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# DESCRIPTION

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

[0001] The present invention relates generally to the repair of underground utilities, and more particularly to equipment that is used to modify the positioning of underground pipe.

### 2. Description of the Related Art

[0002] It is generally known that sewer lines should be constructed with a minimum fall of  $\frac{1}{4}$  inch per 1 foot of pipe. This allows wastewater to continue flowing via gravity through the pipe while minimizing any deposit of debris. When pipes have sags, or low spots in the pipe, also known as "belly", that don't meet this minimum fall, debris can settle into the low spots. Sags are typically a problem when they are severe enough to cause debris to settle in the pipe. The sag or belly is where the sewer pipe has lost a continuous slope on its way to its destination, and where the rate at which liquids travel through it is significantly reduced. The reduced velocity of liquids allows the belly area to collect solids, eventually obstructing the line, resulting in sewer backups.

[0003] Additionally, the Clean Water Act has mandated that ground water infiltration into our sewer systems be substantially reduced or eliminated. Many methods of repair of pipelines have been devised. Some of those repair methods include slip lining, pipe bursting, cured in place pipe lining (CIPP), fold and form thermoplastic lining, spot repairs, as well as the traditional dig and removal/replacement of pipelines.

[0004] The "in situ lining" repair of pipes has often been the most effective alternative to pipe "dig and replacement". An annular space or void adjacent to the outside surface of the pipe can be injected with a gelatinous grout material to eliminate water infiltration into the pipe. This repair is only temporary since the gelatinous material is not dimensionally stable and often requires later replacement. The grout material is not capable of stabilizing the ground around the pipe even if the entire annular space is filled with the gelatinous grout. The lack of stability and support can result in additional stress on the pipe structure, with eventual degradation of the pipe and resulting water infiltration. This sort of in situ repair deals with leaks, but fails to address dips or sags in the pipeline.

[0005] Injection of expanding closed cell foams and cementitious grout has been used to level or reinforce pipe sections; however, there can be a migration of the foam or grout into the pipe joint that, if left in place, can cause an occlusion or blockage. When this migration into the

interior diameter of the pipe does occur, a cutting or grinding device must be inserted as a subsequent step to remove the excess foam or grout.

**[0006]** Remedial repairs of infrastructures that have experienced differential settlement supported on soils often rely on helical piers and brackets in conjunction with excavation to support below grade utilities. However, these devices cannot lift a utility to an original elevation but rather immobilize the utility from further settlement. Often, these piers and brackets are installed in conjunction with newly installed utilities in weak soil environments to minimize the likelihood of future settlement.

**[0007]** Presently, there is no known mechanical device for the raising of below grade utilities which can be operated for the use of utility raising without excavation. Presently, one known methodology/process for raising below grade utilities is compaction grouting. Currently, the process for raising below grade utilities without excavation has been through the use of compaction grouting utilizing either cementitious grout or an expanding polyurethane foam. Cementitious grouting is primarily limited to exterior uses due to the nature of the work. Polyurethane grouting is considerably cleaner and a more expeditious process. However, with both techniques the amount of achievable lift is dependent upon soil type, age of the pipeline and the amount of settlement. From WO 2014/091474 A1 an apparatus for lifting and supporting pipelines through which is flowable fuel, gas or hazardous industrial liquids, for maintenance and restoration purposes, which comprises a hybrid sling for supporting a pipeline segment when being raised, where the sling comprises a flexible belt portion contacting an underside of the pipeline segment and a chain portion vertically extending from each end of the belt portions to an element through which a lifting force is transmittable has been made known. The sling is assured of being sufficiently structurally strong and dimensionally stable to ensure that the difference in height of any two points of the segment when being raised is not so great as to create a danger to the integrity of the pipeline.

**[0008]** US 4,028,903 B1 discloses a method and apparatus for laterally maneuvering the end of pipes supported on the seabed under a body of water. The method includes mounting a first support frame adjacent to one of the pipe ends and supporting the first frame on the seabottom. A connecting means is secured between the pipe and the first support frame and thereafter the adjacent pipe is raised by applying a lifting force to the connecting means. A second separate support frame is mounted adjacent to the other of said pipes and with the second frame being supported on the seabottom. Another connecting means is secured between the other pipe and the second support member and the other pipe is raised by applying a lifting force to the other connecting means. Thereafter, with both pipe ends thus supported in cantilevered fashion, the pipe ends are moved laterally and vertically relative to the support frame until the pipe ends are brought into positions where the axes thereof generally intersect.

**[0009]** DE 10 2016 103 534 A1 discloses a system for shoring a trench, which is dug for receiving a pipeline and includes spaced apart sidewalls, includes at least two supporting units that are spaced apart from one another in the longitudinal direction of the trench and

configured for absorbing transverse forces from the sidewalls. Disposed between the two supporting units is a plurality of shoring units, each configured for supporting the sidewalls of the trench. Together with the supporting units, the shoring units are configured to form a barrier-free lowering space within which the pipe can be lowered into the trench from outside the trench to the floor of the trench. A method for laying a pipe using the shoring system is also disclosed.

**[0010]** Problem in the art is that an in situ method of removing pipe sags and stabilize the position of the pipes, without the drawbacks discussed above should be provided, to enable utility lines to be raised with precision regardless of the soil type.

### **SUMMARY OF THE INVENTION**

**[0011]** The above problem is solved by a method of claim 1 and an underground utility according to claim 9. By the invention especially an underground utility grade restoration device and method is provided.

