **003**.

[0142] When each front dual track tire **003** applies inward lateral force against the guide horns inner edge **022** of each inside row of guide horns **020**, the top of the rubber belt **004** is forced inwards. When the slightly looser inside edge of the rubber belt **004** rides up the inside front track tire **003**, the rubber belt **004** will be held in place by its outer edge which is tightly fitted around the outer front track tire **003**. The top of the rubber belt **004** is forced inwards by each dual tensioning tire **015** which applies inward lateral force against the guide horns inner edge **022** of each inside row of guide horns **020**. The outside tensioning guide **006** applies lateral force against the guide horns outer edge **021** along the outside edge of the rubber belt **004**. Furthermore the rubber belt **004** is prevented from slipping outwards and off from the front dual track tires **003** by the outside front road tire **002** which applies lateral force against the guide horns outer edge **021** along the outside edge of the rubber belt **004**.

[0143] The bottom of the rubber belt **004** is forced inwards by each rear dual track tire **003** applying inward lateral force against the rubber belt guide horns inner edge **022** of each inside row of rubber belt guide horns **020**. When the slightly looser inside edge of the rubber belt rides down the inside rear track tire **003**, the rubber belt **004** will be held in place by its

outer edge which is tightly fitted around the outer rear track tire **003**. Furthermore the rubber belt **004** is prevented from slipping outwards and off from the dual track tires **003** by the outside rear road tire **002** which applies lateral force against the rubber belt guide horns outer edge **021** of the row of rubber belt guide horns **020** along the outside edge of the rubber belt **004**.

[0144] Separately lowering the front axle shaft **001** or raising the rear axle shaft **001** will cause top rear of the rubber belt **004** to twist inwards and the bottom rear of the rubber belt **004** to twist outwards. As the hybrid rubber belt vehicle travels forward, the rubber belt **004** needs to move outward along the top between the rear and front dual track tires **003** and needs to move inward along the bottom between the front and rear dual track tires **003**. The outer edge of the rubber belt **004** also tightens as the front and rear axle shafts **001** move up and down separately. Some of the slackness along the inside edge of the rubber belt **004** will be taken up by the tensioning shaft **007** pivoting outwards on the tensioning pivot joint **036**. The elastomer construction of the rubber belt's belt prevents the pivoting of the tensioning shaft **007** from taking up the inside edge slackness around the full length of the rubber belt **004**. As a result the rubber belt **004** is forced to fit tightly around the outer track tire **003**.

[0145] When each front dual track tire **003** applies outwards lateral force against the guide horns inner edge **022** of each outside row of guide horns **020**, the top of the rubber belt **004** is forced outwards. When the slightly looser inside edge of the rubber belt **004** rides up the inside front track tire **003**, the rubber belt **004** is held in place by its outer edge which is tightly fitted around the outer front track tire **003**. The top of the rubber belt **004** is forced outwards by each dual tensioning tire **015** which applies outward lateral force against the guide horns inner edges **022** of each inside row of guide horns **020**. The inside tensioning guide **006** applies lateral force against the track guide horns outer edge **021** of the row of guide horns **020** along the inside edge of the rubber belt **004**. Furthermore the rubber belt **004** is prevented from slipping inwards and off the front dual track tires **003** by the inside front road tire **002** which applies lateral force against the guide horns outer edge **021** along the inside edge of the rubber belt **004**.

[0146] The bottom of the rubber belt **004** is forced outwards by each rear dual track tire **003** applying inward lateral force against the guide horns inner edge **022** of each outside row of guide horns **020**. When the slightly looser inside edge of the rubber belt **004** rides down the inside rear track tire **003**, the rubber belt **004** is held in place by its outer edge which is tightly fitted around the outer rear track tire **003**. Furthermore the rubber belt **004** is prevented from slipping inwards and off the rear dual track tires **003** by the inside rear road tire **002** which applies lateral force against the rubber belt guide horns outer edge **021** along the inside edge of the rubber belt **004**.

[0147] In an outward rear skid turn, the rubber belt **004** is forced inwards on the rear and forced outwards on the front. The outside rear road tire **002** clears debris away from rear dual track tires **003**. The inside rear road tire **002** provides extra protection preventing the rubber belt **004** from slipping off the rear dual track tires **003** and sliding inwards. The inside front road tire **002** clears debris away from the front dual track tires **003**. The outside front road tire **002** provides extra protection preventing the rubber belt **004** from slipping off the front dual track tires **003** and sliding outwards.

