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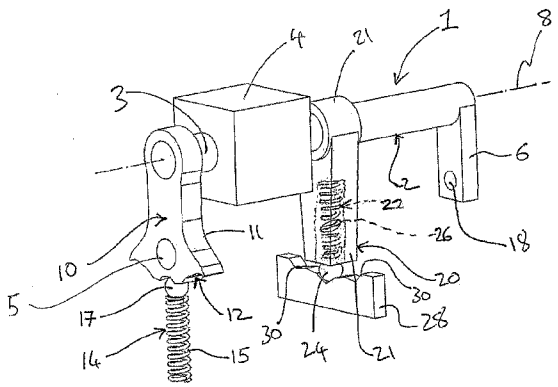
(54) **Title:** APPARATUS AND METHOD FOR CHANGING GEAR IN MECHANICAL GEARBOXES



(57) **Abstract:** An apparatus (1) comprises a gear lever (not shown) connected to a servo control unit (4) via a rotatable input shaft (3) and a lever element (11). The apparatus 1 includes a rotatable gear selector shaft (2) and servo means (not sown) for executing mechanical movement of the gear selector shaft (2). The gear selector shaft (2) and the input shafts are rotatable about a longitudinal axis (8). The apparatus (1) further comprises sensory feedback means, whereby in use the sensory feedback means indicates to the operator a relative location of a gear lever by the provision of a variable force that resists the movement of the gear lever. The sensory feed back means comprises a detent mechanism (10) disposed between the gear lever and the control unit (4). The detent mechanism (10) comprises a moveable lever element (11) attached to the input shaft (3) and an indexing element (14) in the formed of a compression spring (14) and a ball bearing (17). The distal end of the lever element (11) is formed with a series of three detents (12) arranged in an arc. The lever element (11) is pivoted about the axis (8) by a rotational force directed through a lower pin connection (5). The rotational force originates from the operator moving the gear lever. The ball bearing (17) is urged towards the lever element (11) by the compression spring (15). The ball bearing (17) is in slidable contact with detents (12) and is receivable by the detents (12) in a snap-engaging action. A pivoting movement of the lever element (11) causes the input shaft (3) to pivot about the axis (8).

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Apparatus and Method for Changing Gear in Mechanical Gearboxes

The present invention relates to an apparatus and method for changing gear in a mechanical gearbox and is concerned particularly with providing a sensory feedback to an operator of gear changing apparatus.

Background of the Invention

In accordance with the prior art, the gear changing mechanisms, such as the shift forks and the synchronisation mechanisms in manual gearboxes, are constructed so as to be able to withstand the forces to which they are subjected when operated manually. On operation of a manual gearbox, the forces employed by the driver when he operates the gear lever are transmitted by, for example, a mechanical or hydraulic transmission to the gear shifting mechanism in the gearbox.

In lorries with large motor torques available, the gearboxes will have to be constructed to withstand these motor torques, and this involves high shifting forces in order to change gear. The forces required to change gear are in some constructions so great that the driver needs assistance in the form of power assistance from some form of assistance system/servo system in order to be able to operate the gear lever in a comfortable manner. There are many different solutions which attempt to provide the necessary power assistance to ensure that a gear change can be made in a comfortable manner. In this connection, reference is made, for instance, to DE 2223881 which discloses examples of assistance systems/servo solutions.

Also, there are existing gear shift systems including servo units that are equipped with detents. The detents are arranged at the outgoing shaft of the servo, i.e. normally corresponding to input shaft to gearbox. These detents ensure that the shift rail and the gear box are held in position via the servo, e.g. held in neutral or in-gear position. An example of this type of assembly is shown in the patent specification DE 19 839 850.

With existing servo aided gear shifting systems a gear is selected with the use of a servo unit. The servo unit is activated by a servo valve being opened with a movement of a gear lever by the vehicle driver. The driver can experience problems with a lack of a precise feeling in the gear lever. There can be difficulties for the driver to, via the gear lever, tell the position of the gear box and the shifting system. There is an 'elastic' feeling on the driver side due to movement of a spring arrangement of the servo valve.

The present invention sets out to address some of the problems of existing servo assisted gearbox assemblies, such as a lack of distinctive feel when operating the gear lever.

Disclosure of the Invention

According to a first aspect of the present invention there is provided an apparatus for facilitating gear changing in mechanical gearboxes, the apparatus comprising a gear lever linked to a servo control unit by a connection assembly, a displaceable gear selector shaft and servo means for executing mechanical movement of the gear selector shaft in response to a movement of the gear lever characterised in that, the apparatus comprises sensory feedback means for the gear lever, the sensory feedback means comprising a resistance mechanism, whereby in use the resistance mechanism indicates to the operator a relative location of the gear lever by the provision of a variable force related to the position of the gear lever.

The variable force of the resistance mechanism may initially resist the movement of the gear and then the variable force may aid the movement of the gear lever. This arrangement will help to provide the operator of the gear lever with a positive feedback function that indicates the gear lever has reached a desired location.

