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(56) Documents Cited:
GB 2460129 A
US 6010290 A
US 1966015 A
JP 2012247023 A
US 5795037 A
US 20140259673 A1

(58) Field of Search:
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Other: **EPODOC, WPI.**

(54) Title of the Invention: **Wheel securing system and method of use**
Abstract Title: **Wheel securing system and method of use**

(57) The invention relates to a downhole deployment system for use in oil or gas wells, in particular a wheel securing system for downhole devices (10 figure 1) which may be a housing (14 figure 1) formed from two cylindrical shells (14a, 14b figure 1C). The downhole system comprises at least one wheel 26 and a wheel retaining member 48 having threads (54 figure 2C) to engage the downhole device and mount the at least one wheel to the downhole device. The system also comprises a locking member 50 which may be in the form of a key or pin to engage the wheel retaining member from threadably disengaging the downhole device. The key may be received in a keyway on the wheel retaining member. Later embodiments relate to a downhole deployment device, a method of securing a wheel to a downhole device and a kit of parts for securing a wheel to a downhole deployment device.

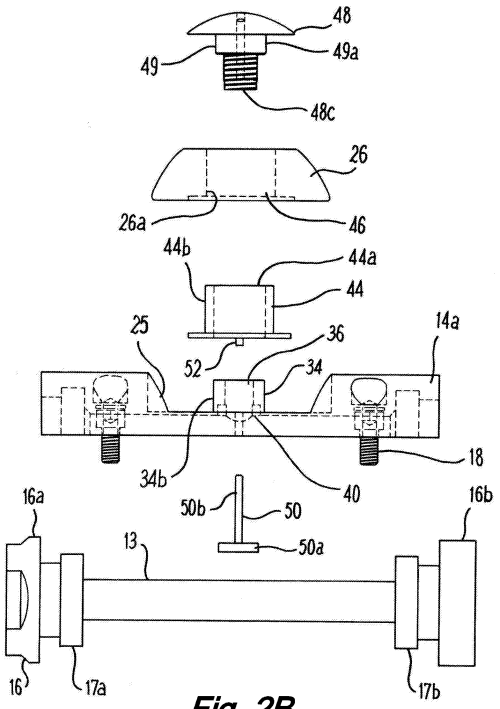


Fig. 2B

GB 2547471 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

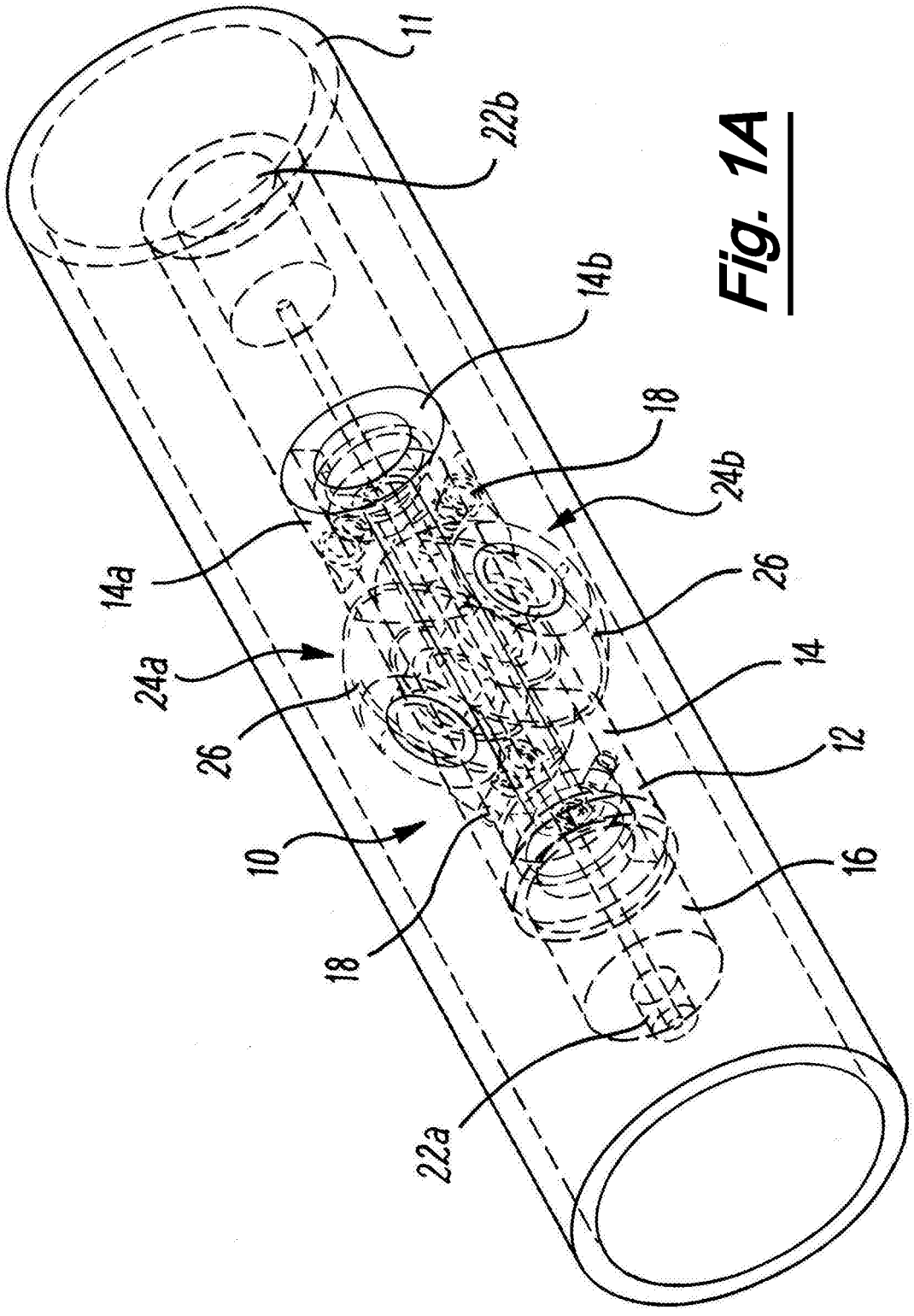
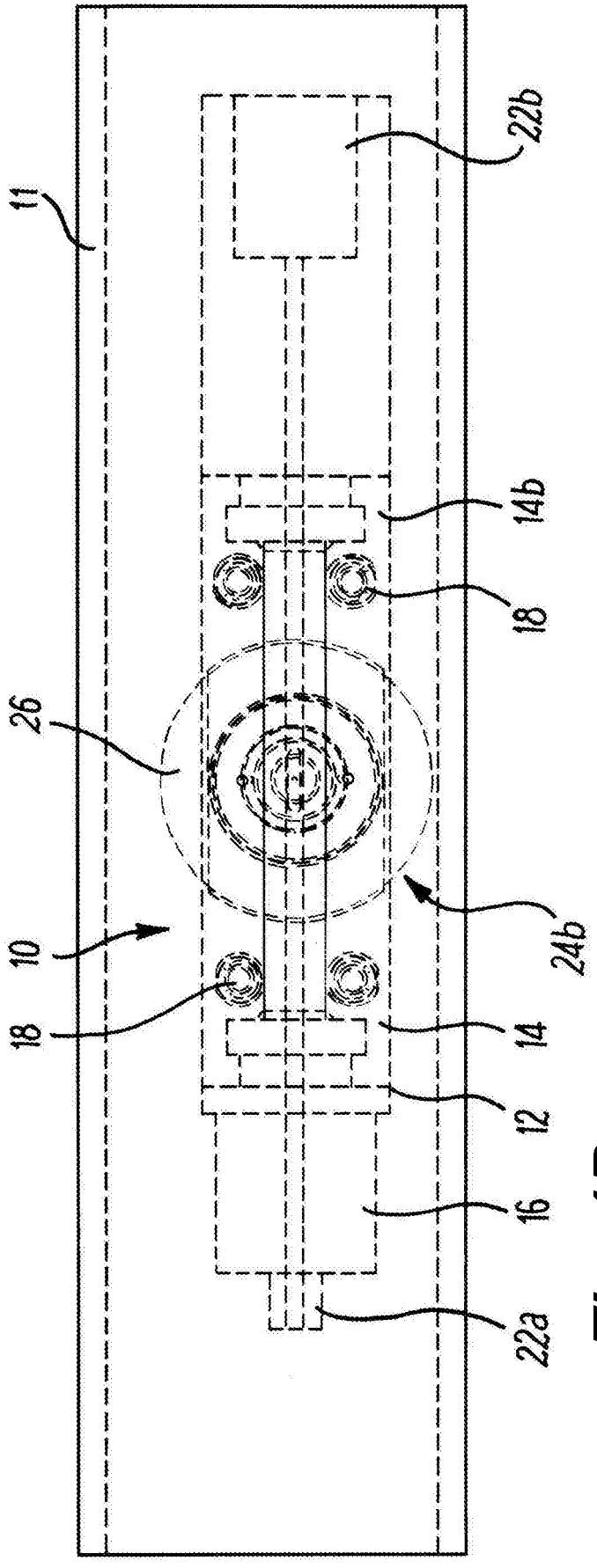