**[0012]** The invention in one form is directed to a method for in situ relocation of an underground utility including the steps of inserting, extending, raising and continuing to raise. The inserting step is carried out by the inserting of at least one lifting member down into the ground alongside the underground utility. The extending step extends a lifting bracket from the at least one lifting member. The raising step raises the lifting member causing the lifting bracket to engage a portion of the underground utility. The continuing step continues to raise the lifting member until the underground utility reaches a predetermined position.

**[0013]** The invention in another form is directed to an underground utility in situ relocation mechanism including a beam, a lifting device coupled to the beam, the lifting device being positioned on a surface of the ground, and a plurality of lifting members for insertion down into the ground alongside the underground utility. The lifting members are coupled to the beam, each of the lifting members having a lifting bracket that is extensible from the respective lifting member. The lifting bracket engages a portion of the underground utility. The lifting device is configured to apply an upward force on the beam that withdraws the lifting members, to some extent, from the ground to thereby lift the underground utility to a predetermined position.

**[0014]** The invention in still another form is directed to an underground utility relocation system for use with a lifting device. The system includes at least one lifting member for insertion down into the ground alongside the underground utility. The lifting members are coupleable to the lifting device. The lifting member has a lifting bracket that is extensible from the respective lifting member. The lifting bracket is capable of engaging a portion of the underground utility. The lifting device is configured to apply an upward force on the lifting member that withdraws the lifting member to some extent from the ground to thereby lift the underground utility to a predetermined position.

**[0015]** An advantage of the present invention is that the sag of an underground utility can be eliminated without excavating the utility.

**[0016]** Another advantage is that the present invention allows for a precise staged movement of the sections of the utility.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0017]** The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematical side view of an embodiment of three pipeline lifting devices of the present invention positioned to alter a sagged pipeline;

Fig. 2 is an enlarged schematical view of one of the lifting devices of Fig. 1;

Fig. 3 is a further side view of a portion of a lifting device of Figs. 1 and 2;

Fig. 4 is another detailed view of a portion of a lifting member of the lifting devices of Figs. 1-3, showing the extension of a lifting bracket;

Fig. 5 is another view of the portion of the lifting member of Fig. 4, with the lifting bracket positioned within the lifting member;

Fig. 6 is a schematical representation of a void created by the extension of the lifting bracket of Fig. 4;

Fig. 7 is a schematical representation of a lifting system of the present invention; and

Fig. 8 is another embodiment of a lifting bracket of the present invention.

**[0018]** Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one embodiment of the invention, in one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

#### **DETAILED DESCRIPTION OF THE INVENTION**

**[0019]** Referring now to the drawings, and more particularly to Fig. 1, there is shown a system 10 for the in situ relocation of a buried pipe 14. There are shown three underground utility in

situ relocation mechanisms 12 each having hydraulic rams 16 also referred to as a lifting device 16, a beam 18, lifting members 20 and lifting collars 22.

**[0020]** Three pipe segments are identified as segments 14A, 14B, and 14C with joints J1, J2, J3 and J4 of the segments identifying where each segment 14A, 14B, and 14C is coupled to an adjacent pipe segment. Pipes 14 once installed sometimes develop sags or what is also referred to as a belly, which is illustrated by segments 14A, 14B, and 14C, in perhaps a somewhat exaggerated manner, to illustrate the problem that system 10 corrects.

**[0021]** A survey of the condition of pipe 14 may reveal the location of the sage of pipe segments 14A, 14B, and 14C as well as the locations of joints J1, J2, J3 and J4. Such a survey, perhaps with a sensor package inserted inside of pipe 14, assists in the positioning of lifting members 20 alongside of pipe 14 at the appropriate locations. Lifting members 20 are driven into the ground using conventional methods so that sections of pipe 14 can be engaged (discussed later) and lifted.

**[0022]** Here lifting members 20A and 20 B are positioned along pipe 14, with lifting member 20A being to the left of joint J1 and lifting member 20B being to the right of joint J1. In a like manner lifting members 20C, 20D, 20E, 20F, 20G and 20H are respectively arranged about joints J2, J3 and J4. Lifting members 20 are slidingly engaged with respective beams 18 with lifting collars 22 being clamped onto lifting members 20 so that the distance above beam 18 is selected to properly raise the respective pipe sections of pipe 14. Here lifting collars 22A and 22B are positioned above beam 18, while collars 22C and 22D are positioned on beam 18. In a similar fashion collars 22E and 22F are positioned on another beam 18 while collars 22G and 22H are located above beam 18. Note collar 22G is a bit closer to beam 18 than collar 22H. When lifting devices 16, which are positioned on ground G, in the form of hydraulic rams 16, are activated the lifting of pipe section 14B starts before the lifting starts at joints J1 and J4.

**[0023]** Now, additionally referring to Figs. 2 and 3 there is shown a more schematized view of a lifting mechanism 12, with hydraulic rams 16 supporting beam 18 as lifting members 20 are supported by beam 18. Collar 22A may be positioned a distance 24 above beam 18, so that lifting member 20B will start lifting pipe section 14A before lifting member 20A starts to lift. The positioning of collars 22 can be arranged with a laser system or other reference apparatus.

**[0024]** Now, additionally referring to Figs. 4 and 5 there are shown details of the lower end of lifting members 20 and how the system 10 engages pipe 14. A lifting bracket 30 is stowed within lifting member 20 as lifting member 20 is driven in direction 26 into ground G. A sacrificial point 32, with an oversized diameter is placed on the end of lifting member 20 as it is driven into the ground in direction 26, so that sacrificial point 32 provides a side clearance in the penetration of the soil for lifting member 20. As lifting member 20 is moved in direction 28 lifting member 20 disengages from sacrificial point 32.