[0148] Similarly in an inward rear skid turn, the rubber belt **004** is forced outwards on the rear and forced inwards on the front. The inside rear road tire **002** clears debris away from rear dual track tires **003**. The outside rear road tire **002** provides extra protection preventing the rubber belt **004** from slipping off the rear dual track tires **003** and sliding outwards. The outside front road tire **002** clears debris away from the front dual track tires **003**. The inside front road tire **002** provides extra protection preventing the rubber belt **004** from slipping off the front dual track tires **003** and sliding inwards.

[0149] Near constant tensioning is maintained in the rubber belt **004** by the hydro-pneumatic cylinder **008** which applies a nearly constant extension force. The hydro-pneumatic cylinder **008** applies longitudinally outward force to the tensioning shaft **007**. The constant force applied by the dual tensioning tires **015** maintains a constant rubber belt **004** tension. The rubber belt **004** length is shortened by twisting. A longer rubber belt **004** length is required when the rubber belt **004** is supporting the vehicle's weight on boulders, tree limbs or other hard debris. As the vehicle craws over the hard debris, the vehicle's weight forces the rubber belt **004** upwards. When the rubber belt **004** is not directly supported by the dual track tires **003**, the rubber belt **004** is allowed to bend upwards. This upwards bending of the rubber belt **004** results in a longer rubber belt **004** length required when the vehicle craws over hard debris. When sticky debris accumulates around the dual track tires **003** or in the rubber belt wheel runway **027**, the effective track tire **003** size increases. Changing track tire **003** size also requires rubber belt **004** length to change. The hydro-pneumatic cylinder **008** dynamically extends and retracts to accommodate changes in the required length of the rubber belt **004**.

[0150] Optionally the rubber belt **004** may be disengaged during on road usage to reduce rubber belt **004** wear, heat and noise. Disengaging the rubber belt **004** during high speed travel greatly reduces any chance of throwing a high velocity rubber belt with a destructive amount of kinetic energy. In order to be able to disengage the rubber belt, the dual track wheel rims **014** are bolted to a brake assembly which is in turn bolted onto the rear axle shaft extension **070**. Also the road tires **002** need to be inflated such that there is a clearance between the rubber belt **004** and the road surface. The rubber belt **004** is disengaged from the road tires **002** by releasing the brakes of the brake assembly to which dual track wheel rims **014** are bolted. With the rubber belt **004** disengaged, the rubber belt **004** is able to freely rotate or cease to rotate as the hybrid rubber belt vehicle travels on roads. The rubber belt **004** is re-engaged with the road tires **002** by applying the brakes of the brake assembly to which dual track wheel rims **014** are bolted.

[0151] To change either the front or rear outside road tire **002**, the vehicle is lifted on jacks so that the outside road tire **002** to be removed is no longer bearing the vehicle's weight. The outside road wheel rim **013** together with the mounted road tire **002** are unbolted from axle extension **070**. After the outside road tire **002** and outside road wheel rim **013** have been removed, the road tire **002** is taken off and a replacement road tire **002** is put on the road wheel rim **013**. The outside road tire **002** and outside road wheel rim **013** are bolted onto the axle extension **070**. Finally the vehicle is lowered and jacks are removed.

[0152] To change the rubber belt **004** without breaking the endless belt, the vehicle is jacked so that neither the outside road tires **002** nor the rubber belt is bearing the vehicle's weight. Both front and rear outside road wheel rims **013** together with the mounted road tires are unbolted from the

axle extensions **070**. After the outside road tires **002** with road wheel rims **013** have been removed the hydro-pneumatic cylinder **008** is retracted. With the hydro-pneumatic cylinder **008** retracted, the rubber belt **004** can be slipped over the dual tensioning tires **015** and idle guides **006**. The rubber belt **004** is also slipped over the dual track tires **003** and removed. A replacement rubber belt **004** is similarly put on by slipping it over the dual track tires **003**, the dual tensioning tires **015** and idle guides **006**. The outside road tires **002** and outside road wheel rims **013** are bolted onto the axle extensions **070**. Finally the vehicle is lowered and jacks are removed.

