

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(10) **DK/EP 3487724 T3**

(12) Oversættelse af
europæisk patentskrift

-
- (51) Int.Cl.: **B 60 M 1/234 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2020-08-31**
- (80) Dato for Den Europæiske Patentmyndigheds
bekendtgørelse om meddelelse af patentet: **2020-06-17**
- (86) Europæisk ansøgning nr.: **17755565.3**
- (86) Europæisk indleveringsdag: **2017-07-24**
- (87) Den europæiske ansøgnings publiceringsdag: **2019-05-29**
- (86) International ansøgning nr.: **IB2017054474**
- (87) Internationalt publikationsnr.: **WO2018020397**
- (30) Prioritet: **2016-07-25 IT 201600077791**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV
MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **OFFICINA FRATELLI BERTOLOTTI S.p.A., 4, Via Milano, 10088 Volpiano (TO), Italien**
- (72) Opfinder: **MARCHESIELLO, Stefano, Via Freidour 15, 10139 Torino, Italien**
GARIBALDI, Luigi, Corso F. Ferrucci 91, 10138 Torino, Italien
ANASTASIO, Dario, Via Giuseppe Garibaldi 4, 95027 San Gregorio di Catania, Italien
FASANA, Alessandro, Via Torino 23, 10080 Salassa, Italien
- (74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**
- (54) Benævnelse: **Forbedret ophæng til en hængende kontaktledning af en jernbaneledning og en strømledning med
ophænget**
- (56) Fremdragne publikationer:
CN-A- 103 904 603
GB-A- 438 492
GB-A- 918 317
US-A- 3 044 763

DESCRIPTION

TECHNICAL FIELD

[0001] The present invention relates to a hanger for a suspended contact wire of a railway overhead power supply line and a railway overhead power supply line comprising said hanger.

PRIOR ART

[0002] A hanger holds a power supply contact wire of a railway overhead power supply line in suspension. The hanger hangs from a carrying cable along a span between two successive poles or portals of the railway power supply line or, at the pole, directly from a bracket fixed to the pole or portal.

[0003] The stretched contact wire is a linear electrical conductor on which the pantograph of a train carriage rests for supplying an electric assembly for the traction of the train, and possibly other devices on board the train.

[0004] The contact wire has a predetermined cross-section which, when the cable is in operation, has a bottom convex profile in contact with the pantograph and a top shaped profile with undercuts, e.g. swallowtailed, for a connection clamp of the hanger.

[0005] The connection clamp of the hanger is preferably made of a copper alloy, still more preferably of an alloy also comprising nickel and silicon, and is fixed to the top profile of the contact wire by form-fitting connection so as not to interfere with the passage of the pantograph.

[0006] A need is felt to minimise and possibly prevent separation between the pantograph and the suspended contact wire while the train is moving. In particular, one of the causes of separation is the movement of the contact wire with respect to the ground. This movement is due to both natural causes, such as the wind, and oscillations that propagate along the contact wire when the train passes by. In addition, the contact wire, although taut by counterweights, still has an arrow between two adjacent hangers due to its own weight.

[0007] In particular, the pantograph is configured to apply a contact pressure to the contact wire, and said contact pressure, in particular on high-speed trains, causes an upward movement of the contact wire and, more generally, a stress of a certain magnitude. In greater detail, this movement is localized and has its maximum in the contact area between the pantograph and the contact wire.

[0008] Hangers are disclosed, for example, in GB 918 317 A and US 3 044 763 A.

[0009] Others solution relating shock absorbers are disclosed in CN 103 904 603 A and GB 438 492 A.

OBJECT OF THE INVENTION

[0010] The object of the present invention is to reduce and possibly prevent separation between the pantograph and the power supply contact wire, with particular reference to high-speed trains, i.e. those having a cruising speed greater than 200 km/h.

