



The dry double clutch

Technology/special tools



Audi, SEAT, ŠKODA, Volkswagen, 0AM 7-speed transmission
Renault, DC4 6-speed transmission
Ford, DPS6 6-speed transmission



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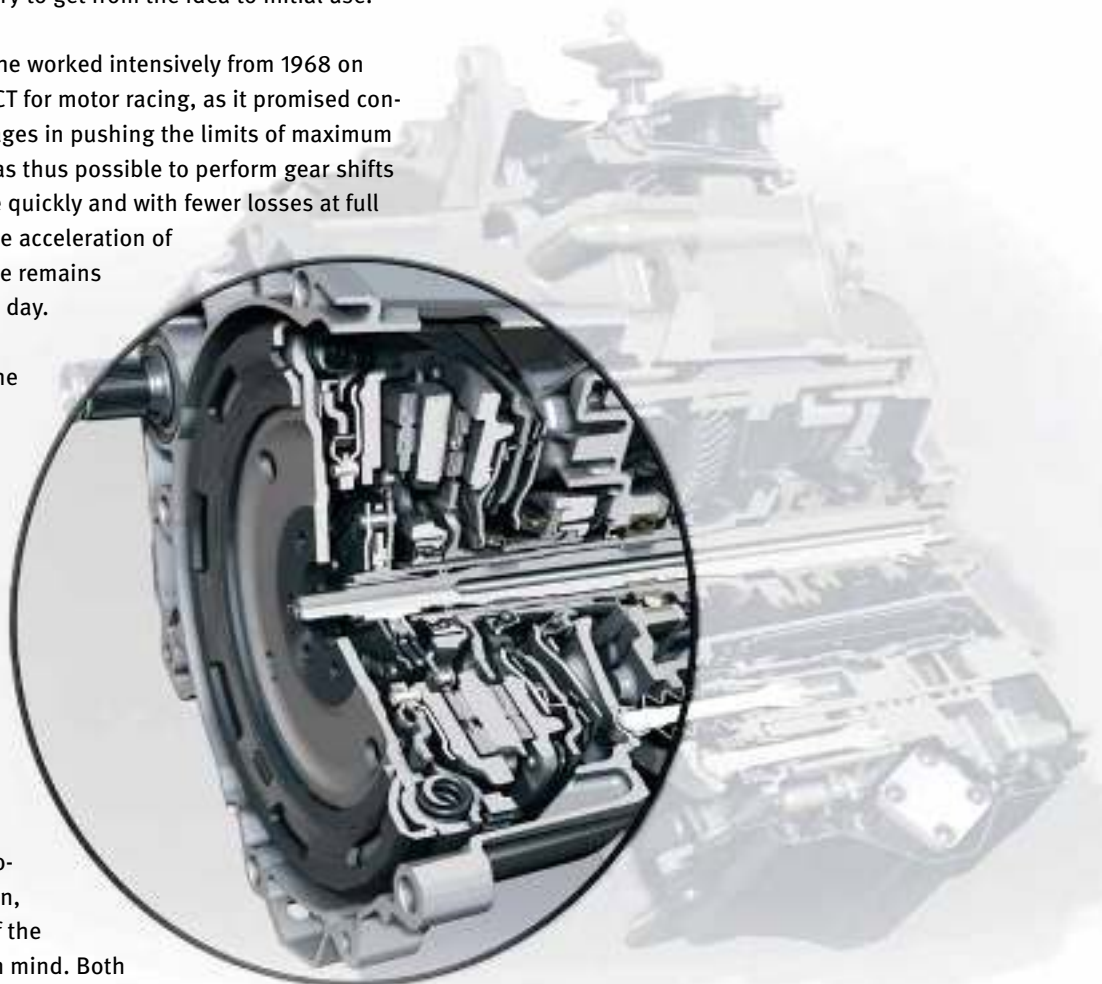
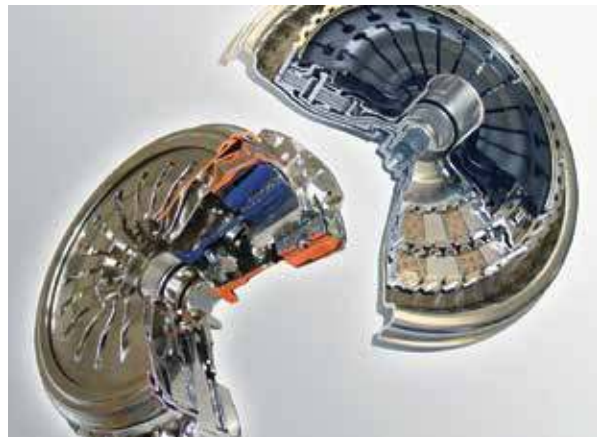
1 The double clutch transmission (DCT)

Since automatic torque converter transmissions have been in existence, their greatest advantage, gear shifts under load, has been highly valued. However, due to converter losses, automatic transmissions had considerably reduced efficiency in comparison with manual transmissions. For this reason, great efforts were already being made to develop a DCT from an early stage. The objective was to combine the efficiency of manual transmissions with the comfort of automatic transmissions in a new transmission design.

The French inventor Adolphe Kégresse and Darmstadt-based Professor Rudolf Franke registered the first patents for a type of DCT in 1939/40. However, it took a good quarter of a century to get from the idea to initial use.

Most of all, Porsche worked intensively from 1968 on developing the DCT for motor racing, as it promised considerable advantages in pushing the limits of maximum acceleration. It was thus possible to perform gear shifts significantly more quickly and with fewer losses at full tractive power. The acceleration of cars from that time remains impressive to this day.

For many years, the DCT was merely used as a special solution for use in sport, but in the mid-90s the transmission system increasingly became the focus of automotive development. During the search for an alternative to automatic transmission, the advantages of the DCT were borne in mind. Both the sports and consumer-oriented requirements of European customers as well as stricter laws to promote a reduction in CO₂ emissions ultimately gave the decisive impetus for development for series production. In autumn 2002, the Volkswagen Group presented the first production vehicle with this technology. It initially contained a wet double clutch (running in an oil bath), followed five years later by the dry version. This type of transmission is now supplied by other renowned automotive manufacturers.



What is a double clutch transmission?

The DCT consists of two independent sub-transmissions positioned in a single transmission housing. Each sub-transmission is constructed like a manual transmission in terms of function. Consequently, each sub-transmission is assigned its own clutch. Dry and wet versions of the clutches are possible, depending on the engine torque and mounting space.

While driving, all the processes of a gear shift are regulated automatically. A control unit relays commands to either an electrohydraulic or electromechanical actuating mechanism. This enables the clutches and gear shift forks to perform their work within a precisely defined time window. One sub-transmission is therefore always connected to the engine in a non-positive connection. In the other sub-transmission, the next gear is pre-selected and is ready to be requested. In driving mode, the clutches are then actuated alternately within a matter of milliseconds. For the driver, this means, among other things, greater driving comfort due to barely noticeable interruptions of tractive power when accelerating.

An overview of all the advantages of a double clutch transmission



- Combines the comfort of automatic transmissions with the responsiveness of manual transmissions
- Similar properties to an automatic transmission, but with excellent efficiency
- Barely noticeable interruption of tractive power when performing crossover gear shifts
- Reduction in fuel consumption
- Reduction in CO₂ emissions

This brochure describes the function and design of LuK's various dry double clutch systems.

2 Design and function of the dry double clutch system — Audi, SEAT, ŠKODA, Volkswagen

The double clutch system consists of three main components: the dual mass flywheel (DMF), the double clutch (DC) and the engaging system. The system is controlled by the mechatronics. These consist of an electronic control unit, sensors and an electrohydraulic control unit (actuating mechanism). These functional groups are combined in a single housing. The compact design enables integration into the transmission housing without requiring any extra space.

In driving mode, the mechatronics evaluate, among other things, the following information:

- Speed of both transmission input shafts
- Wheel speed and driving speed
- Gear selection
- Accelerator pedal position (acceleration or deceleration)

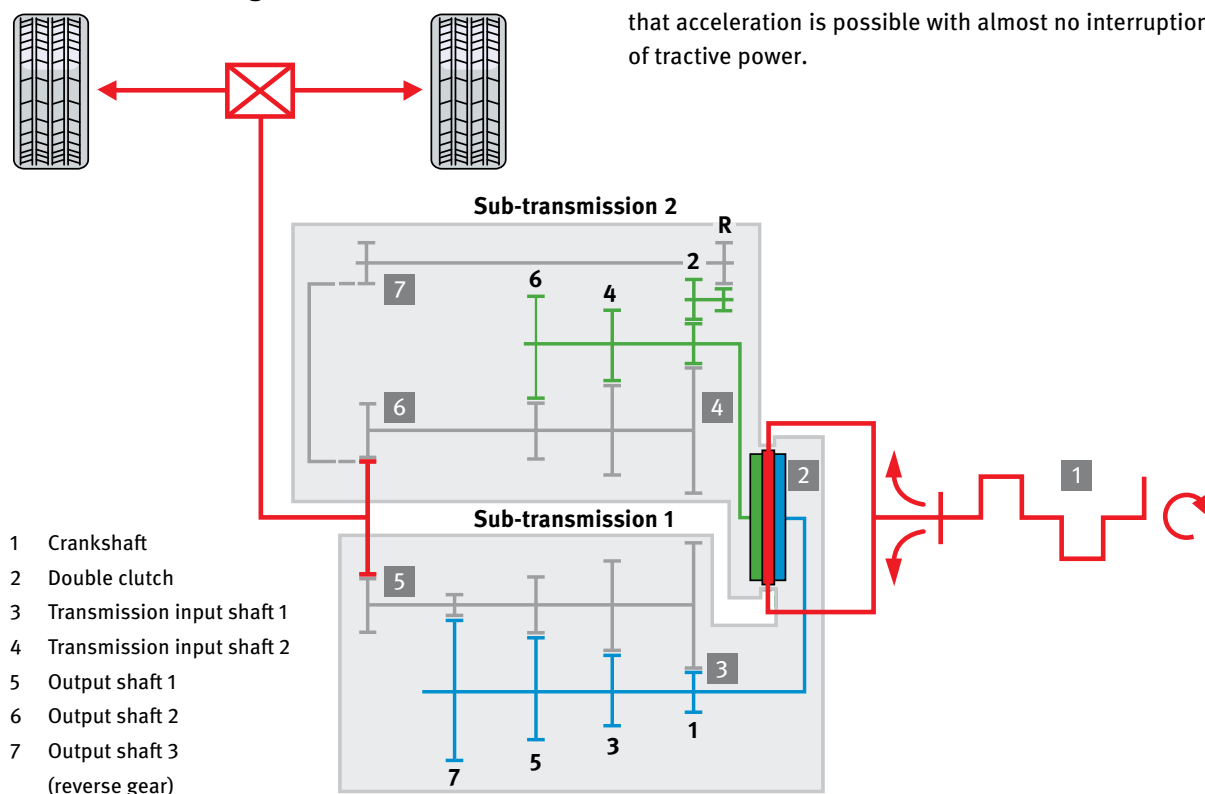
Depending on this data, the mechatronics calculate which gear is to be selected and engage the gear by means of the gear actuator and the gear shift forks. The clutches are opened and closed by means of two actuator cylinders, which each activate an engagement lever.



- 1 Dual mass flywheel
- 2 Double clutch
- 3 Engaging system

The system is constructed so that both sub-clutches are open when the engine is idling and in neutral and are not closed until the engagement lever is activated (normally open). One clutch is always closed in driving mode and therefore one sub-transmission is always connected in a non-positive connection. The gear in the other sub-transmission is already pre-selected since the clutch for this sub-transmission is still open. During a gear shift, one clutch opens while the other clutch closes simultaneously. The force transmission is then transmitted via the previously engaged gear. This means that acceleration is possible with almost no interruption of tractive power.

Transmission diagram



2.1 Double clutch

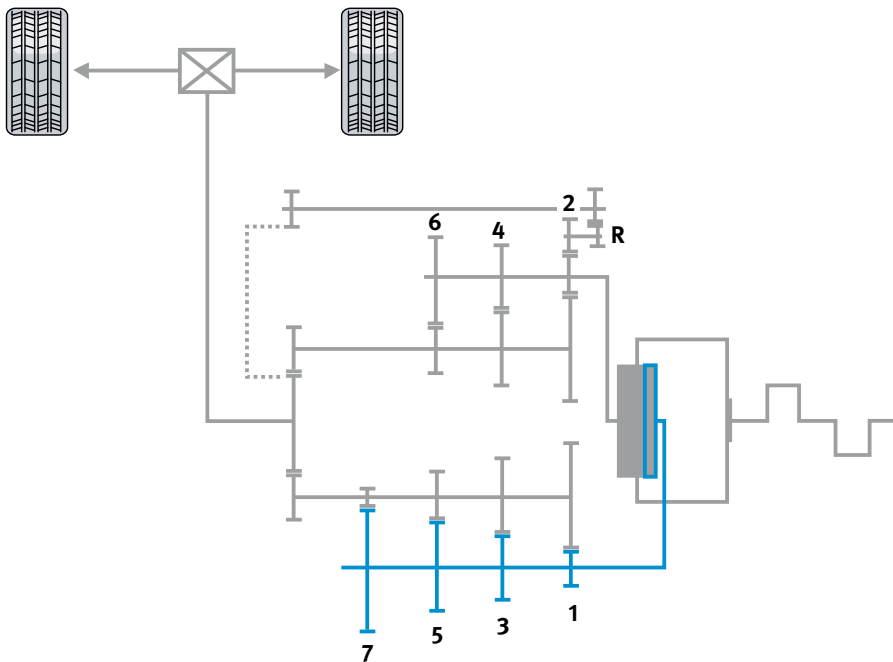
Basic principle

In the case of 7-speed double clutch transmissions, each sub-transmission is constructed like a manual transmission in terms of function. A sub-clutch is responsible for each sub-transmission. Both clutches are located on two interlocking transmission input shafts, the outer hollow

shaft and the inner solid shaft. Gears 1, 3, 5 and 7 are engaged by clutch 1 (K1) and the torque is induced in the transmission via the solid shaft. Gears 2, 4, 6 and reverse are engaged by clutch 2 (K2) and the torque is induced in the transmission via the hollow shaft.

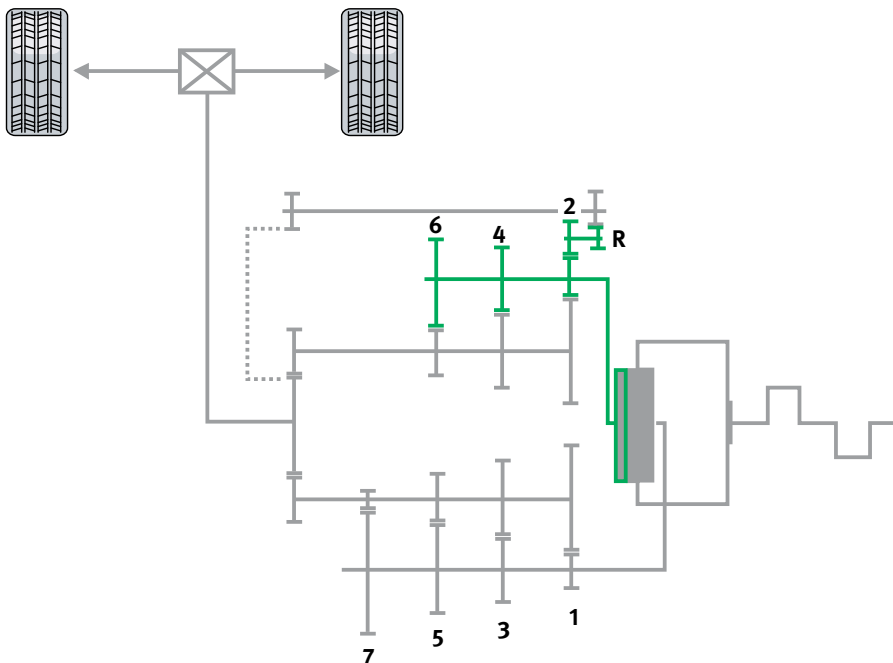
Clutch 1 (K1)

K1 is responsible for gears 1, 3, 5 and 7.



