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(54) A steering means and quick release arrangement for a wheelchair

(57) A wheelchair 1 is adapted for one handed operation by incorporation of a foot operated steering means that allows a user to steer a steerable castor 6 by swivelling a footplate 8. A drive means 15 between footplate 8 and the steerable castor 6 is adapted to translate an angle of swivel of the footplate 8 about a swivelling axis 14 to a greater angle of rotation of the steerable castor 6 about a steering axis 21. Typically the ratio of footplate swivel to steerable castor rotation is around 1:2. The wheelchair 1 also has a drive wheel 3 incorporating a differential 41 that allows both drive wheels 3, 4 of the wheelchair 1 to be driven from just one hand rim 42. The drive wheel 3 has a brake 59 for locking the differential 41 such that the wheelchair 1 can pirouette on the spot. Both the differential 41 and the brake 59 are incorporated in a quick release arrangement, such that the drive wheel 3 can be easily removed from the wheelchair 1 for transport and stowage.

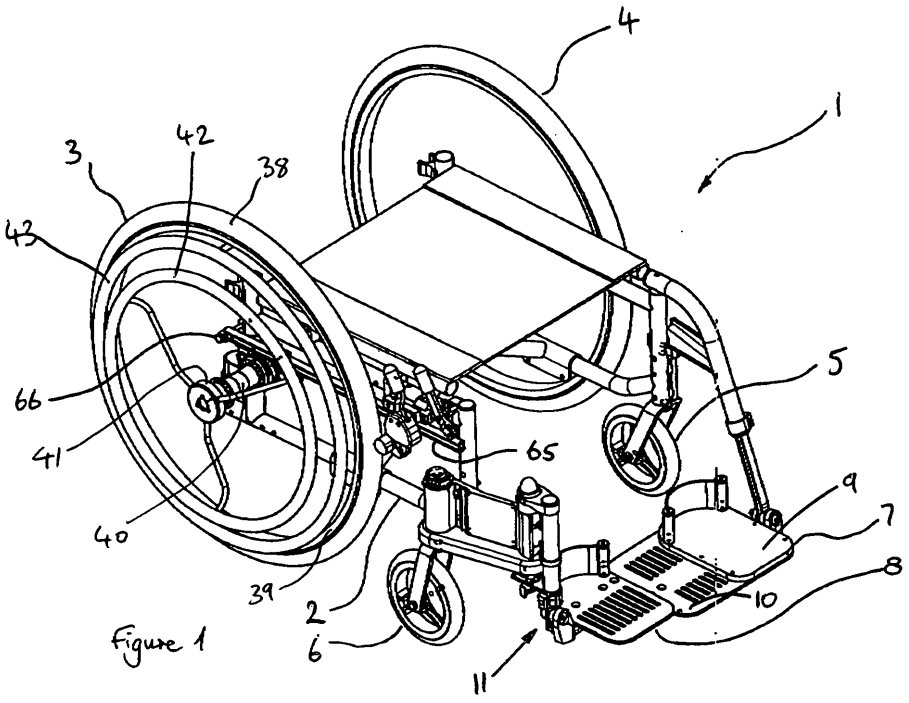

Figure 1

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Description

Field of the Invention

[0001] This invention relates to a steering means and a quick release arrangement for a wheelchair. The invention may be applied particularly, but not exclusively, to a wheelchair adapted for one handed operation.

Background to the Invention

[0002] Hand-propelled wheelchairs provide a means of mobility for people who have difficulty in walking. The most usual means of propelling a wheelchair are hand rims attached to the two main driving wheels of the wheelchair, one on each side. However, the user of the wheelchair may find difficulty in propelling the wheelchair in a straight line if one arm is stronger than the other. In such a case there is a tendency for the wheelchair to turn towards the user's weaker side, and the weaker arm then has to do extra work to try to maintain the intended direction. Hence forward progress goes at the pace of the weaker arm, and the additional power of the stronger arm is not utilised. An extreme example of this occurs when the user has hemiplegia, which is paralysis of one side of the body, say as a result of a stroke. A user with hemiplegia will find great difficulty in propelling the wheelchair in a straight line.

[0003] So-called hemiplegic wheelchairs are available commercially with three different types of propulsion - the 'push and walk', the dual hand rim, and the reciprocating lever - but they do not satisfy the needs of the user. In the prior art there are also wheelchairs having foot-operated steering, such as described US 4,241,932. Such devices include a swivelling footrest permanently connected to a steerable wheel via a rigid link. By this means any difference in strength between the user's arms may be compensated by using the foot-operated steering. However, the permanent connection creates a problem. If the user needs occasionally to be pushed by a carer, then the user needs to cooperate with the carer on the angle of the steering. In practice, the carers prefer to have full control over the direction of the wheelchair when they are pushing it, and this requires that the steering be disengaged at such times.

[0004] A disengagable steering means is described in Porter L A, Lesley S, "An ergonomic one-handed wheelchair", Proceedings of CWUAAT, Cambridge, pp257-266, (2001), but this has the disadvantage that the relationship between foot angle and wheel angle is 1:1. Hence, if the user's range of foot angle is limited to say $\pm$ 20°, then steering angle is also limited to $\pm$ 20°. But $\pm$ 20° is too small to provide tight turns in confined spaces.

[0005] It is also known to have a differential in the hub of one of the drive wheels of a manual wheelchair, as a means of allowing a person with only one active hand to propel the wheelchair easily (see, e.g., "Universal Access and Assistive Technology", Chapter 25, "An ergonomic one-handed wheelchair", Porter L A and Lesley S, Springer-Verlag, 2002, ISBN 1852335955). However, the differential of the prior art does not allow quick-release of the drive wheel. Quick-release of the drive wheels is desirable because carers who are in charge of people in wheelchairs prefer to dismantle the wheelchair into smaller lighter sub-assemblies before putting them into the luggage space of a motor vehicle for example. The differential of the prior art provides a further advantage: it enables the wheelchair to be pirouetted on the spot by fitting a pirouette brake and an additional hand rim. However, the pirouette brake has the form of a disc brake, such as is used in bicycles. This form of the pirouette brake prevents the wheel from being detached quickly from the wheelchair.

[0006] The present invention seeks to overcome these problems.

Summary of the Invention

[0007] According to a first aspect of the present invention, there is provided a steering means for a wheelchair, the steering means comprising:

a wheel steerable about a steering axis to steer the wheelchair;
a footplate swivellable about a swivelling axis, on which footplate a user may place their foot to operate the steering means; and
a drive means between the steerable wheel and the footplate, which drive means is adapted to translate an angle of swivel of the footplate about the swivelling axis to a greater angle of steering of the steerable wheel about the steering axis.

[0008] Usually, the steering axis and the swivelling axis are offset from one another. So, the drive means may comprise a belt driven between two pulleys. This can be arranged to translate rotation about the swivelling axis to rotation about the steering axis. One pulley might be coaxial with the swivelling axis and one pulley might be coaxial with the steering axis. Differing ratios between the pulleys can provide the difference in angle of rotation about the respective axes. In particular examples, the drive means may be a toothed belt and pulleys; or it may be a chain and sprockets.

[0009] It can be useful for the footplate to be detachable from the drive means. This can allow convenient stowage and such like. In a particular example, the footrest may be detached quickly by unlatching a latch. The footplate may be mounted on a footplate assembly that includes a yoke for attaching the assembly to the drive means. The yoke may have pins for locking the assembly to the drive means such that swivelling motion of the footplate can be transferred to the drive means.

[0010] The drive means preferably has a disengagable coupling means that can allow the footplate to disengage

from the steerable wheel. In particular, the coupling means may cause the footplate to disengage from the steerable wheel when the user's foot is removed from the footplate. Again, expressed in more specific terms, when the user places their foot on the footplate, the weight of their foot may cause the coupling means to engage thereby driveably connecting the footplate to the steerable wheel via the drive means, enabling a swivelling movement of the user's foot to cause a swivelling movement of the steerable wheel, thereby allowing the vehicle to be steered.

[0011] In a particularly preferred example of the invention, the coupling means comprises a first cam driveably connected to the steerable wheel and a second cam driveably connected to the footplate. The cams are typically both substantially annualr and slideably engage with each other in an axial direction along a central common axis. This common axis is preferably the swivelling axis.

[0012] The cams can be biased apart by resilient disengaging means, such as a spring. This resilient disengaging means can be overcome by force exerted on the footplate in a direction that is downward in use. The biasing of the resilient means might be less than the typical force generated by the weight of the user's leg on the footrest. More accurately, the resilient means exerts a force that supports the moveable weight of the footrest, but not the moveable weight of the footrest and the typical weight of a user's leg.

[0013] The cams usually each have lobes equally spaced from one another around the respective cam. To allow reliable engagement, the cams may have correspondingly positioned lobes. Preferably, the cams each have helical ramps. This provides smooth engagement and disengagement, and zero backlash when fully engaged. Ideally, the ramps have a maximum rising gradient between around 40° and 75°.

[0014] Again, expressed in more specific terms, the coupling means may comprise two cams, a lower cam driveably connected and axially fixed to a swivelling shaft, and an upper cam coaxial with the swivelling shaft and free to rotate and slide axially on the swivelling shaft; the upper cam having provision for the footplate to be driveably connected to it. The provision for the swivelling footplate may be in the form of slots into which pins on the swivelling footplate may enter to form a driveable connection.

[0015] A steering housing may contain a dock which the footrest may enter when in an uppermost position to prevent it from swivelling. The maximum angle of swivel of the footrest may be limited by limit stops. The position of the limit stops may be varied to suit the needs of the wheelchair user.

[0016] According to a second aspect of the present invention, there is provided a means of steering a single-person vehicle using the driver's foot, including:

a steering housing;
a steerable wheel rotatable about a steering axis;
a swivelling footplate, swivellable about a swivelling axis, on which the user may place their foot to steer the vehicle;
a swivelling shaft coaxial with the swivelling axis;
a drive means between the swivelling footplate and the steerable wheel; and
an engagable/disengagable coupling,
whereby, when the user places their foot on the swivelling footplate, the weight of their foot causes the coupling to engage thereby driveably connecting the footplate to the steerable wheel via the drive means, enabling a swivelling movement of the user's foot to cause swivelling movement of the steerable wheel thereby allowing the vehicle to be steered; in which the drive means includes an angle-increasing means whereby the angle of swivelling movement of the steerable wheel about its steering axis is greater than the angle of swivelling movement of the footplate about its swivelling axis.

[0017] According to a third aspect of the present invention, there is provided a coupling for a foot-steering mechanism, including:

a swivelling shaft;
a lower cam; and
an upper cam;
in which the lower cam is driveably connected and axially fixed to the steering shaft, and the upper cam is coaxial with the steering shaft and free to rotate and slide axially on the steering shaft; each cam having lobes equi-spaced around the cam axis, the lower cam having upward facing lobes and the upper cam having downward facing lobes; each lobe having two helical flanks, one rising flank and one falling flank; with the helical flanks of the upper cam matching those of the lower cam so that the two cams may interlock with their helical flanks in mutual contact thereby forming a zero-backlash driveable coupling which may be engaged or disengaged.

[0018] According to a fourth aspect of the present invention, there is provided a quick release arrangement for a drive wheel of a wheelchair, the arrangement comprising:

a hub for supporting the drive wheel;
a coupling means for connecting the arrangement to a drive axle of the wheelchair;
a differential having an input connectable to a hand rim, a first output for transferring drive from the input to the hub and a second output for transferring drive from the input to the coupling means to drive the axle; and
a quick-release pin for mounting the arrangement on the wheelchair, release of which pin disconnects the coupling means from the axle and allows the ar-

rangement to be dismounted from the wheelchair.