Preferably, the resistance mechanism comprises a detent element and an indexing element urged towards the detent element, the detent element and the indexing element being moveable relative to each other and the indexing element receivable by the detent element.

Preferably, the resistance mechanism comprises at least one detent mechanism disposed between the gear lever and the servo control unit, the detent mechanism comprising a moveable element formed with at least one detent and an indexing element being urged towards the moveable element and receivable by the detent(s), the indexing element comprising a degree of elasticity and being in slidable contact with the moveable element.

The inventive gear changing apparatus may comprise any suitable type of connection assembly linking the gear lever in the vehicle cabin to an ingoing actuation shaft of the servo control unit. Preferably, the resistance mechanism is disposed within the connection assembly between the gear lever and the control unit The assembly may be a mechanical, a hydraulic, an electrical or a cable linkage connecting the gear lever to preferably a pneumatic servo control unit. The connection assembly linking the gear lever to the servo control unit is preferably arranged with the resistance mechanism on the ingoing shaft (actuation side) of a servo control unit. The connecting assembly may include the ingoing shaft (actuation shaft) of the servo control unit.

The servo control unit preferably comprises a control valve function arrangement for the servo means. By having detents on the ingoing shaft there is an improved

feedback feeling in the gear lever. The 'elastic' feeling will be removed or reduced and the driver will have a better feeling of the position of the gearbox, i.e. neutral or in-gear. This will increase the driver's sense of control over the gearbox and the vehicle, resulting in increased driving comfort.

In a first embodiment of the first aspect of the present invention, the moveable element of the resistance mechanism may be moveable in a linear axial direction with respect to the indexing element. Such an arrangements are suitable for a gear changing system where the detents are provided on, or in association with, an axially movable input shaft of the servo control unit. The detents may be positioned outside and 'upstream' in relation to the servo control unit but can also be placed within the servo valve housing.

In a second alternative embodiment the moveable element of the resistance mechanism is moveable in a pivotable direction about an axis of an input element of the servo control unit. Such an arrangement is suitable for a gear changing system where the detents are arranged on a lever arm that pivots to control servo valves in the control unit. Also, in this embodiment the detents, and the lever arm, may be arranged within a servo housing or alternatively in a separate housing.

It shall be appreciated that for both the first and second embodiments the resistance mechanism may alternatively comprise a moveable element comprising an indexing element and a fixed element formed with at least one detent, the indexing element being urged towards the fixed element and receivable by the detent(s), the indexing element comprising a degree of elasticity and being in slidable contact with the moveable element.

In general the detent mechanism may be covered by a separate housing to prevent environmental influence, e.g. dirt, humidity etc..

In both of the above embodiments, the apparatus may comprises the effects of the detents of the first detent mechanism associated with an input shaft of the servo control unit combined with the effects of detents of a second detent mechanism associated with an outgoing gear selector shaft. It shall be appreciated that the second detent mechanism may have the same composition and arrangement as any one of the above arrangements of the embodiments of the first detent mechanism.

The detents of the second detent mechanism associated with an outgoing gear selector shaft primarily ensure that the gearbox remains in the desired position while detents of the first detent mechanism associated with the input shaft primarily ensures a distinct feeling of gearbox state for the driver. For such an arrangement,

the relative length of the detents can be used to adjust or fine-tune the servo assistance. If the detents of the first detent mechanism are designed so that the input shaft passes the peak of the detent before the detents of the second detent mechanism outgoing gear selector shaft passes its peak, the servo assistance will be increased. Alternatively, the servo assistance will be reduced if the outgoing shaft passes the peak of its detent before the ingoing shaft does the same.

The detents of the first detent mechanism associated with the input shaft may preferably have longer distances between the respective peaks than the corresponding distances between the peaks of the detents of the second detent mechanism associated with the outgoing gear selector shaft. Alternatively, the detents of the second detent mechanism associated with the outgoing gear selector shaft may have longer distances between the respective peaks than the corresponding distances between the peaks of the detents of the first detent mechanism associated with the input shaft.

According to a second aspect of the present invention there is provided a method for providing sensory feedback means for apparatus for facilitating gear changing in mechanical gearboxes comprising a gear lever connected to a servo control unit, a displaceable gear selector shaft and servo means for executing mechanical movement of the gear selector shaft in response to a movement of the gear lever, characterised in that, the method comprises indicating to the operator a relative location of the gear lever by the provision of a variable force that resists the movement of the gear lever.

Preferably the resistance force initially increases as the gear lever is moved from a neutral position to a gear shifting position and the resistance force decreases, or becomes an assisting force, as the gear lever is moved from a gear shifting position to an in-gear position.