Fig. 1A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22b
14b
18
26
10
24b
18
14
12
16
22a

Fig. 1B

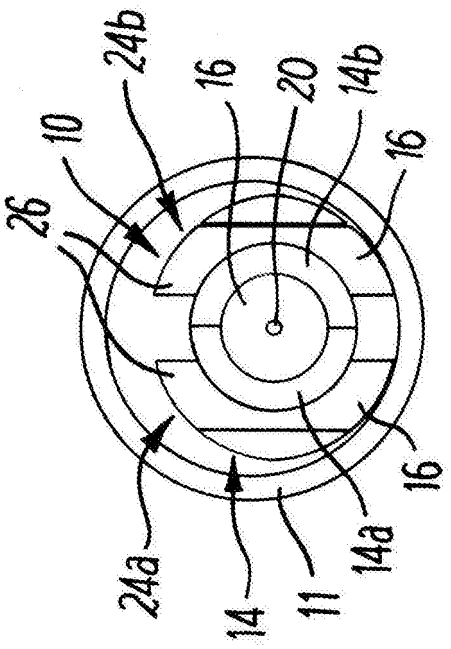
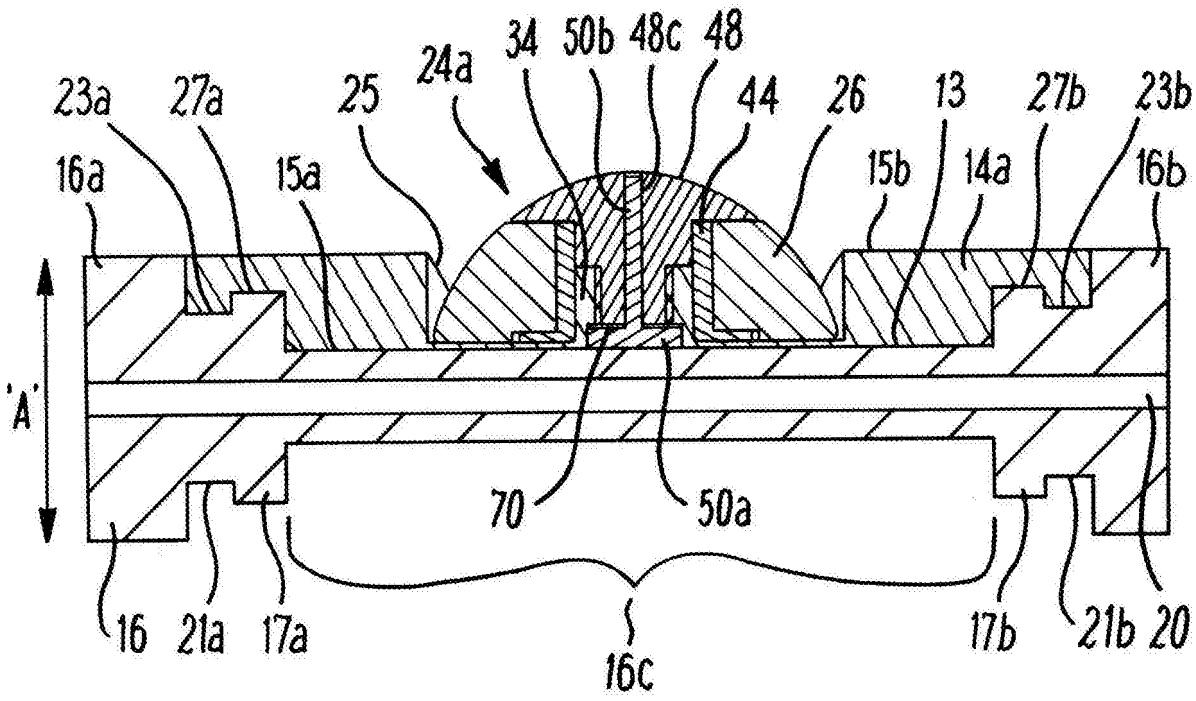

24b
16
20
14b
10
16
26
24a
14
11
14a
16

Fig. 1C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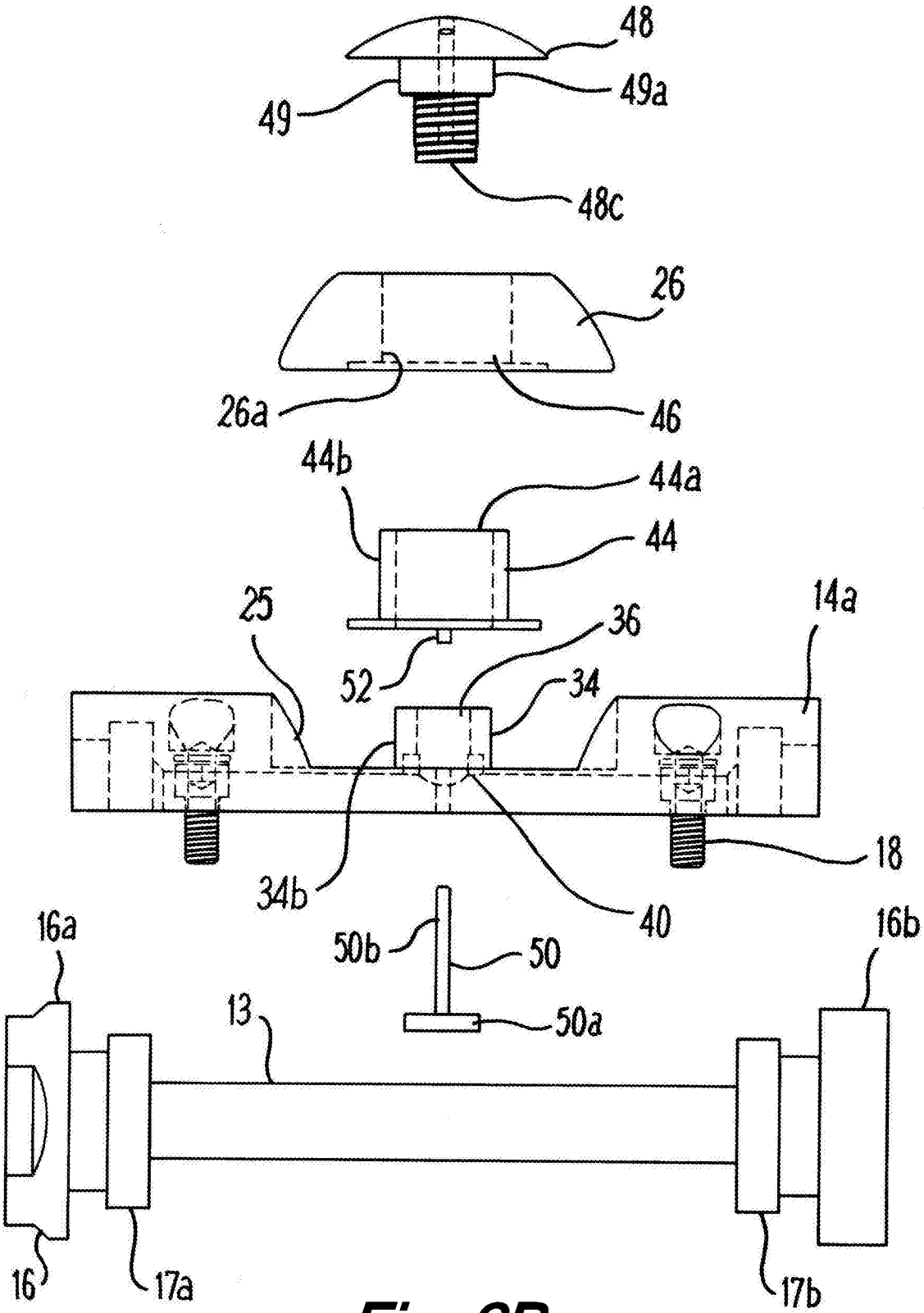
27a
25
24a
34
50b
48c
48
44
26
13
27b
23b
16a
15a
15b
14a
16b
'A'
70
50a
16
21a
17a
16c
17b
21b
20

