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ABSTRACT

Disclosed is an electric propulsion assembly for driving an endless track of a tracked vehicle. The electric propulsion assembly comprises an electric motor, a drive shaft and a sprocket, the sprocket being arranged on the drive shaft and engaging the endless track. The electric motor is mounted to a first end of the drive shaft. The electric propulsion assembly may comprise a coupling mechanism arranged between the electric motor and the drive shaft, the coupling mechanism being configured to transfer the power from the electric motor to the drive shaft.

Fig. 2 to be published

AN ELECTRIC PROPULSION ASSEMBLY FOR A TRACKED VEHICLE AND A TRACKED VEHICLE COMPRISING THE ELECTRIC PROPULSION ASSEMBLY

The present disclosure pertains to the field of vehicle technology. The present disclosure relates to an electric propulsion assembly for a tracked vehicle and a tracked vehicle comprising the electric propulsion assembly.

BACKGROUND

Tracked vehicles, such as snowmobiles or similar tracked vehicles use an endless track assembly to propel the vehicle forward in snow and over other surfaces where an endless track is required to minimize ground pressure and achieve sufficient surface grip.

Historically, snowmobiles and other tracked vehicles have relied on internal combustion engines for generating the energy necessary to drive an endless track by means of a gearing mechanism for propelling the vehicle forwards or backwards.

While combustion engines historically have served their purpose well, especially in achieving high power outputs and for ensuring long operating ranges, an internal combustion engine has several drawbacks. One drawback is that internal combustion engines comprise a substantial number of moving parts requiring periodic maintenance and repairs. Another drawback is that they consume fuel based on non-renewable resources causing both sound and environmental pollution, something that is especially inconvenient given the often serene and delicate environments in which snowmobiles or other tracked vehicles are operated. Some of these drawbacks may be overcome by using an electric motor.

A typical solution for propelling a tracked vehicle, such as a snowmobile or similar tracked vehicle, whether using a combustion engine or electric motor, is one where the rotating force of the engine or motor is transmitted from an output shaft of the engine and/or the motor to a drive shaft by means of a gearing mechanism and/or a gearbox assembly, where the drive shaft is configured to engage one or more endless tracks. However, gearing mechanisms and/or gearbox assemblies typically have high mechanical losses due to for example friction in the gearing mechanisms and/or gearbox assemblies. The losses in a gearing mechanism and/or gearbox assembly may accumulate to a power loss in the range of 15-20% of the available power output from the engine and/or motor.

SUMMARY

Accordingly, there is a need for a propulsion system for tracked vehicles, which mitigates, alleviates, or addresses the shortcomings existing and provides a more efficient and user-friendly tracked vehicle.

Disclosed is an electric propulsion assembly for driving an endless track of a tracked vehicle. The electric propulsion assembly comprises an electric motor, a drive shaft and a sprocket, the sprocket being arranged on the drive shaft and engaging the endless track. The electric motor is mounted to a first end of the drive shaft. The electric propulsion assembly may comprise a coupling mechanism arranged between the electric motor and the drive shaft, the coupling mechanism being configured to transfer the power from the electric motor to the drive shaft.

Further, a tracked vehicle is disclosed, the tracked vehicle comprising a chassis, an endless track, and the electric propulsion assembly according to this disclosure.

It is an advantage of the present disclosure that the disclosed electric propulsion assembly can improve the efficiency and the power output of the electric propulsion assembly and/or the tracked vehicle. By mounting the electric motor, such as an output shaft of the electric motor, to a first end of the drive shaft, no gearing mechanism and/or gearbox assembly is required to transfer the power and/or torque from the electric motor to the drive shaft. This reduces the losses in the propulsion assembly which can increase the efficiency and reduce the sound level of the propulsion assembly. By increasing the efficiency of the propulsion assembly, a larger amount of the available power is transferred to the drive shaft. Thereby, a more powerful tracked vehicle can be provided, or the electric motor can be downsized while providing the same power to the drive shaft as a larger electric motor connected to a gearing mechanism and/or gearbox assembly. By downsizing the electric motor the environmental impact of the tracked vehicle can be reduced. Furthermore, the noise of the propulsion unit may be reduced which reduces the noise pollution and improves the user experience when operating the tracked vehicle. Furthermore, by mounting the electric motor to the drive shaft, the packaging of the propulsion assembly may be improved, such that the space in the tracked vehicle, such as the space in a forward under-hood compartment of a snowmobile, can be used for other purposes than housing the engine and/or motor, such as for storage of luggage and/or equipment. Thereby, the versatility of the tracked vehicle can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present disclosure will become readily apparent to those skilled in the art by the following detailed description of exemplary embodiments thereof with reference to the attached drawings, in which:

Fig. 1A-1C are illustrations of an example tracked vehicle comprising the electric propulsion assembly according to this disclosure,

Fig. 2 illustrates an example electric propulsion assembly having a housing and electric motor arranged on an outer side of the chassis of the tracked vehicle according to this disclosure,

Fig. 3 illustrates an example electric propulsion assembly having the housing and electric motor arranged in a partially recessed position on the chassis of the tracked vehicle according to this disclosure,

Fig. 4 illustrates an example electric propulsion assembly comprising two electric motors arranged on opposite ends of a drive shaft according to this disclosure, and

Fig. 5A-5C illustrates an example electric propulsion assembly comprising a hinge mechanism according to the current disclosure.

DETAILED DESCRIPTION

Various exemplary embodiments and details are described hereinafter, with reference to the figures when relevant. It should be noted that the figures may or may not be drawn to scale and that elements of similar structures or functions are represented by like reference numerals throughout the figures. It should also be noted that the figures are only intended to facilitate the description of the embodiments. They are not intended as an exhaustive description of the disclosure or as a limitation on the scope of the disclosure. In addition, an illustrated embodiment needs not have all the aspects or advantages shown. An aspect or an advantage described in conjunction with a particular embodiment is not necessarily limited to that embodiment and can be practiced in any other embodiments even if not so illustrated, or if not so explicitly described.

The figures are schematic and simplified for clarity, and they merely show details which aid understanding the disclosure, while other details have been left out. Throughout, the same reference numerals are used for identical or corresponding parts. Historically, snowmobiles and other tracked vehicles have been manufactured mainly following a linear model whereby the vehicles have been manufactured and brought to market with little consideration as to the recycling and reuse of the vehicles and its components. Past its initial production by a manufacturer, the manufacturer, as well as other parts of the value chain such as resellers, have taken little or no responsibility for end-of-life management of the vehicles.

The electric motor and battery powered drivetrain has replaced the combustion engines in a large variety of applications and this development has seen a significant ramp-up in the past decade, accelerated by the improvements in battery and electric motor technology, enabling electric motor applications to achieve similar or surpassing output, characteristics and benefits that of its combustion engine counterparts. Electric drivetrain alternatives are available for snowmobiles as well as most other means of personal transportation, including the nearby categories of sports utility vehicles, motorcycles and other tracked vehicles.

In traditional combustion engine and drivetrain configurations for snowmobiles, the engine is arranged in front of an operator, such as a driver, of the snowmobile and/or handlebars of the snowmobile, typically within a hood-covered forward compartment of the snowmobile. The internal combustion engine is typically arranged slightly behind or directly above a front suspension and steering skid assembly of the snowmobile. The internal combustion engine typically drives a primary shaft which through a gearing mechanism engages a drive shaft configured to drive the endless track of the snowmobile. The drive shaft is typically located within a forward section of a chassis tunnel of the snowmobile and is configured to rotate the endless track by means of one or more sprocket wheels. The gearing mechanism is typically a variator. The variator is a variable transmission comprising two cone rings and a belt that can be moved along the cones to variably change the gear ratio of the transmission.