[0011] The object of the present invention is achieved by means of a hanger according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention will now be described with reference to the accompanying drawings, which illustrate some non-limiting embodiments thereof, in which:

- Figure 1 is a schematic view of a railway line;
- Figure 2 is a detail of a clamp of a hanger according to the present invention;
- Figure 3 is a diagram of a first embodiment of a hanger according to the present invention;
- Figure 4 is a diagram of a second embodiment of a hanger according to the present invention; and
- Figure 5 is a graph of the contact forces between the contact wire and the pantograph following a numerical simulation.

PREFERRED EMBODIMENT OF THE INVENTION

[0013] Figure 1 qualitatively shows a train's overhead power supply line. The overhead line comprises a plurality of poles or portals 1, a carrying cable 2 fixed to brackets carried by the poles 1 to be suspended on tracks 3, and a contact wire 4 connected to the carrying cable 2 through a plurality of hangers 5 so as to be in contact with a pantograph of an electric traction train.

[0014] The overhead line further comprises counterweights (not shown) for stretching both the carrying cable 2 and the contact wire 4 so as to reduce the static arrow of the contact wire 4 between two adjacent hangers 5. This static arrow is due to the weight of the contact wire 4 itself.

[0015] The contact wire 4 is obtained by extrusion and has a cross section defined by national regulations. These regulations provide that the cross section has a bottom convex profile 6 oriented, in use, towards the tracks 3 and a top undercut profile 7 oriented towards the hangers 5 and the carrying cable 2. In order to firmly fix in the vertical direction the contact wire 4 to the carrying cable 2, each hanger 5 comprises a clamp 8 which, after being tightened by means of a bolt or other equivalent closure, is connected by form-fitting connection with the contact wire 4 since it tightens the top profile 7. For example, according to Italian regulations, the cross section of the contact wire 4 defines, at the top profile 7, a first and a second 78°-amplitude, V-shaped, swallowtailed undercut (Figure 2).

[0016] According to the present invention, a hanger 5 is modified to include a negative-stiffness elastic device 10 for storing oscillatory energy.

[0017] The elastic device 10 comprises a pre-compressed elastic assembly 11 along a direction A substantially parallel, in use, to the contact wire 4, and configured to have a movable point 12 that moves in a transverse direction B, in particular perpendicular to direction A, so as to decrease, in certain conditions, the pre-compression of the pre-compressed elastic assembly 11. In particular, the elastic assembly 11, if considered separately from the hanger 5, is pre-compressed and kept in a neutral condition of buckling elastic instability which, if disturbed, results in the release of elastic potential energy following a shift of the movable point 12.

[0018] In addition, the elastic device 10 comprises an elastic element 13 connected to the pre-compressed elastic assembly 11 to apply an action onto the movable point 12 along direction B and stably define the neutral position.

[0019] The elastic element 13 is connected to the clamp 8 by means of a spacer 14 to transmit both traction and compression between the elastic element 13 and the clamp 8.

[0020] When the elastic assembly 11 releases part of the compression preload through movement along the direction B of the movable point 12, the negative-stiffness elastic device 10 generates a friction action, preferably a dry friction or a hysteretic internal friction of the deformable elastic material used for the manufacture of the elastic assembly 11 and/or the elastic element 13. When the friction is a dry friction, it is possible to exploit the sliding friction.

[0021] This relatively low friction is combined with the storage of elastic potential energy in the pre-compressed elastic assembly 11 to provide an overall high dissipating action on the wave-like phenomena of the contact wire 4, in particular the wave-like phenomena triggered by the passage of the pantograph. The friction generated by the movement of the elastic assembly 11 and/or the elastic element 13 can therefore be relatively low and is calibrated to be combined with the action resulting from the storage of elastic energy in the pre-compressed elastic assembly 11.

[0022] According to a preferred embodiment of the present invention, the pre-compressed elastic assembly 11 comprises an articulated mechanism 15 having a first and a second arm or strut 16, 17 mutually hinged at the movable point 12. Movement along the direction B of the movable point 12 is obtained by means of guides 18, 19 slidably coupled to the articulated mechanism 15. According to an embodiment, the friction action is generated during interaction between the guides 18, 19 and the articulated mechanism 15. In addition, the position and/or configuration of the guides 18, 19 defines the direction A.