[0153] To change either the front or rear inside road tire **002** or remove the track assembly, the vehicle is jacked so that neither the road tires **002** nor the rubber belt **004** is bearing the vehicle's weight. If there is sufficient clearance in the gap **017** between road tire **002** and rubber belt **004**, a suitable wrench can be inserted. The front and rear axle extensions **070** can be unbolted with a suitable wrench. The front and rear axles **001** and the complete assembly attached to the axle extensions **070** can be removed in one step. The complete assembly attached to the axle extensions **070** consists of the track frame, tensioning idlers, track tires **003**, outer road ties **002** and rubber belt **004**. Otherwise, the rubber belt **004** is removed as described previously. After the rubber belt **004** has been removed, the gap between the inside track tire **003** and the inside road tire **002** will be more than sufficient to insert a suitable wrench. If there are no means of lifting the complete assembly attached to the axle extensions **070**, the assembly can be first disassembled. With a means of lifting, the complete assembly is attached to the axle extensions **070**. The front and rear axle extensions **070** can be unbolted from the front and rear axles **001** and the complete assembly attached to the axle extensions **070** can be removed. Otherwise the assembly needs to be disassembled and removed one piece at a time until the complete assembly attached to the axle extensions **070** has been removed.

[0154] To disassemble the complete assembly attached to the axle extensions **070**, the rubber belt **004** is removed as described previously. The hydro-pneumatic cylinder **008** can be disconnected at the front **041** and rear **040** hinge joints which allows the hydro-pneumatic cylinder **008** to be removed. The front track frame **071** is unbolted from the rear track frame **005** and the attached tensioning idler assembly is removed. The rear track frame **005** is disconnected from the rear axle extension **070** by separating the track frame pivot joint **009** from the rear axle joint **018**. The rear track frame **005** is slid forward in the track frame slide joint **010** until the rear track frame **005** clears the rear dual track tires **003**. The rear axle extension **070** is unbolted from the rear axle **001** allowing the rear axle extension **070** and the attached dual rear track tires **003** to be removed. The rear track frame **005** is slid backwards and out of the track frame slide joint **010**. The front axle extension **070** is unbolted from the front axle **001** and rear axle extension **070** and the attached dual front track tires **003** are removed.

[0155] At this point the track assembly has been completely removed leaving only the inside road tires **002** and road wheel rims **013** bolted onto the axle shafts **001**. At this point either front or rear inside road tire can be replaced or the track assembly may be left removed reducing the total vehicle width. To replace either the front or rear inside road tire **002**, the inside road wheel rim **013** together with the mounted road tire are unbolted from the axle **001**. After the inside road tire **002** and inside road wheel rim **013** have been removed, the road tire **002** is taken off and a replacement road tire **002** is put on the road wheel rim **013**. The inside road tire **002** and outside road wheel rim **013** are bolted onto the axle **001**. Process of reattaching the track assembly is performed by reversal of the removal steps.

CONCLUSION, RAMIFICATIONS, AND SCOPE

[0156] Although the invention has been described and demonstrated with reference to specific preferred embodiments, it should be understood by those who are skilled in the art that some modification in form and detail may be made therein without deviating from the spirit and scope of the invention as defined in the following claims.

[0157] Many other variations are possible. For example these variations include track laying systems where the drive wheels do not support the vehicle's weight as it travels over terrain. Other variations include implementations where the tensioning wheels also support the vehicle's weight as it travels over terrain.

[0158] The first variation embodiment where drive wheels do not support the vehicle's weight is quite popular and is used by a wide variety of vehicles including most military track laying vehicles. In this embodiment track and road wheels support the vehicle weight as it travels over terrain. Track wheel axles are connected to a frame or vehicle body by suspension elements. These suspension elements insure the track wheel axles remain parallel or nearly so through the suspension travel, with each other, with the drive wheel axle and with the tensioning axle. Each track wheel axle has one or more track wheels attached. Prior art track laying systems do not include road wheels which are mounted beside and in proximity to the track. This invention further includes larger diameter road wheels attached on the track wheel axles on either one side or both sides of the track. These road wheels are a greater radius than the combined radius of track wheels and the track thickness. These road wheels are located in close proximity beside the track and support the vehicle's weight on hard ground and roads, such that the track is unloaded or lightly loaded.

