CLAIMS

1. A monitoring system for traction and compression forces in a energy guide chain (1) having a plurality of hingedly interconnected chain link members (2) for protectedly guiding cables, hoses or the like, including at least one force sensor (10; 90) for measuring a traction or compression force transmitted between an entrainment member (4) and a moveable end (3) of the energy guide chain, and an evaluation unit (12) for evaluating the measurement signals detected by the force sensor,

characterised in that the force sensor (10; 90) is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4) and includes at least one web (32, 34; 92) extending substantially transversely to the traction/ compression force direction, wherein the web is stressed in flexing in the event of a traction or compression force acting in the longitudinal direction of the chain and has at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device (621, 622, 641, 642) for measuring a deformation produced by flexing.

2. A monitoring system according to claim 1 characterised in that the force sensor (2) has two webs (32, 34) which each include at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device and are arranged parallel with the same operative length in order upon flexing of the webs to ensure parallel displacement of the moveable end of the energy guide chain relative to the entrainment member.

3. A monitoring system according to one of claims 1 and 2 characterised in that a strain gauge (621, 622, 641, 642) is fixed as the sensor device to the at least one elastically deformable flexural region (321, 322; 341, 342).

4. A monitoring system according to claim 2 or claim 3 characterised in that two series-connected strain gauges (621, 622; 641, 642) are respectively provided at each of the two webs (32, 34), wherein the strain gauges are preferably arranged in symmetrical and diametrically opposite relationship and the series-connected strain gauges (621, 622; 641, 642) are preferably connected in parallel to constitute a Wheatstone bridge so that the strain gauges of each web are respectively connected in series between the two supply terminals (66, 68) of the Wheatstone bridge.

5. A monitoring system according to one of claims 1 to 4 characterised in that the web (92) or the two webs (32, 34) is or are of an operative length (W) which can be stressed in flexing of at least 20%, preferably at least 25%, of the lever arm (H) causing flexing, measured between the fixing location on the entrainment member (4) and the hinge axis of the most closely adjacent hinge of the energy guide chain (1).

6. A monitoring system according to one of claims 1 to 5 characterised in that the force sensor (10; 90) includes a first flange (22) which is shaped in one piece with at least one web (92) or possibly with the two webs (32, 34) and which has means (23) for fixing the force sensor (10; 90) to the entrainment member (4).

7. A monitoring system according to claim 6 characterised in that the force sensor (10; 90) further includes a second flange (24) which is shaped in one piece and which preferably has means (27) for fixing to the moveable end (3) of the energy guide chain (1), wherein a connecting surface (29) on the second flange (24) preferably extends inclinedly relative to a connecting surface (22) on the first flange.

8. A monitoring system according to one of claims 1 to 7 characterised in that the force sensor (10; 90) includes a frame structure (20) which is produced in one piece from metal or plastic and which forms the at least one web (92) or possibly the two webs (32, 34), preferably in

one piece therewith, and also forms perpendicularly thereto the first flange (22) and possibly the second flange (24), wherein the frame structure (20) is in the form of a separate connecting member for fixing the moveable end of the energy guide chain to the entrainment member (4).

9. A monitoring system according to claim 8 characterised in that the first flange (22) for fixing to the entrainment member (4) has a fixing profile, in particular a bore pattern, which is identical to the fixing profile of the moveable end (3) of the energy guide chain.

10. A monitoring system according to one of claims 1 to 7 characterised in that the force sensor, in particular the at least one web, is an integrated component of a chain end member which is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4).

11. A connecting member (10; 90) for fixing the moveable end (3) of a energy guide chain (1) which has a plurality of hingedly interconnected chain link members (2) for protectedly guiding cables, hoses or the like to an entrainment member (4),

characterised in that the connecting member (10; 90) is in the form of a force sensor for measuring traction or compression forces transmitted between the entrainment member (4) and the moveable end (3) and includes at least one web (32, 34; 92) extending substantially transversely relative to the traction/compression force direction, wherein the web is stressed in flexing in the event of a traction or compression force in the longitudinal direction of the chain and has at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device (621, 622, 641, 642) for measuring the deformation produced upon flexing at the flexural region.

12. A connecting member according to claim 11 characterised in that the force sensor (2) has two webs (32, 34) which each include at least one

elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device and are arranged parallel with the same operative length in order upon flexing of the webs to ensure parallel displacement of the moveable end of the energy guide chain relative to the entrainment member.

13. A connecting member according to one of claims 11 and 12 characterised in that a strain gauge (621, 622, 641, 642) is fixed as the sensor device to the at least one elastically deformable flexural region (321, 322; 341, 342).

