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(54) **Device and method for deforming a conduit.**

(57) An aspect relates to deformation of an underground conduit. The cross-sectional shape of the conduit is deformed by enlarging a first cross-sectional dimension of the conduit. Another deformation may be established, at least partially undoing the first deformation and optionally increased a second cross-sectional dimension of the conduit. Yet a further deformation may be established, decreasing the dimension enlarged by previous deformations. Subsequently, the conduit may be removed from the ground.

For deformation, a tool is used. The tool is arranged by exercising forces to the inner surface of the conduit, resulting in the increased dimension. The tool may comprise an elongated body and deformation members protruding from the body. The width of the deformation member is larger than the initial diameter of the conduit. At the end of the tool, viewed from the transportation direction of the tool, a further deformation member may be provided for reducing the dimensions.

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Title: Device and method for deforming a conduit

Technical field

The various aspects apply to the field of removal of conduits from a medium and removal of underground pipes in particular.

Background

With changes in substances used in industrial processes and further consumption of substances, systems for transportation of the substances change. One of such substances is natural gas. Changes in supply and demand and changes in locations of supply and demand in particular results in changes in distribution infrastructure. Certain pipes are not used anymore. Alternatively, pipes need to be replaced from a maintenance perspective. As the pipes are made out of high-quality steel or alloys or other materials, reclaiming the materials comprised by those pipes may be advantageous.

Removing pipes from the ground may be done by digging ditches and lifting the pipe. Alternatively, pits are dug along the track of the piping at regular intervals and pipes are pulled from the ground. As frictional forces between the ground and the pipes are high, the intervals between the pits should be short.

Summary

It is preferred to be able to place the pits further away than possible using conventional methods for removing underground piping.

A first aspect provides a device for

establishing a deformation of a conduit having a cross-section having a cross-section dimension. The device comprises an elongated body having a body centre axis, a leading end and a trailing end, the body being arranged to be transported through the conduit with the leading end leading. The device further comprises a first deformation module provided at a first position of the body, the first deformation module comprising at least two protrusions defining a first deformation circle having a diameter larger than the cross-section dimension and a centre coinciding with the centre axis. And the device comprises a second deformation module provided between the first deformation module and the trailing end, the second deformation module comprising at least one deformation element extending outwardly from the body perpendicular to the centre axis, the deformation element defining a second deformation circle having a circle centre that substantially coincides with the centre axis and having a cross-section smaller than the first deformation circle.

By pulling the device through the conduit, like a pipe, and applying the specified forces, the conduit is deformed. In particular, the shape of the cross-section is deformed. More in particular, the cross-section of the conduit is enlarged in one direction by enlarging the cross-section dimension. With the conduit having a circularly shaped cross-section, the cross-section dimension is the diameter of the conduit. With a rectangular or square cross-section, the cross-section dimension may be a diagonal of the rectangle. Alternatively, the cross-section dimension may be substantially equal to the length of a side of the rectangle. More in general, the cross-section dimension may be the shortest possible length of a straight line through the centre of the conduit, from wall to wall of the conduit.

With for example only two - opposite - forces applied to a, for example, circular, conduit, the conduit will have an elliptical cross-section. This deformation may be elastic, plastic or a combination thereof. In case of an elastic deformation, the pipe resumes its shape prior to the deformation once applied forces are removed. In case of a plastic deformation, the pipe maintains its deformed shape after removal of forces that caused the deformation.

By applying a subsequent deformation by means of the second deformation module, the first deformation is at least partially undone. This may result for example in reinstating the initial circular cross-section and in any case in reduction of the cross-section enlarged by means of the first deformation. But with reduction of that cross-section, the medium does not necessarily flow back at its original location: voids are left. And in those voids, there is no contact between the outer surface of the conduit and the medium. And therefore, the amount of friction between the conduit and the medium is reduced.

More importantly, due to the deformations, bonding between the medium and the outer surface of the conduit is broken for at least part of the surface and preferably most of the surface. Such bonding may be due to hydrodynamic forces, mechanical forces, chemical bonds, other, or a combination thereof. Hence, the deformation results in less contact between the outer wall of the conduit and the medium as a result of creation of voids and/or breaking of bonds between the medium and the conduit. For breaking the bond, an elastic deformation of the cross-section of the conduit may be sufficient. As a result, less force is required for removing the conduit from the medium. Or with the same amount of force, a larger segment of the conduit may be removed from the medium. The latter option is advantageous, as compared to the state of the art, less pits are required for removing a stretch of conduit with the same force.

An embodiment of the device comprises a third deformation module provided between the first deformation module and the second deformation module, the third deformation module comprising at least two protrusions defining a third deformation circle having a diameter larger than the cross-section diameter, wherein the protrusions of the third deformation module are skewed over the centre axis relative to the protrusions of the first deformation module. This embodiment allows for creating of additional voids adjacent to the conduit, which results in a further reduction of the friction.

In another embodiment of the device, the first deformation module comprises a first deformation member and a second deformation member, the deformation members having a proximal deformation end connected to the body and a distal deformation end provided at a distance from the body, the deformation members being provided annularly and equidistantly spaced apart over the body centre axis.

In case of the first deformation module comprising two deformation members, the deformation members are spaced apart at 180 degrees, over the body centre axis. In case of three deformation members, the deformation members are spaced apart at 120 degrees and in case of five deformation members, the deformation members are spaced apart at 72 degrees over the body centre axis. This embodiment is relatively simple to manufacture and to use.

In a further embodiment, at least one of the deformation members is provided with a substantially circular rotation member that is rotatable mounted the distal deformation end of the at least one of the deformation members such that the rotation member extends beyond the distal deformation end, wherein the rotation axis of the rotation member is substantially perpendicular to the centre axis and substantially perpendicular to a line from the centre axis to the distal deformation end.

This embodiment reduces friction between the deformation members and the inner surface of the conduit.

In again another embodiment of the device, the second deformation module comprises a conically shaped deformation member having a cone axis that substantially coincides with the body centre axis, wherein the base of the conically shaped deformation member is provided towards the trailing end of the body.

This embodiment enables brining the cross-section of the conduit back in its original shape, in particular with a conduit having initially a circularly shaped cross-section.

A second aspect provides a method of reducing friction between a conduit and a medium surrounding the conduit. The method comprises establishing a first deformation of the conduit by applying at least a first force and a second force having a component perpendicular to a centre axis of the conduit, the sum of the applied forces being substantially zero perpendicular to the centre axis. The method further comprises establishing a second deformation of the conduit, thereby at least partially undoing the first deformation.

Such method enables convenient removal of the conduit from the medium, as friction between the medium is reduced. The first deformation may be plastic, elastic or a combination thereof. In case of a substantially solely elastic first deformation, the second deformation is established by removing a force that established the first deformation. In case of a plastic deformation, the second deformation may be established by applying force to the conduit. A third aspect provides a method of removing a conduit from a medium. The method comprises the method according to the second aspect, executed by pushing or pulling a device according to the first aspect through the conduit; and removing the conduit from the medium by pulling and/or pushing the conduit relative to the medium.

