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Di Martino

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(54) **DEVICE FOR SYNCHRONIZATION AND ENGAGEMENT OF A GEAR TRANSMISSION OF A MOTOR VEHICLE**

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F16H 3/38 (2006.01)
F16D 11/00 (2006.01)

(52) **U.S. Cl.** **74/339**; 192/53.35

(58) **Field of Classification Search** 74/339, 74/333, 473.36; 192/53.35
See application file for complete search history.

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(57) **ABSTRACT**

A synchronization and engagement device for a gear transmission of a motor vehicle is provided with: a cylindrical hollow portion, which is fixed and coaxial with respect to a shaft of the gear transmission; a toothed driving ring, fixed to an idle or neutral gear of the gear transmission; a first conical friction surface, carried by one between the driving ring and the gear; a floating toothed synchronizing ring, which has a second conical friction surface mating with the first conical surface; and at least one engagement member, which is angularly fixed with respect to the cylindrical hollow portion, is able to slide axially under the action of a control device, and has a cylindrical toothing, designed to render the cylindrical hollow portion angularly fixed with respect to the driving ring. The engagement member is located in a radial position that is more internal with respect to the conical friction surfaces, whilst the cylindrical toothing of the engagement member is an external toothing.

21 Claims, 8 Drawing Sheets

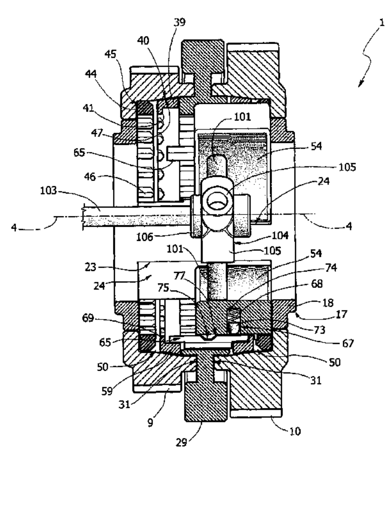

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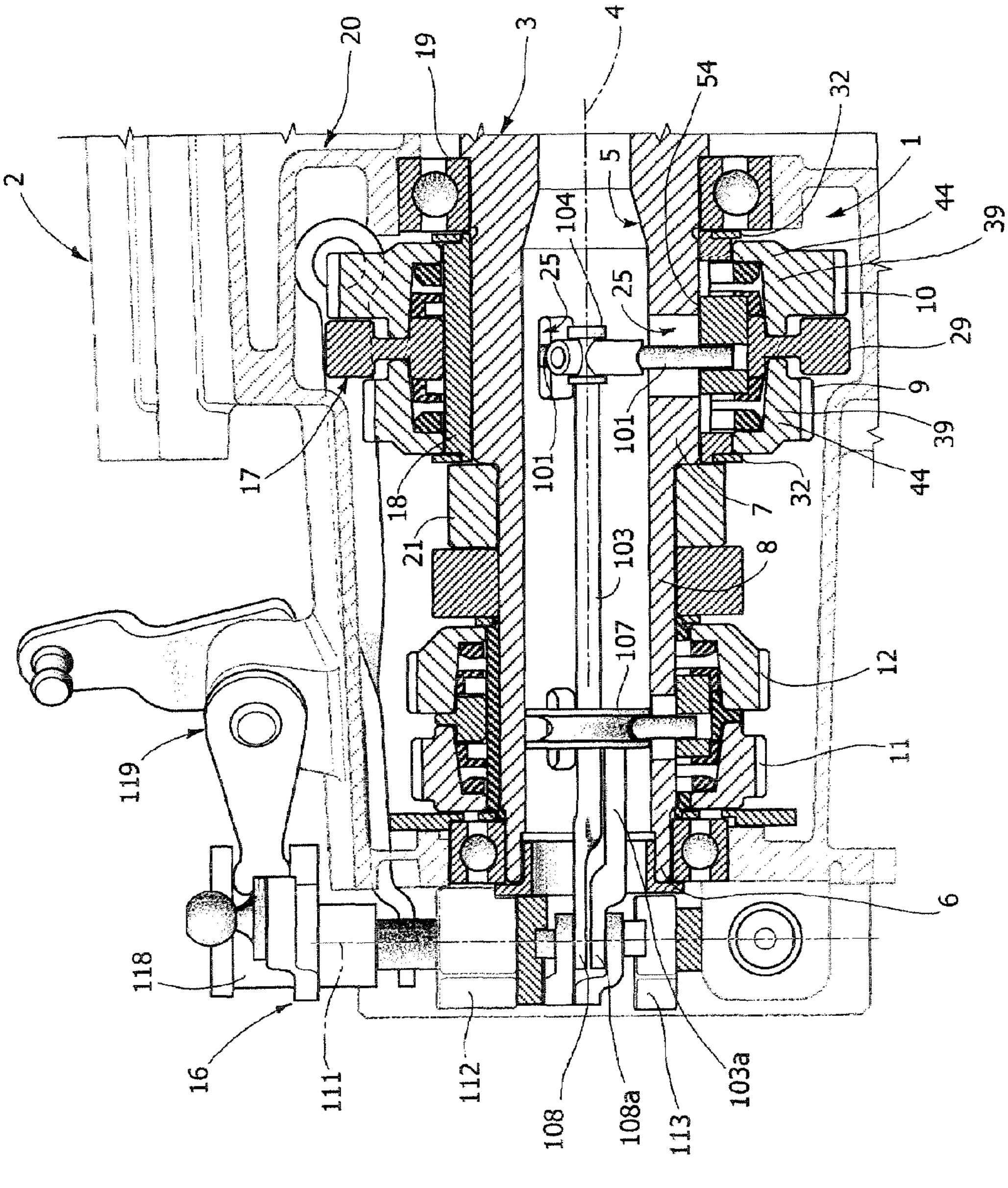
FIG. 1


2
20
19
3
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104
5
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25
10
29
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17
101
101
44
32
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103
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107
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119
11
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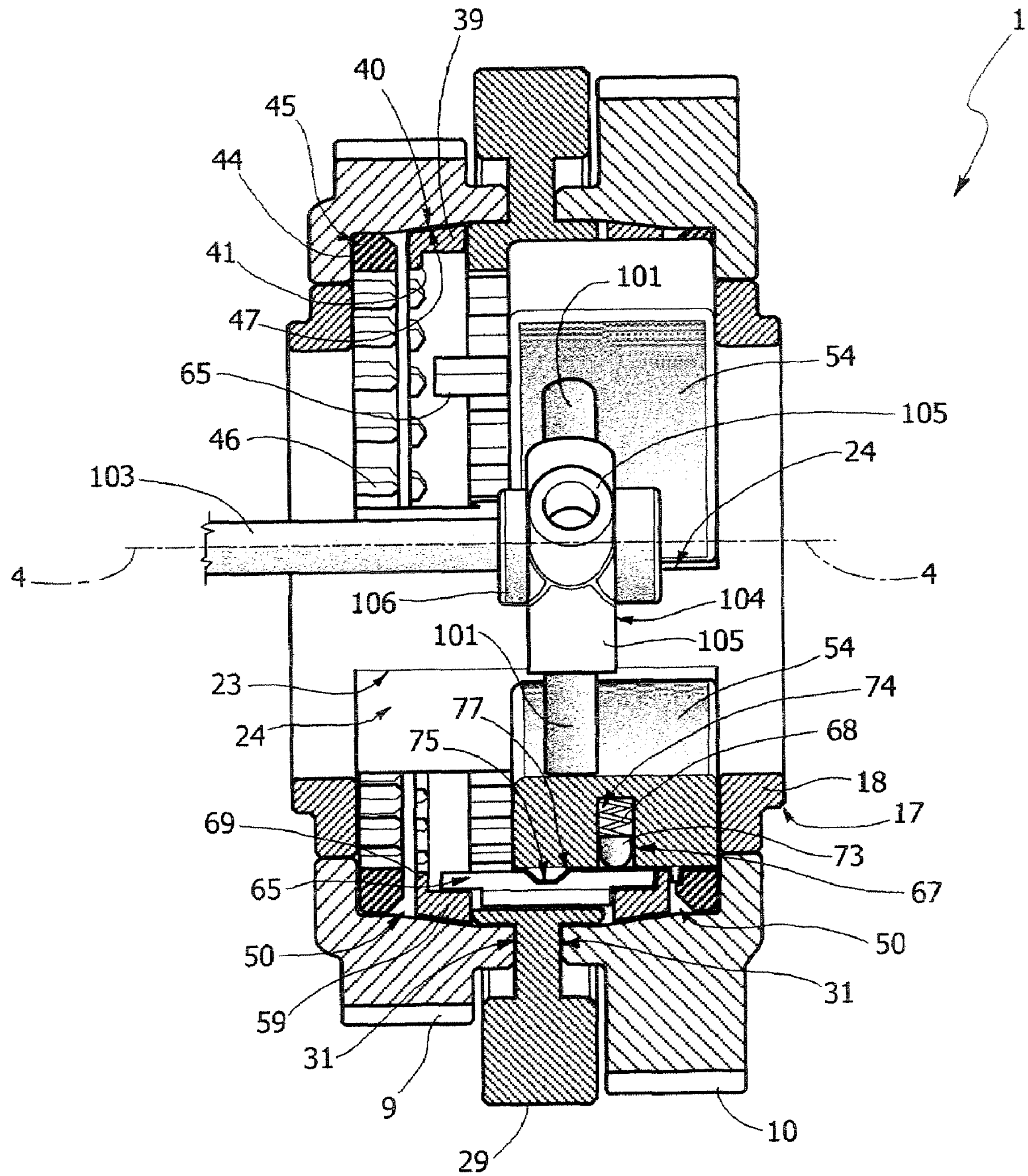
16
111
112
108
108a
113
103a