Clutch 2 (K2)

K2 is responsible for gears 2, 4, 6 and reverse.



Design

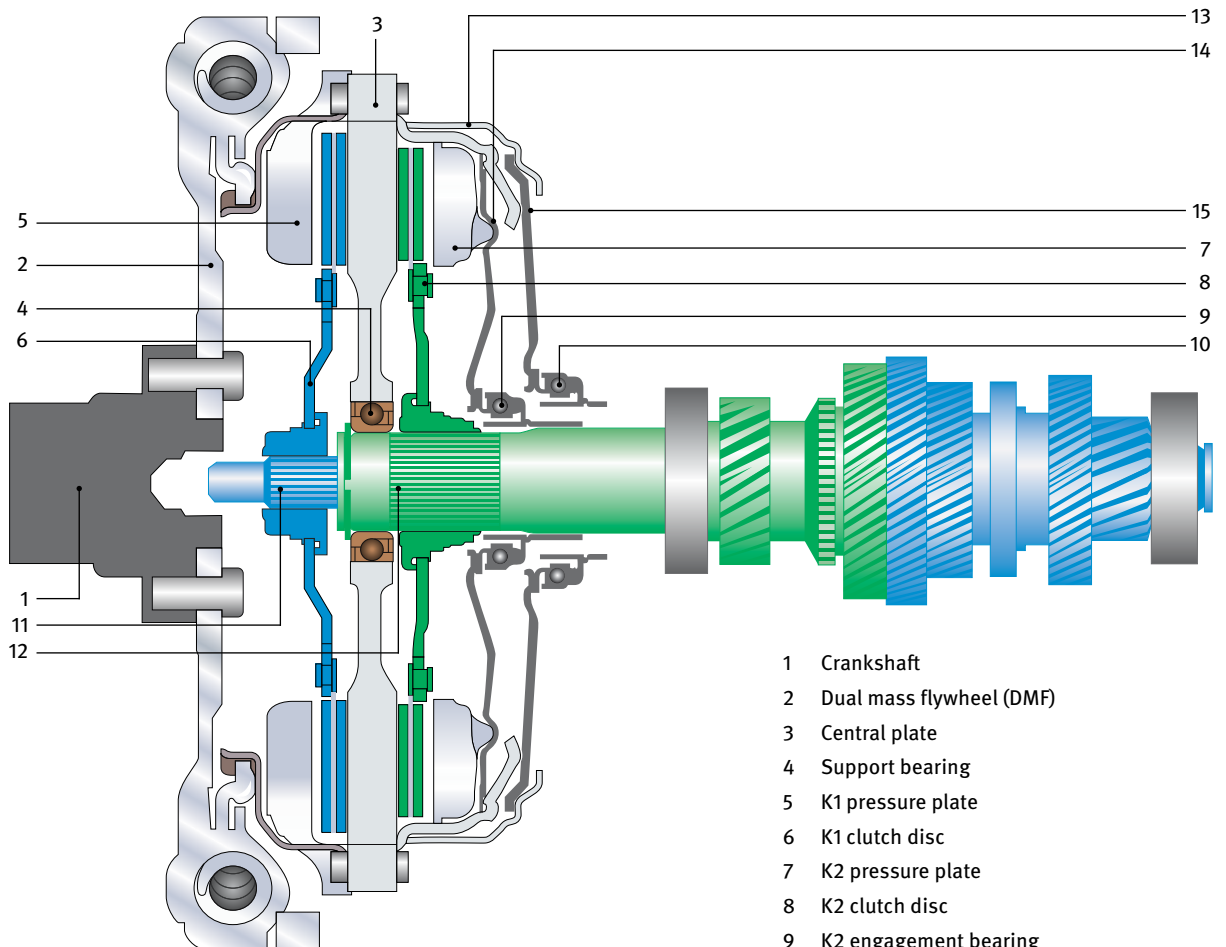


- 1 K1 driving ring with pressure plate
- 2 K1 clutch disc
- 3 Central plate
- 4 K2 clutch disc
- 5 K2 pressure plate

- 6 Lever spring with adjustment device for K2
- 7 Clutch cover with adjustment device for K1
- 8 K1 lever spring
- 9 Retaining ring
- 10 Stop ring

The central plate with its two friction surfaces forms the core of the clutch. It is secured to the hollow shaft via a support bearing.

A clutch disc and the corresponding pressure plate are positioned on each side.

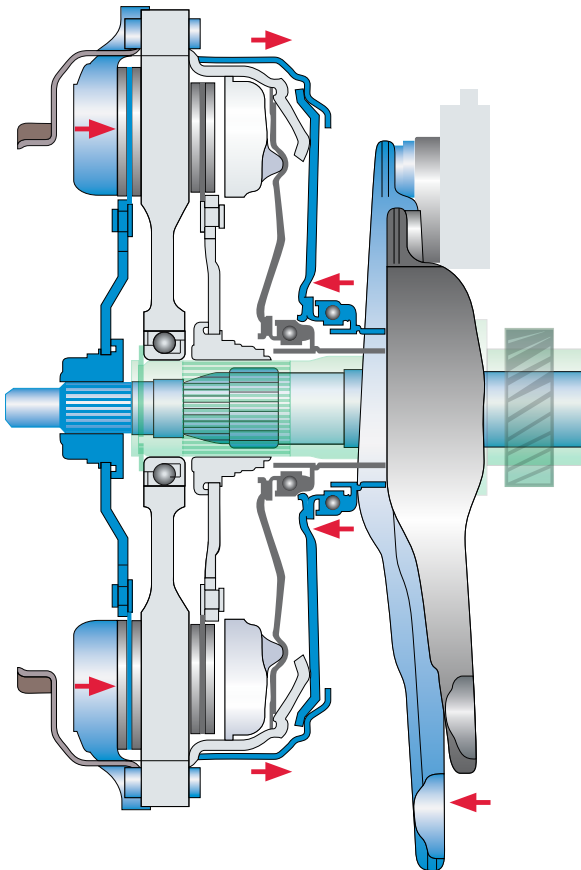


- 1 Crankshaft
- 2 Dual mass flywheel (DMF)
- 3 Central plate
- 4 Support bearing
- 5 K1 pressure plate
- 6 K1 clutch disc
- 7 K2 pressure plate
- 8 K2 clutch disc
- 9 K2 engagement bearing
- 10 K1 engagement bearing
- 11 Transmission input shaft 1 (solid shaft)
- 12 Transmission input shaft 2 (hollow shaft)
- 13 Retaining ring
- 14 K2 lever spring
- 15 K1 lever spring

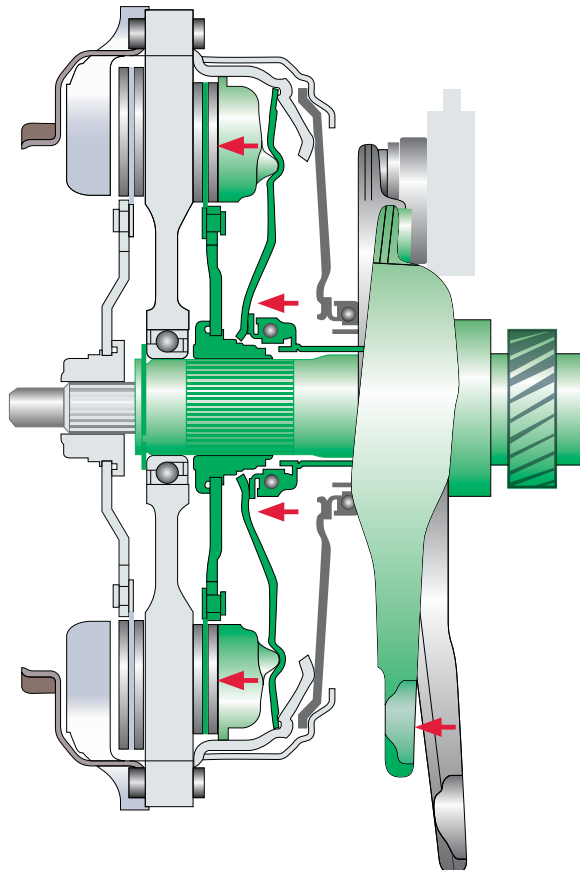
Function

If one of gears 1, 3, 5 or 7 is to be used when driving, the mechatronics actuate the large engagement lever. This closes K1 and the power is transmitted to the solid shaft. While driving in an "uneven" gear, the mechatronics engage the next highest or next lowest gear. This gear "waits" until K2 is closed.

If a shift to gear 2, 4, 6 or reverse is then necessary, the large engagement lever is driven back, thus opening K1. At the same time, the mechatronics actuate the small engagement lever. K2 is closed and the torque is transmitted to the hollow shaft.



- The force of the large engagement lever of K1 is transferred to the lever spring via the engagement bearing and via the deflection points of the pressure plate housing in the reverse direction of action
- The K1 pressure plate moves towards the central plate, thus closing the clutch



- The small engagement lever presses the K2 pressure plate against the K2 clutch disc, thus closing the clutch

2.2 Engaging system

Two different engaging systems are used in Audi, SEAT, ŠKODA and Volkswagen vehicles. The first generation was used in production until May 2011; the second generation has been used in volume production since June 2011.

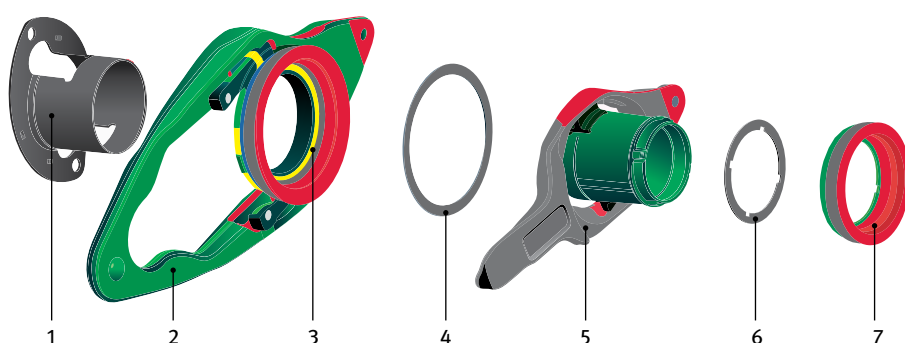
Both systems differ in terms of appearance and technology. Therefore, when repairs are necessary, the entire engaging system must be renewed. The date on the installed transmission can be read off in order to identify which of the two systems is concerned. The date is located near the parking lock cover and also in the area around the mechatronics.

Design

In the first generation, the engagement levers are forged and can be recognised by their rough surface.

Both levers are supported in the clutch housing by a replaceable counter-bearing. Adjusting shims are used on (K1) or under (K2) the respective engagement bearing in order to compensate for axial tolerances.

First generation engaging system*



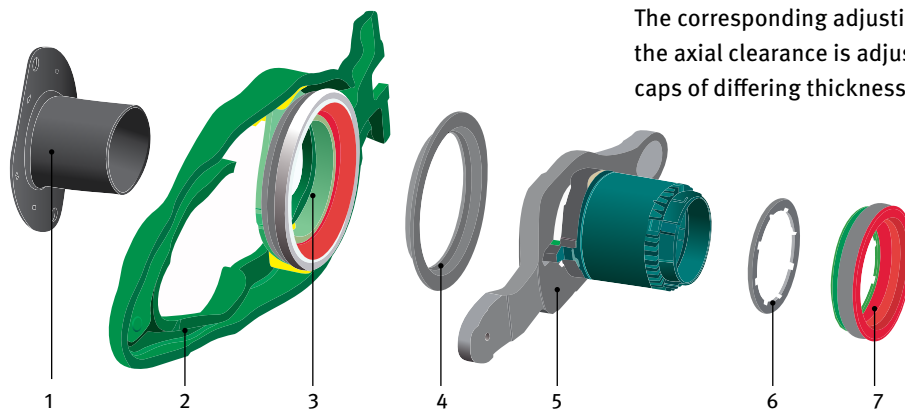
* Up to May 2011 transmission production date, with forged engagement levers

- | | |
|--|--|
| 1 Guiding sleeve | 5 Small engagement lever with guiding pistons for C2 |
| 2 Large engagement lever for engagement bearing K1 | 6 Adjusting shim with 4 or 8 recesses for K2 |
| 3 K1 engagement bearing | 7 Engagement bearing for K2 |
| 4 Adjusting shim for K1 | |

The two second generation engagement levers are made of sheet steel and have a smooth surface.

The K1 lever is supported in the clutch housing by a non-replaceable hinge bearing. In contrast, the counter-bearing (ball head) for the C2 lever is always replaced in the event of a repair. Another change is the K1 engagement bearing, which is now designed as a spherical bearing. The corresponding adjusting shim is omitted. Instead, the axial clearance is adjusted by means of spherical caps of differing thicknesses.

Second generation engaging system*



* From June 2011 transmission production date, with sheet steel engagement levers

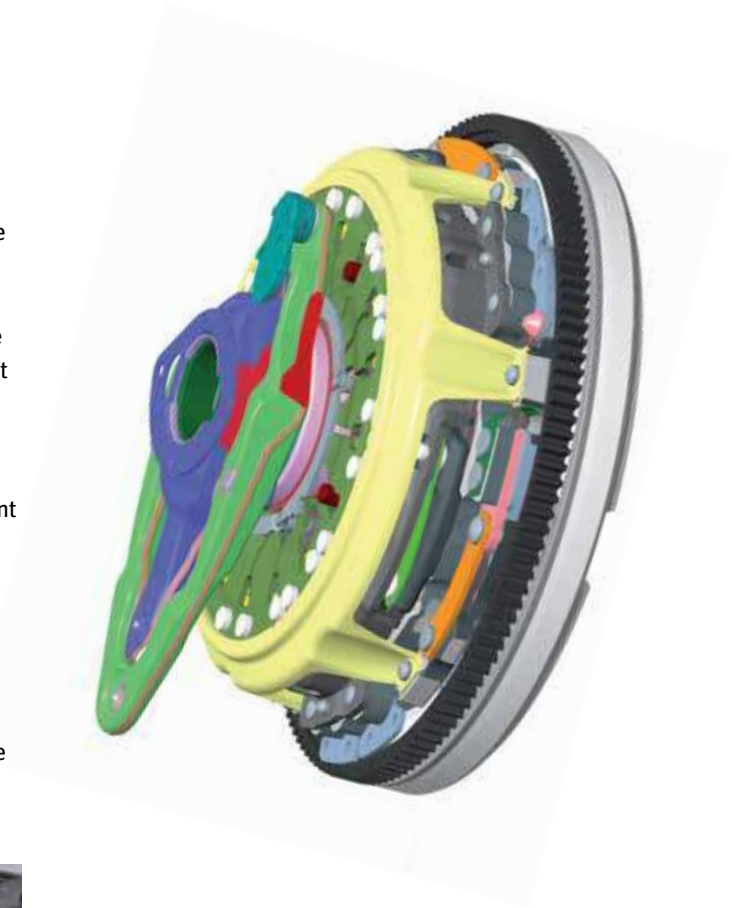
- | | |
|--|--|
| 1 Guiding sleeve | 5 Small engagement lever with guiding pistons for C2 |
| 2 Large engagement lever for engagement bearing K1 | 6 Adjusting shim with 8 recesses for K2 |
| 3 K1 engagement bearing | 7 Engagement bearing for K2 |
| 4 Adjusting spherical cap for K1 | |

Function

In previous manual transmissions with a single disc clutch, the clutch is closed when idling. It is opened by pressing on the clutch pedal, which disconnects the transmission of power. This takes place via the "release system".

