UNIVERSAL LINK CHAIN

The invention refers to a universal ball pivot-link chain arrangement comprising a plurality of chain link elements, each of said chain link elements possessing at one end a ball pivot body and at the other end a ball socket adapted to receive the ball pivot body of the directly neighbouring chain link element, each of said chain link elements being subdivided in an axial plane into two halves and possessing a ring connection located in the end region of the ball socket.

A universal link chain of the aforementioned kind is disclosed in U.K. Patent 980, 302. It is used there as a tension chain for load hoisting hooks guided on rails by means of rollers. The load hoisting hooks are connected with the chain link elements by way of two bearing sleeve halves fastened to each other by bolts, each chain link element shaft adapted to connect the ball pivot body with the ball socket being held in place between said two bearing sleeve halves. In spite of this additional connection grooves of dovetail or similar cross-section with corresponding projections to fit into them may also be provided on the two chain link element halves to safely prevent any axial displacement therebetween. This same object is pursued by the provision of a shoulder on the chain link element shaft, which is thus embraced by the bearing sleeves laterally too, so as to make them hold the halves of the chain link elements fixed not only in

the radial but also in the axial direction. All of these measures indicate, that if the chain link elements are subdivided into two halves which must be held together but also secured against a relative motion in the contact plane thereof, it is extremely difficult to maintain the geometrically correct form of the ball pivot body and the counter surface of the ball socket, particularly under varying operating conditions. In this connection it is noteworthy, that this known link chain is meant to transmit pulling forces only, which results in a continuous centering process taking place between the ball pivot bodies and the ball sockets enclosing the same because the chain is continuously being stretched. In a thrust or pushing type operation, on the other hand, in which the chain would have to be guided within a channel or some similar guide means, the neighbouring chain link elements show a tendency to buckle, resulting in forces acting individually upon the halves of the chain link elements and thereby creating the danger of a relative displacement between said two halves.

Hence from what has been explained heretofore it should be apparent that the art is still in need of universal ball pivot-link chain constructions which are not associated with the aforementioned drawbacks and limitations of the state-of-the-art proposals.

It is therefore an object of the present

invention to provide a universal ball pivot-link chain which obviates or mitigates the drawbacks and limitations of the prior art as heretofore discussed.

Another and more specific object of the present invention relates to a new and improved universal ball pivot-link chain arrangement comprising chain link elements subdivided in an axial plane, the two halves to be connected by simple means to form a monolithic whole, i.e. in a way as if each chain link element were formed of one piece. To state it differently, it is intended to provide the link chain with features it would have, if the ball pivot body could be made "to grow" within a closed ball socket, if this were possible, without any special steps being required for introducing the ball pivot body into the ball socket and to hold it there in place.

This would provide, among other things, the unlimited possibility of using the chain link elements, in spite of their being divided, in a pushing type of operation, and to drive them, if necessary, by means of chain sprocket wheels. Due to the above considerations, the use of chain link elements subdivided into two halves within an axial plane could not hold out any promise for success. The main cause for this lies in the fact, that in an operation within a chain guide channel, and even more so in an operation with chain sprocket

wheels the forces acting on the two halves of the same chain link element may be of different magnitudes. Furthermore these force relations are subject to change from one chain link element to the next one if the chain link elements are able to rotate relative to each other, thus making the dividing planes of adjacent elements tilt in different directions relative to one another. Thus, a chain sprocket wheel may engage both halves of one chain link element, even though to different degrees or it may engage one half only of the subsequent element, in line with the circumstance, that said subsequent element is so rotated with respect to its own axis, that it turns toward the sprocket wheel with its corresponding half only.

According to the present invention there is provided a link chain arrangement comprising a plurality of chain link elements, each of said chain link elements possessing at one end a ball pivot body and at the other end a ball/socket portion adapted to receive the ball pivot body of the next adjacent chain link element, each of said chain link elements being subdivided in an axial plane into two halves and possessing a first ring connection located in the end region of the ball socket portion, wherein the ball pivot body comprises an undercut portion of hemispherical shape and the ball socket portion is surrounded by a second ring connection located in the region of said undercut

portion, both of said ring connections serving to hold together the two halves of the chain link element and each comprising retainer rings engaging complementary counter-surfaces of the ball socket portion.

In spite of having its chain link elements sub-divided into two halves within an axial plane the chain according to the invention possesses, the properties it would have if the chain link elements were made of one piece and the ball pivot body would be made to "grow" within the ball socket of the neighbouring chain link element. This is to be attributed mainly to the circumstance that the retaining rings do not just hold together the two halves of the chain link elements like a peripheral brace, in the radial direction, but they are effective, by mutual support and complementary action, in preventing any relative displacement of the two halves within their plane of contact. Thus, the retainer rings would resist any axial displacement, in a manner similar to that encountered in the case of friction type locking devices, where even the smallest friction force results in a direct increase in the compression force perpendicular to said friction force. Furthermore, the connection by means of the retainer rings acts not only upon on the ball socket but also on the ball pivot body located at the other end of the same chain link element, so that the geometrically correct ball shape is guaranteed, without requiring any contribution from the ball socket of the neighbouring chain element,

as was the case for the above described known chain.

