(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 290 018 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.12.2023 Bulletin 2023/50

(51) International Patent Classification (IPC):
E02F 5/10 *(2006.01)*

(21) Application number: **22178033.1**

(52) Cooperative Patent Classification (CPC):
E02F 5/101; E02F 5/105; E02F 5/106; E02F 5/107

(22) Date of filing: **09.06.2022**

(84) Designated Contracting States:
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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) APPARATUS FOR INSERTING AN ELONGATE OBJECT INTO A TRENCH

(57) A depressor (16) for inserting a cable (4) into a trench (6) is disclosed. The depressor (16) comprises a plurality of cable shoes (22) adapted to be mounted to a support (18) and to engage the cable (4). Locating pins substantially prevent movement of the cable shoes (22) relative to the support (18) in a first direction as a result of movement of the cable shoes (22) relative to the cable (4) in an axial direction of the cable (4). A load cell provides an output dependent on a force applied to the cable shoes (22) in a second direction transverse to the first direction.

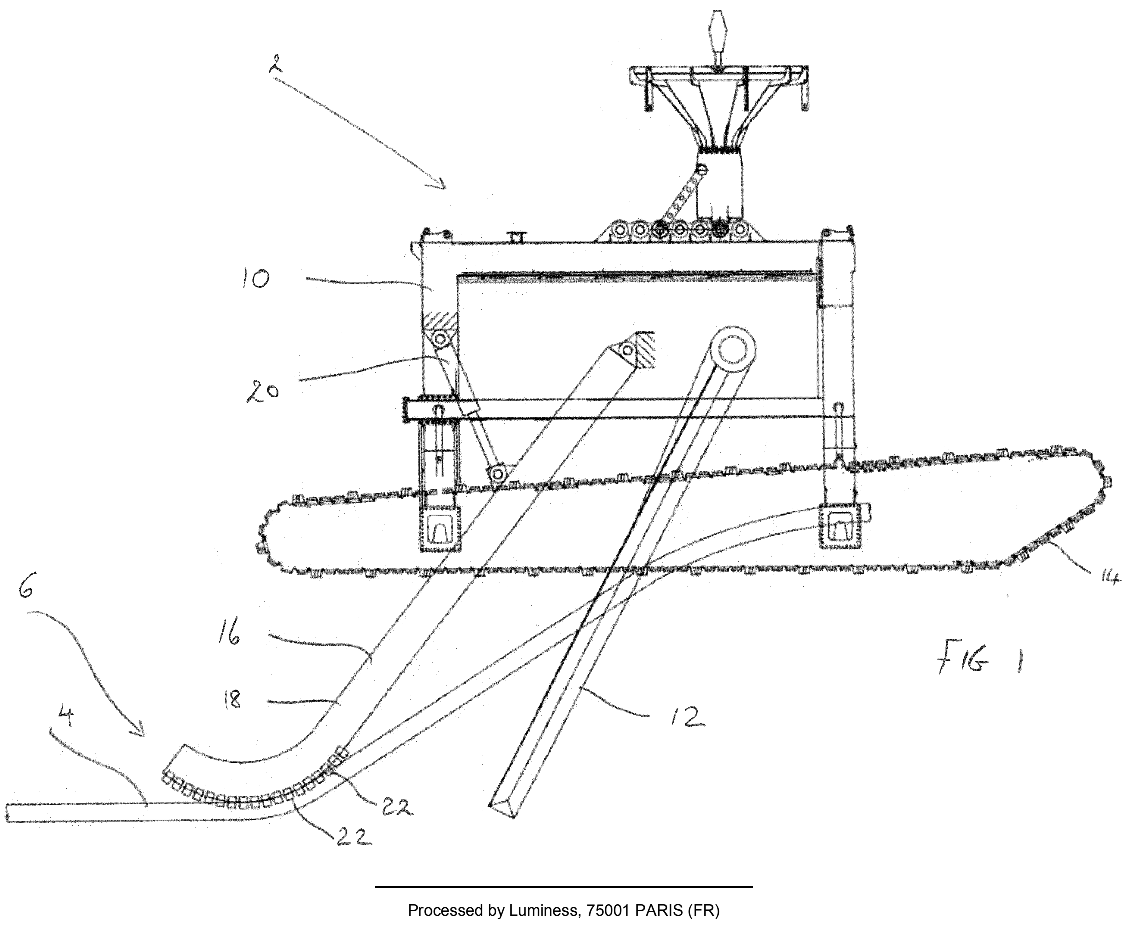

FIG 1

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Description

[0001] The present disclosure relates to an apparatus for inserting an elongate object into a trench, and relates particularly, but not exclusively, apparatus for inserting a cable into a trench in a floor of a body of water, such as the seabed.

