Suspension device, in particular for a vehicle.

The field of the present invention relates to that of the suspension devices, commonly referred to as shock absorbers. These suspension devices are intended to equip vehicles, more particularly for transporting heavy loads, such as containers in harbor or airport areas. These vehicles can namely be trailers or conveyers integrating self-powered means of displacement.

In a known way, the vehicles intended to carry heavy loads include a chassis, as well as axles having means for damping the rebounds of the vehicle in the event of unevenness of the ground. These damping means can also attenuate a rolling or swaying of a load arranged on the chassis of the vehicle during the displacement of said vehicle.

Such vehicles can include, in a known way, axles each supporting one or more wheels. The axles are connected to the chassis through arms, each axle being rigidly connected to one end of an arm, the other end of the same arm pivoting around a shaft passing through the end of the arm and a coupling plate welded to the chassis. Each arm pivots around a separate articulation axis. Elastic means for restoring in compression, such as springs and/or silentblocs®, complement the axles, the articulated arms, the coupling plates of the chassis to form damping means for the vehicle.

By silentbloc® is of course denoted an elastic block made of rubber or equivalent, which is inserted between the arm and a bearing point on the chassis, so that, in the case of a movement with a very low amplitude, it can dampen this movement. A drawback of such a solution lies in that it requires a certain number of joints, one per axle. Now, these joints are particularly stressed and wear out quickly. These joints require regular lubrication and maintenance operations, which are sources of costs. And in the event of a lack of maintenance, increased wear ensues with the risk of breakage and, hence, of an accident. This is all the more true in the case of the carrying and the displacement of heavy and/or high loads, subject to easily pouring, and which highly stress these damping means.

Another drawback results from it being necessary to configure the whole so that, when empty, the articulation axes of the arms of the same axle are in the same alignment parallel to the plane of the chassis. In order to achieve this result, it is necessary to carry

out an operation of boring of the coupling plates once welded to the chassis, which is obviously a constraining machining operation.

As a prior art is also known the solution of a blade-spring suspension. It consists of several superimposed metal blades carrying, in their middle, an axle and the ends of which are made integral, with a certain mobility, with the chassis of the vehicle, such as by using joints.

Here too arises the problem of the lubrication, on the one hand, of the blades, which, while ensuring their function as a shock absorber, slide over each other and, on the other hand, of the joints at the ends of making these blades integral with the chassis, which are necessarily subject to wear over time.

In addition, blade-spring suspensions are bulky. Since they are placed as close as possible to the axle, they interfere with a large steering radius of the wheels. And an offset of the blade-springs upwards increases the height of the vehicle. In fact, there are of course axles with parabolic blade-springs, the blades of which are below the axle beam, which does not increase the height of the vehicle, but this kind of axle is not recommended due to its low ground clearance.

In addition, irrespective of these solutions of this state of the art, they require the use in combination of anti-roll bars, even anti-roll bars limiting the lateral movements of an axle.

In line with an inventive process for improving the existing system, the present invention pretends to cope with the drawbacks of the state of the art mentioned above by going against the prejudices of those skilled in the art. More precisely, the invention imagines that the axle can be applied to the end of a support arm, the other end of which, rather than being articulated to the chassis, is made integral in an embedded manner with the latter. Thus, through its flexibility, this support arm not only contributes to the damping of the vehicle, but, in addition, meets the constraints usually solved by a stabilizing bar, even an anti-roll bar.

The manufacture of the vehicle is thus simplified, while the latter is made more robust, and the costs of its maintenance are reduced. In addition, these damping means can be integrated into the design of the chassis of the vehicle, making the whole particularly compact.

To this end, the invention relates to a suspension device configured to connect a chassis to an axle of a vehicle, the suspension device including elastic means for restoring in compression between a bearing point of the chassis and the axle. Advantageously, the suspension device further includes at least one support arm, a first end of which is made integral in an embedded manner with the chassis, the axle being in turn integrally attached to the second end of the support arm.

This permits to take advantage of the elasticity of the support arm to act as a damping spring, together with the elastic restoring means.

According to an additional feature of the invention, the elastic restoring means are interposed between the support arm and the bearing point of the chassis.

This permits to complement the function as damping spring of the support arm.

According to another feature of the invention, the elastic restoring means include at least one rubber silentbloc®.

This permits to compensate for small variations in height in the case of an uneven distribution of a heavy load to be transported, namely for variations in height of less than 50% of the height without any compression of the silentblocs®.