The current disclosure provides an electric propulsion assembly for driving an endless track of a tracked vehicle. The electric propulsion assembly comprises an electric motor, a drive shaft and a sprocket, such as one or more sprockets. The sprocket is arranged on the drive shaft and is configured to engage the endless track. The sprocket is fixedly attached to the drive shaft, such that the sprocket rotates with the drive shaft. The electric motor, such as a rotor of the electric motor, is configured to directly engage a first end of the drive shaft. In one or more example methods, the electric motor is mounted to the first end of the drive shaft, such as directly mounted to the first end of the drive shaft. Directly mounted can herein be seen as the electric motor engaging the drive shaft without a transmission, such as a variator, being arranged between the electric motor and the drive shaft. The electric motor may however be directly mounted to the drive shaft via a coupling mechanism. The coupling mechanism is configured to transfer the power and/or torque from the electric motor to the drive shaft. In other words, the electric propulsion assembly may comprise a coupling mechanism arranged between the electric motor and the drive shaft. By directly mounting the electric motor to the drive shaft no gearing mechanism or gearbox is required to transfer the rotating force, such as the power and/or torque, from the electric motor to the drive shaft, which increases the efficiency of the electric propulsion assembly since the losses occurring in the gearing mechanism or gearbox can be removed. Furthermore, connecting the electric motor to the drive shaft comprising the sprocket for driving the endless track instead of driving the endless track directly by the electric motor, such as for example via a sprocket mounted to a rotating part of the electric motor, such as to a rotating outer part, such as housing, of the electric motor, the electric motor may be removed from the electric propulsion assembly without having to remove the endless track from the sprocket. Thereby, the serviceability of the electric propulsion assembly can be improved compared to a solution where the sprocket is mounted directly to the electric motor. The coupling mechanism may be a solid or flexible coupling being configured to directly engage the electric motor with the drive shaft. The coupling mechanism may be one or more of a splined coupling, such as a solid spline coupling, and a flexible coupling, such as rubber or composite based coupling. The choice of coupling mechanism may be determined depending on technical requirements in terms of maintenance and absorption of drivetrain vibrations.

In one or more example electric propulsion assemblies, the electric motor is coaxially arranged with the drive shaft. The electric motor being coaxially arranged with the drive shaft can herein be seen as an output shaft of the electric motor, such as the rotor of the electric motor or a shaft fixedly connected to the rotor of the electric motor, being coaxially arranged with the drive shaft. The drive shaft may be configured to be mounted to a chassis, such as a frame, of the tracked vehicle via a bearing, such as a bearing block, such as a sealed pillow bearing block. The chassis can be seen as a frame for supporting components of the tracked vehicle, such as a battery, a seat, a steering arrangement, the propulsion assembly and/or an endless track assembly. The endless track assembly may comprise the endless track, suspension components, and/or one or more tensioners for tensioning the endless track.

In one or more example electric propulsion assemblies, the electric motor is configured to engage the first end of the drive shaft via a clutch assembly arranged between the electric motor, such as the rotor of the electric motor, and the drive shaft. The clutch assembly may be configured to release the direct connection between the drive shaft and the electric motor when the clutch assembly is open and create the direct connection when the clutch assembly is closed. This allows the electric motor to be driven without driving the drive shaft, which allows the electric motor to be used as an auxiliary output when the tracked vehicle is stationary. The auxiliary output may be used for driving auxiliary equipment, such as tools. In one or more example electric propulsion assemblies, the electric motor may comprise a throughgoing output shaft allowing the electric motor to output power in a first direction towards the drive shaft and in a second direction opposite the first direction.

In one or more example electric propulsion assemblies, the electric motor is a brushless axial flux electric motor, or a radial direct current electric motor. The type of electric motor used can vary depending on requirements on power output and vehicle driving characteristics. The electric motor may be one or more of axial flux electric motors (commonly also referred to as “axial gap” or “pancake motors”) or radial electric motors. The axial flux electric motor has the benefit that it has a smaller lateral footprint, such as an extension in the direction of the rotation axis of the electric motor, than the radial electric motors.

In one or more example electric propulsion assemblies, the electric propulsion assembly comprises a plurality of electric motors and/or coupling mechanisms, such as two electric motors and/or two coupling mechanisms. The two electric motors and/or coupling mechanisms may be arranged at, such as connected to, opposite ends of the drive shaft. For example, a first electric motor and/or a first coupling mechanism may be coupled to a first end of the drive shaft, and a second electric motor and/or a second coupling mechanism may be coupled to a second end of the drive shaft. In one or more example electric propulsion assemblies, one or more of the plurality of electric motors may be configured to engage the drive shaft via a respective clutch mechanism. The electric propulsion assembly comprising a plurality of electric motors, such as two electric motors, has the benefit that smaller electric motors may be used to generate the same power as in the single electric motor arrangements of Fig. 2 and Fig. 3. Furthermore, the weight distribution may be further improved, since a similar weight is applied to both sides of the chassis 101, 101A of the tracked vehicle. This can further improve the handling of the tracked vehicle. Another benefit is that a redundancy is provided, which allows the tracked vehicle to be driven on one of the electric motors 2', 2'' on case the other electric motor fails. This improves safety of a user of the tracked vehicle operating in harsh and remote environments in secluded areas, such as in the woods or in the mountains during winter, where it is crucial that the operator can make his way safely back home.

In one or more example electric propulsion assemblies, the electric propulsion assembly comprises a housing for receiving the electric motor and/or the coupling mechanism. The electric motor and/or the coupling mechanism and/or the clutch mechanism may be arranged within the housing to protect the electric motor and/or the coupling mechanism from environmental impact. The housing may also act as a mount for the electric motor, such as for the stator of the electric motor. The housing may be configured to be mounted to a chassis, such as to a frame, of the tracked vehicle. In one or more example electric propulsion assemblies, the housing may comprise a bearing for rotatably arranging the drive shaft to the housing. The bearing may be the same bearing as the bearing used to mount the drive shaft to the chassis of the tracked vehicle, such as a bearing block, such as a sealed pillow bearing block. In other words, both the housing and the drive shaft may be mounted to the chassis via the bearing block.

In one or more example electric propulsion assemblies, the bearing is a bearing block having a mounting surface for mounting the bearing to a chassis of the tracked vehicle.

In one or more example electric propulsion assemblies, the electric propulsion assembly comprises a hinge mechanism. The hinge mechanism may comprise a first hinge part and a second hinge part being pivotably arranged to each other around a first pivot axis. The first hinge part may be configured to be pivotably mounted to the housing and/or to the chassis of the tracked vehicle around a second pivot axis. The second hinge part may be pivotably mounted to the electric motor around a third pivot axis. The hinge mechanism can allow the electric motor to be moved out of the housing in an axial direction of the drive shaft and/or rotated away from the housing to allow access to the coupling mechanism and/or the clutch mechanism, and/or the bearing, and/or the drive shaft. The electric motor may thus be partially disconnected from the housing and/or the chassis of the tracked vehicle, while remaining connected via the hinge, without having to disconnect electrical wiring and/or heating assemblies and/or cooling assemblies of the electric motor. When the electric motor has been moved out of the housing and rotated away from the drive shaft by means of the hinge mechanism, access may be granted to the coupling mechanism and/or the clutch mechanism, and/or the bearing and/or the drive shaft, thereby improving serviceability of these components. Furthermore, by releasing the electric motor from the drive shaft and moving the electric motor out of the way using the hinge mechanism, the endless track assembly can be easily removed for easy replacement and/or maintenance, without having to disconnect the electrical wiring and/or the heating assemblies and/or the cooling assemblies of the electric motor. By improving serviceability, the downtime of the tracked vehicle due to maintenance may be reduced. Furthermore, by disconnecting the electric motor from the drive shaft by moving the electric motor out of the housing in an axial direction of the drive shaft and/or rotating the electric motor away from the housing, auxiliary equipment may be connected to the outgoing shaft of the electric motor, such as to the rotor of the electric motor, to drive the auxiliary equipment. In other words, by pivoting the electric motor away from the drive shaft, the auxiliary equipment may be connected to the electric motor instead of the drive shaft when the tracked vehicle is stationary. Once the auxiliary equipment is not required anymore, the auxiliary equipment may be removed from the electric motor and the electric motor may be pivoted and/or moved in an axial direction of the drive shaft back into engagement with the drive shaft, so that the tracked vehicle can be driven away using the electric motor.

In one or more example electric propulsion assemblies, the housing and/or the electric motor is configured to be arranged on an outer side, such as outside, of the chassis of the tracked vehicle. In one or more example electric propulsion assemblies, the housing and/or the electric motor is configured to be arranged in an at least partially recessed position of the chassis of the tracked vehicle. The arrangement of the housing and/or the electric motor may be selected based on various requirements on engine output and vehicle drive characteristics, and consequently, the type of electric motor used. The outside arrangement may be beneficial for use with electric motors having a limited lateral footprint, such as an extension in the direction of the rotational axis of the electric motor.

The partially recessed position within the chassis, such as within the chassis tunnel, enables the use of radial electric motors or axial gap electric motors having a wider lateral footprint, without the electric motor increasing the boundaries of the tracked vehicle. The boundaries of the tracked vehicle can be seen as the dimensions determined by the widest parts of the tracked vehicle. Further, by partially recessing the electric motor and the housing the weight of the electric motor and the housing can be shifted towards the centre of the tracked vehicle, which improves the weight distribution of the tracked vehicle. By reducing the boundaries, such as the dimensions, of the tracked vehicle, and improving the weight distribution, the handling of the tracked vehicle can be improved.