[0002] Lowering a cable into a trench formed by a trenching vehicle is achieved either passively (by means of reliance on the self-weight of the cable) or actively, i. e. by positively inserting the cable into the trench by means of a mechanical arm, known as a depressor, attached to the trenching vehicle.

[0003] Self-weight lowering has advantages over use of an active depressor in that there is no physical contact between a cable and a depressor, which therefore reduces the risk of damage to the cable. In particular, in self-weight lowering, the cable is subjected to reduced bending compared with passage around a depressor, where it can be forced into an 's' bend, which can damage the cable.

[0004] Another advantage of self-weight lowering is the elimination of radial loading on the cable, which can cause significant risk of damage to the cable. For example, some power cables are sensitive to radial loading, i. e. forces acting perpendicularly to the axis of the cable. Cable manufacturers often specify a loading limit which must not be exceeded during the laying and burial process. For this reason, the amount of downforce applied by a depressor onto a cable must be quantified and limited. In some instances, the depressor acts only as a sensor in order to determine cable position, i.e. burial depth.

[0005] Conversely, the use of a depressor provides one or more advantages over self-weight lowering. In particular, self-weight lowering can involve an increase in the number of trenching passes necessary to lower the cable to the required depth. Each pass lowers the cable a distance dependent upon cable weight, cable diameter, soil strength and composition, how effectively the trench is jetted (to fluidise debris in the trench), cable tension and trenching speed. In the absence of a depressor contacting the cable, the depth of burial is more difficult to measure. Cable depth could be measured using onboard survey equipment, typically using cable sensors or sonar. However, post-lay survey is often carried out to confirm the actual burial depth.

[0006] The total force acting on a conventional depressor is normally measured by means of a shear-pin load cell typically fitted in-line with a raise/lower actuator (a hydraulic cylinder) for raising and lowering the depressor. The force acting on the depressor is the combined cable force and soil forces, which are generated by friction and soil surcharge, i.e. the interaction between the depressor and the cut soil generated during the trenching process.

[0007] The load cell measures force in the direction of its shear planes, which are set in a single orientation. These shear planes tend to suit a narrow range of depressor heights, as a result of which measuring the full range of height is more difficult as it would rely on the load cell rotating in line with the actuator.

[0008] In addition, the use of conventional depressors has the disadvantage that operators often see high loads, which they may attribute to high cable tension. In these circumstances, trenching speed may be reduced, as well as burial depth, or both, but it is possible that these high forces result from soil forces and not from cable tension, as a result of which the reduction in trenching speed and/or burial depth may be unnecessary.

[0009] Preferred embodiments seek to overcome this disadvantage.

[0010] According to an aspect of the disclosure, there is provided an object engaging apparatus for engaging an elongate object being inserted into a trench, the apparatus comprising:

object engaging means adapted to be mounted to a support and to engage an elongate object being inserted into a trench;

restraining means for substantially preventing movement of said object engaging means relative to the support in a first direction as a result of movement of the object engaging means relative to the elongate object in an axial direction of the elongate object; and force measuring means for providing an output dependent on a force applied to the object engaging means in a second direction transverse to said first direction.

[0011] By providing restraining means for substantially preventing movement of the object engaging means relative to the support in a first direction as a result of movement of the object engaging means relative to the elongate object in an axial direction of the elongate object, and force measuring means for providing an output dependent on a force applied to the object engaging means in a second direction transverse to the first direction, this provides the advantage of more accurately measuring radial forces applied to the object, while largely ignoring forces applied to the object engaging means not caused by radial forces between the object engaging means and the elongate object. This in turn enables the risk of damage to the elongate object to be reduced.

