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Connecting device

10 The invention relates to a device for connecting one
 end of a rubber band chain to another end of the rubber
 band chain or for connecting one end of a first band
 segment of a rubber band chain to another end of a
 second band segment of a rubber band chain.

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 Vehicle chains have always been used for mobilizing
 vehicles where, on account of heavy vehicle weight
 and/or the use of the vehicle in rough terrain, the use
 of wheels for propelling the vehicle would be
20 problematic. The use of a vehicle chain involves said
 vehicle chain being exposed to a torsional force at
 regular intervals when circulating in the so-called
 running gear. Such typical load situations are, for
 example in the case of a tank, the return points on the
25 drive gear and the return roller. In the case of a
 vehicle chain with chain links made of steel, the
 torsional capability of the chain can only be ensured
 by segmenting (= dividing into chain links) and
 installing pins and pin supports. However, the
30 technology of a pure steel chain, as was still used
 during the Second World War, quickly reaches its
 limits. Thus, for a higher vehicle speed it is
 necessary for the vehicle chain to have certain
 elasticity. In addition, the service life of a pure
35 steel chain is greatly limited by the constant
 metal/metal contact between the chain links or pin
 supports and the pins. Consequently, in the past
 rubber-mounted pins have been used more and more in the
 production of vehicle chains. Said rubber-mounted pins

are pressed, prestressed, into bores in the chain links in such a manner that when the chain rotates in the running gear, there is neither friction between the steel faces nor friction between the rubber surfaces and the steel faces. The rotating of the pins in the bores of the chain links (= pin supports) is absorbed completely by the elastic deformation of the rubber layer, which is pressed in between the surface of the pin and the bore in the chain link.

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In the more recent past, the great advances in material research have meant that the use of rubber band chains has become more and more interesting, not only in the military sector but also as regards civilian vehicles such as, for example, snow removal vehicles. In contrast to a steel chain, a rubber band chain, in principle, does not need any pin bearings at all. The ability of the rubber band or the tension supports located therein to stretch (steel cables or composite fibers) ensures both the elasticity in the longitudinal direction and the necessary torsional capability when guiding the rubber band chain. However, the handling (fitting and removing) of such a closed, indivisible chain is difficult and expensive. Consequently, it would be desirable to put the principle advantages of a rubber band chain together with the advantage of easy assembly or disassembly of the chain on the vehicle.

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However, transferring the principle of the rubber-mounted pins from the pure steel chain to the rubber band chain proves to be problematic as the body of the rubber band chain, in contrast with the chain link of a steel chain, is itself elastic and consequently deformable.

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Advantages of the invention

The present invention proceeds from the idea of applying the concept of the so-called steel connector chain to a rubber band chain. As shown in figure 1a in top view and in figure 1b in side view, in the case of the steel connector chain adjacent chain links 1', 1" are connected to each other by so-called connectors 10. Each chain link 1', 1" of a steel connector chain includes two link pins 20, 21, which are connected to the chain link body 1', 1" by a link pin mounting 18 containing rubber. Therefore, each chain link 1', 1", - in contrast to the so-called hinge chain - has two axes of rotation Z. The connectors 10 and the link pins 20, 21 connected thereby of two adjacent chain links 1', 1" form a rigid bond on account of the interlocking and/or frictional locking between the connectors 10 and the link pins 20, 21. A chain pitch t^* can be composed of the size of the chain link body t_k^* and the size of the connector t_v^* .

The detailed view in figure 2 shows clearly the situation when the steel connector chain is pivoted out of the position in which the link pin mounting 18 is not exposed to torsional stress in order, for example, to be adapted to the reference circle of the drive wheel. The chain link body 1' is then rotated about the link pin 20, as a result of which the link pin mounting 18_{DEF} is deformed. This deforming is made clear by means of the oblique hatching of the left-hand link pin mounting 18_{DEF}. The rotating of the chain link body 1', 1" about its respective link pin 20, 21 is absorbed completely by the link pin mounting 18 such that no displacement occurs between the surface of the pin and the inside wall of the link pin mounting 18 and also no displacement occurs between the outside wall of the link pin mounting 18 and the inside wall of the chain link bore.