In one or more example electric propulsion assemblies, the electric propulsion assembly comprises a brake assembly. The brake assembly may be a disc brake assembly. The brake assembly may comprise a brake disc and a brake calliper configured to engage the brake disc, for example via a set of brake pads. The brake disc may be fixedly attached to the drive shaft and/or to a rotor of the electric motor, for example via an output shaft of the electric motor protruding through the electric motor. The brake calliper may be configured to be fixedly arranged to the chassis of the tracked vehicle and/or to a stator of the electric motor. In one or more example electric propulsion assemblies, the brake assembly is an electronically or hydraulically actuated disc brake assembly. In one or more example electric propulsion assemblies, the electric propulsion assembly comprise two brake assemblies arranged on opposite ends of the drive shaft.

The current disclosure provides a tracked vehicle, such as a snowmobile or any other vehicle propelled by one or more endless track assemblies. The tracked vehicle comprises a chassis, an endless track, and an electric propulsion assembly according to this disclosure. In one or more example tracked vehicle, the tracked vehicle comprises an energy storage, such as a battery or a battery pack, for providing energy to the electric motor.

In one or more example tracked vehicles, the housing and/or the electric motor is arranged in an at least partially recessed position of the chassis, such as the frame, of the tracked vehicle. The housing and/or the electric motor may be arranged in an at least partially recessed position of a chassis tunnel of the tracked vehicle, wherein the chassis tunnel is configured to house the endless track of the tracked vehicle.

In one or more example tracked vehicles, the housing and/or the electric motor is arranged on an outer side of the chassis of the tracked vehicle, such as arranged on an outside of the chassis tunnel. In other words, the housing and/or the electric motor may not protrude into the chassis tunnel of the tracked vehicle.

By providing an electrical propulsion assembly configured to reduce maintenance needs, reducing the number of moving parts, increasing serviceability, which can lead to a reduction of the overall environmental impact, a circular model for the development, maintenance, and recycling of tracked vehicles comprising the electric propulsion assembly can be introduced. In the circular development model, as opposed to the linear development model, the manufacturer takes responsibility for the entire product life cycle, thereby minimizing the environmental impact of the tracked vehicle through effective life cycle and end-of-life management practices.

Fig. 1A-1C illustrate an example tracked vehicle 100, in this example a snow mobile, comprising the electric propulsion assembly 1 according to this disclosure. Fig. 1A is a front view of the example tracked vehicle 100, Fig. 1B is a side view of the example tracked vehicle 100, and Fig. 1C is a top-down view of the example tracked vehicle 100. The example tracked vehicle 100 comprises a chassis 101, in this example formed as a chassis tunnel 101A, and an endless track 102. The endless track 102 arranged in the chassis tunnel 101A, such that the chassis tunnel 101A at least partly covers the endless track 102. In the example shown in Fig. 1A-1C the chassis tunnel 101A is U-shaped and the endless track 102 is arranged within the U-shape of the chassis tunnel 101A, so that the chassis tunnel 101A at least partly covers the endless track 102 from three sides. The endless track 102 may be comprised in an endless track assembly 103. The endless track assembly 103 may comprise the endless track 102, suspension components, and/or one or more tensioners for tensioning the endless track 102. The propulsion assembly 1 comprises an electric motor 2 arranged outside the chassis 101, such as the chassis tunnel 101A, and being mounted to a drive shaft 3 of the electric propulsion assembly 1. In the example tracked vehicle 100 of Figs. 1A-1C, such as in a snowmobile application, the electric propulsion assembly 1, such as the electric motor 2 and the drive shaft 3, is located in a forward section of the chassis tunnel 101A, such as directly underneath or slightly rearward of a steering arrangement 104, such as a handlebar assembly. Arranging the electric propulsion assembly 1 in the forward section of the chassis tunnel 101A, such as directly underneath or slightly rearward of a steering arrangement 104, has the benefit that the weight distribution of the vehicle may be improved, which can improve handling of the tracked vehicle, such as when the tracked vehicle is operated in terrain. Furthermore, by arranging the electric propulsion assembly 1 in the forward section of the chassis tunnel 101A space can be provided for an energy storage in the rearward section of the chassis.

Fig. 2 illustrates an electric propulsion assembly 1 according to one or more examples of the current disclosure in which the electric motor 2 is arranged on an outer side, such as an outside, of the chassis 101, such as the U-shaped chassis tunnel 101A, of the tracked vehicle. The electric motor 2 being arranged on an outer side of the chassis can herein be seen as the electric motor 2 not being arranged within the U-shape of the chassis tunnel 101A. The electric propulsion assembly 1 comprises the electric motor 2, the drive shaft 3 and a sprocket 4, such as one or more sprocket(s) 4. The one or more sprocket(s) 4 are arranged on the drive shaft 3 and engage the endless track 102. The one or more sprocket(s) 4 are fixedly attached to the drive shaft 3, such that the one or more sprocket(s) 4 rotate with the drive shaft 3. The electric motor 2, such as a rotor of the electric motor 2, is configured to directly engage a first end 3A of the drive shaft 3. In one or more example methods, the electric motor is mounted to the first end 3A of the drive shaft 3, such as directly mounted to the first end 3A of the drive shaft 3 via a coupling mechanism 6. The coupling mechanism 6 may be a splined coupling. In other words, the first end 3A may comprise splines being configured to engage with splines comprised in the electric motor, such as in the rotor of the electric motor. The electric motor 2, such as an output shaft 21 of the electric motor 2, can thus be slid onto the first end 3A of the drive shaft 3, such that the splines of the drive shaft 3 and of the electric motor 2 engage each other. Directly mounted can herein be seen as the electric motor 2 engaging the drive shaft 3 without a transmission, such as a variator, being arranged between the electric motor 2 and the drive shaft 3. The outside arrangement of the electric motor 2 and the housing 7 may for example be used with an axial flux electric motor, such as a brushless axial flux electric motor, due to its small lateral footprint. The coupling mechanism 6 may be a solid or a flexible coupling being configured to directly engage the electric motor with the drive axis. The coupling mechanism may be one or more of a splined coupling and a flexible coupling. The example electric propulsion assembly of Fig. 2 may be configured for either left-hand side or right-hand side installation, such that the electric motor is arranged either on the right-hand side or the left-hand side of the chassis 101, such as the chassis tunnel 101A.

In the example electric propulsion assembly 1 shown in Fig. 2, the electric motor 2 is coaxially arranged with the drive shaft 3. The electric motor 2 being coaxially arranged with the drive shaft 3 can herein be seen as an output shaft of the electric motor 2, such as the rotor 2A of the electric motor 2, being coaxially arranged with the drive shaft 3. In other words, the rotational axis of the 12 of the electric motor 2 and the rotational axis 13 of the drive shaft 3 are aligned with each other, such as are coaxial to each other. The drive shaft 3 is mounted to the chassis 101, such as to the chassis tunnel 101A, of the tracked vehicle via one or more bearings 8, such as bearing blocks, such as a sealed pillow bearing blocks. The drive shaft 3 may extend in a direction perpendicular to a longitudinal direction of the chassis 101, 101A. The longitudinal direction can herein be seen as extending from a front of the chassis to a rear of a chassis. The drive shaft 3 may extend between two opposing longitudinal sides 101AA, 101AB of the chassis tunnel 101A, and may protrude through one or more of the opposing longitudinal sides 101AA, 101AB to allow the electric motor 2 to be mounted to the drive shaft 3 on the outside of the chassis tunnel 101A. The bearings 8 comprise a respective mounting surface for mounting the bearings 8 to the chassis 101, such as to the chassis tunnel 101A. The one or more bearings 8 may support the drive shaft 3 in a radial direction of the drive shaft 3. The example electric propulsion assembly of Fig. 2 further comprises a housing 7 arranged on the outer side, such as the outside, of the chassis 101, such as the U-shaped chassis tunnel 101A. The housing 7 being arranged on the outer side of the chassis 101 can herein be seen as the housing 7 not being arranged within the U-shape of the chassis tunnel 101A. The housing 7 is configured to receive the electric motor 2 and/or the coupling mechanism 6. The electric motor 2 and the coupling mechanism 6 are arranged within the housing 7 to protect the electric motor 2 and the coupling mechanism 6 from environmental impact. The housing 7 may also act as a mount for the electric motor 2, such as for the stator 2B of the electric motor 2. The housing 7 may be mounted to the chassis 101, such as to the chassis tunnel 101A. In the example electric propulsion assembly of Fig. 2, the housing 7 comprises a first of the one or more bearings 8 for rotatably arranging the drive shaft 3 to the housing 7. The first of the one or more bearings 8, may be comprised in the housing 7, for example as an integral part of the housing 7 or as a separate part being mounted to the housing 7. The housing 7 may thus be mounted to the chassis S101, S101A via the first of the one or more bearings 8. In Fig.