[0012] The object engaging means may comprise an object engaging surface, wherein the restraining means is located adjacent said object engaging surface.

[0013] This provides the advantage of more effectively reacting forces applied to the object engaging means in an axial direction of the elongate object so that movement of the object engaging means relative to the support is substantially caused by forces between the object engaging means and the elongate object transverse to the axial direction. This in turn enables a simple determination of transverse forces applied to the elongate object.

[0014] The restraining means may comprise at least one protrusion adapted to be located on one of the object engaging means and the support and adapted to engage the other of the object engaging means and the support.

[0015] The force measuring means may comprise at least one load cell.

[0016] The apparatus may further comprise proximity detection means for detecting proximity of the elongate object.

[0017] This provides the advantage of enabling the trajectory of the object to be determined, thereby reducing the risk of its minimal bend radius being exceeded, and enables the absence of an elongate object in the trench to be determined.

[0018] According to another aspect of the disclosure, there is provided an object inserting apparatus for inserting an elongate object into a trench, the apparatus comprising:

a support adapted to be mounted to a vehicle body of a vehicle and to be moveable relative to the vehicle to insert an elongate object into a trench; and
at least one object engaging apparatus as defined above.

[0019] The object inserting apparatus may comprise a plurality of said object engaging apparatus.

[0020] This provides the advantage of distributing the forces applied to the elongate object over a larger area, thereby minimising the risk of damage to the elongate object, and enabling the trajectory of the elongate object to be determined.

[0021] The object inserting apparatus may further comprise actuator means for moving the support relative to the vehicle body.

[0022] This provides the advantage of enabling the contact force between the object engaging means and the elongate object, caused by the weight of the object inserting apparatus, to be reduced by means of actuation of the actuator means, therefore further reducing the risk of damage to the elongate object.

[0023] The support may be adapted to be pivotably mounted to the vehicle body.

[0024] According to a further aspect of the disclosure, there is provided a vehicle comprising a vehicle body and an object inserting apparatus as defined above.

[0025] The vehicle may further comprise trench forming means.

[0026] The vehicle may further comprise movement means for moving the vehicle relative to a trench.

[0027] A preferred embodiment will now be described, by way of example only and not in any limitative sense, with reference to the following drawings, in which:-

Figure 1 is a schematic side cross sectional view of a cable burying vehicle of an embodiment;

Figure 2 is a side cross sectional view of a depressor of the vehicle of Figure 1;

Figure 3 is a cross sectional view along the line X-X in Figure 2; and

Figure 4 is a cross sectional view along the line Y-Y in Figure 3.

[0028] Referring to the figures, a cable burying vehicle 2 for burying a cable 4 in a trench 6 in the sea bed 8 (Figure 2) has a vehicle body 10, trench forming means in the form of jetter swords 12 mounted to the vehicle body 10, and moving means in the form of tracks 14 for moving the vehicle 2 relative to the trench 6. An object inserting apparatus in the form of a depressor 16 for inserting the cable 4 into the trench 6 comprises a support 18 pivotably mounted to the vehicle body 10 and which is raised or lowered relative to the vehicle body 10 by means of actuator means in the form of a hydraulic actuator 20.

[0029] The depressor 16 includes object engaging apparatus in the form of a plurality of cable shoes 22 mounted at a lower part of the support 18. The cable shoes 22 have object engaging means in the form of cable shoe contact surfaces 24 and are positioned such that the cable shoe contact surfaces form an arc, the radius of which is equal to or greater than the minimum allowable bend radius of the cable 4. Each cable shoe contact surface 24 may also be profiled to the minimum bend radius of the cable 4. The cable shoes 22 can be provided with proximity detection means in the form of proximity sensors 26 (Figure 3) for detecting the presence of the cable 4. In this case, the cable shoes 22 are manufactured from a material which is not detected by the proximity sensors 26.

