

Support means with connection, able to accept shearing force, for connecting several cables

The invention relates to a support means for use in a lift installation with several cables extending at a spacing from one another and a cable casing, according to the introductory part of patent claim 1.

Running cables are an important, highly loaded machine element in conveying technology, particularly in the case of lifts, in crane construction and in mining. The loading of driven cables, as used in, for example, lift construction, is particularly complex.

In the case of conventional lift installations, lift cage and counterweight are connected together by way of several steel strand cables. The cables run over a drive pulley driven by a drive motor. The drive moment is imposed under friction couple on the respective cable section lying on the drive pulley over the looping angle. In that case the cable experiences tension, bending, compression and torsional stresses. The relative motions arising due to the bending over the cable pulley cause friction within the cable structure, which can have a negative effect on cable wear. Depending on a respective cable construction, bending radius, groove profile and cable safety factor the primary and secondary stresses which arise have a negative influence on the cable state.

Apart from strength requirements, there is the further requirement in the case of lift installations for, for reasons of energy, smallest possible masses. High-strength synthetic fibre cables, for example of aromatic polyamides, especially aramides, fulfil these requirements better than steel cables.

Cables made of aramide fibres have, for the same cross-section and same load-bearing capability, by comparison with conventional steel cables only a quarter to a fifth of the specific cable weight. By contrast to steel, however, aramide fibre has a substantially lower transverse strength in relation to longitudinal load-bearing capability.

Consequently, in order to expose the aramide fibres to the smallest possible transverse stresses when running over the drive pulley a parallelly stranded aramide fibre strand cable suitable as a drive cable is proposed in, for example, EP 0 672 781 A1. The aramide cable known therefrom offers very satisfactory values with respect to service life,

high abrasion strength and alternate bending strength; however, in unfavourable circumstances the possibility exists with parallelly stranded aramide cables that partial cable unravelling phenomena occur which permanently disturb the original cable structure in its balance. These twisting phenomena and the changes in cable structure can be avoided with, for example, a synthetic fibre cable according to European Patent Application EP 1 061 172 A2. For this purpose the synthetic fibre cable comprises two parallelly extending cables which are connected together by way of a cable casing. The synthetic fibre cable according to EP 1 061 172 A2 achieves a longitudinal strength substantially through the characteristics of the two cables extending in parallel. The cable casing, thereagainst, prevents twisting phenomena and changes in the cable structure. Moreover, the cable casing serves as insulation (protective effect) and it has a high coefficient of friction. A weak point can be, depending on the respective field of application and use, the web of such a synthetic fibre cable according to EP 1 061 172 A2.

Support means with two and more cables have disadvantages if they are so moved during running around a drive pulley that the individual cables run on tracks with different radius. Due to the radius differences the cables are moved by the traction of the drive pulley at different speed. The web part of the cable casing is thereby exposed to a shearing stress. Due to the shearing action the web region of the cable casing can be damaged, particularly when shearing forces occurring dynamically are concerned.

The invention pursues the object of further improving the known support means, which comprise two or more cables, in order inter alia to avoid web fracture. This applies particularly to support means comprising synthetic fibre cables.

The invention is based on recognition that the stated problems do not gain the upper hand if the web region is stiffened. Thus, the direct effects of shearing forces can indeed be prevented, but in this case the more rapidly circulating cable drags along the other cable and slip occurs which causes increased abrasion.

According to the invention this object is achieved by a support means with the features indicated in patent claim 1. The dependent claims contain expedient and advantageous developments and/or embodiments of the invention given by the features of claim 1.

The invention is described in more detail in the following on the basis of examples of

embodiment illustrated in the drawings, in which:

- Fig. 1A shows a perspective illustration of a first support means according to the invention with two cables;
- Fig. 1B shows a plan view of the support means according to Fig. 1A;
- Fig. 2 shows a plan view of a second support means according to the invention with two cables and rectangular webs;
- Fig. 3 shows a plan view of a third support means according to the invention with two cables and parallelogram-shaped webs with obliquely extending edges; and
- Fig. 4 shows a plan view of a fourth support means according to the invention with two cables and convexly shaped webs.

Constructional elements which are the same or have the same effect are provided in all figures with the same reference numerals even if they are not of identical construction in details. The figures are not to scale.

A first support means 10 for use in a lift installation is shown in Fig. 1A and Fig. 1B. The support means 10 comprises at least two cables 11.1 and 11.2. These cables 11.1 and 11.2 comprise, for example, synthetic fibre strands 12 designed for acceptance of force in longitudinal direction L. The cables 11.1 and 11.2 are arranged parallel to one another along the longitudinal direction L of the support means 10 at a spacing A1 (centre-to-centre). The cables 11.1, 11.2 are fixed relative to one another to be secure against twisting by a cable casing 13. The cable casing 13 forms a transition region 14, which extends parallel to the longitudinal direction L of the support means 10, between the two cables, 11.1, 11.2.