2 the electric motor 2 is shown in an exploded view from the rest of the components of the electric propulsion assembly 1. In the mounted state, the electric motor 2, such as the rotor 2A of the electric motor 2, engages the first end 3A of the drive shaft 3 via the coupling mechanism 6 and an outer surface, such as a cover plate 2C, of the electric motor 2 abuts the housing 7 to enclose the stator 2A, the rotor 2B and the coupling mechanism 6.

The example electric propulsion assembly 1 of Fig. 2 further comprises a brake assembly 9, such as a disc brake assembly. The brake assembly 9 comprises a brake disc 9A and a brake calliper 9B configured to engage the brake disc 9A, for8 example via a set of brake pads 9C. In the example electric propulsion assembly 1 of Fig. 2, the brake disc 9A is fixedly attached to a second end 3B the drive shaft 3. The second end 3B of the drive shaft may be opposite the first end 3A of the drive shaft 3. The brake calliper is fixedly arranged to the chassis S101, such as to the chassis tunnel S101A. The brake assembly 9 may be an electronically or hydraulically actuated disc brake assembly.

Fig. 3 illustrates an electric propulsion assembly 1 according to one or more examples of the current disclosure in which the electric motor 2 and the housing 7 are arranged in a partially recessed position in the chassis 101, such as in the chassis tunnel 101A. At least partially recessed can herein be seen as at least a part of the housing 7 and/or the electric motor 2 being arranged within the chassis tunnel 101A, such as within the U-shape of the chassis tunnel 101A. In this example, the electric propulsion assembly comprises one electric motor 2 arranged at the first end 3A of the drive shaft 3. Due to the at least partially recessed arrangement of the electric motor 2 and the housing 7, the length of the drive shaft 3 may be shorter than the length of the drive shaft 3 in the example electric propulsion assembly of Fig. 2. The example electric propulsion assembly 1 of Fig. 3 differs from the example electric propulsion assembly 1 of Fig. 2 mainly in that the electric motor 2 and the housing 7 are partially recessed in the chassis 101, 101A instead of being arranged on an outside of the chassis. Apart from the arrangement of the electric motor 2 and the housing 7, the example electric propulsion assembly of Fig. 3 corresponds to the example electric propulsion assembly 1 of Fig. 2. The partially recessed position within the chassis, such as within the chassis tunnel, enables the use of radial electric motors or axial gap electric motors having a wider lateral footprint, without the electric motor increasing the boundaries of the tracked vehicle. The boundaries of the tracked vehicle can be seen as the dimensions determined by the widest parts of the tracked vehicle. Further, by partially recessing the electric motor and the housing the weight of the electric motor and the housing can be shifted towards the centre of the tracked vehicle, which improves the weight distribution of the tracked vehicle. By reducing the boundaries, such as the dimensions, of the tracked vehicle, and improving the weight distribution, the handling of the tracked vehicle can be improved. In one or more example electric propulsion assemblies, the partially recessed arrangement is used when the electric motor 2 is a radial direct current electric motor, it may however also be used with an axial flux electric motor.

Fig. 4 illustrates an electric propulsion assembly 1 according to one or more examples of the current disclosure comprising two electric motors 2 arranged on opposite ends of the drive shaft 3. This example electric propulsion assembly may herein be referred to as a dual motor electric propulsion assembly. A first electric motor 2' is arranged at and engaging with the first end 3A of the drive shaft 3 and a second electric motor 2'' is arranged at and engaging with the second end 3B of the drive shaft 3. In the example shown in Fig. 4, the two electric motors 2', 2''and the corresponding housings 7', 7'' are arranged in partially recessed position in the chassis 101, 101A. In one or more example methods, the two electric motors 2', 2'' and the housings 7', 7'' may be arranged in the outside position as described in Fig. 2. In the example electric propulsion assembly of Fig. 4, the brake assembly is mounted on the outside of the electric motor 2''. In this example the brake disc 9A is fixedly attached to an output shaft 21 of the electric motor 2''. The output shaft may be fixedly connected to the rotor 2A of the electric motor 2''and to the drive shaft 3 via the coupling 6. The brake calliper 9B is fixedly arranged to a static part, such as a stator of the electric motor 2'', such as to an outer surface, such as a cover plate 2C, of the electric motor 2'. In one or more example electric propulsion assemblies, the brake calliper 9B may be arranged, such as mounted, to the housing 7''. In the example shown in Fig. 4 only one brake assembly 9 is shown, the electric propulsion assembly may however comprise more than one brake assemblies, such as two brake assemblies, arranged to a respective electric motor 2', 2''. The example dual motor electric propulsion assembly of Fig. 4 has the benefit that smaller electric motors may be used to generate the same power as in the single electric motor arrangements of Fig. 2 and Fig. 3, or to cater for increased demands for motor output and specific driveability requirements. Furthermore, the weight distribution may be further improved, since a similar weight is applied to both sides of the chassis 101, 101A of the tracked vehicle. This can further improve the handling of the tracked vehicle. Another benefit is that a redundancy is provided, which allows the tracked vehicle to be driven using one of the two electric motors 2’, 2’’ in case the other of the two electric motors 2’, 2’’ fails. This improves safety of a user of the tracked vehicle operating in harsh and remote environments in secluded areas, such as in the woods or in the mountains during winter, where it is crucial that the operator can make his way safely back home.

Figs. 5A-5C illustrate an electric propulsion assembly 1 comprising a hinge mechanism 10 according to one or more examples of this disclosure. The hinge mechanism 10 comprises a first hinge part 10A, such as a first hinge arm, and a second hinge part 10B, such as a second hinge arm. The first hinge part 10A and the second hinge part 10B are pivotably arranged to each other around a first pivot axis 11A. The first hinge part 10A is configured to be pivotably mounted to the housing 7 and/or to the chassis 101, such as the chassis tunnel 101A, of the tracked vehicle around a second pivot axis 11B. The second hinge part 10B is pivotably mounted to the electric motor 2, such as to the stator 2B and/or to an outer surface, such as the cover plate 2C of the electric motor 2, around a third pivot axis 11C. In other words, the hinge mechanism is pivotable around three pivot axes, such that each end of the hinge parts 10A and 10B can respectively pivot around a pivot axis. This allows the hinge mechanism to not only pivot, but also extend and retract, so that the hinge mechanism 10 allows the electric motor 2 to be moved in an axial direction of the drive shaft 3 while the electric motor 2 is attached to the hinge mechanism 10. Thereby, the hinge mechanism 10 can allow the electric motor 2 to be moved away from the drive shaft 3 and/or out of the housing 7 in the axial direction of the drive shaft 3 and/or rotated away from the housing 7 and/or the chassis 101, 101A, so that access can be provided to the coupling mechanism 6 and/or a clutch mechanism, and/or the bearing 8, and/or the drive shaft 3. The electric motor 2 may thus be partially disconnected from the housing 7 and/or the chassis 101, 101A of the tracked vehicle, while remaining connected via the hinge mechanism 10, without having to disconnect electrical wiring and/or heating assemblies and/or cooling assemblies (not shown in Figs. 5A-5C) of the electric motor 2. Fig 5A illustrates the electric motor 2 in a first position mounted to the chassis 101, 101A and engaging the drive shaft 3 via the coupling mechanism 6. In the first position the hinge mechanism 10 is in a retracted state in which the first hinge part 10A and the second hinge part 10B are substantially overlapping. In other words, the second pivot axis 11B and the third pivot axis 11C are arranged closer to each other than the second pivot axis 11B or the third pivot axis 11C to the first pivot axis 11A, respectively. The electric motor 2 may be fixed to the chassis 101, and/or the chassis tunnel 101A, via one or more fasteners 104, such as one or more nuts 104A and/or bolts 104B.

Fig. 5B illustrates the electric motor 2 in a second state in which the electric motor 2 has been released from the chassis 101, 101A, such as partially disconnected from the chassis 101, 101A, for example by releasing the one or more fasteners 104. The electric motor 2 has been moved away from the drive shaft 3 in an axial direction of the drive shaft 3 until the coupling mechanism 6 is disengaged. In moving the electric motor in the axial direction of the drive shaft, the hinge mechanism pivots around the pivot axes 11A-11C and extends in the axial direction of the drive shaft 3 to enable the axial movement of the electric motor 2. Once the electric motor 2, such as the output axis 21 of the electric motor 2 has cleared the chassis 101, 101A, and/or the housing (not shown in Figs. 5A-5C), the electric motor m2 may be pivoted away from the drive shaft 3, such that the rotational axis 12 of the electric motor 2 is no longer aligned with the rotational axis 13 of the drive shaft 3.