[0023] Preferably, the elastic element 13 is hinged at the movable point 12 so as to be able to self-align as a result of the action of the contact wire 4 and of the related tension counterweights.

[0024] Preferably, moreover, the pre-compressed elastic assembly 11 and/or the elastic element 13 comprise coil springs.

[0025] In the embodiment according to Figure 3, the articulated mechanism 15 further comprises a first and a second slider 20, 21 hinged to the first and the second arm 16, 17, respectively, to cooperate with the guides 18, 19 along direction A. Furthermore, the pre-compressed elastic assembly 11 comprises a first and a second coil spring 22, 23 compressed and released by the sliders 20, 21 and arranged opposite to one another, parallel to direction A, in order to obtain pre-compression.

[0026] Preferably, the sliders 20, 21 progressively disengage from the guides 18, 19 so as to generate, during the movement of the movable point 12, a variable friction progressively decreasing with the decrease of the pre-compression of the pre-compressed elastic assembly 11.

[0027] According to the particular embodiment shown in Figure 3, the sliders 20, 21 are sleeves and the guides 18, 19 are fixed bars engaged in the sleeves 20, 21. Furthermore, the springs 22, 23 surround the bars 18, 19 and are guided by the latter to remain parallel, in particular coaxial, to/with direction A. Direction A coincides with the axes of the bars 18, 19 and of the bushes 20, 21. According to this embodiment, the springs 22, 23 are fixed with respect to direction A during the movement of the movable point 12. This decreases the movable masses and consequently any negative inertial contributions.

[0028] According to the alternative embodiment of Figure 4, the arms 16, 17 are engaged to generate constant friction in the guides 18, 19 independently of the position of the movable point 12.

[0029] In particular, the guides 18, 19 are angularly adjustable bushes engaged with the arms 16 and 17, respectively, and allow angular movement of the latter when the movable point 12 moves along direction B.

[0030] Furthermore, the springs 22, 23 are preferably carried by the respective arms 16, 17

and, in order to compress, abut respectively against the adjustable bushes 18, 19.

[0031] Advantageously, on the opposite side of the movable point 12 with respect to the related adjustable bush 18, 19, each arm has a counterweight 24, 25 so that each arm 16, 17, with its spring 22, 23, remains in a vertical balance with respect to the corresponding bush 18, 19 when the movable point 12 is located along direction A.

[0032] In addition, the counterweights 24, 25 have such a size as to prevent the arms 16, 17 from slipping off the adjustable bushes 18, 19.

[0033] In the embodiment of Figure 4, the line joining the rotation centres of the bushes 18, 19 defines the direction A.

[0034] In both embodiments, the guides 18, 19 are carried by a rigid frame or casing 30 hanging either from the bracket of the pole/portal 1 or from the carrying cable 2 between two adjacent poles/portals.

[0035] The rigid frame 30 is preferably open, thus allowing the visual inspection of the components of the negative-stiffness elastic device 10.

[0036] The connection between the rigid frame and the bracket or the carrying cable 2 must allow transmission of traction/compression in the vertical direction.

[0037] Advantageously, the movable point 12, the clamp 8 and a connection 31 of the hanger 5 opposite to the clamp 8 along direction B are aligned. The connection 31 is fixed to the bracket and/or the carrying cable 2.

[0038] In use, the hanger 5 according to the present invention is mounted so that, under static conditions, the movable point 12 is substantially aligned along direction A in a condition in which the compression of the elastic assembly 11 is maximum with reference to the other conditions of use.

[0039] When the pantograph of a train passes by, the elastic element 13 transmits to the movable point 12 a disturbance along direction B that is large enough to disturb the position of the movable point 12, causing a consequent release of elastic energy from the pre-compressed elastic assembly 11. Preferably, this disturbance is such as to allow the release of the elastic energy and, at the same time, movement towards the carrying cable 2 of the movable point 12. By doing so, the energy introduced in the negative-stiffness device 10 by the arrival of the pantograph is at least partially compensated by the elastic potential energy released by the release of the preload of the pre-compressed elastic assembly 11. In addition, the elastic energy stored in the pre-compressed elastic assembly 11 and in the elastic element 13 when the clamp 8 brings the movable point 12 back to the neutral position is subtracted to further wave-like phenomena of the contact wire 4. In this way, the conditions of contact with the pantograph improve even when it is a high-speed train to pass by.

