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Jayaram et al.

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(54) **SINGLE MOTOR TRANSMISSION SHIFTING MECHANISM FOR A MOTOR VEHICLE TRANSMISSION**

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F16H 59/00 (2006.01)
F16H 3/34 (2006.01)
B60K 17/04 (2006.01)

(52) **U.S. Cl.** **74/335**; 74/352; 74/473.12

(58) **Field of Classification Search** .... 74/127, 74/335, 352, 353, 354, 396, 397, 424.71, 74/473.12, 471 XY
See application file for complete search history.

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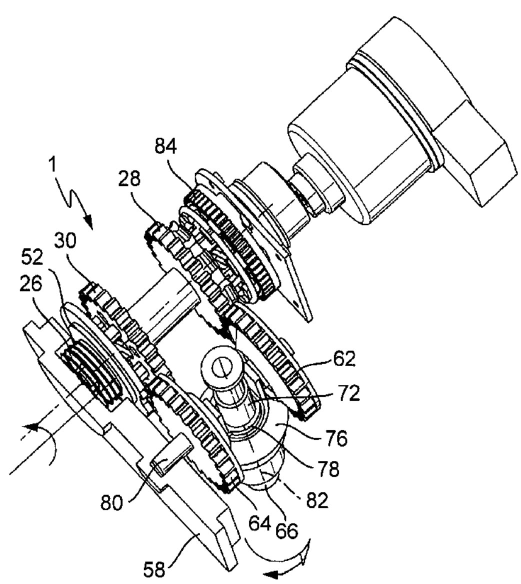
(57) **ABSTRACT**

A single motor transmission shifting mechanism with exactly one electric motor for generating drive motions for selecting, and for generating drive motions for shifting gears of a motor vehicle transmission device, and with a threaded spindle for switching from a mode, in which selection motions can be effectuated, into a mode, in which shifting motions can be effectuated, and with a shifting shaft, which can be moved in axial direction for selecting, and which can be rotated around its longitudinal axis for shifting, wherein all components, transferring the drive load for shifting from the electric motor to the shifting shaft during shifting operation, maintain their axial position relative to the longitudinal axis of the threaded spindle during this shifting operation.

