

Flexible Damping Pieces and Flexible Damping Device

Field of the Invention

The present invention are flexible damping pieces, particularly for a chassis of a traveling device and it can mitigate the external force impacting on the traveling mechanical wheels and their internal components.

Background of the Invention

In a general vehicle, in order to implement the turning of the vehicle, a steering gear is required at the vicinity of the wheel to enable the vehicle to turn smoothly. However, the general steering gears are mostly rigid connections. If the tires hit the pits on the ground during the travel of the vehicle, the tires will instantaneously produce a side angle with respect to the centerline of the wheel. The side angle not only interferes the travel of the vehicle, but also the instantaneous force generated by the tires as hitting the pits on the ground will also be transmitted to the steering gear. Since most vehicles do not have protecting devices installed on the steering gear to withstand these instantaneous forces and these instantaneous forces can cause damages to the steering gear and the steering gear is easy to wear out over a long period of time.

The following details explain how these instantaneous forces can cause damages to the steering gear. In conventional vehicles, the wheels are connected to a gearbox and the gearbox is then connected to the steering gear. A plurality of gears is attached to the gearbox and the gears are engaged with each other or each two of gears are arranged in the direction of rotation of a shaft of the gear. If the plurality of shafts is coaxial and once the gearbox receives these instantaneous forces from the wheels, the plurality of stacked gears will no longer rotate "coaxially". In order to enable the plurality of stacked gears to rotate coaxially under the influences of these instantaneous forces, a coaxial device is used among the plurality of stacked gears in the gearbox to make a plurality of stacked gears can be rotated coaxially under the impact of these instantaneous external forces.

Typically, such a coaxial device is fixed between two shafts of two machines (e.g., two gears) that need to be coaxial. In these two machines, the shaft of the first machine is connected to the other shaft of the other machine through a coaxial device to calibrate these two shafts.

This type of coaxial device has the following designs. One of the designs is to use a coaxial device consisting of flexible damping pieces, an external joint, a pin, a nut, an inner joint, a ring, a ring nut and an anti-friction bushing. The flexible damping pieces are used as flexible rotating devices for the coaxial device and the flexible damping pieces are fixed around each of the parallel shafts of the specific inner and outer coupling portions to form an effective and reliable flexible connection. By absorbing unequal torque and directions from two shafts, these two shafts can be coaxial. However, such a coaxial device has a complicated structure and includes a plurality of shaft joints, pin shafts, and nut fittings, which makes the production difficult and many accessories may cause the weight of the coaxial device itself to be very heavy, which makes the installation more difficult. The rotating of the shaft is inefficient and is extremely inconvenient to use.

In addition, there is a design that uses a coaxial device composing a first semi-coaxial, a second semi-coaxial, a positioning sleeve and an elastomer. The symmetrical design of a first semi-coaxial and a second semi-coaxial is applied and the elastomer is mounted between these two semi-coaxial devices while using. These two semi-coaxial devices are connected by screws and the positioning sleeve to protect and form the entire coaxial device. Although this design is easy to disassemble the two semi-coaxial devices and easy to replace the elastomer, the coaxial device has too many components, screw holes and screws and is not an integrated coaxial device. The cost of manufacturing this coaxial device is extremely high and the manufacturing process of this coaxial device is extremely inconvenient. In addition, when the elastomer is placed in the sealed space formed by the first semi-coaxial device and the second semi-coaxial device, the elastomer is so easy to be deteriorated that the elastomer needs to be replaced very often and is not economical.

In addition, vehicles typically travel on relatively flat roads so they receive fewer external impacts and have less impact loads. However, for modern high-precision mechanical equipment, such as wheeled robots or special vehicles, due to the complexity of their travelling environment, their internal steering gears will receive more external impacts than the steering gears of the vehicles and cause damages easily.