Fig. 5C illustrates the electric motor 2 in a third state, in which the electric motor 2 has been moved away from the chassis 101, 101A and the drive shaft 3, such as out of a housing, and has ben pivoted, such as rotated, away from the drive shaft 3 by means of the hinge mechanism 10. In the third state the rotational axis 12 of the electric motor 2 is arranged substantially perpendicular to the rotational axis 13 of the drive shaft 3. In the third state, the hinge mechanism 10 may be fully or at least substantially extended. In the extended state of the hinge mechanism 10, the second pivot axis 11B and the third pivot axis 11C are arranged further away from each other than the second pivot axis 11B or the third pivot axis 11C to the first pivot axis 11A, respectively. In other words, the first pivot axis 11A is arranged between the second pivot axis 11B or the third pivot axis 11C. Thereby, access is granted to the coupling mechanism 6 and/or a clutch mechanism, and/or the bearing 8 and/or the drive shaft 3, which improves serviceability of these components. By improving serviceability, the downtime of the tracked vehicle due to maintenance may be reduced. Furthermore, in the third state of the electric motor 2, auxiliary equipment may be connected to the outgoing shaft 21 of the electric motor 2, such as via the coupling mechanism 6, to drive the auxiliary equipment. In other words, by pivoting the electric motor 2 away from the drive shaft 3, the auxiliary equipment may be connected to the electric motor 2 instead of the drive shaft 3 when the tracked vehicle is stationary. Once the auxiliary equipment is not required anymore, the auxiliary equipment may be removed from the electric motor 2 and the electric motor 2 may be pivoted and/or moved in an axial direction of the drive shaft 3 back into engagement with the drive shaft 3, such as back to the first state shown in Fig. 5A, so that the tracked vehicle can be driven away using the electric motor 2.

Embodiments of methods and products (electric propulsion assembly and tracked vehicle comprising the electric propulsion assembly) according to the disclosure are set out in the following items:

Item 1. An electric propulsion assembly (1) for driving an endless track of a tracked vehicle, wherein the electric propulsion assembly (1) comprises an electric motor (2), a drive shaft (3) and a sprocket (4), the sprocket (4) being arranged on the drive shaft (3) and being configured to engage the endless track (5), wherein the electric motor (2) is mounted to a first end (3A) of the drive shaft. (3)

Item 2. The electric propulsion assembly (1) according to Item 1, wherein the electric motor (2) is a brushless axial flux electric motor, or a radial direct current electric motor.

Item 3. The electric propulsion assembly (1) according to Item 1 or 2, wherein the electric propulsion assembly (1) comprises a coupling mechanism (6) arranged between the electric motor (2) and the drive shaft (3), the coupling mechanism (6) being configured to transfer the power from the electric motor (2) to the drive shaft (3).

Item 4. The electric propulsion assembly (1) according to Item 3, wherein the coupling mechanism (6) is a solid or flexible coupling mechanism being configured to directly engage the electric motor (2) with the drive axis (3).

Item 5. The electric propulsion assembly (1) according to any one of the previous Items, wherein the electric propulsion assembly (1) comprises a housing (7) for receiving the electric motor (2) and the coupling mechanism (6), wherein the housing (7) comprises a bearing (8) for rotatably arranging the drive shaft (3) to the housing (7).

Item 6. The electric propulsion assembly (1) according to Item 5, wherein the bearing (8) is a bearing block having a mounting surface for mounting the bearing (8) to a chassis of the tracked vehicle.

Item 7. The electric propulsion assembly (1) according to any one of the Items 5 to 6, wherein the electric propulsion assembly (1) comprises a hinge mechanism (10), the hinge mechanism (10) comprising a first hinge part (10A) and a second hinge part (10A) being pivotably arranged to each other around a first pivot axis (11A), wherein the first hinge part (10A) is configured to be pivotably mounted to the housing (7) and/or to a chassis of the tracked vehicle around a second pivot axis (11B) and the second hinge part (10B) is pivotably mounted to the electric motor (2) around a third pivot axis (11C), the hinge mechanism (10) allowing the electric motor (2) to be moved out of the housing (7) in an axial direction of the drive shaft (3) and/or rotated away from the housing (7) to allow access to the coupling mechanism (6) and/or the drive shaft (3).

Item 8. The electric propulsion assembly (1) according to any one of the Items 5 to 7, wherein the tracked vehicle comprises a chassis and the housing (7) is configured to be arranged on an outer side of the chassis of the tracked vehicle.

Item 9. The electric propulsion assembly (1) according to any one of the Items 5 to 7, wherein the tracked vehicle comprises a chassis and the housing (7) is configured to be arranged in an at least partially recessed position of the chassis of the tracked vehicle.

Item 10. The electric propulsion assembly (1) according to any one of the previous Items, wherein the electric propulsion assembly (1) comprises a brake assembly (9), the brake assembly (9) comprising a brake disc (9A) fixedly attached to the drive shaft (3), and a brake calliper (9B) configured to be fixedly arranged to a chassis of the vehicle and/or to a stator of the electric motor (2) and being configured to engage the brake disc (9A).

Item 11. The electric propulsion assembly (1) according to Item 10, wherein the brake assembly (9) is an electronically or hydraulically actuated disc brake assembly.

Item 12. The electric propulsion assembly (1) according to any one of the previous Items, wherein the electric propulsion assembly (1) comprises two electric motors (2’, 2’’) arranged on opposite ends of the drive shaft (3).

Item 13. A tracked vehicle (100) comprising a chassis (101), an endless track (102), and an electric propulsion assembly (1) according to any one of the previous Items.

Item 14. The tracked vehicle (100) according to Item 13, wherein the tracked vehicle (100) is a snowmobile.

The use of the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. does not imply any particular order, but are included to identify individual elements. Moreover, the use of the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. does not denote any order or importance, but rather the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. are used to distinguish one element from another. Note that the words “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. are used here and elsewhere for labelling purposes only and are not intended to denote any specific spatial or temporal ordering. Furthermore, the labelling of a first element does not imply the presence of a second element and vice versa.

It may be appreciated that Figs. 1-5C comprises some circuitries or operations which are illustrated with a solid line and some circuitries or operations which are illustrated with a dashed line. The circuitries or operations which are comprised in a solid line are circuitries or operations which are comprised in the broadest example embodiment. The circuitries or operations which are comprised in a dashed line are example embodiments which may be comprised in, or a part of, or are further circuitries or operations which may be taken in addition to the circuitries or operations of the solid line example embodiments. It should be appreciated that these operations need not be performed in order presented. Furthermore, it should be appreciated that not all of the operations need to be performed. The exemplary operations may be performed in any order and in any combination.

It is to be noted that the word "comprising" does not necessarily exclude the presence of other elements or steps than those listed.

It is to be noted that the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements.

It should further be noted that any reference signs do not limit the scope of the claims, that the exemplary embodiments may be implemented at least in part by means of both hardware and software, and that several "means", "units" or "devices" may be represented by the same item of hardware.

Although features have been shown and described, it will be understood that they are not intended to limit the claimed disclosure, and it will be made obvious to those skilled in the art that various changes and modifications may be made without departing from the scope of the claimed disclosure. The specification and drawings are, accordingly to be regarded in an illustrative rather than restrictive sense. The claimed disclosure is intended to cover all alternatives, modifications, and equivalents.

LIST OF REFERENCES

1	electric propulsion assembly
2	electric motor
2'	first electric motor
2''	second electric motor
2A	rotor
2B	stator
2C	cover plate
3	drive shaft
3A	first end of drive shaft
3B	second end of drive shaft
4	sprocket
6	coupling mechanism
7	housing
8	bearing
9	brake assembly
9A	brake disc
9B	brake calliper
10	hinge mechanism
10A	first hinge part
10B	second hinge part
11A	first pivot axis
11B	second pivot axis
11C	third pivot axis
12	electric motor rotation axis
13	drive shaft rotation axis
21	output shaft
100	tracked vehicle
101	chassis
101A	chassis tunnel
102	endless track
103	endless track assembly
104	steering assembly

CLAIMS

1. An electric propulsion assembly (1) for driving an endless track of a tracked vehicle, wherein the electric propulsion assembly (1) comprises an electric motor (2), a drive shaft (3) and a sprocket (4), the sprocket (4) being arranged on the drive shaft (3) and being configured to engage the endless track, wherein the electric motor (2) is mounted to a first end (3A) of the drive shaft (3), wherein the electric propulsion assembly (1) comprises a coupling mechanism (6) arranged between the electric motor (2) and the drive shaft (3), the coupling mechanism (6) being configured to transfer the power from the electric motor (2) to the drive shaft (3).

2. The electric propulsion assembly (1) according to claim 1, wherein the electric motor (2) is a brushless axial flux electric motor, or a radial direct current electric motor.