[0019] Preferably, the second output of the differential is arranged to transfer drive from the input to the coupling means via the quick-release pin. More specifically, the quick release pin may comprise a shaft extending from the differential to the coupling. The quick-release pin may also have a detent for locking the arrangement to the wheelchair. The quick-release pin may have an operating means operable remotely from the detent for releasing the detent to unlock the arrangement from the mounting. The operating means may be a push button. Usually, the coupling means and the operating means are at opposite ends of the quick-release pin. Expressed in more specific terms, the operating means for the quick-release pin may be a button which can be pushed to unlock the detent. Similarly, the coupling means for the quick-release pin may be at the end of the quick-release pin furthest from the operating means.

[0020] The coupling means is typically a tapered hexagon. This can be arranged to engage or mate with a corresponding socket of the axle, e.g. in an end of the axle. In other embodiments, the coupling means may be a tapered spline; or the coupling means may be a parallel spline.

[0021] In a particularly preferred embodiment, the detent of the quick-release pin may be between the coupling means and the operating means and preferably close to the coupling means. In other words, the detent may be adjacent to the coupling means and nearer to the operating means.

[0022] It is possible for the differential to be a bevel gear differential. However, it is preferred that the differential is an epicyclic differential. An epicyclic differential is generally narrower the a bevel gear differential and can have an input on one side, rather than centrally as required by a bevel gear differential.

[0023] It is preferred that the quick release arrangement has a brake operable to lock the input of the differential in relation to the wheelchair, thereby constraining the two outputs of the differential to rotate in opposite directions such that the wheelchair can pirouette on the spot. Typically, the brake comprises a rotatable member fixed to the input of the differential and a non-rotatable member mountable on the wheelchair. The non-rotatable member may lock the rotatable member by acting on it radially. Importantly, this can allow the rotatable member to be released from the non-rotatable member in an axial direction, for example when the arrangement is dismounted from the wheelchair. In one example, the rotating member is a gear wheel and the non-rotating member is a pawl.

[0024] Expressed in more specific terms, an input member of the differential may have a portion extending through the hub to which may be driveably attached the rotatable member of a pirouette brake, said brake having a stationary member non-rotationally fixed to the wheelchair; whereby, when the pirouette brake is applied, it locks the input member of the differential thereby constraining the two output members of the differential to rotate in opposite directions and causing the wheelchair to pirouette on the spot. When the drive wheel of the wheelchair is being slid into place on the wheelchair, the rotating member of the pirouette brake may be put into proximity with the non-rotating member of the pirouette brake; and allow the drive wheel to be slid out again when the operating means is operated to unlock the detent. For example, the non-rotating member of the pirouette brake may include curved surfaces of friction material which surround the rotating member and which can be moved into contact with and clamp on the rotating member. Alternatively, the rotating member of the pirouette brake may be in the form of a gear wheel, and the non-rotating member of the pirouette brake may include a pawl which may be moved into engagement with the rotating member thereby preventing the rotating member from rotating.

[0025] More simply, the rotating brake member may be in the form of a gear wheel. Similarly, the non-rotating brake member may be a pawl which may be moved into engagement with the teeth of the gear wheel. The pawl may have two teeth and be pivoted so that the teeth are capable of engaging wholly or partially with the teeth of the gear wheel.

[0026] The invention also provides a drive wheel for a wheelchair, the drive wheel comprising the quick release arrangement described above and the hand rim mounted to the differential. The drive wheel may also have a second hand rim connected to the rim of the wheel. This can be helpful to allow the drive wheel to be driven by the user to pirouette the wheelchair when the brake is engaged. Similarly, the invention provides a wheelchair incorporating the steering means described above and/or the drive wheel described above.

[0027] According to a fifth aspect of the present invention, there is provided a wheel for a wheelchair including:

A hand rim
a hub
a differential
a quick-release pin
the hub having an inner flange and an outer flange, the inner flange being adjacent to the wheelchair; the differential having one input member and two output members, a first output member and a second output member; the hand rim being driveably connected to the input member of the differential; the first output driving the drive wheel; the second output driving the quick-release pin; the quick-release pin being concentric with the rotational axis of the drive wheel and having:

a detent,
an operating means,
and a coupling means;
arranged so that the operating means is acces-

sible from the outer-flange side of the hub; the pin passing through the hub, and extending inboard of the inner flange of the hub, with the detent and coupling means external to the hub, so that, when the quick-release pin is pushed into a wheel mounting on the wheelchair, the detent locks and prevents the wheel from being removed until such times as the operating means is operated to unlock the detent; and with the wheel in position the coupling means then being available for coupling to other items such as another drive wheel.

[0028] Also, according to a sixth aspect of the present invention, there is provided a pirouette brake for use on a quick-release drive wheel of a wheelchair including:

a wheel rim
a wheel hub
a differential
a first hand rim and a second hand rim
a rotating brake member
a non-rotating brake member
the hub having an inner flange and an outer flange, the inner flange being adjacent to the pirouette brake; the differential having one input member and two output members, the first hand rim being driveably connected to the input member of the differential, the first output member driving the hub of the drive wheel; the second hand rim being driveably connected to the wheel rim; the input member of the differential having a portion extending beyond the inner flange of the hub, to which the rotating brake member is driveably connected; arranged so that, when the drive wheel is slid into place on the wheelchair, the rotating member of the pirouette brake is in proximity with the non-rotating member of the pirouette brake; so that, when the pirouette brake is operated, the input member of the differential is prevented from rotation, and so that, when the second hand rim is rotated, the wheelchair pirouettes on the spot; and when the pirouette brake is released the wheel may be slid out from the wheelchair.

[0029] Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings.

Brief Description of the Drawings

[0030]

Figure 1 is a schematic illustration of a manually-propelled wheelchair according to a first preferred embodiment of the invention;
Figure 2 is a schematic illustration of a steering unit of the wheelchair illustrated in Figure 1, viewed from above;
Figure 3 is a schematic illustration of the steering unit illustrated in Figure 2, viewed from below;
Figure 4 is a schematic illustration of a steering housing of the steering unit illustrated in Figures 2 and 3;
Figure 5 is a schematic illustration of a footplate assembly of the steering unit illustrated in Figures 2 and 3
Figure 6 is a schematic illustration of the steering unit illustrated in Figures 2 and 3 in an engaged position, viewed in section along the line A-A in Figures 2 and 3;
Figure 7 is a schematic illustration of the steering unit illustrated in Figures 2 and 3 in a disengaged postion, viewed in section along the line A-A in Figures 2 and 3;
Figure 8 is a schematic illustration of a cam arrangement of the steering unit illustrated in Figures 2 and 3 in a disengaged position;
Figure 9 is a schematic illustration of the cam arrangement illustrated in Figure 8 in an engaged position;
Figure 10 is a schematic illustration of a drive wheel of the wheelchair illustrated in Figure 1;
Figure 11 is a schematic illustration of a wheel hub, differential and wheel boss of the drive wheel illustrated in Figure 10;
Figure 12 is a schematic illustration of the wheel hub, differential and wheel boss illustrated in Figure 11, viewed in section along the line B-B in Figure 11;
Figure 13 is a schematic illustration of a quick-release pin of the drive wheel illustrated in Figure 10;
Figure 14 is a schematic illustration of the differential illustrated in Figures 11 and 12, viewed in section along the line C-C in Figure 12;
Figure 15 is a schematic illustration of a pirouette brake of the drive wheel illustrated in Figure 10, shown with a pawl engaging a brake gear asymmetrically; and
Figure 16 is a schematic illustration of the brake illustrated in Figure 15, shown with the pawl engaging the brake gear symmetrically.

Detailed Description of the Preferred Embodiments

[0031] Figure 1 shows a manually-propelled wheelchair 1 having a frame 2, two large driving wheels 3 and 4, two small castors 5 and 6, and two footrests 7 and 8. The left footrest 7 is non-swivellingly mounted on the frame 2 and is wide enough to accommodate both of the user's feet side by side. It has a higher portion 9 for the user's left foot, and a lower portion 10 for the user's right foot. When the user has no need to steer, they can place their right foot on the fixed footrest beside their left foot. The right footrest 8 makes up part of a footrest assembly 11 that is a detachable part of a steering unit 12, shown in more detail in figures 2 and 3. The steering unit 12 is operable by the user to steer the right castor 6, which is referred to below as a steerable castor.

[0032] The steering unit 12 comprises two main parts: a housing 13 and the footrest assembly 11. The footrest assembly 11 is rotatable about a swivelling axis 14. The housing 13 includes a toothed-belt drive 15 comprising a large pulley 16, a small pulley 17, a toothed belt 18, and a cover 19. The large pulley 16 is mounted on a swivelling shaft 20, the major axis of which is coaxial with the swivelling axis 14. The small pulley 17 is fixed in relation to the steerable castor 6, and the pulley 17 and castor 6 are both mounted on the housing 13 such that they can rotate about a steering axis 21. The steerable castor 6 usually contacts the ground at point offset from, and in use usually behind in relation to the direction of travel of the wheelchair 1, the steering axis 21.

[0033] Referring to figures 4 and 5, at the front of the housing 13 there is a dock 22 for accommodating a docking pin 23 on a mounting post 24 of the footrest assembly 11 when the footrest assembly 11 is in an uppermost position. So, in this uppermost position, the footrest assembly 11 is retained by the dock 22 and docking pin 23 to prevent the footrest 8 from swivelling. The housing 13 also has two columns 25 that act as limit stops to limit the maximum angle of swivel of the footrest assembly 11. The positions of the columns 25 can be varied to suit the needs of the user. More specifically, the angle of swivel of the footrest 8 is limited by the columns 25 in order to limit the stress on the user's knee joint, and to prevent injury.

[0034] At the top of the mounting post 24 is a yoke 26 containing two pins 27. These pins 27 can engage with two slots 28 in an upper cam 29, described in more detail below. At the bottom of the mounting post 24 is a fork 30 which straddles the steering shaft 20 when the footrest assembly 11 is in position on the steering housing 13. Below the fork 30 is a latch 31 for retaining the footrest assembly 11 in position. When the latch 31 is unlatched, the footrest assembly 11 may be removed from the steering housing 13, by lifting the pins 27 of the yoke 26 off the upper cam 29.

[0035] Figure 6 shows a disengaging mechanism of the steering unit 12 in more detail. The yoke 26 is shown with its pins 27 engaged in slots 32 in the upper cam 29. The upper cam 29 is kept disengaged from a lower cam 33 by a spring 34 until such times as the user places their right foot on the footrest 8, when the weight of the user's leg overcomes the spring 34 and forces the upper cam 29 into engagement with a lower cam 33. Figure 7 shows the disengaging mechanism with the upper cam 29 and the lower cam 33 in the engaged position. The lower cam 33 is pinned to the swivelling shaft 20 by a pin 35 so that swivelling motion of the footrest assembly 11 is transferred to the swivelling shaft 20 via the yoke 26, the upper cam 29 and the lower cam 33, and thereby swivels the large pulley 16, which in turn swivels the small pulley 17 via the toothed belt 18 and transfers the motion to the steerable castor 6, thereby allowing the wheelchair 1 to be steered.

[0036] It is useful for the steering unit 12 to have the ability to disengage the footrest assembly 11 from the steerable castor 6 when the wheelchair 1 changes from forward to reverse motion, and vice versa. For dynamic stability the steerable castor 6 should normally operate in a trailing mode, whereby the castor 6 contacts the ground at a point behind the steering axis 21 in relation to the direction of motion. The castor 6 can be dynamically unstable when it contacts the ground ahead of the steering axis 21 in relation to the direction of travel. When changing from forward to reverse motion, and vice versa, the user may therefore lift their foot off the footrest 8 momentarily to allow the steerable castor 6 to rotate 180° before replacing their foot on the footrest 8. The 180° rotation is usually achieved after the wheelchair 1 has travelled only around 25 to 35 cm in the new direction.

[0037] In the illustrated embodiment, the pulleys 16, 17 of the belt drive 15 provide a 2:1 increase in the angle of rotation of the steerable castor 6 in comparison to the angle of swivel of the footrest 8. So, when the steerable castor 6 rotates through 180°, the belt drive 15 causes the swivelling shaft 20 and lower cam 33 to rotate through 90°. Hence, if the upper cam 29 is to re-engage with the lower cam 33 when the user's foot is replaced on the footrest 8, then both cams 29, 33 should ideally have lobes with rotational symmetry based on a 90° arc.