[0030] Each cable shoe 22 is mounted on the support 18 by means of force measuring means in the form of a shear pin load cell 28, and rotation of each cable shoe 22 about the corresponding load cell 28 (equivalent to movement of the cable shoe 22 relative to the support 18 in an axial direction of the cable 4) is limited by restraining means in the form of one or more locating pins 30 located approximately in line with the corresponding cable shoe contact surface 24. Clearance between locating pin 30 and cable shoe 22 allows limited movement of cable shoe 22 in a second direction transverse to the first direction. As a result, cable friction is reacted by the locating pins 30 only, and not the load cells 28, as a result of which the load cells 28 experience substantially only load in the direction of their respective shear planes, and therefore measure true contact force between the cable 4 and the cable shoes 22, i.e. radial load applied to the cable 4 in a direction transverse to its axis.

[0031] The proximity sensors 26, where fitted, detect and validate the presence of the cable 4, to ensure that the load pin readings of the load cells 28 refer to cable contact and not to purely soil contact forces. The shoe proximity sensors 26 and the load cells 28 are monitored separately, and therefore contact locations are defined and load pin forces measured at specific locations. This gives an indication of the shape of the cable catenary through the lay process.

[0032] Cable radial loading can be reduced by applying hydraulic pressure to the actuator 20 (typically on an annulus side of a lift cylinder of the actuator 20) to reduce the submerged weight of the depressor 16, and therefore reduce the cable contact force, thereby reducing the risk of damage to the cable 4. Although the depressor 16 will then give only a limited downward force on the cable 4, the cable burial depth can still be measured.

[0033] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the disclosure as defined by the appended claims.

Claims

1. An object engaging apparatus for engaging an elongate object being inserted into a trench, the apparatus comprising:

   object engaging means adapted to be mounted to a support and to engage an elongate object being inserted into a trench;
   restraining means for substantially preventing movement of said object engaging means relative to the support in a first direction as a result of movement of the object engaging means relative to the elongate object in an axial direction of the elongate object; and
   force measuring means for providing an output dependent on a force applied to the object engaging means in a second direction transverse to said first direction.

2. An apparatus according to claim 1, wherein the object engaging means comprises an object engaging surface, wherein the restraining means is located adjacent said object engaging surface.

3. An apparatus according to claim 1 or 2, wherein the restraining means comprises at least one protrusion adapted to be located on one of the object engaging means and the support and adapted to engage the other of the object engaging means and the support.

4. An apparatus according to any one of the preceding claims, wherein the force measuring means comprises at least one load cell.

5. An apparatus according to any one of the preceding claims, further comprising proximity detection means for detecting proximity of the elongate object.

6. An object inserting apparatus for inserting an elongate object into a trench, the apparatus comprising:

   a support adapted to be mounted to a vehicle body of a vehicle and to be moveable relative to the vehicle to insert an elongate object into a trench; and
   at least one object engaging apparatus according to any one of the preceding claims.

7. An apparatus according to claim 6, comprising a plurality of said object engaging apparatus.

8. An apparatus according to claim 6 or 7, further comprising actuator means for moving the support relative to the vehicle body.

9. An apparatus according to any one of claims 6 to 8, wherein the support is adapted to be pivotably mounted to the vehicle body.

10. A vehicle comprising a vehicle body and an object inserting apparatus according to any one of claims 6 to 9.

11. A vehicle according to claim 10, further comprising trench forming means.

12. A vehicle according to claim 10 or 11, further comprising movement means for moving the vehicle relative to a trench.