Object of the Invention

Flexible damping piece suitable for using in a flexible damping device for connecting with

two different mechanical shafts and absorbing torque so the two machines can be coaxial during the rotating process. The flexible damping pieces is arranged between the two machines and it is attached to the two machines. When the flexible damping pieces is installed in the vehicle, it makes the vehicle absorb the larger instantaneous external force received by the wheels when the vehicle is travelling so the impact of the external forces to the structure of the motor and the second gear inside the gearbox can be reduced. Therefore, those parts can be protected.

Summary of the Invention

In summary, in order to improve the defects mentioned in the prior technology, the present invention provides a flexible damping device composing a plurality of flexible damping pieces and a plurality of gears and a shaft.

The structure of this flexible damping pieces is very simple and easy to make, replace and maintain. An integrated design can also reduce the weight and will not become heavy loads for other parts in the flexible damping pieces. Also, it does not need a lot of screws and nuts so the cost of can be reduced greatly and very convenient to use.

This invention provides a plurality of flexible damping pieces for connecting with two shafts in two machines and for absorbing torque, so the two machines are coaxial-running, including the flexible damping pieces is arranged between the two machines and attached to the two machines, and the flexible damping pieces is arranged radially in a first plane. The first plane is composed of the X-axis and the Y-axis in the Cartesian coordinate system.

The material of the flexible damping pieces can be metal or polymer, including steel, synthetic rubber and polyurethane. Preferably, the material selected for the flexible damping pieces is spring steel plates.

Preferably, the number of the flexible damping pieces is more than six and the flexible damping pieces is distributed peripherally over the shaft. When the number of the flexible damping pieces is an even number, each two pairs should be symmetrically distributed. When the number of the flexible damping pieces is a singular number, the angles between the two flexible damping pieces should be equally distributed.

In this invention, the coupling and the flexible damping pieces is applied. When the flexible damping pieces is impacted and shocked by the external force, the flexible damping pieces will be deformed to absorb the impacts caused by the external forces so the impacts on the structure

of the motor and the gears from the external forces can be reduced and the protection from the flexible damping pieces is realized. When the external forces disappear, the deformation of the flexible damping pieces is restored so the wheel can return to the initial state to ensure the normal operation of the wheel.

The present invention also provides a flexible damping device, which is composed of a plurality of flexible damping pieces as described above. It is used for a chassis of a vehicle. The flexible damping device is connected to a motor and a wheel base of the chassis. The features of the flexible damping pieces is: a coupling, a first gear, an upper shaft, a second gear, a plurality of flexible damping pieces and a lower shaft, wherein one end of the coupling is connected to the motor and the other end of the coupling is attached to the second gear, the second gear is engaged with the first gear, the first gear drives the upper shaft to rotate along with an upper axis, the flexible damping pieces is arranged between the upper shaft and the lower shaft, both the lower shaft and the upper shaft rotate along with the second axis, the lower shaft is connected to the wheel base, and a plurality of wheels are attached to the wheel base. The wheels of the vehicle moves toward a first direction when the vehicle travelling, when the external force from a second direction is non-zero, the flexible damping pieces will be in a receiving-force state, so it can absorb the external force and ensure that the upper axis and the lower axis are concurrent in the first plane, wherein the first direction is composed of the Y-axis in the Cartesian coordinate system, and the second direction is composed of the X-axis in the Cartesian coordinate system.

Preferably, the flexible damping pieces is in an initial state when the wheel is subjected to another external force from the second direction.

Preferably, in the initial state, the projected pattern of the flexible damping pieces on the first plane is the first pattern.

Preferably, in the receiving-force state, the projection pattern of the flexible damping pieces on the first plane is the second pattern.

Preferably, the first pattern is composed of a plurality of rectangles and the second pattern is composed of a plurality of polygons.

Preferably, wherein the flexible damping pieces is arranged in a gearbox of the travelling device.