[0038] Figure 8 shows the cams 29, 33 in more detail, with the spring 34 removed. Note that the cams 29, 33 each have four lobes 36 spaced equally (or "equi-spaced") at intervals of 90° around a circumference. If the gearing of the belt drive 15 were 1.5:1, then the cams 29, 33 could have three lobes 36 equi-spaced at 120° intervals. If the gearing of the belt drive 15 were 3:1, then the cams 29, 33 could have six lobes 36 equi-spaced at 60° intervals. It is also possible to design the belt drive 15 having a 1:1 ratio, in which case the cams 29, 33 could have two lobes 36 equi-spaced at 180° intervals. Figure 9 shows the cams 29, 33 engaged with one another.

[0039] However, the user may forget to lift their foot from the footrest 8 during changes between forward and reverse motion of the wheelchair 1. Such changes cause the steerable castor 6 to rotate rapidly through 180°, so, as a safety feature, it is desirable for the cams 29, 33 to be able to forceably disengage with the user's foot in place. So, the cams 29, 33 should ideally have helical ramps 37. This enables the upper cam 29 to slide into full engagement with the lower cam 33 whatever the relative angular positions of the cams at the start of the engagement. It also allows relative rotation of the cams 29, 33 to force disengagement. Indeed, the when the cams 29, 33 are fully engaged, the ramps 37 provides a zero-backlash fit. Together the upper cam 29, the lower cam 33, and the spring 34 therefore form a disengagable coupling.

[0040] So, if the user forgets to lift their foot off the footrest 8 momentarily when changing from forward motion to reverse, or vice versa, then the rotation through 180° of the steerable castor 6 will tend to force the upper

cam 29 upwards to disengage it partially or wholly from the lower cam 33, reducing the torsional impact on the user's knee. Similarly, in the event of the steerable castor 6 striking obliquely an object such as a kerb, the castor 6 may be forced into a sudden change of angular position, in which case the upper cam 29 may be forced upwards to disengage partially or wholly from the lower cam 33 thereby again reducing the torsional impact on the user's knee. The angle of the ramps 37 relative to a plane normal to the axis of the swivelling shaft should ideally have a maximum between around 40° and 75°. The preferred angle is dependent on the coefficient of friction between the upper cam 29 and the lower cam 33. A low coefficient of friction requires a high angle, and a high coefficient of friction requires a low angle. If the angle is too small, then the cams 29, 33 may occasionally disengage during normal use. If the angle is too high, then the cams 29, 33 may not disengage when subjected to a sudden change of direction of the steerable castor 6.

[0041] Referring again to Figure 1, it can be seen that a first of the driving wheels 3, which in this embodiment is on the right hand side of the wheelchair 1 from a user's perspective when seated, includes a tyre 38 mounted on a wheel rim 39, a hub 40 and a differential 41. These are illustrated in more detail in Figure 10. The wheel 3 also incorporates a first hand rim 42 mounted on the differential 41 and a second hand rim 43, of larger diameter than the first hand rim 42, mounted on the wheel rim 39. The wheel 3 is mounted on a wheel boss 44, which is attached to the frame 2 of the wheelchair 1.

[0042] Figure 11 shows the hub 40, differential 41 and boss 44 in more detail. It also shows (in truncated form) two spokes 45, 46 of thirty six spokes of the wheel 3 and shows both ends 47, 48 of a quick-release pin 49 by which the wheel 3 can be secured to the boss 44. The end 47 of the quick-release pin 49 proximate to the boss 44 or inward with respect to the wheelchair 1 in use, includes a male half 50 of a tapered hexagonal coupling means. This coupling means can engage with an axle (not shown) of the wheelchair 1 to drive a second of the drive wheels 4, as described in more detail below.

[0043] Figure 12 shows the internal details of the hub 40, differential 41 and boss 44. The quick-release pin 49 is coaxial with the hub 40, differential 41 and boss 44, and passes through all three of them. It can be seen that the end 47 of the quick-release pin 49, which includes the male half 50 of the tapered hexagonal coupling means, houses detent balls 51. The other end 48 of the quick-release pin 49, proximate to the differential 41 and outward with respect to the wheelchair 1 in use, comprises a release knob 52. The release knob 52 lies within the differential 41 in use and is shown on the right hand side in Figure 12. When the release knob 52 is pressed (inwardly with respect to the differential 41), it moves a central rod 53 of the quick-release pin 49 (again inwardly with respect to the differential 41 or to the left in Figure 12) to unlock the detent balls 51. This allows the hub 40 and differential 41 to be slid away from the boss 44 (to the right in Figure 12) and removed from the boss 44. Indeed, as the wheel rim 39 is mounted on the hub 41 by the spokes 45, 46 and the first hand rim 42 is mounted on the differential 41, basically the complete wheel 3 can be removed from the boss 44.

[0044] Figure 13 shows an external view of the quick-release pin 49, in which the male half 50 of a tapered hexagonal coupling means can be seen more clearly. In particular, the tapered hexagonal shape is more evident. However, it should be noted that, in other embodiments, the coupling means may have other forms, such as a parallel spline. A sun gear 54, which forms part of the differential 41, is fixed to a main shaft 70 of the quick-release pin 49 close to the outward end 48. In this embodiment, the sun gear 54 is bonded to the shaft 70 of the quick-release pin 49 by brazing, adhesive, etc., but it may alternatively be integral with the shaft 70 of the quick-release pin 49. In another embodiment, the sun gear 54 may be coupled to the shaft 70 of the quick-release pin 49 via a spline or other mechanical coupling. The detents may also take forms other than balls 51, and the quick-release pin 49 may be configured such that the release knob 52 operates by pulling instead of pushing.

[0045] Figure 14 shows a cross section of the differential 41 along the line C-C in Figure 13. It can be seen that the differential includes a planet carrier 55, large planets 56, small planets 57, the sun gear 54 and an annular gear 58. The first hand rim 42 is attached, e.g. bolted, to the planet carrier 55 of the differential 41 such that is can rotate the planet carrier 55 to drive the large and small planets 56, 57. A first output from the differential 41 is via the annular gear 58, which is attached to the first drive wheel 3 of the wheelchair 1, e.g. via the hub 40. A second output from the differential 41 is via the sun gear 54, which is attached to the second drive wheel 4 via the shaft 70 of the quick release pin 49 and the axle (not shown).

[0046] In this embodiment, the sun gear 54 has twenty seven teeth, the annular gear 58 has fifty four teeth, the large planet 56 has eighteen teeth and the small planet 57 has nine teeth. Since the nine teeth of the small planet 57 drive the twenty seven teeth of the sun gear 54; and the eighteen teeth of the large planet 56 drive the fifty four teeth of the annular gear 58, the torque on the annular gear 58 equals the torque on the sun gear 54. This ensures that, unless acted upon by a steering force, the wheelchair 1 has a tendency to travel in a straight line when propelled via only the first hand rim 42. The use of only this first hand rim 42 for propulsion reduces the stress on the user's hand and wrist.

[0047] The most common form of differential is a bevel gear differential, as used in virtually every motor vehicle. However, for a given torque capacity, an epicyclic differential, such as the differential 41 described above, is smaller in diameter and considerably shorter in axial length. Hence in order to keep the wheelchair 1 narrow enough to go easily through doorways, the shorter epi-

cyclic type of differential is preferred. Also, unlike the bevel gear differential, which has a central input, the input to an epicyclic differential can be from one end.

[0048] Figures 15 and 16 show one embodiment of a pirouette brake 59. The pirouette brake 59 comprises a rotating member and a non-rotating member. The rotating member is in the form of a brake gear 60 connected to the differential 41 and the non-rotating member is in the form of a pawl 61 mounted on the frame 2 of the wheelchair 1. The pawl 61 has two teeth 62, 63 and rocks (or pivots) on a pin 64 which is mounted on a lever 65, shown in figure 1. The lever 65 is pivoted on pivot 66. The pirouette brake 59 is applied when the lever 65 is lowered, thereby moving pin 64 closer to the brake gear 60 and allowing one or both of the teeth 62, 63 of the pawl 61 to enter spaces 67 between teeth 68 on the brake gear 60. As can be seen most clearly in Figure 12, the brake gear 60 is connected via a hollow shaft 69 through the hub 40 to the planet carrier 55 of the differential 41. So, applying the brake 59 locks the planet carrier 55 (and the first hand rim 42) in relation to the frame 2 of the wheelchair 1. When the second hand rim 43 is then used to drive the wheel rim 39 of the first drive wheel 3, the annular gear 58 and sun gear 54 are forced to turn in opposing directions, causing the drive wheels 3, 4 to also turn in opposing directions and the wheelchair 1 to pirouette.

[0049] It is possible to use a single blade in place of the pawl 61, but in the event of the blade coming into contact with the top of a tooth 68 on the brake gear 60 instead of a space 67, the pirouette brake 59 will fail to lock. The advantage of the pawl 61 is that it has more chance to engage fully with the brake gear 60 whatever the relative angular position of the gear 60 and pawl 61. Figure 16 shows one such position, in which each tooth 62, 63 of the pawl 61 partially engages a space 67 of the brake gear 60.

[0050] In another embodiment, the pirouette brake 59 may be in the form of a more conventional friction brake, in which case the brake gear 60 would be replaced by a simple cylinder and the non-rotating member could be a flexible band brake or could comprise externally-applied brake shoes with curved surfaces of friction material.

[0051] It will be appreciated that the described embodiments of the invention are only examples of how the invention may be implemented. Modifications, variations and changes to the described embodiments will occur to those having the appropriate skills and knowledge. For example, the invention is described above in relation to steering operated by the right foot, but the invention applies equally to steering operated by the left foot. Similarly, the description above refers to a drive wheel 3 and differential 41 located on the driver's right hand side, but the invention applies equally to a drive wheel and differential located on the driver's left side. These modifications, variations and changes may be made without departure from the scope of the invention defined in the claims and its equivalents.

Claims

1. A steering means (11) for a wheelchair (1), the steering means (11) comprising:

   a steerable wheel (6) rotatable about a steering axis (21) to steer the wheelchair (1);
   a footplate (8) swivellable about a swivelling axis (14), on which footplate (8) a user may place their foot to operate the steering means (11); and
   a drive means (15) between the steerable wheel and the footplate (8), which drive means (15) is adapted to translate an angle of swivel of the footplate (8) about the swivelling axis (14) to a greater angle of rotation of the steerable wheel about the steering axis (21).

2. The steering means (11) of claim 1, wherein the swivelling axis (14) and the steering axis (21) are offset from one another.

3. The steering means (11) of claim 1 or claim 2, wherein the drive means (15) comprises a belt (18) driven between two pulleys (15, 16).

4. The steering means (11) of any one of the preceding claims, wherein the footplate (8) is detachable from the drive means (15).

5. The steering means (11) of claim 1, wherein the drive means (15) has a disengagable coupling means that causes the footplate (8) to disengage from the steerable wheel (6) when the user's foot is removed from the footplate (8).

6. The steering means (11) of claim 5, wherein the coupling means comprises a first cam (33) driveably connected to the steerable wheel (6) and a second cam (29) driveably connected to the footplate (8).

7. The steering means (11) of claim 6, wherein the cams (29, 33) are both substantially annular and slideably engage with each other in an axial direction along a central common axis.

8. The steering means (11) of claim 7, wherein the common axis is the swivelling axis (14).

9. The steering means (11) of any one of claims 6 to 8, wherein the cams (29, 33) are biased apart by resilient disengaging means (34).

10. The steering means (11) of claim 9, wherein the resilient disengaging means (34) can be overcome by movement of the footplate (8) in a direction that is downward in use.

11. The steering means (11) of any one of claims 6 to

10, wherein the cams (29, 33) each have lobes (36) equally spaced from one another around the respective cam (29, 33).