If we now want to apply the above-described principle of the steel connector chain to a rubber band chain, we have the problem that in the case of a rubber band chain not only the link pin mounting 18 but also the rubber band link body would itself be elastic and consequently deformable. The set of problems arising from this is illustrated in figure 3. If a torque M (indicated in the schematic diagram in figure 3 as a lever which co-operates with the axis of rotation Z of the pin 20 and is rotated about the angle β) acts between chain base body 2 and pin 20, this results in forces being transferred via the rubber mounting 18 onto the rubber base body 2 and compressing and/or stretching said rubber base body 2, in particular in its end region 101, 102; 101', 102'. In particular, the region between the pin 20 and any cross members 50, 51 inserted into the rubber base body 2 for structural reinforcement is under particular tensile and/or stretching load. At points that are loaded in this manner 101, 102; 101', 102', this can result in high stresses in the rubber bearing surface which can lead to tearing in the rubber bearing surface. Once there is tearing in the chain base body 2 at the relevant points, said tearing can very quickly progress in the base body 2, which can ultimately result in the pin support part being torn off from the remaining part of the base body 2. Thus, the advantage of freedom from wear between pin 20 and pin mounting, achievable in principle by means of the rubber mounting 18, is cancelled out again by the disadvantage of the fatigue tearing in the chain base body 2 in the region of the ends 101, 102; 101', 102' of the rubber band chain.

In consideration of the set of problems depicted beforehand, the present invention proposes a device for connecting one end of a rubber band chain to another end of the rubber band chain or for connecting one end

of a first band segment of a rubber band chain to another end of a second band segment of a rubber band chain. Said device as claimed in the invention comprises at least two tubes having a pin which is
5 rubber-mounted in the respective tube, it being possible for one of said pins in each case to be inserted into the one end and into the other end of the rubber band chain or of the band segments, and at least one connector, by means of which the pins are
10 couplable together in a rotationally fixed manner. In this case, the rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is adjusted in dependence on the flexural strength of the rubber band chain or of the
15 band segments in the region of the ends. This can ensure that torque acting on the pin is preferably absorbed by the rubber bearing arrangement of the pin. This means that tensile and/or stretch loads in the region of the ends of the rubber band chain or of the
20 band segments can be avoided or at least reduced.

The rotational rigidity of the pins in relation to their respective tube preferably does not exceed the flexural strength of the rubber band chain or of the
25 band segments in the region of the ends. It is advantageous when the last circumstance applies at least in the application-specific pivoting angle region of the ends of the rubber band chain or of the ends of the band segments in relation to each other. In other
30 words, it is advantageous for the rotational rigidity of the pins in relation to their respective tube in the working region of the rubber band chain to be always less than the flexural strength of the rubber band body in the region of the ends. This can ensure that when
35 the ends of the rubber band chain start to pivot towards each other, initially only the rubber mounting of the pins is exposed to torsion such that no forces

or only a small amount of forces act on the structure in the region of the ends of the rubber band body.

According to a particularly preferred embodiment of the present invention, the rotational rigidity of the pins is at least a factor of between 1.5 and 4 times less than the flexural strength of the rubber band chain or of the band segments in the region of the ends. Broadly speaking, the bending load on the ends of the rubber band body is all the smaller, the smaller the rotational rigidity of the pins in relation to the flexural strength of the rubber band chain or of the band segments. Consequently, in certain circumstances it can be particularly advantageous for the rotational rigidity of the pins in relation to the flexural strength of the rubber band chain or of the band segments to be negligibly small in the region of the ends.

The application-specific pivoting angle region of the ends of the rubber band chain or of the band segments in relation to each other is normally between 0 and 30°. Therefore, the rubber mounting of the pins should therefore ensure sufficiently low rotational rigidity of the pins at least in this angular region. The increased susceptibility to torsional deformation of the rubber mounting even in a pivoting angle region of between 0 and 60° is preferably provided in order, for example, to keep the torsional load on the rubber band body low even when the chain vehicle moves quicker. In a particularly preferred manner, the low rotational rigidity of the pins is provided in a pivoting angle region of between 0 and 80° in order to keep the bending and/or stretch loads on the ends of the rubber band body small even at extreme load peaks (e.g. when traveling over ridges or objects with a small radius of curvature).

The rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is adjusted in dependence on the weight of the vehicle on which the rubber band chain is to be fitted. The measurements of the rubber band body, as a rule, are all the greater, the higher the vehicle weight. Greater dimensioned rubber band bodies have an increased flexural strength. The torsional strength of the rubber band body is therefore dependent on the dimension of the chain, which is derived from the vehicle weight. Therefore, the greater the dimensions of a rubber band chain, the more the pin can also be mounted in its rubber mounting in a torsion-proof manner in order, nevertheless, still to ensure sufficiently high susceptibility to torsional deformation of the rubber mounting.

The rotational rigidity of the pins, brought about by the rubber mounting, when the pins are rotated by 15 degrees in relation to their respective tube at a vehicle weight of 4000 kg (that is to say 4 metric tons = 4t), is preferably approximately 5 Nm. At a vehicle weight of 8000 kg, the rotational rigidity is preferably approximately 7 Nm. At a vehicle weight of 12000 kg the rotational rigidity is preferably approximately 12 Nm. At a vehicle weight of 15000 kg the rotational rigidity is preferably approximately 18 Nm. At a vehicle weight of 18000 kg the rotational rigidity is preferably approximately 23 Nm. At a vehicle weight of 20000 kg the rotational rigidity is preferably approximately 25 Nm. The last-mentioned values for the rotational rigidity of the pins, brought about by the rubber mounting, in relation to the vehicle weight provide an ideal compromise between susceptibility to torsional deformation of the pins that is as high as possible and in each case sufficient structural strength of the rubber mounting. The rotational rigidity/susceptibility to torsional

deformation of the pins in relation to their respective tube corresponds to the torque that is required in order to achieve rotation of the pin out of the non-deformed position of the rubber mounting about a certain angle. Therefore, the rotational rigidity of the pins corresponds to the torque resistance with which the rubber mounting opposes a rotation of the pin about this angle.

The rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is preferably adjusted via the tensile stress of the rubber compound. In this case, the tensile stress is preferably all the greater, the greater the vehicle weight. The greater the tensile stress of the rubber compound, the greater the rotational rigidity of the rubber mounting produced from this rubber compound, therefore the "harder" the rubber compound, the greater the torque resistance with which the rubber mounting opposes a rotation of the rubber-mounted pin. The tensile stress δ_i in terms of the present invention refers to the tensile stress to DIN 53504 which is defined as the quotient from the tensile force F_i present when achieving a certain stretch at the rubber body and the initial cross section A_0 of the rubber body. Therefore, $\delta_i = F_i / A_0$ applies. In this case, the index reference i in the symbol δ_i stands for the numerical value of the associated stretch, e.g. δ_{300} for 300% stretch. The tensile stress δ_{300} of the rubber compound for the rubber mounting of the pins at vehicle weights of between 4000 kg and 20000 kg is approximately between 3.8 MPa and 12.4 MPa.

The rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is preferably adjusted via the thickness of the rubber mounting between the pins and the inside surface of the tube. In this case, it is particularly

advantageous when the thickness of the rubber mounting is provided by an approximately constant ratio between the diameter of the pin and the inside diameter of the tube. Broadly speaking, the diameter of the pin in the
5 case of rubber band chains is all the greater, the greater the weight of the vehicle on which the rubber band chain is to be fitted.

According to a particularly preferred embodiment of the
10 present invention, the rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is adjusted via the force to be applied when pressing the pins into their respective tube and the compression of the rubber mounting.
15 connected to said pressing-in. Before pressing in the rubber-encased pins, they are preferably dipped in oil, for example rapeseed oil, and are then pressed into their respective tubes. On the one hand, the oil serves as a lubricant, on the other hand rubber surface of the
20 rubber mounting is loosened by the oil, which subsequently, after the pressing-in operation, results in a fixed bond between the rubber surface of the rubber mounting and the inside surface of the tube.

25 The pressing-in force applied and the compression of the rubber mounting linked thereto are preferably all the greater, the greater the vehicle weight. It has proved particularly advantageous for the pressing-in force at vehicle weights of between 4000 kg and 20000
30 kg to be approximately between 35 kN and 80 kN.