FIG. 2



1
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44
41
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65
46
103
4
101
54
105
24
4
106
104
101
105
54
23
24
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75
74
68
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73
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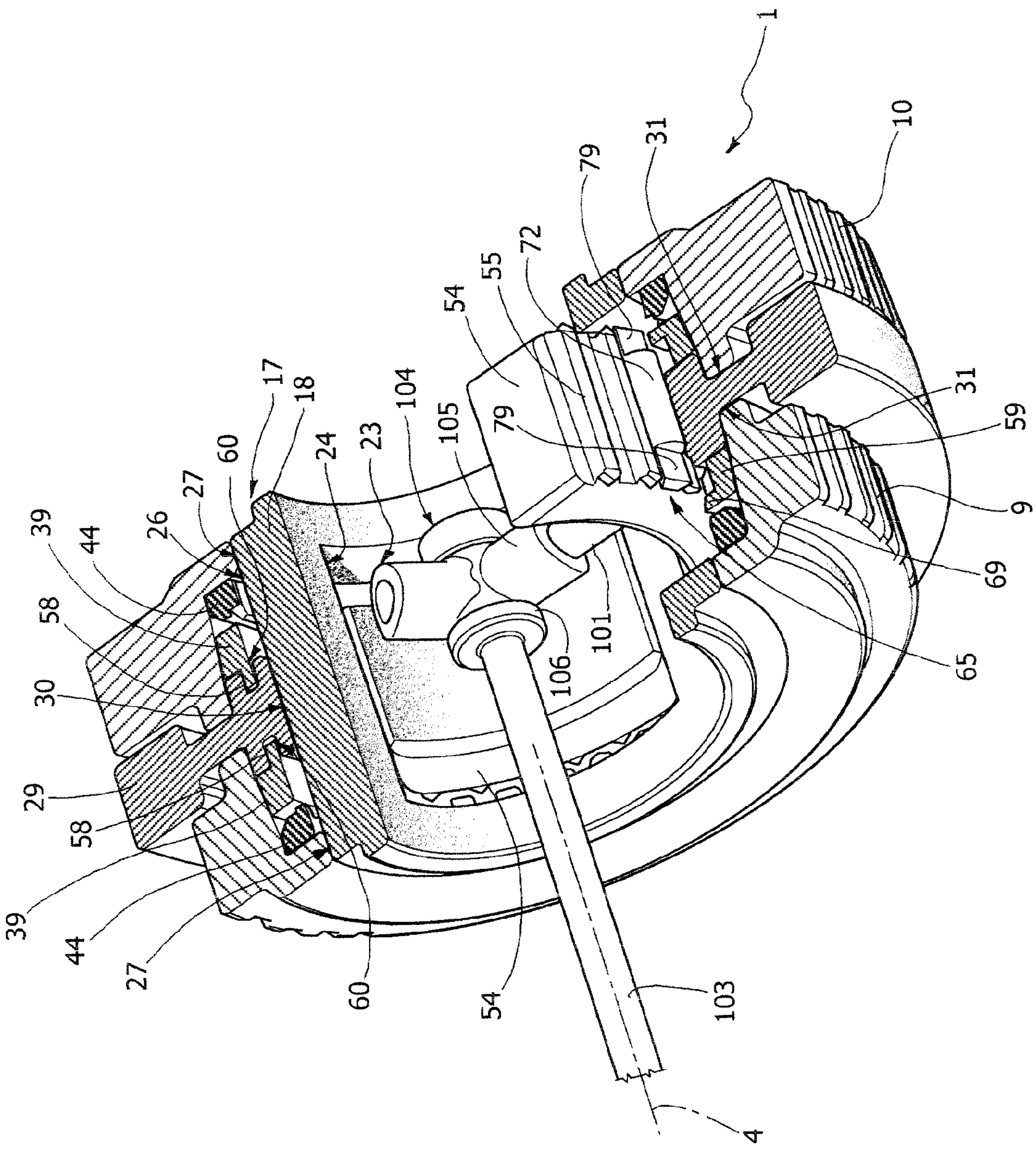
29
10

FIG. 3


1
10
79
31
72
55
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104
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54
106
101
69
65
103
4