Fig. 2A


48
49a
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48c
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26a
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44b
44a
44
25
36
14a
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34b
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16a
50b
50
16b
13
50a
16
17a
17b

Fig. 2B

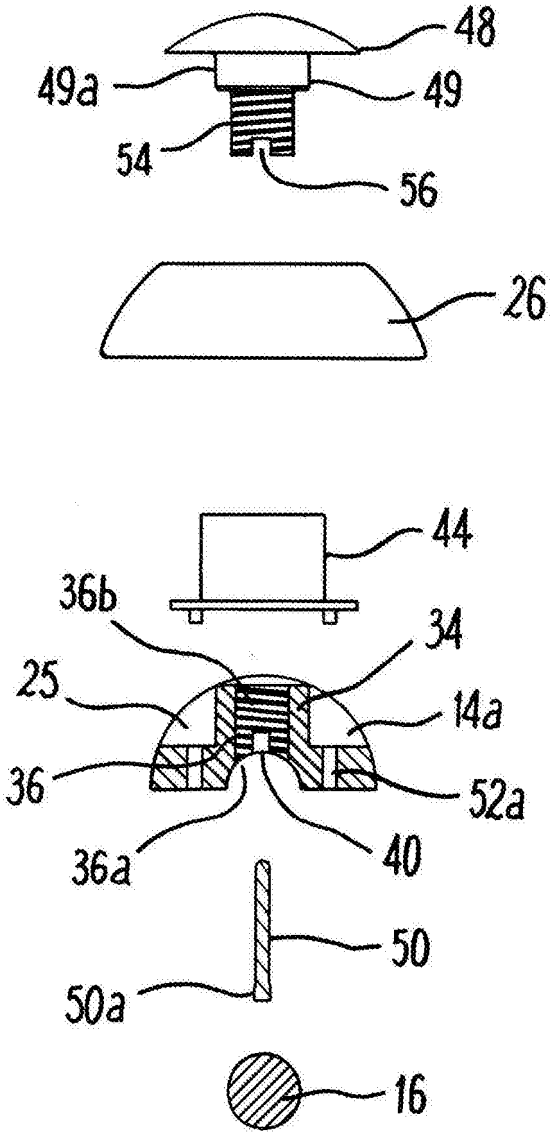

Fig. 2C

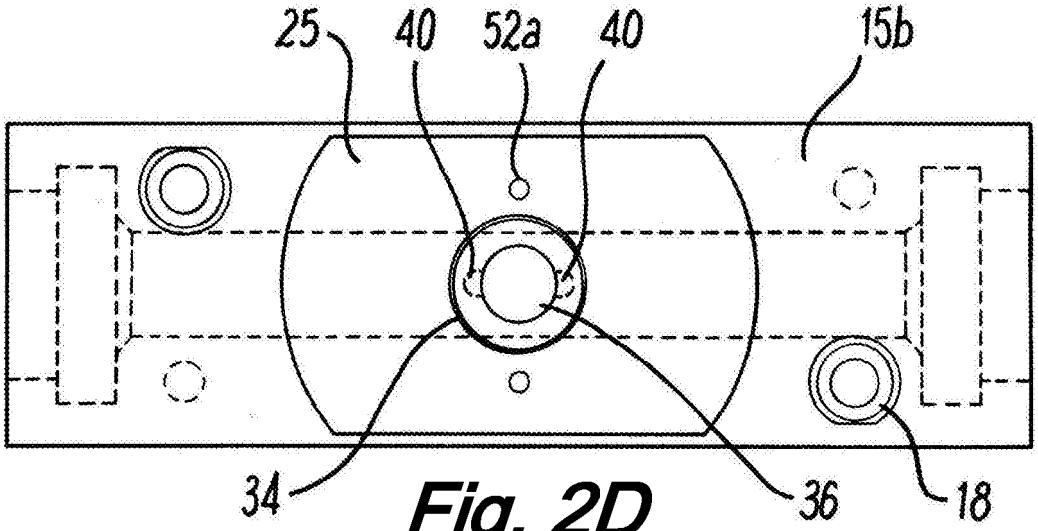

Fig. 2D

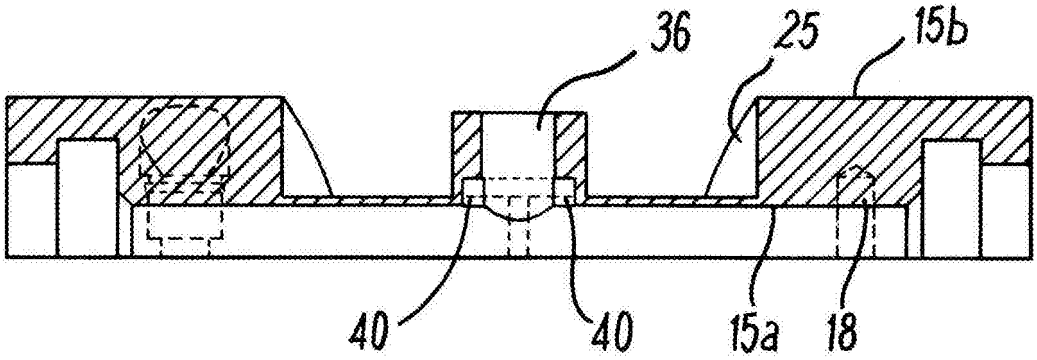

Fig. 2E

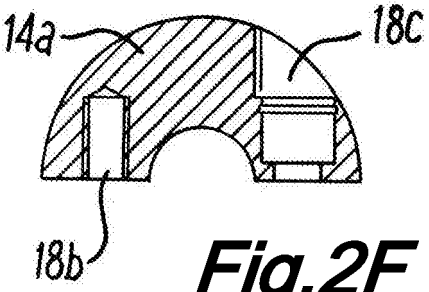

Fig.2F

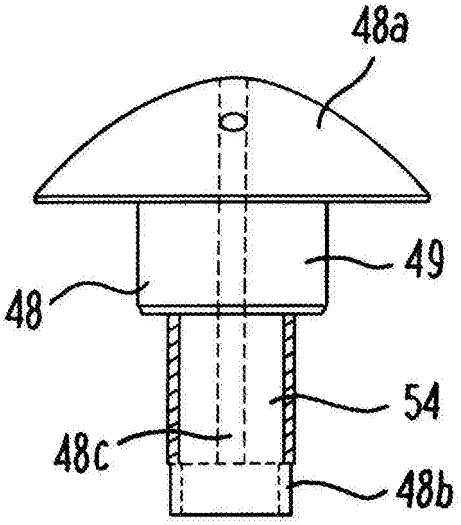

Fig. 3A

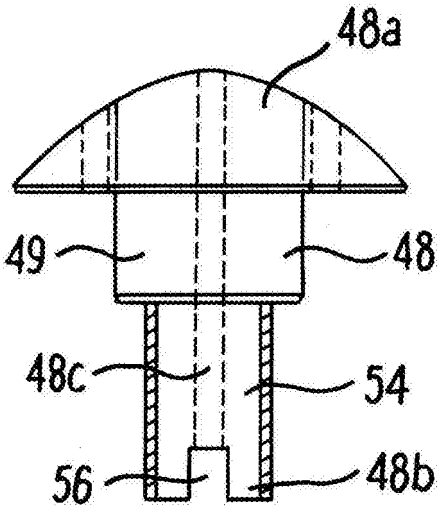

Fig. 3B

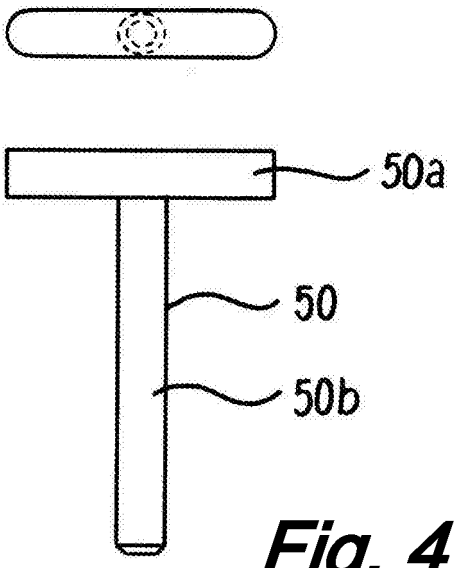

Fig. 4

Wheel Securing System and Method of Use

The present invention relates to downhole deployment systems for use in oil or gas wells, in particular a wheel securing system for downhole devices. Aspects of the invention include a downhole deployment device including a wheel securing system and a method of use.