In contrast, the clutches in this double clutch system are open when idling. They are closed when the engagement lever is actuated. This is therefore referred to as an engaging system.

The mechatronics alternately activate the two engagement levers along with the engagement bearings by means of two tappets. The engagement levers are supported by the counter-bearings and transfer the force to the lever springs via the engagement bearings. This closes the corresponding clutch. The wear of the clutch discs is compensated for by an integrated self-adjustment device. In this way, the position of both actuators in the mechatronics are always kept constant over the whole service life.



3 Design and function of the dry double clutch system — Renault

The Renault double clutch system consists of three main components: the dual mass flywheel (DMF), the double clutch (DC) and the engaging system with lever actuators. The transmission control unit, which is located on the outside of the transmission housing, controls two servo motors. These set the lever actuators into motion and cause the clutches to close and open alternately.

In driving mode, the transmission electronics evaluate, among other things, the following information:

- Transmission input speed
- Vehicle speed
- Gear selection
- Accelerator pedal position
- Brake pedal information

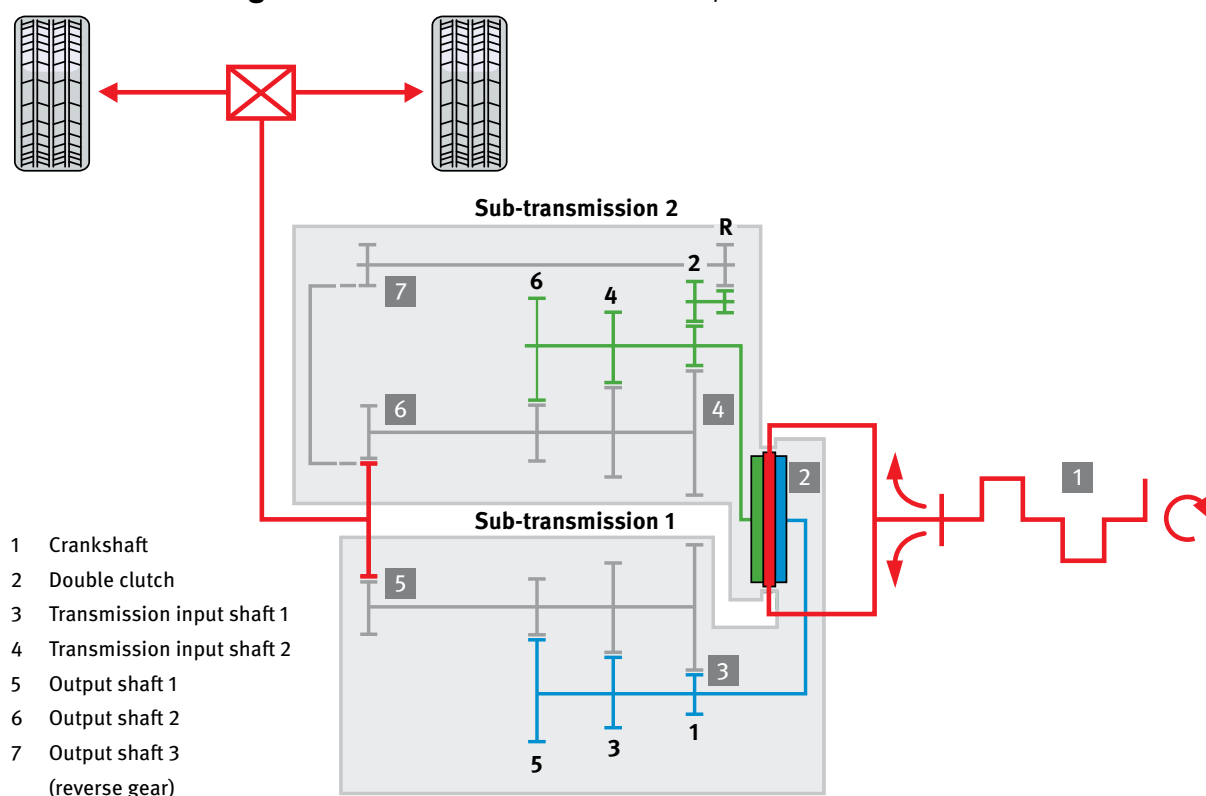
Depending on this data, the control unit calculates which gear is to be selected and engages the gear by means of gear change motors. These are located in the transmission control unit and act directly upon the gear shift forks inside the transmission.



- 1 Dual mass flywheel
- 2 Double clutch
- 3 Guiding sleeve with engagement bearing
- 4 Lever actuators with servo motors

The double clutch system contains two clutches that are open when the engine is idling and in neutral (normally open). One clutch is always closed in driving mode and therefore one sub-transmission is always connected. The gear in the other sub-transmission is already pre-selected since the clutch for this sub-transmission is still open. During a gear shift, one clutch opens while at the same time the other closes. The power is then transmitted via the previously engaged gear. This means that it is possible to drive with almost no interruption of tractive power.

Transmission diagram



3.1 Double clutch

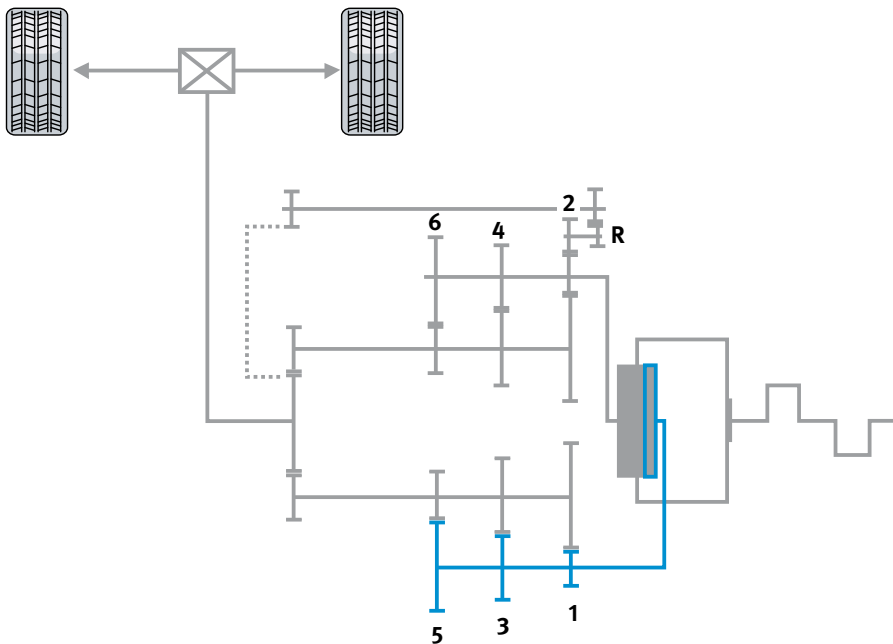
Basic principle

Each sub-transmission in the Renault double clutch transmission is constructed like a manual transmission. One clutch is responsible for each sub-transmission. Both clutches are located on two interlocking transmission input shafts, the outer hollow shaft and the inner solid shaft.

Gears 1, 3 and 5 are engaged by K1 and the torque is transmitted to the transmission via the solid shaft. Gears 2, 4, 6 and reverse are engaged by K2 and the torque is induced in the transmission via the hollow shaft.

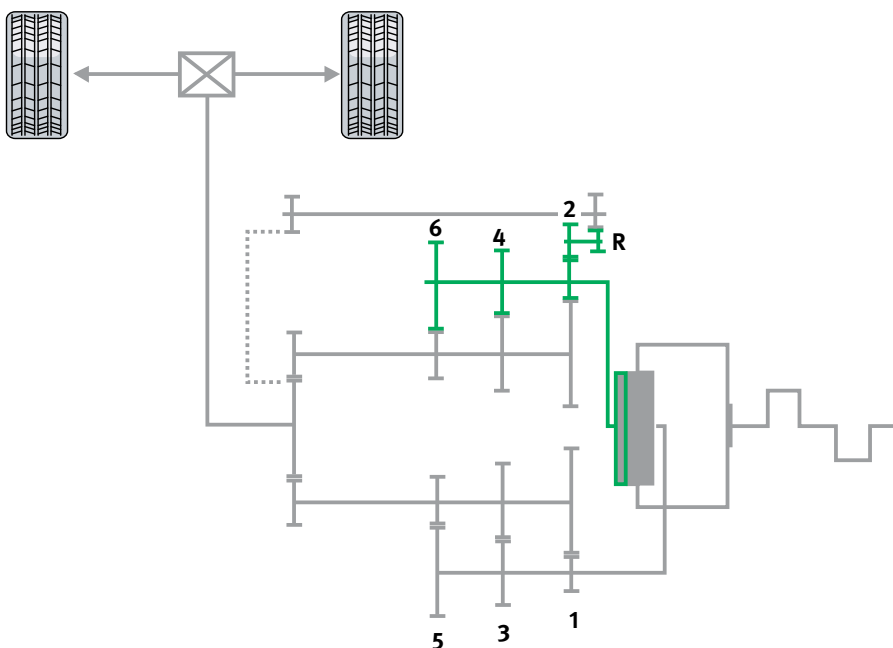
Clutch 1 (K1)

K1 is responsible for gears 1, 3 and 5.

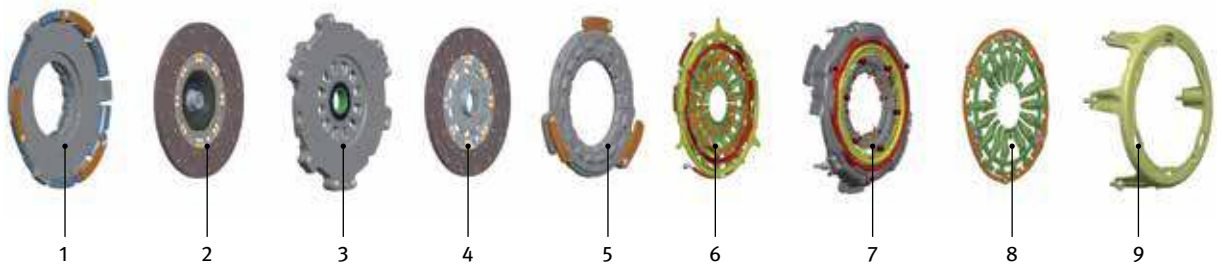


Clutch 2 (K2)

K2 is responsible for gears 2, 4, 6 and reverse.



Design

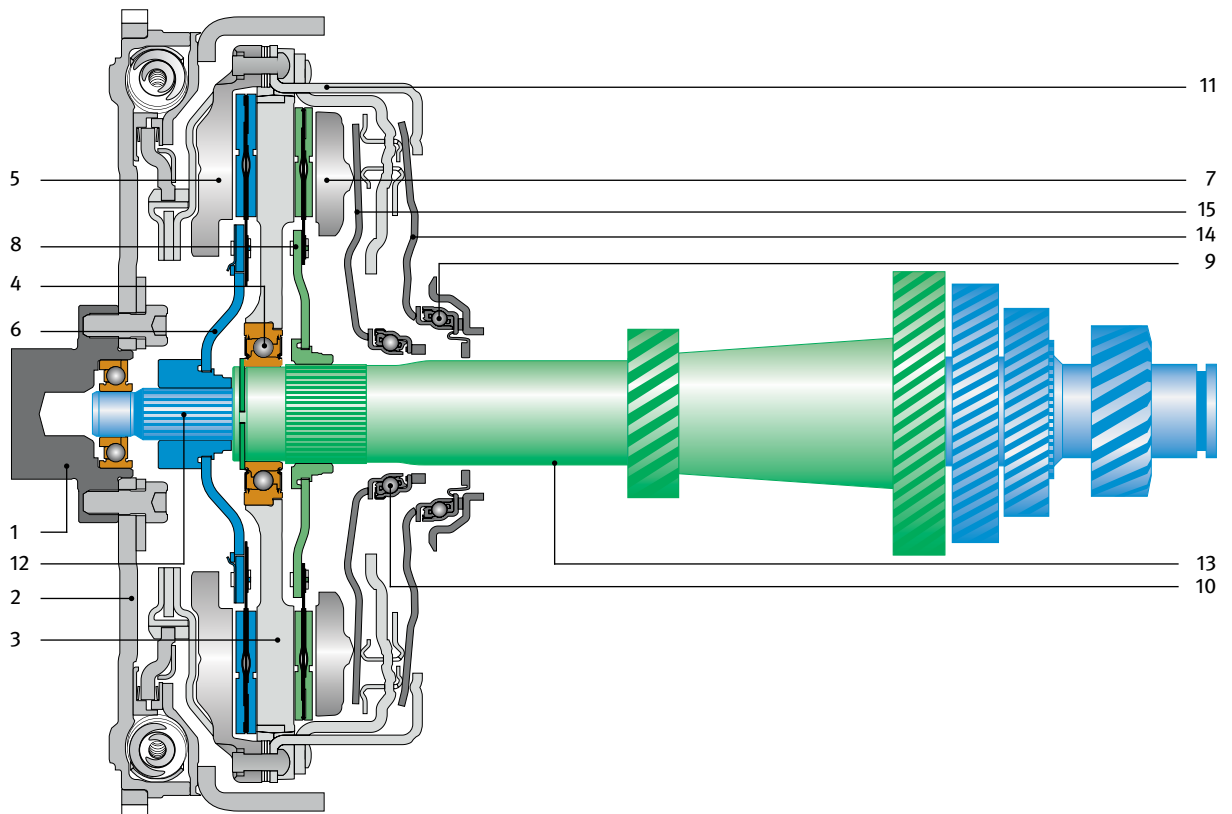


- 1 K1 driving ring with pressure plate
- 2 K1 clutch disc
- 3 Central plate
- 4 K2 clutch disc
- 5 K2 pressure plate

- 6 Lever spring with adjustment device for K2 and the K2 transport fastener
- 7 Clutch cover with adjustment device for K1 and the K1 transport fastener
- 8 K1 lever spring
- 9 Retaining ring

The central plate with its two friction surfaces forms the core of the clutch. It is secured to the hollow shaft via a support bearing.

A clutch disc and the corresponding pressure plate are positioned on each side.