FIG. 4

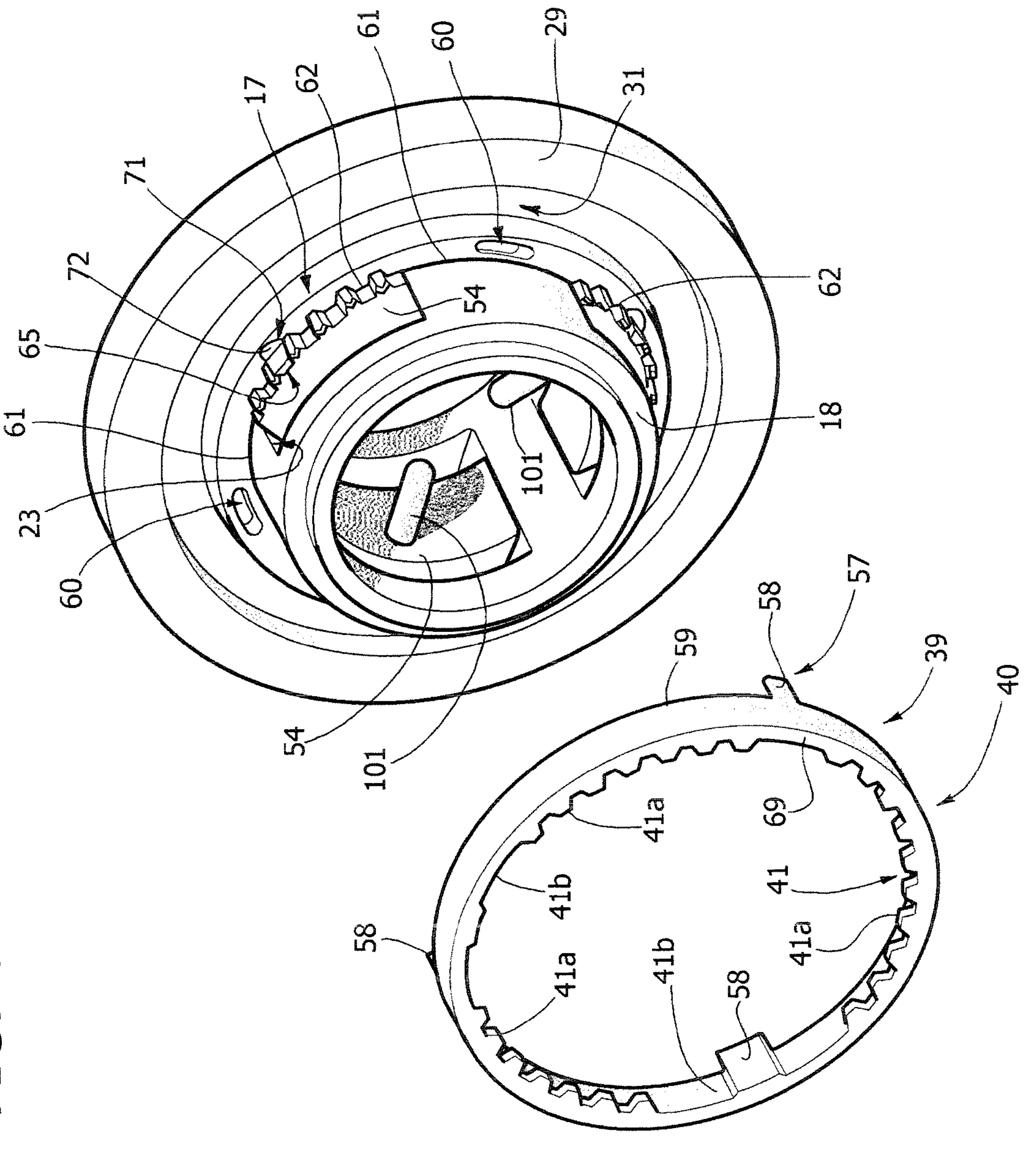
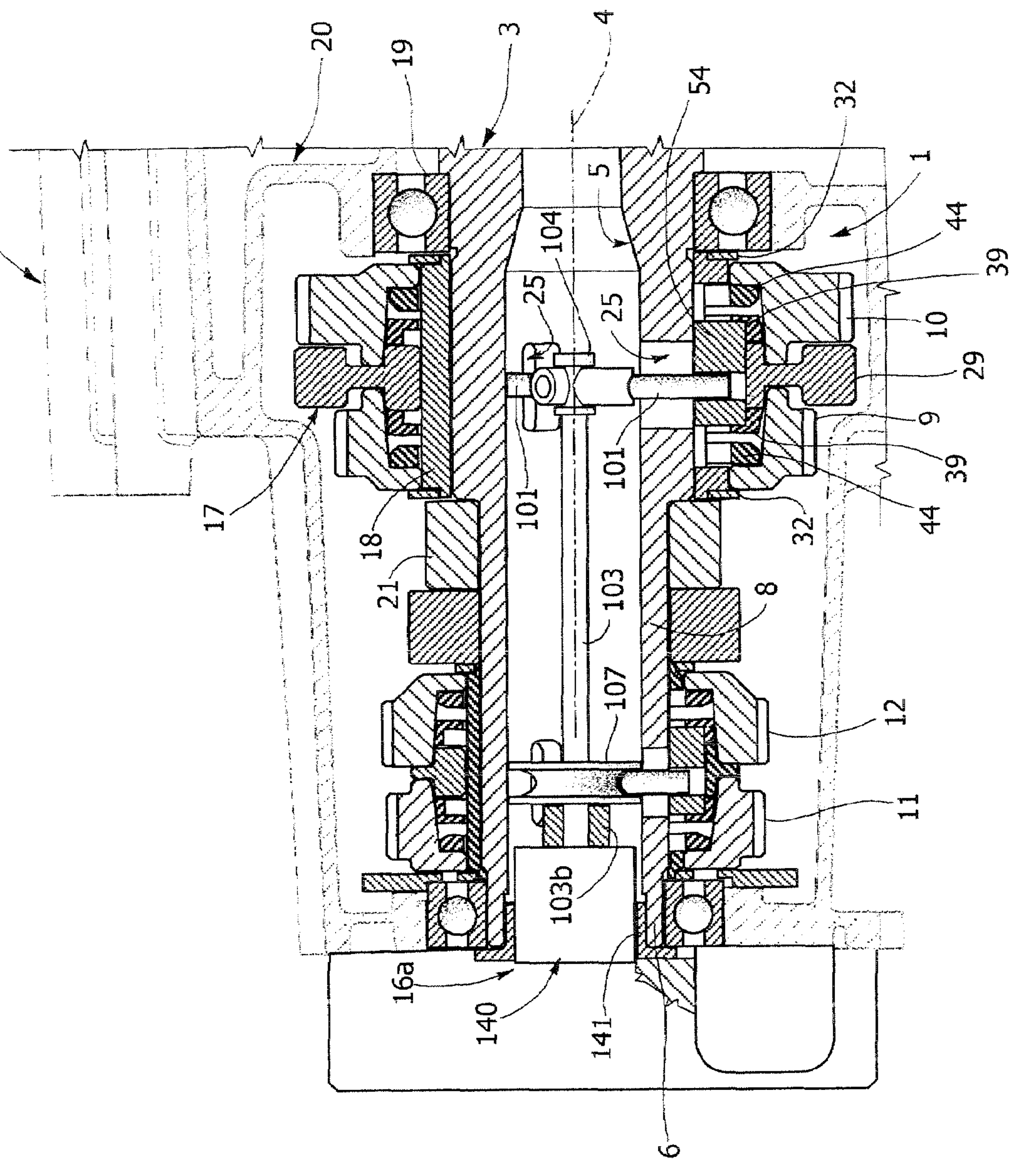


FIG. 5



2
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17
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101
101
32
21
103
8
107
12
11
103b
16a
140
141
6

