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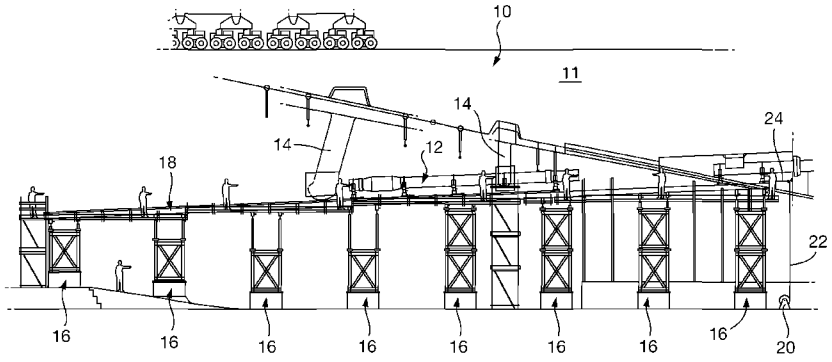
(54) **Title**: INTRODUCTION OR WITHDRAWAL OF AN ELONGATE MEMBER TO OR FROM A BODY

Fig. 1



(57) **Abstract**: A method of moving an elongate member(12) along a predetermined axis (A-A) for the introduction or withdrawal thereof to or from a free body (11). The method includes providing an elongate guide surface (18) extending parallel to the predetermined axis, and also providing a plurality of support elements (26) which are slidable on the support surface in a direction parallel to the predetermined axis. The elongate member is supported on the support elements so that at least a major portion of the mass is supported. The elongate member and the support elements are moved along the predetermined axis. Apparatus for moving an elongate member in this manner is also provided.

WO 2013/061034 A1

2012328226 11 May 2015

INTRODUCTION OR WITHDRAWAL OF AN ELONGATE MEMBER TO OR FROM A FREE BODY

[0001] This invention relates to the introduction or withdrawal of an elongate member to or from a free body.

[0002] In particular, but not exclusively, the preferred embodiments of the invention are concerned with moving a shaft into/out of an enclosed space, where the shaft has to be inserted along its longitudinal axis and traversed across bearings along the route, such as the introduction or withdrawal of a propeller shaft to or from a naval vessel.

[0003] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

[0004] Conventionally, when building large naval vessels such as the Queen Elizabeth, the propeller shaft is manoeuvred into position towards and through one or more bracket barrels by "chaining in", whereby the shaft is manoeuvred inch by inch whilst it is supported by cables slung from eyepads on the nearby surface of the ship's hull. To give an idea of scale, a typical ship's propeller shaft section will be 1 metre in diameter, 20 metres in length, and weigh approximately 40 tonnes. To chain in such a shaft is extremely labour-intensive and relies on chain blocking and manual weight transfer. Unlike most shore applications, where the shafting would be simply be craned into place from above, this approach is not possible with the ship because the installation of the shaft involves a complicated alignment process that is principally dependent on the completeness of the surrounding structure for its "foundation". In fact, the alignment process begins with the locating of the outboard bearings and before the shaft is installed, but it requires the hull form to be substantially complete.

[0005] In addition to requiring large amounts of manpower and taking a long time, there is also a risk of damage to the shaft as it is chained in, due to damage caused by the chain and/or misalignment of the shaft with associated bearing or support surfaces. Further, there are also health and safety risks associated with this conventional approach because the operatives are working close up to the shafting. If the shafting should suddenly lurch or drop then there is a significant risk of an operative getting trapped or injured.

[0006] It will be appreciated that there are other situations where space/location restrictions mean that no overhead lift for installing an elongate shaft, pipe or the like is

2012328226 11 May 2015

possible; for example, when working in a cavern in the side of a hill, or specialist applications in the oil/gas, power generation and water industries.

[0007] It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

[0008] We have therefore designed a method and apparatus which allows controlled sliding movement of the shaft along the installation axis and which can reduce the amount of chain blocking, manual weight transfer and the number of people required to be involved.