Finally, according to an alternative embodiment of the invention, the elastic restoring means include shock absorbers complementary to the silentbloc® or silentblocs®.

This permits to increase the damping rate of the device, namely for variations in height of more than 25% of the height without compression of the silentblocs®. More precisely, the complementary shock absorbers permit to maintain a high characteristic damping rate during quick deflections, these complementary shock absorbers absorbing the energy generated by a movement of more than 25% of the height at rest of the silentblocs, during a short period of about less than 20 ms.

According to yet another feature of the invention, each support arm includes a set-back in its longitudinal direction configured to free up a space permitting a maximum steering angle of a wheel attached to the corresponding axle.

According to another feature of the invention, the suspension device includes two support arms made integral with the same chassis and resting on the same axle.

According to another feature of the invention, the two support arms are configured so that, at rest, these support arms are parallel to each other.

According to another alternative embodiment of the invention, the two support arms attached, on the one hand, to the same chassis and, on the other hand, to the same axle have an X-shaped configuration, i.e. a junction connects the two support arms, said junction occurring between the first and second ends of the support arms.

This permits to further improve the stabilizing properties of the invention.

According to yet another alternative embodiment of the invention, the support arm or arms is or are attached, on the one hand, to a chassis, and on the other hand, to at least two successive axles, namely in the case of a double-axle configuration.

The invention also relates to a vehicle including a chassis, at least one axle, including at least one suspension device having one or more features of a suspension device as stated above, considered alone or in combination.

Further aims and advantages of the present invention will become evident during the following description relating to embodiments, which are given only by way of indicative and non-restrictive examples.

The understanding of this description will be facilitated when referring to the attached drawings, in which:

- Fig. 1: is a schematic perspective view of a suspension device including support arms connected to a chassis of a vehicle, on the one hand, and on the other hand, each connected to an axle, one of these axles being equipped with a wheel.

- Fig.2: is a schematic view from below of the suspension device of Fig. 1, each axle being equipped with a wheel, the wheels being oriented in a maximum steering position.

- Fig.3: is a detailed schematic view of the device of Fig. 1 from another perspective view angle from below of the device.

- Fig.4: is a schematic side view of a portion of the device of Fig. 1 including a first alternative embodiment of the invention in the form of a complementary damper.

- Fig.5: is a detailed schematic view seen from below of an alternative embodiment of the invention showing an alternative form of the support arms of the invention.

- Fig.6: is a detailed schematic perspective view of a suspension device integrating the alternative form of the support arms of Fig. 5.

The invention relates to a suspension device 1, in particular for a vehicle V. With this suspension device 1 is provided a vehicle V, which also includes a chassis 2 and at least one axle 3. The suspension device 1 connects the chassis 2 to one or more axles 3. Each axle 3 supports one or more wheels 30 by means of mounting means 303.

The vehicle V can more particularly be a vehicle for transporting heavy loads, such as containers in harbor or airport areas. This vehicle V can be motorized or not, and it can namely be a trailer. It can also be a conveyer incorporating self-powered means of transportation. In the figures showing the exemplary embodiment of the invention described here, the vehicle V is not shown in its entirety. The figures show only part of the chassis 2, a suspension device 1 according to the invention, an axle 3, and one or two wheels 30 supported by this axle 3.

The invention as explained in the following description is considered as being positioned in a configuration for use on the road. To this end, the vehicle V is resting on the ground by means of its wheels 30. The wheel or wheels 30 is/are then located under the vehicle V and laterally with respect to the axle 3, which it/they is/are attached to. The axle 3 is placed under chassis 2 of the vehicle V.

The chassis 2 includes a structural projection 20 protruding from the latter and oriented downwards. This structural projection 20 cooperates with the suspension device 1 by means of first connecting and positioning means 201. The chassis 2 also includes one or more plates, which form bearing points 21 against the suspension device 1. This/these plate or plates can also cooperate with the suspension device 1 by means of second connecting and positioning means 211.

The axle 3 is connected to the suspension device 1 by means of third connecting and positioning means 31. These first, second and third connecting and positioning means 201, 211, 31 can be reversible assembling means as for example through bolting, or irreversible assembling means such as for example through welding.

The suspension device 1 includes elastic restoring means 4. It also includes at least one support arm 5. This support arm 5 has a longitudinal direction. It includes, in this longitudinal direction, a first end 50, which is made integral in an embedded manner with the chassis 2, and more specifically with the projection 20 of the chassis 2 by means of the first connecting and positioning means 201. The support arm 5 is attached by its second end 51 in this longitudinal direction to the axle 3 by means of third connecting

and positioning means 31. In the embodiment shown here, there are two support arms 5, which are arranged parallel to each other.