[0159] The advantages provided by the road wheels included in this invention are increased protection from debris entering the track during turning, reduced track wear and heat generation hard ground and roads, bearing greater side loading forces without requiring large track guide wedges, reduced force required to turn, this is particularly true when turning on hard surfaces, the track confined between guides and road wheels greatly reduces the possibility of de-tracking of band tracks, reduced track angular momentum and kinetic energy when the vehicle is traveling at high speeds on roads and the track rotation is decoupled from road wheel rotation.

[0160] Thus the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims and their legal equivalents.

What is claimed is:

1. A means of track laying for a vehicle, comprising:

a. an inextensible track having one or more longitudinal rows of guide wedges located on the interior surface of said track,

b. a plurality of track wheels that run on said lower interior surface of said track, such that said track wheels support a portion of or all of said vehicle's weight, such that said track wheels fit snugly against one or more said longitudinal rows of said guide wedges, such that one or more

of said track wheels may simultaneously serve as drive wheels, and such that one or more of said track wheels may simultaneously serve as tensioning wheels,

c. a plurality of track wheel axles, such that one or more of said track wheels is mounted to each said track wheel axle, such that one or more of said track wheel axles may simultaneously serve as drive axles, and such that one or more of said track wheel axles may simultaneously serve as tensioning axles,

d. one or more drive axles, such that each said drive axle is connected to said vehicle and such that each said drive axle is forcibly rotated by one or more apparatuses associated with said vehicle and/or restrained by one or more apparatuses associated with said vehicle,

e. a plurality of road wheels, such that said road wheels are mounted on said track wheel axles, such that said road wheels are adjacent to said track, such that said road wheels have a greater radius than the combined radius of said track wheels and thickness of said track, such that on a hard even travel surface said road wheels fully or primarily support said vehicle's weight, such that said road wheels function as guides preventing said track from moving sufficiently sideways to slide off said track wheels that run on said lower interior surface of said track, such that one or more of said road wheels may simultaneously serve as drive guide wheels, and such that one or more of said road wheels may simultaneously serve as tensioning guide wheels,

f. a transaction enhancing material fixed to the outside circumference of said road wheels,

g. one or more track wheel axle supporting structures for supporting said vehicle's weight, such that each said track wheel axle supporting structure is attached to said vehicle and one or more said track wheel axles, and such that said vehicle weight is carried through one or more said track wheel axle supporting structures and applied to said track wheel axles,

h. one or more means of maintaining proper tension of said track with the first part of said means of maintaining proper tension fixed in reference to said track wheel axle supporting structure, and such that the second part of said means of maintaining proper tension moves with respect to said first part,

i. one or more said tensioning axles, such that each said tensioning axle is connected to said second part of a said means of maintaining proper tension,

j. one or more tensioning wheels that run on said interior surface of said track, such that said tensioning wheels are mounted on one or more said tensioning axles, such that said tensioning wheels apply tensioning force to said track, such that said tensioning wheels fit snugly against one or more said longitudinal rows of said guide wedges, and such that said tensioning axle is attached to said second part of said means of maintaining proper tension,

k. one or more tensioning guide wheels mounted on one or more said tensioning axles, such that one of said tensioning guide wheels is located on one side of said track, such that if there is more than one said tensioning guide wheel, one of said tensioning guide wheels is located on the other side of said track, such that said tensioning guide wheels prevent said track from moving sufficiently sideways to slide off said tension wheels that run on said interior surface of said track,

l. one or more drive wheels that run on said interior surface of said track, such that said drive wheels are mounted on one or more said drive axles, such that said drive wheels apply drive torque to said track, and such that said drive wheels fit snugly against one or more said longitudinal rows of said guide wedges,

m. one or more drive guide wheels mounted on one or more said drive axles, such that one of said drive guide wheels is located on one side of said track, such that if there is more than one said drive guide wheel, one of said drive guide wheels is located on the other side of said track, and such that said drive guide wheels prevent said track from moving sufficiently sideways to slide off said drive wheels that run on said interior surface of said track,

whereby said road wheels, said tensioning guide wheels, and said drive guide wheels protect the edge of said track by pushing debris away from said track,

whereby said road wheels, said tensioning guide wheels, and said drive guide wheels inhibit said track from moving sufficiently sideways to slide off said track wheels, said tensioning wheels, and/or said drive wheels,

whereby the amount of side loading force that said track is able to bear before sliding sideways off said track wheels, said tensioning wheels, and/or said drive wheels is greatly increased by said road wheels, said tensioning guide wheels, and said drive guide wheels,

whereby said road wheels, said tensioning guide wheels, and said drive guide wheels lift said track off even and hard travel surfaces reducing wear and extending useful life of said track.