Brief Description of the Drawings

Two specific embodiment of the invention will now be described by way of example only with reference to the accompanying drawing, in which:

Figure 1 is an isometric view of an apparatus for facilitating gear changing in mechanical gearboxes comprising a pivoting gear selector shaft;

Figure 2 is an isometric view of an apparatus for facilitating gear changing in mechanical gearboxes comprising an axially moveable gear selector shaft;

Figures 3a, 3b and 3c are side views of the apparatus shown in Figure 1 and show the movement of the apparatus as a gear is selected; and

Figures 4a, 4b and 4c are side views of the apparatus shown in Figure 2 and show the movement of the apparatus as a gear is selected.

With reference to the figures 1 and 3b, 3b and 3c, there is shown an apparatus 1 for facilitating gear changing in a mechanical gearbox (not shown). The general construction and general operation of the apparatus 1 conforms to known types of servo assisted gear changing systems for manually operable gearboxes. In such apparatus it is normal practice to transfer movements from a manual gear change lever to the actual gear change means with the help of a ball joint-mounted gear change rod and this type of assembly is descried in the specification number US 4287784. Such apparatus includes a first mechanical arrangement for transferring the movement of the gear change lever to a servo control valve and a second mechanical arrangement for executing mechanical movement of a gear selector shaft with the assistance of a servo. The servo control valve is operated by a movement of the gear lever and in turn the valve activates the servo. The first mechanical arrangement may comprise a series of linkages and assemblies connecting the gear change lever to the servo control valve. The second mechanical arrangement normally comprises a gear selector shaft moveable pivotally, and may be axially, about its longitudinal axis by a servo actuated lever.

The apparatus 1 according to the present invention as shown in figure 1 comprises a gear lever (not shown) connected to a servo control unit 4 via a rotatable input shaft 3 and a lever element 11. The apparatus 1 includes a rotatable gear selector shaft 2 and servo means (not sown) for executing mechanical movement of the gear selector shaft 2. The gear selector shaft 2 and the input shafts are rotatable about a longitudinal axis 8.

The apparatus 1 further comprises sensory feedback means comprising a resistance mechanism, whereby in use the sensory feedback means indicates to the operator a relative location of a gear lever by the provision of a variable force that resists the movement of the gear lever. The resistance mechanism comprises a detent mechanism 10 disposed between the gear lever and the control unit 4. The detent mechanism 10 comprises the moveable lever element 11 attached to the input shaft 3 and an indexing element 14 in the form of a compression spring 14 and a ball bearing 17. The indexing element 14 is held within a suitable housing (not shown). The distal end of the lever element 11 is formed with a series of three detents 12 arranged in an arc. The lever element 11 is pivoted about the axis 8 by a rotational force directed through a lower pin connection 5. The rotational force originates

from the operator moving the gear lever. The ball bearing 17 is urged towards the lever element 11 by the compression spring 15. The ball bearing 17 is in slidable contact with detents 12 and is receivable by the detents 12 in a snap-engaging action. A pivoting movement of the lever element 11 causes the input shaft 3 to pivot about the axis 8.

The servo means consists of an operating cylinder comprising at least one pressure transmitting element that acts on a slidable shaft. The servo can be operated by a hydraulic or pneumatic medium. The slidable shaft is connected to the distal end of a lever 6 via a pin connection 18. The servo is supplied with a pressurised medium by two pipes (not shown) extending from the control unit 4. The control unit 4 comprises a valve mechanism that is activated by the rotational movement of the input shaft 3.

Attached to the gear selector shaft 2 is a second detent mechanism 20. The detent mechanism 20 comprises a moveable lever element 21, one end of which is attached to the output gear selecting shaft 2 and an indexing element 22 in the form of a ball bearing 24 and a compression spring 26. The compression spring 26 is disposed within a cylindrical bore formed in the distal end of the moveable element 21. A fixed catch element 28 is formed with a series of three detents 30. The lever element 21 is pivotable about the axis 8 by a rotational force directed through a lower pin connection 18. The rotational force originates from the servo.

With reference to figures 3a to 3c, there is shown the operation of the apparatus 1 at various stages. Figure 3a shows the apparatus 1 in a neutral position, figure 3b shows the apparatus in a gear shifting position and figure 3c shows the apparatus in a gear engaged position. The operation of the apparatus 1 begins with the driver moving the gear lever from a neutral position to select a desired gear, the movement of the gear lever causes a force to be exerted on the pin connection 5 in the direction of arrow 32. This force in direction 32 causes the lever 11 to rotate about the axis 8. In the initial neutral position the ball bearing 17 is located within the central detent 12 and the servo control valve is closed. As the lever 11 pivots in the direction 32 the ball bearing slides along the surface of the distal end of the lever 11 and compresses the spring 15 and the servo control valve is opened. The force required to compress the spring 15 provides a resistance to the movement of the lever 11 and hence provides a resistance of the gear lever. At the intermediate position shown in figure 3b the ball bearing 17 is between two of the detents. Eventually the ball bearing 17 enters one of the outer detents in a snap-like action. This action provides a sudden decrease to the resistance felt by the operator of the gear lever.