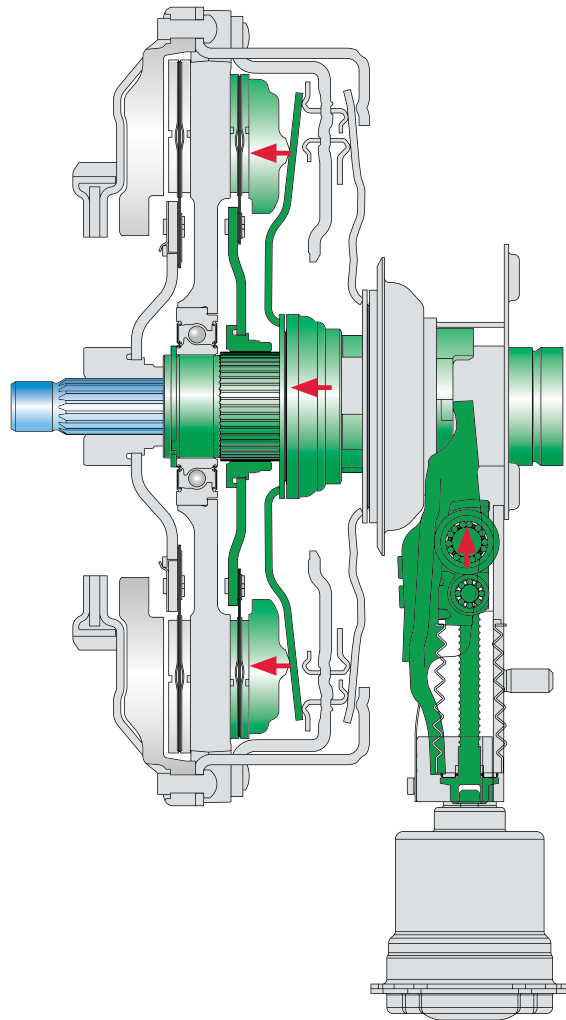
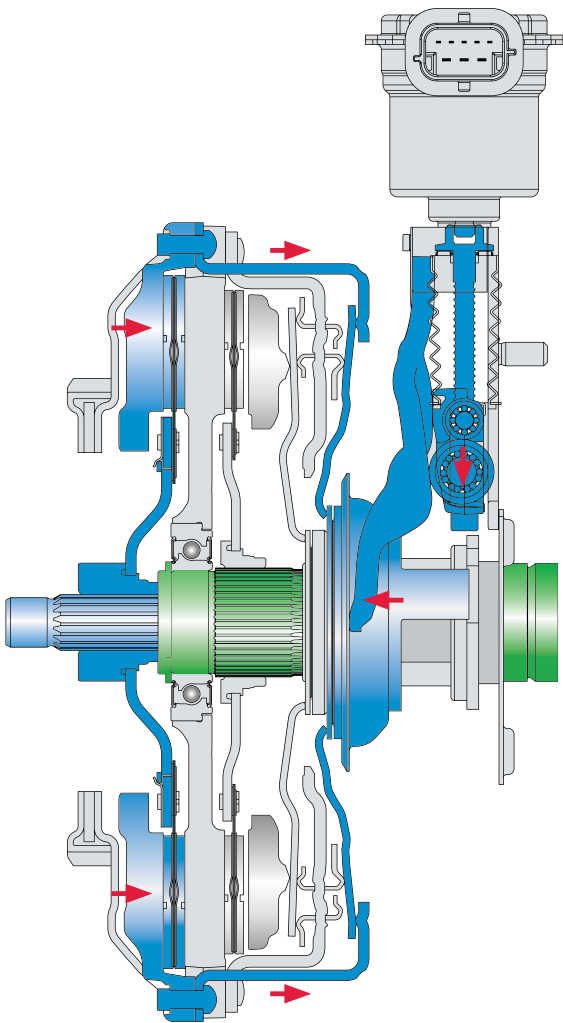
- 1 Crankshaft
- 2 Dual mass flywheel (DMF)
- 3 Central plate
- 4 Support bearing
- 5 K1 pressure plate
- 6 K1 clutch disc
- 7 K2 pressure plate
- 8 K2 clutch disc

- 9 K1 engagement bearing
- 10 K2 engagement bearing
- 11 Retaining ring
- 12 Transmission input shaft 1 (solid shaft)
- 13 Transmission input shaft 2 (hollow shaft)
- 14 K1 lever spring
- 15 K2 lever spring

Function

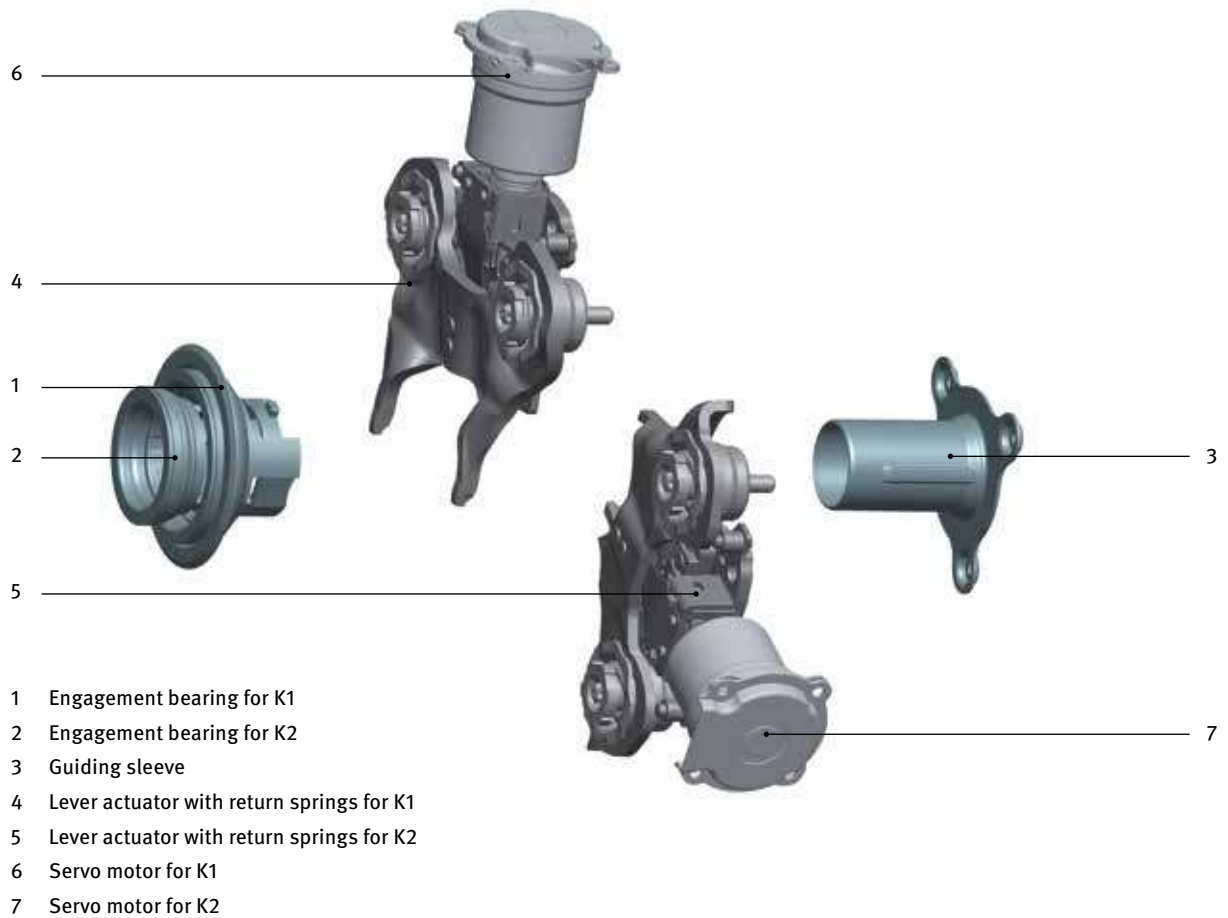
When driving in gears 1, 3 or 5, the servo motor for K1 is activated electrically. This causes the engagement lever with the wide fork opening and the large engagement bearing to move towards the double clutch. The outer lever spring transmits this movement to the retaining ring and reverses the effective direction of the engagement force. As a result, the pressure plate for K1 is pulled towards the central plate, closing the clutch. The clutch disc then transfers the engine torque to the solid shaft.

If one of gears 2, 4, 6 or R is to be used when driving, the servo motor for K2 actuates the engagement lever with the narrow fork opening. The inner lever spring is activated via the engagement bearing. This moves the K2 pressure plate towards the central plate. This creates a connection to the clutch disc. The engine torque is transmitted to the hollow shaft. At the same time, K1 opens.



3.2 Engaging system

Structure of the overall system



With previous manual transmissions with single disc clutch, the clutch is closed when idling. It is opened by pressing on the clutch pedal, thus disconnecting the transmission of power. This takes place via the "release system".

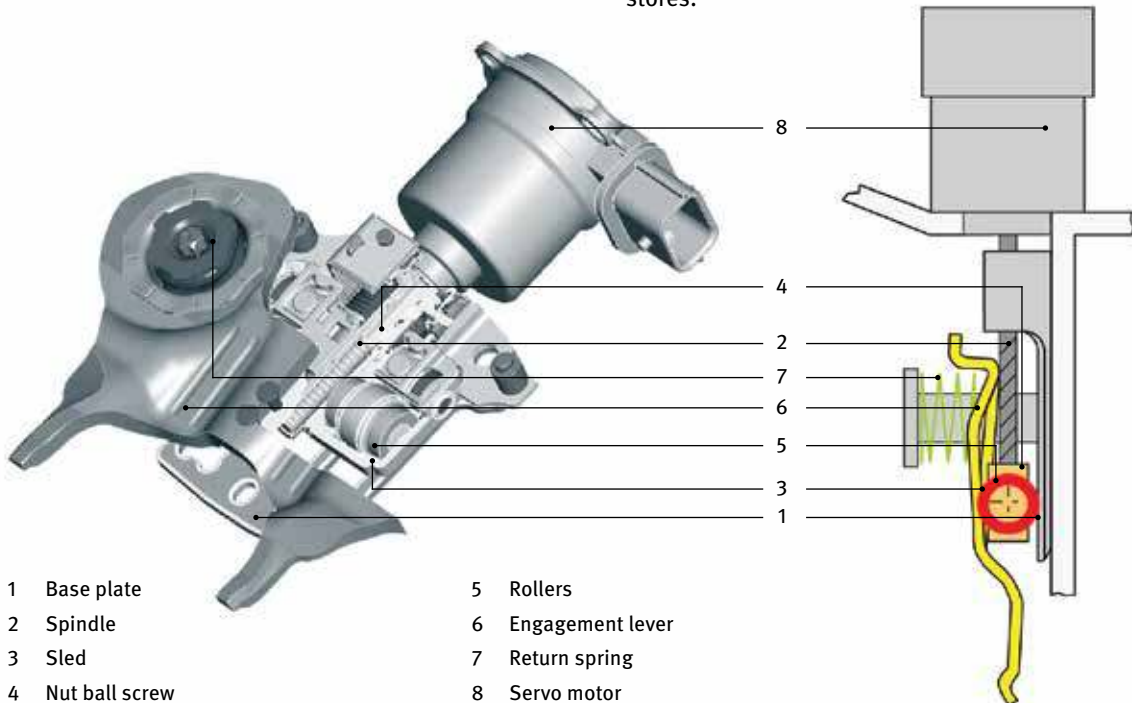
By contrast, the clutches in this double clutch system are open when idling (normally open). They are closed when the engagement lever is actuated. This is therefore referred to as an engaging system.

The engaging system is operated electrically and consists of the two engagement bearings for K1 and K2 [1 and 2], the guiding sleeve [3] and two lever actuators [4 and 5]. These components are arranged in the transmission bell housing. The two servo motors [6 and 7] are mounted on the outside. They are connected to the respective lever actuator via a spindle. Both work identically, only the fork openings on the engagement levers are different.

Structure of the lever actuator

The lever actuator consists of a base plate, spindle, sled (nut ball screw with multi-part rollers), engagement lever and return springs. Together they form the actuating mechanism.

The base plate is used to secure the lever actuator in the transmission bell housing and to guide the rollers precisely. The engagement lever contains two return springs, which serve as deflection points and energy stores.



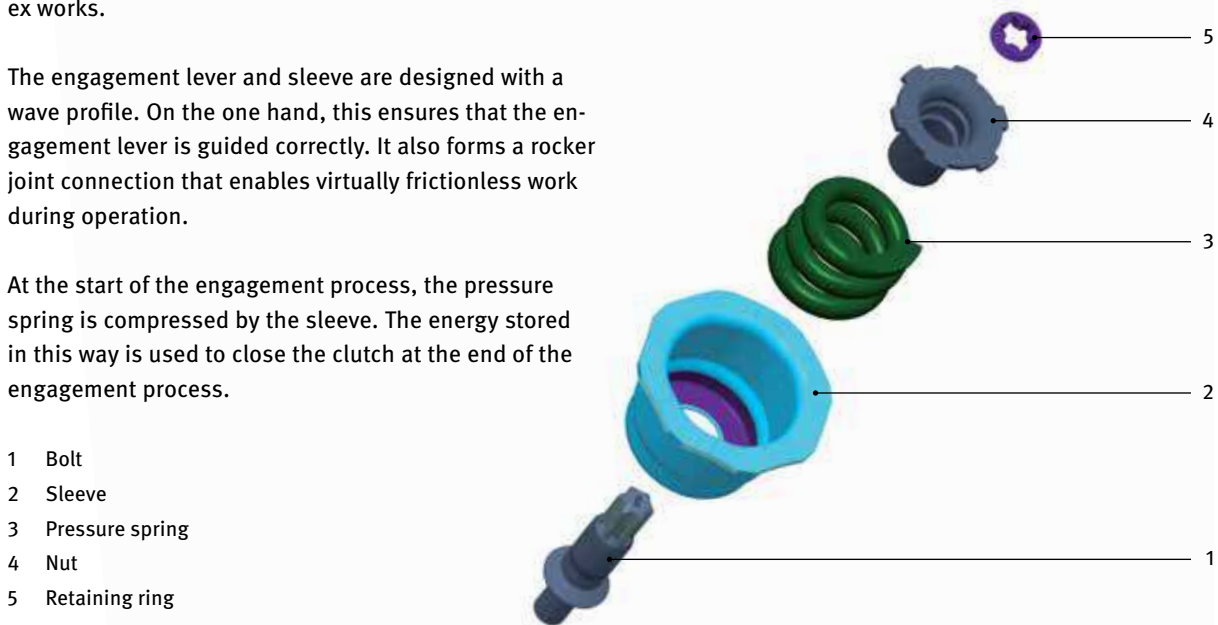
Design and function of the return spring

The return spring acts as an energy store during the engagement process. The sleeve [2] and the pressure spring [3] form a single unit. There is a stop at the lower end of the screw [1] that limits the path of the sleeve. There is a nut [4] at the upper end. This supports the pressure spring and is used to adjust the return spring ex works.

The engagement lever and sleeve are designed with a wave profile. On the one hand, this ensures that the engagement lever is guided correctly. It also forms a rocker joint connection that enables virtually frictionless work during operation.

At the start of the engagement process, the pressure spring is compressed by the sleeve. The energy stored in this way is used to close the clutch at the end of the engagement process.

In order to achieve the optimum performance of the engaging system, return springs and lever actuators are adapted to one another and paired ex works. These units are identified by an identical four-digit number that is located on the sleeve and the engagement lever.