Due to its substantially hemispherical undercut portion the ball pivot body possesses two concentric spherical surfaces of different radii of curvature, the bearing surface having the smaller radius of curvature, meaning the undercut portion of about hemispherical shape, being arranged forwardly of the bearing surface having the larger radius of curvature in the direction of the neighbouring chain element. Within the framework of this design the present embodiment has a certain similarity with a universal link chain arrangement disclosed in German (Fed. Rep.) Auslegeschrift 22 20 259. In this chain, which also may be used in an operation involving pushing forces, the object was to reduce the radial dimensions of the ball pivot elements and to reduce at the same time the friction forces acting on the chain when guided within a guide tube. For this purpose the hemispherical bearing surface has been arranged at the end of a slender conical extension diverging toward the bearing surface having the larger radius of curvature. At the same time, the ball socket being subdivided by means of slots into a number of segments, the conical ball pivot bodies may be inserted into the ball socket by forcing it apart. It is noteworthy, that even though the chain link elements of this known chain comprise slots extending lengthwise, they are not subdivided into halves independent of

each other. Thus, the segments of the chain link elements separated by slots are all made of one piece. They may be moved in a radial direction relative to one another but are restricted with respect to any other type of movement. This one-piece construction was apparently considered absolutely necessary for satisfying the compulsory requirement of maintaining the bearing surfaces in their geometrically correct shape, and it is particularly worth noticing, that the bearing surface provided for a pushing type of operation has been left without slots. In contradistinction to this known chain although the link chain of the invention has chain link elements subdivided into two halves within an axial plane, and even though the retainer rings are provided only in the region of the ball socket, the chain link elements possess the properties of a chain link formed of one piece, even in the region of the ball pivot body located at the other end of the chain link element. Expressed in another way one may say, that the ball socket fulfils no holding function in relation to the ball pivot body enclosed therein. A chain of this kind may thus very well be used for example as a pushing rod of a sort, whereby the ball pivot body of the foremost chain link element is adapted to engage the item to be displaced, a machine part, for example. Even if in the course of such operation the point of action between said machine part and said foremost chain

link element undergoes changes as a result of manufacturing inaccuracies or of any rotation of the chain link element and/or the machine part causing the pushing forces to act essentially upon one half of the foremost chain link element only, such changes are inconsequential in their effects, because the chain link elements possess the properties of a link element made of a single piece.

Various objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description of embodiments thereof when considered in connection with the accompanying drawings, in which

Figure 1 shows a first embodiment of a chain guided within a tube;

Figure 2 shows another embodiment of a chain guided within a tube; and

Figure 3 shows a detail of the embodiment of Figure 2 drawn at a larger scale.

Each chain link element of Fig. 1, generally identified by the reference numeral 1, is subdivided into two halves 11 and 12 connected with each other by means of a ring connection, generally identified by the reference numeral 2. Each ring connection 2 comprises a retainer ring 3, which abuts against one of the front surfaces of a peripheral annular shoulder 4 and is held fixed between this annular shoulder 4 and a snap ring 5. To this purpose, the snap rings 5

are seated in grooves 6. The retainer rings 3 comprise rectangular cross-sections, each retainer ring 3 being made to fittingly surround a cylindrical surface 7 of its chain link element. The retainer rings of the present design thus comprise two plane front surfaces able to serve as axial supporting surfaces, as well as a hollow cylindrical surface effective in the radial direction. The snap rings, too, have been provided with rectangular cross-sections. The two halves 11 and 12 are connected to form a whole by only the ring connection 2, as may be seen on the chain link element in the drawing on the left, rendering it thus superfluous to have to hold together the ball pivot body, generally identified by the reference numeral 8, by any other means such as the ball socket. As mentioned before, the ball pivot body 8 comprises an undercut portion 82 of roughly hemispherical shape and a ring-shaped bearing surface 81 having its curvature established by the larger (original) radius. The ball sockets, generally identified by the reference numeral 9, are provided with corresponding counterbearing surfaces 91 and 92. The arrangement is such, that the retainer rings 3 and the snap rings 5 of the ring connection 2 are located in the regions of the bearing surfaces 81 and 82 and the corresponding counterbearing surfaces 91 and 92. The spreading action developed in these regions is transferred directly onto the ring connection and is completely neutralised at this

location. At the same time, any possibility of impairment of the correct geometrical shape of the ball socket is excluded. In this context, it is the ring connection which also guarantees the correctness of shape of the ball pivot bodies, in particular that of their two bearing surfaces unequally curved. The same applies evidently to the annular shoulder 4 and to the convex guide surface 13 provided at the periphery thereof and guided in the embodiment shown within the guide tube 14. At the same time it is possible to properly adhere to the minimum play required for the faultless functioning of the chain, exactly as if the chain link elements were made of one piece each. The significance of this fact becomes particularly evident if one keeps in mind that the drawing is shown significantly enlarged in relation to most of the practical applications. As a matter of fact, both driving and actuation forces may be transmitted both in rotational and in reciprocating operation while using radial dimensions considerably reduced. Embodiments made of injection moulded plastics have proved particularly successful in this respect.