4 Claims, 10 Drawing Sheets



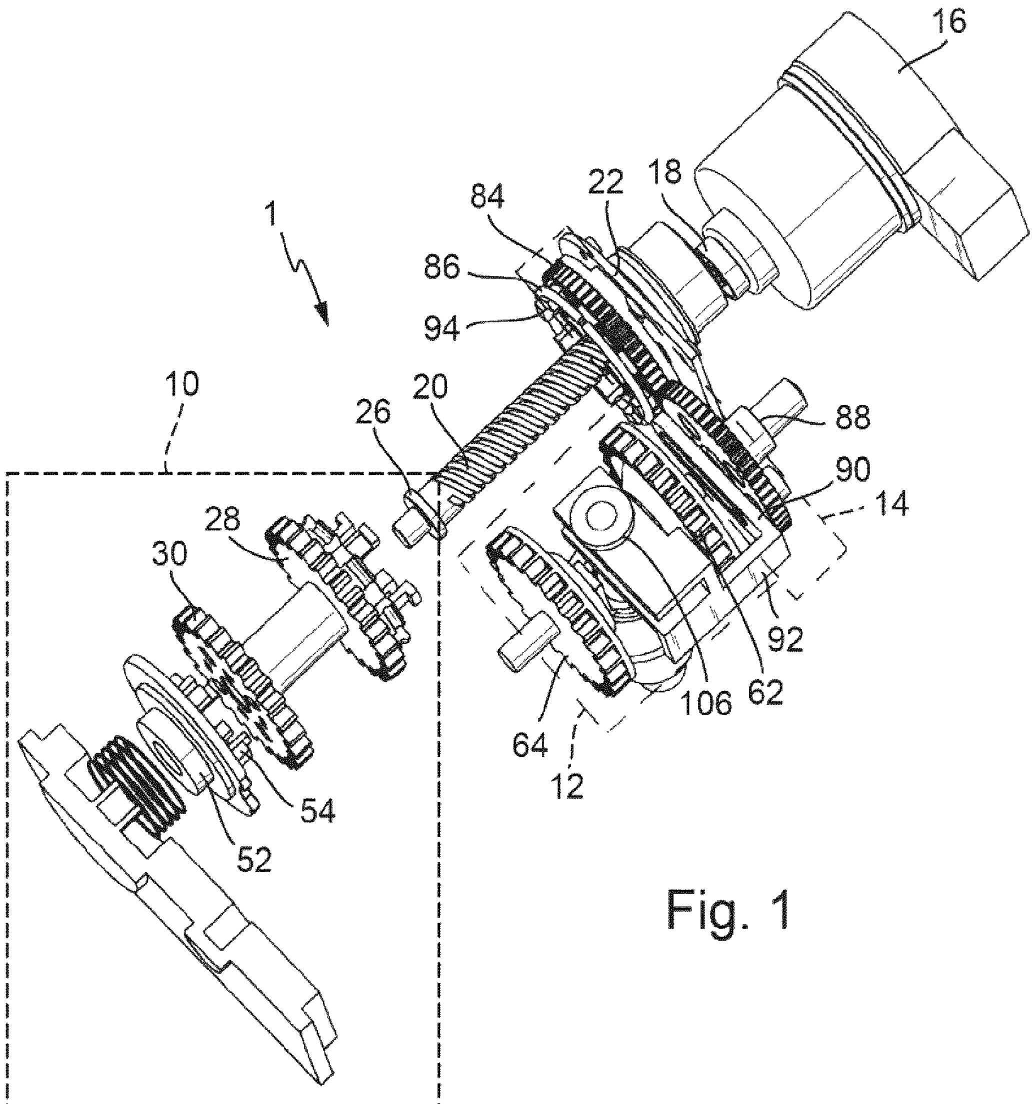


Fig. 1

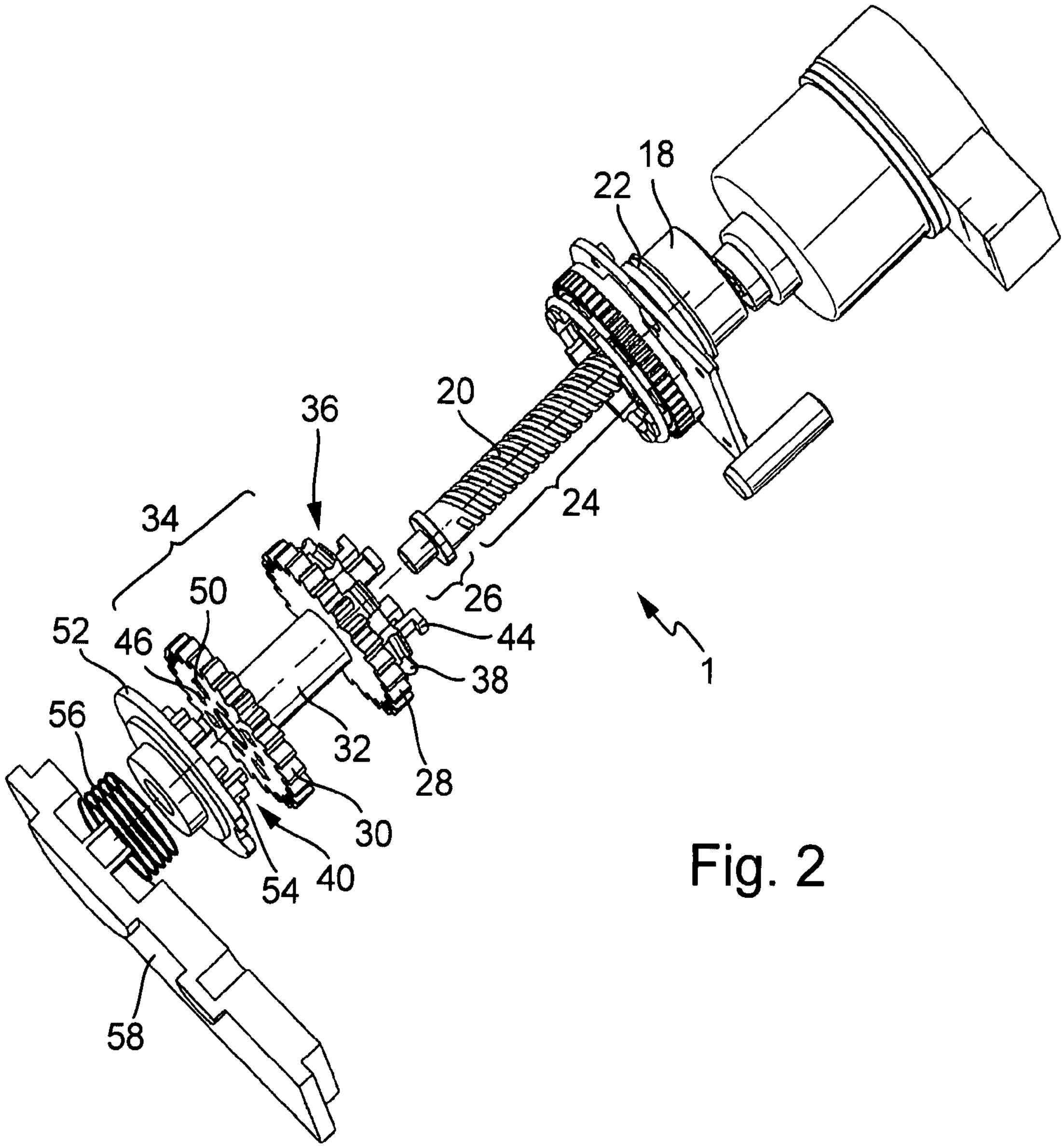


Fig. 2

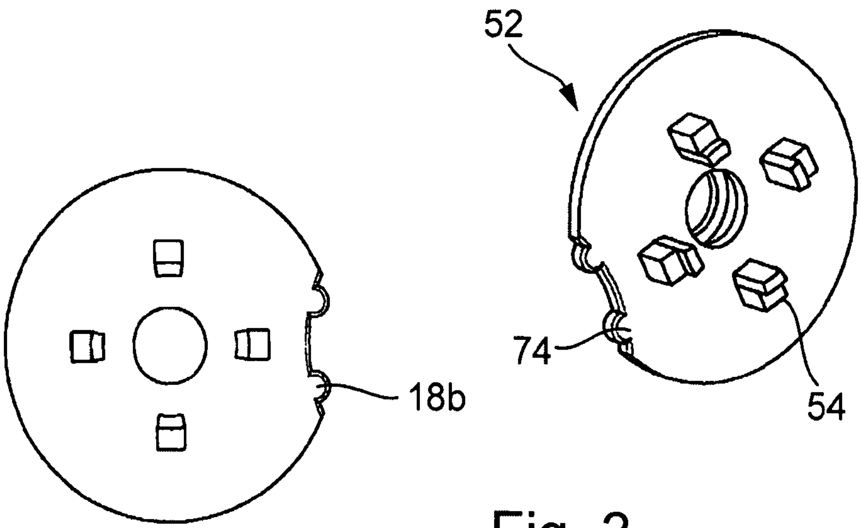


Fig. 3

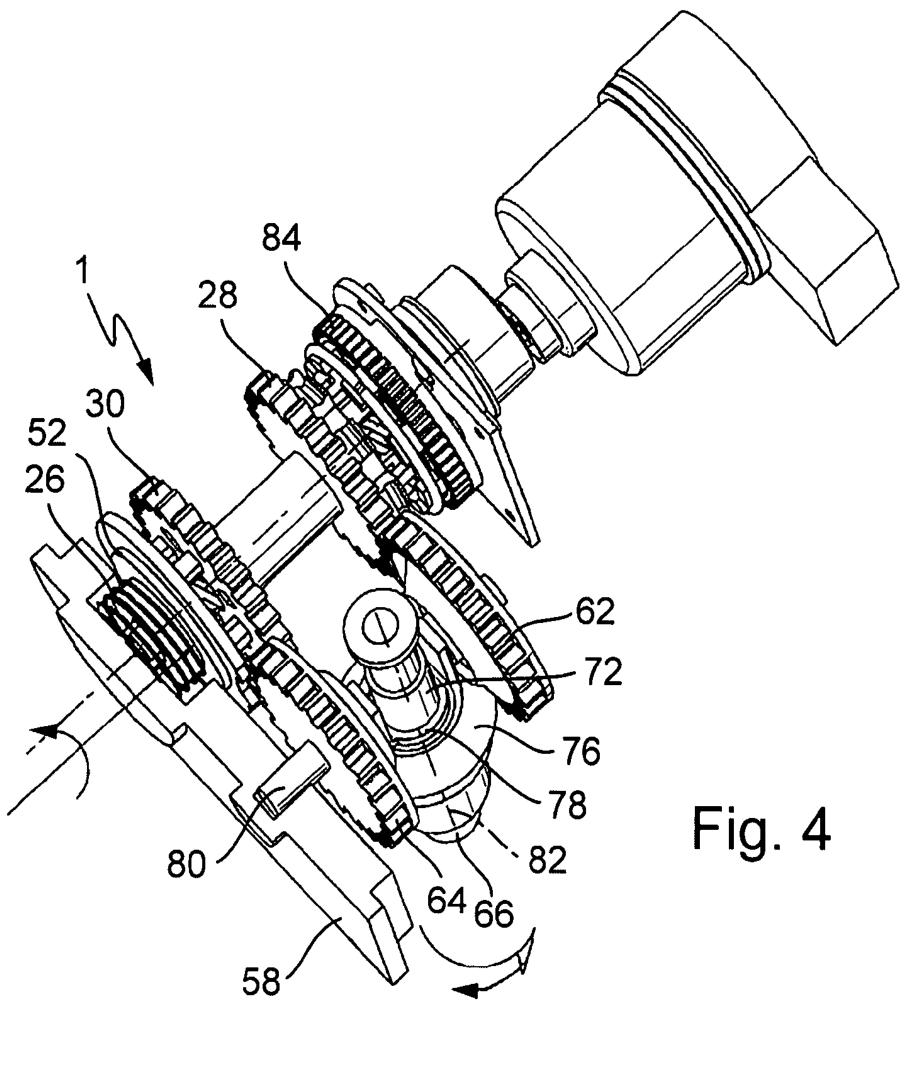


Fig. 4

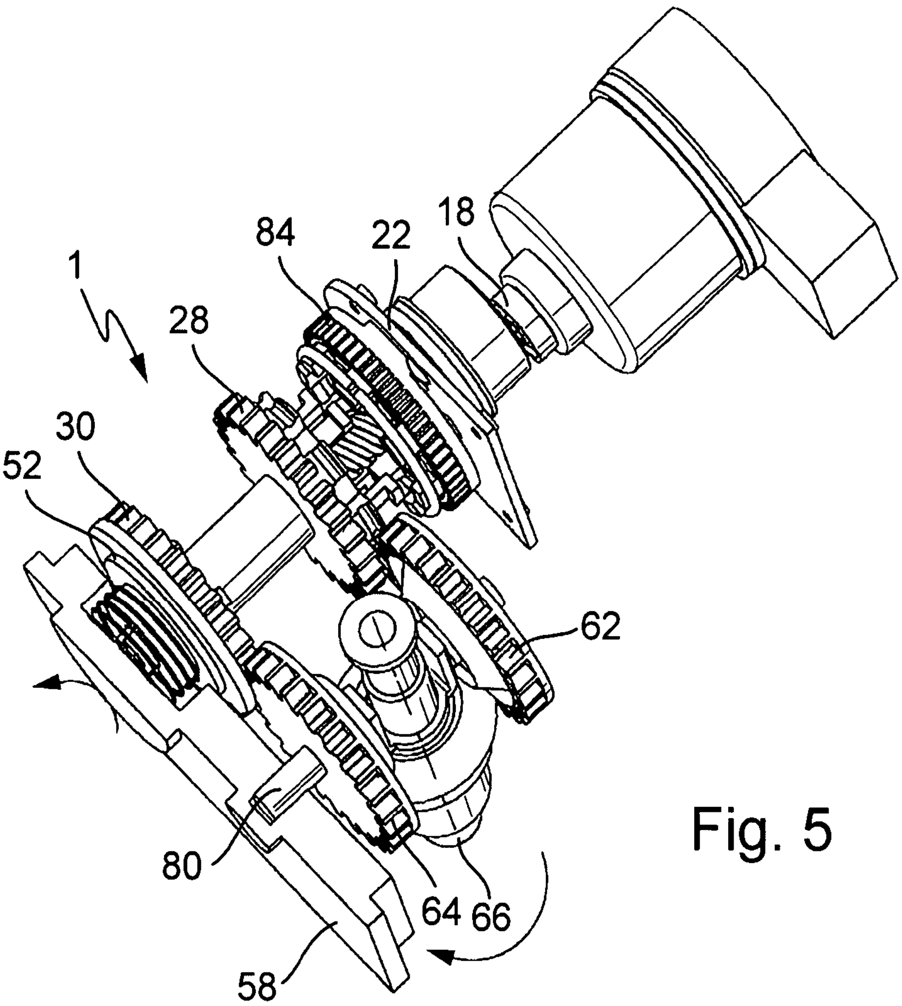


Fig. 5

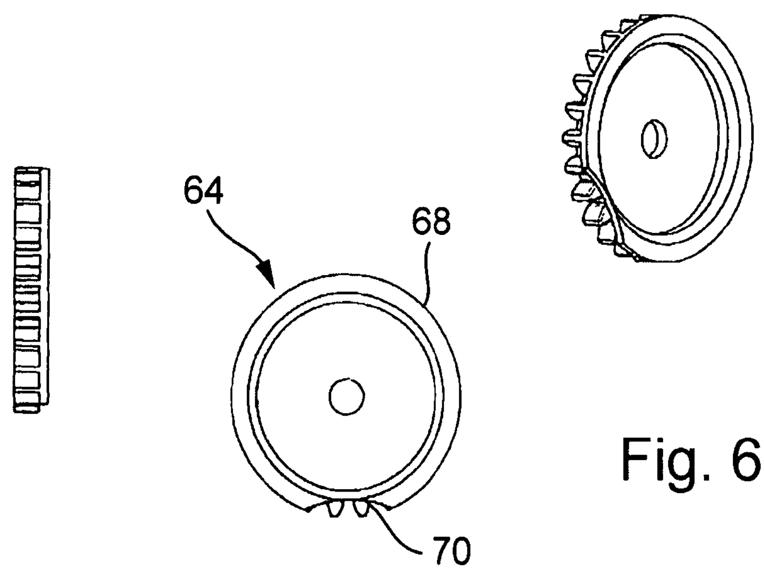


Fig. 6

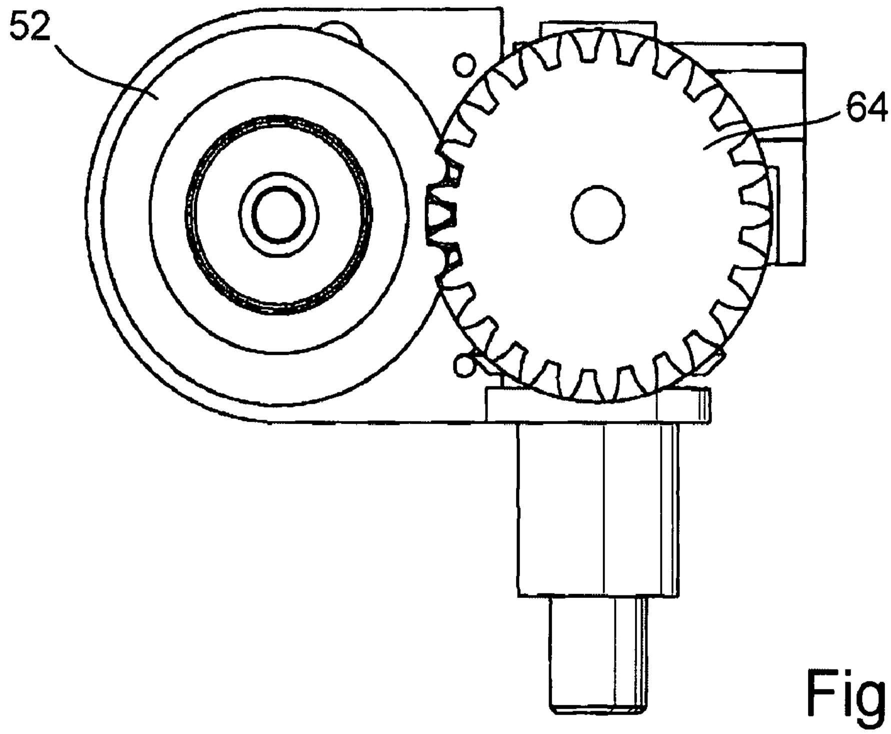


Fig. 7

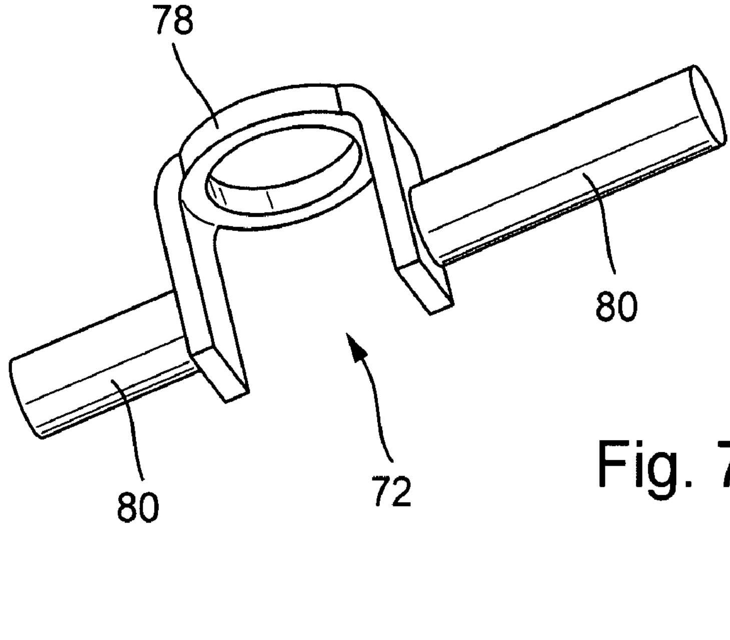


Fig. 7a

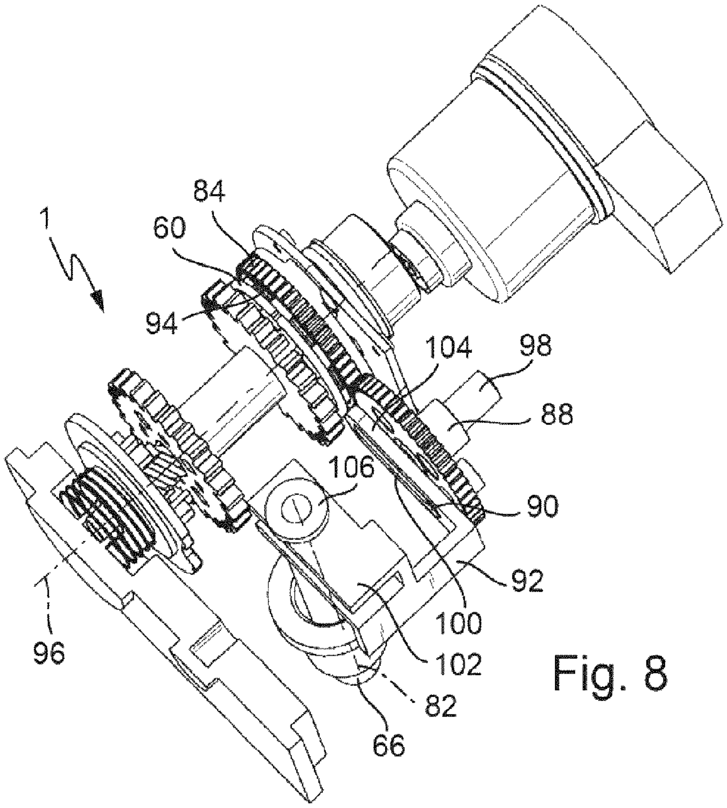


Fig. 8

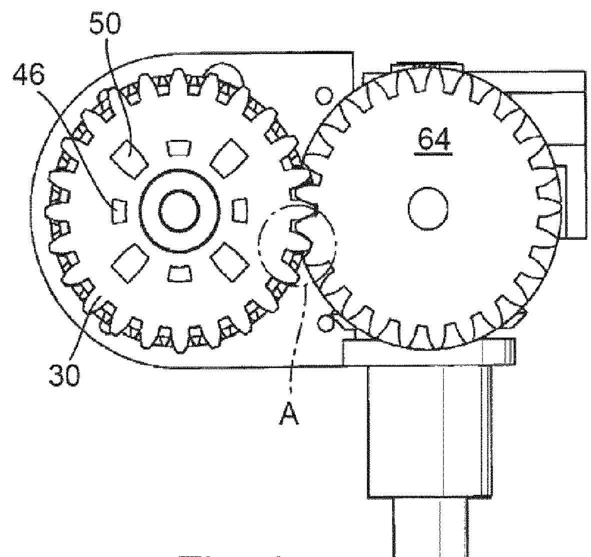


Fig. 9

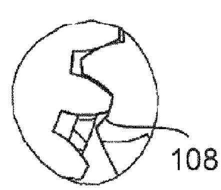


Fig. 9a

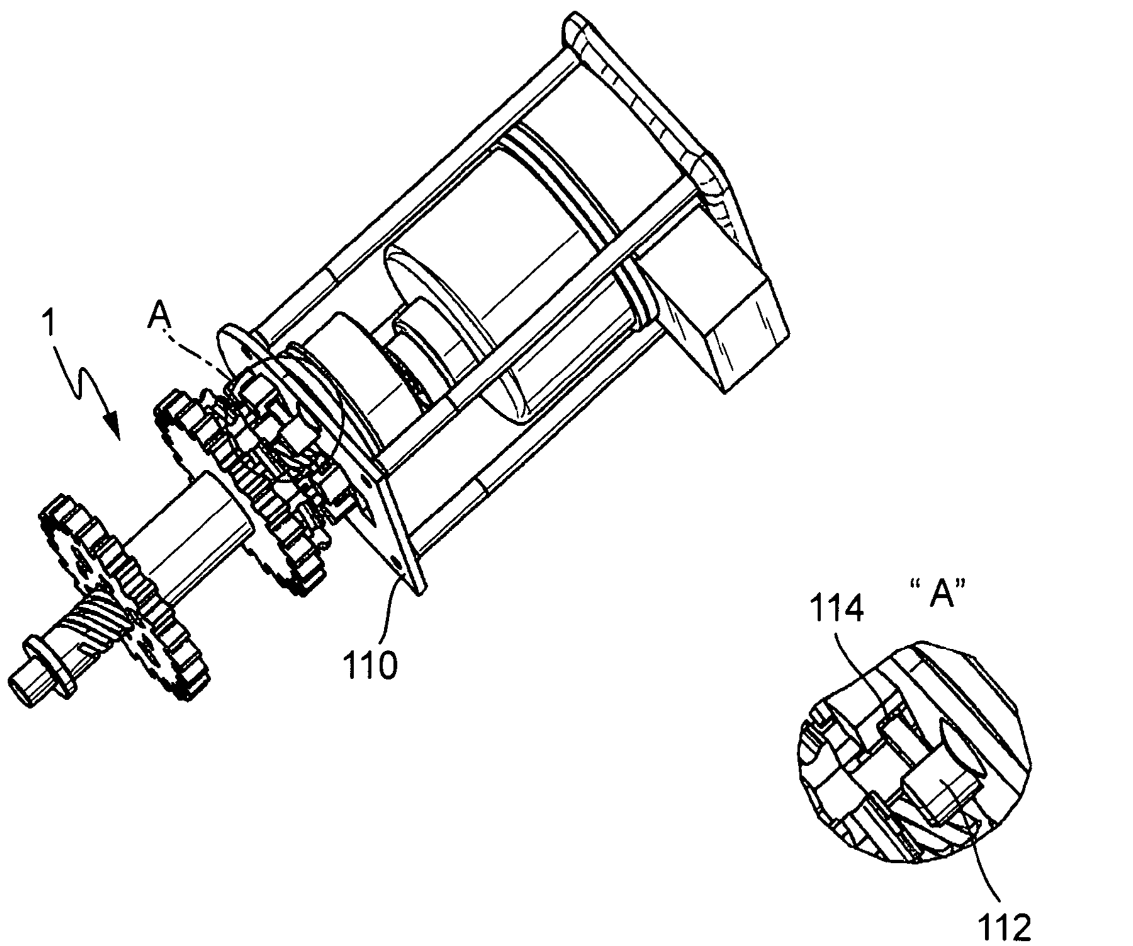


Fig. 10

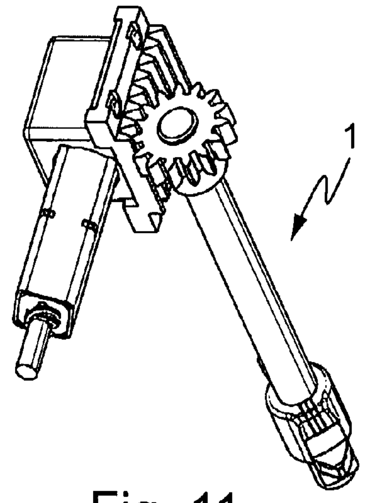


Fig. 11

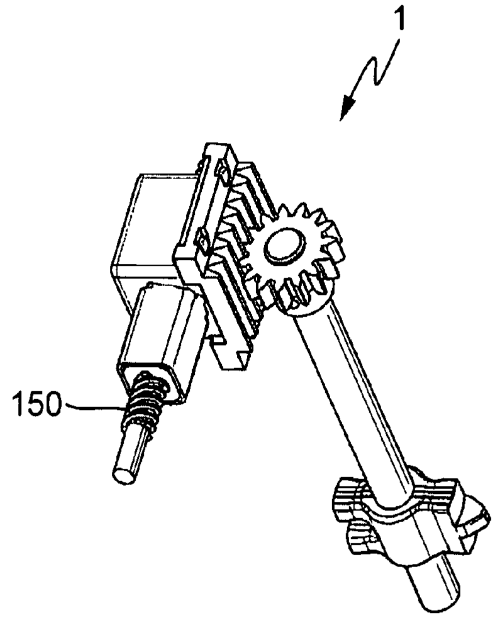


Fig. 12

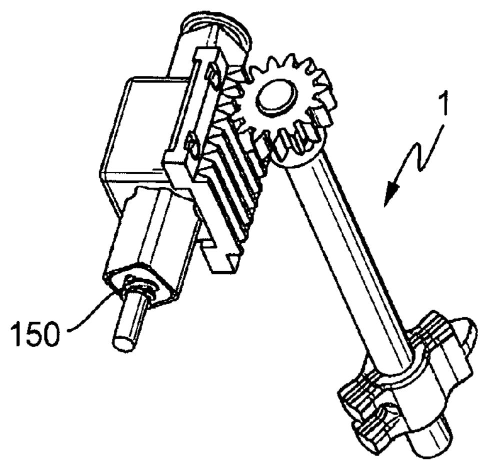


Fig. 13

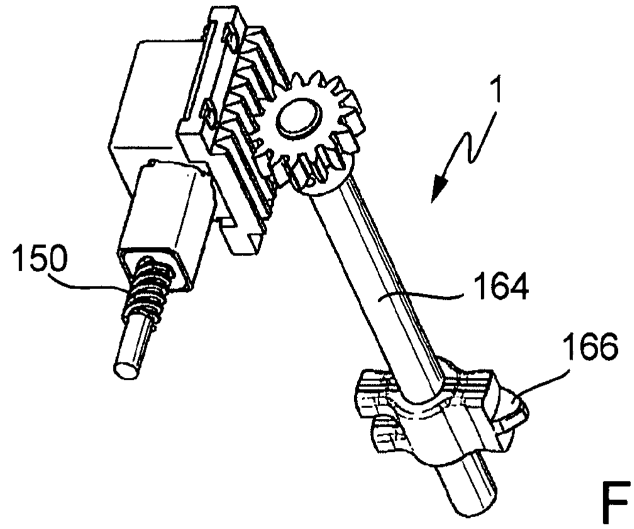


Fig. 14

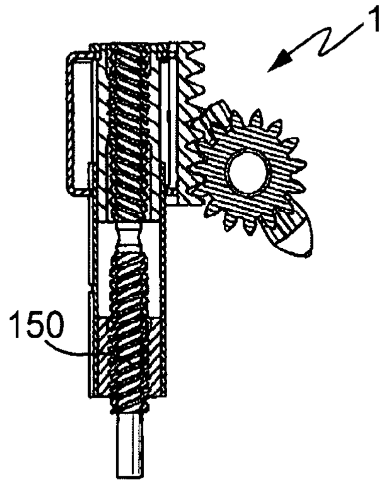


Fig. 15

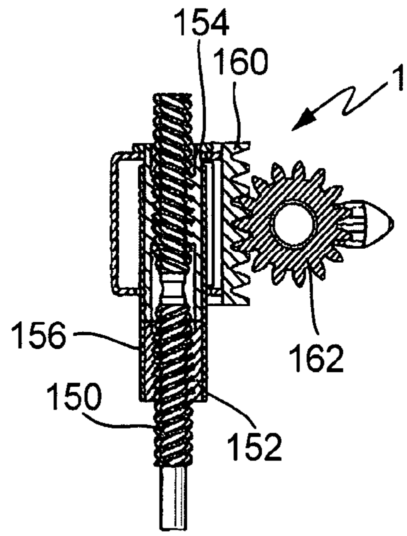


Fig. 16

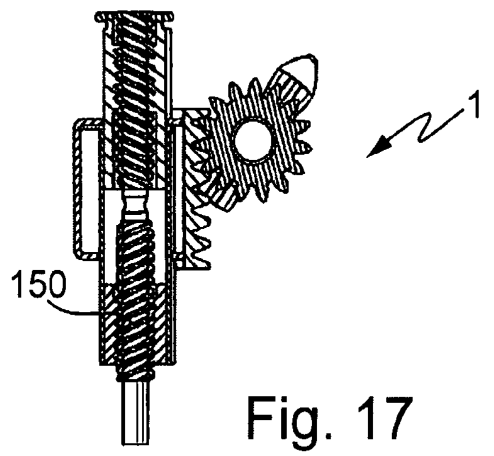


Fig. 17

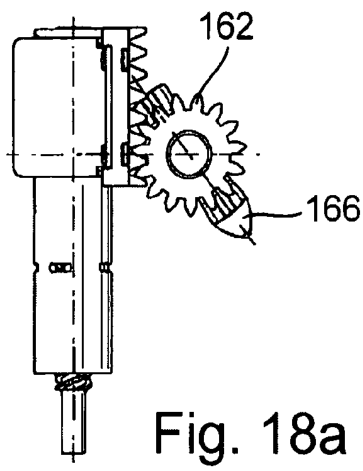


Fig. 18a

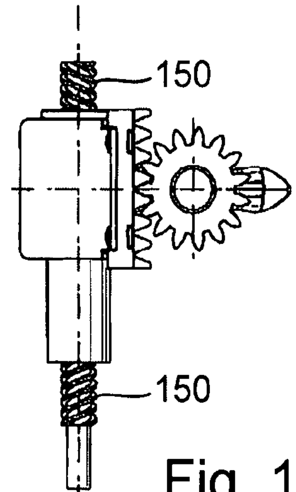


Fig. 19a

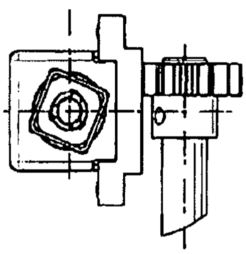


Fig. 18b

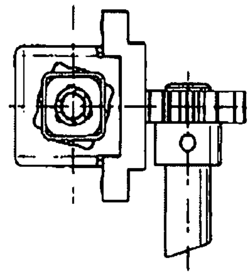


Fig. 19b

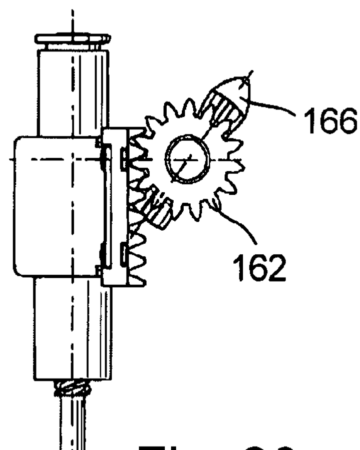


Fig. 20a

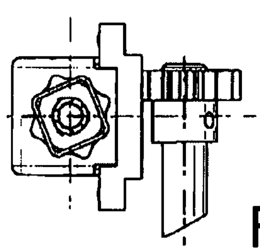


Fig. 20b

SINGLE MOTOR TRANSMISSION SHIFTING MECHANISM FOR A MOTOR VEHICLE TRANSMISSION

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Application No. 60/843,039, filed Sep. 8, 2006, which application is incorporated herein by reference.

FIELD OF THE INVENTION

The invention relates to a single motor shifting mechanism for a motor vehicle transmission.

BACKGROUND OF THE INVENTION

Conventional shifting mechanisms, through which shifting motions were accomplished through electric motors, were provided, so that an electric motor was provided for generating selection motions, and an electric motor was provided for generating shifting motions. Meanwhile, however, also transmission shifting mechanisms are known, which only have one, or exactly one, electric motor, through whose drive motions, actuating motions for selecting and also actuating motions for shifting gears can be caused. Transmission shifting mechanisms of the latter kind are also called single motor transmission shifting mechanisms, since they only have one or exactly one electric motor.