Brief description of the drawings

The various aspects and embodiments thereof will now be described in detail in conjunction with drawings. In the drawings,

Figure 1:	a tool for applying a deformation of a conduit;
Figure 2:	a medium with a conduit comprised therein;
Figure 3 A:	a cross-section of a pipe in the ground;
Figure 3 B:	a cross-section of a deformed pipe in the ground;

Figure 3 C: a cross-section of a further deformed pipe in the ground;

Figure 3 D: a pipe in the ground with adjacent voids;

Figure 4 A: a cross-section of a pipe in the ground;

Figure 4 B: a cross-section of a deformed pipe in the ground;

Figure 4 C: a cross-section of a further deformed pipe in the ground;

Figure 4 D: a pipe in the ground with adjacent voids;

Figure 5 A: a construction site with an underground pipe being deformed;

Figure 5 B: a construction site with an underground pipe being pulled out of the ground; and

Figure 5 C: a construction site with segments of a pipe and optionally refilled hole.

Detailed description

Figure 1 shows a device 100 for establishing a deformation of a conduit like a pipe. The device 100 comprises an elongated body 110. To the elongated body 110, a first deformation module 120, a second deformation module 130 and a third deformation module 140 are connected. In extension of the elongated body 110, a connection rod 150 is provided. At the end of the connection rod 150, not connected to the elongated body 110, a device connector 152 is provided. The device connector 152 is arranged to be connected to a pulling or towing arrangement. Such pulling or towing arrangement is arranged for pulling the device 100 through a pipe.

The first deformation module 120 comprises a first wedge 122 and a second wedge 126 as deformation members, protruding from the elongated body 110. The first wedge 122 is provided opposite to the second wedge 126. This means the wedges are equidistantly and annularly spaced over the centre axis of the elongated body 110. Together with the centre axis of the elongated body 110, the outer ends of the wedges define a first virtual circle.

The first wedge 122 is provided with a first rotational deformation member 124. The first rotational deformation member 124 comprises two guiding wheels. The two guiding wheels that are rotatable mounted to the first wedge 122 via common axle. The two guiding wheels extend beyond the outer end of the first wedge and are preferably provided in steel or another metal or metal alloy. Alternatively, plastic guiding blocks comprising for example polyethylene or another organic polymer may be provided for reducing friction between the inner wall of a pipe and the first deformation module 120. The second wedge 126 is provided with a second rotational deformation member 128 in an equivalent way.

The second deformation module 130 comprises a third wedge 132 and a fourth wedge 136 as deformation members. The third wedge 132 is provided opposite to the fourth wedge 136. This means the wedges are equidistantly and annularly spaced over the centre axis of the elongated body 110. Together with the centre axis of the elongated body 110, the outer ends of the wedges of the second deformation module define a second circle. The second virtual circle preferably has a diameter substantially equal to that of the first circle.

The third wedge 132 and the fourth wedge 136 are skewed 90 degrees over the centre axis of the body 110, relative to the first wedge 122 and the second wedge 126. A skew over another angle may be envisaged as well. For example, if yet an additional deformation module comprising wedges would be provided, wedges of the deformation modules could be skewed 60 degrees relative to one another.

The third wedge 132 is provided with a third rotational deformation member 134. The third rotational deformation member 134 comprises two guiding wheels. The two guiding wheels that are rotatable mounted to the third wedge 132 via common axle. The two guiding wheels extend beyond the outer end of the third wedge. The fourth wedge 136 is provided with a fourth rotational deformation member 138 in an equivalent way.

The third deformation module 140 comprises a conical member 142 and a cylindrical member 144. The third deformation module 140 and the conical member 142 in particular extend outwardly from the elongated body 110. The conical member 142 preferably has a circular diameter smaller than the first circle defined by the outer ends of the wedges of the first deformation module 120 and the centre axis of the body 110. In further embodiments, the third deformation module 140 has a different shape. Preferably, the third deformation member 140 has a shape substantially equal to the initial shape of the cross-section of the conduit that is to be deformed.

Figure 2 shows a pipe 250 as a conduit. The pipe 250 is buried in the ground 200 as a medium. The ground 250 may comprise clay, sand, other matter or a combination thereof, either dry or containing water. The ground 250 is compressible. The pipe 250 may comprise steel, predominantly comprising iron and optionally further metals and other materials. The ground 200 exerts a slightly compressive force on the pipe 250. This results in a considerable frictional force between the ground 200 and the pipe 250. This makes it very difficult or even impossible to pull the pipe 250 out of the ground 200.

The device 100 is arranged for applying deformations to the pipe 250. To this purpose, the device 100 is pulled through the pipe 250. For enabling deformation of the pipe 250, the width of the first deformation module 120 and the second deformation module 130 is between 1 and pi/2 times the diameter of the pipe 250, preferably between 1,2 and 1,5. In a particularly preferred embodiment, the width of the first deformation module 120 and the second deformation module 130 is between 1,25 and 1,3 times the diameter of the pipe.

More in general, the width of the first deformation module should be more than the length of the shortest line from two points on the inner wall of the conduit to be deformed, which line is to cross a centre of the cross-section of the conduit. This condition holds also for conduits having a cross-section having a non-circular shape.

Figure 3 depicts a process of deforming the pipe 250 by means of the tool 100. Referring to Figure 1 and Figure 2, the tool 100 is pulled or pushed through the pipe 250. The connection rod 150 is at a leading end of the tool and the third deformation module 140 is at a trailing end.

Figure 3 A shows a cross-section of the pipe 250 in the ground 200. Figure 3 B shows a cross-section of the pipe 250 in the ground 200, with the tool 100 inside. The cross-section shown by Figure 3 B is taken at a location of the first deformation module 120. The centre axis of the tool 100 preferably coincides with the centre axis of the pipe 250. The rotational deformation members are not shown, but may yet be present when putting this example in practice.

The first wedge 122 exerts a first force on the pipe 250 having a component perpendicular to the central axis of the body 110 and the second wedge 126 exert a second force on the pipe 250 that is perpendicular to the central axis of the body 110 as well. By virtue of the symmetry of the first deformation module 120, the sum of the applied forces, perpendicular to the centre axis of the pipe 250, is substantially zero at the centre axis. This means that the tool 100 may be kept at a stable location, with the centre axis of the pipe 250 at substantially the same position at the centre axis of the tool 100. As the tool 100 is pushed or pulled through the pipe 250, forces exerted on the pipe 250 by the first deformation module will also have components parallel to the centre axis of the pipe 250.

The exerted forces result in deformation of the cross-section of the pipe 250, as depicted by Figure 3 B. After the first deformation shown by

Figure 3 B, the cross-section of the pipe 250 has a substantially elliptical shape.