12. The steering means (11) of any one of claims 6 to 11, wherein the cams (29, 33), each have helical ramps (37).

13. The steering means (11) of any one of claim 6 to 11, wherein the cams (29, 33), each have ramps (37) with a maximum rising gradient between around 40° and 75°.

14. A quick release arrangement for a drive wheel (3) of a wheelchair (1), the arrangement comprising:

a hub (40) for supporting the drive wheel (3);
a coupling means (50) for connecting the arrangement to a drive axle of the wheelchair (1);
a differential (41) having an input connectable to a hand rim (42), a first output for transferring drive from the input to the hub (40) and a second output for transferring drive from the input to the coupling means (50) to drive the axle; and
a quick-release pin (49) for mounting the arrangement on the wheelchair (1), release of which pin (49) disconnects the coupling means (50) from the axle and allows the arrangement to be dismounted from the wheelchair (1).

15. The quick release arrangement of claim 14, wherein the second output of the differential (41) is arranged to transfer drive from the input to the coupling means (50) via the quick-release pin (49).

16. The quick release arrangement of claim 14 or claim 15, wherein the quick-release pin (49) has a detent (51) for locking the arrangement to a mounting on the wheelchair (1).

17. The quick release arrangement of claim 16, wherein the quick-release pin (49) has an operating means (52) operable remotely from the detent (51) for releasing the detent (51) to unlock the arrangement from the wheelchair (1).

18. The quick release arrangement of claim 17, wherein the operating means (52) is a push button.

19. The quick release arrangement of claim 17 or claim 18, wherein the coupling means (50) and the operating means (52) are at opposite ends of the quick-release pin (49).

20. The quick release arrangement of any one of claims 14 to 19, wherein the coupling means (50) is a tapered hexagon.

21. The quick release arrangement of any one of claims 14 to 20, wherein a/the detent (51) of the quick-release pin (49) is adjacent to the coupling means (50) and nearer to the operating means (52) along the length of the quick-release pin (49).

22. The quick release arrangement of any one of claims 14 to 21, comprising a brake (59) operable to lock the input of the differential (41) in relation to the wheelchair (1), thereby constraining the two outputs of the differential (41) to rotate in opposite directions such that the wheelchair (1) can pirouette on the spot.

23. The quick release arrangement of claim 22, wherein the brake (59) comprises a rotatable member fixed to the input of the differential (41) and a non-rotatable member mountable on the wheelchair (1).

24. The quick release arrangement of claim 22 or claim 23, wherein the non-rotatable member locks the rotatable member by acting on it radially, such that the rotatable member can be released from the non-rotatable member in an axial direction when the arrangement is dismounted from the wheelchair (1).

25. The quick release arrangement of any one of claims 24 to 26, wherein the rotating member is a gear wheel (60) and the non-rotating member is a pawl (61)

26. The quick release arrangement of any one of claims 14 to 25, wherein the differential (41) is an epicyclic differential.

27. A drive wheel (3) for a wheelchair (1), the drive wheel (3) comprising the quick release arrangement of any one of claims 14 to 26 and the hand rim (42) mounted to the differential (41).

28. The drive wheel (3) of claim 27, having a second hand rim (43) connected to a rim (39) of the wheel (3).

29. A wheelchair (1) incorporating the steering means (11) of any one of claims 1 to 13 and/or the drive wheel of claim 28 or claim 29.