3. The electric propulsion assembly (1) according to claim 1 or 2, wherein the coupling mechanism (6) is a solid or flexible coupling mechanism being configured to directly engage the electric motor (2) with the drive axis (3).

4. The electric propulsion assembly (1) according to any one of the previous claims, wherein the electric propulsion assembly (1) comprises a housing (7) for receiving the electric motor (2) and the coupling mechanism (6), wherein the housing (7) comprises a bearing (8) for rotatably arranging the drive shaft (3) to the housing (7).

5. The electric propulsion assembly (1) according to claim 4, wherein the bearing (8) is a bearing block having a mounting surface for mounting the bearing (8) to a chassis of the tracked vehicle.

6. The electric propulsion assembly (1) according to any one of the claims 4 to 5, wherein the electric propulsion assembly (1) comprises a hinge mechanism (10), the hinge mechanism (10) comprising a first hinge part (10A) and a second hinge part (10A) being pivotably arranged to each other around a first pivot axis (11A), wherein the first hinge part (10A) is configured to be pivotably mounted to the housing (7) and/or to a chassis of the tracked vehicle around a second pivot axis (11B) and the second hinge part (10B) is pivotably mounted to the electric motor (2) around a third pivot axis (11C), the hinge mechanism (10) allowing the electric motor (2) to be moved out of the housing (7) in an axial direction of the drive shaft (3)

and/or rotated away from the housing (7) to allow access to the coupling mechanism (6) and/or the drive shaft (3).

7. The electric propulsion assembly (1) according to any one of the claims 4 to 6, wherein the tracked vehicle comprises a chassis and the housing (7) is configured to be arranged on an outer side of the chassis of the tracked vehicle.

8. The electric propulsion assembly (1) according to any one of the claims 4 to 6, wherein the tracked vehicle comprises a chassis and the housing (7) is configured to be arranged in an at least partially recessed position of the chassis of the tracked vehicle.

9. The electric propulsion assembly (1) according to any one of the previous claims, wherein the electric propulsion assembly (1) comprises a brake assembly (9), the brake assembly (9) comprising a brake disc (9A) fixedly attached to the drive shaft (3), and a brake calliper (9B) configured to be fixedly arranged to a chassis of the vehicle and/or to a stator of the electric motor (2) and being configured to engage the brake disc (9A).

10. The electric propulsion assembly (1) according to claim 9, wherein the brake assembly (9) is an electronically or hydraulically actuated disc brake assembly.

11. The electric propulsion assembly (1) according to any one of the previous claims, wherein the electric propulsion assembly (1) comprises two electric motors (2’, 2’’) arranged on opposite ends of the drive shaft.

12. A tracked vehicle (100) comprising a chassis (101), an endless track (102), and an electric propulsion assembly (1) according to any one of the previous claims.