FIG. 6

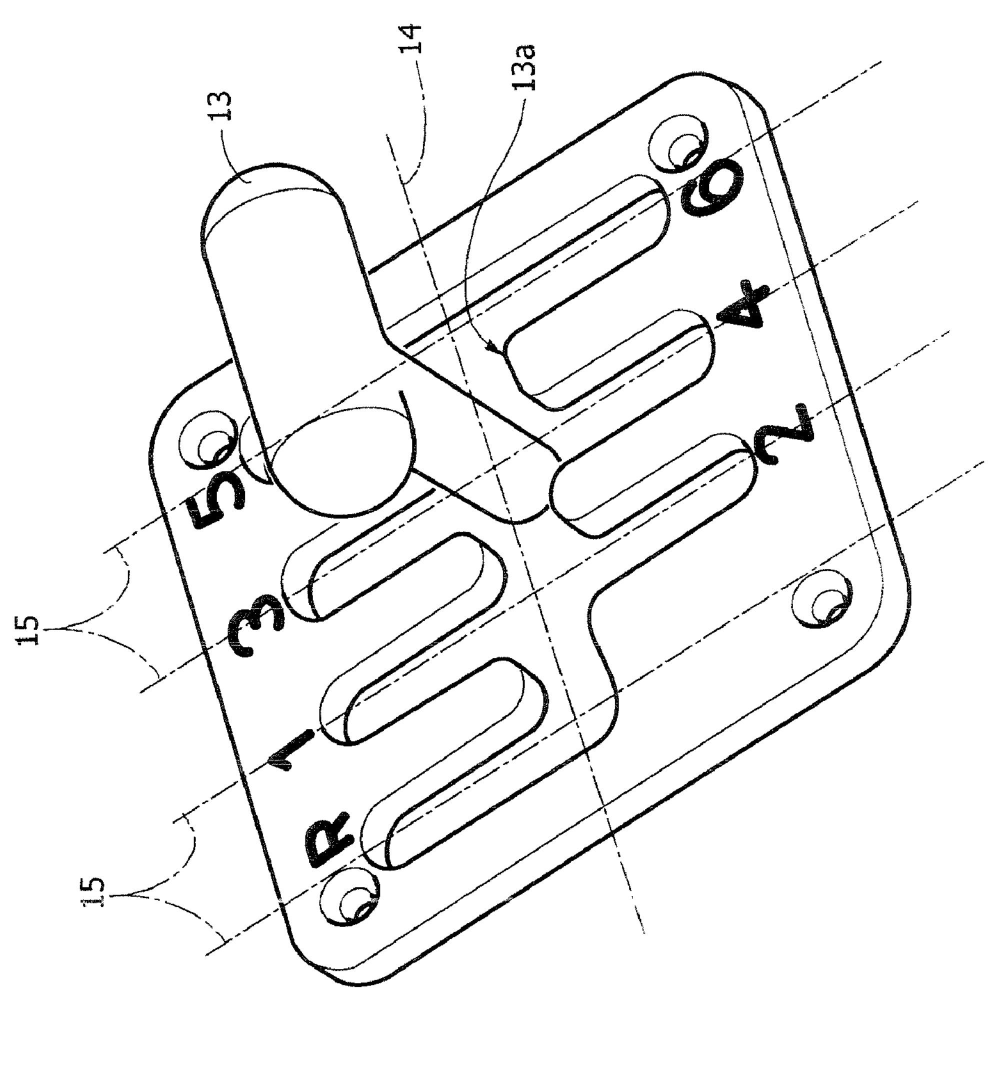
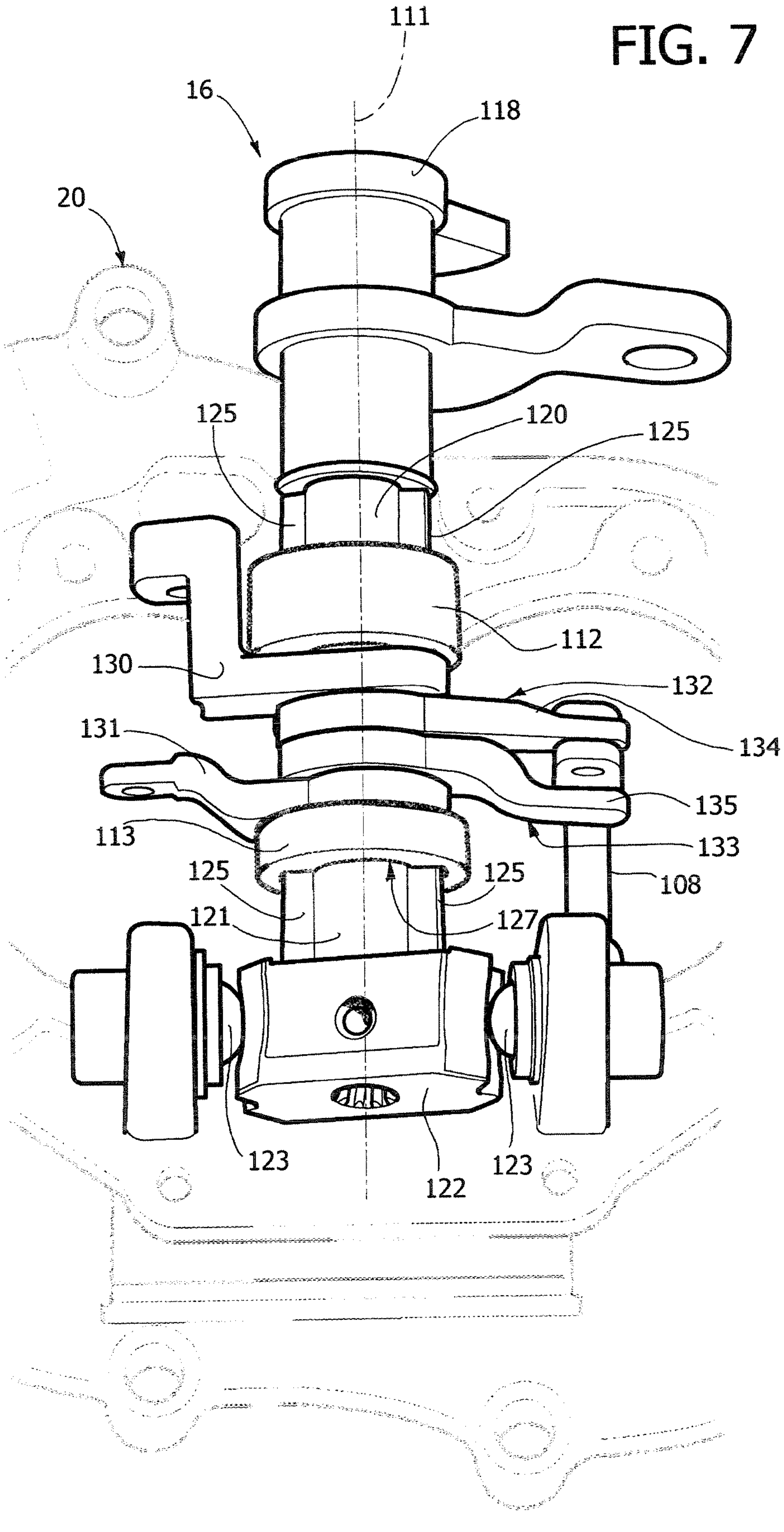


FIG. 7


111
16
118
20
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120
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112
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132
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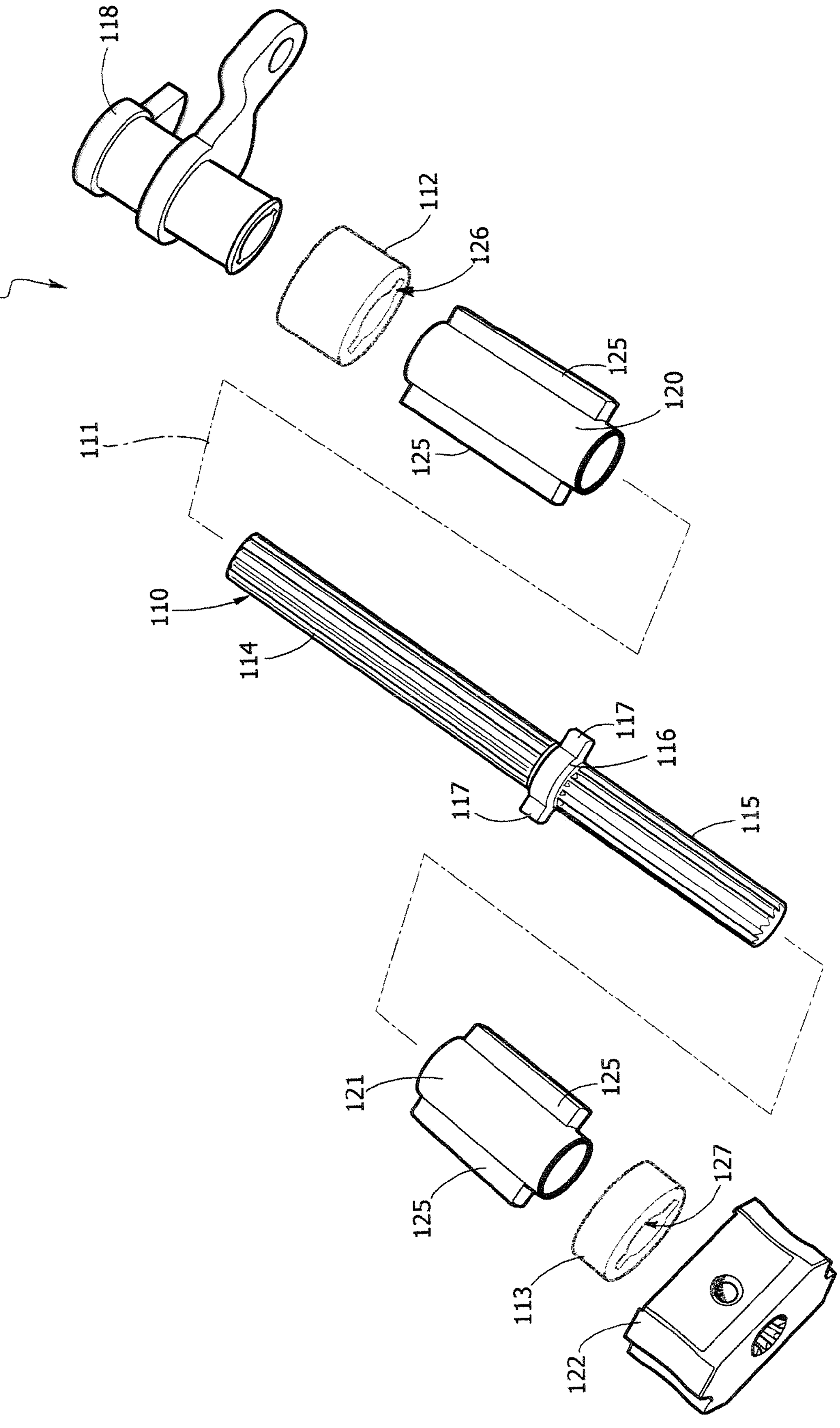
125
108
121
127
123
123
122


16
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112
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127
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122

FIG. 8

DEVICE FOR SYNCHRONIZATION AND ENGAGEMENT OF A GEAR TRANSMISSION OF A MOTOR VEHICLE

TECHNICAL FIELD

The present invention relates to a synchronizing device for a gear transmission of a motor vehicle.