[0009] In one aspect, this invention provides a method of moving an elongate member along a predetermined axis for the introduction or withdrawal thereof to or from a free body, the method including:

providing an elongate guide surface extending parallel to said predetermined axis;

providing a plurality of support elements which are slideable on said support surface in a direction parallel to said predetermined axis;

supporting said elongate member on said support elements so that at least a major portion of the mass is supported thereby,

causing said elongate member and said support elements to move along said predetermined axis; and

wherein the support elements are dismantlable whereby, when the elongate member is supported by a series of three or more said support elements, one of said support elements of the series may be dismantled to leave the elongate member supported in alignment with said predetermined axis by the remaining support elements.

[0010] In this way the majority of the mass of the elongate member is supported on the support elements which may be slid along the guide surface so as to give continuous linear movement of the elongate member.

[0011] Said elongate guide surface preferably comprises a flat planar load-supporting surface, and said support elements each comprise at least one load-supporting pad that, in use, engage and are slideable along said load-supporting surface.

[0012] Preferable, each said support element comprises a plurality of said load-supporting pads. More preferably, each load-supporting pad is conveniently made of low friction material, such as e.g. polytetrafluoroethylene (PTFE). The support elements

2012328226 11 May 2015

are preferably constrained against transverse movement with respect to said load-supporting surface by suitable means, for example by spaced generally parallel side elements upstanding from opposite edges of said load-supporting surface, although other constraints may be used.

[0013] Preferably the effective height of the support elements is adjustable. Preferably said support elements are interconnected by tie elements to transmit a drive load there between. The tie elements are conveniently flexible.

[0014] Each support element preferably comprises a cradle portion upwardly open to receive and engage a portion of the elongate member when lowered in use. It is preferred for the support elements to be dismantleable into parts whereby, when the elongate member is supported by a series of three or more support elements, one of said support elements of the series may be dismantled and removed to leave the elongate member still supported in alignment with said predetermined axis by the remaining support elements.

[0015] Although the method may be used to introduce or withdraw the elongate member to or from a bore which supports and encloses the adjacent portion of the elongate member, it is particularly useful for situations where a elongate member needs to be passed through and beyond a structural member, such as a propeller shaft bracket boss (or an “A bracket barrel”). Thus, where an end of the elongate member is caused to move towards and beyond an associated structural member in use the method may conveniently comprise:

causing said elongate member and said at least three support elements to move in the direction of said associated structural member until said one end of the elongate member is adjacent said associated structural member,

dismantling said leading support element leaving the elongate member supported at least partially by the remaining elements, and

causing further movement of said elongate member beyond said associated structural member.

[0016] In some such cases part of the load may be supported by the associated structural member after dismantling of said leading support element.

[0017] Where the elongate member needs to be supported to the other side of the support bracket, the said elongate guide surface provided may extend beyond said associated structural member, and the method may further include the steps of:

reassembling said leading support element at a location beyond said

2012328226 11 May 2015

associated structural member,

continuing movement of said elongate member until the next support element in the series approaches said associated structural member,

dismantling said next support element, and

further moving said elongate member, and

optionally repeating said moving, dismantling, moving and reassembling steps until the required support elements have been reassembled beyond said associated structural member.

[0018] The elongate member may comprise a propeller shaft and the free member may comprise a waterborne vessel, or at least the stern portion of a waterborne vessel. The waterborne vessel may in particular be a naval vessel, and the invention extends to a method of constructing a naval vessel comprising applying the above method.

[0019] The invention extends to apparatus for use in the method. Thus, in another aspect, the invention provides apparatus for moving an elongate member along a predetermined axis for the introduction or withdrawal thereof to or from a free body, which comprises:

an elongate guide surface extending parallel to said predetermined axis;

a plurality of support elements which are slidable on said guide surface in a direction parallel to said predetermined axis;

said support elements being adapted to receive and support at least a major portion of the mass of said elongate member,

a drive for causing said elongate member and said support elements to move along said predetermined axis; and

wherein the support elements are dismantlable whereby, when the elongate member is supported by a series of three or more said support elements, one of said support elements of the series may be dismantled to leave the elongate member supported in alignment with said predetermined axis by the remaining support elements.