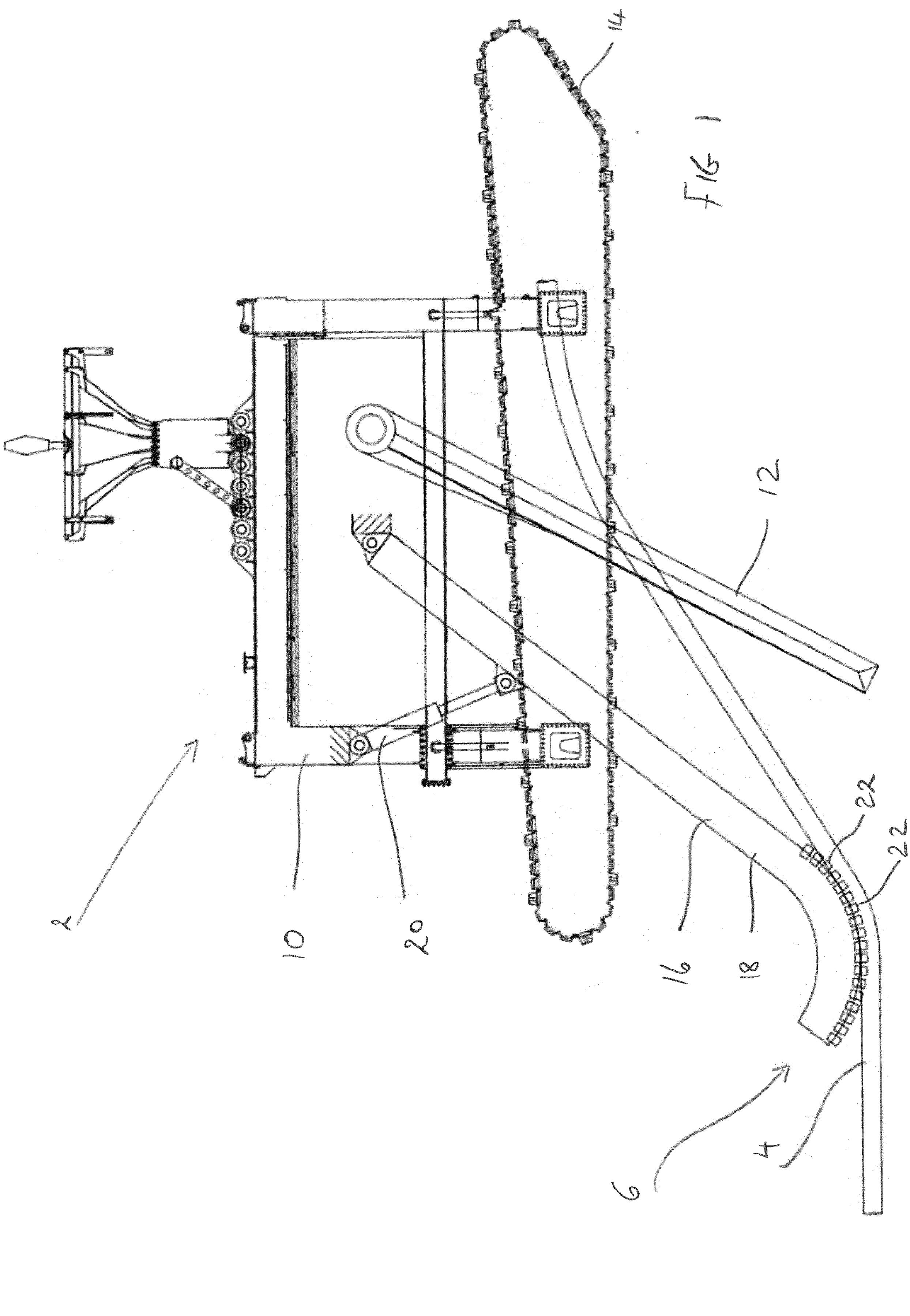

FIG 1

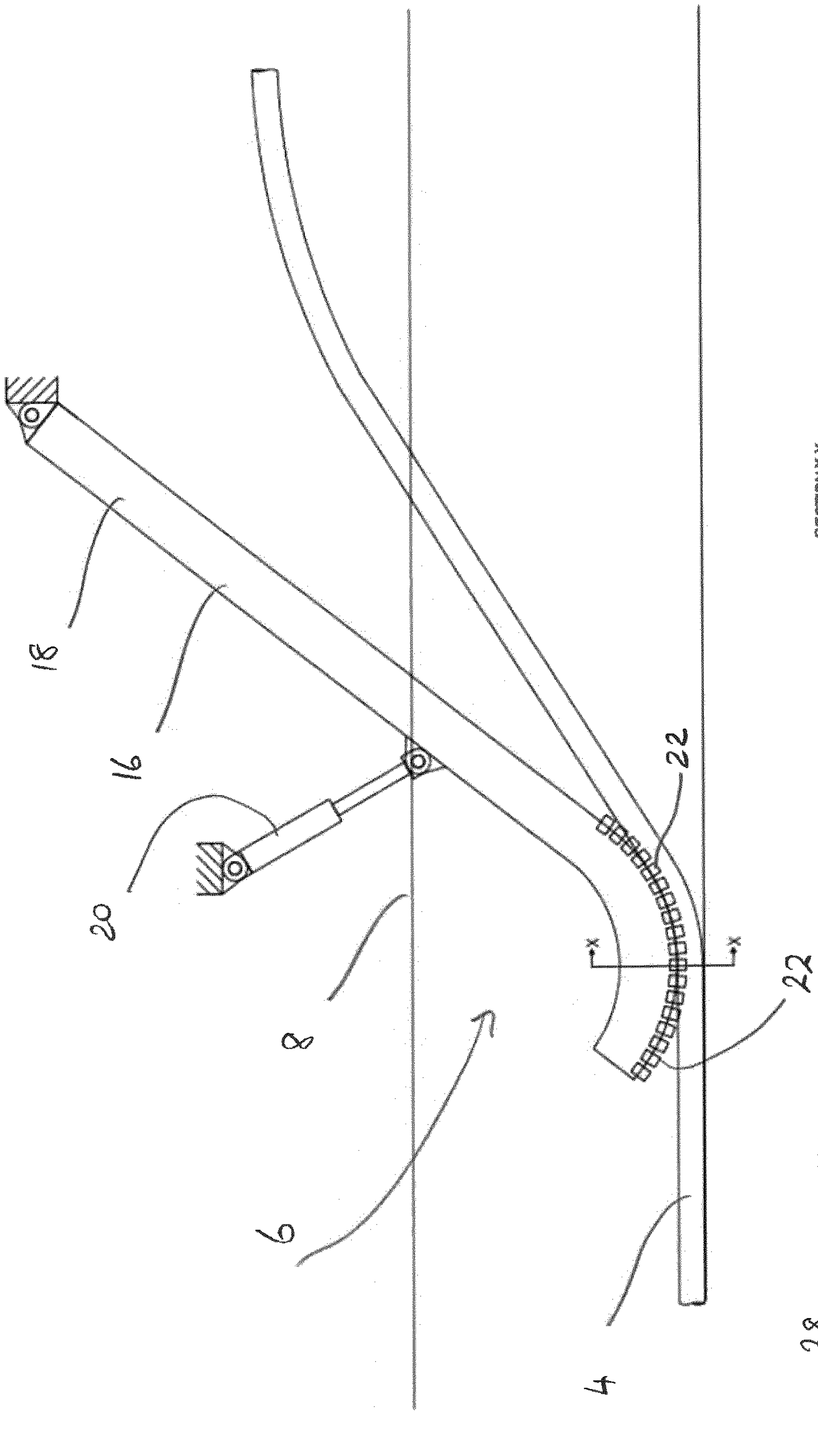

FIG 2

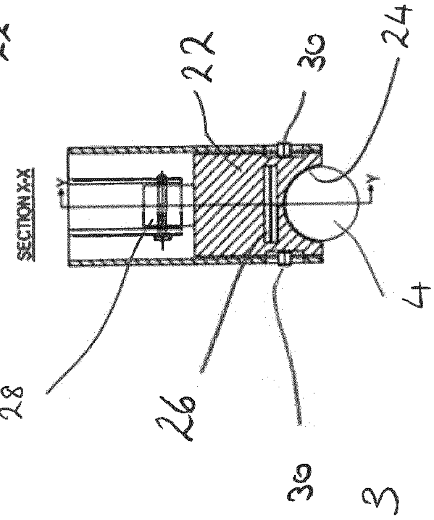

FIG 3

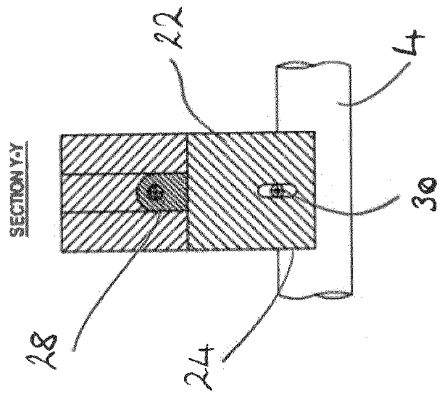

FIG 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 8033

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	18 November 2022	Leclaire, Thomas

CATEGORY OF CITED DOCUMENTS

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