Function

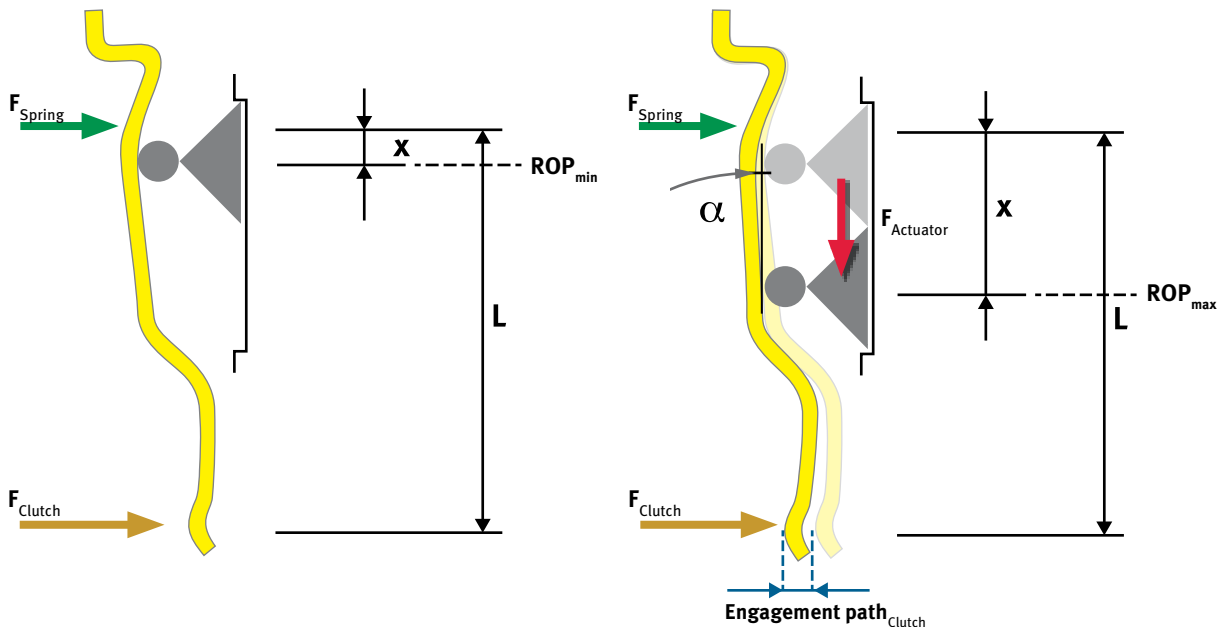
The servo motor changes the central bearing point of the engagement lever, the sled, via a ball screw drive. This influences the effective lever ratio, which changes continually over the course of the engagement process.

The sled moves towards the transmission input shaft during the engagement process. The return spring is compressed due to the inclined plane (working angle) of the engagement lever and thus acts as an energy store. The force on the engagement bearing increases but, due to the unfavourable lever ratio, is not yet sufficient to close the clutch.

By moving the sled further, even more energy is stored in the return spring, to the point where the changed lever ratio together with the force of the return spring is sufficient to close the clutch.

Intelligent use of the lever principle results in an almost constant force level for the servo motor. This allows a considerable reduction in motor size. Due to the low energy requirement and the universally applicable actuating mechanism, this system also fulfils the future requirements for hybrid systems.

Schematic representation



The pre-tension force of the pressure spring [F_{Spring}] in the return spring and the leverage ratio [$x/(L - x)$] resulting from the position [x] of the sled determine the engagement force of the clutch [F_{Clutch}].

$$F_{\text{Clutch}} = F_{\text{Spring}} \cdot \frac{x}{L - x}$$

In order to engage the clutch, the sled must be moved along its max. roller path [ROP_{max}].

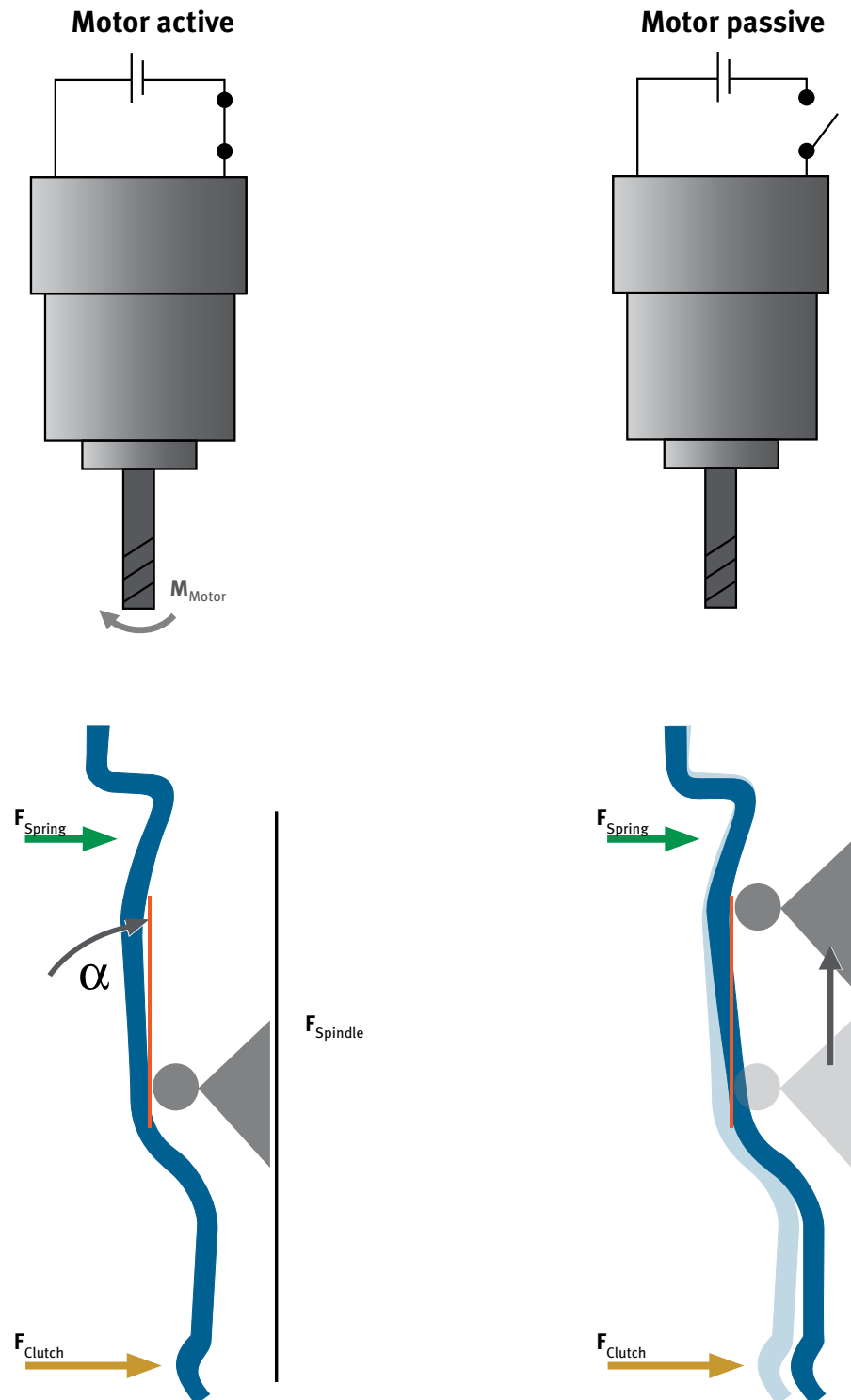
$$F_{\text{Actuator}} = (F_{\text{Clutch}} + F_{\text{Spring}}) \cdot \alpha$$

The actuator force [F_{Actuator}] consists of the equilibrium between the spring and clutch force, offset against the working angle [α].

Automatic emergency clutch opening

Since, in contrast to manual transmissions, the clutches are actively closed, in the event of a malfunction the engaging system could come to a stop in an inseparable clamped state. The vehicle would then no longer be able to move with a gear engaged.

In order to prevent this, the lever actuators are designed so that, with a currentless servo motor, the counter force of the lever spring is sufficient to push back the sled automatically, thus opening the clutch. In this way, the vehicle can still be moved in an emergency, even when a gear is engaged.



4 Design and function of the dry double clutch system — Ford 1.6-litre and 2.0-litre naturally aspirated engines

The main components of the Ford double clutch system are the double clutch, the engaging system with lever actuators and a rigid flywheel. A control unit, which is located on the outside of the transmission housing, controls two servo motors. These set the lever actuators into motion and cause the clutches to close and open alternately.

In driving mode, the transmission electronics evaluate, among other things, the following information:

- Transmission input speed
- Vehicle speed
- Gear selection
- Throttle position
- Accelerator pedal position
- Brake pedal information
- Engine speed and engine torque
- Engine temperature and external temperature
- Steering angle

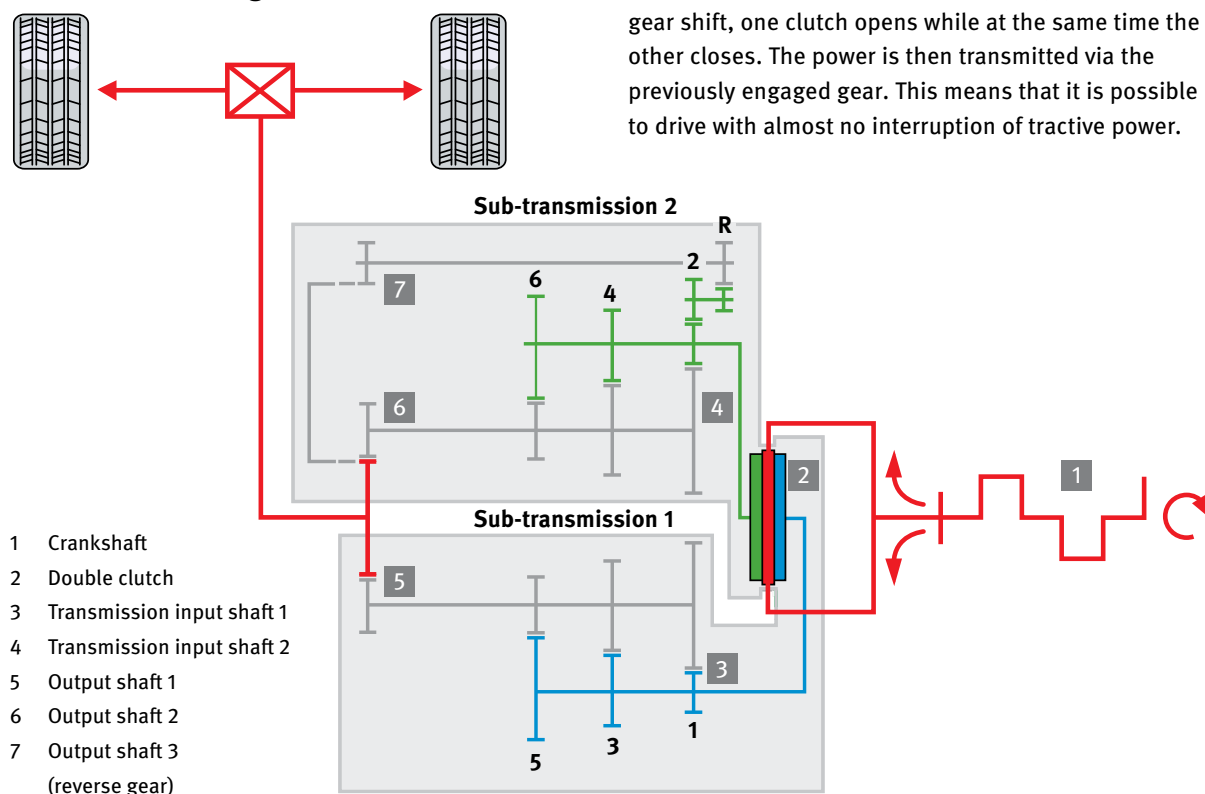


- 1 Flywheel
- 2 Double clutch
- 3 Guiding sleeve with engagement bearing
- 4 Lever actuators with servo motors

Depending on this data, the control unit calculates which gear is to be selected and engages the gear by means of servo motors. These are located in the transmission control unit and act directly upon the gear shift forks inside the transmission.

The double clutch system contains two clutches that are open when the engine is idling and in neutral (normally open). One clutch is always closed in driving mode and therefore one sub-transmission is always connected in a non-positive connection. The gear in the other sub-transmission is already pre-selected since the clutch for this sub-transmission is still open. During a gear shift, one clutch opens while at the same time the other closes. The power is then transmitted via the previously engaged gear. This means that it is possible to drive with almost no interruption of tractive power.

Transmission diagram



4.1 Double clutch

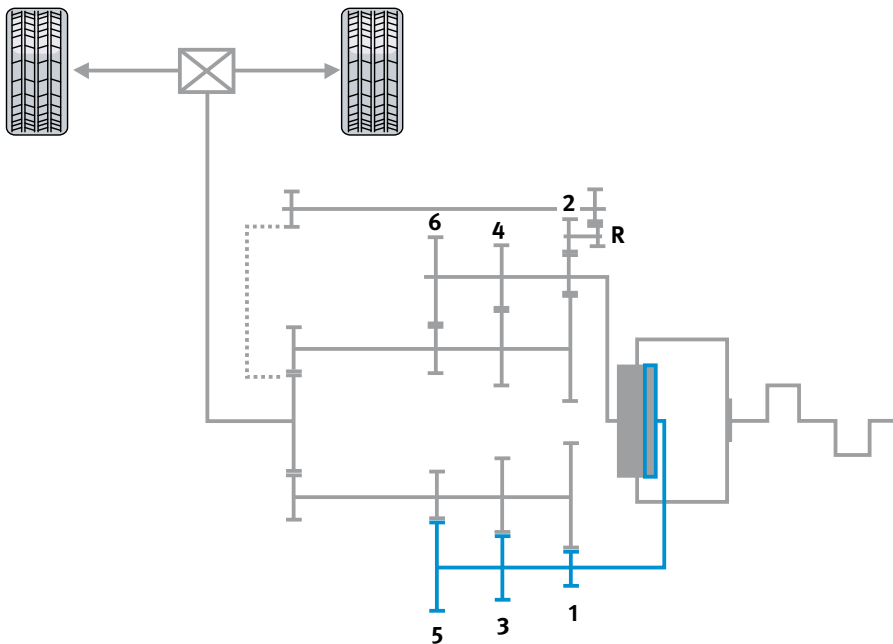
Basic principle

Each sub-transmission in the Ford double clutch transmission is constructed like a manual transmission. One clutch is responsible for each sub-transmission. Both clutches are located on two interlocking transmission input shafts, the outer hollow shaft and the inner solid shaft.

Gears 1, 3 and 5 are engaged by K1 and the torque is transmitted to the transmission via the solid shaft. Gears 2, 4, 6 and reverse are engaged by K2 and the torque is induced in the transmission via the hollow shaft.