The flexible damping device provided by this invention can absorb the large instantaneous

external force received by the wheel and reduce the impact of the external force on the structure of the motor and the second gear inside the gear box during the travel of the device in order to protect these parts. When the external force disappears, the deformation of the flexible damping pieces is restored so that the wheel can return to the initial state to ensure the normal operation of the travelling device.

Brief description of the drawings

Fig. 1 shows a side view of one embodiment of the disclosed technology in accordance with the present invention.

Fig. 2 shows a top view of one embodiment of the disclosed technology in accordance with the present invention.

Fig. 3 shows a top view about the arrangement of the axis for the two machines while the flexible damping pieces in an initial state in accordance with the disclosed technology of the present invention.

Fig. 4 shows another embodiment about top view on the first plane when an flexible damping pieces implements a receiving-force state.

Fig. 5 shows a side view showing the flexible damping device in accordance with the disclosed technology of the present invention.

Fig. 6 shows a side view relates to the internal composition of the flexible damping device according to another embodiment of the disclosed technology of the present invention.

Fig. 7 shows a top view about the flexible damping device according to another embodiment of the disclosed technology of the present invention.

Fig. 8 shows schematic diagram about the flexible damping device according to another embodiment of the disclosed technology of the present invention.

Detailed Description

To make the objects, technical features and advantages of this present invention easy to understand for those skilled engineers and easy to implement, a description of the progress of the preferred embodiments would be stated below. The drawings referred to hereinafter are intended to be illustrations of the features of the present invention and are not necessarily required to be fully drawn according to the actual situation. If the description of the

embodiments of this present invention relates to technical contents which are well known to skilled engineers, they will not be described.

Please refer to Fig. 1. Fig. 1 is a cross-sectional view of one embodiment of the disclosed technology in accordance with the present invention. The flexible damping pieces 41 of Fig. 1 are connected to two different shafts of the machines for coaxial rotation during travelling. The term "coaxial" used here means: the projection line of the rotation axis for two different machines, which are the upper shaft and the lower shaft on the third plane, is a straight line as shown on Fig.1. The two machines rotate by the axes of the upper shaft 1 and the lower shaft 2. In the embodiment of the present invention, the axis of the upper shaft 1 is called the first axis 11 and the axis of the lower shaft 2 is called the second axis 21. The upper shaft 1 is connected to the power supply device (not shown in Fig. 1). The power supply device drives the upper shaft 1 to rotate. After the upper shaft 1 and the lower shaft 2 are connected by the flexible damping pieces 41 and when the upper shaft is rotating, a torque is generated, and the torque is transmitted to the gearing wheel 40 and the lower shaft 2 through the flexible damping pieces 41. After the lower shaft 2 receives the torque and then drive the device attached to the lower shaft 2 to rotate. The device attached to the lower shaft mentioned above can be any device that can be driven by the steering lower shaft 2, such as a gear or a wheel of travelling device. If the torque is transmitted without any loss of energy, the lower shaft 2 and the upper shaft 1 will rotate with the same axis, in the same direction and with the same speed, and then the lower shaft 2 drives the device attached to the lower shaft 2 to rotate in order to complete the rotating process. It should be noted that "same direction of rotation" means that when the upper shaft 1 and the lower shaft 2 are rotating, their directions of the force moment are the same. The two machines described in all embodiments of the present invention may be gears or mechanical devices with two parallel or coaxial shafts. In the present embodiment, the two machines are the first machine, which includes the upper shaft and a first gear 3 and the second machine 40 which includes a gearing wheel 40 and the lower shaft 2. The first gear 3 is attached with the upper shaft 1 and the gearing wheel 40 is attached with the lower shaft 2. In other embodiments, these two machines may also include one or more rotating components, which are not limited in the present invention. In addition, the flexible damping pieces 41 may be a plate. The center of the sheet can be cut off so the hollow portion of the flexible damping pieces 41 can be fixed to the shaft. The distribution of the hollow portion (not shown in Fig. 1) of the plate and the

diameter are not necessarily uniform. They can be uneven diameters in order to match with the upper shaft 1 and the lower shaft 2. The changing ranges and sizes of the diameters of the hollow portions are not limited by the claims of the present invention.