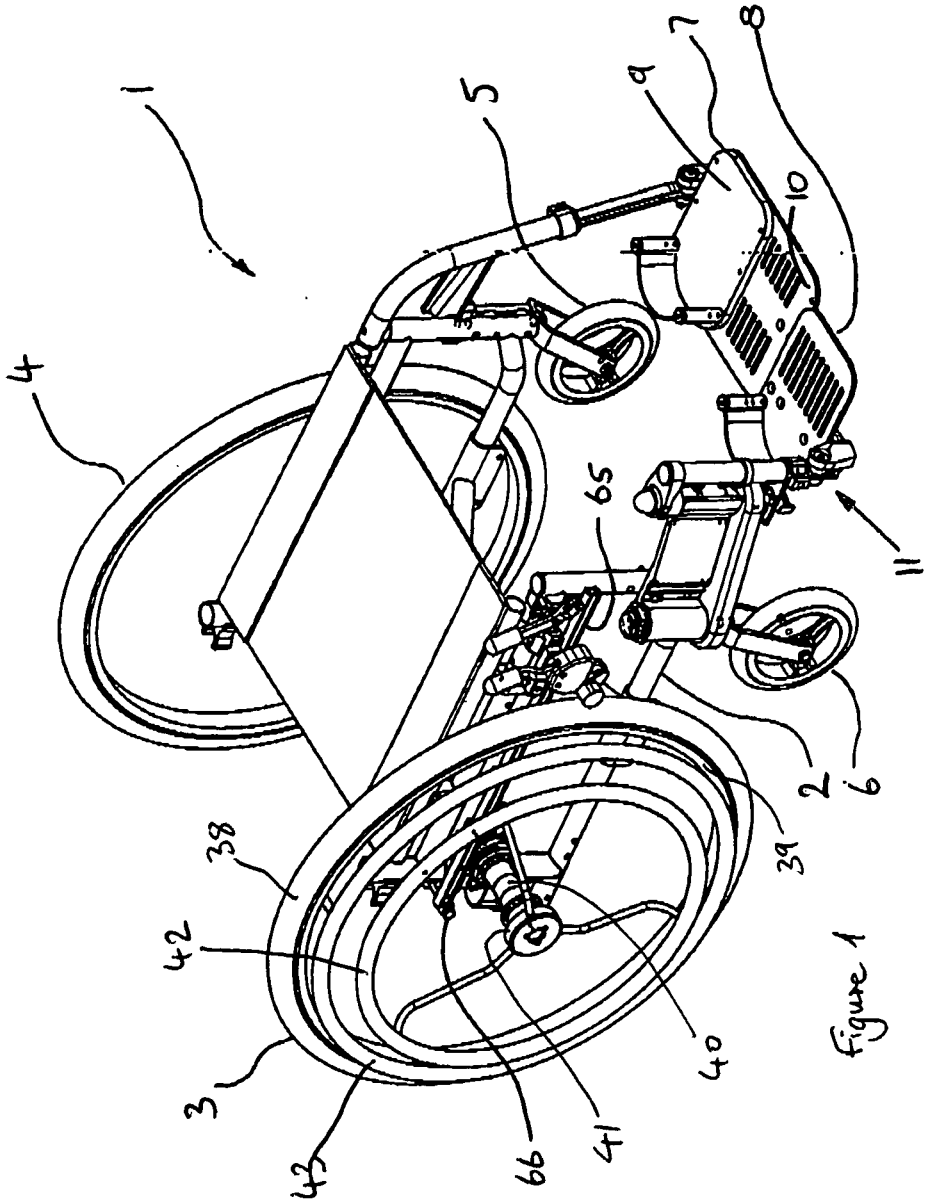

Figure 1

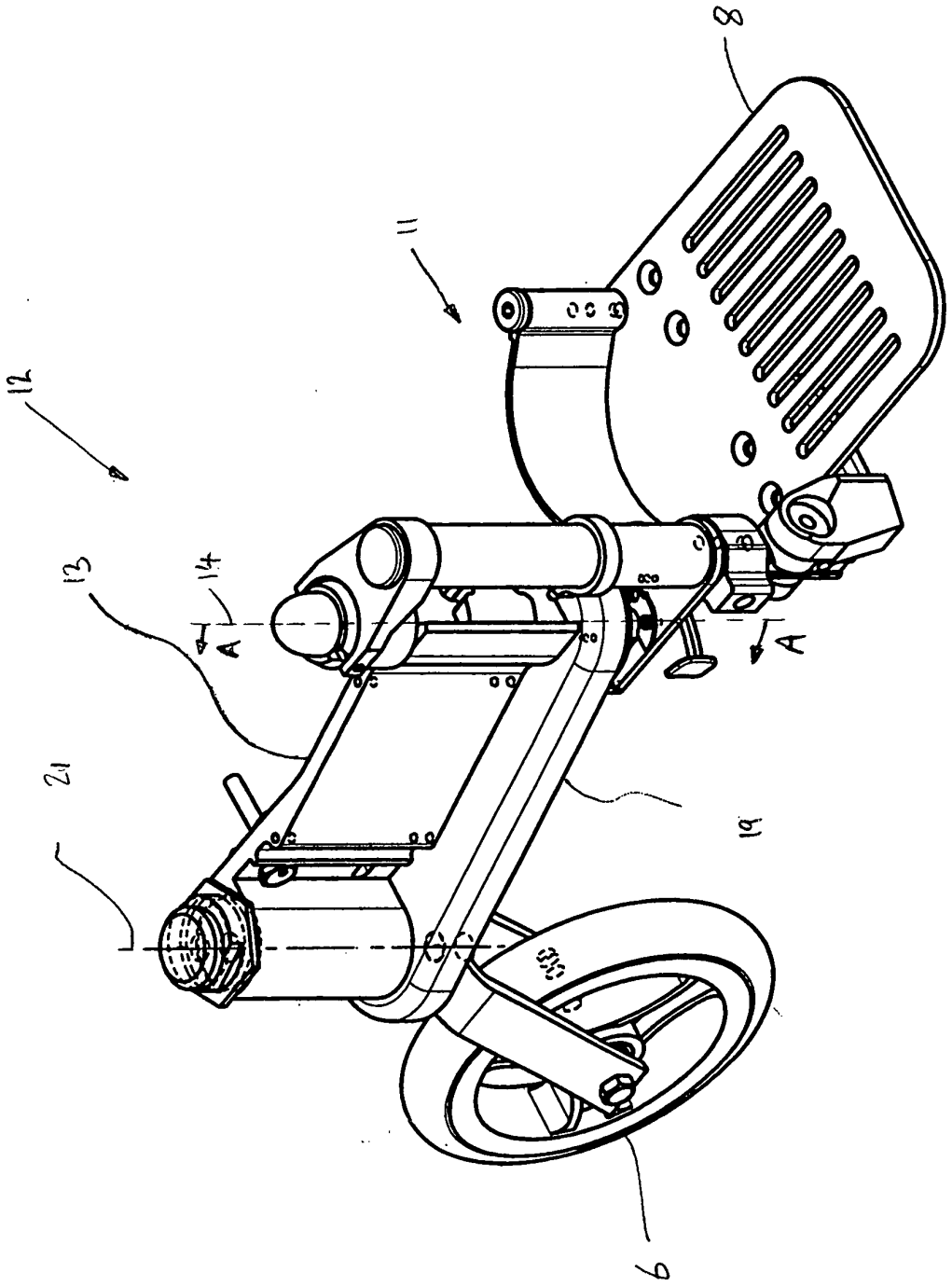

Fig. 2

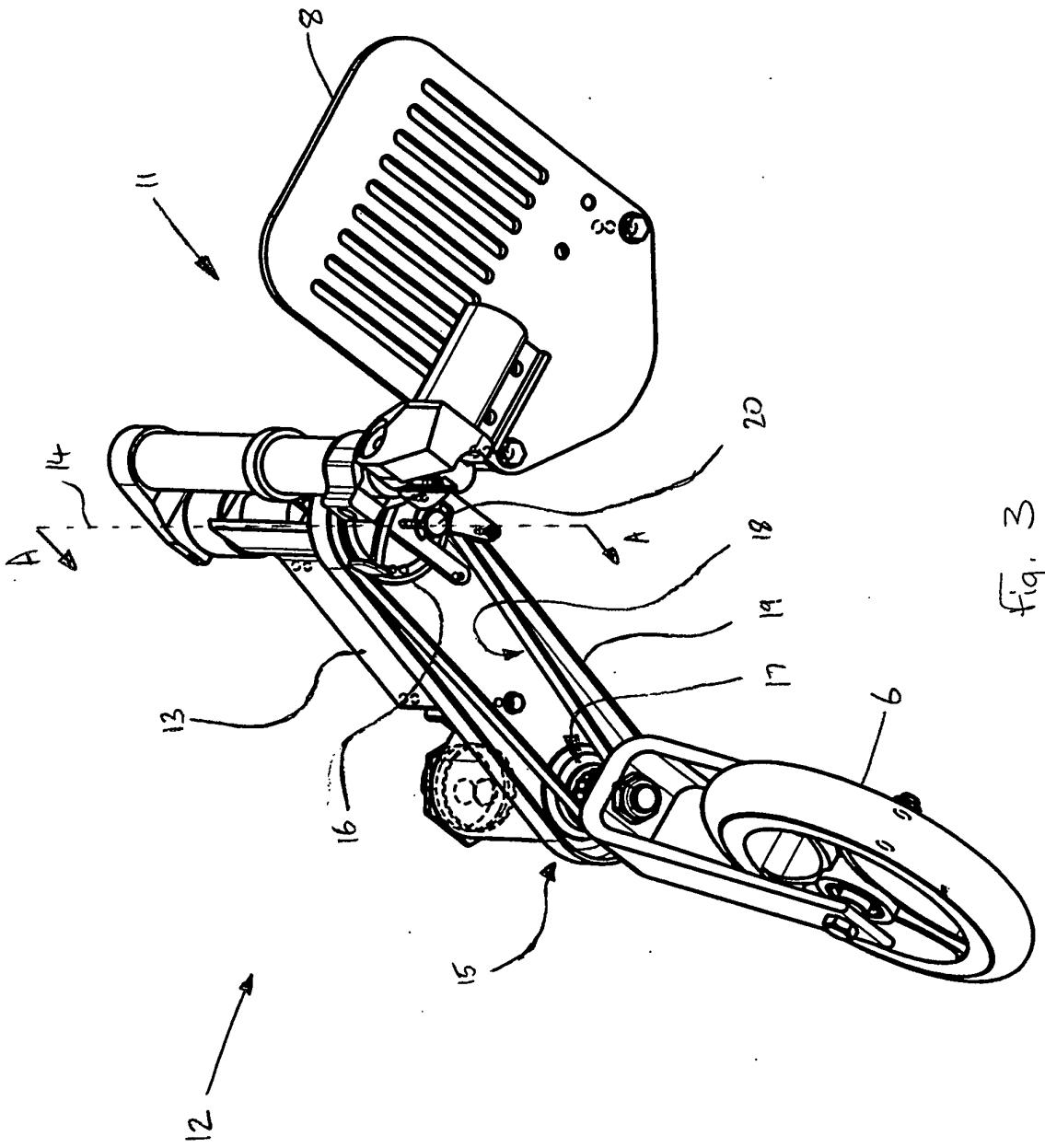

fig. 3

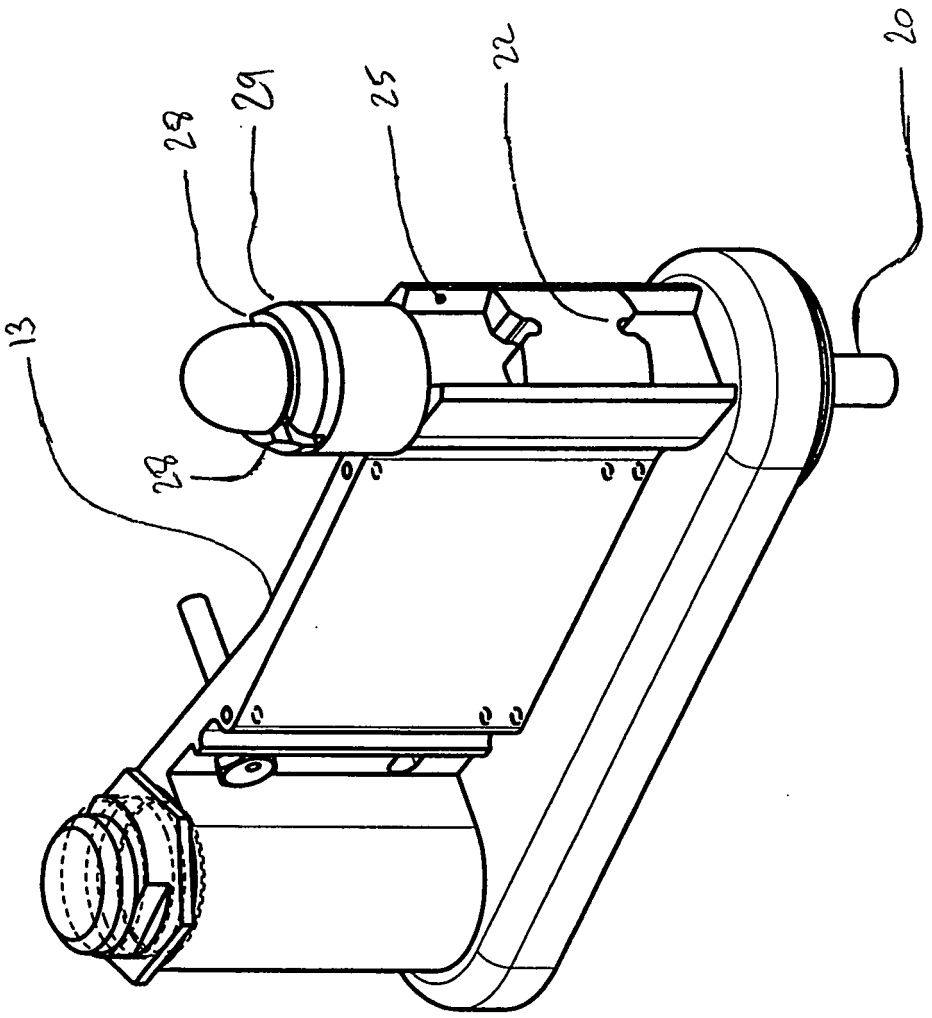

Fig. 4