The invention also relates to a rubber band chain having two ends which are connectable together to form a closed chain by means of one of the above-described
35 devices as claimed in the invention. A tube having a pin which is rubber-mounted in the tube is inserted in each end of the rubber band chain. The pins are couplable to each other in a rotationally fixed manner

by means of at least one connector. This rotational rigidity can be produced, for example, by means of an interlocking fit between connector and pin. To this end, for example, the pin ends can be milled in a tangential manner and inserted into corresponding fits in the connector. In particular, in order to prevent the connector slipping off the pin ends, the frame of the connector can be clamped fixedly to the pin ends by means of a screw (force locking connection). The rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is adjusted in the case of the rubber band chain as claimed in the invention in dependence on the flexural strength of the rubber band chain in the region of the ends.

In addition, the present invention also comprises a rubber band chain having several band segments, the ends of which are connectable to each other to form a closed chain by means of one or several above-described devices as claimed in the invention. In this case, in each case a tube having a pin which is rubber-mounted in the tube is inserted in each of the ends. The pins of two band segments to be connected together are couplable to each other in a rotationally fixed manner by means of at least one connector. The rotational rigidity of the pins in relation to their respective tube, brought about by the rubber mounting, is adjusted in dependence on the flexural strength of the band segments in the region of the ends.

The band segments each preferably have a base body made of rubber, which has inserts which have been vulcanized-in, can be loaded in a tensile manner and wrap around the tubes inserted in a transverse manner in the base body.

Further advantageous embodiments and improvements of the invention are produced from the following description of preferred realization examples of the invention. It is pointed out that the invention also
5 comprises further embodiments which are produced by a combination of features which are detailed separately in the patent claims and/or in the description and the figures.

10 The invention is explained in more detail below by way of its advantageous embodiments with reference to the drawings.

Identical or similar references in the drawings
15 designate identical or similar parts, in which:

figures 1a and 1b show a schematic representation of a steel vehicle chain in accordance with the connector principle,

20 figure 2 shows an illustration of the method of operation of the rubber-mounted pins in a steel vehicle chain in accordance with the connector principle,
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figure 3 shows a representation to explain the risk of tearing and kinking in the end region of a rubber band chain in accordance with the connector principle,
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figure 4a shows a top view of a preferred embodiment of the device as claimed in the invention,
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figure 4b shows a sectional view of the preferred embodiment of the device as

claimed in the invention in figure 4a
along the line of intersection marked
there,

- 5 figure 4c shows a sectional view of the
preferred embodiment of the device as
claimed in the invention in figure 4b
along the line of intersection marked
there,
- 10 figure 5 shows an arrangement of several
devices as claimed in the invention
within the framework of the concept
of a caterpillar band chain,
- 15 figure 6 shows a sectional view along the line
of intersection marked in figure 5,
- 20 figure 7 shows a preferred embodiment of a
band segment of a rubber band chain
as claimed in the invention,
- 25 figure 8 shows a schematic representation of a
rubber band chain as claimed in the
invention having two ends,
- 30 figure 9 shows a schematic representation of a
rubber band chain as claimed in the
invention having several band
segments and
- 35 figure 10 shows a diagram to represent the
angular dependence of the torque
which is required in order to achieve
rotation of a rubber-mounted pin, on
the one hand for a moving chain with
steel links, on the other for a band
chain with non-adapted pin bearings

and finally for a rubber band chain with a pin mounting as claimed in the invention.

5 Figures 4a, 4b and 4c show different views of a preferred embodiment of the device 3 as claimed in the invention for connecting one end 101 of a rubber band chain 1 to another end 102 of the rubber band chain or for connecting one end 101' of a first band segment 1'
10 of a rubber band chain to another end 102' of a second band segment 1'' of a rubber band chain.

The device 3 comprises two tubes 6. A pin 20, 21 is situated in each of the tubes 6. The pins 20, 21 are
15 rubber-mounted in their respective tube 6. The rubber mounting 18 is situated between the surface of the pin and the inside wall of the tube. The rubber mounting 18 contacts both the surface of the pin and the inside wall of the tube in a force-fitting or frictionally
20 engaged manner. A rotating of the pins 20, 21 in their respective tube 6 therefore brings about deformation or twisting of the rubber mounting 18 without the contact faces between the pins 20, 21 and the rubber mounting 18, on the one hand, and between the inside wall of the
25 tube and the rubber mounting 18, on the other hand, being displaced mutually towards each other. The rubber mounting 18 preferably has a hollow cylindrical shape. The rubber mounting 18, in this case, can consist of a single hollow cylinder per tube 6. However, it is just
30 as possible for the rubber mounting 18 to consist of two or more hollow cylindrical parts. There can be identical or different spacings between said hollow cylindrical parts. A multi-part rubber mounting 18 is advantageous as a pin 20, 21 with such a multi-part
35 rubber mounting 18 is easier to press into the respective tube 6, i.e. using less force. The individual hollow cylinder parts of the rubber mounting 18 are preferably spaced apart by a few millimeters,