BACKGROUND ART

As is known, the configurations of an automobile gear transmission are characterized by rather consolidated schemes, which envisage use of: a primary shaft, on which the driving gears are fitted, either idle or fixed; a secondary shaft, on which the driven gears are fitted, again either idle or fixed; a mechanism for synchronization and engagement between the idle gears and the shaft on which these are fitted; a pair of gears for final reduction of the transmission ratio at output from the secondary shaft; and, finally, a differential, which supplies the final output of the motion to two axle shafts.

The above arrangement is accompanied by a control device, which constitutes an interface between the driver and the synchronization and engagement mechanism. In particular, the transmission ratios or gears are engaged selectively by operating a gear lever in the passenger compartment. Said lever actuates a finger-shaped control member, which in turn actuates a series of gearshift forks, which are movable in a direction parallel to the axes of the primary and secondary shafts. The gearshift forks are arranged on the outside of said shafts, correspond to respective ranges of the gears (for example, the range of the first and second gears, the range of the third and fourth gears, and the range of the fifth and reverse gears), and are associated to respective parallel control seats facing one another, engaged by the finger member. The finger member is movable along a selection path that freely traverses the control seats for selecting one of said control seats and, hence, a range of the gears (first and second, or else third and fourth, or else fifth and reverse) and along an engagement path parallel to the planes of lie of the control seats for displacing the seat selected and engaging one of the two gears of the corresponding range, said finger member shifting in opposite directions starting from a central position, to which there corresponds an idle or "neutral" condition. In general, one of the two paths of the finger member is rectilinear, whilst the other is defined by a rotation.

In known solutions, each gearshift fork engages a corresponding sleeve of the synchronization and engagement mechanism. For each pair of idle gears associated to the same range and fitted on the same shaft (whether primary or secondary), the synchronization and engagement mechanism is normally provided with: a hub fitted externally on the shaft; a pair of driving rings arranged on opposite axial sides of the hub, each of which is angularly fixed with respect to a corresponding gear and which have respective external toothings; and a pair of rings for synchronizing the motion that are able to activate the driving rings selectively.

The synchronizing rings are each set axially between the hub and the corresponding driving ring, have respective conical friction surfaces designed to co-operate, in use, with corresponding conjugated friction surfaces carried by the driving rings, and are provided with respective external toothings.

The sleeve is located on the outside of the hub and is rendered angularly fixed with respect to the hub itself by means of an internal toothing of its own. The sleeve can slide axially on opposite sides of the hub under the action of the corresponding gearshift fork. During the axial travel of the sleeve in one direction or else in the other, the internal toothing of the sleeve engages first the external toothing of the synchronizing ring and then the external toothing of the driving ring, when the relative speed of the latter with respect to the synchronizing ring goes to zero as a result of the contact between the respective conjugated friction surfaces.

The synchronization and engagement mechanism just described, albeit satisfactory from the functional standpoint, as a whole requires a space that is relatively large, in particular in a direction parallel to the axes of the primary and secondary shafts.

Indeed, the engagement between the sleeve and the gearshift fork, and the travel of the sleeve itself in opposite directions with respect to the central idle position impose the need for a minimum axial distance that is relatively large between the two gears associated to the same range.

Another solution is disclosed in WO2005/036007A1, where a sliding sleeve is rotationally fixed between two gear wheels so that it can be displaced axially on a gearbox shaft. Said gearbox shaft is configured as a hollow shaft. A gearshift rod is mounted in the gearbox shaft so that it can be axially displaced. The axial shift displacements of the gearshift rod are transmitted to the sliding sleeve by means of radial connection elements. Synchronisation rings are located between the sliding sleeve and the gear wheels in order to adapt the speeds of the sliding sleeve and the gear wheel that is to be shifted to one another during the shift operation.

Also this solution requires a space that is relatively large.

DISCLOSURE OF INVENTION

The aim of the present invention is to provide a device for synchronization and engagement of a gear transmission of a motor vehicle which will enable a simple and inexpensive solution to the problems set forth above and at the same time is preferably simple to produce and to install.

According to the present invention, a device for synchronization and engagement of a gear transmission of a motor vehicle is provided, as defined in claim **1**.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention a preferred embodiment thereof is now described, purely by way of non-limiting example, with reference to the annexed plate of drawings, wherein:

FIG. **1** is a cross section, with parts removed for reasons of clarity, of a gear transmission provided with a preferred embodiment of the synchronization and engagement device according to the present invention;

FIG. **2** shows at an enlarged scale, with parts in cross-sectional view and with parts removed for reasons of clarity, the synchronization and engagement device shown in FIG. **1**, at the end of an engagement manoeuvre;

FIG. **3** is a perspective view of the synchronization and engagement device shown in FIG. **2**, sectioned with a different plane of cross section and set in an idle condition;

FIG. **4** shows in exploded view some components of the synchronization and engagement device shown in FIGS. **2** and **3**;

FIG. **5** is similar to FIG. **1** and schematically shows a variant of the device shown in FIG. **1**;

FIG. **6** schematically shows the gear lever of the gear transmission of FIG. **1**;

FIG. **7** is a front view, at an enlarged scale and with parts removed for reasons of clarity, of a device for controlling the synchronization and engagement device shown in FIG. **1**; and

FIG. **8** is an exploded perspective view of some components shown in FIG. **7**.

BEST MODE FOR CARRYING OUT THE INVENTION

In FIG. **1**, the reference number **1** designates a synchronization and engagement device, forming part of a gear transmission **2** (partially shown) for a motor vehicle (not shown).

The gear transmission **2** comprises two or three transmission shafts that are parallel to one another, of which one is the primary driving shaft. FIG. **1** shows partially just one of said shafts, designated by the reference number **3**. The shaft **3** has an axis designated by **4**, is axially hollow, i.e., has a cavity **5** that gives out at one end **6** through an opening, and comprises two intermediate portions **7** and **8**, which carry respective pairs of gears, designated, respectively, by **9**, **10** and by **11**, **12**.

The gears **9**-**12** are angularly idle and axially fixed with respect to the shaft **3** and mesh permanently with respective gears (not shown) fitted on another shaft of the gear transmission **2**. Each pair of idle gears is associated to a corresponding range of gears, which is activated by the driver of the motor vehicle by operating a control grip **13**, for example, the gear lever that is shown in FIG. **6** and that is movable in a grid **13***a* of seats. Via said grip **13** it is possible to select the different ranges of the gears, i.e., the range of the first and second gears, the range of the third and fourth gears, the range of the fifth and sixth gears, and the range of the reverse gear, by shifting the grip **13** in the grid **13***a* along a transverse selection path **14** and keeping in any case the gear transmission **2** in a neutral condition, and it is possible to engage, for the range selected, the two corresponding gears, shifting the grip **13** in the grid **13***a* along a longitudinal engagement path **15** starting from a central position in one direction or, respectively, in the opposite one.

Once again with reference to FIG. **1**, the grip **13** actuates the device **1** via a control device **16**, which will be described in greater detail hereinafter. The following description refers to the part of the device **1** that is associated to the pair of gears **9** and **10**, it being understood that the remaining part associated to the other ranges is analogous.

The device **1** comprises a hub **17**, which is fixed and coaxial with respect to the shaft **3** and comprises, in turn, an internal bushing **18**, which is fitted on the portion **7** in a fixed angular position, for example via a grooved coupling (not shown), and is withheld axially, on one side, by the internal ring of a bearing **19**, which keeps the shaft **3** coupled, so that it can turn axially, to a supporting structure **20** obtained via casting, and on the other side by a locator spacer ring **21** fitted in a fixed axial position on the shaft **3**.

According to what is shown in FIGS. **2** and **3**, the bushing **18** has three seats **23**, which are arranged at 120° apart from one another about the axis **4**, have the shape of a cylindrical sector, pass in a radial direction through the bushing **18**, and have respective pairs of plane axial-guide surfaces **24** facing one another in a circumferential direction. In a position corresponding to the seats **23**, the shaft **3** has respective through slots **25**, which are made in a radial direction and are axially elongated (FIG. **1**).