Preferably, the width of the first deformation module 120 and the second deformation module 130 is chosen such that the cross-section of the pipe 250 is deformed only and not stretched. This means that the circumference of the pipe 250 after a deformation is substantially equal to the initial circumference of the pipe 250. A reason for this preference is that stretching of the diameter of the pipe 250 may result in weak spots in the pipe 250. This, in turn, may result in cracks and/or ruptures in the pipe, which may cause leakage of toxic contaminants in the ground 200. And this should be prevented.

Figure 3 C shows a cross-section of the pipe 250 in the ground 200, with the tool 100 inside. The cross-section shown by Figure 3 C is taken at a location of the second deformation module 130. Due to forces exerted by the third wedge 132 and the fourth wedge 136 and due to the second deformation module 130 being skewed 90 degrees to the first deformation module 120, the cross-section of the pipe 250 is deformed again. As with the first deformation module 120, the the sum of the applied forces applied by the second deformation module 130, perpendicular to the centre axis of the pipe 250, is substantially zero at the centre axis. This is due to the symmetrical nature of the second deformation module 130.

This second deformation results in an elliptical shape of the cross-section of the pipe 250 as well. The ellipse resulting out of the second deformation is rotated by 90 degrees over the central axis of the pipe 250, relative to the elliptical shape resulting out of the first deformation. Furthermore, as shown by Figure 3 C, voids remain at the locations of the lobes of the ellipse that resulted out of the first deformation. Above the pipe 250, a first void 352 is located and below the pipe 250, a second void 354 is located.

After the second deformation, a third deformation is applied by means of the third deformation module 140. This is depicted by Figure 3 D. The conical member 142 of the third deformation module 140 preferably has a diameter substantially equal to or slightly smaller than the diameter of the pipe 250. As a result, the cross-section of the pipe 250 is brought back to its initial shape - or at least nearly brought back to that shape.

With the shape of the cross-section of the pipe 250 back or almost back to its initial shape, additional voids remain at locations where lobes of the second ellipse were located. In particular, a third void 362 and a fourth void 364 remain. With voids surrounding the pipe 250, the amount of ground 200 in direct contact with the pipe 250 is significantly less than in the situation depicted by figure 3 A. Furthermore, due to the deformations, bonds between the pipe 250 and the ground 200 are broken. Such bonds are usually mechanical bonds due to fluid dynamics in the ground 200 and other forces. However, chemical bonds may be an issue as well and may be broken in the same way. This means that far less frictional forces - shear forces - exist between the outer surface of the pipe 250 and the ground 200. Which means that less force is required for pulling the pipe 250 out of the ground 200.

Figure 4 shows another embodiment, using a different tool. Figure 4 A shows an initial situation, with the pipe 250 provided in the ground 200. Figure 4 B shows a cross-section at a location of a first deformation module. The first deformation module comprises a first protrusion 422, a second protrusion 424 and a third protrusion 426. The three protrusions of the first deformation module are annularly equidistantly spaced apart, at 120 degrees over a centre axis of an elongated body 410 of the tool 400. Pulling of the tool 400 through the pipe 250 results in the cross-section of the pipe 250 being deformed towards a substantially first triangular shape. It will be apparent that in a practical situation, the corners of the triangular shape will not be as sharp as depicted by Figure 4 B. Also in this embodiment, the sum of vertical components of forces exerted by the protrusions is zero at the centre axis of the elongated body 410.

Figure 4 C shows a cross-section at a location of a second deformation module comprised by the tool 400. Figure 4 C shows the second deformation module comprising a fourth protrusion 432, a fifth protrusion 434 and a sixth protrusion 436. Compared to the protrusions of the first deformation module, the protrusions are skewed 60 degrees. Alternatively stated, the second deformation module is a mirrored version of the first deformation module. The deformation established by the second deformation module results in second triangular shape of the cross-section of the pipe 250. The second deformation results in voids where the points of the first triangular shape were located; a first void 452, a second void 454 and a third void 456.

After passage of a third deformation module 440 having a circular shape defining a circle around the central axis of the body 414 as depicted by Figure 4 D, the cross-section of the pipe 250 is substantially back to its initial shape as depicted by Figure 4 A. Figure 4 D also shows additional voids; a fourth void 462, a fifth void 464 and a sixth void 466. With the voids, there is less contact area between the ground 200 and the outer surface of the pipe 250. This results in a reduction of frictional forces between the pipe 250 and the ground 200, which mean less force is required for pulling the pipe 250 out of the ground 200.

So far, the device according to the first aspect has been discussed having a deformation module comprising two, three or five protrusions. A device having a deformation module comprising four or more than five protrusions may be envisaged as well. The larger the cross-sectional area of the pipe 250, the more protrusions are preferred. In particular for pipes having a very large diameter, up to 1,22 metres (48 inch), a device with a first deformation module having ten or more protrusions may be employed.

In the embodiments discussed so far, pulling the tool 100 at a more or less constant speed through the pipe 250 is discussed. This results in forces exerted by the protrusions or wedges of the deformation modules in directions having components parallel to the centre axis of the tool 100 and perpendicular to the centre axis of the tool 100. Alternatively, a further tool is provided, comprising retractable protrusions. This allows the further tool to be pulled through the pipe 250 without significant force required, with retracted protrusions. At a location in the pipe 250 where deformation is required, the protrusions are expelled from the further tool. This may be done by means of hydraulic, mechanical or pneumatic force. After deformation, the protrusions are retracted and the further tool is moved to the next position where deformation is required.

Figure 5 schematically shows application of the tool 100 in a construction site 500 for removing the pipe 250 from the ground 200. Figure 5 A shows the pipe 250 in the ground 200. In the ground 200, a first construction pit 510 is provided. In the first construction pit 510, a pulling machine 520 is set up for pulling the tool 100 through the pipe 250. The tool 100 is loaded in the pipe 250 via a second construction pit 520.

Figure 5 B shows the pipe 250 being pulled out of the ground 200. The pipe 250 is pulled out of the ground 200 by means of a pulling device (not shown). This may be a mechanically, hydraulically or pneumatically driven device, or a combination thereof. As the dimensions of the first construction pit 510 are preferably smaller than the length of the pipe 250, the pipe 250 is cut in segments. Figure 5 B shows a first segment 252 and a second segment 254.

After the pipe 250 has been removed in full or after the pipe 250 is at least partially withdrawn from the ground 200, a void left by the pipe 250 is filled with a filling material 530 as shown by Figure 5 C. The filling material may have a constitution similar to that of the ground 200. Alternatively, the filling material may have a different constitution.

In a preferred embodiment, the pipe 250 is cleaned prior to deforming and removal from the ground 200.

The tools and methods disclosed above may be employed for a wide range of pipe diameters. In practice, for example pipes for transporting gas and natural gas in particular have diameters ranging from 50.8 millimetres (two inch) to 1219.2 millimetres (48 inch). The width of the deformation modules, as depicted by Figure 1, is preferably between 1,25 and 1,3 times the initial diameter of the conduit, as discussed above.