In the present invention, the purpose of providing the flexible damping pieces 41 for connecting the upper shaft 1 and the lower shaft 2 is that if the first axis 11 and the second axis 21 of two shafts (the upper shaft 1 and the lower shaft 2) does not rotate with the same axis, the flexible damping pieces 41 can let the first axis 11 and the second axis 21 of two shafts rotate with the same axis so the rotating process can be processed smoothly. At the same time, the flexible damping pieces 41 can partially absorb the external torque that is transmitted from the lower shaft 2 to the upper shaft 1 so the first machine can be protected.

Please continue referring to Fig. 2. Fig. 2 is a cross-sectional view on the first plane along the W-W Line in Fig.1., showing one embodiment of the installation and connection relationship of the flexible damping pieces 41. In the present embodiment, the flexible damping pieces 41 is arranged in radial style using the axis of the first axis 11 as a reference point so the flexible damping pieces 41 forms a sun-like shape surface on the first plane. The material of the flexible damping pieces 41 is generally selected from the material that possess a good pliability, such as a metal plate, a hard rubber plate, a polyurethane block, etc. Preferably, the material of the flexible damping pieces 41 to be spring steel plate. These materials will deform if they receive the external force, but after the external force disappears, these materials may return to their original shape or remain their deforming shapes. In a specific embodiment, applying 8 parts of the flexible damping pieces 41 and using the first axis 1 as a point of symmetry configures a point-symmetric arrangement on the first plane. According to the spirit of symmetry disclosed in the present embodiment, in other embodiments, the number of flexible damping pieces 41 may be 6, 4 or 2 in even numbers. In another embodiment of the present invention, the number of flexible damping pieces 41 may be an odd number. However, applying the even number of the flexible damping pieces 41 is the best implementation. Viewed from the third direction, the first gear 3 is configured above the flexible damping pieces 41. In the present embodiment, the shape of the first gear 3 is designed to conform to the shape of the flexible damping pieces 41. That means the first gear 3 shields the position of the flexible damping pieces 41 and the first gear 3 has an opening to expose the flexible damping pieces 41, therefore, when the flexible damping pieces 41 is viewed from the third direction, the flexible damping

pieces 41 is exploded out from the first gear 3.

Fig.1 and Fig.2 describes the details about each part of the flexible damping pieces 41 and its configuration. It also shows the connecting relationship with other devices when the flexible damping pieces 41 is at rest. Later, we will describe the details about the flexible damping pieces 41 while it is running. Please refer to Fig. 3. Fig. 3 is a top view showing the arrangement of the axes for the two machines while the flexible damping pieces 41 in an initial state in accordance with the disclosed technology of the present invention. Fig.3 is a simplified view that only shows parts such as the upper shaft 1, the second gear 80, the first axis 11, the lower shaft 2, the second machine 40 and the lower shaft 2, etc. In Fig. 3, while in the initial state, which means if the lower shaft 2 and the second machine 40 receive a external force of zero, the upper shaft 1 and the lower shaft 2 are rotated in a coaxial manner and the projection point of the first axis 11 of the upper shaft 1 and the second axis 21 of the lower shaft is the same point on the first plane. However, if the lower shaft 2 and the second machine 40 receive the external force is not zero, the projection point on the first axis 11 of the upper shaft 1 and the second axis 21 of the lower shaft is not on the same point on the first plane. Both machines may receive the external impacts or their own vibration so the two machines will not rotate with the same axis. If two machines do not rotate with the same axis, then the rotating efficiency would be very poor. That means the energy of the first gear 3 cannot be completely transmitted to the gearing wheel 40 and it results in energy loss and waste. In order to let two machines, rotate with the same axis, the flexible damping pieces 41 needs to be install between the upper shaft 1 and the lower shaft 2, as shown in Fig. 1 and Fig. 2, in order to make these two machines rotate with the same axis, so the issue of not rotating with the same axis can be avoided. In addition, as the gearing wheel 40 receives the external torque from different positions and directions, it may drive the lower shaft to generate the external torque. After this external torque is transmitted to the first machine through the upper shaft 1, which is connected to the lower shaft 2, may cause damage to the first machine. The flexible damping pieces 41 can partially absorb the external torque that is transmitted to the upper shaft 1 by the lower shaft 2 so to provide protection for the first machine.

