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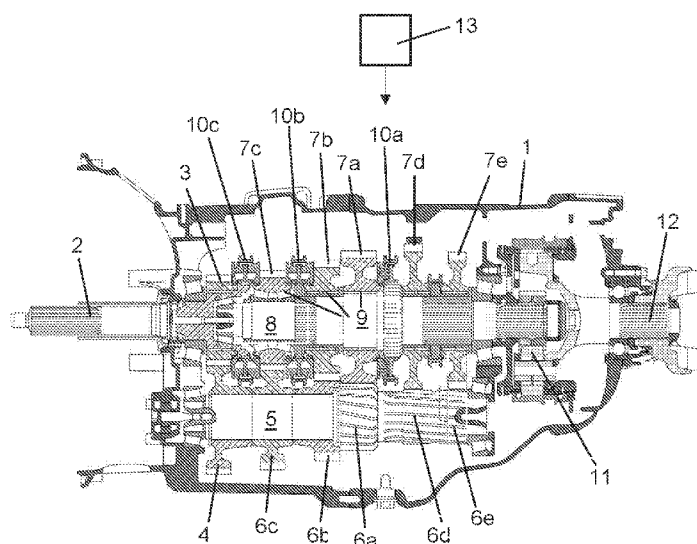


Fig 1

(57) Abstract: The present invention relates to an arrangement and a method for engagement of a gear in a gearbox. The arrangement is adapted, in connection with disengagement of a gear that is defined by a first secondary cogwheel (7c), and an engagement of a gear that is defined by a second secondary cogwheel (7b), to provide an activation movement of the synchronising device (10b) for the second secondary cogwheel (7b), from a disconnected state to a synchronisation state, and subsequently to a locked state. The arrangement (13) is adapted (7a-d) to also provide an activation movement, during the engagement of said gearing, of at least one extra synchronising device (10a) for a third secondary cogwheel (7a), and to set the extra synchronising device (10a) in the synchronisation state during at least a part of the time when the synchronising device (10b) for the second secondary cogwheel (7b) is in the synchronisation state, so that the extra synchronising device (10a) also participates in the synchronisation of the second secondary cogwheel's (7b) rotational speed with the main shaft (8).

ARRANGEMENT AND METHOD FOR ENGAGING A GEAR IN A GEARBOX

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BACKGROUND OF THE INVENTION AND PRIOR ART

The invention relates to an arrangement and a method for engaging a gear in a gearbox according to the preambles of patent claims 1 and 8.

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Conventional gearboxes comprise a countershaft, a main shaft, several gear sets, each one of which comprises a cogwheel which is rotatably arranged on the countershaft and a cogwheel which is arranged on the main shaft. Synchronising devices are used to synchronise and lock the cogwheels on the main shaft in connection with engaging
15 gears. A synchronising device may comprise a shiftably arranged clutch sleeve, which is connected with a latch cone having a conically shaped friction surface adapted to go into engagement with a corresponding conically shaped friction surface of a clutch cone, which is connected with the cogwheel. When a gear is to be engaged in the gearbox, the clutch sleeve is shifted in an axial direction, from an initial stage to a
20 synchronising stage, in which the clutch cone's conical friction surface goes into engagement with the latch cone's conical friction surface. Thus, the clutch cone and the latch cone obtain a synchronous rotational speed relatively soon. When the synchronous rotational speed has been achieved, the clutch sleeve may be shifted further to a locked state, in which it goes into engagement with a lock element on the
25 clutch cone, so that the cogwheel obtains a rotational locking on the main shaft.

The synchronising devices' friction surfaces are subjected to a relatively substantial wear. One operating mode, where the wear is substantial and the shift times are long, is where a higher gear is engaged in the gearbox at the same time as the vehicle has a
30 quickly decelerating speed, which may occur when the vehicle is driven on a steep uphill slope. In this case, the synchronising device must synchronise a relatively large rotational speed difference, between a cogwheel initially having a higher rotational speed than the main shaft, and a main shaft having a quickly decelerating engine speed. In this case, as a rule it takes a relatively long time before the cogwheel may
35 obtain a synchronous rotational speed with the main shaft and to provide a rotational locking.

SUMMARY OF THE INVENTION

The objective of the present invention is to provide an arrangement, which reduces the wear of the synchronising devices and shorten the shift times in a gearbox.

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This objective is achieved with the arrangement of the type specified at the beginning, which is characterised by the features specified in the characterising portion of claim 1. The secondary cogwheel, which is intended to be disengaged during a shifting process, is referred to herein as a first secondary cogwheel. The secondary cogwheel, which is intended to be engaged in the gearbox, is referred to herein as a second secondary cogwheel. The secondary cogwheel, whose synchronising device is used to help at a synchronising process of the second secondary cogwheel, has been referred to herein as a third secondary cogwheel. When a gear is to be engaged in a gearbox, the synchronising device's primary task is to synchronise the secondary cogwheel's rotational speed with the rotational speed of the main shaft. The synchronising entails that the main shaft is connected, via a friction clutch, with the secondary cogwheel and the components which are connected to the secondary cogwheel. The components connected with the secondary cogwheel on the main shaft consist of the primary cogwheel of the relevant gear set, the countershaft and the input shaft of the gearbox. The friction clutch generally comprises two or more conically shaped friction surfaces, which are pressed against each other. After the secondary cogwheel has obtained a rotational speed which is synchronous with that of the main shaft, the synchronising device's task is to rotationally lock the secondary cogwheel on the main shaft.