In the embodiment shown here, the elastic restoring means 4 are formed by at least one solid cylinder made of elastomer. Preferably, but optionally, this solid cylinder made of elastomer is a silentbloc® made of rubber, but it can also be a cylinder having an O-ring-shaped base or a disc-shaped base, or having any other shape. This solid cylinder can also be made of another elastic material, namely such as EPDM. In the example described here, there are two solid cylinders made of elastomer, each arranged close to means for mounting 303 the wheels 30 connecting the axle 3 to the wheel or wheels 30. These solid cylinders made of elastomer are substantially vertical, and each of their base is surmounted by a high platen 40 and a low platen 41. In fact, the high platen 40 is mounted integral with the plate forming a bearing point 21 for the chassis 2 by means of the second connecting and positioning means 211. The low platen 41 is in turn attached to the second end 51 of the support arm 5 by means of connecting and positioning means, which may be identical to the second connecting and positioning means 211.

According to an alternative embodiment of the invention, the silentblocs® made of elastomer are hollow, with a central hole oriented in the direction of the generatrix of said silentbloc®. This permits to increase the maximum compression ratio with respect to the height at rest of said silentbloc®. This also permits to adjust its progressive stiffness through the dimensions of the peripheral walls of the Silentbloc®.

The elastic restoring means 4 are configured to operate in compression between a bearing point of the chassis 2 and the axle 3. The weight of the vehicle V, and more specifically of the chassis 2, as well as eventually the load that it bears, is transmitted to the wheels namely through the elastic restoring means 4. More precisely, the solid cylinders made of elastomer, such as silentbloc®, forming the elastic restoring means 4 are interposed and compressed between the plate forming a bearing point 21 for the chassis 2 and the second end 51 of the support arm 5.

The silentbloc® type solid cylinders made of elastomer used here have the advantage of being suspension elements, the stiffness of which increases as the cylinder is compressed. Thus, the more the cylinder is compressed, the more it is necessary to apply a significant additional compressive force to compress it further. The structural

damping of such silentbloc® type solid cylinders made of elastomer is within the range of a maximum compression varying between 5 and 25% of the height of said cylinders, even between 15 and 25% of the height of said cylinders. Beyond that value, the silentbloc® type solid cylinders made of elastomer no longer play their role as shock absorbers. In fact, the structural damping of such forms of elastomeric element gradually decreases. Their performances permit to compensate for variations in height at a frequency between 1.4 Hertz and 10 Hertz. This frequency range makes these elastomeric elements effective for filtering low-amplitude trepidations in addition to being configured to store shocks by a progressive thrust.

In order to complement the damping of these silentbloc® type solid cylinders made of elastomer, namely beyond the maximum compression, corresponding namely to a compression of more than 25% of the height of the elastomeric elements mentioned above, there may be provided, as shown in Fig. 4, additional shock absorbers 6, namely in the form of a gas-filled shock absorber, connected by a ball type connection, on the one hand, to the axle 3, and on the other hand, to the chassis 2.

The support arm or arms 5 are also a help for the damping function of the suspension device 1. Each support arm 5 can be an arm having an elastic effect of restoring into the initial position. This can be achieved through its shape of a blade spring, as can be seen in Fig. 3, but also through its manufacture in one piece without welding, and/or in that it is made of a high elastic limit steel (commonly referred to in the field as HTS steel), even made of very high elastic limit steel (commonly referred to in the field as UHTS steel). This steel can namely have an elastic limit value in torsion of more than 800 megapascals.

In order to make sure that the first end 50 of the support arm 5 is made integral in an embedded manner with the chassis 2, and more specifically with the projection 20 of the chassis 2, the first connecting and positioning means 201 include a bolted assembling. But the first connecting and positioning means 201 also include pawls 22 protruding from the projection 20, which cooperate with openings 52 ending in front of same, pierced in the first end 50 of the support arm 5. The cooperation of pawls 22 in the corresponding holes permits to accurately position the support arms 5 relative to the chassis 2 before they are made integral. It is then possible to bolt or weld the support arms 5 to the

projection 20 of the chassis 2 so as to limit the bolting tensions and stresses, which could lead to fatigue fracture due to the stresses on the connection when using the vehicle V.