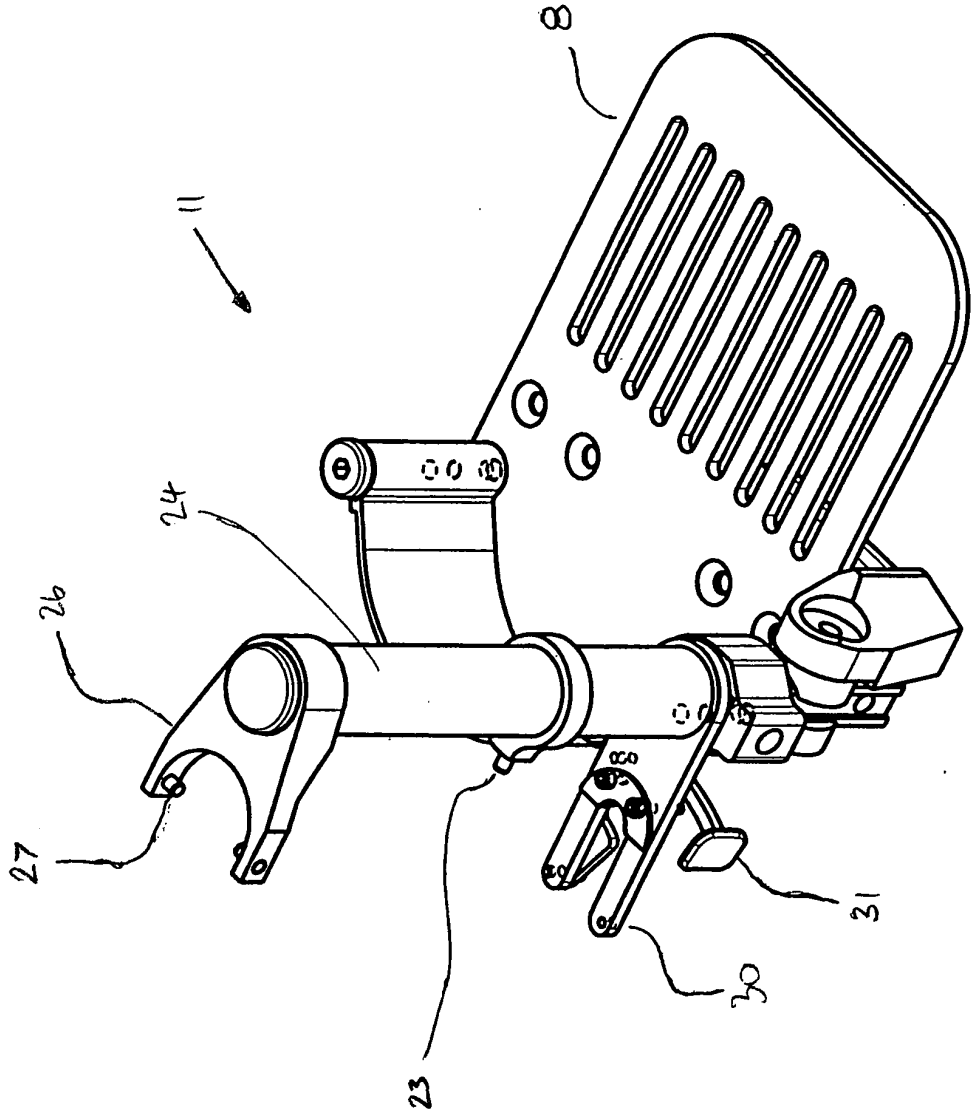

Fig. 5

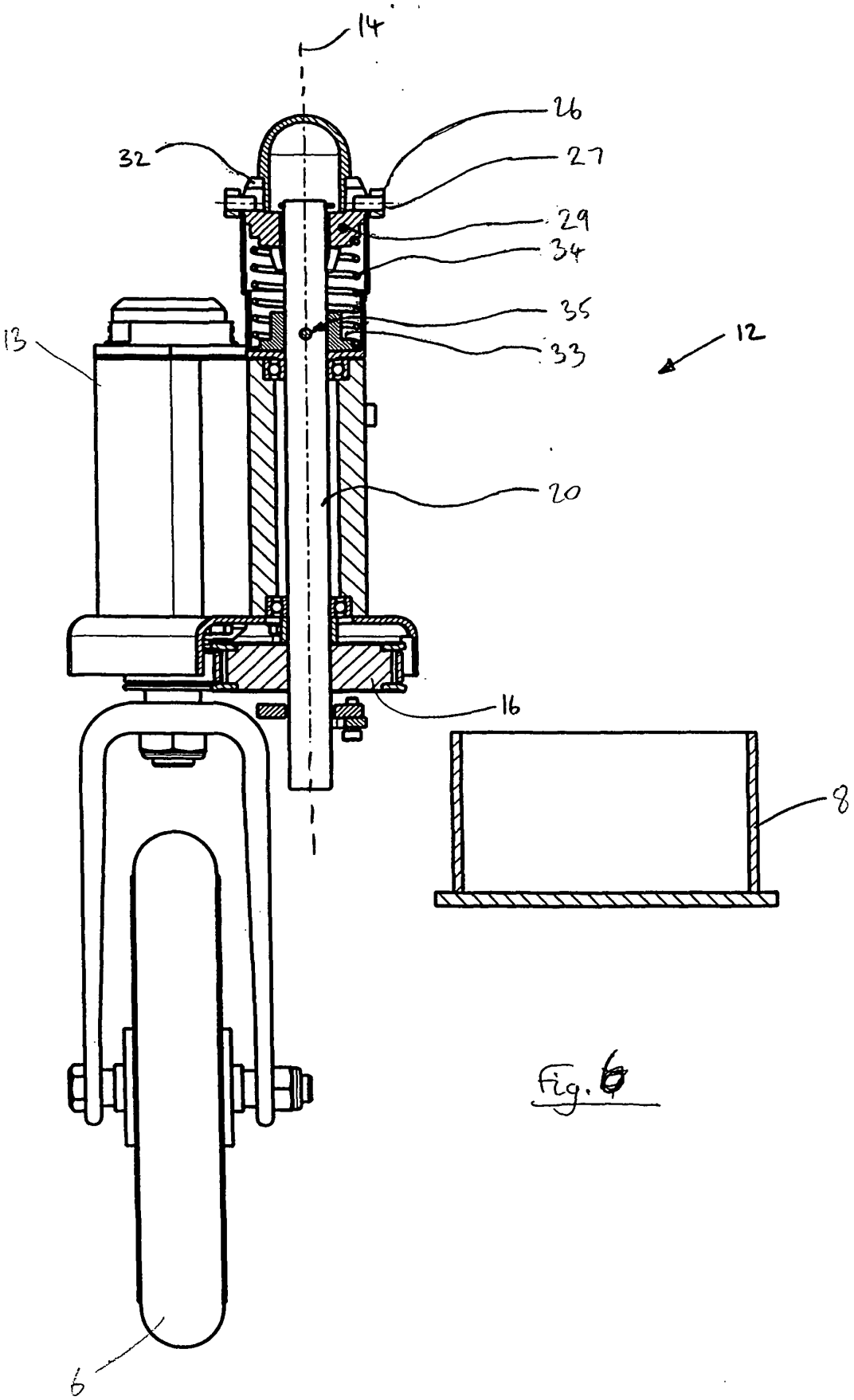

Fig. 6

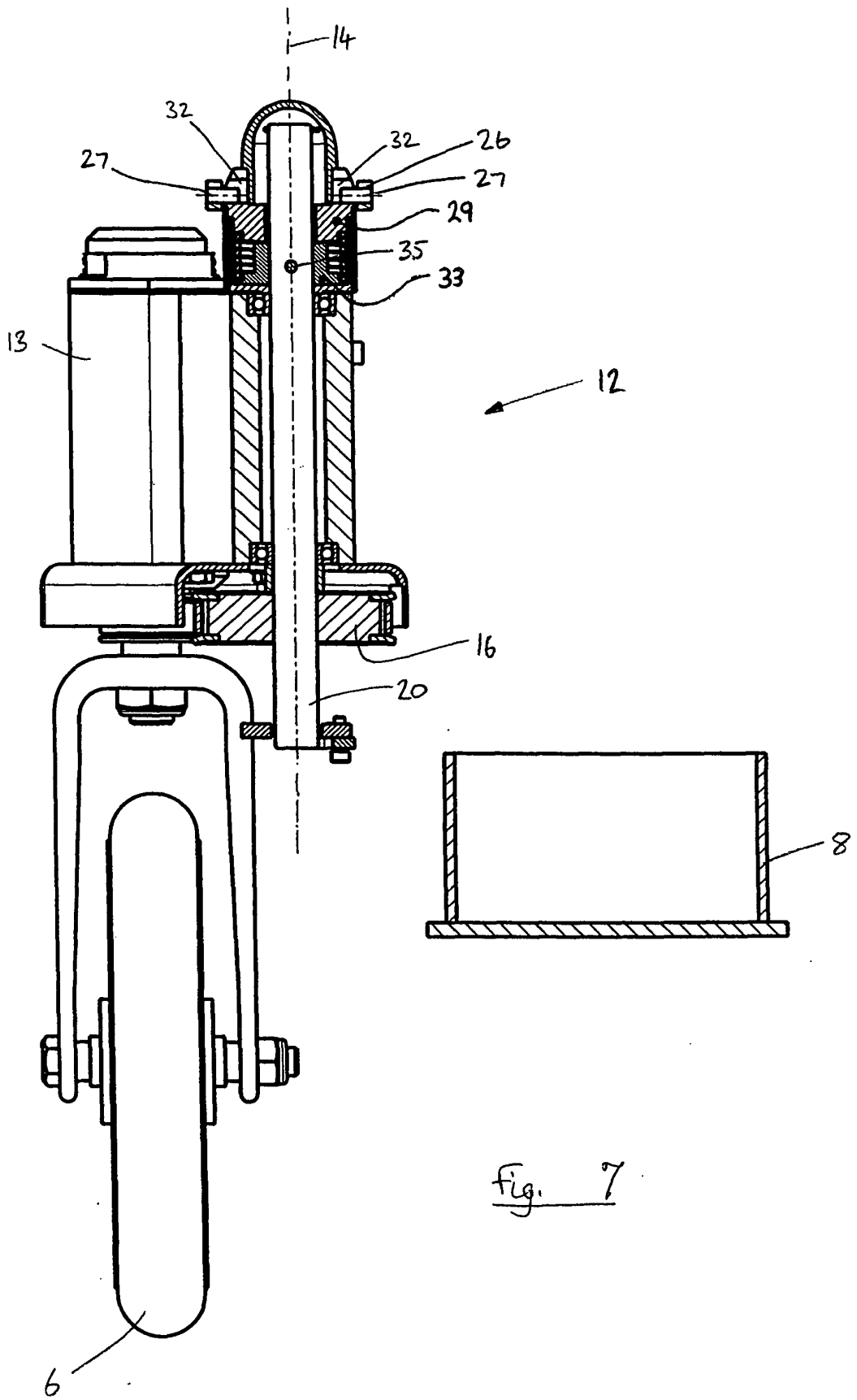

Fig. 7

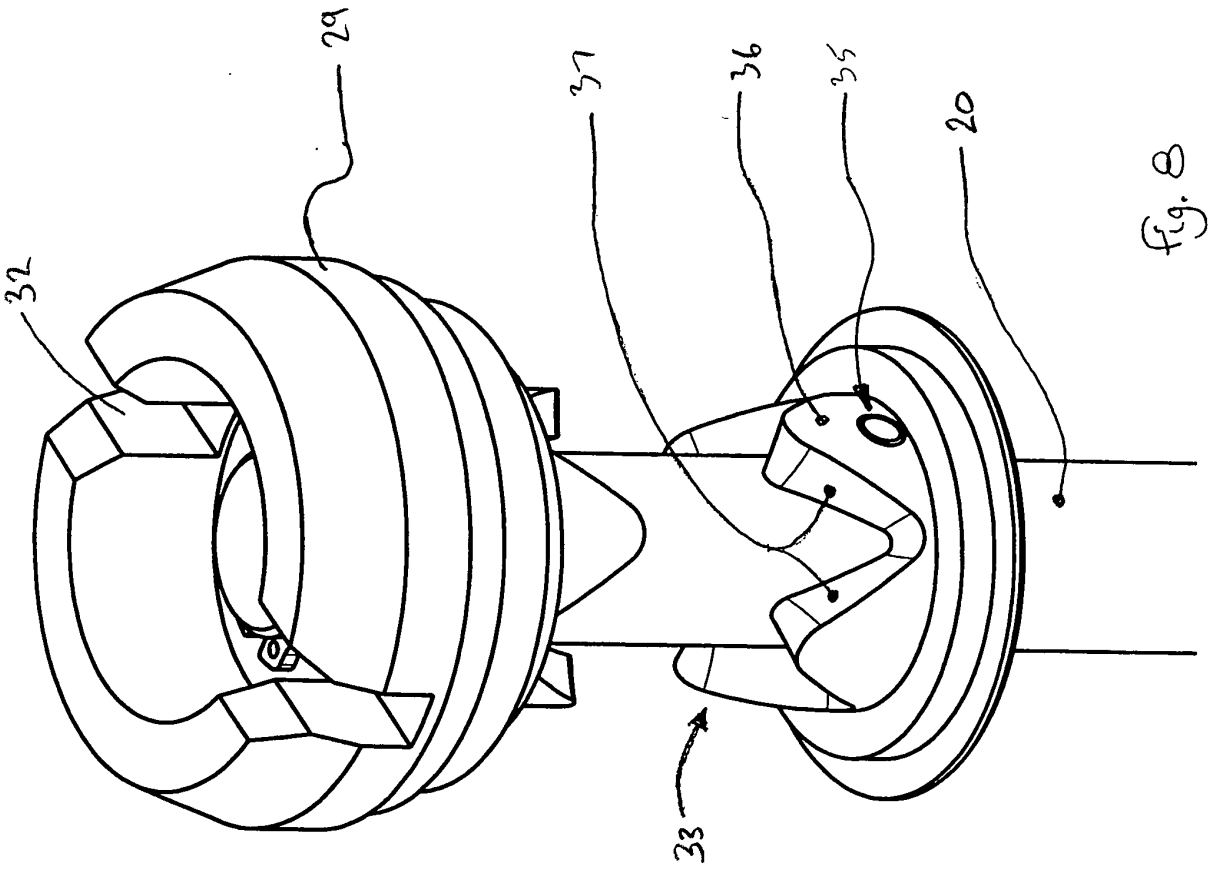

Fig. 8