[0020] Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

[0021] Whilst the invention has been described above, it extends to any inventive combination of features set out above in the following description, claims or drawings.

2012328226 11 May 2015

[0022] By way of example only, one specific embodiment of the invention will now be described by reference to the accompanying drawings, in which:

[0023] Figure 1 is a side view of the aft end of a naval vessel into which a propeller shaft is to be installed;

[0024] Figure 2 is a view of a system for slideably supporting a propeller shaft for movement along an installation axis;

[0025] Figure 3(a) is a detailed view of a cradle when assembled, and

[0026] Figure 3(b) is a detailed view on the underside of the foot of a cradle.

[0027] Referring initially to Figure 1, there is shown the stern portion 10 of a naval vessel 11 in which an elongate (i.e. the length of the shaft is greater than the span of the bearings (described below) provided for it) propeller shaft 12 is required to be aligned with an axis A-A, a few degrees below horizontal, and inserted along this axis. The shaft will normally be a single component, but in some cases can be formed of several components fixed together. The shaft passes through two "A" bracket barrels 14 aft of its emergence from the hull. An "A" bracket is a bracket that is attached to the side of the vessel and is so called because it is shaped like the letter "A", with the shaft running through a bearing that is placed inside a bearing boss (commonly known as a "barrel" in ship building because of its similarity in shape) located at the apex of the "A". In order to install the shaft, a platform structure is built comprising a number of support towers 16 which support a straight guide surface 18 parallel to, but spaced by a set distance from, the shaft centre line or installation axis A-A. The guide surface 18 and associated structure will be described in further detail in relation to the following figures. A cable winch 20 is disposed on the ground at the forward end of the platform structure with the cable 22 passing over a pulley 24 to then pass to the structure as to be described below.

[0028] Referring now to Figures 2, 3(a) and 3(b), the installation system comprises the guide surface 18 on which can slide a number of cradles 26, of which four are illustrated. The cradles 26 are interconnected by tie cables 28 with the forwardmost cradle being connected to the winch cable 22. As best seen in Figures 3(a) and (b), each cradle 26 has a lower portion 30 of rectangular form connected to a foot 32, on the underside of which are provided one or more (three in the example) load supporting, low-friction pads 34 (e.g. of PTFE). The guide surface 18 is provided with upstanding lateral constraint edges 19 which ensure that the cradle is constrained to move in the direction parallel to the installation axis. The upper part of the cradle 26 is provided with

2012328226 11 May 2015

a dismantlable, rigid height adjustable wedge jack 33 which connects the box section 30 to a semi-circular cradle portion 40 designed to receive the shaft when lowered into it. The cradle portion has slots 42 or other suitable attachment means to allow a strap 44 to be applied in order to strap the shaft into the cradle. The wedge jacks may be eg Titan™ wedge jacks.

[0029] In addition to the cradles, the shaft may be supported by top steadies 46 (see Figure 2), e.g. of webbing. The top steadies function as a safety harness and are intended to receive the load quickly and safely if there is a failure in the mechanism. In this arrangement, the majority of the mass of the shaft is supported by the cradles. In use, the shaft may be drawn along the installation direction by operating the winch 20 which moves cradles (four in the example) 26 and the supported shaft 12, via the winch cable 22 and the tie cables 28. The shaft 12 may be passed through the "A" bracket barrels 14 by moving the shaft and the cradle assemblies 26 towards the first "A" bracket barrel 14. As the first cradle assembly 26 approaches the first "A" bracket barrel 14, the associated wedge jacks 33 can be adjusted upwards or downwards to ensure alignment between the shaft and the bracket barrel. The jack and the box section 30 must then be removed to allow the shaft to pass through the bracket barrel. When a cradle assembly approaches, and is close to contact, the Titan™ jack is lowered to take that cradle assembly off load. The jack and the box section can then be unbolted and removed. This will allow the shaft - with semi circular cradle 40 still attached - to pass through the bracket barrel unhindered when the winch 20 is used. When the shaft emerges from the bracket barrel, the procedure is reversed and the jack and the box section are reassembled to support the shaft and the winch 20 is applied again and the process repeated for each of the successive cradles.