Background to the invention

In the oil and gas industry, downhole tools and equipment are lowered into wellbores to install and retrieve apparatus during wellbore completion, perforation operations, maintenance and servicing. Downhole tools may also be used to in well logging operations and collect data on the wellbore conditions such as pressure, temperature and salinity. The wellbores are typically vertical bores. However, in recent years the oil and gas industry has pursued less accessible reservoirs and downhole tools must be able to travel with minimal resistance in deviated bores.

Prior art downhole deployment systems utilise wheels or roller subs which are attached to the downhole tool string to facilitate travel through the wellbore with reduced friction between the tool string and the wellbore.

GB 2429483 discloses a roller sub system which has removably mounted wheels fixed to the roller sub axles using a spring action connector. The connector provides the wheels with a snap-fit.

WO 2005/116387 discloses a deployment system and sub sections for running logging tools in a well bore. The tool body has roller wheels which are mounted to an axle by quick release canted coiled springs. Over time and repetitive use, the tension of the springs may become reduced which can lead to the wheel dislodging from the tool and causing damage to the downhole tool or other equipment.

Another downhole device for incorporation into a tool string is disclosed in GB2460129. The device comprises a mandrel having a central bore with rollers secured to the mandrel by a roller housing. Each roller is mounted on a roller shaft with washers and is connected to a shaft rotating head, each shaft and rotating head is in turn connected to the roller housing by roll pins.

A disadvantage of the above mentioned prior art downhole deployment systems are that they require multiple component fixings for securing the wheel or rollers to the downhole device such as pins, washers and/or ball bearings which are vulnerable to damage and dislocation during downhole operations. If any of these locking components fail, dislodged or work loose it may lead to the tool string becoming stuck in the wellbore and affecting downhole operations. Due to the restricted access in the wellbore the retrieval of the downhole device for repair or replacement can be difficult and expensive and result in delayed downhole operations.

Summary of the invention

It is an object of an aspect of the present invention to obviate or at least mitigate the foregoing disadvantages of prior art downhole deployment systems.

It is another object of an aspect of the present invention to provide a deployment device with improved productivity and/or efficiency which is capable of reliably performing a range of downhole tasks in horizontal, vertical and deviated wellbores.

It is a further object of at least one aspect of the present invention to provide a wheel securing system that is capable of reliably securing wheels or rollers on a deployment device suitable for wireline and slickline applications and improving the performance of the deployment device in which the wheel securing assembly is used and may prolong the working lifespan of the deployment device.

Further aims of the invention will become apparent from the following description.

According to a first aspect of the invention, there is provided a wheel securing system for a downhole device comprising:
at least one wheel;
a wheel retaining member having threads formed thereon configured to threadably engage the downhole device and mount the at least one wheel to the downhole device; and
a locking member configured to engage the wheel retaining member and prevent the wheel retaining member from threadably disengaging the downhole device.

The downhole device may be selected from the group comprising a downhole tool, a downhole deployment device and/or a component of a work string. The work string may be a tool string and/or a drill string.

The downhole device may be configured to be connected to a downhole tool, a downhole deployment device and/or or a component of a work string.

The downhole device may be mounted on a downhole tool, a downhole deployment device and/or a component of a work string. Preferably, the downhole device may be rotatably mounted on a downhole tool, a downhole deployment device and/or a component of a work string.

The component of a work string may comprise a mandrel, journal and/or shaft. The downhole device may be connected to and/or mounted on a mandrel, journal and/or shaft. The downhole device may be rotatably mounted on a mandrel, journal and/or shaft.

Preferably the downhole device comprises a housing.

The housing may be configured to be releasably connected to a downhole tool, a downhole deployment device and/or a component of a work string. The housing may be rotatably mounted on a downhole tool, downhole deployment device and/or a component of a work string.

Preferably the housing is formed from two substantially semi-cylindrical shells. The substantially semi-cylindrical shells may be releasably connected to one another.

The wheel retaining member may be configured to be received in a threaded bore on the housing of the downhole device.

Preferably the wheel retaining member is partially threaded and is configured to be threadably mounted on the housing of the downhole device.

Preferably the wheel retaining member is configured to mount and/or retain the at least one wheel to the housing.

Preferably the at least one wheel is supported on the downhole device, housing and/or shell by a bearing and/or bush located between the wheel and the downhole device, housing and/or shell.

The locking member may be configured to prevent the loosening of the wheel retaining member from unscrewing from the downhole device, housing and/or shell. The separation of the wheel retaining member from the downhole device, housing and/or shell may be prevented by the locking member.

The locking member may be configured to prevent unintentional loosening, unscrewing or uncoupling of the wheel retaining member from the downhole device, housing and/or shell.

The locking member may be configured to engage the wheel retaining member and the downhole device, housing and/or shell to lock the position of the wheel retaining member relative to the downhole device, housing and/or shell.

The locking member is configured to engage a keyway. The locking member may be mounted in a keyway.

The keyway may be formed from a slot on the wheel retaining member. The keyway may be formed from a slot on the downhole device, housing and/or shell. The keyway may be formed from a combination of a slot on the wheel retaining member and a slot on the downhole device, housing and/or shell. The keyway may be formed from the alignment of a slot or keyway on the wheel retaining member and a slot or keyway on the downhole device, housing and/or shell.

The locking member may be slidably mounted in the keyway. The locking member may be received in a keyway formed from the aligned slot or key to prevent rotation of the wheel retaining member relative to the downhole device, housing and/or shell.

Preferably the locking member is a key or pin. The locking member may be selected from the group comprising a square key, rectangular key, Woodruff key, Cotter pin or Gib-head key.

The housing may be releasably connected to and/or rotatably mounted on a mandrel, journal and/or shaft. The substantially semi-cylindrical shells may surround or partially surround the mandrel, journal and/or shaft.

Preferably, in use, the mandrel is fixed relative to a work string and the housing is rotatable relative to the downhole tool or mandrel. Preferably the housing rotates around the longitudinal axis of a mandrel journal and/or shaft.

The locking member may be configured to abut against a surface of a downhole tool, a downhole deployment device and/or a component of a work string. The locking member may be configured to abut against a surface of a mandrel, journal and/or shaft.

The locking member may be retained in the keyway by abutting the locking member against the surface of a downhole tool, a downhole deployment device and/or a component of a work string. The locking member may be retained in the keyway by abutting the locking member against the surface of a mandrel, journal and/or shaft.

The at least one wheel may comprise a generally hemispherical shape. The at least one wheel may comprise a truncated hemispherical shape.

The at least one wheel is configured to rotate relative to the wheel retaining member.

According to a second aspect of the invention, there is provided a downhole deployment device comprising:
a device body; and
a wheel securing assembly comprising
at least one wheel;
a wheel retaining member having threads formed thereon configured to threadably engage the body and mount the at least one wheel to the body; and
a locking member configured to engage the wheel retaining member and prevent the wheel retaining member from threadably disengaging the body.