Embodiments of such single motor transmission shifting mechanisms are disclosed in unpublished U.S. Patent Application Nos. 60/750,538; 60/750,555; 60/750,571; 60/750,572; 60/750,554; 60/750,527; 60/750,526 and 60/750,688 of the applicant, all of which are incorporated herein by reference. Also DE 10 2004 038 955 A1 of the applicant discloses exemplary embodiments of a single motor transmission shifting mechanism.

As can be seen, in particular, also from the state of the art, known single motor transmission shifting mechanism are often, or typically provided, so that they are driven by a threaded spindle.

While in the known embodiments of single motor transmission shifting mechanisms, a threaded spindle is often used to generate a high torque, which is necessary for the shifting motion, the problem of low efficiency (approximately 70%) exists, which is mostly due to the arrangement and connection of the threaded spindle. This requires an electric motor or a servo motor in the known embodiments, which is sized, so that it compensates the torque losses.

From U.S. Patent Application No. 60/750,538 of the applicant, furthermore, a design is known, in which nuts and tubes are being used, wherein coupling ears are provided, to couple them in rotation, while an axial motion is allowed. It has become evident that in some cases these parts are difficult to manufacture and very expensive. With this background, an alternative design for the design is desirable, which is simpler in manufacture.

SUMMARY OF THE INVENTION

The object of the invention is to provide a single motor transmission shifting mechanism, which is reliable in operation, and simple to manufacture.

In the design according to the invention, it is provided, in particular, that it is formed as a gear driven design. According