[0040] In particular, after the passage of the pantograph, the contact wire 4, as a result of the tension obtained by means of the counterweights along the overhead power supply line, brings the movable point 12 back to the neutral position through the action of the elastic element 13.

[0041] Figure 5 illustrates the results of a comparative simulation using a finite element model for the carrying cable 2, the hangers 5, and the contact wires 4, and a concentrated parameter model for the pantograph. The simulated speed of the pantograph is 350km/h.

[0042] The rigidity of each spring 22, 23 is 15 N/mm and the rigidity of the elastic element 13 is 12 N/mm, with reference to the diagram of Figure 3.

[0043] In particular, Figure 5 shows that in no case the contact force between the pantograph and the contact wire 4 is null when the hanger 5 according to the present invention is used (solid line). This ensures no separation compared to when the hanger 5 according to the present invention is not used (dashed line).

[0044] Preferred materials for manufacturing the clamp 8 are copper and alloys thereof or steel and alloys thereof, particularly stainless steel and alloys thereof.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB918317A [0008]
- US3044763A [0008]
- CN103904603A [0009]
- GB438492A [0009]

P a t e n t k r a v

1. Ophæng (5) til en jernbanelinje, der er indrettet til at fastgøres mellem et bærekabel eller et beslag og en strømforsyningskontaktledning (4), omfattende:
- 5 en klemme (8) til at stramme en underskåret del af kontaktledningen, og en elastisk indretning (10) med negativ stivhed, der er forbundet med klemmen, hvor den elastiske indretning omfatter:
- 10 et elastisk element (13), en afstandsholder (14) til at forbinde klemmen (8) med det elastiske element (13) under trækraft/kompression; en kalibreret friktionshandling;
- 15 **kendetegnet ved, at** den elastiske indretning yderligere omfatter en forkomprimeret, elastisk enhed (11) langs en første retning (A) og har et bevægeligt punkt (12) til at skifte i en anden retning (B) på tværs af den første retning (A) for at mindske forkomprimeringen efter en belastningsforstyrrelse; og **ved, at** det elastiske element (13) er forbundet med den forkomprimerede, elastiske enhed (11) for i den anden retning (B) at påføre en handling på det bevægelige punkt (12), når klemmen (8) bevæges ved passage af en strømaftager på kontaktledningen;
- 20 hvor den kalibrerede friktionshandling genereres ved bevægelsen af det bevægelige punkt (12); og hvor den elastiske enhed (10) med negativ stivhed er konfigureret således, at det bevægelige punkt (12) har en neutral position, når ophænget (5) er fastgjort til overledningen og kontaktledningen står stille, og således at klemmen (8), der påvirker det elastiske element (13) ved hjælp af afstandsstykket (14), bringer det bevægelige punkt (12) tilbage til den neutrale position på grund af den langsgående spænding af kontakttråden efter passagen af strømaftageren, hvor det bevægelige punkt (12) bevæger sig langs den anden retning (B)
- 25

for at frigive elastisk energi af den elastiske enhed (11) under passagen af strømaftageren.

5 **2.** Ophæng ifølge krav 1, **kendetegnet ved, at** den kalibrerede friktionshandling er defineret ved tør friktion og/eller hysteretisk, indvendig friktion af et deformerbart, elastisk materiale i den elastiske enhed (11) og/eller af det elastiske element (13).

10 **3.** Ophæng ifølge krav 2, **kendetegnet ved, at** den elastiske indretning (10) med negativ stivhed omfatter en leddelt mekanisme (15), der har en første og en anden stiver (16, 17), som er hængslet ved det bevægelige punkt (12) og glider langs de respektive føringer (18, 19), når det bevægelige punkt (12) skifter langs den anden retning (B).