[0030] It will be appreciated that the apparatus and method described above can be adapted to install and/or remove other types of elongate members, such as pipes in height-restricted locations.

2012328226 11 May 2015

CLAIMS

1. A method of moving an elongate member along a predetermined axis for the introduction or withdrawal thereof to or from a free body, the method including:

providing an elongate guide surface extending parallel to said predetermined axis;

providing a plurality of support elements which are slidable on said elongate guide surface in a direction parallel to said predetermined axis;

supporting said elongate member on said support elements so that at least a major portion of the mass is supported thereby,

causing said elongate member and said support elements to move along said predetermined axis; and

wherein the support elements are dismantlable whereby, when the elongate member is supported by a series of three or more said support elements, one of said support elements of the series may be dismantled to leave the elongate member supported in alignment with said predetermined axis by the remaining support elements.

2. A method of according to Claim 1, wherein said elongate guide surface comprises a flat planar load-supporting surface, and said support elements each comprise at least one load-supporting pad that, in use, engage and are slidable along said load-supporting surface.

3. A method according to Claim 2, wherein each said support element comprises a plurality of said load-supporting pads.

4. A method according to Claim 2 or Claim 3, wherein said load-supporting pad(s) is/are of low friction material.

5. A method according to Claim 4, wherein said low friction material is polytetrafluoroethylene (PTFE).

6. A method according to any one of Claims 2 to 5, wherein said support elements are constrained against transverse movement with respect to said load-supporting surface by spaced generally parallel side elements upstanding from opposite edges of said load-supporting surface.

7. A method according to any one of the preceding Claims, wherein said

2012328226 11 May 2015

support elements are interconnected by tie elements.

8. A method according to Claim 7, wherein said tie elements are flexible.

9. A method according to any one of the preceding Claims, wherein each said support element comprises a cradle portion upwardly open to receive and engage a portion of the elongate member when said elongate member is lowered in use.

10. A method according to any one of the preceding claims, wherein an end of the elongate member is caused to move towards and beyond an associated structural member, and wherein the method further comprises:

causing said elongate member to move in the direction of said associated structural member until said one end is adjacent to said associated structural member,

dismantling a leading said support element, leaving the elongate member supported by remaining said support elements, and

causing further movement of said elongate member beyond said associated structural member.

11. A method according to Claim 10, wherein said elongate guide surface extends beyond said associated structural member and the method further includes steps of:

reassembling said leading support element at a location beyond said associated structural member,

continuing movement of said elongate member until a next said support element approaches said associated structural member,

dismantling said next support element, and

further moving said elongate member, and

optionally, repeating said moving, dismantling, moving and reassembling steps until a preset number of said supporting elements have been reassembled beyond said associated structural member.

12. A method as claimed in any one of the preceding claims, wherein said elongate member comprises a propeller shaft for a naval vessel, and wherein said free body comprises a naval vessel, or at least the stern portion of a naval vessel.

13. A method of constructing a naval vessel comprising applying the method of claim 12.

2012328226 11 May 2015

14. Apparatus for moving an elongate member along a predetermined axis for the introduction or withdrawal thereof to or from a free body, the apparatus including:

an elongate guide surface extending parallel to said predetermined axis;

a plurality of support elements which are slidable on said guide surface in a direction parallel to said predetermined axis;

said support elements being adapted to receive and support at least a major portion of the mass of said elongate member,

a drive for causing said elongate member and said support elements to move along said predetermined axis; and

wherein the support elements are dismantlable whereby, when the elongate member is supported by a series of three or more said support elements, one of said support elements of the series may be dismantled to leave the elongate member supported in alignment with said predetermined axis by the remaining support elements.