to one embodiment, it is thus provided that the single motor transmission shifting mechanism has a threaded spindle, which, however, is used for switching between selecting and shifting, and therefore, the high friction losses in the area of the threaded spindle do not occur. Thus, in particular for shifting and laying out the gears, the principle that a nut or something similar is moved along a spindle is not employed. It is provided, in particular, that the greatest percentage of the motor torque is transmitted into the area of the output shaft, or the shifting shaft. This allows the use of smaller electric, or servo motors, or to generate a higher torque output with the same motor size.

The design can be provided, in particular, so that intermediate transmission gears are used, which are provided similar to those in a differential of rear wheel driven vehicles, or motor vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

Subsequently, exemplary embodiments, according to the invention, will be described with reference to the figures, whereby, however, the invention is not limited. It is shown in the several views of the drawings, wherein:

FIGS. **1-10** show a first exemplary single motor transmission shifting mechanism, according to the invention, in different schematic views; and,

FIGS. **11-20***b* show a second exemplary single motor transmission shifting mechanism in various schematic views.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a three-dimensional exploded view of an exemplary single motor transmission shifting mechanism **1**, or a single motor transmission shifting unit **1** in a schematic view. The single motor transmission shifting mechanism **1** consists of three modules **10**, **12**, **14**, or comprises three modules **10**, **12**, **14**. First module **10** of these three modules **10**, **12**, **14** is a select shift switching mechanism; a second one of the modules **10**, **12**, **14** is shifting mechanism **12**; third module **14** of these three modules **10**, **12**, **14** is gear selecting mechanism **14**. The single motor transmission shifting mechanism **1** furthermore comprises one, or exactly one electric motor **16**. Together with electric motor **16**, or exactly one electric motor **16**, the three components, or modules **10**, **12**, **14** for selecting and shifting gears in a transmission that is not shown, or in a motor vehicle transmission device, can be used.