25 According to the invention, an arrangement is used, which in addition to the activation of the synchronising device for the second secondary cogwheel, which thus defines the gear to be engaged in the gearbox, also activates at least one extra synchronising device for a third secondary cogwheel. The extra synchronising device is thus also moved to the synchronising state during at least a part of the time, during which the synchronising device for the second secondary cogwheel is in the synchronising state. Since the extra synchronising device also participates in the synchronising of the second secondary cogwheel's rotational speed with the main shaft's rotational speed, the load is distributed over the two synchronising devices. The wear on a synchronising device does not vary linearly with the size of the load, but the wear arises primarily in connection with top loads. In this case, the top loads may be distributed over the two synchronising devices. The wear on the individual

synchronising devices is therefore smaller. The individual synchronising devices may thus obtain a longer life. With the help of one or several extra synchronising devices, the duration of a synchronising process may be considerably reduced. Accordingly, a faster shifting process may be obtained.

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According to a preferred embodiment of the present invention, the arrangement is adapted to activate, in connection with engaging a lower gear in the gearbox, an extra synchronising device for a third secondary cogwheel, defining a lower gear than the gear which is defined by the first secondary cogwheel. In a down-shift process in the gearbox, the second secondary cogwheel has a lower rotational speed than the main shaft. The synchronising in this case entails that the second secondary cogwheel and connected components, such as the primary cogwheel and the countershaft, must be accelerated so that they obtain a higher rotational speed. Help with accelerating the countershaft may only be obtained from a gear set, in the case where the third secondary cogwheel, like the second secondary cogwheel, defines a lower gear than the first secondary cogwheel.

According to one preferred embodiment of the present invention, the arrangement is adapted, in connection with engaging a lower gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel, defining a lower gear than the gear which is defined by the second secondary cogwheel. In this case, the second secondary cogwheel obtains a synchronous rotational speed with the main shaft before the third secondary cogwheel. Thus, the extra synchronising device for the third secondary cogwheel may participate in the entire synchronising process of the second secondary cogwheel on the main shaft.

According to a preferred embodiment of the present invention, the arrangement is adapted, in connection with engaging a higher gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel, defining a higher gear than the first secondary cogwheel. In an up-shift process in the gearbox, the second secondary cogwheel has a higher rotational speed than the main shaft. The synchronising in this case entails that the second secondary cogwheel and connected components, such as the primary cogwheel and the countershaft, must be decelerated so that they obtain a lower rotational speed. Help with decelerating the countershaft may only be obtained from a gear set in the case where the third secondary cogwheel, like the second secondary cogwheel, has a higher gear than the first secondary cogwheel.

According to a preferred embodiment of the present invention, the arrangement is adapted, in connection with engaging a higher gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel, defining a higher gear than the gear defined by the second secondary cogwheel. In this case, the second secondary cogwheel obtains a synchronous rotational speed with the main shaft before the third secondary cogwheel. Thus, the extra synchronising device for the third secondary cogwheel may participate in the entire synchronising process of the second secondary cogwheel on the main shaft.

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According to a preferred embodiment of the present invention, the arrangement is adapted to move the extra synchronising device for the third secondary cogwheel from the synchronising state to the disconnected state, before it provides an activation movement to the locked state of the synchronising device for the second secondary cogwheel. Thus, there is no risk that the extra synchronising device contributes to the second secondary cogwheel getting too high a rotational speed during a synchronising process in connection with a down-shift process, and getting too low a rotational speed during a synchronising process in connection with an up-shift process.

According to the invention, the arrangement comprises an actuator for each one of the synchronising devices, a movement transferring mechanism, transferring the actuators' activation movements to the respective synchronising devices, and a control device, which is adapted to control the activation of the actuators. The actuators may consist of pneumatic cylinders providing an activation movement that is transferred, via the movement transferring mechanisms, to the respective synchronising devices. Thus, the respective synchronising devices may obtain a movement from a disconnected state to a synchronising state, and subsequently to a locked state.

According to the invention, the arrangement comprises a latch device which is adapted to prevent that the extra synchronising device obtains a movement from the synchronising state to the locked state. Such a latch device eliminates the risk that the third secondary cogwheel is moved to the locked state on occasions, where it only assists with synchronising a second secondary cogwheel's rotational speed in relation to the main shaft. The latch device comprises a latch element, which blocks the movement of a component in the movement transferring mechanisms, and an actuator that moves the latch element from an unlatched state to a latched state. Accordingly,

the latch element may be moved quickly to the latched state on occasions, where the extra synchronising device is used as extra help to synchronise the rotational speed of the second secondary cogwheel. The actuator may be a pneumatic cylinder. The same control device that controls the activation of the synchronising devices may
5 advantageously also be used to activate and deactivate the latch element.

According to one embodiment of the invention, the extra synchronising device has a design, which results in improved strength properties compared to other synchronising devices. Since this synchronising device also, in addition to the synchronising process
10 for connecting secondary cogwheels, participates in the synchronising process for other secondary cogwheels, it may be provided with strength properties, making it wear no faster than the other synchronising devices.