While in the operating state, the state of the flexible damping pieces 41 is shown in Fig. 4. Fig. 4 shows a cross-sectional view on the first plane along the W-W Line in Fig.1. Fig. 4 shows the composition of the flexible damping pieces 41, in the state of receiving force, according to

the technology disclosed in the present invention. Fig. 4 is a top view on the first plane from the section W-W in Fig.1. When the upper shaft 1 and the first gear 3 receive the external force is not zero, this external force is transmitted to the flexible damping pieces 41 and this external force causes an additional torque. In the initial state, the flexible damping pieces 41 is rotated according to the rotation of the first gear 3 and the gearing wheel 40. Therefore, the rotation axis of the first gear 3 and the gearing wheel 40, will share the same rotation speed, the force and direction. That means the common center of mass of the plurality of flexible damping pieces 41 is the same with the first gear 3 and the first gearing wheel 40. When the second machine 40 receives an external force during the rotation, the external force and the torque generated by the external force are transmitted to the flexible damper pieces in 41. When the flexible damping pieces 41 receive the external force, the flexible damping pieces 41 instantaneously generate a displacement relative to the upper shaft 1. That means the flexible damping pieces 41 is twisted and deformed. If the additional torque combined with the rotation torque generated originally by the upper shaft 1 and the first gear 3 exceeds the maximum torque that the flexible damping pieces 41 can withstand, the flexible damping pieces 41 will be deformed and damaged. Therefore, designing the maximum torque that the flexible damping pieces 41 can withstand is a key point for the present invention. The maximum torque that the flexible damping pieces 41 can withstand is based on the number, size, and material of the flexible damping pieces 41, which is not limited by the present invention. In one embodiment, the flexible damping pieces 41 can withstand a maximum torque of 40 to 70 Nt-m. In addition, since the details of each flexible damping pieces 41 is different, the situation of deformation and distortion of each flexible damping pieces 41 is different. In the initial state, the projected pattern of the flexible damping pieces 41 on the first plane is the first pattern. However, in the receiving-force state, the projected pattern of the flexible damping pieces 41 on the first plane is the second pattern. The patterns of the first pattern and the second pattern may be the same or different. The first pattern is composed of a plurality of rectangles and the second pattern is composed of a plurality of polygons. The polygon may be a plurality of triangles, a plurality of quadrangles, or a combination of a plurality of diamonds. When the flexible damping pieces 41 is deformed, the first gear 3 and the gearing wheel 40 rotate coaxially. The flexible damping pieces 41 also rotate coaxially with the first gear 3 in the form of the deformed flexible damping pieces 41. And this additional torque is absorbed by the flexible damping pieces 41 and this

additional torque is not transmitted to the upper shaft 1. After the external force disappears, the flexible damping pieces 41 restores to the same shape as before the deformation. In another embodiment, after the first gear 3 and the second machine 40 rotate coaxially, the center of mass of the flexible damping pieces 41 returns to its original center of mass. That means the center of mass of the first gear 3 and the center of mass of the gearing wheel 40 is the same. Therefore, the deformation of the flexible damping pieces 41 disappears, and the first pattern is restored from the second pattern. The flexible damping pieces 41 provided by the above embodiment are not only simple in structure, but also do not require complicated fittings such as pin shafts and nuts. The flexible damping pieces 41 is light in weight and extremely convenient in manufacturing. Moreover, the flexible damping pieces 41 is not easily deteriorated, it is not necessary to replace the elastomer very often and is very convenient to use.