15 **4.** Ophæng ifølge krav 3, **kendetegnet ved, at** den tørre friktion er skrå på grund af den translatoriske bevægelse af stiverne (16, 17) i forhold til føringerne (18, 19).

20 **5.** Ophæng ifølge et hvilket som helst af kravene 3 eller 4, **kendetegnet ved, at** den leddelte mekanisme (15) omfatter glidere (20, 21), der gradvis frigøres fra de respektive føringer (18, 19) for at definere en friktionshandling, der aftager med reduktionen af forkomprimeringen af den elastiske enhed (11), når det bevægelige punkt (12) skifter.

25 **6.** Ophæng ifølge krav 5, **kendetegnet ved, at** føringerne (18, 19) er fastgjort i forhold til den leddelte mekanisme (15), og **ved, at** den forkomprimerede, elastiske enhed (11) omfatter modstående fjedre (22, 23), der understøttes af føringerne (18, 19) og komprimeres ved hjælp af gliderne (20, 21).

7. Ophæng ifølge et hvilket som helst af kravene 3 eller 4, **kendetegnet ved, at** føringerne (18, 19) er justerbare bøsninger, der hver især går i indgreb med en stiver (16, 17).

5 8. Ophæng ifølge krav 7, **kendetegnet ved, at** den forkomprimerede, elastiske enhed (11) omfatter modstående fjedre (22, 23), der understøttes af stivere (16, 17) og komprimeres ved hjælp af justerbare bøsninger, og **ved, at** fra den modsatte ende af fjedrene (22, 23) i forhold til føringerne (18, 19) omfatter hver stiver (16, 17) en modvægt (24, 25).

10

9. Ophæng ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det omfatter en ramme eller et hus (30), der understøtter den elastiske indretning (10) med negativ stivhed og åbnes for visuelt at inspicere den elastiske indretning (10) med negativ stivhed og det elastiske element (13).

15

10. Ophæng ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det omfatter en forbindelsesdel (31) til at forbinde ophænget med beslaget eller bærekablet (2), og **ved, at** forbindelsesdelen (31), det bevægelige punkt (12) og klemmen (8) er på linje.