The objective mentioned in the introduction is also achieved with the method
15 according to patent claims 8-13.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Below is a description, as an example, of preferred embodiments of the invention with reference to the enclosed drawings, on which:

- Fig. 1 shows a gearbox, which is equipped with an arrangement according to the present invention,
25 Fig. 2 schematically shows an embodiment of a part of the arrangement in Fig. 1 and
Fig. 3 shows a part of the arrangement providing an activation movement and a blocking of the extra synchronising device.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE 30 INVENTION

Fig. 1 shows a gearbox that may be arranged in a schematically drawn vehicle 19, which may be a heavy goods vehicle. The gearbox is attached inside a house 1. The gearbox comprises an input shaft 2, which is operated by a non-displayed combustion
35 engine. The gearbox comprises a split gear which, in a first split state, connects the input shaft 2 with a countershaft 5 in the gearbox via a cogwheel 3, which is in

constant engagement with a cogwheel 4 on a countershaft 5 in the gearbox. In a second split state, the input shaft 2 is connected with the countershaft 5 via a cogwheel 7c, which is in constant engagement with a cogwheel 6c on the countershaft 5. The countershaft 5 thus provides a rotation movement of the input shaft 2. The countershaft 5 is equipped with several additional cogwheels 6a-e of various sizes. The cogwheels 6a-e are separate units, fixedly fitted on the countershaft 5 or constituting a homogeneous part of the countershaft 5. Each one of the cogwheels 6a-e on the countershaft 5 is in constant engagement with a corresponding cogwheel 7a-e on a main shaft 8. The gearbox thus contains several gear sets, which are in constant engagement with each other. Each one of the gear sets comprises a primary cogwheel 6a-e, which is fixedly arranged on the countershaft, and a secondary cogwheel 7a-e, which is rotatably arranged on the main shaft 8. One gear set, comprising a primary cogwheel 6a and a secondary cogwheel 7a, provides a gearing that defines the first gear in the gearbox. One gear set, comprising a primary cogwheel 6b and a secondary cogwheel 7b, provides a gearing that defines the second gear in the gearbox. One gear set, comprising a primary cogwheel 6c and a secondary cogwheel 7c, provides a gearing that defines the third gear in the gearbox. A gear set, comprising a primary cogwheel 6d and a secondary cogwheel 7d, defines a creeper gear. A gear set, comprising a primary cogwheel 6e and a secondary cogwheel 7e, defines a reverse gear. The gear set 6e, 7e for the reverse gear comprises an interim cogwheel, which provides a reverse rotational direction of the main shaft 8.

The secondary cogwheels 7a-e are rotatably arranged on the main shaft 8, with the help of a bearing 9 that may be a needle bearing. The synchronising devices 10a-c are arranged in connection with the secondary cogwheels 7a-e on the main shaft 8. The task of each of the synchronising devices 10a-c is to achieve a synchronising and a subsequent rotational locking of at least one of the secondary cogwheels 7 in relation to the main shaft 8, in connection with engaging a gear. A synchronising device 10a is adapted to be responsible for synchronising and rotational locking of the secondary cogwheel 7a for the first gear. A synchronising device 10b is adapted to be responsible for synchronising and rotational locking of the secondary cogwheels 7b, 7c for the second and third gears. A synchronising device 10c is comprised in the split gear, whose task is to set the different split positions so that it connects the input shaft 2 with a countershaft 5 in the gearbox, via the cogwheels 3, 4 in the first split state, and via the cogwheels 7c, 6c in the second split state.

The synchronising devices 10a-c may have a conventional design and comprise a shiftably arranged clutch sleeve, which is connected with a latch cone with a conically shaped friction surface, adapted to be engaged with a correspondingly shaped conical friction surface of a clutch cone connected with the cogwheel. The conically shaped friction surfaces may be referred to as a friction clutch. When a gear is to be engaged in the gearbox, the clutch sleeve is shifted in an axial direction on the main shaft, towards the secondary cogwheel, so that the clutch cone's conical friction surface goes into engagement with the latch cone's conical friction surface. Thus, the clutch cone and the latch cone obtain a synchronous rotational speed relatively soon. When the synchronous rotational speed has been achieved, the clutch sleeve may be shifted further along to an end state, in which it goes into engagement with the clutch cone and the connected cogwheel. When a secondary cogwheel 7a-e has been moved to a rotation-locked state on the main shaft 8, it constitutes a power transferring component in the gearbox. The gearbox also comprises a range gear 11, which is arranged between the main shaft 8 and an output shaft 12 in the gearbox. With the help of a range gear 11, all ordinary gears in the gearbox may be provided with a high and a low gearing, respectively. Accordingly, the gearbox may obtain twice as many gears. An arrangement 13 is adapted to control the activation of the synchronising devices 10a-c during shifting processes in the gearbox.

Fig. 2 schematically shows selected parts of the arrangement 13, which are adapted to control the activation of the synchronising devices 10a, 10b for the secondary cogwheels 7a-c. The parts of the arrangement 13 controlling the split gear with the help of the third synchronising device 10c are not displayed, since these parts of the arrangement 13 are not necessary for the invention. The arrangement 13 comprises a shifting control 14, with which a driver indicates the engagement of a desired gear in the gearbox. A control device 15 is adapted to receive information, relating to the desired gear in the gearbox, from the shifting control 14 or to decide about a suitable gear. When a gearing, which is defined by the first gear, is obtained in the gearbox, the control device 15 is adapted to create an activation movement with the help of an actuator 16a and a movement transferring mechanism 17a, which transfers the movement to the synchronising device 10a for the secondary cogwheel 7a, which defines the first gear. When a gearing, which is defined by the second or third gear, is obtained in the gearbox, the control device 15 is adapted to create an activation movement with the help of an actuator 16b and a movement transferring mechanism 17b, which transfers the movement to the synchronising device 10b for the secondary