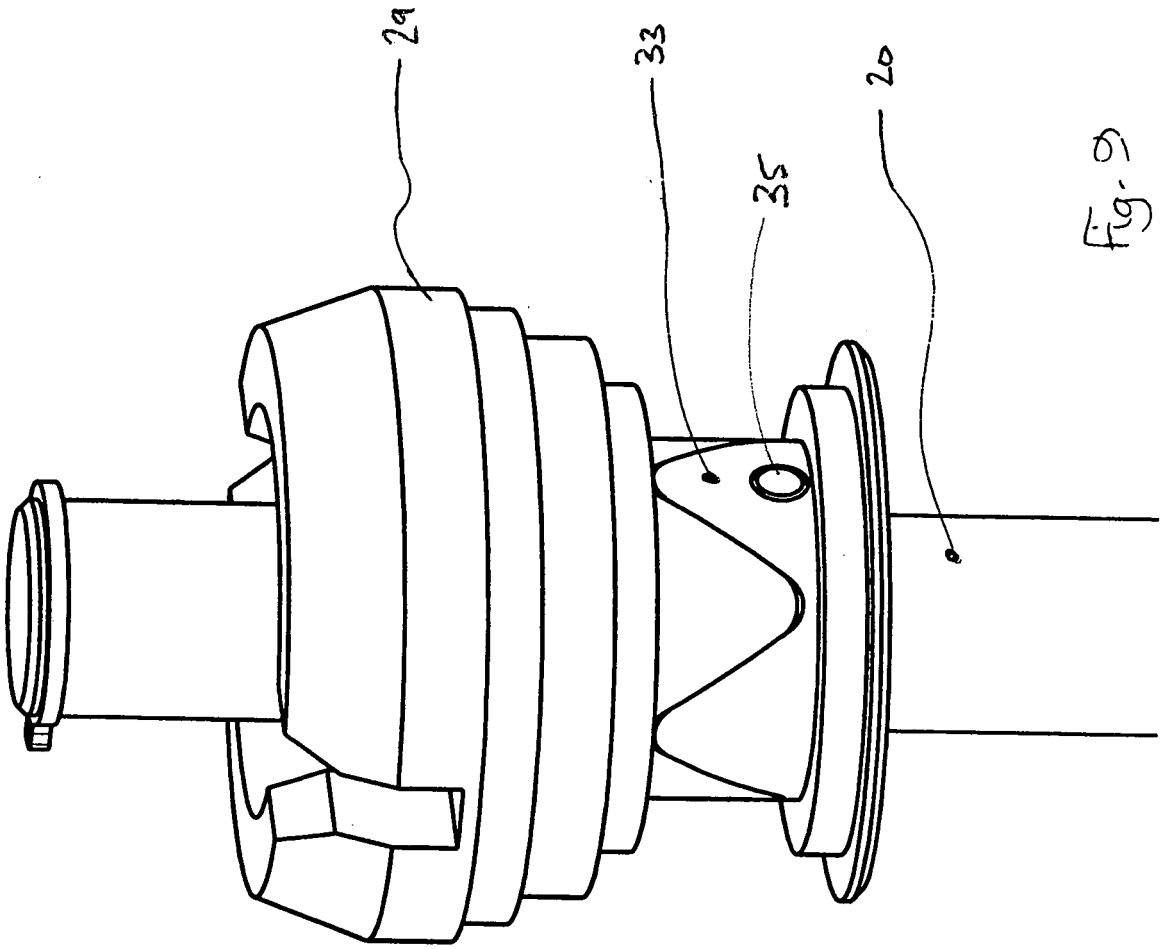

Fig. 5

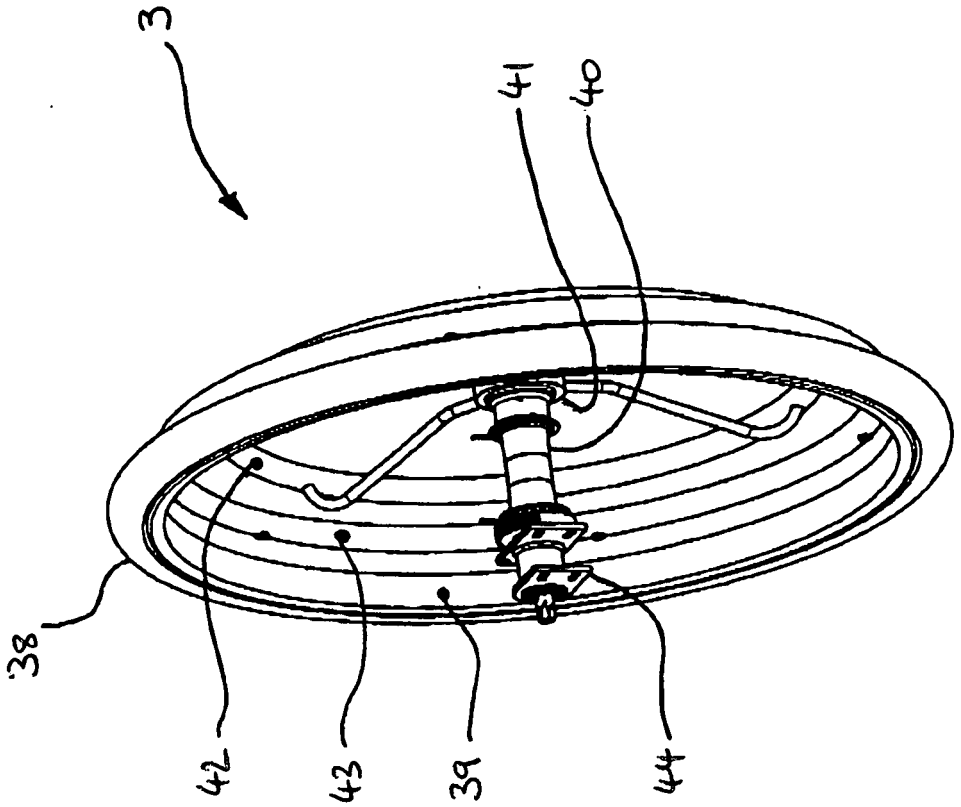

Figure 10

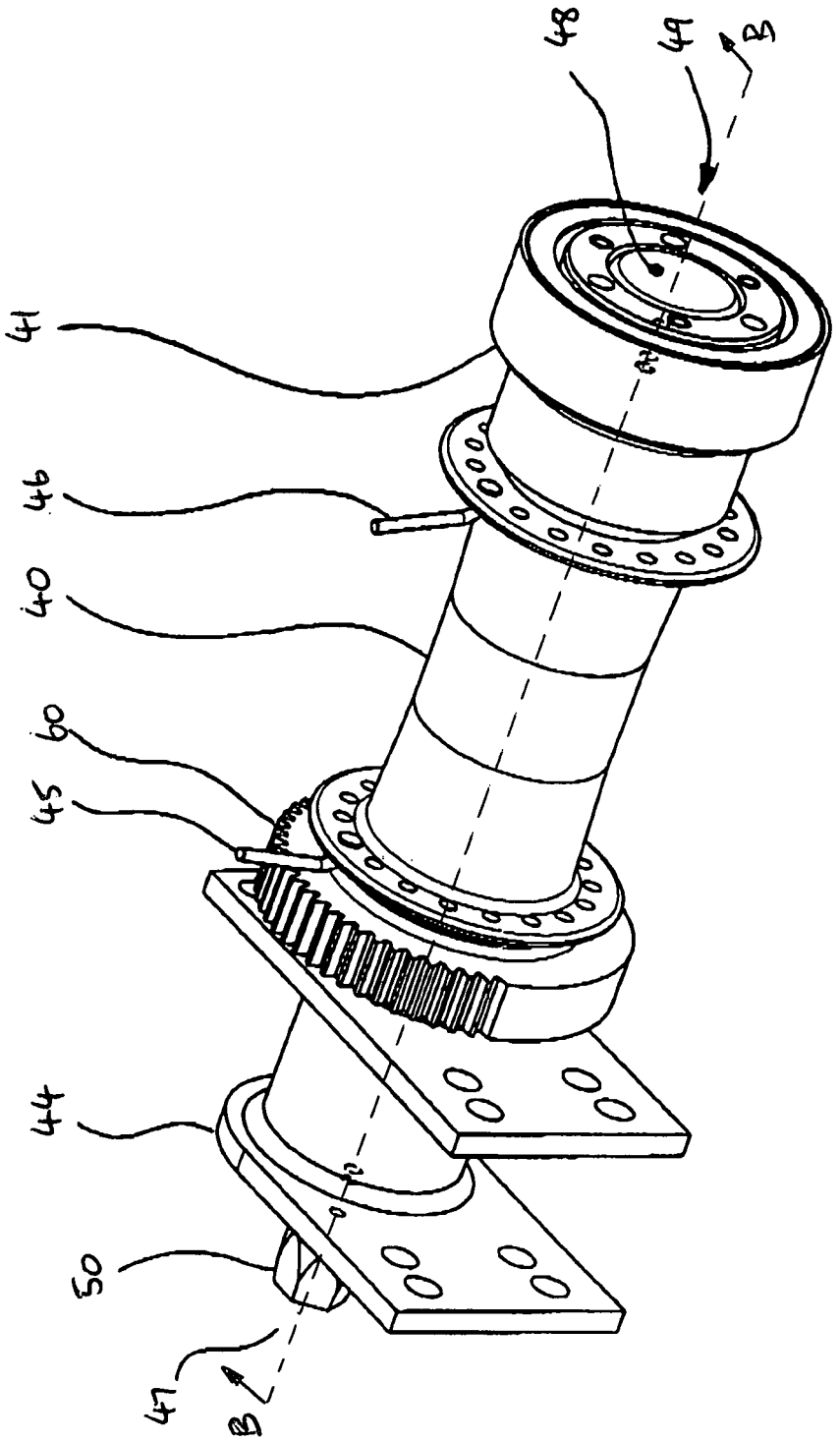

Figure 11

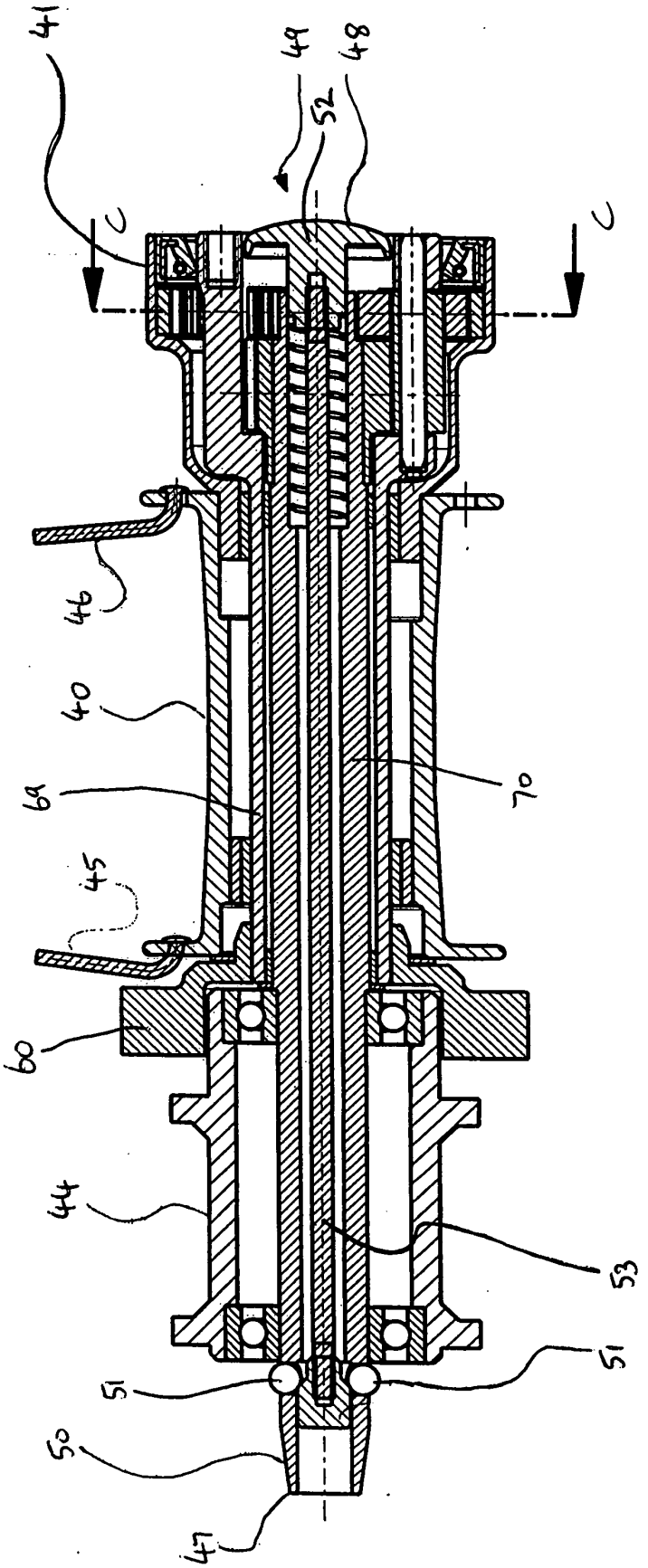

FIGURE 12