In the initial neutral position the servo control valve is closed. As the lever 11 pivots in the direction 32 the servo control valve is opened. When the control valve is opened the servo is activated and begins to move the gear selector shaft 2. As shown in figure 3b there is a slight lag between the movement of the lever 11 and the movement of the movable element 21 attached to the gear selector shaft 2. This difference may aid the gear selection as the ball bearing 17 has passed the maximum resistance to the movement of the lever 11 and is being snapped into the outer detent.

The detents 12 associated with the input shaft 3 may have longer distances between the respective peaks than the corresponding distances between the peaks of the detents 30 associated with the gear selector shaft 2. Alternatively, the detents 30 may have longer distance between the peaks than detents 12 on input shaft 3. For such arrangements, the relative length of the detents can be used to adjust or fine-tune the servo assistance.

With reference to figures 2 and figures 4a to 4c, there is shown a second embodiment of the present invention of an apparatus 41 for facilitating gear changing in a mechanical gearbox (not shown). The apparatus 1 according to the present invention as shown in figure 4 comprises a gear lever (not shown) connected to a servo control unit 42 via a linearly moveable input shaft 43, a moveable gear selector shaft 44 and servo means 45 for executing mechanical movement of the gear selector shaft 44. The gear selector shaft 44 and the input shaft 43 are moveable in the longitudinal direction of an axis 46. The apparatus 41 further comprises sensory feedback means, whereby in use the sensory feedback means indicates to the operator a relative location of a gear lever by the provision of a variable force that resists the movement of the gear lever. The sensory feed back means comprises a resistance mechanism formed by a detent mechanism 48 disposed between the gear lever and the control unit 42. The detent mechanism 48 comprises a series of three detents 50 formed on the input shaft 43 and an indexing element in the form of a compression spring 51 and a ball bearing 52.

The control unit 42 comprises two springs 58, 59 disposed each side of a separating plate 60.

The servo means 45 comprises an operating cylinder 53 containing a reciprocateable piston 54. The piston 54 is attached to the selector shaft 44. The shaft 44 is formed with a second detent mechanism 56. The second detent mechanism 5 comprises a compression spring 58, a ball bearing 60 and a series of three detents 61 formed in the gear selector shaft 44.

The apparatus 41 operates in a similar way as the apparatus 1, except that the moveable elements move in a linear axial direction and not a pivoting rotational direction. With reference to figures 4a to 4c, there is shown the operation of the apparatus 41 at various stages. Figure 4a shows the apparatus 41 in a neutral position, figure 4b shows the apparatus in a gear shifting position and figure 4c shows the apparatus in a gear engaged position. The operation of the apparatus 41 begins with the driver moving the gear lever from a neutral position to select a desired gear, the movement of the gear lever causes a force to be exerted on the input shaft 43 in the direction of arrow 62. This force in direction 62 causes the input shaft 43 to move linearly along the axis 46. In the initial neutral position the ball bearing 52 is located within the central detent 50 and the servo control valve 42 is closed. As the input shaft 43 moves in the direction 62 the ball bearing 52 slides along the surface detents 50 and compresses the spring 51 and the servo control valve 42 is opened. The force required to compress the spring 51 provides a resistance to the movement of the input shaft 43 and hence provides a resistance of the gear lever. At the intermediate position shown in figure 4b the ball bearing 52 is between two of the detents 50. Eventually the ball bearing 52 enters one of the outer detents in a snap-like action. This action provides a sudden decrease to the resistance felt by the operator of the gear lever.

In the initial neutral position the servo control valve 42 is closed. As the input shaft 43 moves in the direction 62 the servo control valve 42 is opened. When the control valve 42 is opened the servo 45 is activated and begins to move the gear selector shaft 44. As shown in figure 4b there is a slight lag between the movement of the input shaft 43 and the movement of the selector shaft 44. This difference may aid the gear selection as the ball bearing 17 has passed the maximum resistance to the movement of the lever 11 and is being snapped into the outer detent.

The detents 50 associated with the input shaft 43 may have longer distances between the respective peaks than the corresponding distances between the peaks of the detents 61 associated with the gear selector shaft 44. Alternatively, the detents 61 may have longer distance between the peaks than detents 50 on input shaft 43.

It shall be appreciated that the detent mechanism 10 may be replaced by a mechanism the same as the detent mechanism 20, wherein the resistance mechanism may alternatively comprise a moveable element comprising an indexing element and a fixed element formed with at least one detent, the indexing element being urged towards the fixed element and receivable by the detent(s), the indexing element comprising a degree of elasticity and being in slidable contact with the moveable element.

CLAIMS

1. An apparatus for facilitating gear changing in mechanical gearboxes, the apparatus comprising a gear lever linked to a servo control unit by a connection assembly, a displaceable gear selector shaft and servo means for executing mechanical movement of the gear selector shaft in response to a movement of the gear lever characterised in that, the apparatus comprises sensory feedback means for the gear lever, the sensory feedback means comprising a resistance mechanism, whereby in use the resistance mechanism indicates to the operator a relative location of the gear lever by the provision of a variable force related to the position of the gear lever.