cogwheels 7b, 7c, which define the second and third gears. The activation movements transferred to the respective synchronising devices 10a, 10b entail, in a first step, that they are moved from a disconnected state, in which the connecting secondary cogwheels 7a-c rotate freely on the main shaft 8, to a synchronising state, in which the rotational speed of the secondary cogwheels 7a-c is synchronised with the rotational speed of the main shaft 8. After the secondary cogwheels 7a-c have achieved a synchronous rotational speed, the synchronising devices 10a, 10b are moved, in a second step, to a locked state, in which they provide a rotational locking of the secondary cogwheels 7a-c on the main shaft 8. The actuators 16a, 16b and the movement transferring mechanisms 17a, 17b are also used to return the respective synchronising devices 10a-c from the locked state, via the synchronising state, which is not active when a gear is disengaged, to the disconnected state. A maximum of one of the secondary cogwheels 7a-e is in the rotationally locked state on the main shaft 8 at a time, while the remaining secondary cogwheels 7a-e are in the disconnected state. The cogwheel 7c may, however, provide a rotational locking in relation to the input shaft 2 in the second split state. The control device 15 is also connected with a latch device 18 for the first synchronising device 10a. The latch device 18 is adapted, in such a way that it does not impact the first synchronising device's 10a movement from the disconnected state to the synchronising state. The latch device 18 may, on the other hand, prevent the synchronising device's 10a continued movement from the synchronising state to the locked state.

Fig. 3 shows the part of the arrangement 13, which is adapted to provide the activation movement of the first synchronising device 10a for the secondary cogwheel 7a, in more detail. The arrangement 13 thus comprises a control device 15, which is connected with an actuator 16a providing an activation movement, which is transferred, via a movement transferring mechanism 17a, to the synchronising device 10a. The actuator 16a may be a pneumatic cylinder. The movement transferring mechanism 17a comprises a shiftable shaft 17a₁, which is equipped with a fork-shaped element 17a₂. The fork-shaped element 17a₂ is attached on a clutch sleeve 10a₁ of the synchronising device 10a. When control device 15 activates the pneumatic cylinder 16a, it shifts the shaft 17a₁ with the fork-shaped element 17a₂, and therefore the control sleeve 10a₁ of the synchronising device 10a, in a first step from a disconnected state to the synchronising state, in which the synchronising device 10a synchronises the secondary cogwheel's 7a rotational speed with the rotational speed of the main shaft 8. Once a synchronous rotational speed has been achieved, the synchronising device 10a

is moved, in a second step, to a locked state, in which the secondary cogwheel 7a provides a rotational locking on the main shaft 8. The part of the arrangement providing an activation movement of the second synchronising device 10b may comprise a corresponding actuator 16b, and a movement transferring mechanism 17b
5 in the form of a shiftable shaft and a fork-shaped element. Since the second synchronising device 10b is double-acting, it may be shifted from a disconnected state in two directions, depending on which of the secondary cogwheels 7b, 7c, which must be synchronised and locked on the main shaft 8.

10 The arrangement 13 thus comprises a latch device 18 in connection with the synchronising device 10a. The latch device 18 comprises an actuator 18a and a latch element 18b. The actuator 18a may be a pneumatic cylinder, which is directly connected with the latch element 18b or indirectly connected with the latch element
15 18b via a suitable movement transferring mechanism. When the control device 15 activates the actuator 18a, it shifts the latch element 18b to a latched state. The latched state is selected in such a way that the latch element 18b allows the fork-shaped element 17a₂ to shift the clutch sleeve 10a₁ from the disconnected state to the synchronising state. The latch element 18a, on the other hand, blocks a continued movement of the fork-shaped element 17a₂ and the synchronising device 10a towards
20 the locked state. Fig. 3 shows the latch element 18b in a latched state, where it is in contact with the fork-shaped element 17a₂.

During operation, the control device 15 receives information from the gear control 14, relating to the driver's desired gear in the gearbox. The gear control 14 is in this case a
25 gearing state, which is transferred via the gear set 6c, 7c that defines the third gear in the gearbox. The driver decides, however, to down-shift and indicates, with the help of the shifting control 14, disengagement of the gear set 6c, 7c that defines the third gear, and indicates engagement of the gear set 6b, 7b that defines the second gear. The control device 15 receives this information from the shifting control 14 and activates
30 the actuator 16b, which, via the movement transferring mechanism 17b, provides a movement of the synchronising device 10b from the locked state to the disconnected state for the secondary cogwheel 7c that defines the third gear. The secondary cogwheel 7c that defines the third gear, may thus rotate freely on the main shaft 8.

35 Since the second synchronising device 10b is double-acting, it is also responsible, in this case, for engaging the desired gearing, transferred via the gear set 6c, 7b that

defines the second gear. The control device 15 now again activates the actuator 16b, so that it provides, via the movement transferring mechanism 17b, an activation movement of the synchronising device 10b, so that this is moved from the disconnected state to the synchronising state for the secondary cogwheel 7b that defines the second gear. The secondary cogwheel 7b that defines the second gear, initially has a lower rotational speed than the main shaft 8 during the down-shifting process. The secondary cogwheel 7b must, like that of the countershaft 5, be accelerated before the secondary cogwheel 7b may obtain a synchronous rotational speed with the main shaft 8.

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The control device 15 simultaneously activates the actuator 16a, so that it provides an activation movement, via the shiftable shaft 17a₁ and the fork shaped element 17a₂, of the synchronising device 10a for the secondary cogwheel 7a that defines the first gear. The synchronising device 10a is moved from the disconnected state to the

15 synchronising state. In this case, both the synchronising devices 10a, 10b contribute to the acceleration of the countershaft's 5 rotational speed. The control device 15 also activates the actuator 18a, which moves the locking element 18b toward the latched state. This eliminates the risk that the synchronising device 10a for the secondary cogwheel that defines the first gear, provides a continued movement past the
20 synchronising state to the locked state. As soon as the countershaft's 5 rotational speed has been accelerated to a rotational speed at which the secondary cogwheel 7b that defines the second gear, obtains a synchronous rotational speed with the main shaft 8, the synchronising device 10a for the secondary cogwheel 7a that defines the first gear, provides a movement from the synchronising state to the disconnected state.