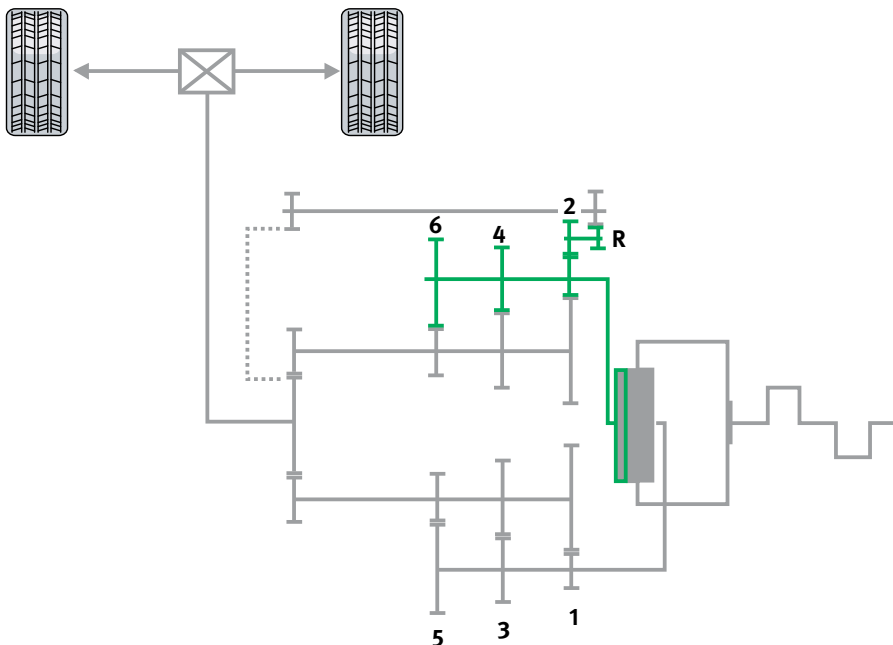
Clutch 1 (K1)

K1 is responsible for gears 1, 3 and 5.



Clutch 2 (K2)

K2 is responsible for gears 2, 4, 6 and reverse.



Design



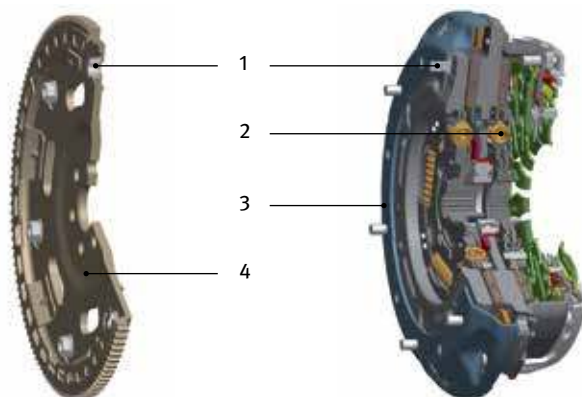
- 1 Flywheel
- 2 Driving ring with leaf springs
- 3 K1 pressure plate
- 4 K1 clutch disc
- 5 Bush
- 6 Sliding disc
- 7 Bearing

- 8 Retaining ring
- 9 Central plate
- 10 K2 clutch disc
- 11 Clutch cover with lever spring and K2 adjustment device
- 12 Self-adjustment ring for K1
- 13 Lever spring for K1
- 14 Retaining ring

The central plate with its two friction surfaces forms the core of the double clutch. The central plate is equipped with a bearing that, together with the retaining ring, the sliding disc and the bush, forms the sliding offset compensator.

A clutch disc with torsional damping and a pressure plate with wear adjustment are positioned on each side of the central plate. The driving ring is positioned on the flywheel side. Thanks to its leaf springs, the driving ring forms a flexible connection element with the engine.

Offset compensator



- 1 Screw connection
- 2 Torsional damper
- 3 Driving ring
- 4 Flywheel

A special characteristic of this system is the type of connection with the engine. On previous double clutches, a connection with the engine was established via a specially designed dual mass flywheel (DMF) (see page 30). In this case, a combination of internal gearing and the rim of the driver enabled compensation of the different kinds of technical offset between the engine and the transmission. In contrast to such a design, a conventional flywheel is used in this system. The reason for this change lies in the favourable torsional-vibration behaviour of the 1.6 and 2.0-litre naturally aspirated engines used, which allows for torsional damping via

the clutch discs. The form-fit gear connection between the clutch and the DMF has been omitted. Instead, the driving ring is bolted to the flywheel.

To compensate for the different kinds of offset, the double clutch is equipped with additional functions: The sliding offset compensator compensates for the radial offset and the leaf springs on the driving ring compensate for the angular displacement and the axial offset.

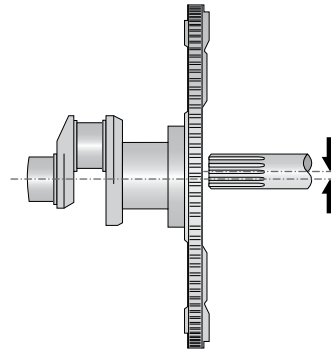
Radial offset

Automotive components are generally produced within a defined range of tolerance, which allows for deviations from the standard state without preventing a system from functioning correctly. When fitting the engine and transmission together, the combination of component tolerances may be unfavourable, thereby causing a radial offset. In such instances, the axes of rotation of the crankshaft and the transmission input shaft are not at the same level. This offset can lead to idling noises and increased wear, particularly if the transmission input shaft does not have a pilot bearing.

The sliding offset compensator is employed here as a countermeasure. It uses a dry-running plain bearing to provide the double clutch with radial flexibility on the transmission input shaft. As such, the relative movements are directed via a durable sliding disc and radial forces are effectively prevented.

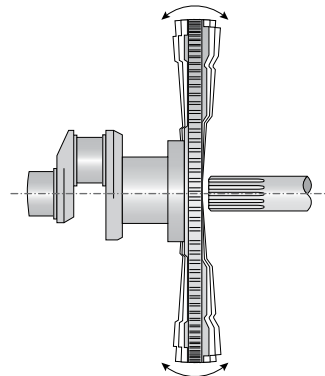
Note:

If the double clutch is removed, the ball bearing of the sliding offset compensator becomes unattached in the central plate. This occurs as a result of the design and should not be regarded as a defect.



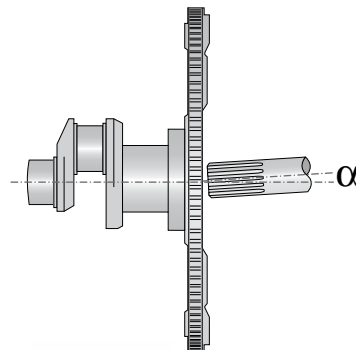
Axial offset

The crankshaft is subject to bending due to the combustion in the cylinders. When these combustion occur, the crankshaft extends to the axis of rotation, resulting in pulsing changes in length at the flange of the crankshaft that occur in line with the combustion frequency. These changes in length create an axial offset, which causes the flywheel to wobble. This movement must not be transferred directly to the double clutch, as this would have a negative impact on comfort characteristics.



Angular displacement

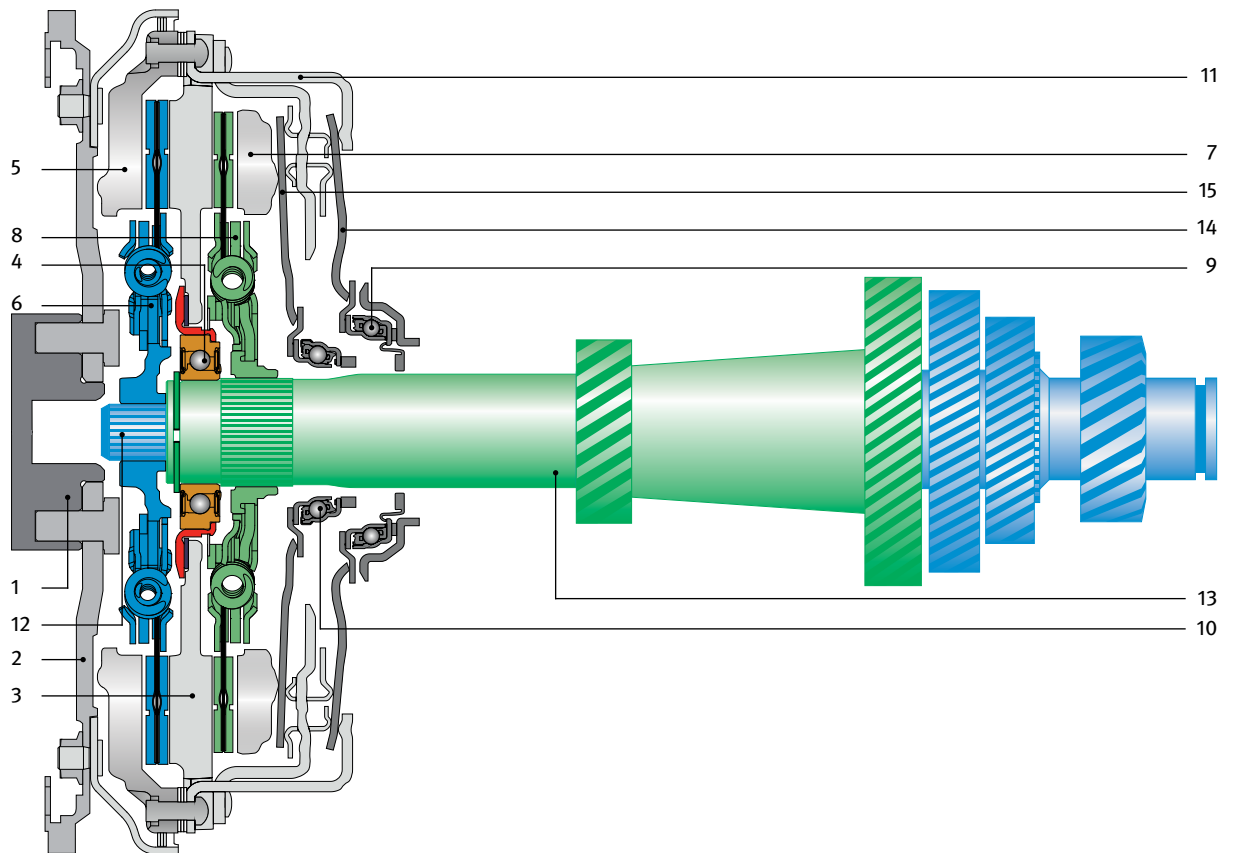
Angular displacement can also result from the combinations of component tolerances. In such instances, the axes of rotation of the crankshaft and the transmission input shaft are positioned at differing angles to each other. Consequently, the clutch discs are constantly subject to bending during operation, causing premature damage to the clutch discs.



To compensate for the axial offset and angular displacement without producing any wear, the double clutch is flexibly mounted in the driving ring. As part of this design, specially shaped leaf springs effectively compensate for the axial offset and angular displacement.



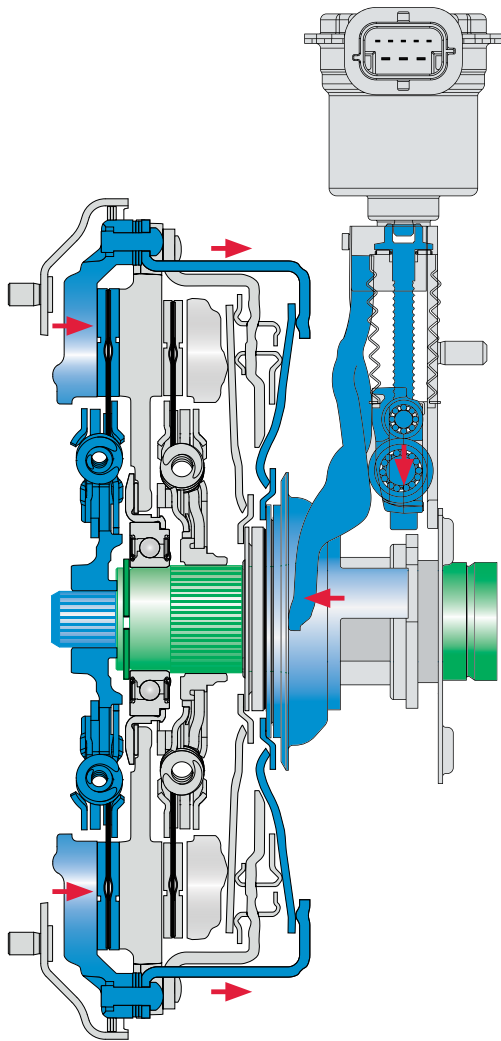
Design



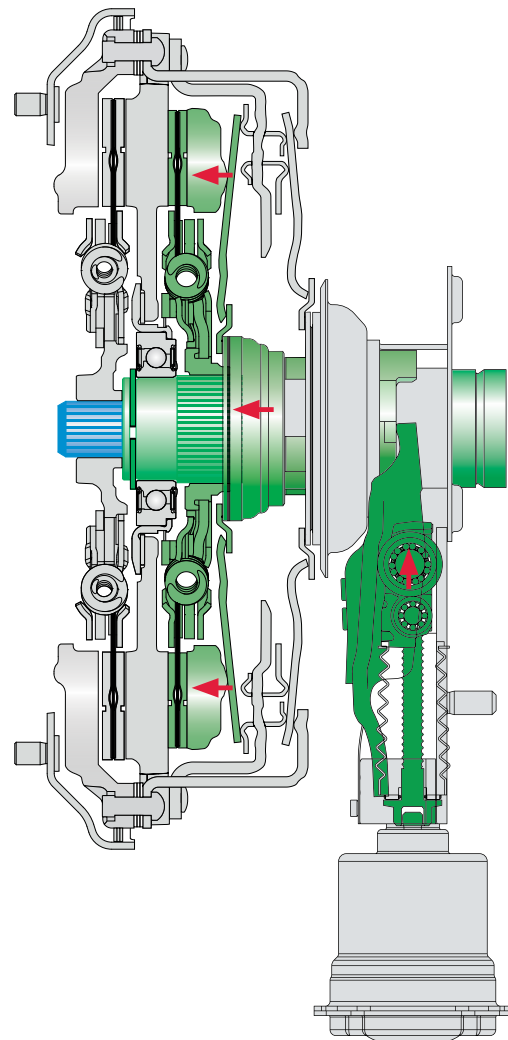
- | | |
|---------------------|--|
| 1 Crankshaft | 9 K1 engagement bearing |
| 2 Flywheel | 10 K2 engagement bearing |
| 3 Central plate | 11 Retaining ring |
| 4 Support bearing | 12 Transmission input shaft 1 (solid shaft) |
| 5 K1 pressure plate | 13 Transmission input shaft 2 (hollow shaft) |
| 6 K1 clutch disc | 14 K1 lever spring |
| 7 K2 pressure plate | 15 K2 lever spring |
| 8 K2 clutch disc | |

Function

When driving in gears 1, 3 or 5, the servo motor for K1 is activated electrically. This causes the engagement lever with the wide fork opening and the large engagement bearing to move towards the double clutch. The outer lever spring transmits this movement to the retaining ring and reverses the effective direction of the engagement force. As a result, the pressure plate for K1 is pulled towards the central plate, closing the clutch. The clutch disc then transfers the engine torque to the solid shaft.