The distance between the various deformation modules may depend on the width of the tool 100 and/or the width of the pipe 250. In a preferred embodiment, intended for a pipe having a diameter of 152,4 millimetres (6 inch), the distance between two deformation modules is preferably 540 millimetres. More generally, the ratio between the width of the deformation modules and the distance between the deformation modules is between 1/2D and 4D, wherein D is the diameter of the pipe 250. Furthermore, the ratio between the width of the deformation modules and the distance between the deformation modules may also depend on the ratio D/t, in which t is the thickness of the wall of the pipe. Preferably, the larger the diameter of the pipe is, the shorter the distance between the deformation modules.

The deformation modules have so far been discussed as comprising wedges, with optional rotating guiding wheels. In another embodiment, the deformation modules are provided as a single body. Such single body may, for example, by provided as an ellipsoid having a shape substantially identical to a desired shape of the cross-section of the pipe 250 after deformation. In yet another alternative, a deformation module comprises a pseudo-conical body. The top of that body points towards the leading end of the tool and the cross-section of the pseudo-conical body has a shape substantially identical to a desired shape of the cross-section of the pipe 250 after deformation. The lobes of the elliptical shape of such deformation module are protrusions that exercise a force on the pipe 250 that results in the deformation. Hence, protrusions comprised by deformation modules may be part of a single body or provided as separate members attached to the elongated main body 100.

Furthermore, whereas deformation by two deformation modules is preferred, followed by a deformation for restoring the initial diameter of the pipe 250, application of the method using a device with only one deformation module for deforming the initial circularly shaped cross-section may be envisaged as well. Alternatively, a device having more than two deformation modules may also be envisaged. In case the deformation provided by the first deformation module 120 is only an elastic deformation, restoration of the shape of the cross-section of the pipe 250 is not required. Within that context, it should be noted that with pipes having a very large diameter, up to 1,22 metres (48 inches), only a relatively small change of the diameter is required for breaking bonds between the outer wall of the pipe and earth or clay surrounding the pipe. Such small change may be effectuated by a small deformation of the diameter of the pipe that is that small the deformation is only an elastic deformation.

Whereas application of the tool 100 or similar tools has been discussed in conjunction with conduits having a circular cross-section, application to conduits having a differently shaped cross-section may be envisaged as well.

An aspect relates to deformation of an underground conduit. The cross-sectional shape of the conduit is deformed by enlarging a first cross-sectional dimension of the conduit. Another deformation may be established, at least partially undoing the first deformation and optionally increased a second cross-sectional dimension of the conduit. Yet a further deformation may be established, decreasing the dimension enlarged by previous deformations. Subsequently, the conduit may be removed from the ground. For deformation, a tool is used. The tool is arranged by exercising forces to the inner surface of the conduit, resulting in the increased dimension. The tool may comprise an elongated body and deformation members protruding from the body. The width of the deformation member is larger than the initial diameter of the conduit. At the end of the tool, viewed from the transportation direction of the tool, a further deformation member may be provided for reducing the dimensions. The further deformation member may have a cross-section substantially identical to that of the initial cross-section of the conduit.

Expressions such as "comprise", "include", "incorporate", "contain", "is" and "have" are to be construed in a non-exclusive manner when interpreting the description and its associated claims, namely construed to allow for other items or components which are not explicitly defined also to be present. Reference to the singular is also to be construed in be a reference to the plural and vice versa. When data is being referred to as audio-visual data, it can represent audio only, video only or still pictures only or a combination thereof, unless specifically indicated otherwise in the description of the embodiments.

In the description above, it will be understood that when an element such as layer, region or substrate is referred to as being “on” or “onto” another element, the element is either directly on the other element, or intervening elements may also be present.

Furthermore, the invention may also be embodied with less components than provided in the embodiments described here, wherein one component carries out multiple functions. Just as well may the invention be embodied using more elements than depicted in the Figures, wherein functions carried out by one component in the embodiment provided are distributed over multiple components.

A person skilled in the art will readily appreciate that various parameters disclosed in the description may be modified and that various embodiments disclosed and/or claimed may be combined without departing from the scope of the invention.

It is stipulated that the reference signs in the claims do not limit the scope of the claims, but are merely inserted to enhance the legibility of the claims.

Conclusies

1. Apparaat voor bewerkstelligen van een deformatie van een leiding welke een doorsnede met een doorsnede afmeting heeft, het apparaat omvattende:

- Een langwerpig lichaam omvattend een centrale lichaamsas, een leidend einde en een volgende einde, het lichaam zijnde ingericht om door de leiding gevoerd te worden met het leidende einde leidend;
- Een eerste deformatie module voorzien op een eerste positie van het lichaam, de eerste deformatiemodule omvattende ten minste twee uitsteeksels welke een eerste deformatie cirkel definiëren welke een diameter heeft groter dan de doorsnede diameter en een middelpunt dat samenvalt met de lichaamsas.

2. Apparaat volgens conclusie 1, verder omvattende een tweede deformatiemodule voorzien tussen de eerste deformatie module en het volgende einde, de tweede deformatiemodule omvattende ten minste een deformatie element welk zich vanaf het lichaam naar buiten uitstrekt loodrecht op de lichaamsas, het deformatie element definiërende een twee deformatie cirkel welke een middelpunt heeft dat in hoofdzaak samenvalt met de lichaamsas en welke een doorsnede heeft kleiner dan de eerste deformatie cirkel.

3. Apparaat volgens conclusie 1 of 2, verder omvattende een derde deformatiemodule voorzien tussen de eerste deformatiemodule en de tweede deformatiemodule, de derde deformatiemodule omvattende ten minste twee uitsteeksel welke een derde deformatie cirkel definiëren welke een diameter heeft groter dan de doorsnede

diameter, waarbij de uitsteeksel van de derde deformatiemodule over de lichaamsas zijn gedraaid ten opzichte van de uitsteeksels van de eerste deformatiemodule.

4. Apparaat volgens conclusie 1, 2 of 3, waarbij de eerste deformatiemodule een eerste deformatie element en een tweede deformatie element omvat, welke deformatie elementen een proximaal deformatie einde omvatten dat verbonden is aan het lichaam en een distaal deformatie einde omvatten op een afstand van het lichaam, welke deformatie elementen annulair op gelijke afstand van elkaar zijn voorzien op de lichaamsas.

5. Apparaat volgens conclusie 3, waarbij de derde deformatiemodule een derde deformatie element en een vierde deformatie element omvat, welke deformatie element een proximaal deformatie einde en omvatten dat verbonden is aan het lichaam en een distaaldeformatie einde omvatten op een afstand van het lichaam, welke deformatie elementen annulair op gelijke afstand van elkaar zijn voorzien op de lichaamsas.