The device body may be releasably connected to a downhole tool or a component of a work string. The component of a work string may comprise a mandrel, journal and/or shaft. The work string may be a tool string or a drill string. The device body may be releasably connected to a mandrel, journal and/or shaft.

Preferably the device body comprises a housing.

Preferably the housing is formed from two semi-cylindrical shells. The substantially semi-cylindrical shells may be releasably connected to one another.

Preferably, the housing has a stepped profile. The housing may have a stepped profile on an inner surface of the housing.

The wheel retaining member may be configured to be received in a threaded bore on the housing and/or shell.

Preferably the wheel retaining member is partially threaded and is be configured to be threadably mounted on the housing and/or shell.

Preferably the wheel retaining member is configured to mount and/or retain the at least one wheel to the housing and/or shell.

Preferably the at least one wheel is supported on the body, housing and/or shell by a bearing and/or bush located between the wheel and the body, housing and/or shell.

The locking member may be configured to prevent unintentional loosening, unscrewing or uncoupling of the retaining member from the body, housing and/or shell. The separation of the retaining member from the body is prevented by the locking member. The locking member is configured to engage a keyway.

The locking member may be configured to engage the retaining member and the housing, shell or body to lock the position of the retaining member relative to the housing shell or body.

The locking member may be mounted in a keyway.

The keyway may be formed from a slot on the retaining member. The keyway may be formed from a slot on the body, housing and/or shell. The keyway may be formed from a combination of a slot on the retaining member and a slot on the body, housing and/or shell. The keyway may be formed from the alignment of a slot or keyway on the retaining member and a slot or keyway on the body, housing and /or a housing shell.

The locking member may be slidably mounted in a slot or keyway. The locking member may be received in the keyway formed from the aligned slot to prevent rotation of the retaining member relative to the body, housing and /or housing shell.

The locking member may be configured to abut against a surface of a downhole tool and/or a component of a work string. The locking member may be configured to abut against a surface of a mandrel, journal and/or shaft.

The locking member may be retained in the keyway by abutting the locking member against the surface of a downhole tool, and/or a component of a work string. The locking member may be retained in the keyway by abutting the locking member against the surface of a mandrel, journal and/or shaft. The locking member may be a key or pin.

Preferably the device body is configured to be releasably connected to a downhole tool and/or a component of a work string. The downhole tool and/or a component of a work string may have a solid core. Alternatively, downhole tool and/or a component of a work string may comprise a throughbore.

The housing may be rotatably mounted on the downhole tool and/or component of a work string. Preferably, the component of a work string may comprise a mandrel, journal and/or shaft.

Preferably, in use, the downhole tool and/or a component of a work string is fixed relative to a work string and the housing is rotatable relative to the downhole tool or a component of a work string. Preferably the housing rotates around the longitudinal axis of the downhole tool or a component of a work string.

The substantially semi-cylindrical shells of the housing may surround or partially surround the downhole tool or a component of a work string. The substantially semi-cylindrical shells of the housing may surround or partially surround the downhole tool or a component of a work string.

The downhole tool and/or a component of a work string may comprise a corresponding stepped profile on an outer surface of the downhole tool and/or a component of a work string. The stepped profile of the housing is configured to engage with the stepped profile of the downhole tool and/or a component of a work string to allow the housing to rotate relative to the downhole tool or and/or a component of a work string. The housing may rotate around the longitudinal axis of the downhole tool and/or a component of a work string.

The stepped profile may be machined directly on the housing. A corresponding stepped profile may be machined directly on the downhole tool or and/or a component of a work string.

Preferably the component of a work string is a mandrel and the housing is configured to rotate around the longitudinal axis of the mandrel.

Multiple downhole devices may be attached to a tool string or drill string. A further advantage is that the tool may have a compact configuration and may be used in a wide variety of downhole slickline and wireline applications.

The device may comprise more than one wheel. The wheels may be located in pairs in a side-by-side arrangement. The wheels may be arranged offset by 90 degrees from one another. The wheels may be arranged axially adjacent to each other. The wheels may be arranged axially separated from one another.

The downhole tool or mandrel throughbore may comprise cables and/or electrical components for slickline and/or wireline applications. The throughbore may comprise non-electric cables to allow control of downhole tools, adjustment of valves and sleeves located downhole, as well as repair tubing within the wellbore. The throughbore may comprise electrical cables or electronic components to control the lowering and operation of tools in the wellbore and transmit data about the conditions of the wellbore.

Embodiments of the second aspect of the invention may include one or more features of the first aspect of the invention or its embodiments, or vice versa.

According to a third aspect of the invention, there is provided a method of securing a wheel to a downhole device, the method comprising:
providing a downhole device;
mounting at least one wheel on the downhole device by mounting the at least one wheel on a wheel retaining member and threadably mounting the wheel retaining member on the downhole device; and
securing the at least one wheel to the downhole device by engaging a locking member with the wheel retaining member to prevent the wheel retaining member from threadably disengaging the downhole device.

The method may comprise securing the at least one wheel to the downhole device by locking the position of the wheel retaining member relative to the downhole device. The method may comprise positioning the locking member in a keyway formed or located between the wheel retaining member and the downhole device.

The downhole device may be selected from the group comprising a downhole tool, a downhole deployment device and/or a component of a work string. The work string may be a tool string and/or a drill string. The component of a work string may comprise a mandrel, journal and/or shaft.

The method may comprise connecting the downhole device to a downhole tool, downhole deployment device and/or a component of a work string.

The method may comprise mounting the downhole device on a downhole tool, downhole deployment device and/or a component of a work string. The downhole device may be rotatably mounted on a downhole tool, downhole deployment device a component of a work string.

Preferably the downhole device may comprise a housing. The housing may be configured to be releasably connected to a downhole tool, downhole deployment device and/or a component of a work string. The housing may be rotatably mounted on the downhole tool downhole deployment device and/or a component of a work string.

The method may comprise mounting the at least one wheel on the housing.

The method may comprise retaining the locking member in the keyway by abutting the locking member against the surface of a downhole tool, downhole deployment device and/or a component of a work string.

The method may comprise assembling the housing around a downhole tool, downhole deployment device and/or a component of a work string to hold the locking member in the keyway.

Preferably, the housing is configured to be releasably connected to a mandrel. The housing may be rotatably mounted on the mandrel. The method may comprise retaining the locking member in the keyway by abutting the locking member against the surface of a mandrel.

The method may comprise assembling the housing around a mandrel to hold the locking member in the keyway.

The method of the third aspect and its embodiments, or certain selected steps thereof, may be reversed to unsecure a wheel from a downhole deployment device.

Embodiments of the third aspect of the invention may include one or more features of the first or second aspects of the invention or their embodiments, or vice versa.

According to a fourth aspect of the invention, there is provided a method of assembling a downhole deployment device, the method comprising:
providing a downhole deployment device body; and
mounting at least one wheel on the body by mounting the at least one wheel on a wheel retaining member; threadably mounting the wheel retaining member on the body; and securing the at least one wheel to the body by engaging a locking member with the wheel retaining member to prevent the wheel retaining member from threadably disengaging the body.

The method may comprise securing the at least one wheel to the body by locking the position of the wheel retaining member relative to the body. The method may comprise positioning the locking member in a keyway formed or located between the wheel retaining member and the body.

The method may comprise retaining the locking member in the keyway by abutting the locking member against the surface of a mandrel and/or downhole tool. The method may comprise assembling the housing around a mandrel and/or downhole tool to hold the locking member in the keyway.

The method of the fourth aspect and its embodiments, or certain selected steps thereof, may be reversed to disassemble a downhole deployment device.

Embodiments of the fourth aspect of the invention may include one or more features of the first to third aspects of the invention or their embodiments, or vice versa.

According to a fifth aspect of the invention, there is provided a kit of parts for securing a wheel to a downhole deployment device, the kit of parts including:
at least one wheel;
at least one wheel retaining member; and

at least one locking member;
wherein the at least one wheel is rotatably mountable on wheel retaining member and the wheel retaining member is threadably mountable on the downhole deployment device; and when the at least one wheel is mounted on the device the locking member is engageable with the at least one wheel retaining member to prevent the wheel retaining member from threadably disengaging the downhole device.