FIG. **2** shows a three-dimensional exploded view of the exemplary transmission shifting mechanism, according to the invention, according to FIG. **1**, in which some of the components shown in FIG. **1** have been omitted, wherein in FIG. **2**, in particular, a perspective exploded view of selecting-shifting switching mechanism **10** is shown. This selecting-shifting switching mechanism **10** has reduction gear **18**, which engages non-rotatably with electric motor **16**, or its motor output shaft, and into threaded spindle **20**. Threaded spindle **20** can thus be driven through electric motor **16** via interconnected reduction gear **18**, selectively in one, or in the other direction of rotation. Threaded spindle **20** is supported through bearing **22**. Threaded spindle **20** has threaded section **24** and flange section **26**. Selecting-shifting switching mechanism **10**, furthermore, has two gears, in particular, tandem gears **28**, **30**. Furthermore, selecting-shifting mechanism **10** comprises connection tube **32**. Tandem gears **28**, **30** are each fixated to one end of connection tube **32**, which holds tandem gear assembly **34**. This is performed, in particular, so that first tandem gear **28** is disposed at the one axial end of connection tube **32**, and second tandem gear **30** is disposed at the other axial end of the connection tube. Connection tube **32** has an inner, or radially inner bolt shaped section, or threaded section, not shown in the figures, forming an opposite piece with respect to outer threaded section **34**, which is provided on threaded spindle **20**. This means that connection tube **32** is provided for thread engagement into threaded spindle **20**. Tandem gear assembly **34**, furthermore, comprises flange area **36**, which is provided adjacent, or axially adjacent to first tandem gear **28**, and a set of first axial protrusions **38** with rounded grooves, and a second set of axial protrusions with radial lobes or ears.