20

DRAWINGS

FIG. 1

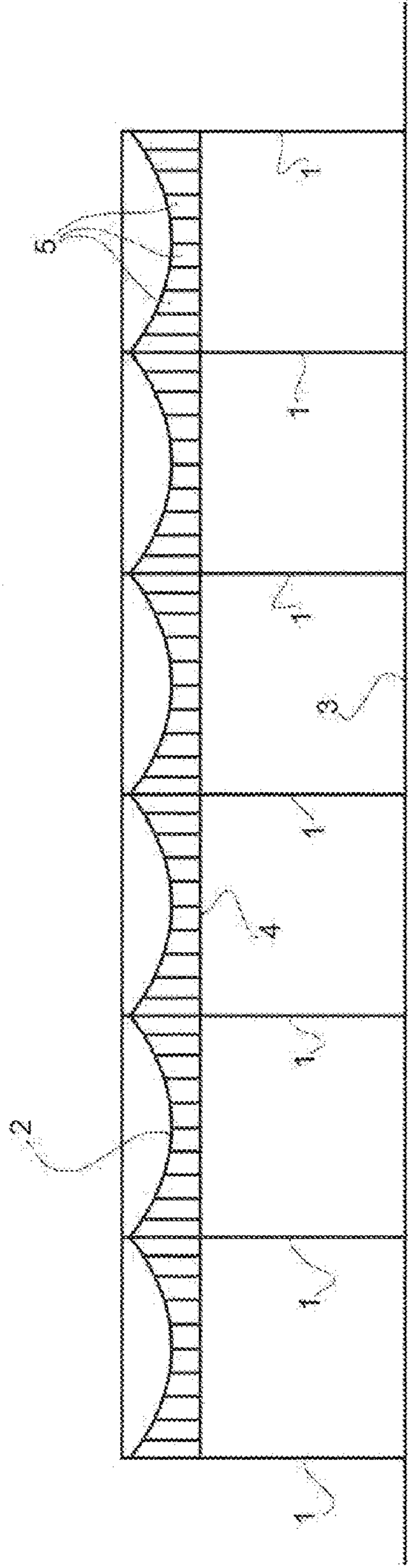


FIG. 2