The bushing **18** has an external cylindrical surface **26** (FIG. **3**) comprising two terminal areas **27**, on which there are coupled idle and sliding the internal cylindrical surfaces of the gears **9** and **10**, respectively.

The hub **17** further comprises an external ring gear **29**, which is coupled in a fixed and coaxial position on a central area **30** of the surface **26** (FIG. **3**) in a way not described in detail, for example by means of welding, and defines a spacer between the gears **9** and **10**. In particular, each gear **9**, **10** is sandwiched in an axial direction between a corresponding face **31** of the ring gear **29** and a corresponding ring **32** fitted on the axial end of the bushing **18** (FIG. **1**).

Once again with reference to FIGS. **2** and **3**, the device **1** further comprises two floating synchronizing rings **39**, which are arranged on axially opposite sides of the ring gear **29** and are each provided with a conical friction surface **40** (FIG. **2**) facing radially outwards, and a toothing **41** facing radially inwards.

The device **1** further comprises two driving rings or flanges **44** coaxial to the bushing **18**, each of which is located between a corresponding ring **39** and a corresponding gear **9**, **10** and is fixed with respect to the latter. In particular, each ring **44** is welded to an internal surface **45** of the corresponding gear **9**, **10** and has a toothing **46** facing radially inwards. The surface **45** of each gear **9**, **10** comprises a conical friction area **47** (FIG. **2**), which is located in an intermediate position between the ring gear **29** and the corresponding ring **44**, mates with surface **40** of the corresponding ring **39**, and co-operates, in use, with said surface **40**.

In particular, for each gear **9**, **10**, the surface **45**, the bushing **18**, and the face **31** of the ring gear **29** define an annular chamber **50** housing the rings **44** and **39**.

The device **1** then comprises three engagement members **54**, which are angularly located at equal distances apart about the axis **4**, are completely housed, each, in a corresponding seat **23**, have the shape of a cylindrical sector, are coupled to the surfaces **24** so as to receive or transmit a torque with respect to the bushing **18**, and are able to slide jointly with one another under the control of the device **16** and under the guidance of the surfaces **24** so as to translate axially between a central idle, or neutral, position, in which they leave the gears **9**, **10** idle, and two opposite lateral end-of-travel engagement positions, in which they render the shaft **3** angularly fixed with respect to the gear **9** or **10** selectively.

In particular, the members or sectors **54** have a cylindrical toothing **55** (FIG. **3**), which faces radially outwards and meshes progressively with the toothing **41** and hence with the toothing **46** during translation from the central idle position towards any one of the lateral end-of-travel engagement positions, thus rendering the bushing **18** angularly fixed with respect to the ring **44** and engaging the corresponding gear.

With reference to FIG. **4**, for each gear **9**, **10**, a device **57** of angular constraint is located axially between the face **31** and the ring **39** for limiting the angular fluctuation of the ring **39** with respect to the sectors **54**. The device **57** comprises three axial teeth **58**, which are fixed to an annular portion **59** of the ring **39** and are angularly located at a distance apart from one another, and three retention seats **60**, which are made on the face **31** and each of which is engaged by a corresponding tooth **58** in a slidable way in a circumferential direction. The seats **60** have in a circumferential direction a dimension greater than that of the teeth **58** to enable a play equal to half the pitch of the toothing **41**.

The internal radial surface of the ring gear **29** comprises three cylindrical portions **61** and three toothed portions **62** angularly alternating with one another about the axis **4**. The portions **61** are coupled to the central area **30** of the surface **26**, whilst the portions **62** are engaged by the toothing **55** of the respective sectors **54** in an axially slidable way.

With reference to FIGS. **2** and **4**, the device **1** comprises three pre-synchronization small blocks **65**, which axially face the rings **39**, are coupled in an axially slidable and angularly fixed way to the sectors **54** and are coupled to the sectors **54** themselves by interposition of a retention device **67**.

The device **67** comprises, for each small block **65**, a corresponding spring **68** that keeps the small block **65** itself in a position axially fixed with respect to the corresponding sector **54** during a first portion of axial travel made by the sector **54** itself starting from the central idle position, referred to as pre-synchronization travel. In said first portion of travel, the small block **65** pushes an annular portion **69** of the ring **39** axially under the driving action exerted by the radial thrust of the spring **68** in order to bring the conical surface **40** to engage with the surface **47**. The device **68** is releasable when the axial travel of the sector **54** continues further towards the lateral end-of-travel engagement position.

In particular, each small block **65** is located radially between a corresponding sector **54** and a corresponding toothed portion **62** of the ring gear **29**, whilst the latter has three axial through grooves **71** (FIG. **4**), which axially guide respective portions **72** of the small blocks **65**. The device **68** comprises, for each small block **65**, a corresponding pin **73**, which can slide radially in a guide cavity **74** made in the corresponding sector **54**. The spring **68** is housed in the cavity **74** and pushes the tip of the pin **73** to engage in an axial retention seat **75** made in the small block **65**. At the end of the pre-synchronization-travel, the small block **65** can no longer advance on account of the axial contrast surface, defined by the portion **69**, having become fixed, so that the external tip of the pin **73** tends to follow a terminal ramp **77** of the seat **75** to exit progressively from the seat **75** itself, receding radially in the cavity **74** against the elastic action of the device **68**. The seat **75** is symmetrical, i.e., it has two ramps **77** opposite to one another for operation in regard to the gears **9** and **10**, respectively.

Preferably, according to what is shown in FIG. **3**, the small blocks **65** have an axial length equal to that of the sectors **54**, and each comprise two ends **79** arranged on opposite sides of the portion **72**, which in turn projects radially outwards with respect to the ends **79** and has an axial length equal to that of the groove **71**. At the same time, for each ring **39**, the portion **59** surrounds an end **79** of the small blocks **65** and axially faces the portions **72**, whilst the portion **69** is set alongside the portion **59** and carries the toothing **41**.

The toothing **41** is discontinuous, i.e., it is made up of three toothed portions **41***a*, which alternate with three edges **41***b* without toothing and are arranged in a position corresponding to the toothings **55** of the sectors **54**.

As regards the simultaneous axial driving of the sectors **54** and engagement of the gears **9** and **10**, with reference to FIGS. **1** and **3**, three control pins **101** are arranged at 120° apart about the axis **4**, engage at one end thereof respective radial seats, each made in a corresponding sector **54**, are thus fixed with respect to the sectors **54** and with respect to the shaft **3**, and extend radially inwards starting from the sectors **54** themselves through the slots **25**. The slots **25** have dimensions such as to enable axial translation of the respective pins **101** between the central idle position and the lateral end-of-travel engagement positions.

The device **16** comprises a control stem **103**, which is coupled to the pins **101** via a cross journal **104**, is housed in the cavity **5** of the shaft **3**, and extends along the axis **4**. The cross journal **104** comprises three radial arms **105** having respective seats engaged by the internal ends of the pins **101**, in a fixed position, and a central portion **106** (FIG. **3**) coupled to one end of the stem **103** by means of a bearing (not shown), in particular a contact bearing.

As regards, instead, engagement of the gears **11** and **12**, a stem **103***a* is provided in a direction parallel to, and located at a distance from, the axis **4** and, hence, the stem **103**. The control pins provided for engagement of the gears **11** and **12** are carried in a fixed position by a supporting ring **107**, which is traversed with play by the stem **103** and has a circular track coupled to one end of the stem **103***a* by means of a bearing (not shown), in particular a contact bearing.

The stems **103**, **103***a* extend outside of the cavity **5** on the side of the end **6**, where they have respective terminal portions **108**, **108***a* external to the shaft **3** and actuated for causing translation of the stems **103**, **103***a* themselves in a direction parallel to the axis **4** under the control transmitted mechanically starting from the grip **13**.

With reference to FIGS. **7** and **8**, the device **16** comprises a control shaft **110**, which has an axis **111** orthogonal and skew with respect to the axis **3**, is located partly in a position facing the end **6** of the shaft **3** and in an intermediate position between the axis **4** and the axis of another shaft of the gear transmission **2**, and is supported by the structure **20** via two fixed portions **112**, **113** axially fixed and located at a distance from one another.