25 At the same time or immediately after this, the synchronising device 10b for the secondary cogwheel 7b that defines the second gear, provides a movement from the synchronising state to the locked state, so that the secondary cogwheel 7b that defines the second gear is rotationally locked on the main shaft 8. Accordingly, the gear requested by the driver is engaged in the gearbox. Since two synchronising devices

30 10a, 10b are used in this case in order to accelerate the rotational speed of the countershaft 5, the secondary cogwheel 7b that defines the second gear, relatively quickly obtains a synchronous rotational speed with the main shaft 8. Thus, the shifting time may be reduced. At the same time, a smaller wear on the individual synchronising devices 10a, 10b is achieved, since they share the work during the
35 synchronising process. Since the synchronising device 10a for the secondary cogwheel that defines the first gear, also cooperates at the synchronising of the secondary

cogwheel that defines the second gear, it is used more frequently than the other synchronising devices 10b-c. The synchronising device 10a that defines the first gear, may thus be made more solid and durable than other synchronising devices 10b-c.

- 5 Fig. 4 shows a flow chart in the form of a method for engaging a gear in a gearbox. The method starts at step 21, where information is received from the shifting control 14, regarding that a gear g_1 defined by a first secondary cogwheel must be disengaged from the gearbox, and that a new gear g_2 defined by a second secondary cogwheel, must be engaged in the gearbox. In step 22 it is determined whether the new gear g_2 is
- 10 a higher gear than the original gear g_1 . If so, this is an up-shift. The method continues, in this case, with step 23 where it is determined whether there is a secondary cogwheel, with which an even higher gear g_3 may be maintained in the gearbox, defined by a third secondary cogwheel. It is also determined whether this secondary cogwheel has a synchronising device s_3 that differs from a synchronising device s_2 for the second
- 15 secondary cogwheel. If both these conditions are met, both the synchronising devices s_2, s_3 in step 24 participate in the synchronising of the second secondary cogwheel's rotational speed with the main shaft's rotational speed. When the second secondary cogwheel has obtained a synchronous rotational speed with the main shaft 8, the third synchronising device is moved from the synchronising state to the disconnected state,
- 20 before the synchronising device for the second secondary cogwheel is moved to the locked state.
- If, in step 23, it is determined, instead, that there is no secondary cogwheel with which a higher gear g_3 may be maintained in the gearbox, or if such a gear does not have a synchronising device s_3 differing from a synchronising device s_2 for the second
- 25 secondary cogwheel, the method continues with step 25. In step 25, only the ordinary synchronising device s_2 participates in the synchronisation of the second secondary cogwheel's rotational speed with the main shaft's rotational speed. When the second secondary cogwheel has obtained a synchronous rotational speed with the main shaft 8, the synchronising device s_2 for the second secondary cogwheel is moved to the locked
- 30 state.

- If, in step 22, it is determined that the new gear g_2 is a lower gear than the original gear g_1 , this is a down-shift. The method continues, in this case, with step 26, where it is determined whether there is a secondary cogwheel, with which an even lower gear g_3 , which is defined by a third secondary cogwheel, may be maintained in the gearbox. It
- 35 is also determined whether this secondary cogwheel has a synchronising device s_3 that

differs from a synchronising device s_2 for the second secondary cogwheel. If both these conditions are met, then, in step 27 both the synchronising devices s_2 , s_3 participate in the synchronisation of the second secondary cogwheel's rotational speed with the main shaft's rotational speed. When the second secondary cogwheel has
5 obtained a synchronous rotational speed with the main shaft 8, the third synchronising device is moved from the synchronising state to the disconnected state, before the synchronising device for the second secondary cogwheel is moved to the locked state. If, in step 26, it is determined, instead, that there is no secondary cogwheel with which a lower gear g_3 may be maintained in the gearbox, or if such a gear does not have a
10 synchronising device s_3 that differs from a synchronising device s_2 for the second secondary cogwheel, the method continues with step 28. In step 28, only the ordinary synchronising device s_2 participates in the synchronisation of the second secondary cogwheel's rotational speed with the main shaft's rotational speed. When the second secondary cogwheel has obtained a synchronous rotational speed with the main shaft 8,
15 the synchronising device s_2 for the second secondary cogwheel is moved to the locked state.

Generally, all synchronising devices, which are responsible for synchronising secondary cogwheels defining a lower gear than the gear which is disengaged during a
20 down-shifting process, may be used as an extra synchronising device during at least a part of the synchronising time, in addition to the ordinary synchronising device in connection with the engagement of the lower gear in the gearbox. Similarly, all synchronising devices, which are responsible for synchronising secondary cogwheels defining a higher gear than the gear which is engaged during an up-shifting process,
25 may be used, during at least a part of the synchronising time, in addition to the ordinary synchronising device in connection with the engagement of the higher gear in the gearbox.

The invention is not limited to the embodiment described above, but may be varied
30 freely within the scope of the patent claims. In the above described embodiment, one of the synchronising devices is used as an extra synchronising device. Obviously, any number of synchronising devices may be used as an extra synchronising device at synchronisation processes in connection with engagement of a gear in the gearbox, and be equipped with a latch device, which ensures that they are not moved to the locked
35 state by mistake.