According to the invention the transition region 14 of the cable casing 13, which lies between the cables 11.1, 11.2, is provided with openings 14.2 and webs 14.1. The webs 14.1 are executed so that they make possible a relative movement of the cables 11.1, 11.2 with respect to one another in longitudinal direction L.

It can be seen on the basis of Figures 1A and 1B how this transition region 14 is designed in the case of the first form of embodiment. The cable casing 13 is a common cable casing which encloses the first cable 11.1 and the second cable 11.2. The cable casing

sole connections between two adjacent cables 11.1 and 11.2.

According to the invention at least two cables are thus connected together, but not by a rigid connection. The connection between adjacent cables 11.1, 11.2 of the support means 10 according to the invention is created by way of the webs 14.1, which on the one hand make possible transmission of torsional moments from one cable 11.1 to the adjacent cable 11.2, but on the other hand enable displacement of the cables 11.1, 11.2 relative to one another in the longitudinal direction L of the support means 10.

It is important that the webs 14.1 are so designed that they make possible the relative displacement at least in certain sections of the support means 10 without, however, breaking or tearing.

The first form of embodiment, which is shown in Figures 1A and 1B, of the support means 10 has openings 14.2 which are straight on the two longitudinal sides (parallel to the longitudinal axis L) and outwardly convex in the end regions. The webs 14.1 in the plan view shown in Fig. 1B are correspondingly dumbbell-shaped. The webs 14.1 thus have, as seen in longitudinal direction, boundaries which go into the web concavely.

The term "relative displacement of the adjacent cables" includes, according to the invention, two cases:

- (1) the two cables 11.1, 11.2 can be uniformly displaced relative to one another over their entire length (with the same stretching of the cables),
- (2) one of the cables 11.1 and 11.2 can be stretched more strongly than the other, wherein, during the stretching, relative displacements between individual length sections of the respective cables arise (the amount of the relative displacement in that case depends on the length position on the cable).

Further support means 10 according to the invention each with two cables 11.1, 11.2 are shown in Figures 2, 3 and 4. The support means 10 are, as also the support means 10 shown in Figures 1A, 1B, designed for use in a lift installation. The support means 10 comprise two cables 11.1, 11.2, wherein each of the cables 11.1, 11.2 comprises several strands 12. The cables 11.1, 11.2 are designed for acceptance of force in longitudinal direction L, wherein the cables 11.1, 11.2 are arranged along the longitudinal direction L of the support means 10 at a spacing A1 from one another and are connected by means of a

the support means 10 at a spacing A1 from one another and are connected by means of a common cable casing 13. The cable casing 13 forms a transition region 14 between each two cables 11.1, 11.2. The transition region of the cable casing 13, which lies between the cables 11.1, 11.2, is provided with openings 14.2 and webs 14.1, wherein also in the case of the forms of embodiment shown in Figures 2, 3 and 4 the webs 14.1 are designed so that they enable a relative movement of the cable 11.1, 11.2 with respect to one another in longitudinal direction L.

The forms of embodiment shown in Figures 2, 3 and 4 differ substantially only by the form of webs 14.1 and by the dimensioning of the webs 14.1 or the holes 14.2.

The second form of embodiment, which is shown in Fig. 2, of the support means 10 has openings 14.2 which are straight on the two longitudinal sides (parallel to the longitudinal axis L) and which are straight in the end regions, i.e. the openings 14.2 are substantially rectangular in the plan view shown in Fig. 2. Correspondingly, the webs 14.1 in the plan view shown in Fig. 2 are rectangular or square.

The third form of embodiment, which is shown in Fig. 3, of the support means 10 has openings 14.2 which extend rectilinearly on the two longitudinal sides (parallel to the longitudinal axis L) and which extend at an inclination in the end regions, i.e. the openings 14.2 are approximately parallelogram-shaped in the plan view shown in Fig. 3. Correspondingly, the webs 14.1 in the plan view shown in Fig. 3 are also lozenge-shaped with obliquely extending edges.

The fourth form of embodiment, which is shown in Fig. 4, of the support means 10 has openings 14.2 which are straight on the two longitudinal sides (parallel to the longitudinal axis L) and which are concave in the end regions. Correspondingly, the webs 14.1 in the plan view shown in Fig. 4 are curved outwardly at both sides, i.e. convex.

The described principle can also be transferred to an ensemble of three and more cables.

In preferred forms of embodiment of the invention the strands 12 of the cables are laid so that at least two of the cables of the support means 10 build up, under torsional stress, (mutually compensating) intrinsic torsional moments of opposite sense.

respectively laid parallelly (with the same rotational sense), whilst the strands of different cables 11.1 and 11.2 are laid with opposite rotational sense.