Next, please refer to Fig. 5, which is a side view showing the flexible damping pieces 41 in accordance with the disclosed technology of the present invention. The flexible damping pieces 41 is another embodiment of the present invention. In this embodiment, the flexible damping pieces 41 is fixed in a gearbox of the wheel part 5 of the travelling device. This travelling device includes removable, wheeled equipment such as special vehicles, wheeled robots, or spacecraft and aircraft, etc. In Fig. 5, the gear box is formed by the shell of the gear box 70 covering various gear components, the shaft components and the flexible damping pieces 41. The material of the gearbox box 70 is primarily configured by the metal, such as iron or aluminum, to provide substantial protection to the internal components of the gearbox. The first ends of the flexible damping pieces 41 is connected to the motor 50 and the second ends of the flexible damping pieces 41 is connected to the wheel base 100. The wheels 110 is configured on the wheel base 100. The wheel part 5 is connected to the steer base 90. Through this steer base 90, the shell of the gearbox can be configured on the chassis of the travelling device. The motor 50 is a machine that controls the wheels 110 and the turning direction of the travelling device. Inside of the motor, it has a plurality of gears that output torque for rotating other machines. In the present embodiment, only one set of wheel part 5 is illustrated. It is to be understood that the general travelling device is composed of four wheels and travelling device has 4 sets of wheel part 5. In some cases, it also has 5 sets, 8 sets and so on.

Next, please refer to Fig. 6. Fig. 6 is a cross-sectional view showing the internal composition of the flexible damping pieces 41 according to another embodiment of the

disclosed technology of the present invention. The flexible damping pieces 41 includes a coupling 60, a second gear 80, an upper shaft 1, a first gear 3, flexible damping pieces 41 and a lower shaft 2, one end of the coupling 60 connected with the motor 50 and the other end of the coupling 60 connected with the second gear 80. The coupling 60 enables the motor 50 and the second gear 80 to rotate with the same axis and ensures that the torque of the motor 50 can be transferred to the second gear 80 firmly. The second gear 80 is configured in the upper shell of gearbox 701 to mesh with the first gear 3 and the second gear 80 transmits the power supply from the motor 50 to the first gear 3. In this embodiment, the first gear 3 is a gear set that has a plurality of gears. The implementer can freely adjust the diameter of the gears of the first gear 3 to match with the second gear 80 to reduce the rotational speed and increase the torque, or to increase the rotation speed and reduce the torque. The present invention does not limit the number of gears configured in the first gear 3 and the distance between the gears. The first gear 3 drives the upper shaft 1 to rotate with the first axis 11. The flexible damping pieces 41 is configured between the upper shaft 1 and the lower shaft 2. The lower shaft 2 linked to the upper shaft 1 rotate with the second axis 21. The lower shaft 2 transmits the torque to the wheels 110 by the wheel base 100 so that the wheels 110 can rotate. The wheel base 100 and the wheels 110 are embodiments of the second machine 40 described above. The wheel base 100 is also attached with a plurality of gears to shift the direction of the torque and transmit it to the wheels 110 for rotating the wheels 110. When the wheels 110 rotates, the direction of the torque is perpendicular to the upper shaft 1 and the lower half shaft 2. When an external force is applied to the wheels 110 (as indicated by the black arrow in Fig. 6), the wheels 110 and the wheel base 100 are bent and shifted toward the direction of the force and the lower shaft 2 is bent as well, therefore, the second axis 21 is shifted from the first axis 11 so the two axis are not coaxial. If non-coaxially occurs inside the travelling device, the internal gear parts can be worn out, the abnormalities of the motor 50 may occur and furthermore, the travelling device may be out of control. The flexible damping pieces 41 is configured in the travelling device. By absorbing the external force, the flexible damping pieces 41 let the lower half shaft 2 and the upper shaft 1 inside the gear box to rotate with the same axis so the travelling device can travel smoothly. At the same time, as the wheels 110 is subjected to different angles and positions of the torque, a part of the torque is converted into an external force torque toward the lower shaft 2. The flexible damping pieces 41 can partially absorb the external torque mentioned above so