6. Apparaat volgens conclusie 4 of 5, waarbij ten minste een van de deformatie element is voor zien van een in hoofdzaak circulair rotatie element dat roteerbaar is gemonteerd aan het distale deformatie einde van ten minste een van de deformatie element zodanig dat het rotatie element buiten het deformatie element uitsteekt, waarbij de rotatie as van het rotatie element in hoofdzaak loodrecht is voorzien ten opzichte van de lichaamsas en in hoofdzaak

loodrecht is ten opzichte van een lijn van de lichaamsas naar het distale deformatie einde.

7. Apparaat volgens een van de conclusies 1 tot en met 6, waarbij de afstand tussen de eerste deformatie module en de tweede deformatie module ongeveer drie keer zo groot is als de diameter van de eerste deformatie cirkel.

8. Apparaat volgens een van de conclusies 3 of 5, waarbij:

- De afstand tussen de eerste deformatie module en de derde deformatie module ongeveer drie keer groter is dan de diameter van de eerste deformatiecirkel; en
- De afstand tussen de tweede deformatiemodule en de derde deformatiemodule ongeveer drie keer zo groot is als de diameter van de eerste deformatiecirkel.

9. Apparaat volgens een van de conclusies 1 tot en met 6, waarbij de tweede deformatiemodule een conisch gevormd deformatie element omvat welke een kegelas omvat die in hoofdzaak samenvalt met de lichaamsas, waarbij de basis van het conisch gevormd deformatie element naar het volgende einde van het lichaam is gericht.

10. Werkwijze voor reduceren van frictie tussen een leiding en een medium dat de leiding omvat, de werkwijze omvattende:

- Bewerkstelligen van een eerste deformatie van de leiding door aanbrengen van ten minste een eerste kracht en een tweede kracht welke een component hebben loodrecht ten opzicht van een hartlijn van de leiding, waarbij de som van de aangebrachte krachten in hoofdzaak nul is loodrecht op de hartlijn;

- Bewerkstelligen van een tweede deformatie van de leiding, waarbij de eerste deformatie ten minste ten dele ongedaan wordt gemaakt.

11. Werkwijze volgens conclusie 10, waarbij de eerste kracht in hoofdzaak loodrecht ten opzichte van de tweede kracht is.

12. Werkwijze volgens een van de conclusies 10 of 11, verder omvattende, voor het bewerkstelligen van de eerste deformatie, toepassen van een derde deformatie aan de leiding door aanbrengen van ten minste een derde kracht en een vierde kracht welke een component hebben loodrecht ten opzicht van een hartlijn van de leiding, waarbij de som van de aangebrachte krachten in hoofdzaak nul is loodrecht op de hartlijn;

Waarbij:

- De derde kracht annulair op afstand is van de eerste kracht en de vierde kracht, ten opzichte van de hartlijn, en/of
- De vierde kracht annulair op afstand is van de eerste kracht en de tweede kracht, ten opzichte van de hartlijn.

13. Werkwijze volgens conclusie 11, waarbij de derde kracht in hoofdzaak tegenovergesteld is aan de vierde kracht.

14. Werkwijze volgens conclusie 11 of 12, waarbij de derde kracht in hoofdzaak loodrecht is ten opzichte van de eerste kracht en de vierde kracht in hoofdzaak loodrecht is ten opzichte van de tweede kracht.

15. Werkwijze volgens een van de conclusies 10 tot en met 14, waarbij bewerkstelligen van de tweede deformatie van de leiding omvat het terugbrengen van de leiding in in hoofdzaak de oorspronkelijke vorm.

16. Werkwijze voor verwijderen van een leiding uit een medium, de werkwijze omvattende:

- De werkwijze volgens een van de voorgaande conclusies 10 tot en met 15, uitgevoerd door duwen of trekken van een inrichting volgens een van de conclusies 1 tot en met 9 door de leiding; en
- Verwijderen van de leiding uit het medium door duwen en/of trekken van de leiding ten opzichte van het medium.

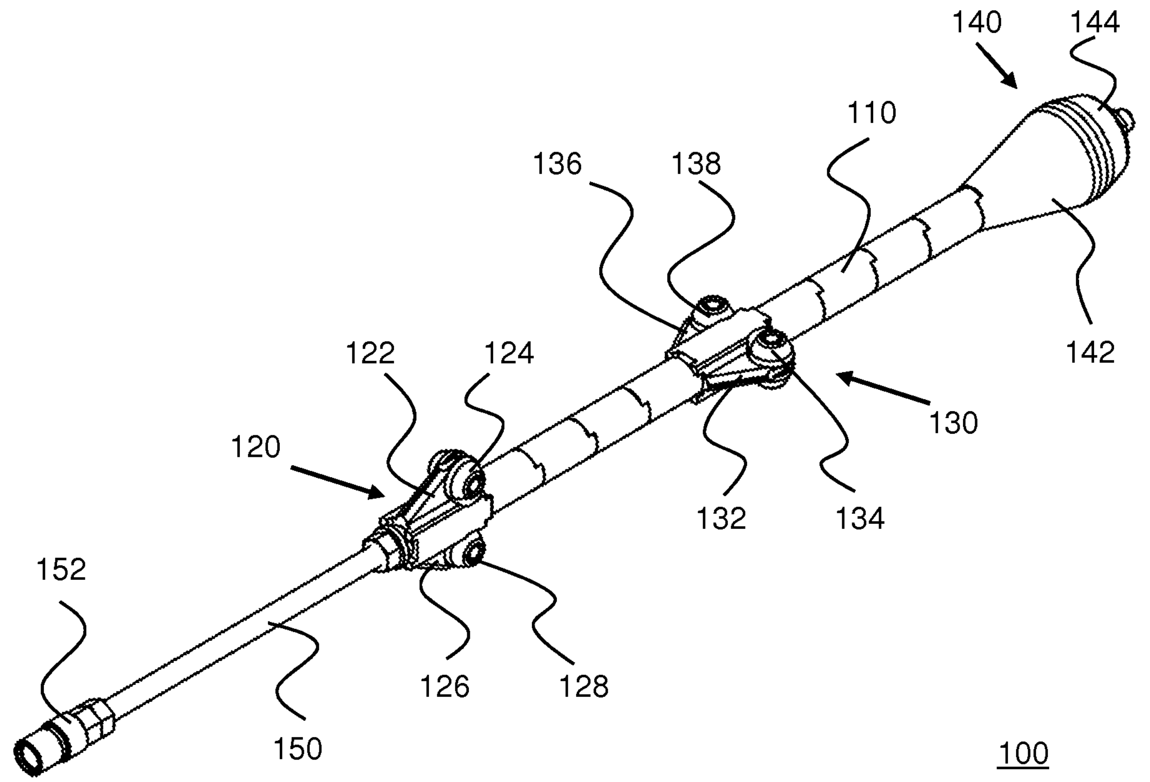
140
144
110
136
138
142
122
124
130
120
132
134
152
126
128
150
100