The shaft **110** comprises a top terminal axial portion **114** and a bottom terminal axial portion **115**, which are provided, on the external side surface thereof, with respective knurlings or groovings. The shaft **110** further comprises an intermediate portion **116**, which brings into a fixed position two fingers **117**, which are diametrally opposite to one another and project radially with respect to the axial portions **114**, **115**.

A lever member **118** is fitted in a fixed position on the end of the axial portion **114** and is coupled to the grip **13** by means of a lever transmission **119** (partially shown and not described in detail), which is able to bestow upon the shaft **110** a motion of selection of the ranges, in translation along the axis **111**, and a motion of engagement of the gears, in rotation about the axis **111** in opposite directions starting from a central reference position corresponding to the idle or neutral condition of the gear transmission **2**.

The device **16** further comprises two sleeves **120**, **121**, which are arranged on opposite axial sides of the portion **116** and are fitted on the axial portion **114** and **115**, respectively, in an angularly idle and axially fixed position. In particular, the sleeve **120** is gripped axially between the member **118** and the portion **116**, whilst the sleeve **121** is gripped between the portion **116** and a positioning member **122**.

The member **122** is fitted in a fixed position on the end of the axial portion **115** and co-operates (in a way not described in detail) with two spherical elements **123** loaded by respective springs (not shown) and carried by the structure **20**, to bring the shaft **110** angularly always back into a central idle position and axially into a central reference position when the gears are disengaged and the action of manual control on the grip **13** ceases.

The sleeves **120**, **121** each carry, in a fixed position, a corresponding pair of radial appendages **125**, which are diametrally opposite to one another, are elongated in a direction parallel to the axis **111**, and, when the shaft **110** is in its central idle position, are aligned to the fingers **117**. The sleeves **120**, **121** engage in an angularly fixed and axially slidable way respective fixed guide seats **126**, **127**, which are made in the portions **112** and **113**, respectively, and are complementary to the shape of the appendages **125** for guiding the sleeves **120**, **121** themselves, and, hence, the shaft **110**, along the axis **111**.

The device **16** further comprises four levers **130**, **131**, **132**, **133**, which are axially packed tight between the portions **112** and **113**, are hence fixed along the axis **111**, are fitted on the sleeves **120**, **121** and on the portion **116**, each has an axial height substantially equal to that of the fingers **117**, and are each associated to a corresponding range of gears.

The levers **130-133** are constrained angularly to the appendages **125** of the sleeves **120**, **121** or else to the fingers **117** of the portion **116**. As will be described more fully hereinafter, just one of the levers **130-133** is selectively coupled to the fingers **117** to turn together with the shaft **110** about the axis **111**. The levers **130-133** comprise respective radial plate-like arms, the ends of which are coupled to the ends of respective control stems, part of which are housed in the shafts of the gear transmission **2**.

In particular, the levers **132**, **133** comprise respective radial arms **134**, **135**, which are hinged at their own ends to the portions **108** and **108***a*, respectively, of the stems **103**, **103***a*, with axes of articulation parallel to the axis **111**.

During the motion of selection of the shaft **110** in axial translation, the fingers **117** translate axially and come to engage in any one of the levers **130-133**, whilst the other levers remain coupled to the appendages **125**. In other words, during displacement of the grip **13** along the path **14**, the shaft **110** translates axially so as to select one of the levers and, hence, one of the ranges.

When the grip **13** is shifted along the longitudinal engagement path **15**, the shaft **110** moves with motion of engagement in rotation. The fingers **117** cause rotation about the axis **111** just of the lever selected, whilst the sleeves **120**, **121**, and hence the other levers, remain in a fixed angular position with respect to the structure **20**.

On account of the circular path of the hinging points between the ends of the arms **134**, **135** and the portions **108**, **108***a* of the stems **103**, **103***a*, the latter have an oscillation in the planes of lie of the respective levers **132**, **133** (orthogonal to the axis **11**) during the motion of engagement: for example, said oscillation is compensated by the internal play of the contact bearings present in the cross journal **104** and in the ring **107**.

An axial translation of the stem **103** starting from the central idle position causes simultaneous displacement of the three sectors **54** towards the lateral end-of-travel engagement position that has been set, for example towards the gear **9**. The sectors **54** in the first portion of travel (of pre-synchronization) draw along with them the three small blocks **65**, thanks to the elastic action of the device **68**. When the surfaces **40**, **47** come to engage with one another under the axial thrust of the small blocks **65**, the gear **9** substantially assumes the same speed of rotation as the ring **39**, and hence as the shaft **3**, given that the ring **39** is driven in rotation by the device **57** in this step.

Continuing the axial travel of the sectors **54**, the pins **73** disengage from the respective seats **75**, whilst the toothing **55** of the sectors **54** starts to mesh with the toothing **41** of the ring **39**. During this meshing step, the toothing **41** is aligned progressively with the toothing **55** rotating in a circumferential direction, thanks to an appropriate front profile of the teeth, in itself known and not described in detail, and hence recovers the play of half a pitch defined by the device **57**.

Then, in the final part of the travel of the sectors **54**, the toothing **46** comes to mesh also with the toothing **55** and is aligned progressively with the toothing **55** itself, thanks to an appropriate front profile of the teeth, in itself known and not described in detail.

Obviously, disengagement is caused by an axial movement of the stem **103** and hence of the sectors **54** in an opposite direction to disengage the toothing **55** of the sectors **65** progressively from the toothings **46** and **41**.

Provided in the variant shown in FIG. **5** is an automated control device **16***a*, instead of the device **16**. In other words, for selection and engagement of the gears, the device **16***a* comprises one or more electrically, pneumatically or hydraulically governed actuators, which are controlled by electrical signals set by actuating the grip **13** or other equivalent control member.

In particular, for selection and engagement of the gears corresponding to the gears **9-12**, the device **16***a* comprises a double-acting linear actuator **140** (shown schematically), comprising a sleeve or liner **141** housed at least partially in the cavity **5** and fixed to the structure **20**, and two internal pistons (not shown), which are movable axially independently of one another and are fixed to the stem **103** and, respectively, to a stem **103***b*. The stem **103***b* replaces the stem **103***a*, is coaxial to the stem **103**, is axially hollow, and is slidably engaged by the stem **103** itself.

The advantages of the present device **1** are described in what follows. The fact that at least one portion of the engagement members **54** (actuated by the device **16**, **16***a*) is located in a radial position that is more internal with respect to the conical surfaces **40**, **47** and to the toothings **41**, **46** enables limitation, in a radial direction, of the overall dimensions on the outside of the ring gear **29** and, in an axial direction, of the dimension of the ring gear **29** itself. Indeed, the fact of envisaging a control of said members **54** within the shaft **3** enables elimination of the encumbrance which, instead, is necessary in the known solutions that envisage the use of gearshift forks in a position outside the shafts, in particular encumbrance due to need to engage the gearshift forks themselves to the engagement sleeves.

As is evident from the figures, the fact of having available the sectors **54** completely in a radial position that is more internal with respect to the conical surfaces **40**, **47** and to the toothings **41**, **46** (which are internal toothings, whilst the toothing **55** is an external toothing) enables elimination of any axially movable portion on the outside of the gears **9**, **10** or in a position set alongside the toothings of the gears **9** and **10**, and hence reduction of the axial distance between the gears **9**, **10** themselves with respect to the known solutions, in which an external sliding sleeve is provided. In other words, it is possible to enable sliding of the members **54** directly in internal chambers **50** made in the gears **9**, **10** and/or in a position that is radially more internal with respect to that of the gears **9**, **10**.

The constructional characteristics of the device **1** described above then enable a solution that is balanced from the standpoint of transmission of engagement forces and of the torque, and have a relatively small number of components and above all contained overall dimensions.

Finally, it is clear that modifications and variations can be made to the synchronization and engagement device **1** described herein with reference to the attached plate of drawings, without thereby departing from the scope of protection of the present invention, as defined in the annexed claims.

In particular, a different number of sectors **54**, a different number of small blocks **65**, and/or a different number of teeth **58** and of corresponding seats **60** could be provided.