2. An apparatus as claimed in claim 1, wherein the resistance mechanism is placed within the connection assembly.

3. An apparatus as claimed in claim 1 or claim 2, wherein the resistance mechanism comprises a detent element and an indexing element urged towards the detent element, the detent element and the indexing element being moveable relative to each other and the indexing element being receivable by the detent element.

4. An apparatus as claimed in any of the above claims, wherein the resistance mechanism comprises a first detent mechanism disposed between the gear lever and the control unit, the detent mechanism comprising a moveable element formed with at least one detent and an indexing element urged towards the moveable element, the indexing element being in slidable contact with the moveable element and receivable by the detent(s).

5. An apparatus as claimed in claim 4, wherein the moveable element of the first detent mechanism is moveable in a linear direction with respect to the indexing element.

6. An apparatus as claimed in claim 4, wherein the moveable element is pivotably moveable with respect to the indexing element about an axis of an input element of the control unit.

7. An apparatus according to any one of the previous claims 3 to 6, wherein a first detent corresponds to a neutral position of the gearbox.

8. An apparatus according to claim 7, wherein a second detent corresponds to an in-gear position of the gearbox.

9. A apparatus as claimed by any one of the previous claims, wherein the apparatus comprises a second detent mechanism connected to the servo means, the detent mechanism comprising a moveable element formed with at least one detent and an indexing element urged towards the moveable element, the indexing element being in slidable contact with the moveable element and receivable by the detent(s).

10. An apparatus according to claim 9, wherein the distance between the respective peaks of the detents of the first detent mechanism is greater than the distance between the respective peaks of the detents of the second detent mechanism.

11. An apparatus according to claim 9, wherein the distance between the respective peaks of the detents of the second detent mechanism is greater than the distance between the respective peaks of the detents of the first detent mechanism.

12. A method for providing sensory feedback means for apparatus for facilitating gear changing in mechanical gearboxes comprising a gear lever connected to a servo control unit, a displaceable gear selector shaft and servo means for executing mechanical movement of the gear selector shaft in response to a movement of the gear lever, characterised in that, the method comprises indicating to the operator a relative location of the gear lever by the provision of a variable force that resists the movement of the gear lever.

13. A method as claimed in claim 12, wherein the resistance force initially increases as the gear lever is moved from a neutral position to a gear shifting position and the resistance force decreases as the gear lever is moved from a gear shifting position to an in-gear position.