**[0025]** Initially lifting member 20 is driven in direction 26 so that lifting member 20 is at a depth such that lifting bracket 30 can be deployed from within lifting member 20. A pivoting

mechanism, not specifically shown, causes lifting bracket 30 to pivot about axis A in an outwardly direction. Liquid cutting jets 34 are positioned along a portion of lifting bracket 30 so that a high pressure liquid, such as water, can be sprayed out to remove or soften the soil adjacent to lifting member 20 as lifting bracket 30 is deployed. The excess liquid and moistened soil may be pumped up lifting member 20 to create a void as lifting bracket 30 moves to position 30A. Lifting bracket 30 exits from lifting member 20 through a slot 36 in a side of lifting member 20.

**[0026]** The high pressure liquid is supplied by way of a line 38 that is supplied from a source, not shown, at the top side of mechanism 12. Once lifting bracket 30 is deployed then lifting member 20 is moved in direction 28 so that lifting bracket 30 then is in the position illustrated at 30B, so that lifting member 20 engages pipe 14. Lifting of utility 14 continues as lifting members 20 are lifted by lifting devices 16. Once the lifting process of pipe 14 is completed, then a supporting foam, grout or other material is injected in the void beneath pipe 14 by way of a supply line 40 that may have nozzles along a portion of lifting member 20. Then in coordination with these supporting steps, lifting member is moved in direction 26 and lifting bracket 30 is pivoted about axis A back through slot 36 into lifting member 20 and then lifting member 20 is withdrawn from ground G.

**[0027]** Now, additionally referring to Fig. 6 there is shown a top down look at lifting bracket 30 that emits a stream 42 of high pressure liquid to form a void 44. Void 44 may be empty or consist of a liquid slurry through which lifting bracket 30 can pivot, about axis A outward into void 44. In a like manner lifting bracket 30 may be retracted back into lifting member 20 as it exits void 44. Material from supply line 40 is then injected into void 44, which can also be thought of as an extended void 44 beneath the lifted section of pipe 14.

**[0028]** Now, additionally referring to Fig. 7, there is illustrated more details of lifting system 10, which has a controller 100 coupled to multiple in situ lifting mechanisms 12. Controller 100 controls the deployment and retraction of lifting brackets 30, as well as the lifting sequence of lifting members 20 and the extent to which pipe 14 is lifted by lifting devices 16. It is contemplated that some of the movement of lifting members 20 in direction 26 can be effected with lifting devices 16 and the weight associated therewith.

**[0029]** Now, additionally referring to Fig. 8 there is shown a cross sectional view of a portion of lifting member 20. Lifting bracket 30 is deployed through slot 36 and an extended back portion of lifting bracket 30 may exit through a slot 37 so that lifting bracket 30 is supported by both sides of the shell of lifting member 20. It is also contemplated that rather than having a slot 37, a protrusion can extend inward from the inside wall so that a portion of lifting bracket 30 can come into contact with it to also support lifting bracket 30.

**[0030]** The present invention is carried out using a method for in situ relocation of an underground utility 14 including the steps of inserting, extending, raising and continuing to raise. The inserting step is carried out by the inserting of at least one lifting member 20 down into the ground G alongside the underground utility 14. The extending step extends lifting

bracket 30 from lifting member 20. The raising step raises the lifting member 20 causing the lifting bracket 30 to engage a portion of the underground utility 14. The continuing step continues to raise the lifting member 20 until the underground utility 14 reaches a predetermined position.

**[0031]** The method further includes the step of inserting material beneath the underground utility 14 thereby supporting the underground utility 14 at the predetermined position. The material flows through the lifting member 20 and/or lifting bracket 30. The method further includes a step of hydro-excavating soil proximate to lifting bracket 30 at least one of prior to and during the execution of the extending step to create void 44. The hydro-excavating step includes emitting water from at least one jet 34 on lifting bracket 30. The extending step includes pivoting of lifting bracket 30 from lifting member 20 as the emitting step takes place. During the extending step a pivoting step takes place in which lifting bracket 30 is pivoted from lifting member 20.

**[0032]** The present invention is an innovative technique that addresses the remedial repair of below grade infrastructures 14 that have experienced differential settlement due to soil loss or consolidation of supporting soils. The device 12 is installed adjacent to the utility line 14 followed by the extension of a lateral cradling bracket 30, which is then elevated to lift the utility line 14 to a higher elevation.

**[0033]** A steel pipe or casing 20 is driven to a predetermined depth adjacent to the buried utility 14, allowing for the deployment of the lifting bracket 30 beneath the utility 14. The lifting bracket 30 is completely housed within the interior of the casing diameter 20, enabling the casing 20 to be driven next to the utility 14.

**[0034]** An articulating steel bracket 30, recessed within the casing 20, is either manually or hydraulically extended. Top of the bracket 30 has a saddle for the utility 14 to rest in, thus minimizing point loading. Hydro jets 34 are recessed in the bottom of the bracket 30 to help weaken soils and aid in the extension of the bracket 30. If necessary, the jets 34 are activated during the extension of bracket 30, dependent upon type of soil and density. By weakening the soils, the jets 34 also assist in creating void 44 for the placement of grout therein.