Fig. 1

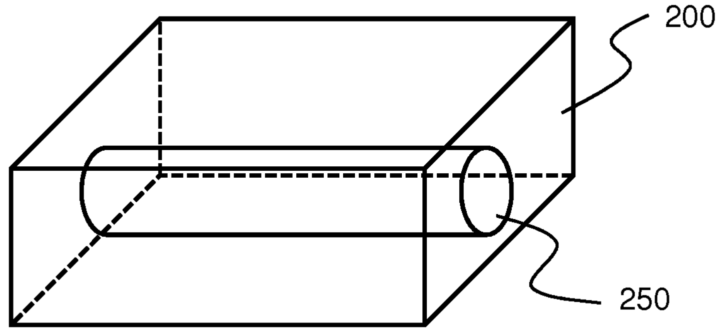
200
250

Fig. 2

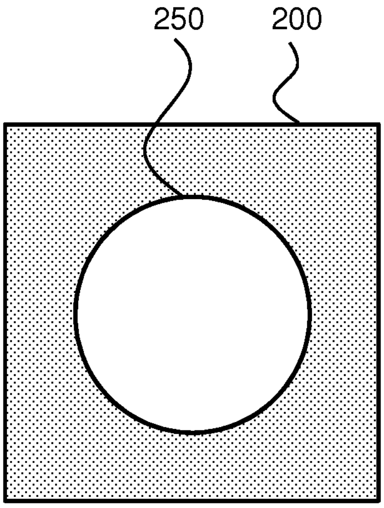

Fig. 3 A

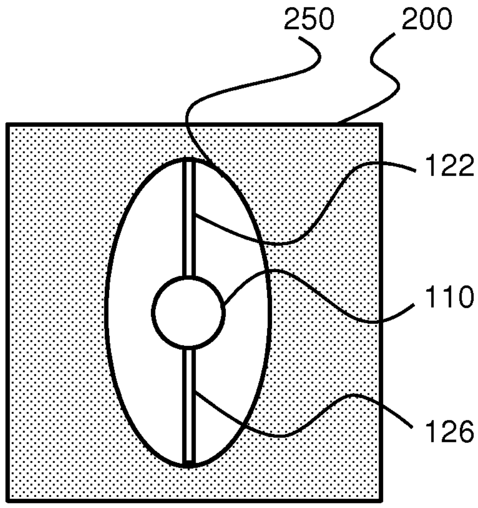

Fig. 3 B

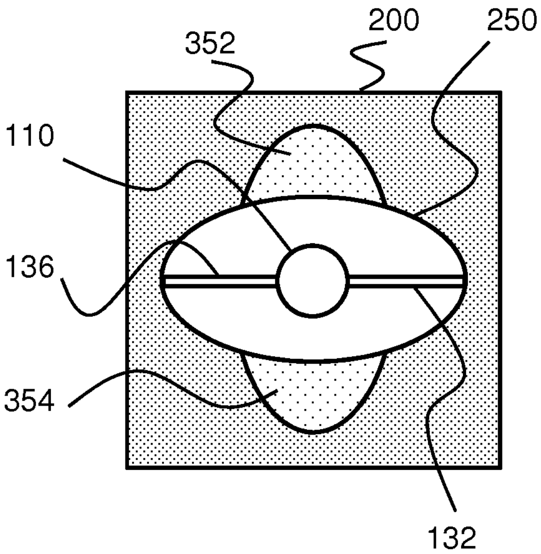

Fig. 3 C

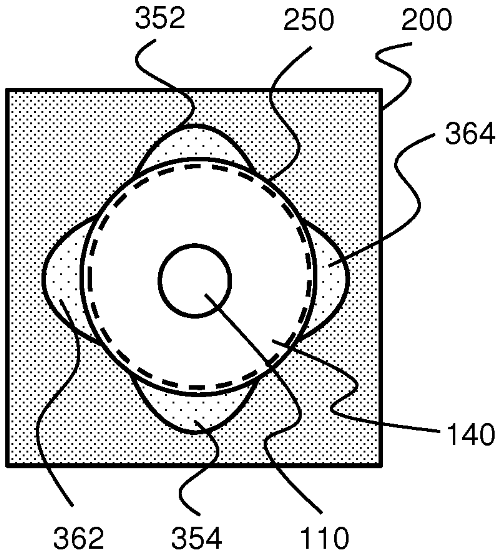

Fig. 3 D

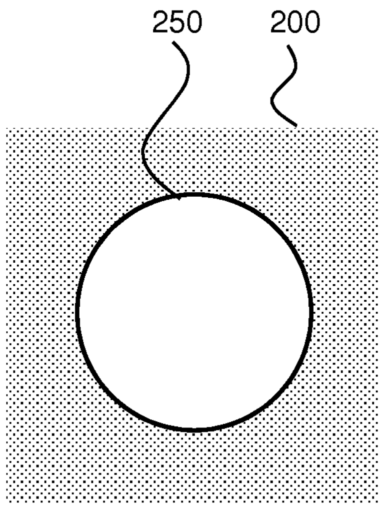

Fig. 4 A

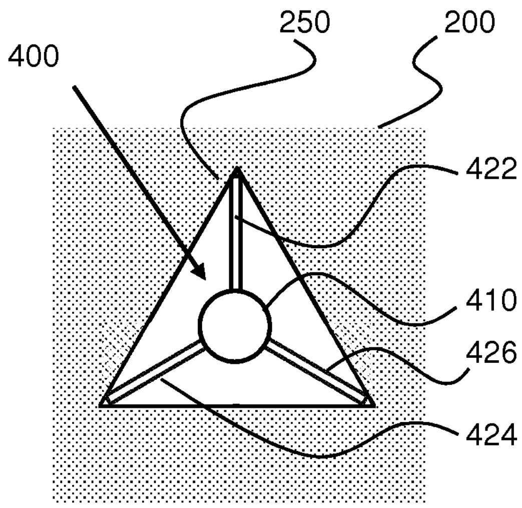

Fig. 4 B

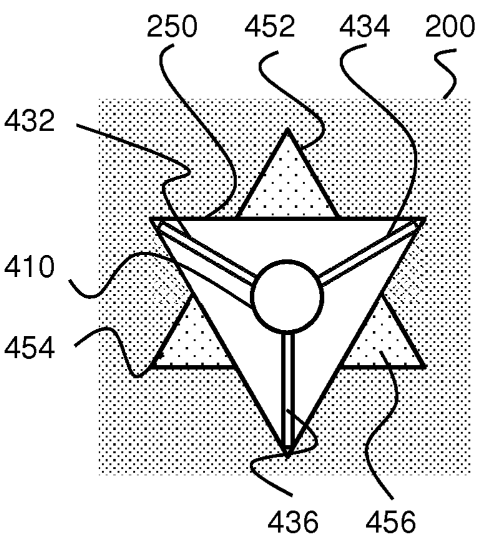

Fig. 4 C

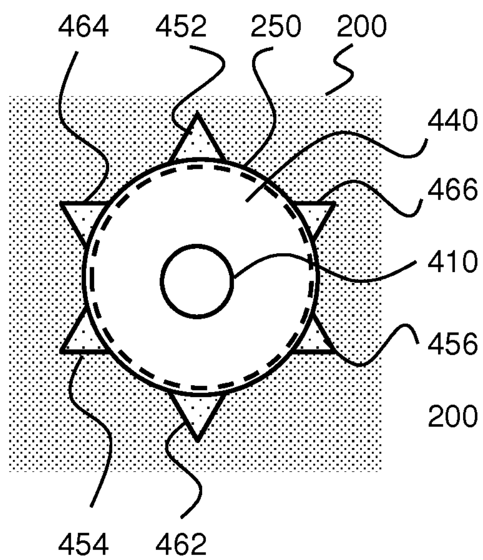

Fig. 4 D

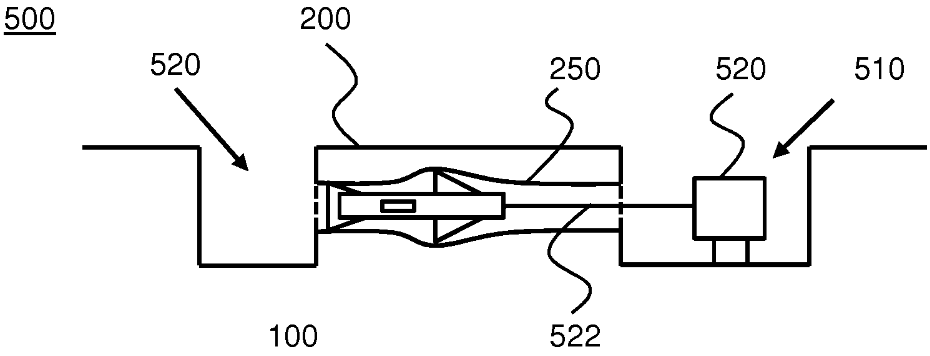

Fig. 5 A

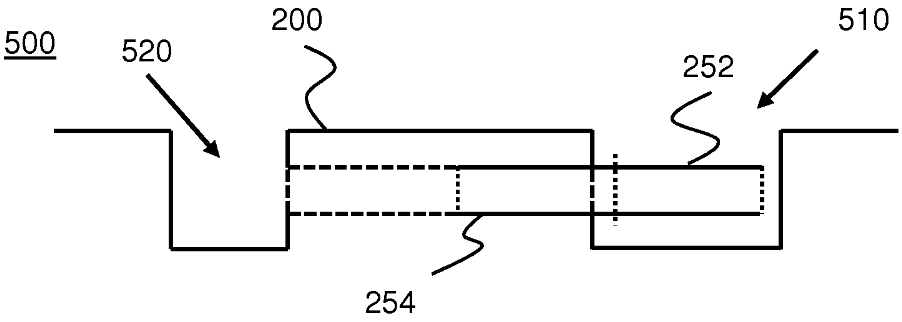

Fig. 5 B

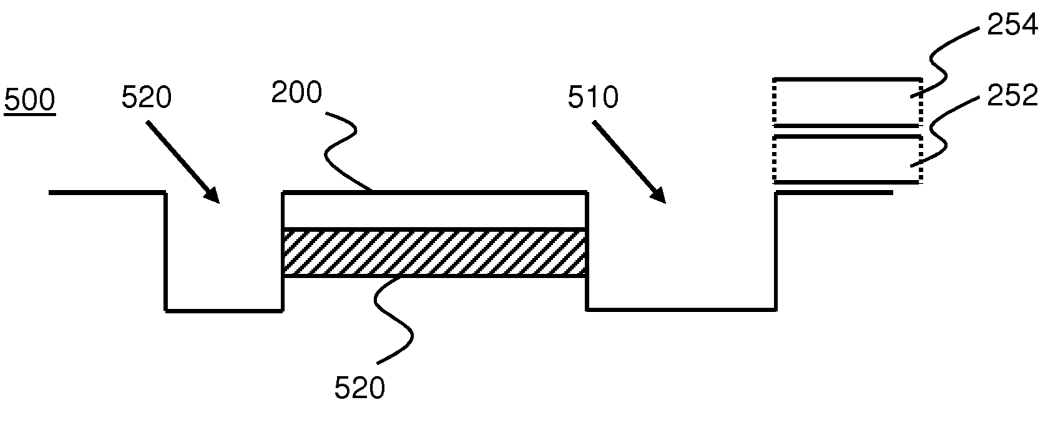

Fig. 5 C

Title: Device and method for deforming a conduit

Abstract

An aspect relates to deformation of an underground conduit. The cross-sectional shape of the conduit is deformed by enlarging a first cross-sectional dimension of the conduit. Another deformation may be established, at least partially undoing the first deformation and optionally increased a second cross-sectional dimension of the conduit. Yet a further deformation may be established, decreasing the dimension enlarged by previous deformations. Subsequently, the conduit may be removed from the ground. For deformation, a tool is used. The tool is arranged by exercising forces to the inner surface of the conduit, resulting in the increased dimension. The tool may comprise an elongated body and deformation members protruding from the body. The width of the deformation member is larger than the initial diameter of the conduit. At the end of the tool, viewed from the transportation direction of the tool, a further deformation member may be provided for reducing the dimensions.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P110486NL00