The webs 14.1 are an integral component of a casing 13. They can in this case be made in a single production step (by extrusion or vulcanisation according to the respective material) together with the casing 13.

The webs 14.1 can be either produced during production of the casing 13 together therewith or they can be formed in a subsequent step (for example, by punching).

An optimisation parameter is the elasticity of the webs 14.1. Through optimisation of the elasticity, relative displacements of the cables are allowed and disturbing shear stresses in the transition region 14 between adjacent cables 11.1, 11.2 can be reduced.

Advantageously the length ratios between webs 14.1 and openings 14.2 are so selected that the webs 14.1 of resilient material function to a first approximation in articulated manner under shearing forces in longitudinal direction (L) of the cables, i.e. the webs 14.1 can accept substantially only forces in transverse direction with respect to the cables 11.1 and 11.2. Such webs 14.1 constructed in articulated manner thus cannot accept substantial forces in longitudinal direction (L) when there are small relative displacements of the cables 11.1 and 11.2 and thus avoid, in the case of occurrence of different cable speeds of the adjacent cables 11.1 and 11.2 such as arise with running surface differences of the drive pulleys, large shearing forces in the transition region of the cable casing 13, which can lead to material failure in the said region. These shearing forces lead to shear stresses which lie in the low double-figure percentage range of the shear strength of the cable casing material.

A suitable material for production of the cable casing 13 is polyurethane. Two commercially available polyurethane synthetic materials suitable for use as cable casing 13 are Elastollan 1185 and Elastollan 1180, which slightly differ. Elastollan is a registered trade mark of the company BASF.

Examples of relative displacements of the cables 11.1, 11.2 are presented in concrete terms in the following.

Elastollan 1185 has a modulus of elasticity of 20 MPa, a shear modulus of 9 MPa and a Poisson's ratio of 0.11. If now the cables 11.1, 11.2 displace relative to one another by a longitudinal displacement $s = 0.8$ millimetres there results in the case of a cable spacing t of 2.3 millimetres, a web length L_1 of 3.0 millimetres, a web thickness d of 3.4 millimetres and the use of Elastollan 1185, a shearing force of 32.1 N and a shear stress of 3.15 MPa, which a web 14.1 absorbs. This example shows that the webs 14.1 absorb only small shearing forces and the shear stress resulting therefrom lies far below the shear strength of the above-mentioned polyurethane. The shear stresses reach approximately 15% of the shear strength.

Shearing forces of 24.3 N and shear stresses of 2.4 MPa result under the same conditions as above for an Elastollan 1180 with a shear modulus of 6.8 MPa. The shear stresses reach approximately 11% of the shear strength.

Further examples for longitudinal displacement s of the cables 11.1, 11.2 of 0.7 millimetres and 0.6 millimetres in the case of use of Elastollan 1185 yield shear stresses of 2.7 MPa and 2.4 MPa. These shear stresses respectively correspond with 13% and 11% of the shear strength.

Elastomers have a yield elongation of more than 100% which can amount to up to 800%. However, it is to be noted that elongations of 25% and more are to be avoided, since otherwise irreversible deformations can quite easily occur. The longitudinal displacements s of 0.6, 0.7 and 0.8 millimetres of the cables 11.1, 11.2 shown by way of example in the foregoing correspond with strains of 20% and less. It follows therefrom that relative displacements of the cables 11.1, 11.2 in the sub-millimetre range do not lead to impermissible material loads of the webs 14.1.

Moreover, it is possible to equip the individual webs 14.1 with a mechanical reinforcement.

The use of support means 10 with synthetic fibre cables is particularly preferred. Metallic, synthetic and/or organic strands 12, or a combination of the said materials, is or are

particularly preferred.

The cables 11.1 to 11.2 are preferably produced by two-stage or multi-stage twisting of strands 12. Cables 11.1, 11.2 comprising three layers 12.2, 12.3, 12.4 with strands and a central strand 12.1 are shown in Figure 1A. However, this is only an example for the construction of the cables 11.1, 11.2.

Cable yarns of aramide fibres, for example, can be twisted together in the cables 11.1, 11.2.

As can be seen in the figures, the entire outer circumference of the cables 11.1, 11.2 is enclosed by a common cable casing 13 of synthetic material. The cable casing 13 can comprise synthetic and/or organic materials. The following materials are particularly suitable as cable casings: rubber, polyurethane, polyolefine, polyvinylchloride or polyamide. The respective resiliently deformable synthetic material is preferably sprayed or extruded on the cables 11.1, 11.2 and subsequently compacted thereon. The cable casing material thereby penetrates from outside into all interstices between the strands 12 at the outer circumference and fills up these. The thus-created coupling of the cable casing 13 to the strands 12 is so strong that only small relative movements arise between the strands 12 of the cables 11.1, 11.2 and the cable casing 13.