e.g. between 1 and 10 mm, preferably between 1 and 5 mm. It is recommended, however, that the so-called fill level of the bearing, that is to say the proportion of rubber-filled space between the pin and the inside wall of the tube, is at least 95%, preferably at least 98% of the overall space. This ensures a reliable interference fit of the rubber mounting 18 between the inside wall of the tube and the rubber mounting 18, on the one hand, and between the outside surface of the pin and the rubber mounting 18, on the other hand.

Each of the pipes 6 can be inserted in each case into the one end 101, 101' and into the other end 102, 102' of the rubber band chain 1 or of the band segments 1', 1". This can be seen in particular from the sectional view in figure 4c where the tube 6 is inserted into the rubber base body 2, 15 of the ends of the band segments 1' and 1". The tubes 6 are preferably inserted into the rubber base body 2 in such a manner that there is no displacement between the outside surface of the tube and the face of the rubber base body abutting thereto. The pins 20, 21 preferably protrude a little out of the tubes 6 in each case at both ends. The pins 20, 21 are couplable to each other in a rotationally fixed manner via said protruding ends of the pins 20, 21 by means of connectors 10. To this end, the connectors 10 preferably have a frame-like structure which can be displaced over the two pins 20, 21. The frame-like structure of the connectors can preferably be clamped by means of a screw 11 such that the connector 10 is connected to the pins 20, 21 in a force locking manner, thereby preventing the connector 10 from slipping off the pins 20, 21. Over and above this, once the connector 10 has been placed in position, connector securing means can also be mounted on the pins 20, 21. Such a connector securing means, for example, can be a split-pin, which is pushed through the pin outside the

connector 10 through a bore in the end of the pin 20, 21 protruding beyond the connector 10.

As claimed in the invention, the rotational rigidity of the pins 20, 21 in relation to their respective tube 6, brought about by the rubber mounting 18, is adjusted in dependence on the flexural strength of the rubber band chain 1 or of the band segments 1', 1" in the region of the ends 101, 102; 101', 102'. In order to achieve this, it can be expedient with reference to figure 4c for the rubber compound of the rubber mounting 18 to differ from the rubber compound of the rubber base body 2. This is advantageous because the specifications of the rubber compound of the rubber mounting 18 can then be adapted especially to the requirements depicted above. However, this is not urgently necessary for it can also be advantageous, under certain circumstances, to use the identical rubber compound in each case for rubber mounting 18 and rubber base body 2.

At least in the application-specific pivoting angle region α (see figure 8 and figure 9 also in this respect) of the ends 101, 102 of the rubber band chain or of the ends 101', 102' of the band segments 1', 1" in relation to each other, the rotational rigidity of the pins 20, 21 in relation to their respective tube 6 is preferably not greater than the flexural strength of the rubber band chain 1 or of the band segments 1', 1" in the region of the ends 101, 102; 101', 102'. The rotational rigidity of the pins 20, 21 in relation to their respective tube 6 corresponds to the torque that is required in order to achieve rotation of the pin 20, 21 out of the non-deformed position of the rubber mounting 18 about an angle β (see figure 3 also in this respect). The rotational rigidity of the pins 20, 21 therefore corresponds to the torque resistance with which the rubber mounting 18 opposes a rotation of the pin 20, 21 about the angle β . The torque resistance

with which the end region 101, 102; 101', 102' opposes a kink in relation to the remaining part of the rubber base body 2 about the angle β can be understood in an analogous manner as the flexural strength of the rubber band chain 1 or of the band segments 1', 1" in the region of the ends 101, 102; 101', 102'. In order to measure the flexural strength of the rubber band chain 1 or of the band segments 1', 1" in the region of the ends 101, 102; 101', 102', it is possible, for example in the case of figure 3, to determine the angle at which the neutral fiber of the rubber base body 2 kinks (this neutral fiber extends approximately in the middle between the cross members 50 and 51) when a certain torque acts directly on the end region of the rubber band chain or of the band segments.