15. Apparatus according to Claim 14, wherein said elongate guide surface comprises a straight load-supporting surface, and said support elements each include a load-supporting pad that engages, and is slidable along, said load-supporting surface.

16. Apparatus according to Claim 15, wherein each said support element comprises a plurality of said load-supporting pads.

17. Apparatus according to Claim 15 or Claim 16, wherein the or each said load-supporting pad is of low friction material.

18. Apparatus according to Claim 17, wherein said low friction material is polytetrafluoroethylene (PTFE).

19. Apparatus according to any one of Claims 15 to 18, wherein said support elements are constrained against transverse movement with respect to said load-supporting surface by spaced generally parallel side elements upstanding from opposite edges of said load-supporting surface.

20. Apparatus according to any one of Claims 15 to 19, wherein said support elements are interconnected by tie elements.

21. Apparatus according to Claim 20, wherein said tie elements are flexible and adjustable.

2012328226 11 May 2015

22. Apparatus according to any of the Claims 15 to 21, wherein each support element comprises a cradle portion upwardly open to receive and engage a portion of the elongate member when said elongate member is lowered in use.

23. Apparatus according to any one of Claims 15 to 22, wherein the support elements are height adjustable.

24. Apparatus according to any one of claims 15 to 23, wherein the elongate member comprises a propeller shaft and the free member comprises a waterborne vessel.