In order for the support arms 5 not to limit the steering radius of the wheels 30 while making sure that the support arms 5 are as close as possible to the wheels 30, each support arm 5 has a set-back 53 in its longitudinal direction configured to free up a space E permitting a maximum steering angle of a wheel 30 attached to the corresponding axle 3. This is shown in particular in Fig. 2 where we see a wheel 30 having a steering radius of substantially 45 degrees occupying a space E freed up by the set-back 53 of the support arm 5 in front of same. This permits to save space, because it is not necessary to raise the suspension device 1 for same not to interfere with the wheels 30 as is common on vehicles using suspension devices with blades. And it is also possible to use a wheel diameter larger than the one used for these same vehicles using suspension devices with blades.

The embodiment of the invention shown here has two support arms 5 made integral with the same projection 20 of the same chassis 2 and resting on the same axle 3. This is shown in particular in Figs. 1 to 3. Of course, according to an alternative embodiment not shown here, there can be provided a single central support arm 5. This configuration shown here permits the support arms 5 to play in reverse torsion with respect to each other, which increases the restoring into the initial position of the structure of the vehicle V in the event of torsion, while requiring only a small amount of steel, hence at little cost.

The reverse torsional stress of the two support arms 5 is improved in that the two support arms 5 are configured so that, at rest, these support arms 5 are parallel to each other.

According to an alternative embodiment of the invention shown in Figs. 5 and 6, the two support arms 5 attached, on the one hand, to the same projection 20 of the chassis 2, and on the other hand, to the same axle 3 have an X configuration. By the term X configuration is denoted the fact that a junction 55 connects the two support arms 5, said junction 55 occurring between the first 50 and second ends 51. According to a preferred embodiment shown in Figs. 5 and 6, the junction 55 is located near the set-backs 53 of each support arm 5 and protrudes from each support arm 5, the corresponding couplings having rounded corners without a sharp angle 56, as can be seen in Fig. 5. This permits

to reduce the stress concentrations at the level of these rounded couplings without a sharp angle 56, and make the support arms 5 and the junction 55 less susceptible to fatigue fracture.

Such a suspension device 1 can be attached to a chassis 2 of a vehicle V, on the one hand, and to an axle 3 of the same vehicle V, on the other hand. It is to be understood that the same suspension device 1 can also be attached to a chassis 2 of a vehicle V, but also attached to at least two axles 3 of the same vehicle V. This can namely be envisaged in the case of a vehicle V having a so-called double-axle configuration.

The invention also relates to a vehicle V including a chassis 2, at least one axle 3 supporting wheels 30, said vehicle V including a suspension device 1 having all or part of the features of the suspension device 1 described above.

Claims

1. Suspension device (1), configured to connect a chassis (2) to an axle (3) of a vehicle (V), the suspension device (1) including elastic means for restoring (4) in compression between a bearing point (21) of the chassis (2) and the axle (3), wherein the suspension device (1) further includes at least one support arm (5), a first end of which (50) is made integral in the embedded manner with the chassis (2), the axle (3) being in turn integrally attached to the second end (51) of the support arm (5).

2. Suspension device (1) according to claim 1, wherein the elastic restoring means (4) are interposed between the support arm (5) and the bearing point (21) of the chassis (2).

3. Suspension device (1) according to claim 1 or claim 2, wherein the elastic restoring means (4) include at least one silentbloc® made of rubber.

4. Suspension device (1) according to claim 3, wherein the elastic restoring means (4) include dampers 6 complementary to the silentbloc® or silentblocs®.

5. Suspension device (1) according to one of the preceding claims, wherein each support arm (5) includes a set-back (53) in its longitudinal direction configured to free up a space (E) permitting a maximum steering angle of a wheel (30) attached to the corresponding axle (3).

6. Suspension device (1) according to one of the preceding claims, wherein the suspension device (1) includes two support arms (5) made integral with the same chassis (2) and resting on the same axle (3).

7. Suspension device (1) according to claim 6, wherein the two support arms (5) are configured so that, at rest, these support arms (5) are parallel to each other.

8. Suspension device (1) according to claim 6 or claim 7, wherein the two support arms (5) attached, on the one hand, to the same chassis (2), and on the other hand, to the same axle (3) have an X configuration, i.e. a junction (55) connects the two support arms (5), said junction (55) occurring between the first and second ends (50, 51) of the support arms (5).

9. Suspension device (1) according to one of the preceding claims, wherein the support arm or arms (5) is or are attached, on the one hand, to a chassis (2), and on the other hand, to at least two successive axles (3), namely in the case of a double-axle configuration.

10. Vehicle (V) including a chassis (2), at least one axle (3), wherein it includes at least one suspension device (1) according to one of the preceding claims.