Preferably, the at least one wheel retaining member has threads formed thereon configured to threadably engage the downhole deployment device and mount the at least one wheel to the downhole deployment device. The downhole deployment device may comprise a threaded bore to receive the retaining member.

Preferably, the at least one locking member is engageable with the at least one wheel retaining member to prevent the wheel retaining member from threadably dismounting or disengaging from the downhole device.

The kit of parts may comprise a downhole deployment device housing. The at least one wheel is rotatably mountable on wheel retaining member and the wheel retaining member is threadably mountable on the housing.

The housing may be releasably connectable to a downhole tool, a component of a work string, a mandrel, journal and/or shaft. The housing may be rotatably mountable on a downhole tool, a component of a work string, a mandrel, journal and/or shaft.

The at least one locking member may be engageable with the at least one wheel retaining member and the housing to prevent the wheel retaining member from threadably dismounting or disengaging the downhole device.

Embodiments of the fifth aspect of the invention may include one or more features of the first to fourth aspects of the invention or their embodiments, or vice versa.

Brief description of the drawings

There will now be described, by way of example only, various embodiments of the invention with reference to the following drawings (like reference numerals referring to like features) in which:

Figures 1A, 1B and 1C present a downhole deployment device in accordance with an embodiment of the present invention, shown in wireframe perspective, side and end views;

Figures 2A, 2B and 2C, present the downhole deployment device of Figure 1A, shown in sectional plan, exploded plan and exploded part-sectional end views;

Figures 2D, 2E and 2F present the housing of the downhole deployment device of Figure 1A, shown in enlarged side, side-sectional and end-sectional views;

Figures 3A and 3B show enlarged side views of a wheel retaining member of the downhole deployment device in accordance with an embodiment of the present invention; and

Figure 4 shows an enlarged side view of a locking member of the downhole deployment device in accordance with an embodiment of the present invention.

Detailed description of preferred embodiments

An embodiment of the present invention is illustrated in Figures 1A, 1B and 1C and provides a number of advantages over prior art downhole deployment devices, specifically by providing a wheel securing system the device is capable of reliably deploying tools downhole in a safe and time efficient manner. The compact deployment tool comprises minimal components which may facilitate a wide range of downhole tasks being performed and mitigates the risk of deployment components being dislodged or damaged and affecting downhole operations.

Figures 1A and 1B show wireframe perspective and side views of a downhole deployment device 10. Figure 1C is an end view of the device 10 shown in a pipe 11. A section of the pipe in Figure 1A has been removed to improve the clarity of the drawing.

The device 10 has a body 12 which comprises a substantially cylindrical housing 14 which may be releasably connected to a downhole tool or a component of a work string such as a mandrel, journal and/or shaft. In this example the housing 14 is releasably connected to a mandrel 16.

The housing 14 is formed from two substantially semi-cylindrical shells 14a and 14b. The housing 14 is rotatably mounted on mandrel 16. The shells 14a and 14b have an inward bearing surface 15a which is configured to bear against the outer surface 13 of a mandrel 16 to allow the body 12 to rotate around the mandrel, best shown in Figure 2A.

The mandrel 16 has connector ends 22a and 22b which are configured to be coupled to a tool string (not shown).

The two shells 14a and 14b are secured to one another by a plurality of suitable threaded fastenings 18. The fastenings 18 are arranged such that they do not contact the mandrel 16 and the body 12 is free to rotate around the longitudinal axis of the mandrel. Although, in the present example threaded fastenings 18 such as bolts are used to secure the shells 14a and 14b to one another, alternative affixing techniques such as welding or chemical bonding may be used if the material is suitable. The thread fastening may be held securely by a circlip, snap ring or split pin (not shown).

The mandrel 16 has a throughbore 20 for cables and/or electrical components for slickline and/or wireline applications. In slickline applications the throughbore 20 may comprise a non-electric cable to allow control of downhole tools as well as maintenance within the wellbore. In wireline applications the throughbore 20 may comprise electrical cables or electronic components to control the lowering and operation of tools in the wellbore and transmit data about the conditions of the wellbore.

The device 10 comprises two wheel assemblies 24a and 24b. The wheel assemblies 24a and 24b have wheels 26 configured to engage an inner surface of the pipe 11.

The downhole deployment device is described further in relation to Figures 2A and 2B. Figures 2A is a partial cross section of the downhole deployment device in which shell 14b and wheel assembly 24b have been removed to improve the clarity of the drawings.

The mandrel 16 is substantially cylindrical with a stepped profile on its outer surface. The mandrel has first end section 16a and second end section 16b. The first and second ends 16a and 16b having a first diameter “A”. The mandrel has a reduced diameter portion 16c between the first and second ends 16a and 16b. The reduced diameter portion 16c is substantially cylindrical with a diameter less than the first diameter “A” of end sections 16a and 16b. The stepped profile of the mandrel may be machined from a single piece of material.

An annular shoulder 17a is formed at the junction of the first end 16a and the reduced diameter portion 16c. A groove 21a is directly adjacent to shoulder 17a. An annular shoulder 17b is formed at the junction of the second end 16b and the reduced diameter portion 16c. A groove 21b is directly adjacent to shoulder 17b.

The shells 14a and 14b (not shown) have an inner bearing surface 15a and an outer surface 15b. The inner bearing surface 15a of the shells 14a and 14b have a surface profile which corresponds with the reduced diameter portion 16c and shoulders 17a and 17b of mandrel 16. The shells 14a and 14b are designed to engage the surface of the mandrel 16.

The shoulders 17a and 17b are configured to retain the axial position of the housing relative to the mandrel. The shoulders 17a and 17b on the mandrel 16 are configured to engage grooves 27a and 27b on the inner surface 15a of the shells. The inner surface 15a has shoulders 23a and 23b which are configured to engage grooves 21a and 21b on the mandrel.

The axial position of the shell relative to the mandrel is maintained as the shell rotates about the longitudinal axis of the mandrel. Shoulders 17a and 17b on the mandrel are kept in abutment with grooves 27a and 27b on the inner surface of the shell 14a. Shoulders 23a and 23b on the inner surface of the shell are kept in abutment with grooves 21a and 21b of the mandrel 16.

The shells 14a and 14b are positioned surrounding the mandrel with coupling bolts 18 engaging the bores 18b and 18c on the inner surface of the corresponding shell to draw the shells towards one another, best shown in Figures 2E and 2F. The bolts 18 are secured by a circlip, snap ring or split pin (not shown).

The outer surface 15b of the shells 14a and 14b have a recess 25 where the wheel 26 is located, best shown in Figure 2D. The recess is dimensioned to accommodate the wheel 26. The recess 25 is dimensioned slightly larger than the wheel to allow the wheel to rotate freely but minimise the risk of debris in the wellbore entering between the recess 25 and the wheel 26.

As shown in Figures 2C and 2E, the recess has a central hub 34. The hub 34 has a throughbore 36 having first end 36a on the inner bearing surface 15a and second end 36b on the outer surface 15b. The throughbore 36 is threaded. The first end 36a of the throughbore 36 expands to form a recess section 40.

The wheel securing assembly 24a comprises a wheel bearing 44, wheel 26, wheel retaining member 48 and key 50. The wheel bearing 44 has a throughbore 44a which is configured to receive and surround hub 34. The wheel bearing 44 has protrusions 52 on its lower surface which are configured to engage bores 52a on the outer surface 15b of the shell 14a to locate and fix the position of the bearing 44 relative to the shell 14a and prevent the bearing from rotating as the wheel rotates.

The wheel 26 has a generally truncated hemispherical shape, specifically a hemisphere with a dome section removed. The wheel 26 has a central throughbore 46 configured to receive the wheel bearing 44.

The wheel 26 has an inner surface 26a which, in use, bears against an outer surface 44b of the wheel bearing 44. The bearing 44 is made of brass or brass alloys or of reinforced hard synthetic materials which assures that the wheel 26 is free to rotate relative to the bearing 44 and protects the bearing from wear and tear.

The wheel 26 and bearing 44 are secured to the hub 34 by a wheel retaining member 48. Figure 3A and 3B show enlarged views of the wheel retaining member 48. The wheel retaining member 48 has a first dome shaped end 48a, shoulder 49, shaft 54 and second end 48b. The second end 48b of wheel retaining member 48 has a groove 56 and a central bore 48c. The shaft 54 is threaded and is configured to engage threaded throughbore 36 of the hub 34.