Fig. 1

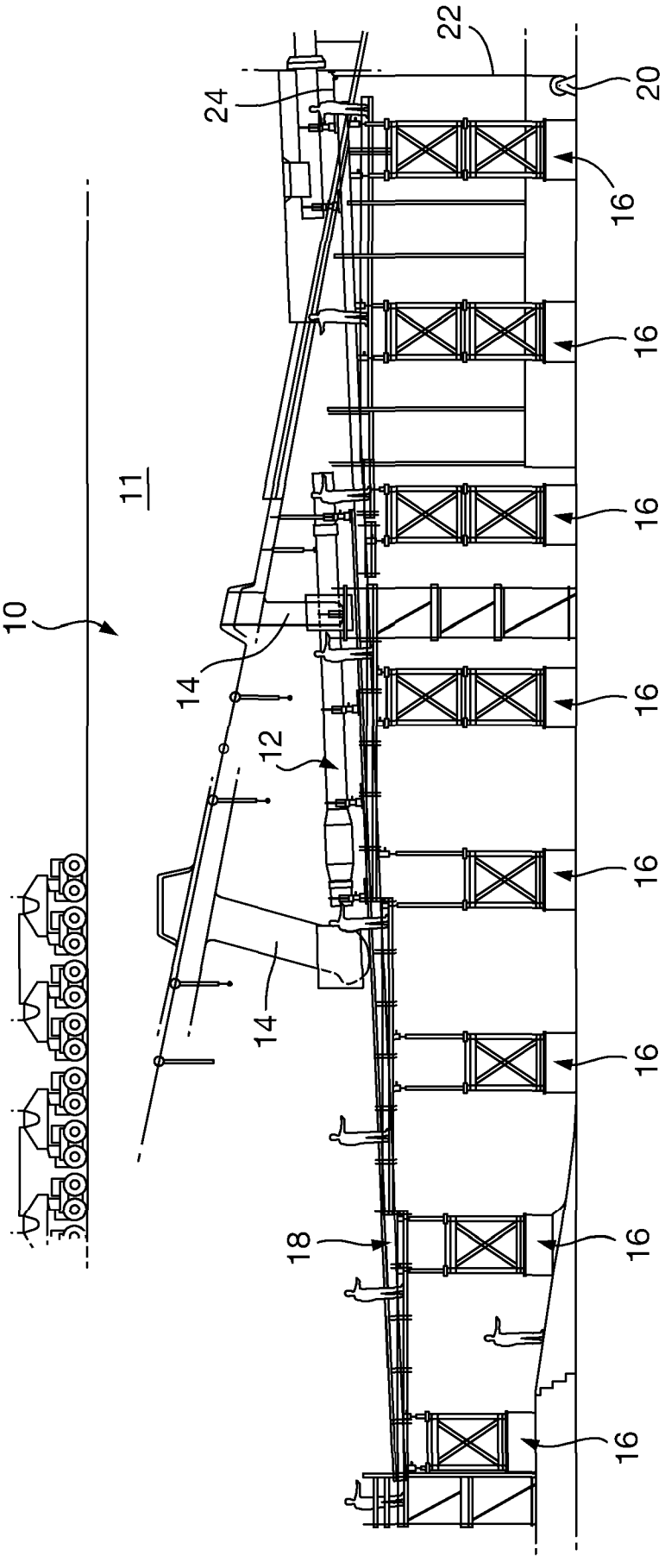


Fig. 2

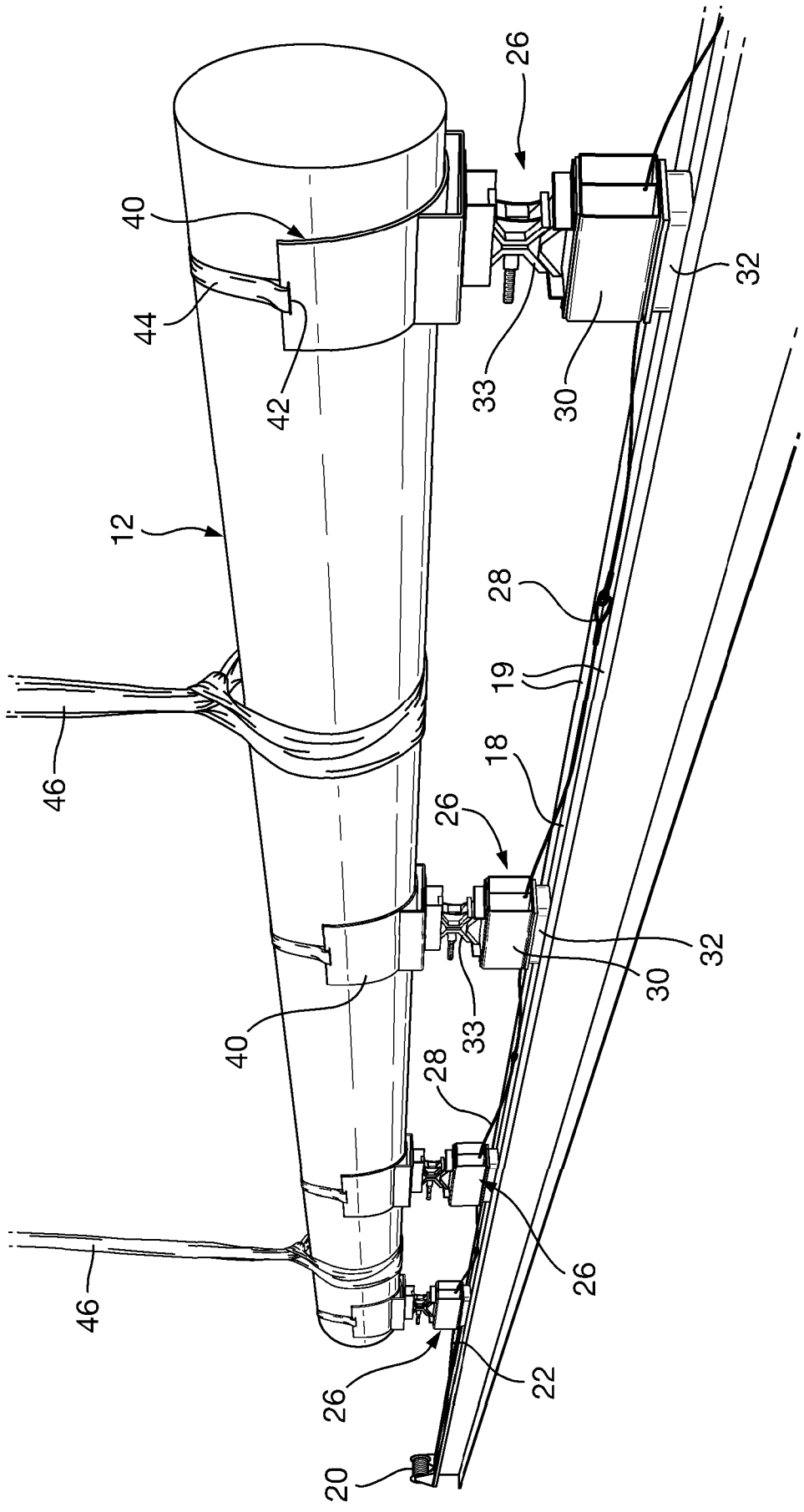