14. A connecting member according to claims 12 and 13 characterised in that two series-connected strain gauges (621, 622; 641, 642) are respectively provided at each of the two webs (32, 34), wherein the strain gauges are preferably arranged in symmetrical and diametrically opposite relationship and the series-connected strain gauges (621, 622; 641, 642) are preferably connected in parallel to constitute a Wheatstone bridge so that the strain gauges of each web are respectively connected in series between the two supply terminals (66, 68) of the Wheatstone bridge.

15. A connecting member according to one of claims 11 to 14 characterised in that the web (92) or the two webs (32, 34) is or are of an operative length (W) which can be stressed in flexing of at least 20%, preferably at least 25%, of the lever arm (H) causing flexing, measured between the fixing location on the entrainment member (4) and the hinge axis of the most closely adjacent hinge of the energy guide chain (1).

16. A connecting member according to one of claims 11 to 15 characterised in that the force sensor (10; 90) includes a first flange (22) which is shaped in one piece with at least one web (92) or possibly with the two webs (32, 34) and which has means (23) for fixing the force sensor (10; 90) to the entrainment member (4).

17. A connecting member according to claim 16 characterised in that the force sensor (10; 90) further includes a second flange (24) which is shaped in one piece and which preferably has means (27) for fixing to the moveable end (3) of the energy guide chain (1), wherein a connecting surface (29) on the second flange (24) preferably extends inclinedly relative to a connecting surface (22) on the first flange.

18. A connecting member according to one of claims 11 to 17 characterised in that the force sensor (10; 90) includes a frame structure (20) which is produced in one piece from metal or plastic and which forms the at least one web (92) or possibly the two webs (32, 34), preferably in one piece therewith, and also forms perpendicularly thereto the first flange (22) and possibly the second flange (24), wherein the frame structure (20) is in the form of a separate connecting member for fixing the moveable end of the energy guide chain to the entrainment member (4).

19. A connecting member according to claim 18 characterised in that the first flange (22) for fixing to the entrainment member (4) has a fixing profile, in particular a bore pattern, which is identical to the fixing profile of the moveable end (3) of the energy guide chain.

20. A connecting member according to one of claims 11 to 17 characterised in that the force sensor, in particular the at least one web, is an integrated component of a chain end member which is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4).

21. A energy guide chain (1) comprising a plurality of hingedly interconnected chain link members (2) for protectedly guiding cables, hoses or the like, wherein the chain link members are respectively formed by side plates which are interlinked by the hinged connections to constitute side plate line arrays (7, 8), characterised in that provided at at least one and preferably at both side plate line arrays (7, 8) of the moveable end (3) of

the energy guide chain is a connecting member according to the characterising portion of claim 11 for fixing to the entrainment member.

CLAIMS

1. A monitoring system for traction and compression forces in a energy guide chain (1) having a plurality of hingedly interconnected chain link members (2) for protectedly guiding cables, hoses or the like, including at least one force sensor (10; 90) for measuring a traction or compression force transmitted between an entrainment member (4) and a moveable end (3) of the energy guide chain, and an evaluation unit (12) for evaluating the measurement signals detected by the force sensor,

characterised in that the force sensor (10; 90) is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4) and includes at least one web (32, 34; 92) extending substantially transversely to the traction/ compression force direction, wherein the web is stressed in flexing in the event of a traction or compression force acting in the longitudinal direction of the chain and has at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device (621, 622, 641, 642) for measuring a deformation produced by flexing; and in that

the force sensor (10; 90) includes a frame structure (20) which is produced in one piece from metal or plastic and which forms the at least one web (32, 34, 92) and also forms perpendicularly thereto a first flange (22) having means (23) for fixing the force sensor (10; 90) to the entrainment member (4), wherein the frame structure (20) forms a separate connecting member for fixing the moveable end of the energy guide chain to the entrainment member (4).

2. A monitoring system according to claim 1 characterised in that the force sensor (2) has two webs (32, 34) which each include at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device and are arranged parallel with the same operative length in order upon flexing of the webs to ensure parallel displacement of

the moveable end of the energy guide chain relative to the entrainment member.

3. A monitoring system according to one of claims 1 and 2 characterised in that a strain gauge (621, 622, 641, 642) is fixed as the sensor device to the at least one elastically deformable flexural region (321, 322; 341, 342).

4. A monitoring system according to claim 2 or claim 3 characterised in that two series-connected strain gauges (621, 622; 641, 642) are respectively provided at each of the two webs (32, 34), wherein the strain gauges are preferably arranged in symmetrical and diametrically opposite relationship and the series-connected strain gauges (621, 622; 641, 642) are preferably connected in parallel to constitute a Wheatstone bridge so that the strain gauges of each web are respectively connected in series between the two supply terminals (66, 68) of the Wheatstone bridge.