The rotational rigidity of the pins 20, 21 is preferably less, at least by a factor of 1.5 to 4, than the flexural strength of the rubber band chain 1 or of the band segments 1', 1" in the region of the ends 101, 102; 101', 102'. In a particularly preferred manner, the rotational rigidity of the pins 20, 21 in relation to the flexural strength of the rubber band chain 1 of the band segments 1', 1" is negligibly small in the region of the ends 101, 102; 101', 102'.

Figures 5 and 6 show the use of the device 3 as claimed in the invention with a caterpillar band chain. The closing point 3, which is defined by the pins 20, 21 and the connector 10, has a pitch 29. This is preferably a third of the band segment pitch 31, which is defined by the distance between the guide teeth 32 and between the drive cams 34 which are in alignment with the guide teeth 32. The caterpillar band chain has running cams 36 vulcanized-in on the bottom side. In the case of the caterpillar band chain shown in figures 5 and 6, three closing points 3 are arranged at a level next to each other. However, it is also just as

possible to provide only one single closing point 3 over the entire width of the chain instead of this. The band segments 1', 1" of the caterpillar band chain can have inserts 5, which have been vulcanized-in in their base body 2, can be loaded in a tensile manner and wrap around the tubes 6 inserted in a transverse manner in the base body 2.

The connector 10 provides for simple mountability of the chain on the vehicle and simple demountability of the chain from the vehicle. It is not necessary to raise the vehicle. The caterpillar band track is laid out on the ground and, once the vehicle has been driven onto the laid-out line of chain, is connected at the closing point or points 3. The removal of the divisible chain is carried out in the reverse order. One advantage is that expenditure of time and money when mounting the chain on the vehicle and removing said chain from the vehicle is very small and requires little labor. The risk of accident when mounting the band chain on the vehicle is reduced as the vehicle does not have to be raised. Finally, the space required for storage and transport is small as it is possible to roll up the band chain with closing point or closing points. In the case of band chains with several closing points, individual band segments can be replaced directly on the vehicle in the event of damage.

Figure 7 shows a band segment 1', 1" or a band chain 1 with a closing point as claimed in the invention. Neither the presence of running cams 36 nor the provision of guide teeth 32 and drive cams 34 is necessary for the functioning of the device 3 as claimed in the invention.

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Figure 8 consequently shows, as an example, a rubber band chain 1, without guide teeth and drive cams, having two ends 101, 102 which are connectable to each

other to form a closed chain by means of one single device 3 as claimed in the invention. In this case, in the event of a wide rubber band chain 1, the single device 3, in an analogous manner to figure 5, can also
5 be replaced by several closing points 3 which are in alignment with each other. Figure 8 also illustrates the concept of the application-specific pivoting angle region α introduced above. The ends 101, 102 of the rubber band chain 1 are pivoted towards each other by
10 the angle α at the guide rollers and/or drive rollers of the crawler vehicle. As each of the two rubber mountings 18 about the pins 20, 21 absorbs in each case approximately half of the pivoting α of the ends towards each other, $\alpha = 2\beta$ is roughly true.

15 Figure 9 shows a rubber band chain as claimed in the invention having several band segments 1', 1'', 1 $\square$, the ends of which 101', 102' are connectable to each other to form a closed chain by means of one or several
20 devices 3 as claimed in the invention. In order to avoid repetitions, the embodiments in respect of figure 8 are referred to in a fully extensive manner, the same also being applicable in an analogous manner to the embodiment in figure 9.

25 Figure 10 shows a diagram in which the dependency of the rotational rigidity of the pin 20, 21 on the respective angle of rotation β is represented for three different types of bearing. The x-axis is marked off in
30 steps of 10° , therefore extends from 0 to 180° . The rotational rigidity, that is to say the torque resistance, with which the corresponding bearing opposes a rotation of the pin, is specified in Nm (Newton meters).