Nederlands aanvraag nr. 2016455	Indieningsdatum 18-03-2016
	Ingeroepen voorrangsdatum
Aanvrager (Naam) Callidus Capital B.V.	
Datum van het verzoek voor een onderzoek van internationaal type 25-07-2016	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN 66886

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC)	
F16L1/028	F16L55/165

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK		
Onderzochte minimumdocumentatie		
Classificatiesysteem	Classificatiesymbolen	
IPC	F16L	E21B
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen		

III.	☐	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES	(opmerkingen op aanvullingsblad)
IV.	☐	GEBREK AAN EENHEID VAN UITVINDING	(opmerkingen op aanvullingsblad)

Form PCT/ISA 201 A (11/2000)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2016455

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F16L1/028
ADD. F16L55/165

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
F16L E21B

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 2015/198279 A1 (RANDA MARK D [US] ET AL) 16 juli 2015 (2015-07-16) * samenvatting; figuren * * alineas [0022] - [0035] * -----	1-16
X	US 2013/156507 A1 (TJADER MICHAEL [US]) 20 juni 2013 (2013-06-20) * samenvatting; figuren * * alineas [0015] - [0031] * -----	1-16
X	US 5 173 009 A (MORIARTY MARTIN [IE]) 22 december 1992 (1992-12-22) * samenvatting; figuren * * kolommen 3-6 * -----	1
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