**[0035]** Depending on the diameter of the utility 14, settlement and length of repair, a single or multiple lifting members 20, each having a lifting bracket 30, may be installed and employed in unison (as shown in Fig. 1) to achieve a desired lift or stabilization.

**[0036]** Once the brackets 30 are in place, hydraulic rams 16 are utilized to raise the casing 20 and attached lifting bracket 30 to the utility 14 underside and continue until the desired lift has been achieved. Upon successful raising of utility 14, the casing 20 is lowered, and the bracket 30 is retracted within the casing 20. The rams 16 are reactivated, and the casing 20 is extracted from the ground G.

**[0037]** At grade, a single or unison of clamps 22 are attached to the casings 20. Clamp

locations can be adjusted at varying elevations for allowance of more progressive lifts. Where headroom allows, a lifting beam 18 and harness can be used in place of a series of hydraulic rams associated with each lifting member 20.

**[0038]** It is contemplated that the interior of the lifting member 20 and components therein may be affixed or inserted from grade.

**[0039]** The development of the present invention has resulted in devices 12 to lift below grade utilities 14 and infrastructure for the purposes of supporting and lifting the utilities 14 to a desired elevation and to restore a uniform flow of any drainage if pipe 14 is a drain line. The elements of the present invention are used to accomplish utility, infrastructure and below grade structure lifting and immobilizing without correctional excavation. The device cuts soils from pre-determined locations, at elevations below the surface ground. The device can contact and cradle the below grade utility 14 for the purposes of remediation, elevation and immobilization.

**[0040]** The manufactured cavities 44 allow the lifting bracket arm 30 to be extended without restriction to an elevation directly below the item 14 to be raised.

**[0041]** Some of the benefits and advantages of the present invention include that an interior mechanical device 30 is contained within a small diameter, installation in extremely close proximity to the item 14 to be lifted is accomplished. Also the extending lifting bracket 30 is capable of cradling a utility 14 in numerous locations with incrementally accurate lifts, which minimizes stress to the utility 14 and allows for precision realignment of the utility 14.

## **REFERENCES CITED IN THE DESCRIPTION**

Cited references

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**

- [WO2014091474A1 \[0007\]](#)
- [US4028903B1 \[0008\]](#)
- [DE102016103534A1 \[0009\]](#)

**PATENTKRAV**

1. Fremgangsmåde til in situ relokering af en underjordisk forsyningsindretning omfattende trinnene med indsætning af i det mindste et løfteelement (16) ned i jorden langs  
5 en nedgravet underjordisk forsyningsindretning;

**kendetegnet ved, at**

- en løftebøjle (30) udstrækkes fra det i det mindste ene løfteelement (20);  
hævning af løfteelementet (20) forårsager at løftebøjlen indgriber med en del af  
10 den nedgravede underjordiske forsyningsindretning; og  
fortsat hævning af løfteelementet (20) indtil den nedgravede underjordiske forsyningsindretning når en forudbestemt position.

2. Fremgangsmåde ifølge krav 1, som yderligere omfatter trinnet med indsætning af  
15 materiale under den nedgravede underjordiske forsyningsindretning for derved at understøtte den underjordiske forsyningsindretning ved den forudbestemte position.

3. Fremgangsmåde ifølge krav 2, hvor materialet strømmer igennem i det mindste én af løfteelementet (20) og løftebøjlen (30).

20

4. Fremgangsmåde ifølge krav 1, som yderligere omfatter et trin med hydro-udgravning af jord i tilstødning til løftebøjlen (30) før og/eller under udførelse af udstrækningstrinnet.

- 25 5. Fremgangsmåde ifølge krav 4, hvor hydro-udgravningstrinnet omfatter udsending af vand fra i det mindste én dyse på løftebøjlen (30).

6. Fremgangsmåde ifølge krav 5, hvor udstrækningstrinnet omfatter et trin med vipning af løftebøjlen (30) fra løfteelementet (20) medens udsendingstrinnet finder sted.

30

7. Fremgangsmåde ifølge krav 1, hvor udstrækningstrinnet omfatter et trin med vipning af løftebøjlen (30) fra løfteelementet (20).

8. Fremgangsmåde ifølge krav 1, hvor det i det mindste ene løfteelement (20) omfatter  
35 et første løfteelement (20A) og et andet løfteelement (20B), indsætningstrinnet omfatter indsætning af det første løfteelement (20A) i tilstødning til den underjordiske forsy-

ningsindretning på én side af en samling i den underjordiske forsyningsindretning og indsætning af det andet løfteelement (20B) i tilstødning til den underjordiske forsyningsindretning på en anden side af samlingen, således at hævnningen og fortsættelsestrinnene finder sted på begge sider af samlingen.

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9. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14), omfattende

en bjælke (18);

10 en løfteindretning (16) forbundet med bjælken (18), hvilken løfteindretning (16) er placeret på en overflade af jorden; og adskillige løfteelementer (20) til indsætning ned i jorden langs en nedgravet underjordisk forsyningsindretning, hvilke løfteelementer (20) er forbundet med bjælken (18),

15 **kendetegnet ved, at**

hvert af løfteelementerne (20) har en løftebøjle (30), som kan udstrækkes fra det respektive løfteelement (20), hvilken løftebøjle (30) indgriber med en del af den nedgravede underjordiske forsyningsindretning, løfteindretningen er konfigureret til at påføre en opadrettet kraft på bjælken (18), som trækker løfteelementerne 20 (20) i en vis udstrækning fra jorden, for derved at løfte den nedgravede underjordiske forsyningsindretning til en forudbestemt position.

10. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14) ifølge krav 9, hvor i det mindste ét af løfteelementerne (20) omfatter en ledningsstreng, som 25 leverer materiale under den nedgravede underjordiske forsyningsindretning, for derved at understøtte den underjordiske forsyningsindretning ved den forudbestemte position.

11. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14) ifølge krav 10, hvor materialet strømmer i det mindste en del af vejen langs løftebøjlen (30).

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12. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14) ifølge krav 9, hvor i det mindste én af løfteelementet (20) og løftebøjlen (30) har i det mindste en vandudsøsende dyse (34), som er konfigureret til hydro-udgravning af jord i tilstødning til løftebøjlen (30) før og/eller under udstrækning af løftebøjlen (30) fra 35 løfteelementet (20).

13. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14) ifølge krav 12, hvor løftebjælen (30) strækkes ud fra løfteelementet (20) ved at vippe derfra.

14. Mekanisme til in situ relokering af en underjordisk forsyningsindretning (14) ifølge krav 9, hvor det i det mindste ene løfteelement (20) omfatter et første løfteelement (20A), et andet løfteelement (20B), et tredje løfteelement (20C) og et fjerde løfteelement (20D), idet det første løfteelement (20A) indsættes i jorden i tilstødning til den underjordiske forsyningsindretning (14) på én side af en første samling i den underjordiske forsyningsindretning og det andet løfteelement (20B) indsættes i jorden i tilstødning til den underjordiske forsyningsindretning (14) på en anden side af den første samling, det tredje løfteelement (20C) indsættes i jorden i tilstødning til den underjordiske forsyningsindretning (14) på én side af en anden samling i den underjordiske forsyningsindretning (14) og det fjerde løfteelement (20D) indsættes i jorden i tilstødning til den underjordiske forsyningsindretning (14) på en anden side af den anden samling, idet det første løfteelement (20A), det andet løfteelement (20B), det tredje løfteelement (20C) og det fjerde løfteelement (20D) hver især er forbundet med bjælken (18) således, at løftningen af bjælken (18) ved hjælp af løfteindretningen forårsager at et forsyningsindretningssegment imellem den første samling og den anden samling løftes til den forudbestemte position.