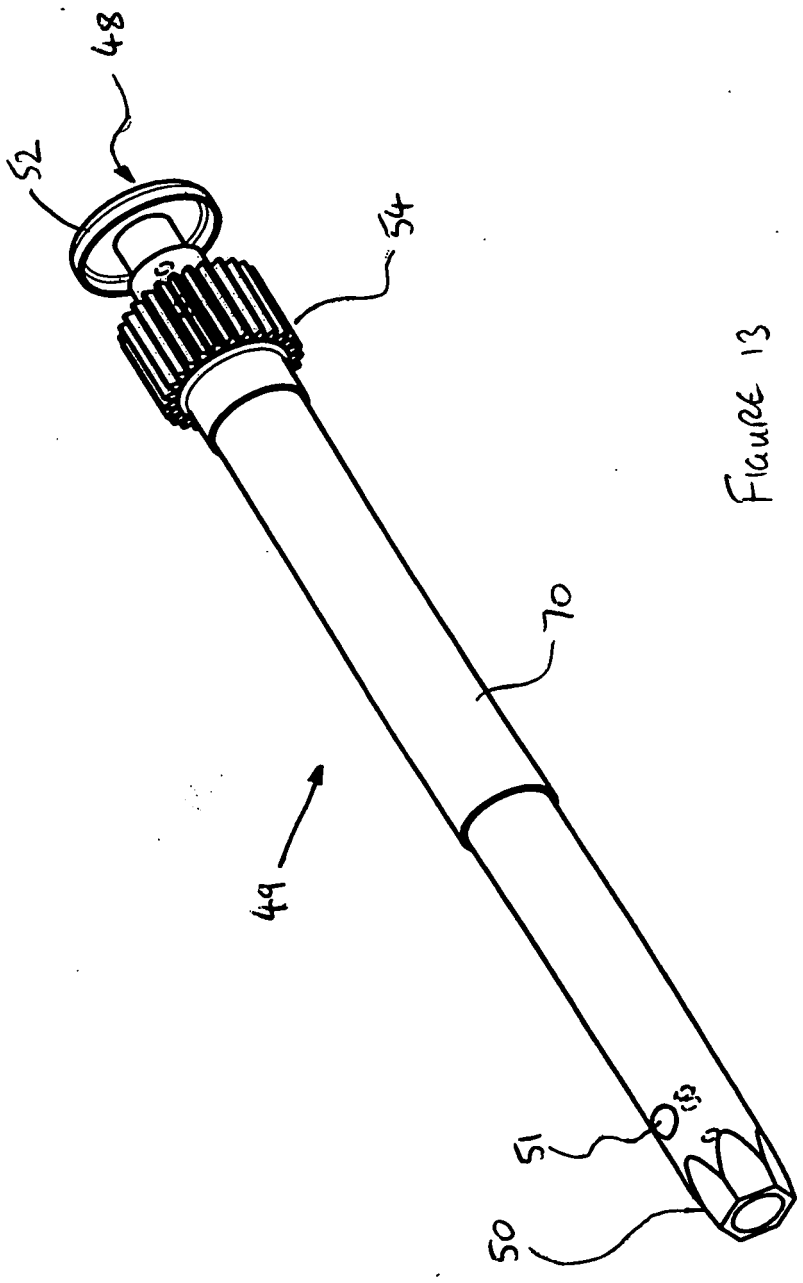

Figure 13

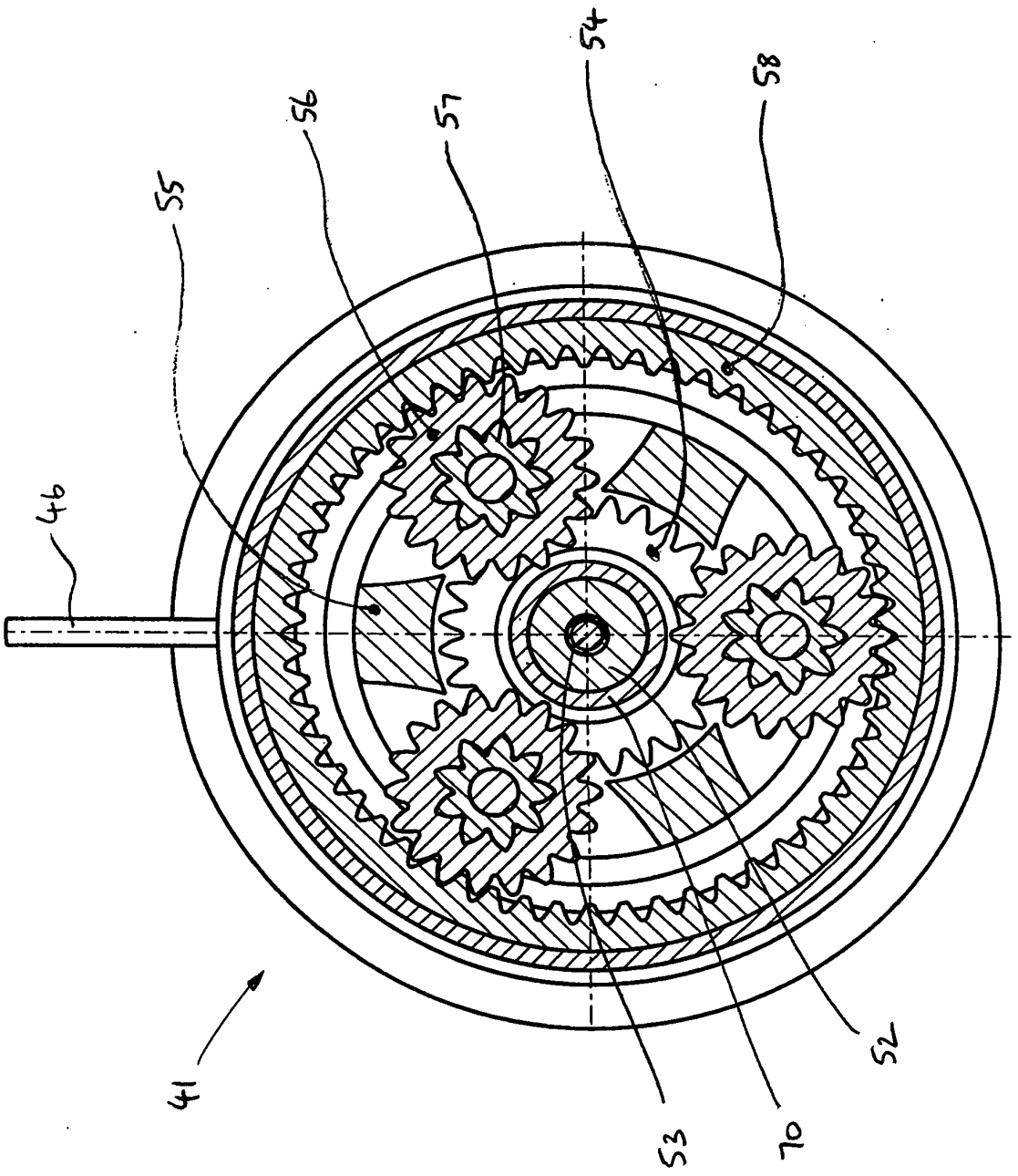

Figure 14

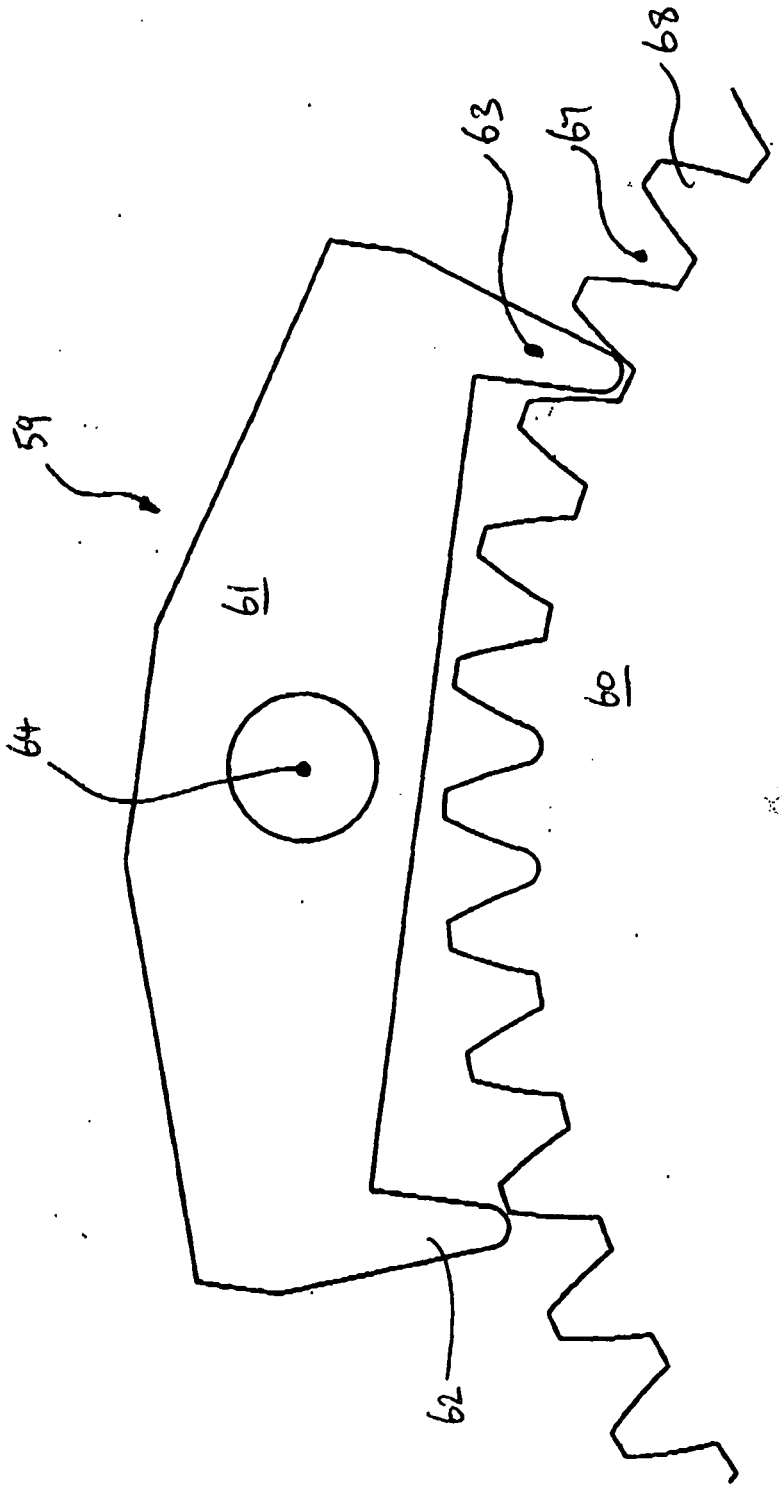

FIGURE 15

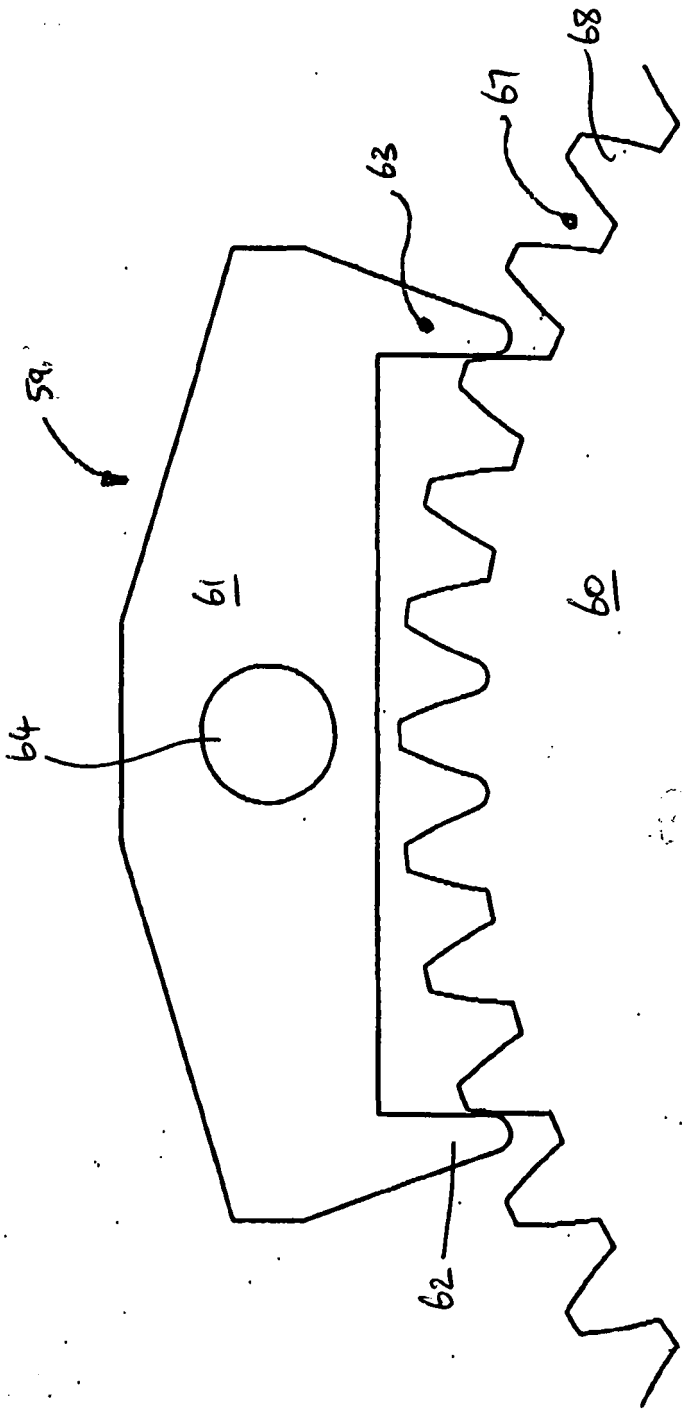

Figure 16