In addition, the members **54** could have a different shape, and/or be just partially housed in the seats **23**, and/or the small blocks **65** could be arranged in a position different from what is described above; moreover, the conical surfaces **47** could be carried by the rings **44** instead of by the gears.

Furthermore, the bushing **18** could be defined by a portion of the shaft **3**, instead of being a distinct piece; and/or the device **1** could be used for engaging even just a single gear.

The invention claimed is:

1. A device (**1**) for synchronization and engagement of a gear transmission of a motor vehicle comprising a shaft (**3**) and at least one idle gear (**9**) coaxial with respect to said shaft; the device comprising:

a cylindrical hollow portion (**18**) designed to be coaxial and in a fixed position with respect to said shaft;

a driving ring (**44**), designed to be fixed to said gear and comprising a first toothing (**46**);

a first conical friction surface (**47**), carried by one between said driving ring (**44**) and said gear (**9**);

a floating synchronizing ring (**39**), set between said cylindrical hollow portion (**18**) and said driving ring (**44**) and comprising:

a) a second conical friction surface (**40**) mating with said first conical friction surface (**47**); and

b) a second toothing (**41**); and

at least one engagement member (**54**), which is angularly fixed with respect to said cylindrical hollow portion (**18**), is able to slide axially under the action of a control device (**16**, **16***a*), and has a cylindrical toothing (**55**) designed to mesh progressively with said second toothing (**41**) and with said first toothing (**46**) to render said cylindrical hollow portion (**18**) angularly fixed (**17**) with said driving ring (**44**); an inner portion of said engagement member (**54**) being actuated by said control device (**16**, **16***a*) and being located in a radial position that is more internal with respect to that of said toothings (**41**, **46**, **55**);

said device being characterized in that said toothings (**41**, **46**, **55**) are located in a radial position that is more internal with respect to that of said conical friction surfaces (**40**, **47**).

2. The device according to claim **1**, characterized in that:

said engagement member (**54**) is located completely in a radial position that is more internal with respect to that of said toothings (**41**, **46**, **55**);

said first and second toothings (**41**, **46**) are internal toothings;

the cylindrical toothing (**55**) of said engagement member (**54**) is an external toothing;

said second conical friction surface (**40**) faces radially the outside of said synchronizing ring (**39**).

3. The device according to claim **1**, characterized in that said cylindrical hollow portion (**18**) has a guide seat (**23**) that guides the axial translation of said engagement member (**54**).

4. The device according to claim **3**, characterized by comprising a plurality of said engagement members (**54**) angularly located at a distance with respect to one another about the axis of said cylindrical hollow portion (**18**), and in that said cylindrical hollow portion (**18**) has a corresponding guide seat (**23**) for each said engagement member (**54**).

5. The device according to claim **4**, characterized in that said engagement members (**54**) have the shape of a cylindrical sector and are completely housed in the respective guide seats (**23**).

6. The device according to claim **3**, characterized in that said guide seat (**23**) passes radially through said cylindrical hollow portion (**18**).

7. The device according to claim **3**, characterized in that said cylindrical hollow portion (**18**) has an outer cylindrical surface (**27**); an internal cylindrical surface of said gear (**9**) being coupled to said outer cylindrical surface (**27**) in a rotatable manner.

8. The device according to claim **7**, characterized by comprising an outer ring gear (**29**) fitted in a coaxial and fixed position on said cylindrical hollow portion (**18**); said driving and synchronizing rings (**44**, **39**) being housed in an annular chamber (**50**) defined by said cylindrical hollow portion (**18**), by said outer ring gear (**29**) and by said gear (**9**).

9. The device according to claim **8**, characterized by comprising angular-constraint means (**57**) located axially between a face (**31**) of said outer ring gear (**29**) and said synchronizing ring (**39**) to limit the angular fluctuation of said synchronizing ring (**39**) with respect to said engagement member (**54**).

10. The device according to claim **9**, characterized in that said angular-constraint means (**57**) comprise:

at least one axial tooth (**58**) fixed to said synchronizing ring (**39**); and

at least one retention seat (**60**) made on said face (**31**), which has a larger size than said axial tooth (**58**) in a circumferential direction and is engaged slidably in a circumferential direction by said axial tooth (**58**).

11. The device according to claim **8**, characterized in that said outer ring gear (**29**) has an internal radial surface comprising a cylindrical portion (**61**) coupled to said cylindrical hollow portion (**18**) and a toothed portion (**62**) coupled to said cylindrical toothing (**55**) in such a way that it is able to slide axially.

12. The device according to claim **8**, characterized by comprising:

at least one pre-synchronization block (**65**), which faces axially said synchronizing ring (**39**) and is coupled in such a way that it is able to slide axially and is angularly fixed to said engagement member (**54**);

axial retention means (**67**), which are located between said block (**65**) and said engagement member (**54**) and comprise elastic means (**68**) to maintain said engagement member (**54**) and said pre-synchronization block (**65**) axially fixed with respect to one another during a portion of axial pre-synchronization travel, in which said pre-synchronization block (**65**) pushes said synchronizing ring (**39**) axially to bring said second conical friction surface (**40**) into engagement with said first conical friction surface (**47**); said axial retention means (**67**) being releasable when the axial path of said engagement member (**54**) continues beyond said portion of axial pre-synchronization travel.

13. The device according to claim **12**, characterized in that said pre-synchronization block (**65**) is located radially between said engagement member (**54**) and said outer ring gear (**29**); said outer ring gear (**29**) having a groove (**71**) axially guiding a portion (**72**) of said pre-synchronization block (**65**).

14. The device according to claim **13**, characterized in that said axial retention means (**67**) comprise:

a pin (**73**) that can slide radially in a guide cavity (**74**), which is made in said engagement member (**54**) and houses said elastic means (**68**); and

a retention seat (**75**) made in said pre-synchronization block (**65**).

15. The device according to claim **13**, characterized in that said pre-synchronization block (**65**) has an axial length equal to that of said engagement member (**54**) and comprises two axial ends (**79**) and an intermediate portion (**72**) that projects radially outwards with respect to said axial end (**79**) to engage said axial guide groove (**71**).

16. The device according to claim **15**, characterized in that said synchronizing ring (**39**) comprises:

a first annular portion (**59**), which surrounds one said axial end (**79**) and faces axially said intermediate portion (**72**); and

a second annular portion (**69**), which is located axially alongside the first annular portion (**59**) and carries said second toothing (**41**).

17. The device according to claim **16**, characterized in that said second toothing (**41**) is discontinuous and extends in a corresponding axial position of said engagement member (**54**).

18. A gear transmission (**2**) for a vehicle, comprising a synchronization and engagement device (**1**) according to claim **1**, and a control device (**16***a*) comprising: at least one linear actuator (**140**) comprising a liner (**141**), which is at least partially housed in said shaft (**3**); and at least one stem (**103**, **103***b*), which is coupled to said engagement member (**54**) and is axially movable for axial translation of the engagement member (**54**).

19. A gear transmission (**2**) for a vehicle, comprising a synchronization and engagement device (**1**) according to claim **1**, and a control device (**16**, **16***a*) comprising:

a control pin (**101**), which is fixed with respect to said engagement member (**54**) and extends radially inwards with respect to said engagement member (**54**); and

a stem (**103**, **103***a*, **103***b*), which is coupled to said control pin (**101**), at least partially housed in the shaft (**3**), and is actuated for axial translation of said engagement member (**54**);

said shaft (**3**) having a radial hole (**25**), which is traversed by said control pin (**101**) and has dimensions such as to enable axial translation of said control pin (**101**).

20. The gear transmission according to claim **19**, characterized in that said stem (**103**) extends along the axis (**5**) of said shaft (**3**), and by comprising a cross journal (**104**) carrying a plurality of said control pins (**101**), each associated to a corresponding engagement member (**54**); said cross journal (**104**) being coupled to one end of said stem (**103**) by means of a bearing.

21. The gear transmission according to claim **19**, characterized in that said stem (**103***a*) is parallel and located at a distance from the axis (**4**) of said shaft (**3**), and by comprising a supporting ring (**107**), which is traversed by a further stem (**103**) and carries a plurality of said control pins (**101**), each associated to a corresponding engagement member (**54**); said supporting ring (**107**) having a circular track coupled to one end of said stem (**103***a*) by means of a bearing.

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