Second tandem gear **30** furthermore comprises a first row of first slots **46**, which are disposed with equidistant spacing around the central axis, and a second row of longitudinal second slots **50**, which are provided with an offset in rotation direction from the first row, and which are disposed with equidistant spacing around the axis. Mechanism **10**, furthermore, comprises switching unit **52** for shifting gears, which is mounted rotatably on threaded spindle **20**.

FIG. **3** shows a detail view of switching unit **52** for shifting. Switching unit **52** comprises two components, connected to each other in a solid manner, which are disposed, so that they can slide, or be moved over the cylindrical surface of threaded spindle **20**, wherein flange area **36** is captured in between. Switching unit **52** for switching operation furthermore comprises stepped axial protrusions **54**, which are sized so that they engage, or can engage into first slots **46**, and can engage into longitudinal second slots **50** of tandem gear **30**. This means that a stepped area of each axial protrusion **54** is sized for the engagement into first slots **46** in tandem gear **30**, and a second area of each axial protrusion **54** is sized for the engagement into second longitudinal slots in tandem gear **30**. When the stepped area engages into first slot **46** of second tandem gear **30**, an annular area of switching unit **118** is positioned at an elevation for shifting, which is remote from second tandem gear **50**, and thus corresponds to length L of the non stepped area of axial protrusion **54**, which is not shown in the figures. When axial protrusion **54** engages into second longitudinal slot **50** in second tandem gear **30**, the annular surface of switching unit **52** remains at second tandem gear **30** for the shifting. Furthermore, coil spring **56** is provided. Furthermore, housing **58** is provided. Coil spring **56** is disposed between housing **58** and switching unit **52** for shifting, and presses switching unit **52** against flange area **36** of threaded spindle **20** for shifting.

Mechanism **100** is assembled as follows:

The shifting unit for shifting is mounted above flange area **36** of threaded spindle **20**. In a certain sense, switching unit **52** has an indentation or a depression, and flange area **36** moves or slides within this indentation or depression, and remains at the bottom of this indentation or this depression.

Next, connection **32** of tandem gear assembly **34** is brought into threaded engagement with threaded spindle **20**, so that second tandem gear **30** is adjacent to slots **46** and longitudinal slots **50** to axial protrusions **54** of switching **52** unit for shifting. Selection gear **60** and bearing assembly **22** are positioned on threaded spindle **20**, before the reduction gear is brought into rotatable engagement with threaded spindle **20**. Coil spring **56** is mounted against switching unit **52** for shifting, before threaded spindle **20** is inserted into the housing.

FIG. **4** shows a perspective view of a section of single motor transmission shifting mechanism **1**, which is disposed in order to engage into a gear in circumferential direction.

FIG. **5** shows a perspective view of a section of the single motor transmission shifting mechanism **1**, which is disposed to engage into a gear in counter clockwise direction. Shifting mechanism **12** comprises intermediate bevel gears **62** and **64**, and shifting shaft **66**.

FIG. **6** shows a detailed view of intermediate bevel gear **64**. Each intermediate bevel gear **62** or **64** has a straight gear section and a beveled gear section. The straight gear section furthermore has a rim or a lip **68**, which is provided, e.g., for the avoidance of an axial movement of tandem gears **28**, **30**, when coupling with intermediary gears **62** or **64**. Intermediary gear **62** is provided for the engagement into first tandem gear **28**, and second intermediary gear **64** is provided for engagement into second tandem gear **30**. Lip or rim **68**, which extend around intermediary gears **64** further have access openings which are provided according to the axial offset and the radius of tandem wheels **28**, **30**. This means, that opening **70** allows tandem gears **28**, **30** to pass intermediary gears **62** or **64**, when tandem gear assembly **34** is moved axially with a rotation of threaded spindle **20**.

FIG. **7** shows an end view of switching unit **52** for shifting, which is engaged (here) into second intermediary gear **64**.

FIG. **7***a* shows a detail view of positioning device **72**. Switching unit **52** for shifting furthermore comprises teeth **74**. In particular, two teeth **74** are formed, so that a rotation of the engaging gear is avoided, when switching unit **52** for shifting is engaged with the engaging gear. This means that teeth **74**, which are provided at switching unit **52** for shifting, avoid a rotation of intermediary gear **64** during the selection cycle. The bevel gear section of bevel gear **62** or **64** is provided for engagement with bevel gear **76**, which is coupled non-rotatably with shifting shaft **66** for shifting and laying out transmission gears. In particular, it is provided that the rotation axis of bevel gear **76** is perpendicular to the rotation axes of gears **62**, **64**. Positioning device **72** has an annular section, which is rotatably mounted on shift shaft **66**, as well as axial protrusions, comprising shafts **80**, which are provided to provide intermediary gears **62** and **64** around axis **82** of shift shaft **66**. It can be provided that at least one of shafts **80** of positioning device **72** extends into housing **58**, in order to avoid a rotation of positioning device **72** around axis **82** of shift shaft **66**.

FIG. **8** shows a three-dimensional view of gear selection mechanism **14**. Selection mechanism **14** has selection gear **84**, elastic or resilient piece **86**, selection bolt gear **88**, eccentric (selection) drive bolt **90**, and selector fork **92**. Selector gear **84** has a gear section, a shoulder, an annular cutout or notched section (not shown), and axial lobes or ears **94**. The annular cutout or notched section of the selector gear **84** has cutouts or notches, which are provided for the coupling with the axial or radial ears or lobes **44** of the tandem gear **28**. Axial lobes or ears **94** have an outer cutout or notched section, which is provided for holding elastic or resilient part **86**. During the installation on axial lobes or ears **94**, the diameter of elastic or resilient part **86** increases. This means, the outer radius of the cutout or notch relative to central axle **96** is larger than the inner diameter of elastic or resilient piece **86** in its free state. Therefore, through the pressing force of elastic or resilient part **86**, elastic or resilient part **86** is held in the cutout or notched area of axial lobes or ears **94**. Selector gear **84** is rotatably connected with threaded spindle **20**, as it has been previously described. Selector gear **66** is axially positioned on threaded spindle **20** through the shoulder section, which is not shown.

Selector bolt gear **88** has a teethed section, and an assembly opening for a bolt, wherein the assembly opening is positioned in the annular surface of the teethed section. Eccentric selector drive bolt **90** is inserted into the assembly opening of selector bolt gear **88** for the bolt. The eccentric selector drive bolt is integral with selector bolt gear **88**. Selector bolt gear **88** is mounted non-rotatably on a shaft **98**, which is mounted to the housing, or supported in the housing, which is not shown in the figures. Eccentric selector drive bolt **90** is disposed in transversal slot **100** in selector fork **92**. Selector fork **92**, furthermore, comprises shift shaft connector fork **102** and eccentric bolt connecting arm **104**. In other words, shift shaft connecting fork **102** and eccentric bolt connecting arm **104** extend in parallel. Eccentric bolt connecting arm **104** is parallel to the annular surface of the teethed section of selector bolt gear **88**, and abuts to this annular surface. Through eccentric bolt connecting arm **104**, which abuts to selector bolt gear **88**, a rotation of selector fork **92** around axis **96** is avoided.

Shift shaft **66** has a bevel or bevel tooth section and a shoulder, which is not shown, and a cutout or notch, which is provided to receive a holding clip. The diameter of the opening in shift shaft connecting fork **104** of selector fork **92** is smaller than the bevel or bevel tooth section of shift shaft **66**. Therefore, a bottom surface of shift shaft connecting fork **102** abuts to the shoulder of shift shaft **66**. Holding clip **106** furthermore, positions selector fork **92** in an axial manner on shift shaft **66**, so that selector fork **92** is held between holding clip **106** and the shaft shoulder. Bevel gear **76** has a beveled teething, which is provided, to engage into the beveled teething section of shift shaft **66**. Gear **76** is axially positioned at the upper side, when the coupling with intermediary gears **62** and **64**, and at the bottom side of the housing, which is not shown. Beveled gear **76** is disposed on the bevel teething section of shift shaft **66**. Positioning device **72** is disposed on the upper side of bevel gear **76**.