the external torque transmitted to the upper shaft 1 is reduced and the second gear 80 and the motor 50 are protected. In the present embodiment, Whether the flexible damping pieces 41 is in the initial state or in the receiving-force state, the embodiments of the present invention, the flexible damping pieces 41, are the same so they will not be described again herein.

Please refer to Fig. 7. FIG. 7 is a top view showing the flexible damping pieces 41 according to another embodiment of the disclosed technology of the present invention. Fig. 7 is a top view on the first plane from the section V-V in Fig.6. As shown in Fig. 7, the axis of the flexible damping pieces 41 is the first axis 11 and the shaft is configured in the upper shaft. The flexible damping pieces 41 is configured in the upper shell 720 of the gearbox. Fig. 7 only illustrates the configuration of the flexible damping pieces 41 in the gear box. The functions, the connecting relationships of the flexible damping pieces 41 in the initial state and in the receiving-force state are described in the embodiments of the flexible damping pieces 41 of the present invention; therefore, it will not be described again here.

In one embodiment of the present invention, the upper shaft is connected to the first gear 3 and the lower shaft 2 is connected to the gearing wheel 40. The flexible damping pieces 41 is fixed between the first gear 3 and the gearing wheel 40. The methods of connecting each part include welding and slot connections. The method of slot connection includes grooving a slot between the first gear 3 and the gearing wheel 40 and then embedding the flexible damping pieces 41 in the groove, so the first gear 3 and the gearing wheel 40 can be connected. Please refer to Fig. 8, which is another embodiment of the present invention. Fig. 7 is an upward view on the first plane from the section W-W in Fig.1. In the present embodiment, the first machine includes the upper shaft 1 (not shown), and the first gear 3 and the upper shaft 1 are connected. The second machine 40 includes the lower shaft 2. The plurality of flexible damping pieces 41 is fixed to an annular structure 410 and the plurality of flexible damping pieces 41 mentioned above are arranged in radial and evenly distributed in the circumferential direction of the annular structure 410 and form a sun-like shape on the first plane. A space is left between adjacent pieces in 41 and the number of flexible damping pieces 41 is equal to the number of spaces mentioned above. The flexible damping pieces 41 is not fixed to the first gear 3 and the second machine 40. Preferably, the flexible damping pieces 41 is made from resilient materials, including polyurethane or rubber. The flexible damping pieces 41 is fixed to the annular structure 410 through press molding or press forming.

One end of the first gear 3, which is connected to the flexible damping pieces 41 is configured at least one first protrusions 309. The shape of the first protrusions 309 is consistent with the space between two adjacent flexible damping pieces 41. One end of the lower half shaft 2 connected with the flexible damping pieces 41 is configured at least one second protrusions 409. The shape of the second protrusions 409 is consistent with the space between the two adjacent flexible damping pieces 41. The sum of the number of the first protrusions 309 and the number of the second protrusions 409 shall not exceed the number of the flexible damping pieces 41. Between the position of the first protrusions 309 and the position of the second protrusions 409 shall leave a space for the position of the flexible damping pieces 41. In FIG. 8, there are six flexible damping pieces 41 and the number of spaces between adjacent flexible damping pieces 41 is six so the number of the second protrusions 409 is three and the number of the first protrusions 309 is three.