20



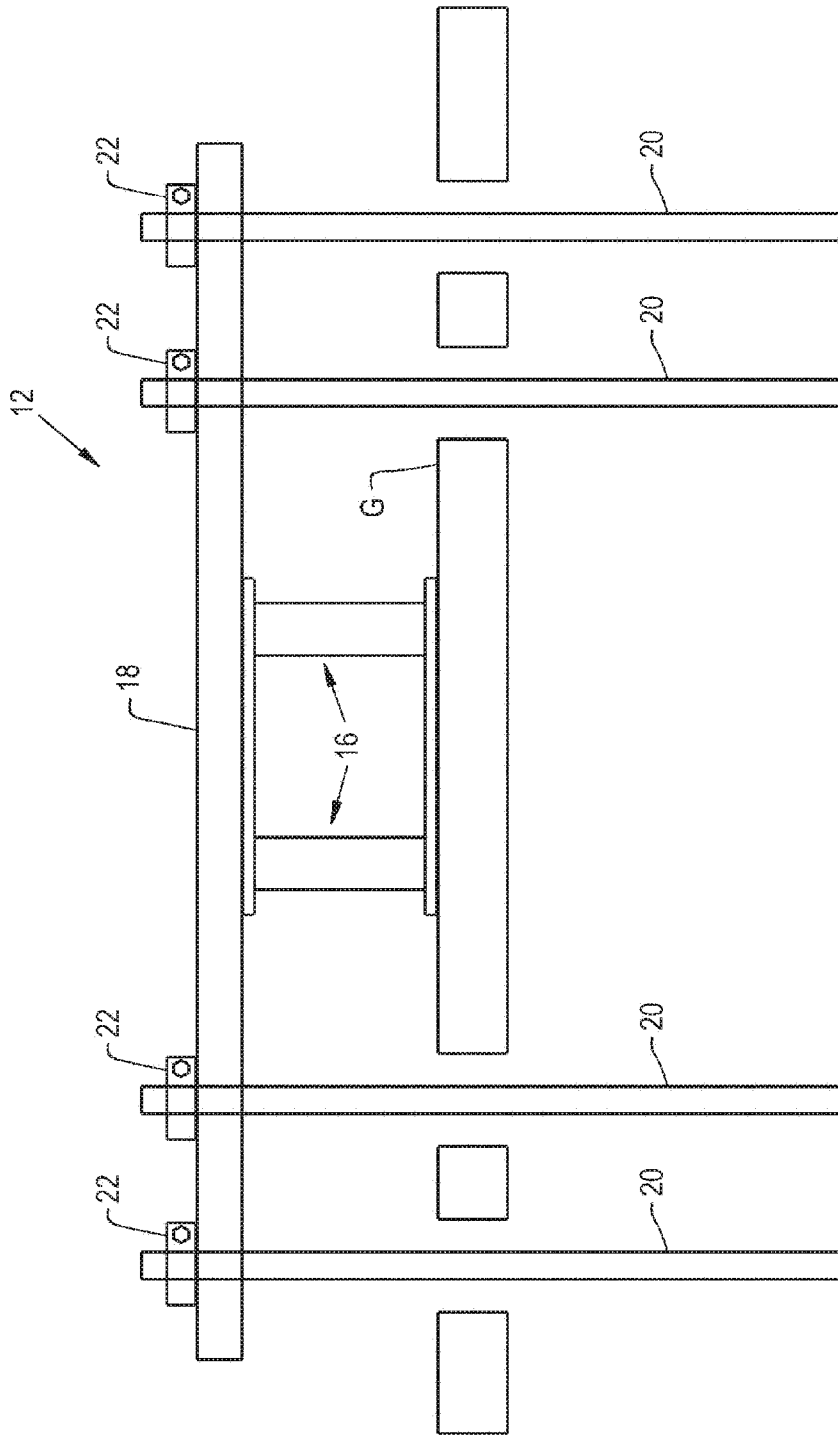


Fig. 2

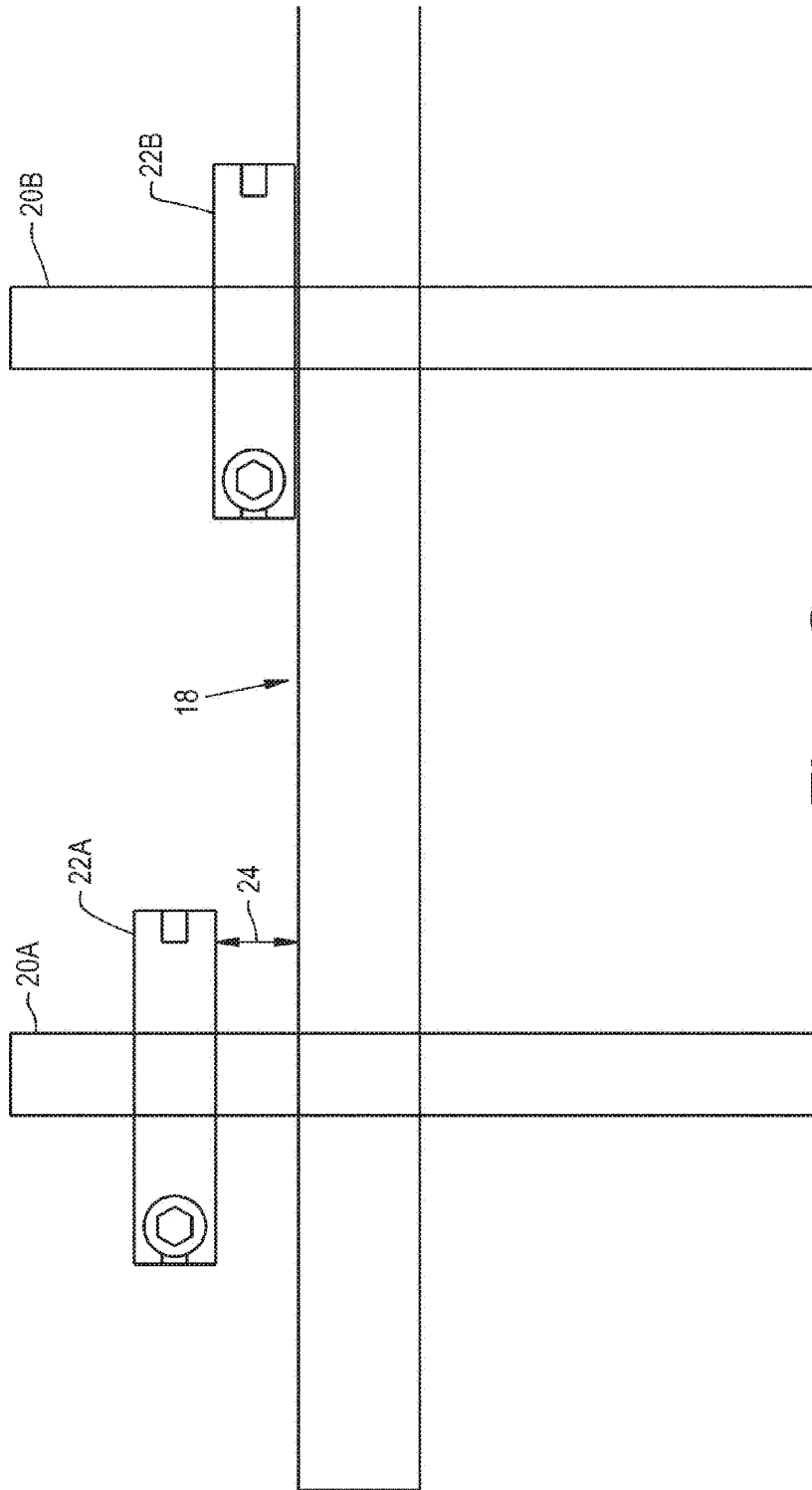


Fig. 3