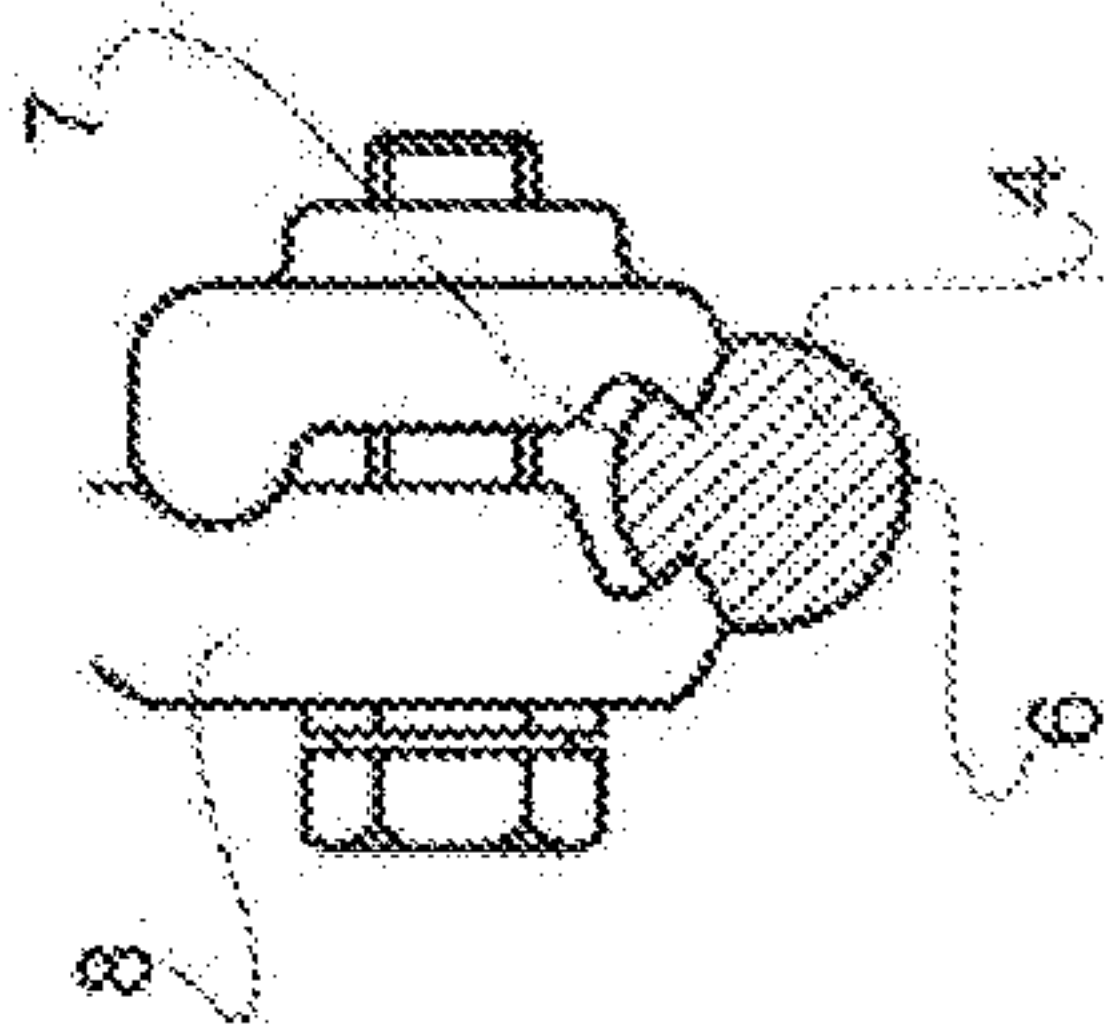


FIG. 4

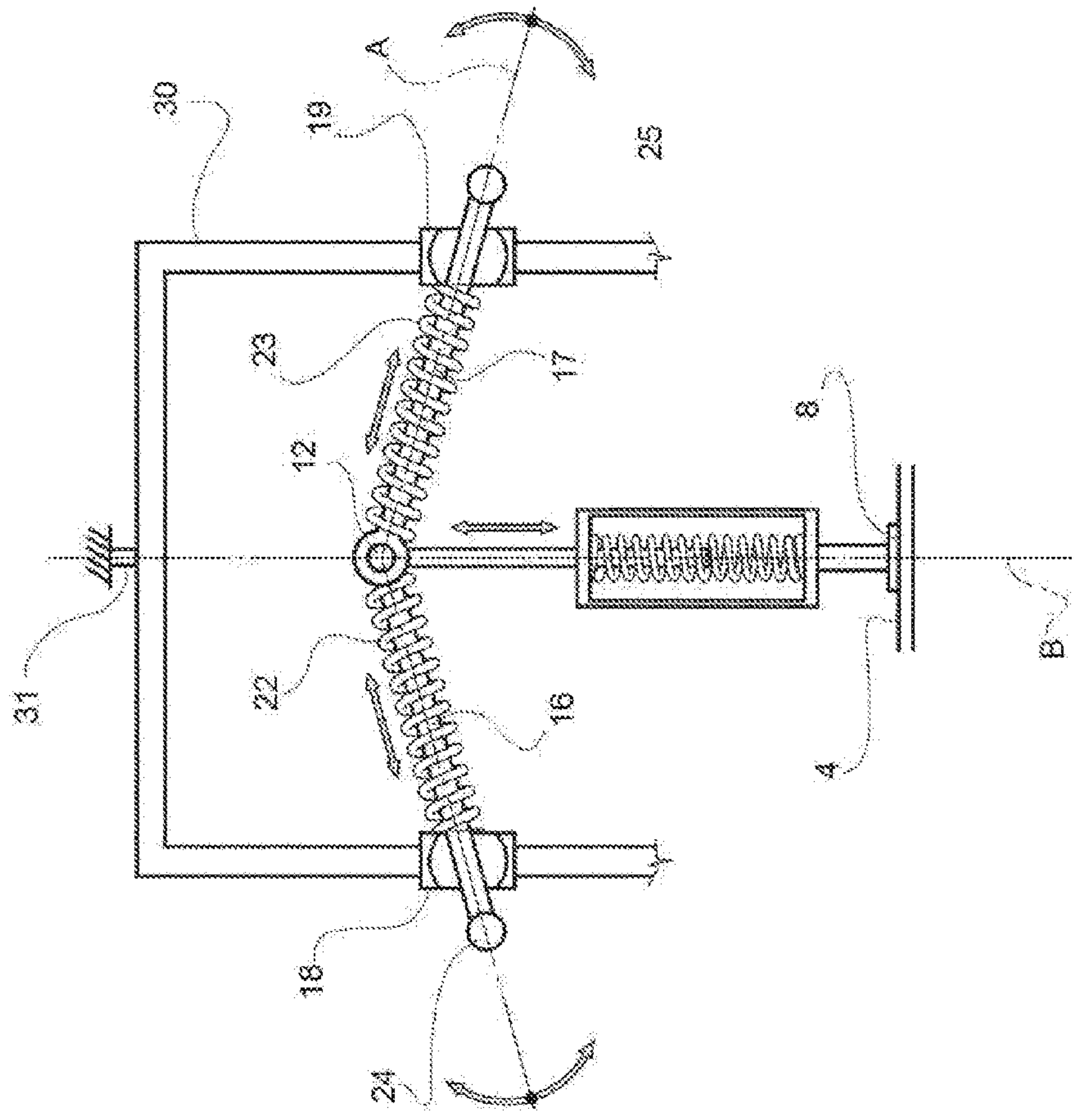


FIG. 5