Fig 1

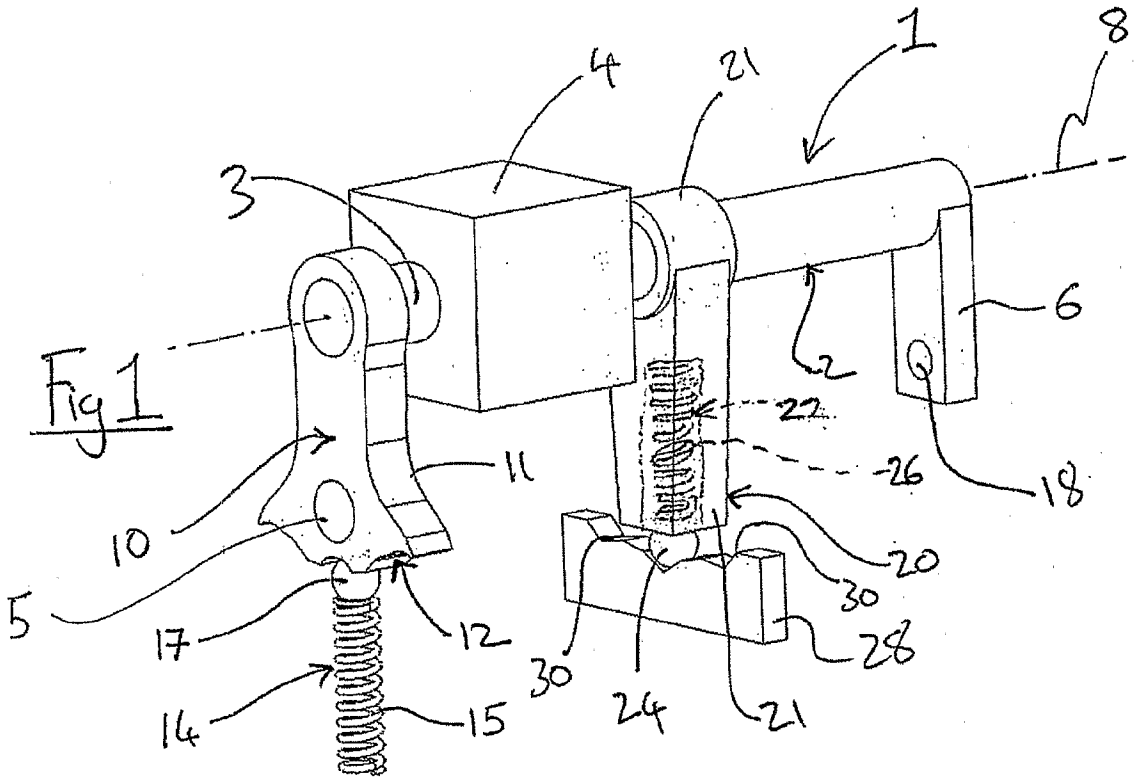
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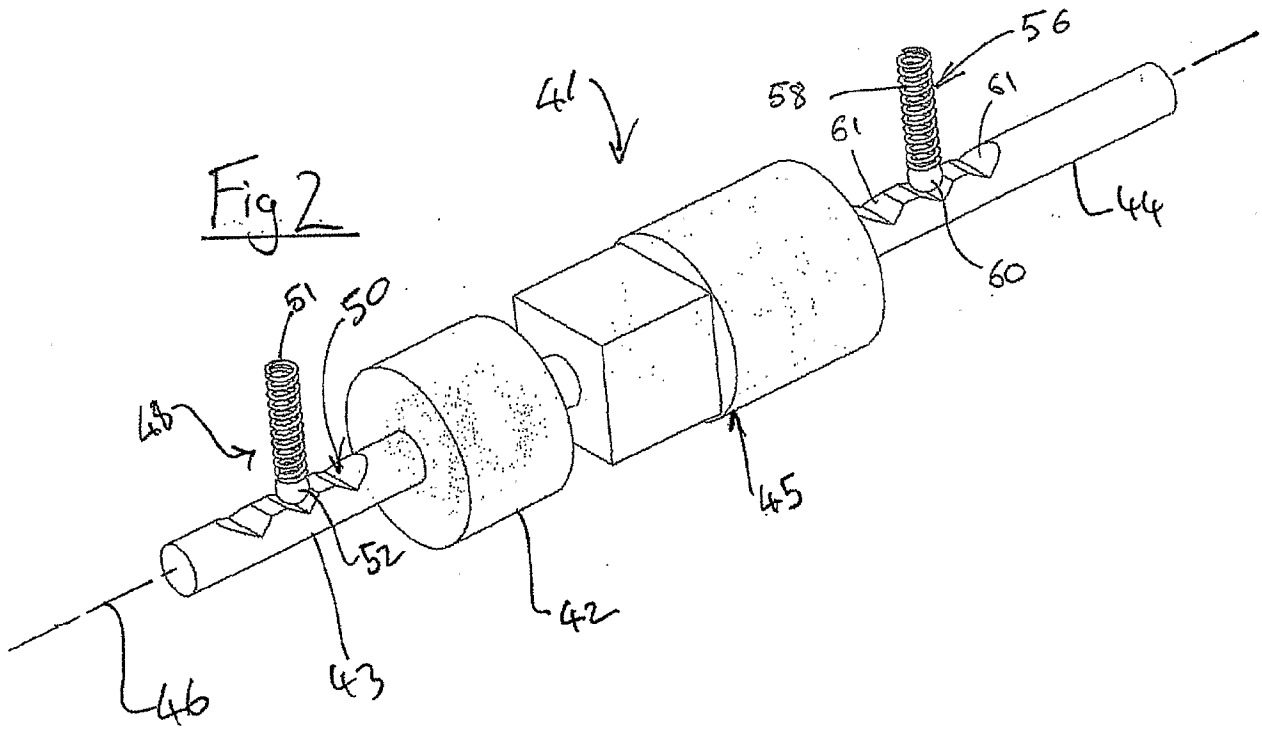
Fig 2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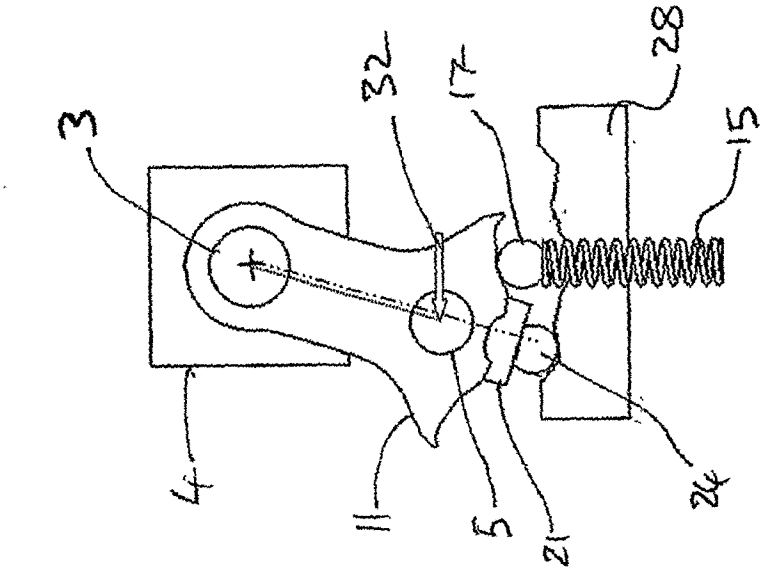