According to a further form of embodiment short fibre pieces (for examples glass fibres, aramide fibres or the like) or a woven mat can be embedded in the region of the webs 14.1 and serves or serve as reinforcement.

The support means 10 shown in the figures are particularly suitable for drive by a cable pulley, wherein the force transmission between the cable pulley and the support means 10 takes place substantially by friction couple.

The two or more cables 11.1, 11.2 are, according to the invention, so connected together that the torsional moment of one cable 11.1 is transmitted to the other cable 11.2 and conversely. The torsional moments thereby compensate one another. In the ideal case the total torsional moment of the support means 10 in the case of an even-numbered number of cables and with symmetrical construction is equal to zero. By contrast to the known support means 10, the cables of the support means 10 according to the invention

are not connected together by a single transition region extending over the entire length of the support means 10, but by a number of webs 14.1 (plurality of transverse connections). These transverse connections are relatively stiff relative to forces transverse to the longitudinal direction L of the support means 10, but are designed to be sufficiently narrow with respect to the longitudinal direction L of the support means 10. By comparison with conventional support means according to the state of the art cited in the introduction, the transverse connections in the support means 10 according to the invention are significantly less stiff in longitudinal direction L. The transverse connections of the cables are thereby relatively easily resiliently deformable by shear forces in the longitudinal direction L of the support means 10 (by contrast to the state of the art). The two cables 11.1, 11.2 of the support means 10 can accordingly easily be displaced relative to one another in the longitudinal direction L by shear forces acting in the longitudinal direction L. Equally, the two cables 11.1, 11.2 can accept stretchings of different magnitude in the longitudinal direction L without damage of the transverse connections.

The forms of embodiment according to the invention make it possible to avoid fractures or weakenings in the transition region 14 in that shearing movements are converted into longitudinal displacements parallel to the longitudinal axis L. Damage of the transition region 14 and at the same time abrasion of conventional support means with two or more cables can thereby be reduced.

The double, triple or multiple cable according to the invention can without problems provide compensation for running radius differences at drive pulleys when the cables of the support means 10 move at a drive pulley along circular paths of different radius and accordingly at different speed at the circumference of the drive pulley.

Patent claims

1. Support means (10) for use in a lift installation, wherein the support means (10) comprises at least two cables (11.1, 11.2) of several strands (12), which are designed for acceptance of force in longitudinal direction (L), wherein the cables (11.1, 11.2) are arranged along the longitudinal direction (L) of the support means (10) at a spacing (A1) from one another and are connected by means of a cable casing (13), wherein a transition region (14) of the cable casing (13), which lies between the cables (11.1, 11.2), is provided with openings (14.2) and webs (14.1), characterised in that the webs (14.1) are so executed that they are resiliently deformable relatively easily by shearing forces in longitudinal direction (L) and that they enable a relative displacement of the cables (11.1, 11.2) with respect to one another in longitudinal direction (L).
2. Support means (10) according to claim 1, characterised in that the strands (12) of one cable (11.1) and the strands (12) of the other cable (11.2) are loaded by intrinsic torsional moments of opposite sense so as to avoid twisting of the support means along the longitudinal axis (L).
3. Support means (10) according to claim 1, characterised in that the cable casing (13) comprises synthetic and/or organic materials.
4. Support means (10) according to claim 1, characterised in that the strands (12) comprise metallic, synthetic and/or organic strands (12).
5. Support means (10) according to claim 1, characterised in that the openings (14.2) are realised in the form of slots, preferably in longitudinal direction (L) of the cable.
6. Support means (10) according to claim 1, characterised in that openings (14.2) and webs (14.1) have different lengths (L1, L2) in longitudinal direction (L) of the support means (10).
7. Support means (10) according to claim 1, 5 or 6, characterised in that the webs (14.1) have, in a plane spanned by the cables (11.1, 11.2), any desired shape, but preferably a dumbbell-shaped, cylindrical, oval, concave, convex, rectangular or wedge-shaped form.

8. Support means (10) according to claim 1, 5, 6 or 7, characterised in that the transition region (14) with the webs (14.1) is executed as an integral component of the cable casing (13) and firmly connects together the two cables (11.1, 11.2).
9. Support means (10) according to claim 1, characterised in that the webs (14.1) in the case of relative displacement of the cables (11.1, 11.2) in longitudinal direction (L) transmit shear stresses of at most 20%, advantageously at most 15% and advantageously at most 10%, of the shear strength of an elastomeric material.
10. Support means (10) according to claim 1, characterised in that the webs (14.1) in the case of relative displacement of the cables (11.1, 11.2) in longitudinal direction (L) are stretched by at most 25%, advantageously at most 20%, advantageously at most 15%, advantageously at most 10% and advantageously at most 5%.