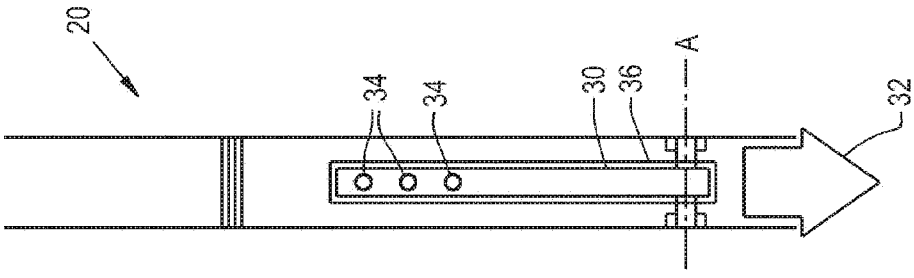


Fig. 5

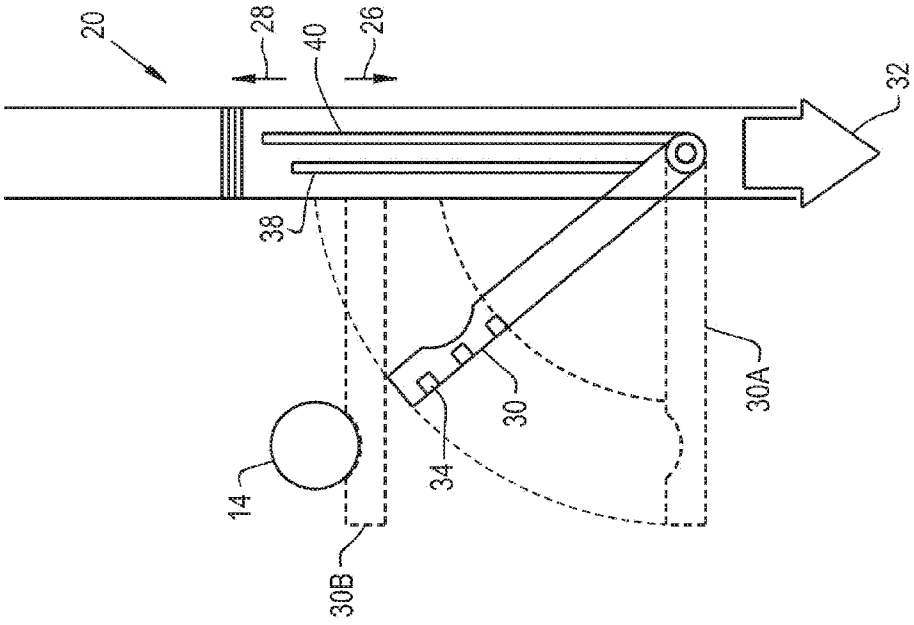


Fig. 4

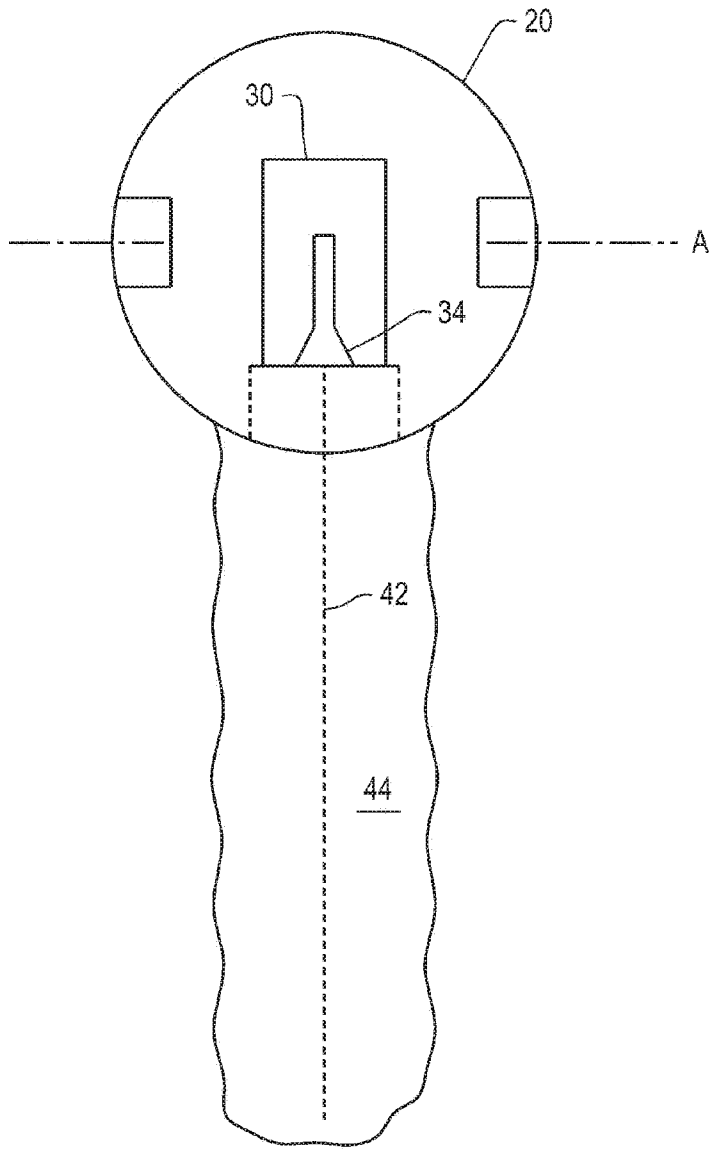