5. A monitoring system according to one of claims 1 to 4 characterised in that the web (92) or the two webs (32, 34) is or are of an operative length (W) which can be stressed in flexing of at least 20%, preferably at least 25%, of the lever arm (H) causing flexing, measured between the fixing location on the entrainment member (4) and the hinge axis of the most closely adjacent hinge of the energy guide chain (1).

6. A monitoring system according to claim 2 characterised in that the force sensor (10; 90) further includes a second flange (24) which is shaped in one piece and which preferably has means (27) for fixing to the moveable end (3) of the energy guide chain (1), wherein a connecting surface (29) on the second flange (24) preferably extends inclinedly relative to a connecting surface (22) on the first flange.

7. A monitoring system according to claim 6, characterised in that the frame structure (20), which is produced in one piece from metal or plastic, forms the two webs (32, 34), and perpendicularly thereto the first flange (22) and the second flange (24).

8. A monitoring system according to claim 7 characterised in that the first flange (22) for fixing to the entrainment member (4) has a fixing profile, in particular a bore pattern, which is identical to the fixing profile of the moveable end (3) of the energy guide chain.

9. A monitoring system according to one of claims 1 to 6 characterised in that the force sensor, in particular the at least one web, is an integrated component of a chain end member which is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4).

10. An energy guide chain (1) comprising a plurality of hingedly interconnected chain link members (2) for protectedly guiding cables, hoses or the like, wherein the chain link members are respectively formed by side plates which are interlinked by the hinged connections to constitute side plate line arrays (7, 8), characterised in that provided at at least one and preferably at both side plate line arrays (7, 8) of the moveable end (3) of the energy guide chain there is a connecting for fixing to the entrainment member, wherein
the connecting member (10; 90) is in the form of a force sensor for measuring traction or compression forces transmitted between the entrainment member (4) and the moveable end (3) and includes at least one web (32, 34; 92) extending substantially transversely relative to the traction/compression force direction, wherein the web is stressed in flexing in the event of a traction or compression force in the longitudinal direction of the chain and has at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device (621, 622, 641,

642) for measuring the deformation produced upon flexing at the flexural region; and in that the force sensor (10; 90) includes a frame structure (20) which is produced in one piece from metal or plastic and which forms the at least one web (92) and also forms perpendicularly thereto a first flange (22) having means (23) for fixing the force sensor (10; 90) to the entrainment member (4), wherein the frame structure (20) forms the separate connecting member for fixing the moveable end of the energy guide chain to the entrainment member (4) .

11. An energy guide chain (1) according to claim 10 characterised in that the force sensor (2) has two webs (32, 34) which each include at least one elastically deformable flexural region (321, 322; 341, 342) with an associated sensor device and are arranged parallel with the same operative length in order upon flexing of the webs to ensure parallel displacement of the moveable end of the energy guide chain relative to the entrainment member.

12. An energy guide chain (1) according to one of claims 10 or 11 characterised in that a strain gauge (621, 622, 641, 642) is fixed as the sensor device to the at least one elastically deformable flexural region (321, 322; 341, 342).

13. An energy guide chain (1) according to claims 11 and 12 characterised in that two series-connected strain gauges (621, 622; 641, 642) are respectively provided at each of the two webs (32, 34), wherein the strain gauges are preferably arranged in symmetrical and diametrically opposite relationship and the series-connected strain gauges (621, 622; 641, 642) are preferably connected in parallel to constitute a Wheatstone bridge so that the strain gauges of each web are respectively connected in series between the two supply terminals (66, 68) of the Wheatstone bridge.

14. An energy guide chain (1) according to one of claims 10 to 13 characterised in that the web (92) or the two webs (32, 34) is or are of an operative length (W) which can be stressed in flexing of at least 20%, preferably at least 25%, of the lever arm (H) causing flexing, measured between the fixing location on the entrainment member (4) and the hinge axis of the most closely adjacent hinge of the energy guide chain (1).

15. An energy guide chain (1) according to claim 11 characterised in that the force sensor (10; 90) further includes a second flange (24) which is shaped in one piece and which preferably has means (27) for fixing to the moveable end (3) of the energy guide chain (1), wherein a connecting surface (29) on the second flange (24) preferably extends inclinedly relative to a connecting surface (22) on the first flange.

16. An energy guide chain (1) according to claim 15 characterised in that the frame structure (20), which is produced in one piece from metal or plastic, forms the two webs (32, 34) and perpendicularly thereto the first flange (22) and the second flange (24).

17. An energy guide chain (1) according to claim 16 characterised in that the first flange (22) for fixing to the entrainment member (4) has a fixing profile, in particular a bore pattern, which is identical to the fixing profile of the moveable end (3) of the energy guide chain.

18. An energy guide chain (1) according to one of claims 10 to 16 characterised in that the force sensor, in particular the at least one web, is an integrated component of a chain end member which is in the form of a connecting member for fixing the moveable end (3) of the energy guide chain (1) to the entrainment member (4).