The first gear 3 is connected to the flexible damping pieces 41 through the first protrusions 309 and the flexible damping pieces 41 is connected to the second protrusions 409 of the lower shaft 2. By doing so, the plurality of flexible damping pieces 41 is fixed closely between the first protrusions 309 and the second protrusions 409 so the torque can be transmitted between the upper shaft 1 and the lower shaft 2. When an external torque is applied to the lower shaft 2, the flexible damping pieces 41 can absorb the external force through its own deforming so the first machine can be protected. The flexible damping pieces 41 provided by the present invention can absorb the large instantaneous external force received by the wheels 110 during the travel of the vehicle to reduce the external force on the structure of the motor 50 and the second gear 80 inside the gearbox so these components are protected. When the external force disappears, the deformation of the flexible damping pieces 41 is restored (and may not be restored) so the wheels 110 can return to its initial state to ensure the normal operation of the wheels 110 and have a safe drive.

The embodiment mentioned above is the preferred embodiment of the present invention and is not intended to limit the scope of the present invention. The descriptions mentioned above should be understood and implemented by those skilled in the relevant technology fields. Therefore, the other embodiments are deviated from the spirit, equivalent changes or modifications of the present invention shall be included in the scope of this patent application.

We claim:

1. A flexible damping device, which is composed of a plurality of flexible damping pieces, is constructed in a chassis of a vehicle and is connected to a motor and a wheel base of the chassis, the flexible damping pieces **is characterized by:**

a coupling, a first gear, an upper shaft, a second gear, the plurality of flexible damping pieces and a lower shaft, wherein one end of the coupling is connected to the motor and the other end of the coupling is attached to the second gear, the second gear is engaged with the first gear, the first gear drives the upper shaft to rotate along with an upper axis, the flexible damping pieces is arranged between the upper shaft and the lower shaft, both the lower shaft and the upper shaft rotate along with the second axis, the lower shaft is connected to the wheel base, and a plurality of wheels are attached to the wheel base;

wherein the damping pieces connects with two shafts in two machines, and the damping pieces is the means for absorbing torque and making the two machines are coaxial-running;

wherein the flexible damping pieces is arranged between the two machines and attached tightly to the two machines, and the flexible damping pieces is arranged radially in a first plane; wherein the first plane is composed of the X-axis and the Y-axis in the Cartesian coordinate system;

whereby, the wheels of the vehicle move toward a first direction when the vehicle travelling, when the external force from a second direction is non-zero, the flexible damping pieces will be in a receiving-force state, so it can absorb the external force and ensure that the upper axis and the lower axis are concurrent in the first plane, wherein the first direction is composed of the Y-axis in the Cartesian coordinate system, and the second direction is composed of the X-axis in the Cartesian coordinate system.

2. The flexible damping device according to claim **1**, wherein the material of the flexible damping pieces is made of metal or polymer.

3. The flexible damping device according to claim **1**, wherein the number of the flexible damping pieces is more than six and the flexible damping pieces is distributed peripherally over the shaft.

4. The flexible damping device according to claim **1**, wherein the two machines further

comprise a first gear, and a gearing wheel, and the flexible damping pieces connecting with the first gear and the gearing wheel, so that torque generated by the first gear is transferred to the gearing wheel.

5. The flexible damping device according to claim **1**, wherein the two machines further comprise a first gear and a lower shaft, the first gear connecting to the flexible damping pieces via first protrusions, the flexible damping pieces connecting to the lower shaft via second protrusions, and the flexible damping pieces is attached between the first protrusions and the second protrusions, so that torque generated by the first gear transferred to the gearing wheel.

6. The flexible damping device according to claim **1**, wherein the flexible damping pieces is in an initial state when the wheel is subjected to an external force from the second direction.

7. The flexible damping device according to claim **1**, wherein the projected pattern on the first plane relates to the flexible damping pieces running an initial state is a first pattern.

8. The flexible damping device according to claim **1**, wherein the projection pattern on the first plane relates to the flexible damping pieces running a receiving-force state is a second pattern.

9. The flexible damping device according to claim **1**, wherein the flexible damping pieces is arranged in a gearbox.