Fig. 6

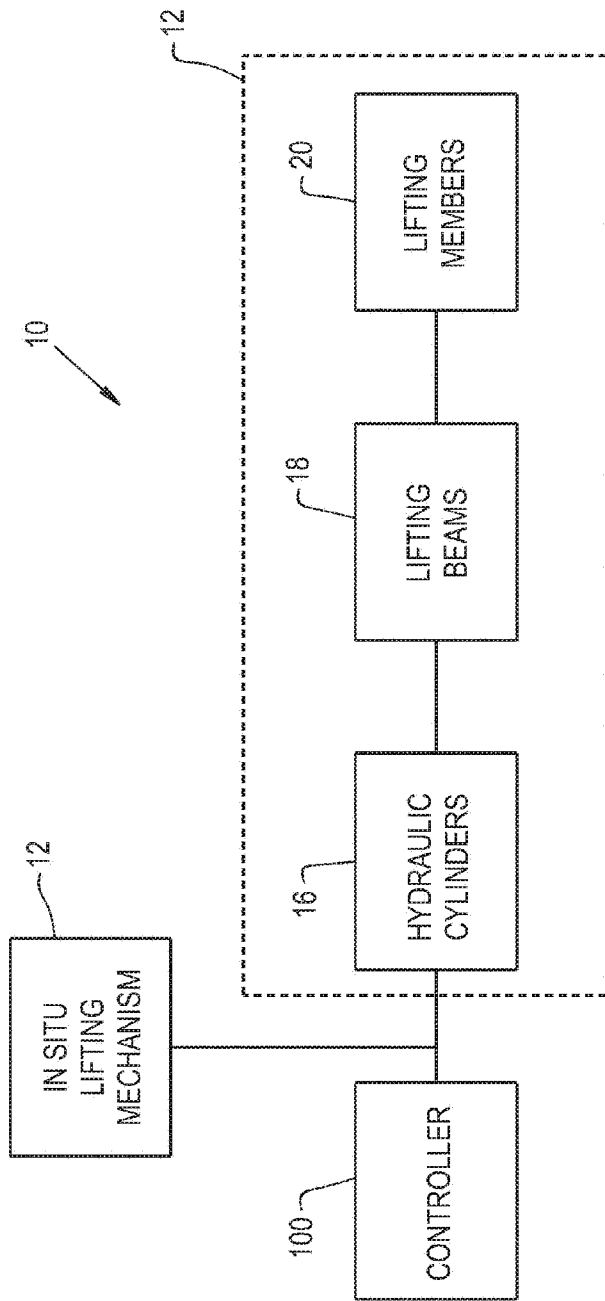


Fig. 7

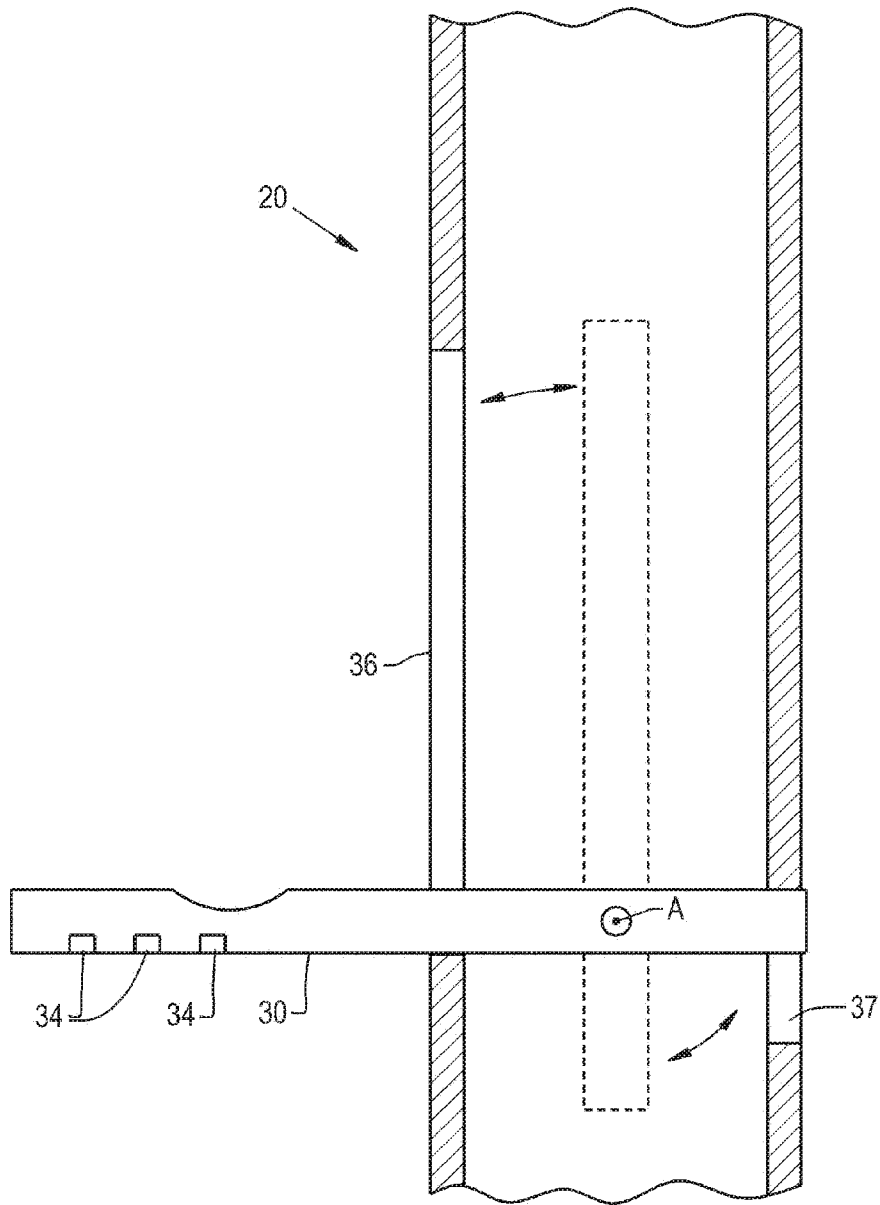


Fig. 8