2. The means of track laying as set forth in claim **1**, further including:

a. said longitudinal rows of guide wedges located along the outer edge or edges of said track,

b. said tensioning guide wheels have a greater diameter than said track fitted around said tensioning wheels, such that said longitudinal rows of said guide wedges are confined between said tensioning guide wheels and said tensioning wheels,

whereby sideways movement of said track is reduced by said confined longitudinal rows of said guide wedges,

whereby reduced sideways movement of said track improves alignment and reduces uneven wear of said track,

whereby reduced sideways movement of said track increases the amount of side loading force said track is able to bear before sliding sideways off said track wheels, said tensioning wheels, and/or said drive wheels.

3. The means of track laying as set forth in claim **1**, further including:

a. said longitudinal rows of guide wedges located along the outer edge or edges of said track,

b. said drive guide wheels have a greater diameter than said track fitted around said drive wheels, such that said longitudinal rows of said guide wedges are confined between said drive guide wheels and said drive wheels, such that contacting surface is between said confined longitudinal rows of said guide wedges and said drive wheels and/or such that contacting surface is between said confined longitudinal rows of said guide wedges and said drive wheel guides and such that said contacting surface provides a large surface friction,

whereby said large surface friction enables a large torque to be transmitted through said drive axles to said track,

whereby sideways movement of said track is reduced by said confined longitudinal rows of said guide wedges,

whereby reduced sideways movement of said track improves alignment and reduces uneven wear of said track,
whereby reduced sideways movement of said track increases the amount of side loading force said track is able to bear before sliding sideways off said track wheels, said tensioning wheels, and/or said drive wheels.

4. The means of track laying as set forth in claim **1**, further including a frame to which said drive axles, said track wheel axle supporting structures, and/or said first part of said means of maintaining proper tension are attached, such that said frame bears forces between said drive axles, said track wheel axle supporting structures, and/or said first part of said means of maintaining proper tension and such that said frame may also be directly attached to said vehicle,
whereby said frame is an efficient means of transmitting force between said drive axles, said track wheel axle supporting structures, and/or said first part of said means of maintaining proper tension,
whereby said frame reduces forces on said vehicle attachment points of said drive axles, said track wheel axle supporting structures, and/or said first part of said means of maintaining proper tension.

5. The means of track laying as set forth in claim **1**, further including one or more track wheel axle suspension, such that each said track wheel axle has a track wheel axle suspension and such that each said track wheel axle suspension absorbs impacts by said track wheels and said road wheels with surface terrain upon which said vehicle moves,
whereby the life expectancy of said vehicle and said means of track laying is increased by said track wheel axle suspension absorbing impacts by said track wheels and said road wheels with surface terrain upon which said vehicle moves.

6. The means of track laying as set forth in claim **1**, further including tires that absorb impacts mounted on the circumference of said road wheels and/or said track wheels and such that said tires absorb impacts by said track wheels and said road wheels with surface terrain upon which said vehicle moves,
whereby the life expectancy of said vehicle and said means of track laying is increased by said tires absorbing impacts.

7. The means of track laying as set forth in claim **1**, further including a fixed mounted or spring mounted means of removing debris between any or all sets of said track wheels and said road wheels, said tensioning wheels and said tensioning guide wheels, and/or said drive wheels and said drive guide wheels,
whereby accumulation of debris is prevented between any or all said sets of said track wheels and said road wheels, said tensioning wheels and said tensioning guide wheels, and/or said drive wheels and said drive guide wheels,
whereby said track is prevented from coming off due to said accumulation of debris between any or all said sets of said track wheels and said road wheels, said tensioning wheels and said tensioning guide wheels, and/or said drive wheels and said drive guide wheels.