Fig. 3c

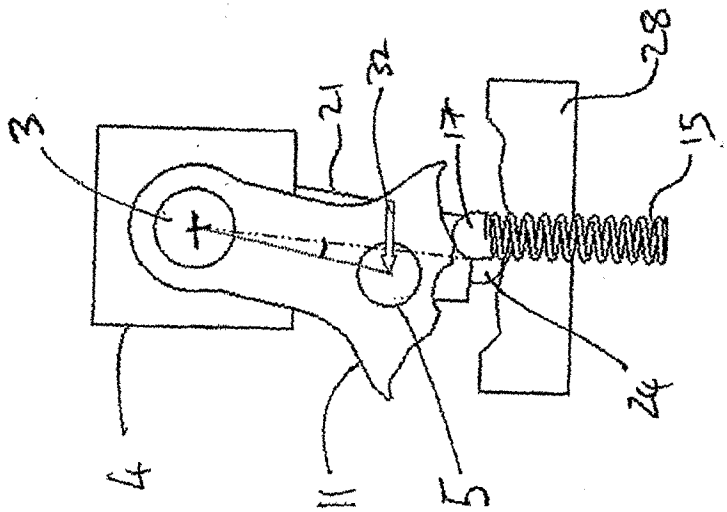

Fig. 3b

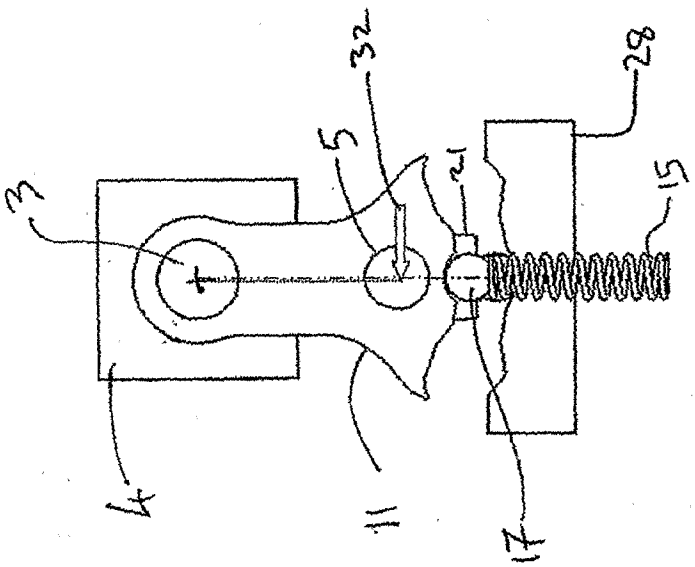

Fig. 3a

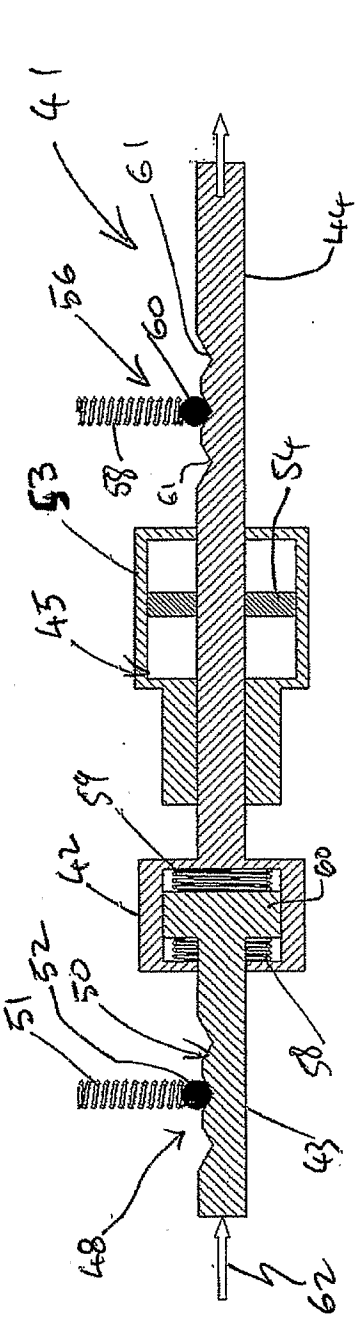

Fig. 4A

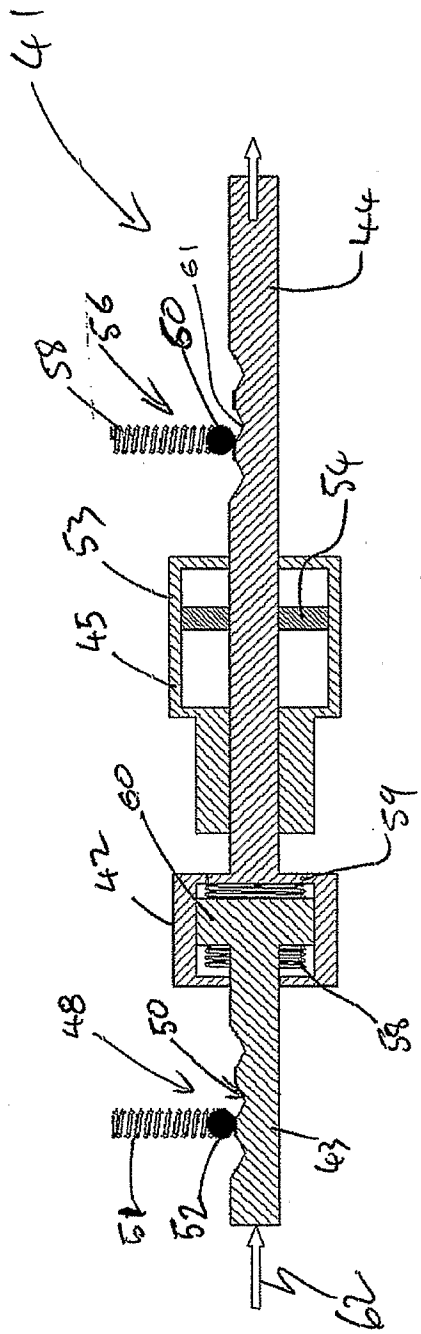

Fig. 4B

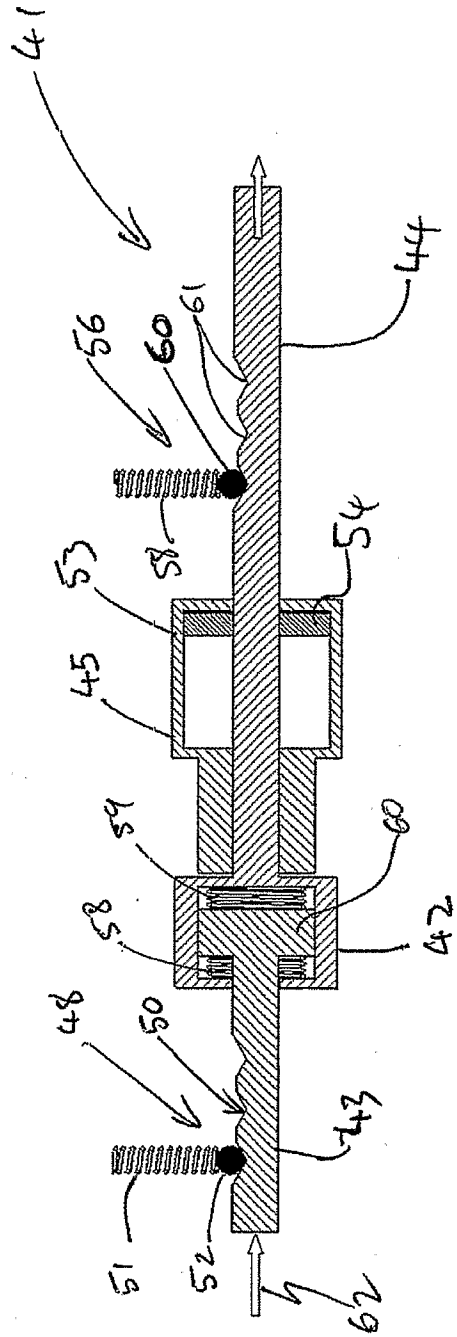

Fig. 4C

INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2007/000154

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H61/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/060019 A1 (SATO TAKESHI [JP] ET AL) 23 March 2006 (2006-03-23) paragraphs [0146] - [0175]; figures 29-51	1-9,12, 13
A	DE 30 48 093 A1 (NISSAN MOTOR [JP]) 17 September 1981 (1981-09-17) pages 6-17; figures 1-5	1-13
A	EP 1 591 697 A (CALSONIC KANSEI CORP [JP]) 2 November 2005 (2005-11-02) paragraphs [0013] - [0033]; figures 1-3	9
A	DE 102 15 116 C1 (SIEMENS AG [DE]) 10 July 2003 (2003-07-10) paragraphs [0006], [0031] - [0036]; figures 1,2	1-13

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2007	07/09/2007

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2007/000154

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 646 582 A (KIJIMA NOBUO [JP]) 3 March 1987 (1987-03-03) abstract; figures 1-12	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NO2007/000154

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006060019 A1	23-03-2006	EP 1666772 A1	07-06-2006
DE 3048093 A1	17-09-1981	JP 56095713 U	29-07-1981
		JP 60012165 Y2	20-04-1985
		US 4365522 A	28-12-1982
EP 1591697 A	02-11-2005	JP 2005315344 A	10-11-2005
		US 2005247154 A1	10-11-2005
DE 10215116 C1	10-07-2003	WO 03085286 A1	16-10-2003
		US 2005043878 A1	24-02-2005
US 4646582 A	03-03-1987	NONE	