Claims

1. Arrangement for engaging a gear in a gearbox, wherein the gearbox comprises a countershaft (5), a main shaft (8), several gear sets, each of which comprises a primary cogwheel (6a-e), which is rotatably arranged on the countershaft (5), and a secondary cogwheel (7a-e), which is arranged on the main shaft (8), and a synchronising device (10a-c) for the secondary cogwheels (7a-e), which may be set in a disconnected state, whereat it allows the secondary cogwheels (7a-e) to rotate freely on the main shaft (8), in a synchronising state whereat it provides a synchronisation of the secondary cogwheels' (7a-e) rotational speed with the main shaft's (8) rotational speed, and in a locked state whereat it provides a rotational locking of the secondary cogwheels (7a-e) on the main shaft (8), an actuator (16a, 16b) for each one of the synchronising devices (10a, 10b), a movement transferring mechanism (17a, 17b), which transfers activation movements from the actuators (16a, 16b) to the respective synchronising devices (10a, 10b), and a control device (15), adapted to control the activation of the actuators (16a, 16b), wherein the arrangement (13) is adapted, in connection with the disengagement of a gear defined by a first secondary cogwheel (7c) and an engagement of a gear defined by a second secondary cogwheel (7b), to provide an activation movement for the synchronising device (10b) for the secondary cogwheel (7b), from the initial position to the synchronising position, and then to the locking position, and also to provide an activation movement during the engaging of said gear, which is defined by the second secondary cogwheel (7b), by at least one extra synchronising device (10a) for a third secondary cogwheel (7a), and to set the extra synchronising device (10a) in the synchronising state for during at least a part of the time when the synchronising device (10b) for the second secondary cogwheel (7b) is in the synchronising state, so that the extra synchronising device (10a) also participates in the synchronisation of the second secondary cogwheel's (7b) rotational speed with the main shaft (8),
characterised in that the arrangement comprises a latch device (18), adapted to prevent that the extra synchronising device (10a) obtains a movement from the synchronising state to the locked state, wherein the latch device (18) comprises a latch element (18b) and an actuator (18a), which is adapted to move the latch element (18b) to a latched state, whereat it blocks the movement of a component (17a₂) of the movement transferring mechanism (17a), so that the extra synchronising device (10a) is prevented from being moved to the locked state.

2. Arrangement according to claim 1, characterised in that the arrangement is adapted, in connection with engagement of a lower gear in the gearbox, to activate an extra synchronising device (10a) for a third secondary cogwheel (7a) that defines a lower gear than the gear defined by the first secondary cogwheel (7c).

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3. Arrangement according to claim 2, characterised in that the arrangement is adapted, in connection with engagement of a lower gear in the gearbox, to activate an extra synchronising device (10a) for a third secondary cogwheel (7a) that defines a lower gear than the gear defined by the second secondary cogwheel (7b).

10

4. Arrangement according to any of the previous claims, characterised in that the arrangement is adapted, in connection with engagement of a higher gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel that defines a higher gear than the gear defined by the first secondary cogwheel.

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5. Arrangement according to claim 4, characterised in that the arrangement (13) is adapted, in connection with engagement of a higher gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel that defines a higher gear than the gear defined by the second secondary cogwheel.

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6. Arrangement according to any of the previous claims, characterised in that the arrangement (13) is adapted to move the extra synchronising device (10a) for the third secondary cogwheel (7a) from the synchronising state to the disconnected state, before it provides an activation movement of the synchronising device (10b) for the second secondary cogwheel (7b) to the locked state.

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7. Arrangement according to any of the previous claims, characterised in that the extra synchronising device (10a) is adapted in such a way that it has more durable strength characteristics than the other synchronising devices (10b).

30

8. Method for engaging a gear in a gearbox, wherein the gearbox comprises a countershaft (5), a main shaft (8), several gear sets, each of which comprises a primary cogwheel (6a-e), which is rotatably arranged on the countershaft (5), and a secondary cogwheel (7a-e), which is arranged on the main shaft (8), and a synchronising device (10a-c) for the secondary cogwheels (7a-e), which may be set in a disconnected state whereat it allows the secondary cogwheels (7a-e) to rotate freely on the main shaft (8),

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- in a synchronising state whereat it provides a synchronisation of the secondary cogwheels' (7a-e) rotational speed with the main shaft's (8) rotational speed, and in a locked state whereat it provides a rotational locking of the secondary cogwheels (7a-e) on the main shaft (8), an actuator (16a, 16b) for each one of the synchronising devices (10a, 10b), a movement transferring mechanism (17a, 17b), which transfers activation movements from the actuators (16a, 16b) to the respective synchronising devices (10a, 10b), wherein the method comprises the step that, in connection with the disengagement of a gear defined by a secondary cogwheel (7c) and an engagement of a gear defined by a second secondary cogwheel (7b), to provide an activation movement of the synchronising device (10b) for the second secondary cogwheel (7b), from the initial position to the synchronising position, and then to the locking position, and also to provide an activation movement during the engagement of the said gear of at least one extra synchronising device (10a) for a third secondary cogwheel (7a), and to set the extra synchronising device (10a) in the synchronising state during at least a part of the time when the synchronising device (10b) for the second secondary cogwheel (7b) is in the synchronising state, so that the extra synchronising device (10a) also participates in the synchronisation of the second secondary cogwheel's (7b) rotation speed with the main shaft (8), characterised by the steps to prevent the extra synchronising device (10a) from obtaining a movement from the synchronising state to the locked state, in connection with its participation in the synchronisation of the second secondary cogwheel's (7a-d) rotational speed and of blocking the movement of a component (17a₂) in the movement transferring mechanism (17a), so that the extra synchronising device (10a) is prevented from being moved to the locked state.
- 25 9. Method according to claim 8, characterised by the steps of, in connection with engaging a lower gear in the gearbox, activating an extra synchronising device (10a) for a third secondary cogwheel (7a) that defines a lower gear than the gear defined by the first secondary cogwheel (7c).
- 30 10. Method according to claim 9, characterised by the step of, in connection with engagement of a lower gear in the gearbox, activating an extra synchronising device (10a) for a third secondary cogwheel (7a) that defines a lower gear than the gear defined by the second secondary cogwheel (7b).
- 35 11. Method according to any of the previous claims 8-10, characterised by the step of, in connection with engagement of a higher gear in the gearbox, activating an extra