The wheel assembly comprises a key 50 which has a lock section 50a and optionally a shaft 50b, best shown in Figure 2B and Figure 4. The shaft 50b is configured to be received in throughbore 36 of the hub 34 and received in bore 48c of the wheel retaining member 48.

As shown in Figures 2C and 3B, the second end section 48b of the wheel retaining member 48 has a groove 56. The lock section 50a of the key 50 is configured to be received in a keyway 70 formed from the alignment of groove 56 and recess 40 in order to lock the position of the wheel retaining member relative to the hub 34.

When the wheel assembly 24a is assembled as shown in Figure 2A, the wheel 26 and bearing 44 are secured to the hub 34 of the shell 14a by the wheel retaining member 48 engaging the threaded throughbore 36 of the hub 34. The wheel retaining member 48 is locked in position by the key 50 which engages the wheel retaining member and the hub in keyway 70.

When the lock section 50a of the key 50 is located in the keyway 70 the retaining member 48 is unable to rotate or unscrew and the wheel assembly components including the wheel 26 and bearing 44 are unable to uncouple from the deployment device.

When the wheel 26 is mounted on the shell 14a by the retaining member and locked by locating the key in the keyway 70, the wheel 26 is able to rotate around the bearing 44. The wheel 26 and wheel retaining member 48 form a hemispherical surface from the first dome shaped end 48a of the retaining member and the truncated hemispherical shape wheel. Although the retaining member 48 is fixed and does not rotate, the first dome shaped end 48a provides a curved surface which provides a smooth contact with the wellbore or pipe.

To secure the wheel assembly 24a to the device 10 the wheel bearing 44 is first positioned around the hub 34 best shown in Figures 2A and 2B. The protrusions 52 on the lower surface of wheel bearing 44 engage bores 52a on the outer surface 15b of the shell 14a to locate and fix the position of the bearing 44 relative to the shell 14a.

The wheel 26 is then positioned on the bearing 44 such that the inner surface of the wheel 26 engages the outer surface of the bearing 44b. The end section 48b of the wheel

retaining member 48 is inserted through the bore 44a of wheel bearing 44 such that the threads of the shaft 54 of the wheel retaining member 48 engage the threads in the throughbore 36 of hub 34.

The wheel retaining member 48 is screwed into a position where the shoulder 49 of the wheel retaining member abuts the hub 34. In this position, the outer surface 49a of the shoulder 49 is flush with the outer surface of hub 34b and provide a continuous bearing surface for the bearing 44.

The groove 56 of the end section 48b of the wheel retaining member 48 aligns with the recess 40 in the throughbore 36 of the hub 34 to form a keyway 70. In this position the wheel 26 is mounted to shell 14a of the deployment tool but is not locked in position. In order to prevent the wheel retaining member 48 from being unscrewed and uncoupling the wheel 26, the key 50 is positioned in throughbore 36 of hub 34. In order to position the key in the throughbore 36 of hub 34 access is required to the inner bearing surface 15a of the shell 14a.

The shaft 50b of key 50 is located in bore 48c of the wheel retaining member with lock section 50a of the key 50 located in keyway 70. As long as the lock section 50a of the key 50 is located in the keyway 70 the wheel retaining member is unable to rotate relative to the hub and is locked in position.

The wheel assembly 24b mounted on shell 14b is assembled in the same way as described above in relation to the wheel assembly 24a mounted on shell 14a.

The shells 14a and 14b with their respective wheel assemblies can then be mounted on the mandrel 16 such that the inner surfaces of the shells 14a and 14b engage the profiled surface of the mandrel 16. Once the shells 14a and 14b are mounted on the mandrel, the mandrel outer surface abuts the key 50 ensuring that the lock section 50a of the key 50 is located in keyway 70 as the housing rotates about the longitudinal axis of the mandrel.

Once the downhole deployment device with the wheel securing system has been assembled the device is connected to a work string via the end connectors 22a and 22b and run into a wellbore. The wheel 26 and wheel retaining members of the deployment device contact the walls of the wellbore allowing easy movement of the work string and

protection of the downhole tools and equipment on the tool string. The housing is configured to rotate about the longitudinal axis of the mandrel to overcome objections or allow the deployment to navigate deviated pathways in horizontal, vertical and deviated wellbores.

It will be appreciated that the principles of the invention may be used in a method of removing a wheel or disassembling the deployment device. In particular, the steps of the example methodology, or a subset thereof, may be reversed. For example, the downhole deployment device comprising the wheel securing system may be raised to surface and disconnected from the work string. In order to remove the wheel from the wheel assembly, the key 50 must first be released from its abutting position with the mandrel. The shells 14a and 14b are first removed from the mandrel. The lock section 50a of the key 50 may be removed from keyway 70. The wheel retaining member is able to rotate relative to the hub and may be unscrewed from the throughbore 36 of hub 34 and the wheel may be removed from the bearing 44.

Performing the steps of the above described method (or selected steps thereof) in reverse, highlight an advantage of the invention in that the deployment device described must be physically disassembled in order to remove the wheels. This mitigates the risk of the wheel becoming loose or falling off accidently during use.

Although the above described examples relate to the deployment device comprising a wheel securing assembly or system being connected to a mandrel, the present invention may also be connected to a downhole tool and/or components of a work string including a journal or shaft. The downhole tool, journal or shaft may have a stepped profile. The downhole tool, journal and/or shaft may have a stepped profile on an outer surface and the housing of the deployment tool may comprise a corresponding stepped profile on an inner surface of the housing. The deployment device may be configured to rotate around the longitudinal axis of the downhole tool and/or components of a work string.

The wheel securing assembly or system may be used to secure at least one wheel to a downhole tool, a downhole deployment device or a component of a work string.

The above described example describes an inverted T-shaped locking member. However, different locking member types and/or key shapes may be used.

The described embodiments use wheels. However, the present invention may also be applied to downhole devices that use rollers or tracks.

Throughout the specification, unless the context demands otherwise, the terms 'comprise' or 'include', or variations such as 'comprises' or 'comprising', 'includes' or 'including' will be understood to imply the inclusion of a stated integer or group of integers, but not the exclusion of any other integer or group of integers. Furthermore, relative terms such as", "horizontal", "vertical", raise, lower and the like are used herein to indicate directions and locations as they apply to the appended drawings and will not be construed as limiting the invention and features thereof to particular arrangements or orientations.

The foregoing description of the invention has been presented for the purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed. The described embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilise the invention in various embodiments and with various modifications as are suited to the particular use contemplated. Therefore, further modifications or improvements may be incorporated without departing from the scope of the invention herein intended.

A wheel securing system for a downhole device which comprises at least one wheel. The system also comprises a wheel retaining member having threads formed thereon configured to threadably engage the downhole device and mount the at least one wheel to the downhole device. The system also comprises a locking member configured to engage the wheel retaining member and prevent the wheel retaining member from threadably disengaging the downhole device.

Another benefit of the invention is that the wheel securing system mitigates the risk of the components becoming loose during operation, becoming lost downhole and/or damaged which can affect downhole operations. The wheel securing components are protected from exposure for the wellbore and/or debris and are therefore protected from impacts or erosion that may result in their damage or loosening.

The ability of the wheels to be secured to the downhole device as the device rotates around the longitudinal axis of the tool string enables the downhole device to navigate,

traverse and overcome obstacles. This may provide the device a high degree of orientation flexibility. It also avoids the need to provide multiple wheel assemblies fixed around the circumference of the device to support a tool or work string which can be costly and increases the component requirements of the tool. The ability to rotate on the longitudinal axis of the mandrel increases the likelihood of the wheel maintaining contact with the wellbore and protect the tool string and aid in their deployment.

Various modifications to the above described embodiments may be made within the scope of the invention herein intended.

Claims

1. A wheel securing system for a downhole device comprising:
at least one wheel;
a wheel retaining member having threads formed thereon configured to threadably engage the downhole device and mount the at least one wheel to the downhole device; and
a locking member configured to engage the wheel retaining member and prevent the wheel retaining member from threadably disengaging the downhole device.