10 november 2016

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

De bevoegde ambtenaar

Untermann, Nils

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2016455

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	CH 680 776 A5 (MINDER SCHWEISS SERVICE) 13 november 1992 (1992-11-13) * samenvatting; figuren * * kolommen 2,3 * -----	1
X	US 5 306 101 A (ROCKOWER GERALD [US] ET AL) 26 april 1994 (1994-04-26) * samenvatting; figuren * * kolommen 4,5 * -----	1-16

1

Formulier PCT/ISA/201 (vervolg tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2016455

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 2015198279 A1	16-07-2015	GEEN	
US 2013156507 A1	20-06-2013	US 2013156507 A1	20-06-2013
		US 2015211672 A1	30-07-2015
US 5173009 A	22-12-1992	US 5173009 A	22-12-1992
		US 5302053 A	12-04-1994
CH 680776 A5	13-11-1992	GEEN	
US 5306101 A	26-04-1994	GEEN	

WRITTEN OPINION

File No. SN66886	Filing date *(day/month/year)* 18.03.2016	Priority date *(day/month/year)*	Application No. NL2016455
International Patent Classification (IPC) INV. F16L1/028 ADD. F16L55/165			
Applicant Callidus Capital B.V.			

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Untermann, Nils

WRITTEN OPINION

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	10-16
	No:	Claims	1-9
Inventive step	Yes:	Claims	
	No:	Claims	1-16
Industrial applicability	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations

   see separate sheet

WRITTEN OPINION

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 US 2015/198279 A1 (RANDA MARK D [US] ET AL) 16 juli 2015 (2015-07-16)

D2 US 2013/156507 A1 (TJADER MICHAEL [US]) 20 juni 2013 (2013-06-20)

D3 US 5 173 009 A (MORIARTY MARTIN [IE]) 22 december 1992 (1992-12-22)

D4 CH 680 776 A5 (MINDER SCHWEISS SERVICE) 13 november 1992 (1992-11-13)

D5 US 5 306 101 A (ROCKOWER GERALD [US] ET AL) 26 april 1994 (1994-04-26)

1 **Claim 1**

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

1.1 Document D1 discloses (the references in brackets applying to this document):

een apparaat (figures 1-5) voor bewerkstelligen van een deformatie van een leiding welke een doorsnede met een doorsnede afmeting heeft, het apparaat omvattende:

een langwerpig lichaam (10) omvattend een centrale lichaamsas, een leidend einde en een volgende einde, het lichaam zijnde ingericht om door de leiding gevoerd te worden met het leidende einde leidend ([0022]);

een eerste deformatie module ("slitter 18", "expander 20") voorzien op een eerste positie van het lichaam, de eerste deformatiemodule (18) omvattende ten minste twee uitsteeksels ("four blades 22", [0022], figure

1) welke een eerste deformatie cirkel definiëren welke een diameter heeft groter dan de doorsnede diameter en een middelpunt dat samenvalt met de lichaamsas.

1.2 Furthermore, the subject matter of claim 1 lacks novelty over D2, figures 1-6, "floating cutter 120, 400 with blades 600"; "cutter 114, 216 with blades 218"; paragraphs [0016]-[0022].

1.3 Furthermore, the subject matter of claim 1 lacks novelty over D3, figures 1-8, "body 22 with protrusions 26"; col. 4, lines 12-42.

1.4 Furthermore, the subject matter of claim 1 lacks novelty over D4, figures 1-5, "Schneidkegel 3 mit Schneidkanten 7, 7' in Form von Profilstäben 11", col. 2, 3.

1.5 Furthermore, the subject matter of claim 1 lacks novelty over D5, figures 1-13, "first, second and third cutter wheels 25, 29, 32", col. 5, lines 3-30.

2 **Claim 10**

Claim 10 is directed to a method of reducing friction between a conduit and a medium surrounding the conduit. The method comprising the steps of establishing a first deformation and a second deformation, which second deformation partially undoes the first deformation.

Such a method does not involve an inventive step in view of the devices known from each of documents D1-D5. All these devices are configured to establish first and second deformations, the second deformation partially "undoing" the first deformation, as best understood.

3 **Claims 2-9 and 11-16**

Dependent claims 2-9 and 11-16 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

3.1 Claims 2, 7, 8, 9, 12-16: D1, figure 1, first deformation module ("slitter 18"), second deformation module ("expander 20"); D2, figure 1; D5, figures 2-5, "cutter wheels 25, 29, 32", "guide rollers 16", "scoring wheel 22", "deburring wheel 36"

3.2 Claim 3: D2, figure 1, "floating cutter 120", "cutter 114", "expander 112"; D5, "cutter wheels 25, 29, 32".

3.3 Claims 4-6: D1, blades 22; D2, blades 218, 600; D5, figures 2-5, "cutter wheels 25, 29, 32", "guide rollers 16", "scoring wheel 22", "deburring wheel 36"

4 **General remark**

The present application seems to contain subject matter which can be considered as new and inventive. In particular, the method as shown in figures 3A-3D and described on page 9, line 6 - page 11, line 19 does not seem to be known from the available documents. However, this concept is not adequately phrased in independent method claim 10.

Re Item VIII

Certain observations on the application

5 The subject-matter of claim 1 is not clear.

Claim 1 not only defines a device as such, but also specifies its relationship to a cross-section dimension of a conduit which is not part of the claimed device:

> "at least two protrusions defining a first deformation circle having a diameter larger than the cross-section dimension [of the conduit]".

Claim 1 should be clarified such that claim 1 is directed to an assembly comprising a device and a conduit. In the absence of such clarification, the diameter of the at least two protrusions is considered as not limiting.

6 In claim 1, line 2, "een doorsnede afmeting" is defined. In contrast, in line 10 of claim 1, the term "doorsnede diameter" is used. One of these terms should used consistently throughout the wording of claim 1.

7 In claim 2, a second deformation module is defined. According to claim 9, this second deformation module is the one having a conical member 142. Therefore, the second deformation module as defined in claims 2 and 9 is the module 140 shown in figure 1. However, the description, page 8, lines 4-13 defines this module 140 as the <u>third</u> deformation module. The description and claims are therefore not consistent in terms of terminology.

8 Claims 7 and 9 are not clear because they refer to the second deformation module, which is only defined in claim 2. Hence, claims 7 and 9 should refer to claims 2-6 rather than to claims 1-6.

9 Claim 11 is not clear. If the first force is substantially perpendicular relative to the second force, the sum of the forces cannot be zero at the axis of the conduit, contrary to the teaching of claim 10.

10 Claim 13 is not clear because a third force is only defined in claim 12, not in claim 11. Hence, claim 13 should refer to claim 12.

11 Claim 14 is not clear because a third force is only defined in claim 12 and 13, not in claim 11. Hence, claim 14 should refer to claim 12 or 13.