synchronising device for a third secondary cogwheel that defines a higher gear than the gear defined by the first secondary cogwheel (7a-d).

12. Method according to claim 11, characterised in that the arrangement (13) is
5 adapted, in connection with engagement of a higher gear in the gearbox, to activate an extra synchronising device for a third secondary cogwheel that defines a higher gear than the gear defined by the second secondary cogwheel.

13. Method according to any of the previous claims 8-12, characterised by the step of
10 moving the extra synchronising device (10a) for the third secondary cogwheel (7a) from the synchronising state to the disconnected state, before the synchronising device (10b) for the second secondary cogwheel (7b) is moved to the locked state.

14. Vehicle with a gearbox comprising an arrangement according to any of claims 1-7.
15

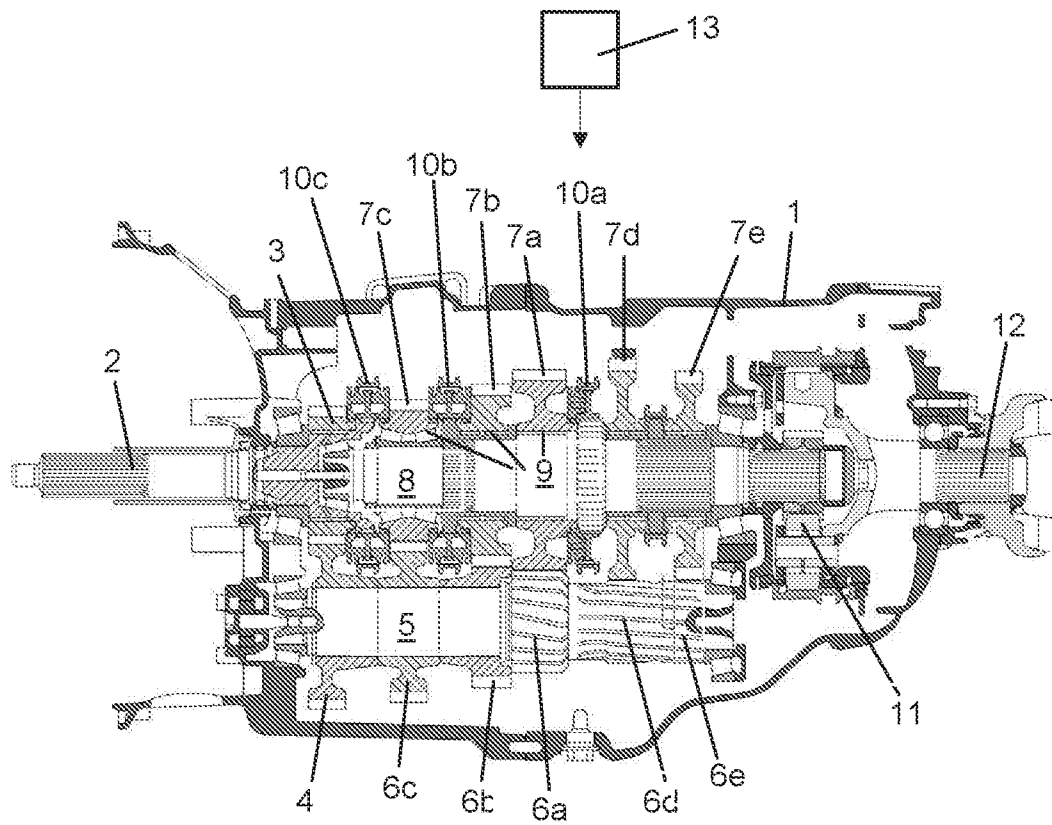


Fig 1

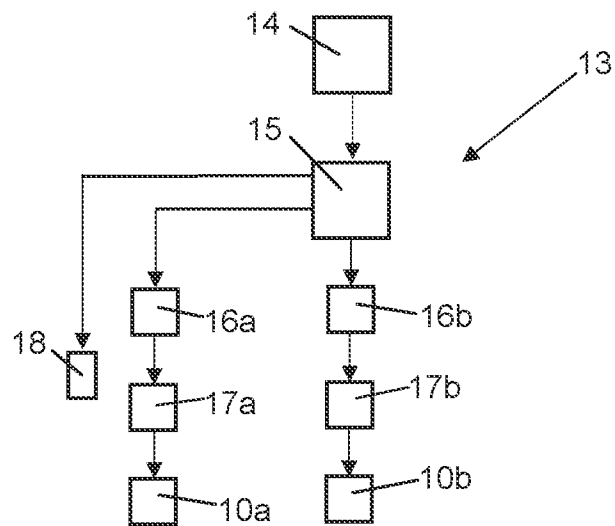


Fig 2

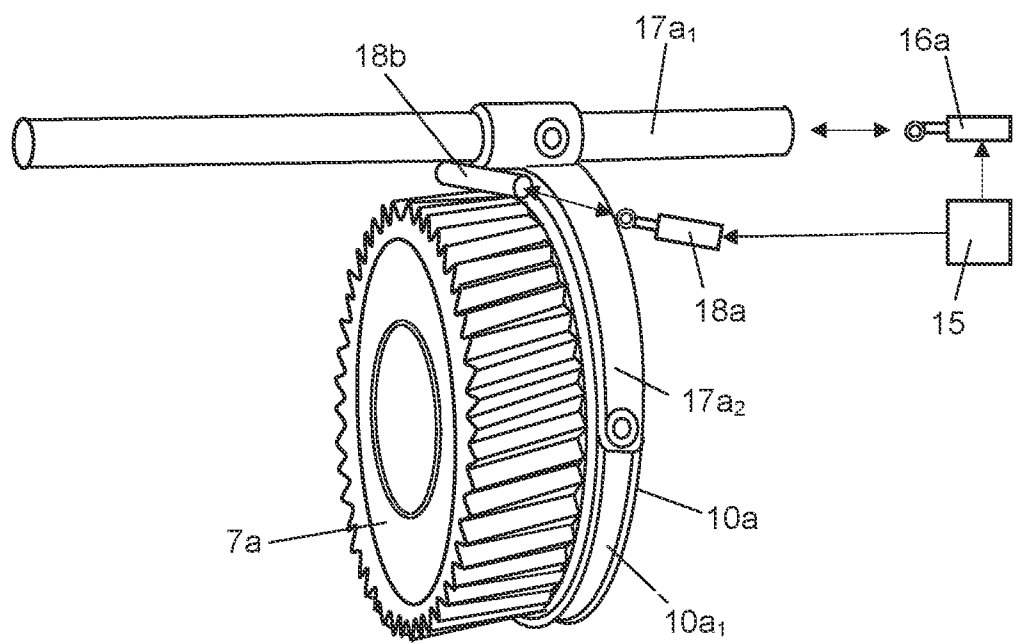


Fig 3

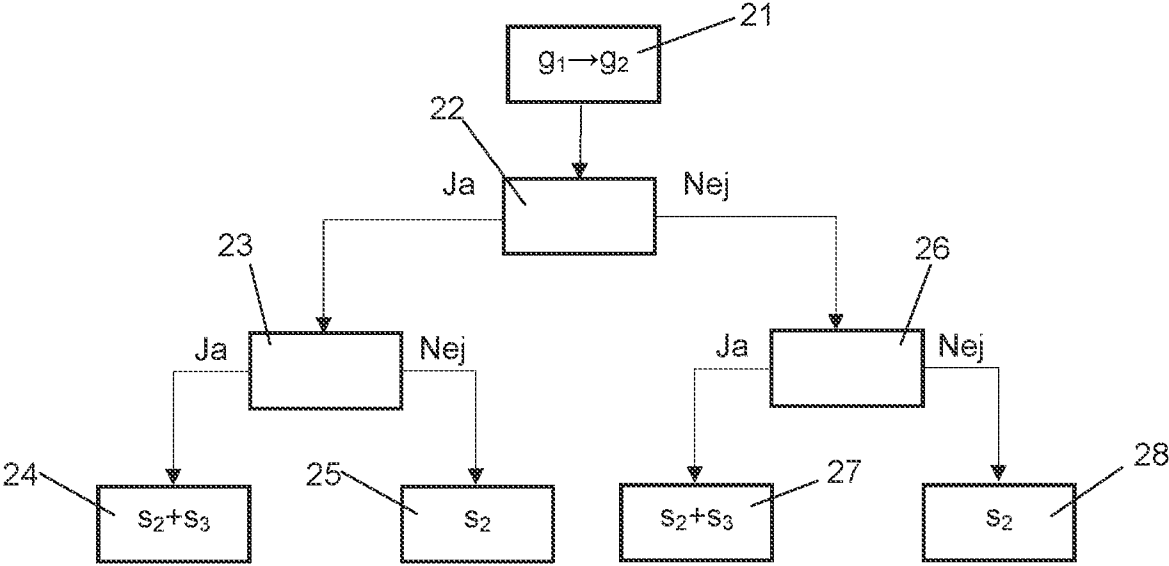


Fig 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050376

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B60W, F16D, F16H

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2131065 A2 (AISIN AI CO LTD), 9 December 2009 (2009-12-09); abstract; paragraphs [0035]-[0040], [0051]-[0053]; figures 1,5-8 --	1-14
Y	US 5433125 A (MUELLER ROBERT), 18 July 1995 (1995-07-18); abstract; column 2, line 66 - column 3, line 20; figure 1 --	1-14
Y	US 20040192503 A1 (MATSUMURA TETSUO ET AL), 30 September 2004 (2004-09-30); abstract; paragraphs [0006]-[0011], [0152]-[0158], [0197]-[0200]; figures 11,15 --	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

01-07-2015

Date of mailing of the international search report

02-07-2015

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050376

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	DE 10029527 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN), 10 January 2002 (2002-01-10); abstract; paragraphs [0025]-[0026]; figure 4 --	1-14
A	US 4449416 A (HUITEMA THOMAS W), 22 May 1984 (1984-05-22); abstract -- -----	1-14

Continuation of: second sheet

International Patent Classification (IPC)

F16H 61/04 (2006.01)

B60W 30/19 (2012.01)

F16D 23/02 (2006.01)

F16H 63/34 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2015/050376

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US	4449416 A	22/05/1984	NONE		