2. The wheel securing system as claimed in claim 1 wherein the downhole device is selected from the group comprising a downhole tool, a downhole deployment device or a component of a work string.

3. The wheel securing system as claimed in claim 1 or claim 2 wherein the downhole device comprises a housing.

4. The wheel securing system as claimed in claim 3 wherein the housing is formed from two substantially semi-cylindrical shells.

5. The wheel securing system as claimed in claim 4 wherein the substantially semi-cylindrical shells are releasably connected to one another.

6. The wheel securing system as claimed in any of claims 3 to 5 wherein the wheel retaining member is configured to be received in a threaded bore on the housing.

7. The wheel securing system as claimed in any preceding claim wherein the at least one wheel is supported on the downhole device by a bearing.

8. The wheel securing system as claimed in any preceding claim wherein the locking member is configured to engage the wheel retaining member and/or the downhole device to lock the position of the wheel retaining member relative to the downhole device.

9. The wheel securing system as claimed in any preceding claim wherein the locking member is configured to be received in a keyway.

10. The wheel securing system as claimed in claim 9 wherein the keyway is formed from a slot, groove or recess on the wheel retaining member.

11. The wheel securing system as claimed in claim 9 wherein the keyway is formed from a slot, groove or recess on the wheel retaining member aligned with a slot, groove or recess on the downhole device.

12. The wheel securing system as claimed in any preceding claim wherein the locking member is a key or pin.

13. The wheel securing system as claimed in any preceding claim wherein the at least one wheel is configured to rotate relative to the wheel retaining member.

14. The wheel securing system as claimed in any claim 9 to 13 wherein the locking member is retained in the keyway by abutting the locking member against the surface of a downhole tool, a downhole deployment device and/or a component of a work string.

15. The wheel securing system as claimed in any of claims 3 to 14 wherein the housing is rotatably mounted on a mandrel, journal and/or shaft.

16. The wheel securing system as claimed in claim 15 wherein the housing surrounds or partially surrounds the mandrel, journal and/or shaft.

17. The wheel securing system as claimed in claim 15 or 16 wherein the locking member may be retained in the keyway by abutting the locking member against the surface of a mandrel, journal and/or shaft.

18. A downhole deployment device comprising:
a device body; and
a wheel securing system comprising
at least one wheel;

a wheel retaining member having threads formed thereon configured to threadably engage the body and mount the at least one wheel to the body; and

a locking member configured to engage the wheel retaining member and prevent the wheel retaining member from threadably disengaging the body.

19. The downhole deployment device as claimed in claim 18 wherein the device body is releasably connected to a downhole tool or a component of a work string.

20. The downhole deployment device as claimed in claim 18 or claim 19 wherein the device body comprises a housing.

21. The downhole deployment device as claimed in claim 20 wherein the housing is formed from two substantially semi-cylindrical shells.

22. The downhole deployment device as claimed in claim 20 or claim 21 wherein the housing has a stepped profile on an inner surface of the housing.

23. The downhole deployment device as claimed in any of claims 20 to 22 wherein the wheel retaining member is configured to be received in a threaded bore on the housing.

24. The downhole deployment device as claimed in any of claims 20 to 23 wherein the wheel retaining member is partially threaded and is be configured to be threadably mounted on the housing.

25. The downhole deployment device as claimed in any of claims 20 to 24 wherein the locking member is configured to engage the wheel retaining member and the housing to lock the position of the wheel retaining member relative to the housing.

26. The downhole deployment device as claimed in any of claims 18 to 25 wherein the locking member is configured to engage a keyway.

27. The downhole deployment device as claimed in any of claims 18 to 26 wherein the locking member is a key or pin.

28. The downhole deployment device as claimed claims 26 or 27 wherein the keyway is formed from the alignment of a slot, groove or recess on the wheel retaining member and a slot, groove or recess in the housing.

29. The downhole deployment device as claimed in any of claim 20 to 28 wherein the housing is rotatably mounted on a downhole tool or a component of a work string.

30. The downhole deployment device as claimed in claim 22 wherein the stepped profile of the housing is configured to engage with a stepped profile on a downhole tool or a component of a work string to allow the housing to rotate relative to the downhole tool or a component of a work string.

31. The downhole deployment device as claimed claims 30 wherein the housing is configured to rotate around the longitudinal axis of the downhole tool or a component of a work string.

32. The downhole deployment device as claimed in claim 26 wherein the locking member is retained in the keyway by abutting the locking member against the surface of a downhole tool and/or a component of a work string.

33. A method of securing a wheel to a downhole device, the method comprising:
providing a downhole device;
mounting at least one wheel on the downhole device by mounting the at least one wheel on a wheel retaining member and threadably mounting the wheel retaining member on the downhole device; and
securing the at least one wheel to the downhole device by engaging a locking member with the wheel retaining member to prevent the wheel retaining member from threadably disengaging the downhole device.

34. The method as claimed in claim 33 comprising securing the at least one wheel to the downhole device by locking the position of the wheel retaining member relative to the downhole device.

35. The method as claimed in any claims 33 or claim 34 comprising mounting the at least one wheel on a housing of the downhole device.

36. The method as claimed in claim 35 comprising assembling the housing around a mandrel and/or a downhole tool.

37. The method as claimed in any of claims 33 to 36 comprising positioning the locking member in a keyway formed or located between the wheel retaining member and the downhole device.

38. The method as claimed in claim 37 comprising retaining the locking member in the keyway by abutting the locking member against the surface of a mandrel and/or downhole tool.

39. A method of assembling a downhole deployment device, the method comprising:
providing a downhole deployment device body; and
mounting at least one wheel on the body by mounting the at least one wheel on a wheel retaining member; threadably mounting the wheel retaining member on the body; and
securing the at least one wheel to the body by engaging a locking member with the wheel retaining member to prevent the wheel retaining member from threadably disengaging the body.

40. The method as claimed in claim 39 comprising securing the at least one wheel to the body by locking the position of the retaining member relative to the body.

41. The method as claimed in claim 39 or claim 40 comprising positioning the locking member in a keyway formed or located between the wheel retaining member and the body.

42. The method as claimed in claim 41 comprising assembling the downhole deployment device body around a mandrel and/or downhole tool to hold the locking member in the keyway.

43. The method as claimed in claim 42 comprising retaining the locking member in the keyway by abutting the locking member against the surface of a mandrel and/or downhole tool.

44. A kit of parts for securing a wheel to a downhole deployment device, the kit of parts including:
at least one wheel;
at least one wheel retaining member; and
at least one locking member;
wherein the at least one wheel is rotatably mountable on wheel retaining member and the wheel retaining member is threadably mountable on the downhole deployment device; and
when the at least one wheel is mounted on the device the locking member is engageable with the at least one wheel retaining member to prevent the wheel retaining member from threadably disengaging the downhole device.

45. A wheel securing system for a downhole device substantially as described herein with reference to the appended drawings.

46. A downhole deployment device substantially as described herein with reference to the appended drawings.

Application No:	GB1602966.2	**Examiner:**	Mr Haydn Gupwell
Claims searched:	XXXXXXXX	**Date of search:**	5 September 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1-44	GB2460129 A (WIRELINE ENGINEERING LTD) see whole document especially the figures relating to a downhole device comprising wheels 16 and stepped cylindrical housings 36 & 38.
Y	1-44	US6010290 A (DANA CORP) see whole document especially the figures noting threaded wheel retaining member 6 and locking member 2 & 7.
Y	1-44	US5795037 A (HAGELTHORN GEORGE ALLAN) see whole document especially the figures noting threaded wheel retaining member 11 and various locking members 18 & 19, 23 & 25, 32, 34.
Y	1-9, 12-27, 29-44	JP2012247023 A (NTN TOYO BEARING CO LTD) see whole document especially the figures noting threaded retaining member 20 and locking member 30.
Y	1-8, 13-25, 29-40 & 44	US2014/259673 A1 (EBERT JAMES L) see whole document especially the figures noting device 12, threaded wheel retaining member 102 and locking member 120, 128.
A	None	US1966015 A (KUZOVENKOFF IGNATIE I)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

E21B; F16C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI.

International Classification:

Subclass	Subgroup	Valid From
E21B	0041/00	01/01/2006