The number of teeth on the gears, the number of ears or lobes, the number of slots, and the number of positions of the unidirectional freewheel clutch, which will be addressed in another section of this disclosure, are multiples of the number of axial positions, which are required for shift shaft **66**. It can be provided that shift shaft **66** requires four axial positions. Selector gear **84** thus has eight axial lobes or ears **94**. First tandem gear **28** thus has four axial lobes or ears **44**, eight axial protrusions **38** and 32 teeth. The second tandem gear thus has eight first slots **46**, eight longitudinal second slots **50** and 32 teeth. Intermediary gears **62** and **64** thus have **32** teeth on the respective straight tooth sections. Switching unit **52** for shifting thus has four axial protrusions **54**. The unidirectional freewheeling clutch, which is not shown, has eight positions in circumferential direction.

The single motor transmission shifting mechanism **1** allows a motion of shift shaft **66** in an axial direction and a rotation of shift shaft **66** for shifting and laying out a gear or of gears of the transmission, which is not shown. In order to adjust an axial position of the shift shaft, electric motor **16** turns in a first direction. The speed of the electric motor is reduced, and through the reduction gear the torque is proportionally increased before transmission to the threaded spindle, or transfer into threaded spindle **20**. Tandem gear assembly **34** is moved in a direction, where an approach to selector gear **84** is performed, through the engagement with threaded spindle **20**. While tandem gear assembly **34** approaches selector gear **84**, axial protrusions **54** of tandem gear **28** engage into the annular cutout or notched area of selector gear **84**. The outer set of axial protrusions **38** engages into the intermediary space between axial protrusions **94** of selector gear **84**, and resilient or elastic part **86**. Resilient or elastic part **86** radially expands during the installation of first tandem gear **28**, and then presses against the grooved surface of axial protrusions **38**. Therefore, it is avoided, that the first tandem gear disengages from selector gear **84**, without elastic or resilient piece **86** being removed from the grooved surface of axial protrusions **38**, whereby a shock free or soft engagement between tandem gear assembly **34** and selector gear **84** is assured.

As soon as tandem gear assembly **34** is completely positioned or located in selector gear **84**, tandem gear **28** cannot move axially along threaded spindle **20** anymore, and tandem gear assembly **34** starts to rotate with threaded spindle **20**. The axial motion of tandem gear assembly **34** is sufficient to avoid that tandem gears **28** and **30** engage with intermediary gears **62** or **64**, wherein a rotation of tandem gear **28** is enabled. The rotation of tandem gear **28** is transferred to selector gear **88**. Under certain conditions tandem gear **28** rotates selector gear **84** through the engagement between ears or lobes **44**, and the not shown indentations or notches. According to another aspect, tandem gear **28** rotates selector gear **84** through the engagement between protrusions **38** and axial lobes or ears **94**. Selector gear **84** rotates bolt gear **88** through a teeth engagement. When selector bolt gear **88** rotates, eccentric selector drive bolt **90** rotates. A rotation of selector drive bolt **90** is transmitted through the combination of laterally extending slot **100** and the restricted motion of shift shaft **66** in the housing (not shown) into an axial motion. This means that a rotation of the eccentric selector drive bolt moves the shift shaft in an axial manner. Through controlling the number of rotations of electric motor **16** (or its motor shaft), a suitable axial position of shift shaft **66** can be adjusted. A slight rotation of the electric motor or its shaft in a second rotation brings a unidirectional freewheeling clutch into engagement, which is provided to position selector gear **84** with higher precision relative to the housing, which is not shown. An improved position of selector gear **84** is transferred into an axial position of the shift shaft through selector bolt gear **88**, wherein a precise axial position of shift shaft **66** is assured.

As soon as the not shown unidirectional freewheeling clutch is engaged through selector gear **84**, an additional rotation of selector gear **84** and tandem gear assembly **34** is avoided, wherein tandem gear assembly **84** is caused to move axially along threaded spindle **20**, when motor **16**, or its motor shaft rotate in a second direction. The axial force acting upon tandem gear **108** releases or removes elastic or resilient part **86**, wherein tandem gear assembly **34** is enabled to move axially in the direction of switching unit **52** for shifting operations. The rotation position of tandem gear assembly **34** is maintained through the engagement with selector gear **84** and intermediary gears **62** and **64**. This means that when tandem gear assembly **34** begins to axially move along threaded spindle **20**, tandem gear **28** is in rotation contact with selector gear **84**, which, on the other hand, is positioned in rotation direction through the unidirectional freewheeling clutch, which is not shown. Before tandem gear **28** is decoupled in rotation from selector gear **84**, the teeth of tandem gear **28** engage into intermediary gear **62**. Intermediary gear **62** is positioned in rotation through the engagement of teeth **74** on shift unit **52** for shifting with intermediary gear **64**, which is coupled in rotation with intermediary gear **62** through bevel gear **76**. When tandem gear assembly **34** moves further along threaded spindle **20**, the teeth of tandem gear **30** engage with intermediary gear **64**, which, as described at another location in this patent, is positioned in rotation through switching unit **52** for shifting operation, before tandem gear **28** disengages from intermediary gear **62**. Therefore, the rotation position of tandem gear assembly **34** is controlled during its entire axial motion along threaded spindle **20**.

When tandem gear **30** approaches switching unit **52** for shifting operation, axial protrusions **54** of switching unit **52** for shifting operation engage into slots **46** or **50** of tandem gear **30**. It depends on the rotation position of tandem gear **30**, if protrusions **54** engage into slots **46** or **50**. This means that slot **46** corresponds to a first rotation position of second tandem gear **30**, or is associated with it, and second slot **50** corresponds to a second rotation position of second tandem gear **30**, or is associated with it.

When protrusions **54** engage into first slots **46**, the shoulders of protrusions **54** are located along threaded spindle **20** at the annular surface of tandem gear **30**, during the further motion of tandem gear assembly **34**. In a continued motion, or during continued migration, spring **56** is compressed, until switching unit **52** for shifting operation contacts shoulder **24** on threaded spindle **20**, wherein a further migration of tandem gear assembly **34** along threaded spindle **20** is avoided. In this position, teeth **74** on switching unit **52** for shifting operation are disengaged from intermediary gear **64**, and tandem gear **28** engages into intermediary gear **62**. This position is shown in FIG. **4**. A continued rotation of threaded spindle **20** causes a rotation of tandem gear **28**, and intermediary gear **62**. A rotation of intermediary gear **62** is transmitted into shift shaft **66** or transferred to shift shaft **66** through bevel gear **76**. Therefore, shift shaft **66** is rotated in a first direction, in order to shift a gear, or lay a gear out in the transmission.

When protrusions **54** engage into second slots **50**, the shoulders of protrusions **54** run through second slots **50**, and the annular surface of switching gear unit **52** for shifting operation abuts to the annular surface of tandem gear assembly **30**, during a further migration of tandem gear assembly **34** along threaded spindle **20**. During continued migration, spring **56** is compressed, until switching unit **52** for shifting operations contacts shoulder **24** on threaded spindle **20**, whereby an additional migration of the tandem gear assembly along threaded spindle **20** is avoided. In this position, the teeth on switching unit **52** for shifting operation are disengaged from intermediary gear **64**, and tandem gear **30** engages with intermediary gear **64**. FIG. **5** shows this position. A continued rotation of threaded spindle **20** causes a rotation of tandem gear **30** and intermediary gear **64**. A rotation of intermediary gear **64** is transferred to shift shaft **66** through bevel gear **76**. Therefore, the shift shaft is rotated in a second direction for shifting or outlaying a gear or gears in the transmission.

FIG. **9** shows an end view of the tandem gear **30**, and intermediary gear **64**.

FIG. **9***a* shows a detail view of cutout or locator feature **108** of intermediary gear **64**. During a rotation of intermediary gears **62** and **64** through tandem gears **28** or **30**, lips or rim **68** avoid an axial migration of tandem gear assembly **34** along threaded spindle **20**.