8. The means of track laying as set forth in claim **1**, further including one or more longitudinal rows of uniformly spaced drive lugs located on the interior surface of said track, such that said drive wheels mesh with said drive lugs,
whereby friction between said drive wheels and said track is increased by the meshing of said drive wheels with one or more said longitudinal rows of uniformly spaced drive lugs.

9. The means of track laying as set forth in claim **1**, further including a means of adjusting the ride height of said road wheels, such that increasing the ride height of said road wheels lifts said track further off said travel surface and such that decreasing the ride height of said road wheels lowers said track further toward said travel surface,
whereby the portion of said vehicle weight supported by said road wheels and said track wheels is adjusted by said means of adjusting the ride height of said road wheels.

10. The means of track laying as set forth in claim **1**, further including:

a. either said track wheels decoupled from said road wheels or a means of decoupling said track wheels from said road wheels, such that when said track wheels are decoupled from said road wheels, then they rotate independently,
b. either said drive wheels decoupled from said drive wheel axles or a means of decoupling said drive wheels from said drive wheel axles, such that when said drive wheels are decoupled from said drive wheel axles, then said drive wheels and said drive wheel axles rotate independently, and such that when said drive wheels are coupled to said drive wheel axles, then said drive wheels and said drive wheel axles rotate in unison,
c. either said track decoupled from said road wheels or a means of decoupling said track from said road wheels, such that when said track is decoupled from said road wheels and said track wheels are decoupled from said road wheels and when said drive wheels are decoupled from said drive wheel axles, then said track rotates independently of said road wheels,

whereby when said drive wheels are coupled to said drive wheel axles, then said track rotates in unison with said drive wheel axles,
whereby when said drive wheels are coupled to said drive wheel axles, then said vehicle is propelled by said road wheels and said track,
whereby when said drive wheels are decoupled from said drive wheel axles, then said track rotates independently of said drive wheel axles,
whereby said track rotation speed can be less than that of said vehicle speed over said travel surface,
whereby when said drive wheels are decoupled from said drive wheel axles, then said vehicle is propelled by only said road wheels,
whereby the angular momentum and kinetic energy of said track is reduced during high speed operation of said vehicle by decoupling said drive wheels from said drive wheel axles and allowing said track to rotate independently.

11. The means of track laying as set forth in claim **1**, further including:

a. a plurality of self-aligning curvilinear track teeth, such that the longitudinal cross section of each said self-aligning curvilinear track tooth is that of a curvilinear synchronous timing track tooth that is not self-aligning, such that the latitudinal cross section of each said self-aligning curvilinear track tooth is sloped outward toward the base of each said curvilinear track tooth, such that said latitudinal cross section of each said self-aligning curvilinear track tooth is rounded at the upper and lower portions, and such that latitudinal cross section of each said self-aligning curvilinear track tooth is devoid of abrupt corners,
b. an inextensible track having one or more longitudinal rows of spaced plurality of said self-aligning curvilinear track teeth located on the interior surface of said track,

such that said drive wheels mesh with said curvilinear track teeth, whereby torque is smoothly transmitted between said self-aligning synchronous track teeth and meshing of said drive wheels,

whereby said self-aligning curvilinear synchronous track teeth are self-aligning.

12. A self-aligning synchronous belt, comprising:

a. a plurality of self-aligning curvilinear belt teeth, such that the longitudinal cross section of each said self-aligning curvilinear belt tooth is that of a curvilinear synchronous timing belt tooth that is not self-aligning, such that the latitudinal cross section of each said self-aligning curvilinear belt tooth is sloped outward toward the base of each said curvilinear belt tooth, such that said latitudinal cross section of each said self-aligning curvilinear belt tooth is rounded at the upper and lower portions, and such that latitudinal cross section of each said self-aligning curvilinear belt tooth is devoid of abrupt corners,

b. an inextensible belt having one or more longitudinal rows of spaced plurality of said self-aligning curvilinear belt teeth located on the interior surface of said belt,

whereby torque is smoothly transmitted between said self-aligning synchronous belt and meshing pulley,

whereby said self-aligning curvilinear synchronous belt teeth provided power transmission efficiency comparable to curvilinear synchronous timing belt teeth that are not self-aligning,

whereby said self-aligning curvilinear synchronous belt teeth are self-aligning.

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