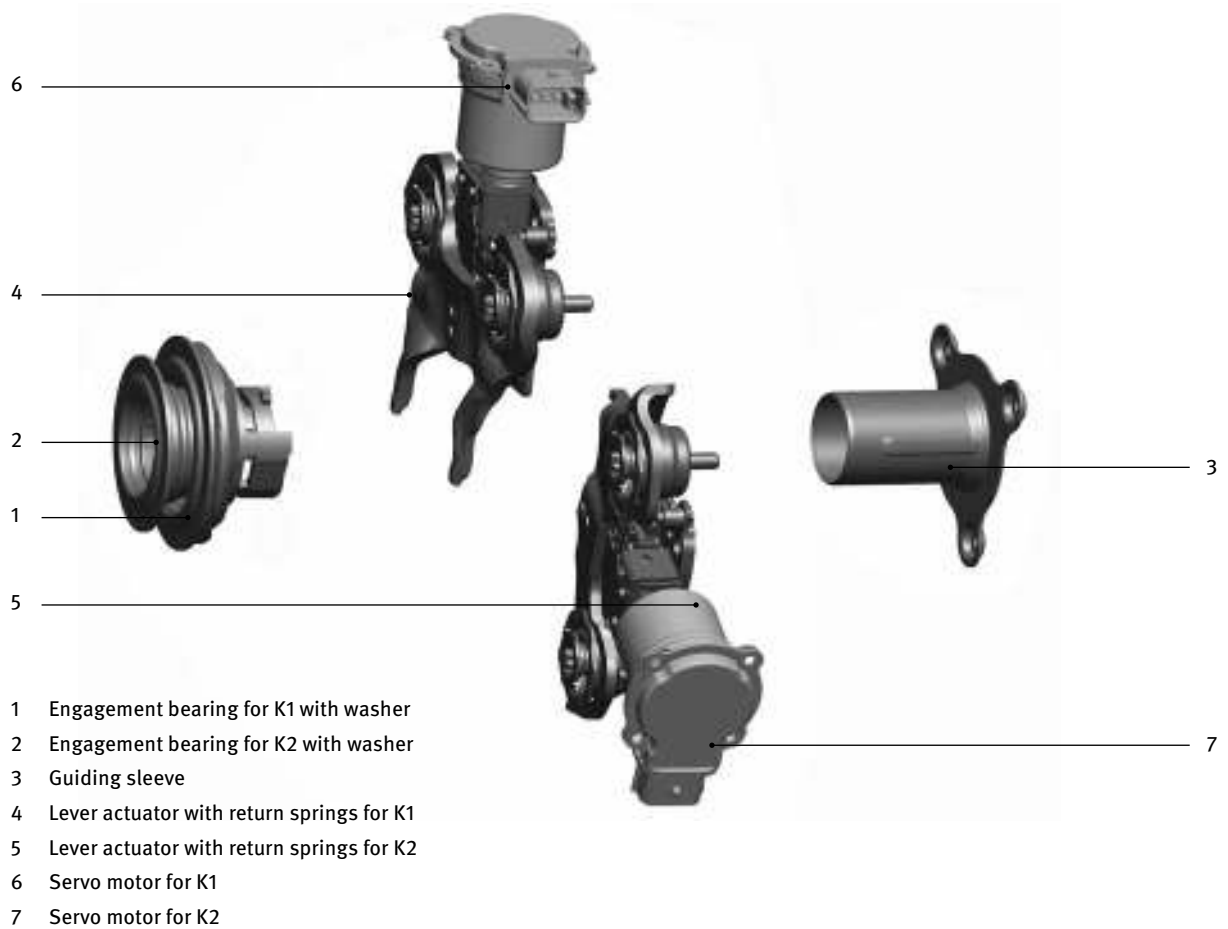


If one of gears 2, 4, 6 or R is to be used when driving, the servo motor for K2 actuates the engagement lever with the narrow fork opening. The inner lever spring is activated via the engagement bearing. This moves the K2 pressure plate towards the central plate. This creates a connection to the clutch disc. The engine torque is transmitted to the hollow shaft. At the same time, K1 opens.



4.2 Engaging system

Structure of the overall system



With previous manual transmissions with single disc clutch, the clutch is closed when idling. It is opened by pressing on the clutch pedal, thus disconnecting the transmission of power. This takes place via the "release system".

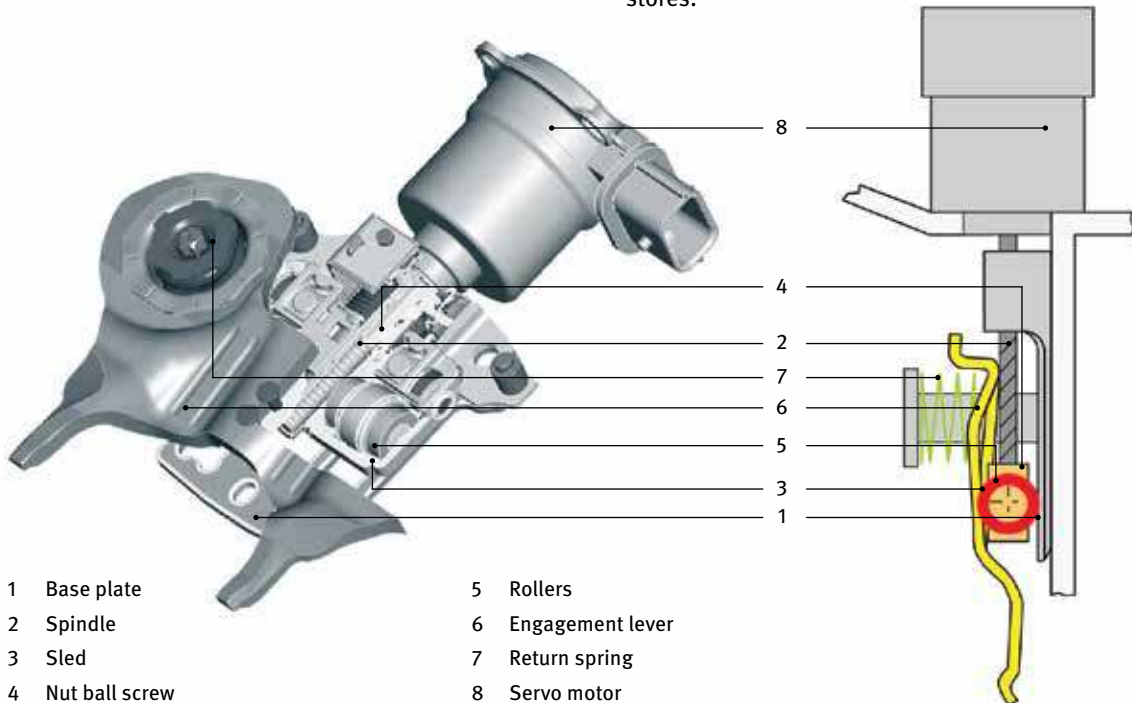
By contrast, the clutches in this double clutch system are open when idling (normally open). They are closed when the engagement lever is actuated. This is therefore referred to as an engaging system.

The engaging system is operated electrically and consists of the two engagement bearings with washers for K1 and K2 [1 and 2], the guiding sleeve [3] and two lever actuators [4 and 5]. These components are arranged in the transmission bell housing. The two servo motors [6 and 7] are mounted on the outside. They are connected to the respective lever actuator via a spindle. Both work identically, only the fork openings on the engagement levers are different.

Structure of the lever actuator

The lever actuator consists of a base plate, spindle, sled (nut ball screw with multi-part rollers), engagement lever and return springs. Together they form the actuating mechanism.

The base plate is used to secure the lever actuator in the transmission bell housing and to guide the rollers precisely. The engagement lever contains two return springs, which serve as deflection points and energy stores.



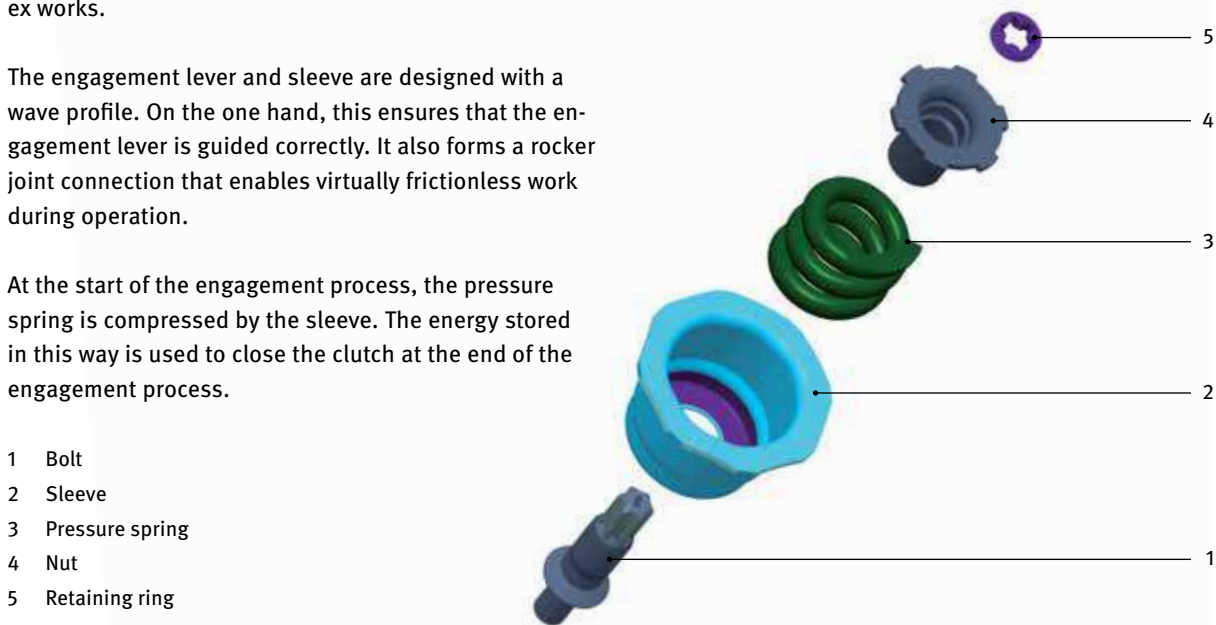
Design and function of the return spring

The return spring acts as an energy store during the engagement process. The sleeve [2] and the pressure spring [3] form a single unit. There is a stop at the lower end of the screw [1] that limits the path of the sleeve. There is a nut [4] at the upper end. This supports the pressure spring and is used to adjust the return spring ex works.

The engagement lever and sleeve are designed with a wave profile. On the one hand, this ensures that the engagement lever is guided correctly. It also forms a rocker joint connection that enables virtually frictionless work during operation.

At the start of the engagement process, the pressure spring is compressed by the sleeve. The energy stored in this way is used to close the clutch at the end of the engagement process.

In order to achieve the optimum performance of the engaging system, return springs and lever actuators are adapted to one another and paired ex works. These units are identified by an identical four-digit number that is located on the sleeve and the engagement lever.



Function

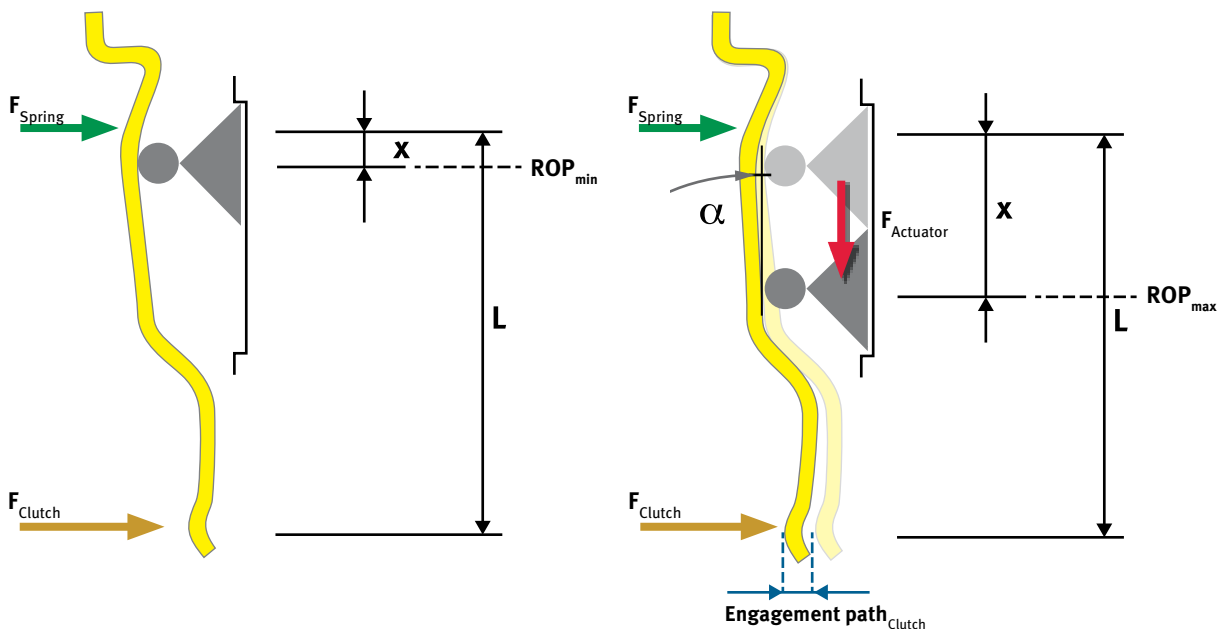
The servo motor changes the central bearing point of the engagement lever, the sled, via a ball screw drive. This influences the effective lever ratio, which changes continually over the course of the engagement process.

The sled moves towards the transmission input shaft during the engagement process. The return spring is compressed due to the inclined plane (working angle) of the engagement lever and thus acts as an energy store. The force on the engagement bearing increases but, due to the unfavourable lever ratio, is not yet sufficient to close the clutch.

By moving the sled further, even more energy is stored in the return spring, to the point where the changed lever ratio together with the force of the return spring is sufficient to close the clutch.

Intelligent use of the lever principle results in an almost constant force level for the servo motor. This allows a considerable reduction in motor size. Due to the low energy requirement and the universally applicable actuating mechanism, this system also fulfils the future requirements for hybrid systems.

Schematic representation



The pre-tension force of the pressure spring [F_{Spring}] in the return spring and the leverage ratio [$x/(L - x)$] resulting from the position [x] of the sled determine the engagement force of the clutch [F_{Clutch}].

$$F_{Clutch} = F_{Spring} \cdot \frac{x}{L - x}$$

In order to engage the clutch, the sled must be moved along its max. roller path [ROP_{max}].