13. The tracked vehicle (100) according to claim 12, wherein the tracked vehicle (100) is a snowmobile.

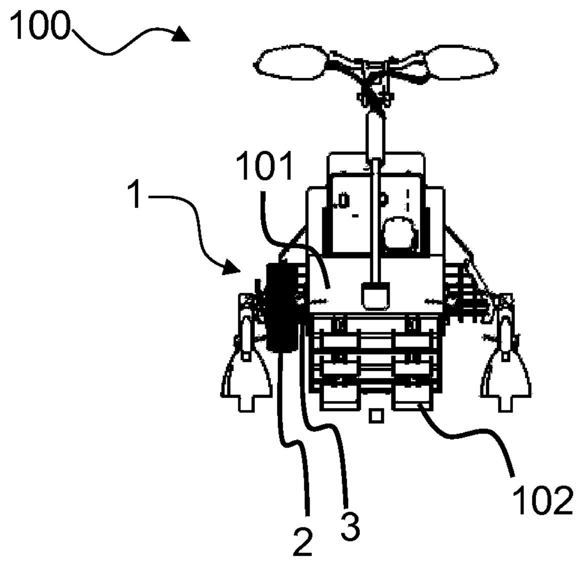


Fig. 1A

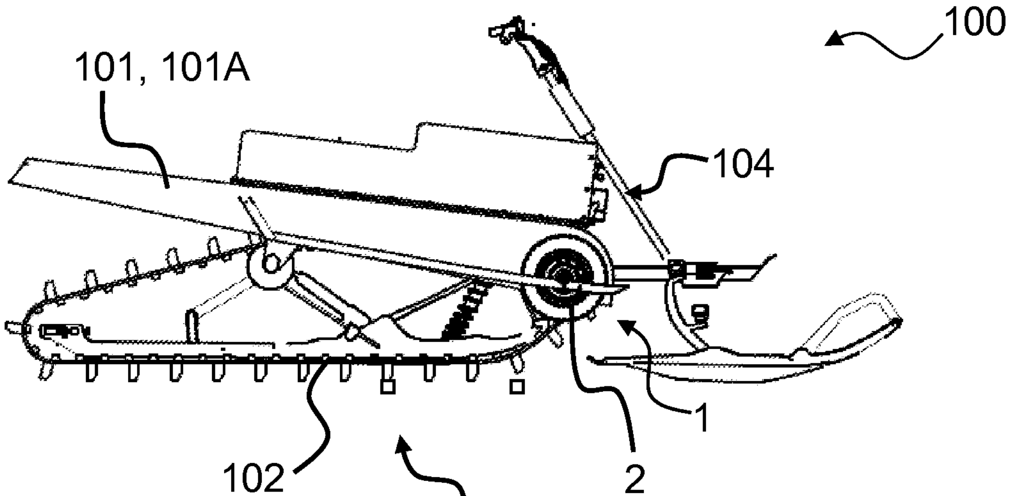


Fig. 1B

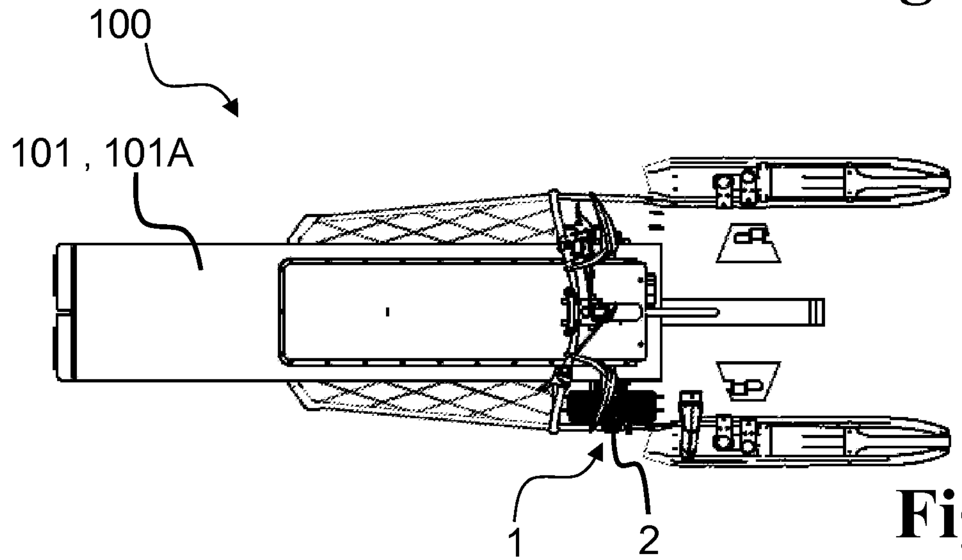


Fig. 1C

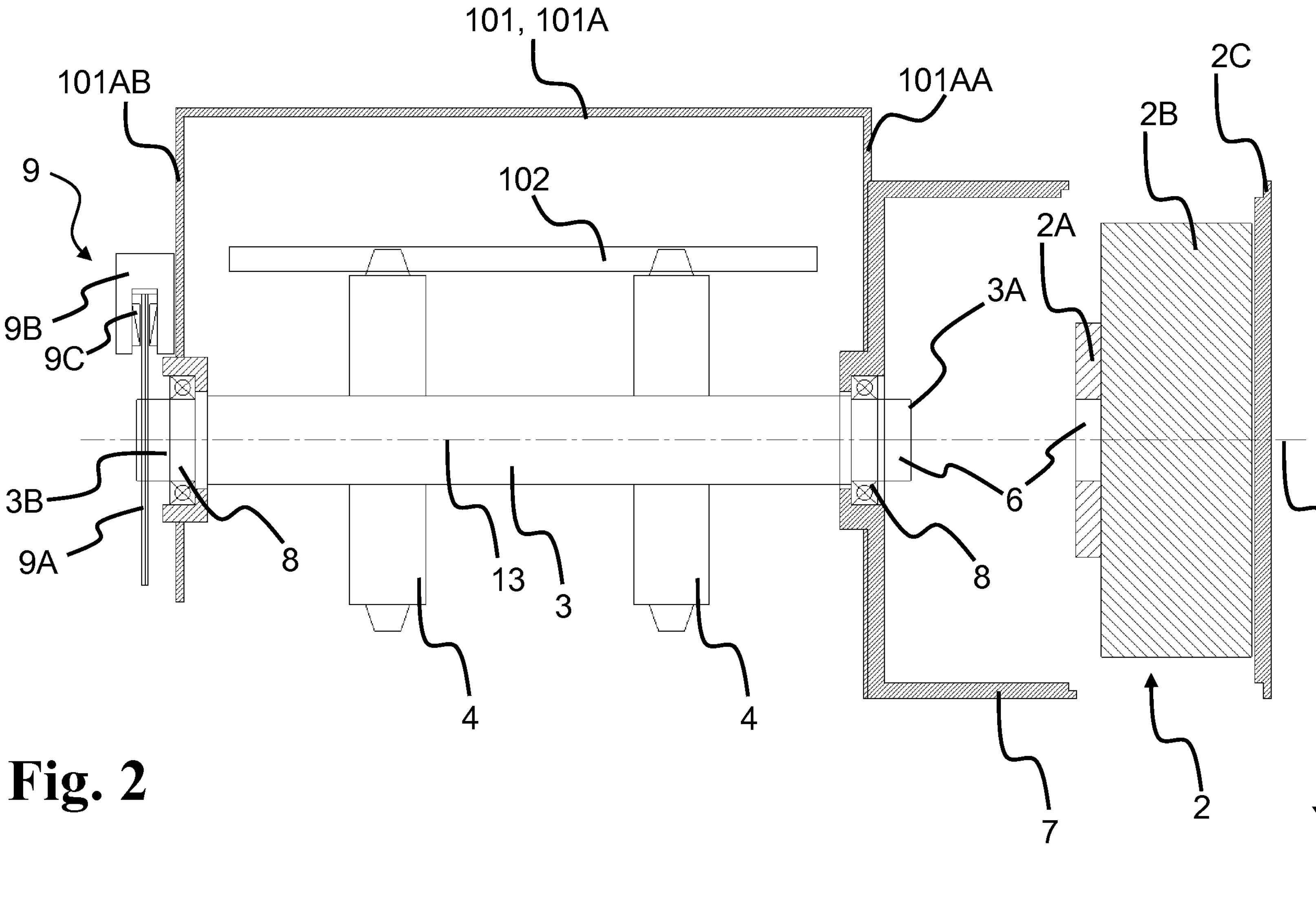

101, 101A
101AB
101AA
2C
2B
9
102
2A
3A
9B
9C
3B
9A
8
13
3
6
8
12
4
4
7
2
1

Fig. 2

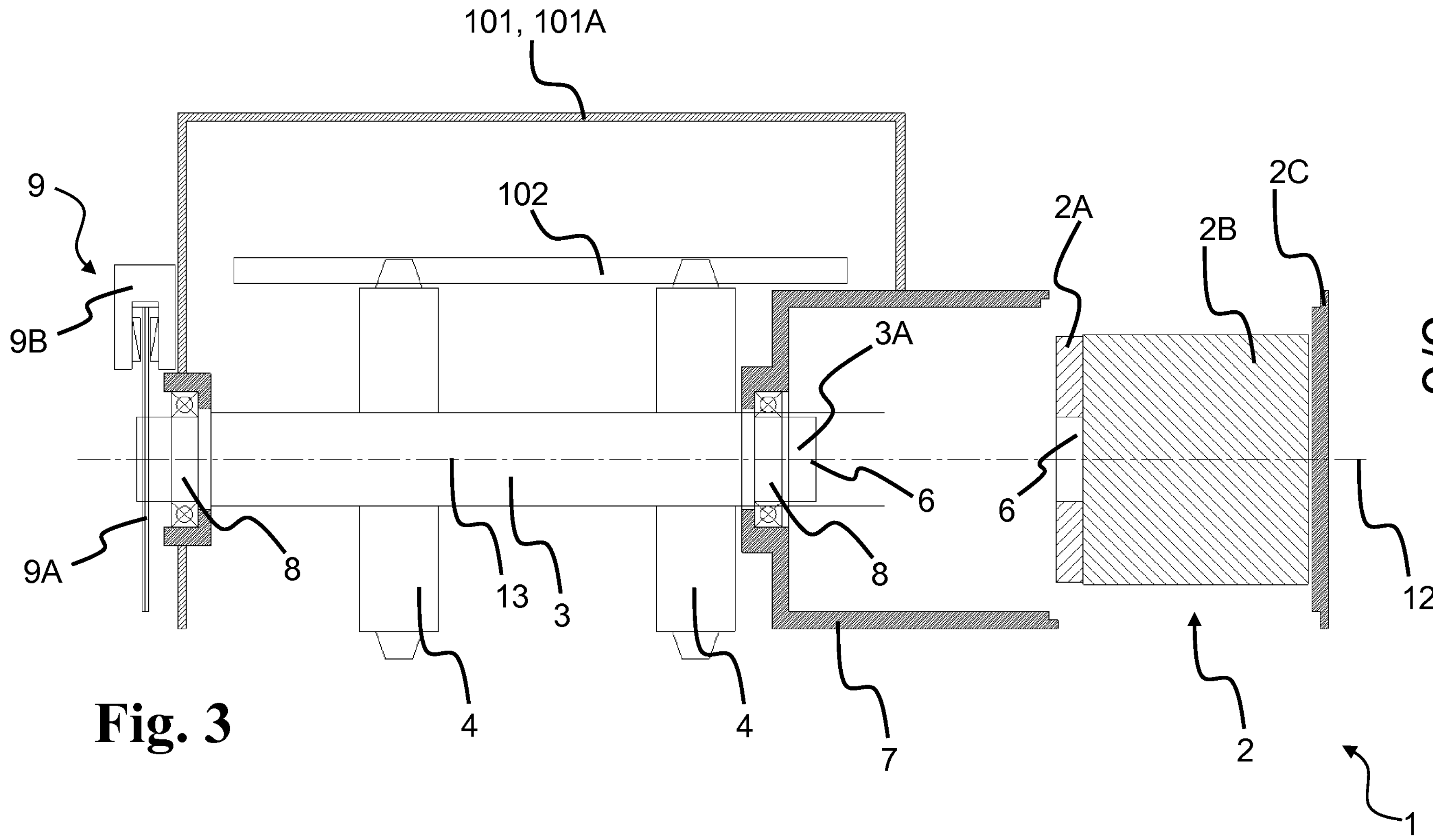