Fig. 3(a)

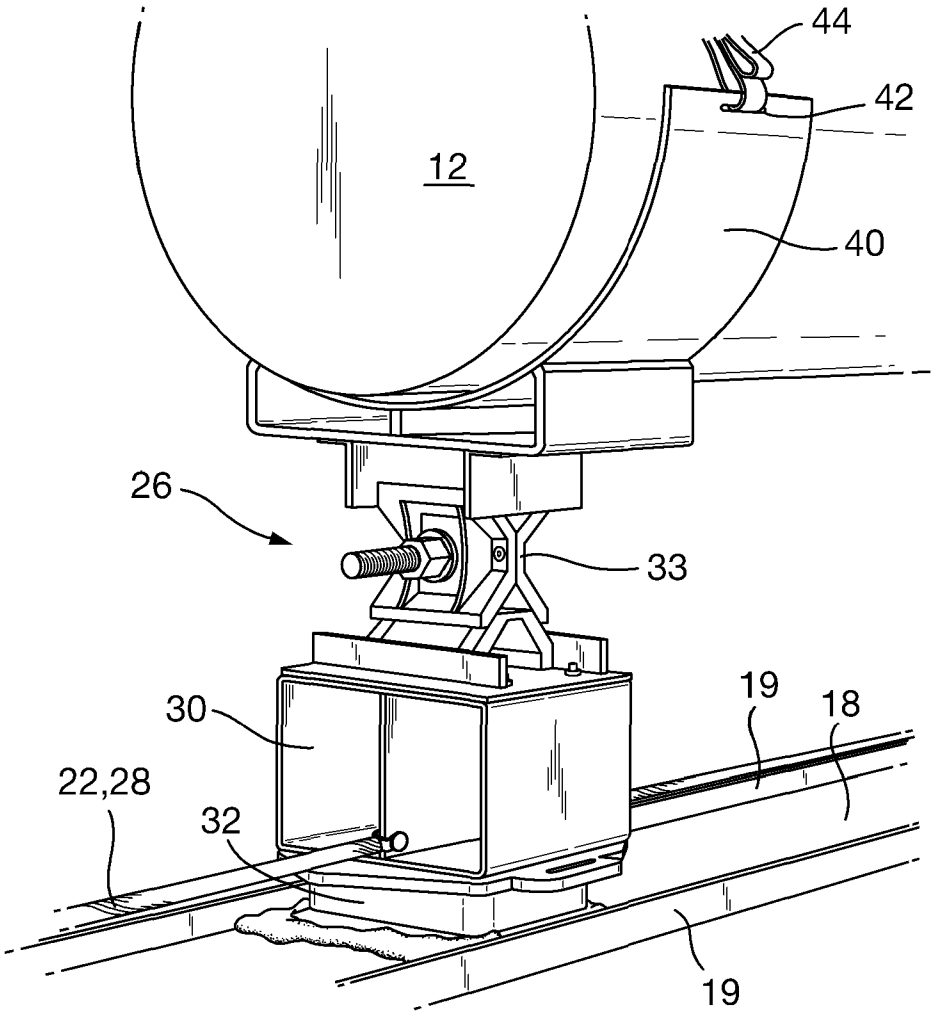


Fig. 3(b)