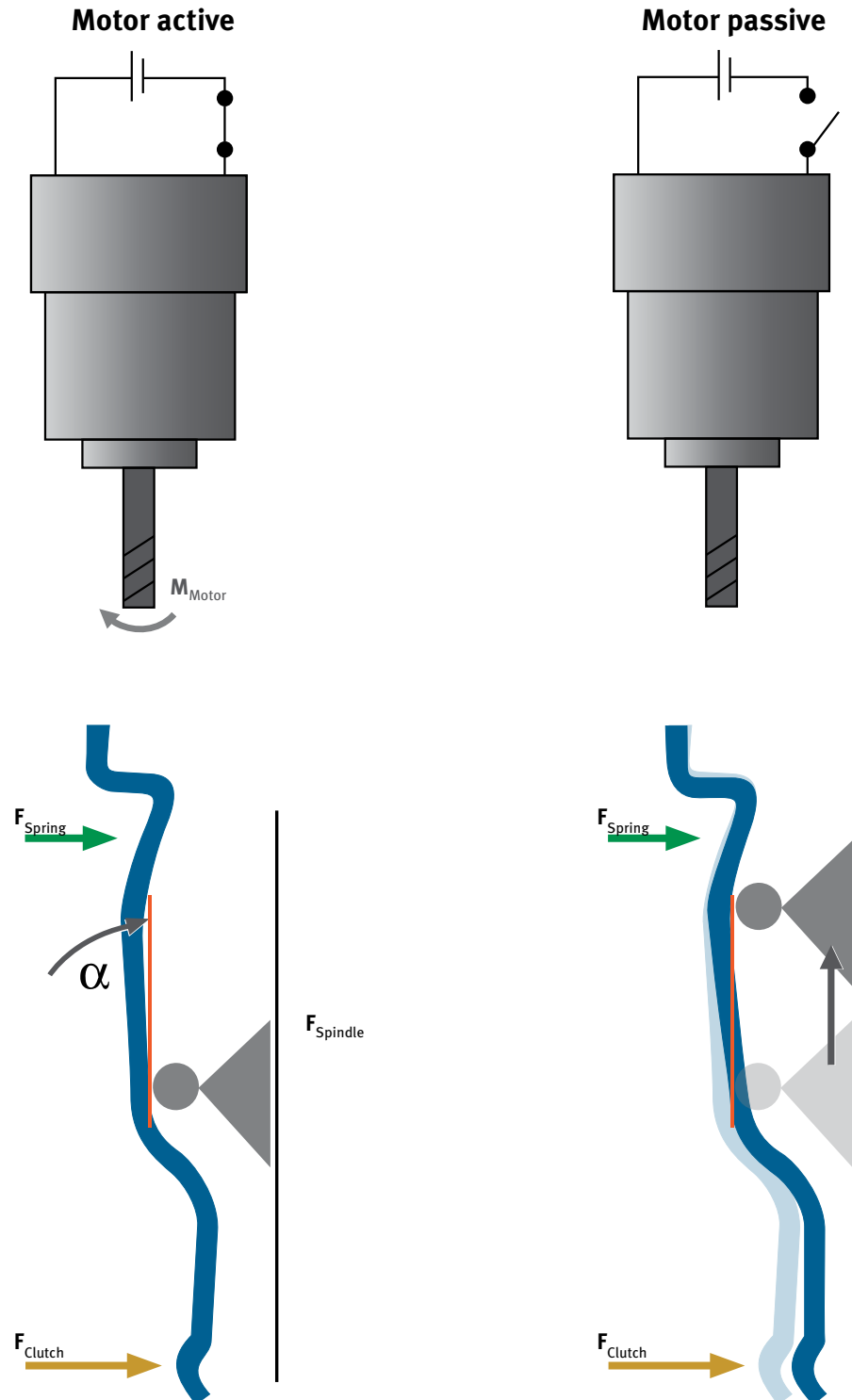
$$F_{Actuator} = (F_{Clutch} + F_{Spring}) \cdot \alpha$$

The actuator force [$F_{Actuator}$] consists of the equilibrium between the spring and clutch force, offset against the working angle [α].

Automatic emergency clutch opening

Since, in contrast to manual transmissions, the clutches are actively closed, in the event of a malfunction the engaging system could come to a stop in an inseparable clamped state. The vehicle would then no longer be able to move with a gear engaged.

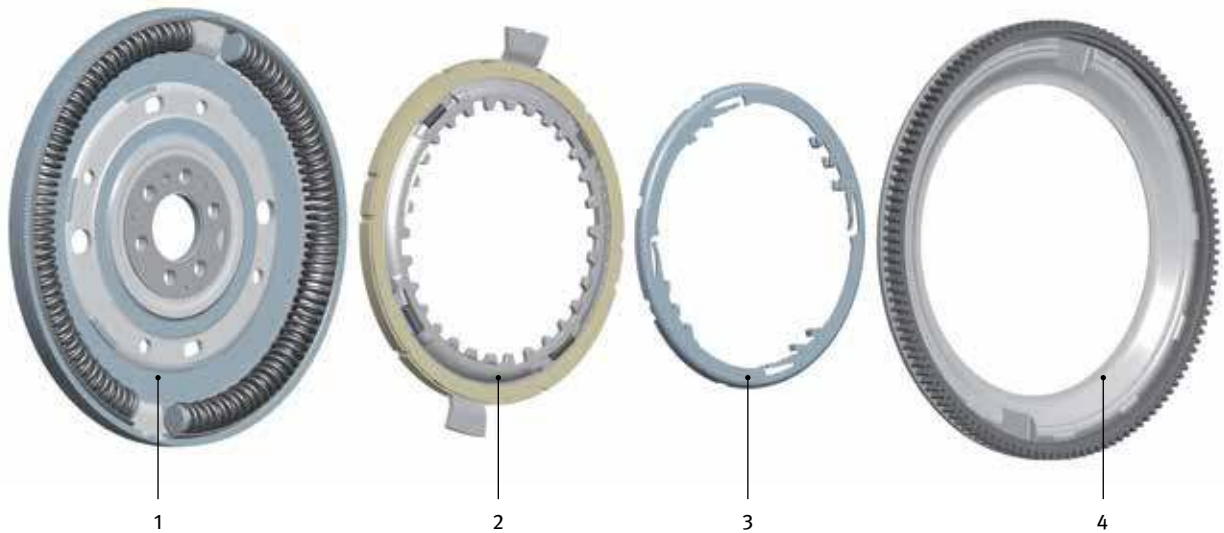
In order to prevent this, the lever actuators are designed so that, with a currentless servo motor, the counter force of the lever spring is sufficient to push back the sled automatically, thus opening the clutch. In this way, the vehicle can still be moved in an emergency, even when a gear is engaged.



5 Dual mass flywheel (DMF) for the double clutch transmission (DCT)

The flywheel used with the DCT is a special form of the LuK DMF. Just like conventional DMFs in manual transmissions, there is a primary side and a secondary side. However, in contrast to conventional DMFs, the secondary side is not a fixed part of the DMF and is therefore not designed as a flywheel mass, rather in the form of a flange, and only serves as a connection between the primary mass and the double clutch.

In this case, the secondary flywheel mass is incorporated into the weight of the double clutch, which is located on an input shaft (hollow shaft) belonging to the transmission. This means that the direct bearing arrangement of the adjacent masses using a ball bearing or plain bearing that is implemented in conventional DMFs is also omitted.

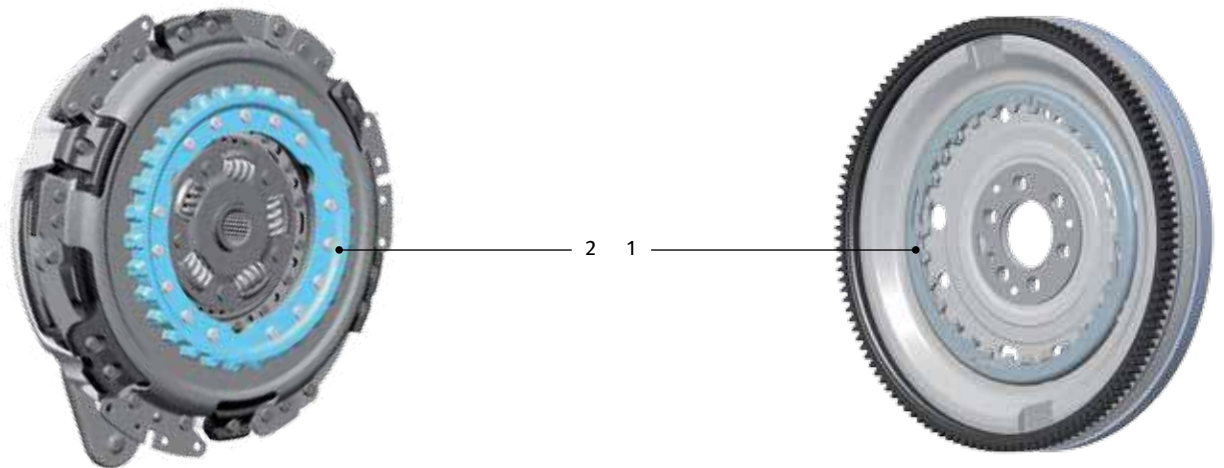


1 Primary mass with arc springs

2 Flange with internal teeth to accommodate the rim of the driver of the double clutch

3 Anti backlash ring

4 Cover for the primary mass with gear ring



1 Anti backlash ring

2 Rim of the driver of the double clutch

One further difference from conventional DMFs is that the friction surface on the secondary side is omitted. This is also located in the double clutch, where it forms the central plate on which the friction surfaces for both clutches are located. Instead of the friction surface on the DMF, a flange with internal teeth is used. The rim of the driver of the double clutch meshes with this flange.

Since the two interlocking sprockets would produce noise as a result of tooth backlash, a backlash ring is attached as a countermeasure. This tensions the two sprockets so that the tooth flanks have no clearance between them. On some versions, the backlash ring must be reset using a special tool before being installed in the transmission.

Note:

Further information on the DMF is described in the LuK brochure "Dual mass flywheel".

6 Description and contents of the LuK special tools

Work on the dry double clutch system must always be carried out using appropriate special tools. This ensures professional repairs and prevents damage to the clutch and transmission.

Schaeffler Automotive Aftermarket offers a future-proof tool system for correct assembly/disassembly. It has a modular design and consists of a basic tool kit and several vehicle-specific tool kits. The range of tools can be easily adapted to new and future double clutch systems. This enables tools to be put together as required.

Note:

The basic tool kit and the corresponding vehicle-specific tool kit must always be used for repairs.

The following tool kits are currently available:

- Basic tool kit
- Volkswagen tool kit (Audi, SEAT, ŠKODA, Volkswagen)
- Renault tool kit
- Ford tool kit
- Reset tool kit, Renault, Ford
- Supplementary tool kit (for previous LuK double clutch special tool, part no.: 400 0240 10)



Note:

If you have any questions about the special tool case or diagnostics and repairs, please call our Service Centre on +XX XXXX XXX-XXX.

6.1 Basic tool kit

The basic tool kit (part no. 400 0418 10) forms the basis of the modular tool system. It contains those tools that are generally required for all repairs to double clutches. Together with a vehicle-specific tool kit, they form a

complete kit for professional repairs. This is based on all dry double clutch systems currently available from LuK.



Part no. 400 0418 10

- | | |
|---|--|
| 1 Puller with spindle and pressure piece | 8 2 plugs for driveshaft holes |
| 2 3 thumb screws | 9 DMF reset tool |
| 3 3 M10 threaded bolts, 100 mm long | 10 Unlocking key |
| 4 3 M10 threaded bolts, 160 mm long | 11 Special open-end wrench |
| 5 Circlip pliers, angled | 12 DVD with assembly/disassembly instructions and training video |
| 6 Magnet | |
| 7 Transmission support with height adjustment | |

6.2 Volkswagen tool kit

This vehicle-specific tool kit (part no. 400 0419 10) must be combined with the basic tool kit. It can be used to disassemble, assemble and adjust both first generation dry double clutches (up to May 2011) and second generation dry double clutches (from June 2011) in

vehicles manufactured by Audi, SEAT, ŠKODA and Volkswagen with a OAM transmission.



- | | |
|---|--|
| 1 Dial gauge with tripod | 9 Plugs |
| 2 Reference gauge 32.92 mm (1st generation, K2) | 10 3 hooks |
| 3 Reference gauge 48.63 mm (1st generation, K1) | 11 Setting gauge for reference gauge |
| 4 Reference gauge 32.12 mm (2nd generation, K2) | 12 Coupling hooks |
| 5 Reference gauge 48.42 mm (2nd generation, K1) | 13 Weight, 3.5 kg |
| 6 3 thrust pieces | 14 DVD with assembly/disassembly instructions and training video |
| 7 Support sleeve for disassembly | |
| 8 Pressure sleeve for assembly | |

6.3 Renault tool kit

This tool kit (part no. 400 0423 10) contains all tools that are required to carry out professional repairs on a dry double clutch on a Renault vehicle (DC4 6-speed transmission). It must be used together with the basic tool kit.



- 1 3 hooks
- 2 Pressure sleeve for assembly
- 3 Support sleeve for disassembly
- 4 Locking piece
- 5 DVD with assembly/disassembly instructions and training video

6.4 Ford tool kit

This tool kit (part no. 400 0427 10) contains all tools that are required to carry out professional repairs on a dry double clutch on a Ford DPS6 6-speed transmission. It must be used together with the basic tool kit.



- | | | | |
|---|--------------------------------|---|---|
| 1 | 3 hooks | 6 | Template KL-0500-8341 for 1.6-litre engines |
| 2 | 3 thrust pieces | 7 | Template KL-0500-8342 for 2.0-litre engines |
| 3 | Support sleeve for disassembly | 8 | DVD with assembly/disassembly instructions and training video |
| 4 | Pressure sleeve for assembly | | |
| 5 | 2 handles | | |

6.5 Reset tool kit

New double clutches for Renault vehicles with a DC4 transmission and for Ford vehicles with a DPS6 transmission are in principle fitted with a transport fastener. This means that no additional work is necessary prior to assembly.

The transport fastener must be put back in place if the double clutch is used again after disassembly, e.g. because work has been carried out on the transmission seals. The reset tool kit (part no. 400 0425 10) must be used for this type of work.



- 1 Base plate with spindle
- 2 Pressure nut
- 3 Adapter
- 4 2 fixing pins
- 5 2 knurled nuts
- 6 K2 pressure piece, Ø 115 mm
- 7 K2 pressure piece, Ø 131 mm

- 8 K1 pressure ring, Ø 85 mm
- 9 K1 pressure ring, Ø 105 mm
- 10 K1 return ring
- 11 K2 return ring
- 12 3 K1 fixing pieces
- 13 DVD with assembly/disassembly instructions and training video

6.6 Supplementary tool kit

The previous LuK double clutch special tool (part no. 400 0240 10) can be adapted to the new, modular tool system range with the supplementary tool kit (part no. 400 0420 10).

Together, the contents of the two tool kits correspond to the basic tool kit and the Volkswagen tool kit.



- | | |
|---|---|
| 1 Transmission support with height adjustment | 6 DMF reset tool |
| 2 Plugs for driveshaft holes | 7 Unlocking key |
| 3 Special open-end wrench | 8 DVD with assembly/disassembly instructions and training video |
| 4 Reference gauge 32.12 mm (2nd generation, K2) | |
| 5 Reference gauge 48.42 mm (2nd generation, K1) | |

6.7 Overview of tool kit applications

The table below shows which tool kits need to be combined if no LuK special tool is available yet.

Application		Audi, SEAT, ŠKODA, VW 1st generation	Audi, SEAT, ŠKODA, VW 2nd generation	Renault	Ford
Tool kit	Basic tool kit Part no. 400 0418 10	X	X	X	X
	Volkswagen tool kit Part no. 400 0419 10	X	X		
	Renault tool kit Part no. 400 0423 10			X	
	Ford tool kit Part no. 400 0427 10				X

This table illustrates how the tool systems are combined if the LuK double clutch special tool part no. 400 0240 10 is already available.

Application		Audi, SEAT, ŠKODA, VW 1st generation	Audi, SEAT, ŠKODA, VW 2nd generation	Renault	Ford
Tool kit	Previous LuK special tool Part no. 400 0240 10	X	X	X	X
	Supplementary tool kit Part no. 400 0420 10		X	X	X
	Renault tool kit Part no. 400 0423 10			X	
	Ford tool kit Part no. 400 0427 10				X

If a Ford or Renault double clutch already in use is reassembled, the transport fasteners must be reset using the specified tool.

Application		Audi, SEAT, ŠKODA, VW 1st generation	Audi, SEAT, ŠKODA, VW 2nd generation	Renault	Ford
Tool kit	Reset tool kit Part no. 400 0425 10			X	X

[illegible]