During shifting and outlaying a gear in the transmission, the direction of rotation of motor **16** is reversed. An axial migration of the tandem gear assembly through the lip or the rim is avoided, until cutout area **108** is aligned, in order to allow tandem gear **28** or **30**, to disengage from tandem gear **62** or **64**. The cut-out, or locator feature **70** of intermediary gear **64** avoids a further rotation of tandem gear **30** and intermediary gear **64**, wherein cutout or notch **70** is aligned with tandem gear **30**. During a respective alignment, spring **56** presses switching unit **52** for shifting operation axially against flange **26** of threaded spindle **20**. An axial motion of switching unit **52** for shifting operation engages teeth **74** with intermediary gear **64** again, as shown in FIG. **7**. Therefore, a rotation of switching unit **52** for shifting operation and of intermediary gear **64** is avoided, wherein, on the other hand, a rotation of bevel gear **76**, intermediary gear **62**, and tandem gear assembly **74** is avoided, until tandem gear **28** is disengaged from intermediary gear **62**, as described also at another location of this disclosure.

FIG. **10** shows a detail view of gate, or gate feature **110**. The single motor transmission shifting mechanism furthermore comprises gate feature **110**, in order to assure a correct position of the electric motor, or of the motor shaft of the electric motor. Gate feature **110**, or gate **110** has protrusions **112**. Tandem gear assembly **34** can rotate freely in cut-outs **114** of the gate feature, or gate **110**, when it has the correct position or the correct fit relative to gate feature or gate **110**. Protrusions **44** of tandem gear **28** contact protrusions **112** of gate feature, or gate **110**, wherein a migration of tandem gear assembly **34** along the threaded spindle, and away from gate feature **110** is avoided, when the rotation position of the tandem gear assembly is not correct, this means, in particular, during the engagement of the unidirectional freewheeling clutch. When the position of freewheeling clutch **28** is corrected, protrusions **44** are clear, or disengaged from protrusions **112**, and the tandem gear assembly is free to migrate along threaded spindle **20**, or can migrate along threaded spindle **20**.

It is appreciated that exemplary single motor transmission shifting mechanism **1** according to the invention, which was described with reference to the FIGS. **1** through **10**, is provided, in particular, so that it works with a relatively small electric motor. Thereby, it is provided, in particular, that threaded spindle **20** is preferably only used to switch back and forth between "shifting mode" and "selector mode", so that, in particular, during shifting operations and thereby, contrary to the state of the art, almost no friction losses or reduced friction losses occur at the threaded spindle. Therefore, it is accomplished in this embodiment that the major part of the engine torque of electric motor **16** can be transferred to the output shaft through the shifting shaft. Hereby, it is accomplished that a smaller servo motor, or a smaller electric motor can be used, or a respective higher output torque can be generated with the same engine size, compared to the state of the art.

With reference to the FIGS. **11** through **20***b*, subsequently an additional exemplary single motor transmission shifting mechanism **1** shall be described, which is schematically partially illustrated in these FIGS. **11-20***b* in an exemplary manner. In the design according to the FIGS. **11-20***b*, in particular, a mechanism is emphasized, which relates to the shifting motion for a single motor transmission shifting mechanism **1**. This design can be combined, or combinable with any method or any design to generate a selecting motion.

The design of single motor transmission shifting mechanism **1**, shown in the FIGS. **11-20***b*, has a ball screw with two opposite threads, or threaded spindle **150**, which can move two nuts **152** and **154** in opposite directions through a rotating motion. Nuts **152**, **154** are provided as tubes reaching into each other, and sliding in each other, e.g., with rectangular or square or pentagonal cross section. The nut can, e.g., have such a shape as, e.g., nut **154**, or it can be integrated in another part, as, e.g., tube **156**. Each nut **2**, **4** or each tube **3** has grooves **158**, using the corners, in order to contact gear rack **160**, in order to generate the necessary motion in both directions through sprocket **162**, shaft **164** and shift finger or shift lever **166**. These grooves **158** also have to allow a rotation of nuts **152**, **154** within gear rack **160**.

The shape of nuts **152**, **154**, or of the tubes depends on the number of rotation positions, which is required for the shifting motion. Four shifting positions require, e.g., a rectangular or square shape (360°/4=90° symmetry), while five positions would require a pentagonal shape (360°/5=72° symmetry). This can be varied according to the requirements, and does not have to maintain a constant space.

Cutout (gate) **168** can, e.g., be provided or required on both sides of the gear rack, so that nuts **152**, **154** slide through it and so that they can rotate. In order to generate a motion in both directions, it is provided in an advantageous embodiment that these gates are disposed at an angular offset relative to each other, like, e.g., by half of the angular rotation between the gates. Hereby, it can be assured, that always when a gate is aligned with nut **152** or **154**, corners **170** are held at opposite gates in groove **158**, wherein gear rack **160**, and nut **154** or **152** are held together, in order to move gear rack **160** in a respective direction. Through providing the offset of the gates in the said manner, it is accomplished that the direction of the motion of gear rack **160** is changed at any other location.

During operation, spindle **150** is rotated or driven to rotate through an electric motor, or through a respective drive unit. In the one rotating direction, nuts **152**, **154** join, and can then not move anymore along spindle **150**, in particular, they block each other, so that therefore the entire unit rotates. This is also known as selection motion and allows nuts **152**, **154**, or the respective selection mechanism to be positioned in a desired position. In the selected position, the direction of rotation of the electric motor, or of the motor shaft of this electric motor is reserved, wherein an unidirectional freewheeling clutch engages, avoiding a rotation in the selection direction. Since the **152**, **154** cannot rotate any further, they move along spindle **150** and away from each other, wherein engaging nut **152** or **154**, or nut **152** or **154** engaging gear rack **160**, move this gear rack **160**, which in turn then moves the sprocket, the shaft and the shifting lever. The motion in this direction is then also called shifting motion.

DESIGNATIONS

1 single motor transmission shifting mechanism
10 selector/shifter switching mechanism
12 shifting mechanism
14 gear selector mechanism
16 electric motor
18 reduction gear
20 threaded spindle
22 support assembly for **20**
24 threaded section of **20**
26 flange section of **20**
28 first tandem gear
30 second tandem gear
32 connection tube
34 tandem gear assembly
36 flange section of **34**
38 first axial protrusion of **34**
44 axial or radial lobe or axial or radial ear
46 first slot
50 second slot
52 switching unit for shifting
54 stepped axial protrusion of **52**
56 coil spring
58 housing
60 selector gear
62 intermediary bevel gear
64 intermediary bevel gear
66 shifting shaft
68 lip or rim of **202** or **204**
70 cutout or notch of **68**, location feature
72 positioning device
74 tooth of **52**
76 bevel gear
78 annular section of **72**
80 shaft of **72**
82 axle
84 selector gear
86 elastic or resilient part
88 selector bolt gear
90 eccentric selector drive bolt
92 selector fork
94 axial lobe or axial ears
96 central axis
98 shaft
100 transversal slot in **92**
102 shifting shaft connector fork
104 eccentric bolt connector arm
106 holding clip
108 location feature, cutout
110 gate, gate feature
112 protrusion of **110**
114 cutout
150 threaded spindle
2 152 nut
4 154 nut
3 156 tube
10 158 nut
5 160 gear rack
6 162 sprocket
8 164 shaft
9 166 shifting shaft (shifting finger)
11 168 cutout, gate
12 170 corner

What is claimed is:

1. A single motor transmission shifting mechanism comprising:

exactly one electric motor (**16**) for generating drive motions for selecting and for generating drive motions for shifting gears of a motor vehicle transmission device;

a threaded spindle for switching from a mode in which selection motions can be effectuated, into a mode in which shifting motions can be effectuated; and,

a shifting shaft, which can be moved in axial direction for selecting, and which can be rotated around its longitudinal axis for shifting;

wherein all components, transferring the drive load for shifting from the electric motor to the shifting shaft during shifting operation, maintain their axial position relative to the longitudinal axis of the threaded spindle during this shifting operation.

2. The single motor transmission shifting mechanism recited in claim **1**, wherein a connection tube (**32**) with a thread is provided, engaging with its thread into the thread of the threaded spindle, and coupled with two gears (**108**, **110**) in a solid manner.

3. The single motor transmission shifting mechanism recited in claim **2**, wherein the relative axial position of the connection tube (**32**), seen in the direction of the longitudinal axis of the threaded spindle (**20**), can be changed relative to the threaded spindle (**20**) through a rotation of the threaded spindle (**20**), driven by the electric motor (**16**).

4. The single motor transmission shifting mechanism recited in claim **3**, wherein a holding mechanism is provided, through which the axial relative position of the connection tube (**32**), seen in the direction of the longitudinal axis of the threaded spindle (**20**), relative to the threaded spindle (**20**), is maintained during a pivoting motion of the shifting shaft (**66**), around the longitudinal axis of this shifting shaft (**66**), driven by the electric motor (**16**), for shifting a gear.

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