The ring connections of the embodiment of Figures 2 and 3 are formed each of a one piece ring 21 comprising a hollow cylindrical retaining surface 22. This surface 22 fittingly bears on the cylindrical counter surface 7 of the chain link elements. A ring

shaped projection 23 of the retaining surface comprises a saw tooth shaped cross-section and penetrates like a barb into the groove 6. The ring 21 comprises a spherical outer surface 24 arranged to be essentially an extension of the guide surface 13. Thereby the cross-section of the ring 21 decreases toward the ring-shaped projection 23 and the ring 21 is made to possess a higher compliance in the region of said projections 23. The ring 21 is made of a material so selected, that while being elastically expandable, the ring 21 may be slid over the cylindrical sections 25 undercut in relation to the peripheral annular shoulder 4, said sections 25 comprising the counter surfaces 7 and the grooves 6. The projection 23 thus forms a snap connection. The steep flank 26 of the projection 23 is also preferably inclined, to make the frontal surfaces of the ring 21 and the peripheral annular shoulder 4 fittingly abut against one another.

The aforedescribed measures result in the exclusion of any relative motion of the two halves of the chain link elements, each of which forms a complete whole. External effects, due for example to unequal friction within the guide tube or to the action of sprocket wheels, or even to the mutual influence of the chain link elements on one another, fail to produce any deformation. Moreover, the rings 21 lend themselves well for coaction with sprocket wheels and other driving members. Any differences in the positions of

rotation of the chain link elements thus become neutralised. It is also worth mentioning that the aforedescribed embodiment shown in Figures 2 and 3 may be assembled without any tools, because the rings 21 may be easily slid over the extensions 25 by hand, whether their dimensions are large or small. These rings 21 may be removed with similar ease by means of a blade.

The chain link elements and the ring connections may be made partially or wholly of a plastic material. In the embodiment of Figure 1, of course, the snap rings 5 would be made of steel and the retainer rings, if necessary, of a metal. In the embodiment of Figures 2 and 3 the retainer ring and the snap ring are united into a single ring, as described above, the thicker section of which representing the retainer ring, and the section of diminishing thickness and comprising the ring shaped protrusion representing the snap ring.

Obviously, numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practised otherwise than as specifically described herein.

CLAIMS:

1. A link chain arrangement comprising a plurality of chain link elements, each of said chain link elements possessing at one end a ball pivot body and at the other end a ball socket portion adapted to receive the ball pivot body of the next adjacent chain link element, each of said chain link elements being subdivided in an axial plane into two halves and possessing a first ring connection located in the end region of the ball socket portion, wherein the ball pivot body comprises an undercut portion of hemispherical shape and the ball socket portion is surrounded by a second ring connection located in the region of said undercut portion, both of said ring connections serving to hold together the two halves of the chain link element and each comprising retainer rings engaging complementary counter-surfaces of the ball socket portion.

2. An arrangement as claimed in claim 1, wherein said counter-surfaces of the ball socket portion and the complementary surfaces of the retainer rings are cylindrical in shape.

3. An arrangement as claimed in claim 1 or 2, wherein said counter surfaces are provided on opposing sides of a peripheral annular shoulder of the ball socket portion.

4. An arrangement as claimed in claim 3, wherein the retainer rings are each supported in the axial direction by an expanding component engaging a peripheral groove of the ball socket portion.

5. An arrangement as claimed in claim 4, wherein retainer rings and snap rings are provided.

6. An arrangement as claimed in claim 5, wherein the snap rings comprise rectangular cross-sections.

7. An arrangement as claimed in claim 4, wherein the retainer rings comprise parts engaging the peripheral groove and are adapted to elastically expand in the region of said parts.

8. An arrangement as claimed in claim 7, wherein the retainer rings possess a reduced cross-section in the region of the parts engaging the peripheral groove.

9. An arrangement as claimed in claim 7 or 8, wherein the retainer rings parts engaging the groove are saw tooth shaped and each comprise a relatively steep flank engaging a wall of said groove.

10. An arrangement as claimed in any one of claims 1 to 9, wherein the ball socket portion comprises a part-spherical ring-shaped guide surface located between the retainer rings.

11. An arrangement as claimed in claim 10, wherein the peripheral surfaces of the retainer rings are adapted to form spherical extensions of the guide surface.

12. A link chain arrangement substantially as herein described with reference to and as illustrated in Fig. 1 or Figs. 2 and 3 of the accompanying drawings.

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