35 The continuous line shows the ratios with a conventionally rubber-mounted pin in the case of a caterpillar track with steel links. The curve climbing

steeply right from the start makes clear that the rubber mounting opposes the pin rotation right from the start with a high, constantly increasing torque resistance. The torque resistance increases already in the first 50° to the very high value of 400 Nm. Even at this angular value of 50° the bearing is already not able to absorb any more torque resistance such that in the event of potential further rotation, the forces have to be absorbed by the steel links of the chain. However, with the toughness and structural strength of steel this does not, as a rule, present a problem for such a chain.

The broken line shows the ratios in the case of a rubber band chain with conventional rubber mounting. The characteristic of this broken-line curve is similar to the continuous-line curve of the steel chain, only with the difference that the gradient of the broken-line curve of the rubber band chain does not climb as steeply. This is because when the ends of the rubber band chain are pivoted towards each other, the torque is absorbed not only by the rubber bearing but also by the ends of the rubber band body themselves. However, the problem with the conventional rubber mounting is that as early as at the first degree of the rotation of the pin 20, 21 in relation to its mounting, as the rotation increases a constantly growing bending torque is transferred onto the rubber band body arranged around the rubber mounting. This leads to fatigue in the rubber material of the rubber band body in the connection region of the two ends, which can ultimately result in destructive tearing in the rubber band body and, in the worst case, in the destruction of the rubber band chain.

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The dash-dot line shows the ratios in the case of a rubber band chain with rubber mounting 18 as claimed in the invention. Here it can clearly be seen that the

rubber mounting 18 opposes rotation of the pin 20, 21 as far as up to an angle of ca. 40° with almost no torque resistance. This ensures that in the first 40° of the rotational region of the pin almost all torques and forces are absorbed only by the bearing and do not load the surrounding rubber band body. Only when, from a rotation of the pin about approximately 40° , the rubber mounting 18 can no longer absorb any additional forces, the torque resistance increases and the chain body has to absorb the additional forces. Only then would the rubber band body start to rotate. As, however, the angular region of rotation for β from 0 to 40° (= application-specific pivoting angle region α from 0 to 80°) covers the operation of a rubber band chain even at extreme load peaks, this increase in the torque resistance no longer has any effect.

Therefore the device 3 as claimed in the invention ensures a wear-free connection between two ends of a rubber band chain or of two band segments, both as concerns the friction-free mounting of the pins 20, 21 per se and the reduced tensile and/or stretch load of the end regions of the rubber band body.

Claims

1. A device (3) for connecting one end (101) of a rubber band chain (1) to another end (102) of the rubber band chain (1) or for connecting one end (101') of a first band segment (1') of a rubber band chain to another end (102') of a second band segment (1'') of a rubber band chain, said device comprising:
- at least two tubes (6) having a pin (20, 21) which is rubber-mounted (18) in the respective tube (6), it being possible for one of said pins (6) in each case to be inserted into the one end (101, 101') and into the other end (102, 102') of the rubber band chain (1) or of the band segments (1', 1''), and
- at least one connector (10), by means of which the pins (20, 21) are couplable together (11) in a rotationally fixed manner,
- wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted in dependence on the flexural strength of the rubber band chain (1) or of the band segments (1', 1'') in the region of the ends (101, 102; 101', 102'),
- wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted via the thickness of the rubber mounting (18) between the pins (20, 21) and the inside surface of the tube or via the force to be applied when pressing the pins (20, 21) into their respective tube (6) and the compression of the rubber mounting (18) connected to said pressing-in.
2. The device (3) as claimed in claim 1, wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), at least in the application-specific pivoting angle region (α) of the ends (101,

102) of the rubber band chain (1) or of the ends (101', 102') of the band segments (1', 1'') in relation to each other, does not exceed the flexural strength of the rubber band chain (1) or of the band segments (1', 1'') in the region of the ends (101, 102; 101', 102'), the rotational rigidity of the pins (20, 21) preferably being at least a factor of between 1.5 and 4 times less than the flexural strength of the rubber band chain (1) or of the band segments (1', 1'') in the region of the ends (101, 102; 101', 102'), or, in a particularly preferred manner, the rotational rigidity of the pins (20, 21) in relation to the flexural strength of the rubber band chain (1) or of the band segments (1', 1'') being negligibly small in the region of the ends (101, 102; 101', 102').