Fig. 3

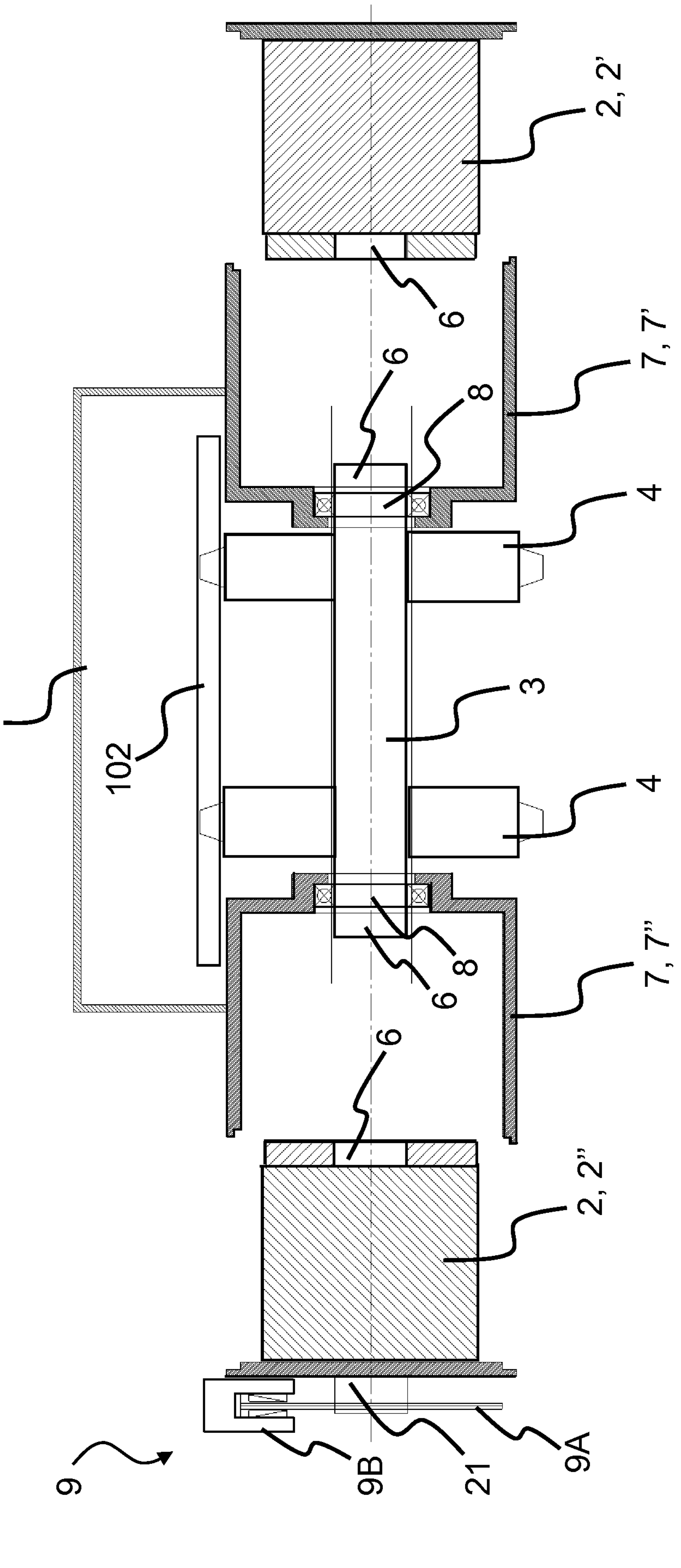


Fig. 4

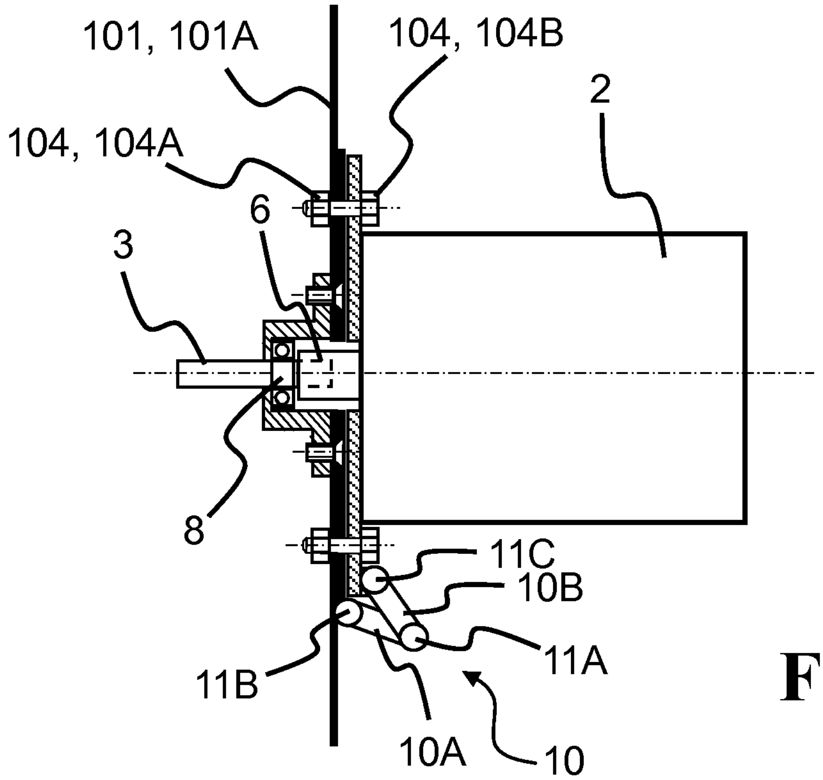
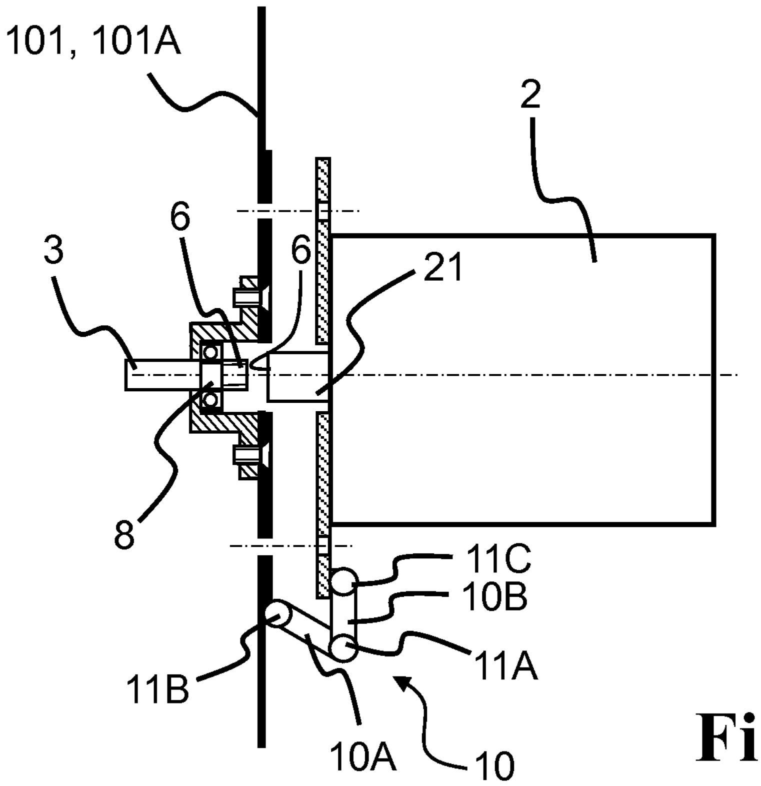

101, 101A
104, 104B
104, 104A
2
6
3
8
11C
10B
11A
11B
10A
10

Fig. 5A


101, 101A
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6
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8
11C
10B
11A
11B
10A
10

Fig. 5B

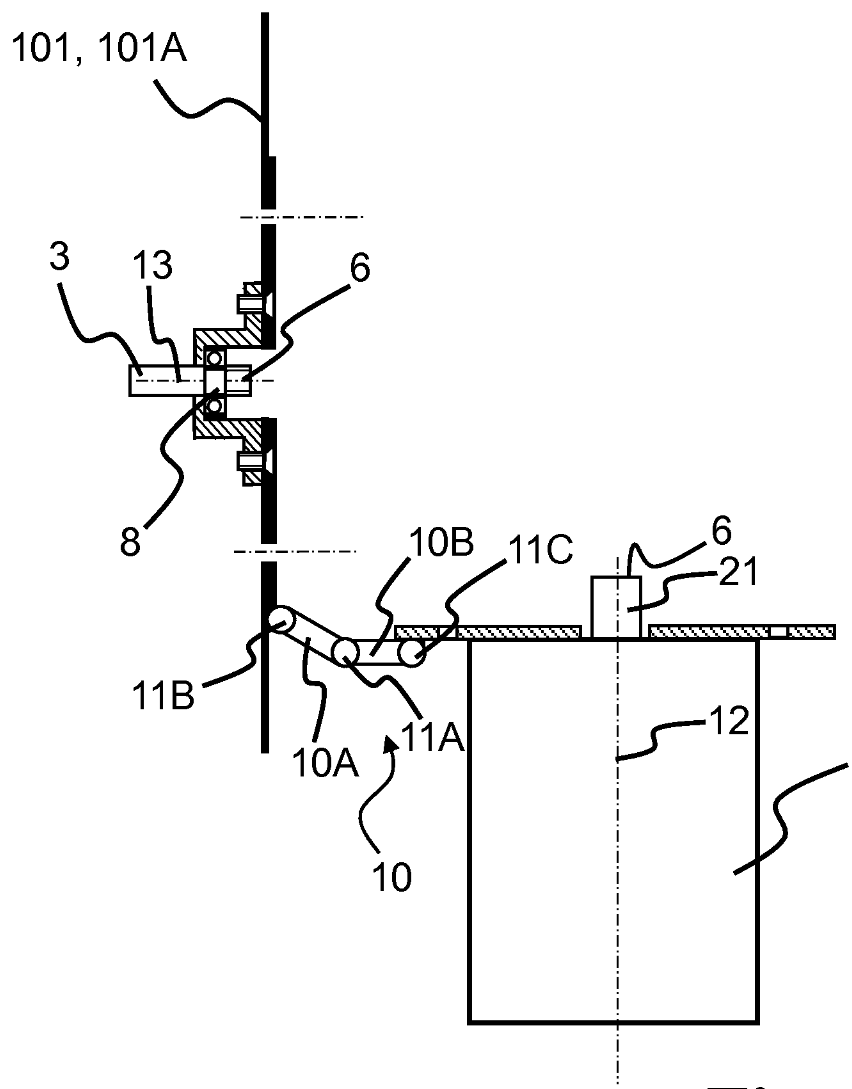

Fig. 5C