3. The device (3) as claimed in claim 2, wherein the application-specific pivoting angle region (α) of the ends (101, 102; 101', 102') of the rubber band chain (1) or of the band segments (1', 1'') in relation to each other is between 0 and 30 degrees, preferably between 0 and 60 degrees and, in a particularly preferred manner, for also covering extreme load peaks, between 0 and 80 degrees.

4. The device (3) as claimed in one of claims 1 to 3, wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted in dependence on the weight of the vehicle on which the rubber band chain (1; 1', 1'') is to be fitted.

5. The device (3) as claimed in claim 4, wherein the rotational rigidity of the pins (20, 21), brought about by the rubber mounting (18), when the pins (20, 21) are rotated (β) by 15 degrees in relation to their respective tube (6) at a vehicle weight of 4000 kg, is approximately 5 Nm, at a vehicle weight of 8000 kg it

is approximately 7 Nm, at a vehicle weight of 12000 kg it is approximately 12 Nm, at a vehicle weight of 15000 kg it is approximately 18 Nm, at a vehicle weight of 18000 kg it is approximately 23 Nm and at a vehicle weight of 20000 kg it is approximately 25 Nm.

6. The device (3) as claimed in claim 4 or 5, wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted via the tensile stress of the rubber compound, the tensile stress being all the greater, the greater the vehicle weight.

7. The device (3) as claimed in claim 6, wherein the tensile stress₃₀₀ to DIN 53504 (σ_{300}) of the rubber compound at vehicle weights of between 4000 kg and 20000 kg is approximately between 3.8 MPa and 12.4 MPa.

8. The device (3) as claimed in one of claims 4 to 7, wherein the thickness of the rubber mounting (18) is provided by an approximately constant ratio between the diameter of the pin and the inside diameter of the tube, the diameter of the pin being all the bigger, the greater the vehicle weight.

9. The device (3) as claimed in one of claims 4 to 8, wherein the pressing-in force applied and the compression of the rubber mounting (18) connected thereto is all the greater, the greater the vehicle weight.

10. The device (3) as claimed in claim 9, wherein the pressing-in force at vehicle weights between 4000 kg and 20000 kg is approximately between 35 kN and 80 kN.

11. A rubber band chain (1) having two ends (101, 102) which are connectable together to form a closed chain

by means of one single device (3) as claimed in one of claims 1 to 10,

5 wherein a tube (6) having a pin (20, 21) which is rubber-mounted (18) in the tube is inserted in each of the two ends (101, 102),

10 wherein the pins (20, 21) are couplable to each other (11) in a rotationally fixed manner by means of at least one connector (10),

15 wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted in dependence on the flexural strength of the rubber band chain (1) in the region of the ends (101, 102) and

20 wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted via the thickness of the rubber mounting (18) between the pins (20, 21) and the inside surface of the tube or via the force to be applied when pressing the pins (20, 21) into their respective tube (6) and the compression of the rubber
25 mounting (18) connected to said pressing-in.

12. The rubber band chain having several band segments (1', 1''), the ends (101', 102') of which are connectable to each other to form a closed chain by
30 means of one or several devices (3) as claimed in one of claims 1 to 10,

35 wherein in each case a tube (6) having a pin (20, 21) which is rubber-mounted (18) in the tube is inserted in each of the ends (101', 102'),

wherein the pins (20, 21) of two band segments (1', 1'') to be connected together are couplable to each other

(11) in a rotationally fixed manner by means of at least one connector (10),

5 wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted in dependence on the flexural strength of the band segments (1', 1'') in the region of the ends (101', 102') and

10 wherein the rotational rigidity of the pins (20, 21) in relation to their respective tube (6), brought about by the rubber mounting (18), is adjusted via the thickness of the rubber mounting (18) between the pins (20, 21) and the inside surface of the tube or via the force to
15 be applied when pressing the pins (20, 21) into their respective tube (6) and the compression of the rubber mounting (18) connected to said pressing-in.

13. The rubber band chain as claimed in claim 12,
20 wherein the band segments (1', 1'') each have a base body (2) made of rubber, which has inserts (5) which have been vulcanized-in, can be loaded in a tensile manner and wrap around the tubes (6) inserted in a transverse manner in the base body (2).