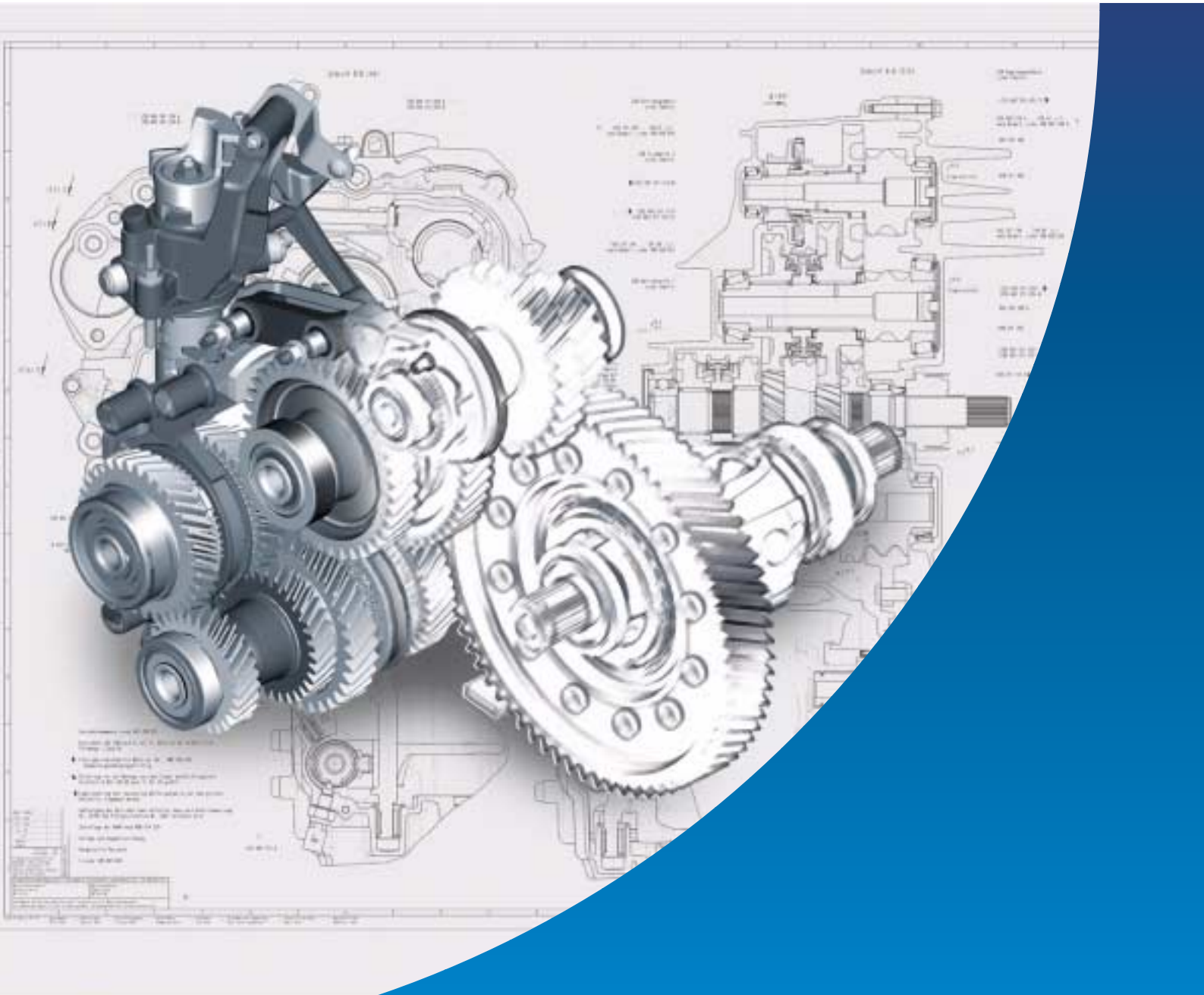
Service Training

Self-study programme 320

6-speed manual gearbox 0A5

Design and function



S320_002

In addition to meeting increasing technical demands, modern cars also have to represent effective space concepts. However, to do this there should be no adverse effects on the design.

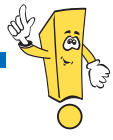
More and more emphasis, therefore, is placed on a space-saving component construction, which is adapted to the respective installation dimensions.

The 0A5 gearbox, developed for engines with particularly high torque, such as the new R5 TDI engine, is a good example of such a construction.

It is of a very short design, which takes into consideration the restricted space available for front transverse installation in the Transporter. It is therefore also suitable for use in future passenger vehicle models.

This short design was made possible by distribution of the gear wheels on 4 shafts. The gear wheels could therefore be located in a particularly space-saving way.

NEW



Important Note

This self-study programme shows the design and function of new developments!
The contents will not be updated.

For the latest testing, adjustment and repair instructions, please refer to the relevant service literature.

Contents

Introduction

General

The development of increasingly more powerful vehicles makes it necessary for a drive system to be adapted to the performance return of the engine. On a 6-speed manual gearbox, a short layout of the individual gears can be achieved to this end. An effective adaptation of the gear stages to the engine characteristics lowers the speed level and the fuel consumption. Driving comfort and driving dynamics can be improved at the same time.

S320_003

Initially, the newly developed 6-speed manual gearbox 0A5 will be installed in the Transporter 2004 together with the R5 TDI and V6 engines.

It is the first 6-speed manual gearbox installed transversely with a torque capability of up to 500 Nm.

Technical data

Gearbox designation	0A5
Input shafts	1
Output shafts	3
Forwards gears	6
Reverse gears	1
Maximum input torque	500 Nm
Provision for distance and speed monitoring	In vehicles with tachograph, a special gearbox is installed (with tachograph sender and sensor ring)
Gear oil specification	SAE 75 W in accordance with TL 521 71
Gear oil volume	2.7 ltr. filled for life
Clutch actuation	Hydraulic
Type of installation	Front/transverse
Weight	72.6 kg (with oil)
Installation length	374,3 mm

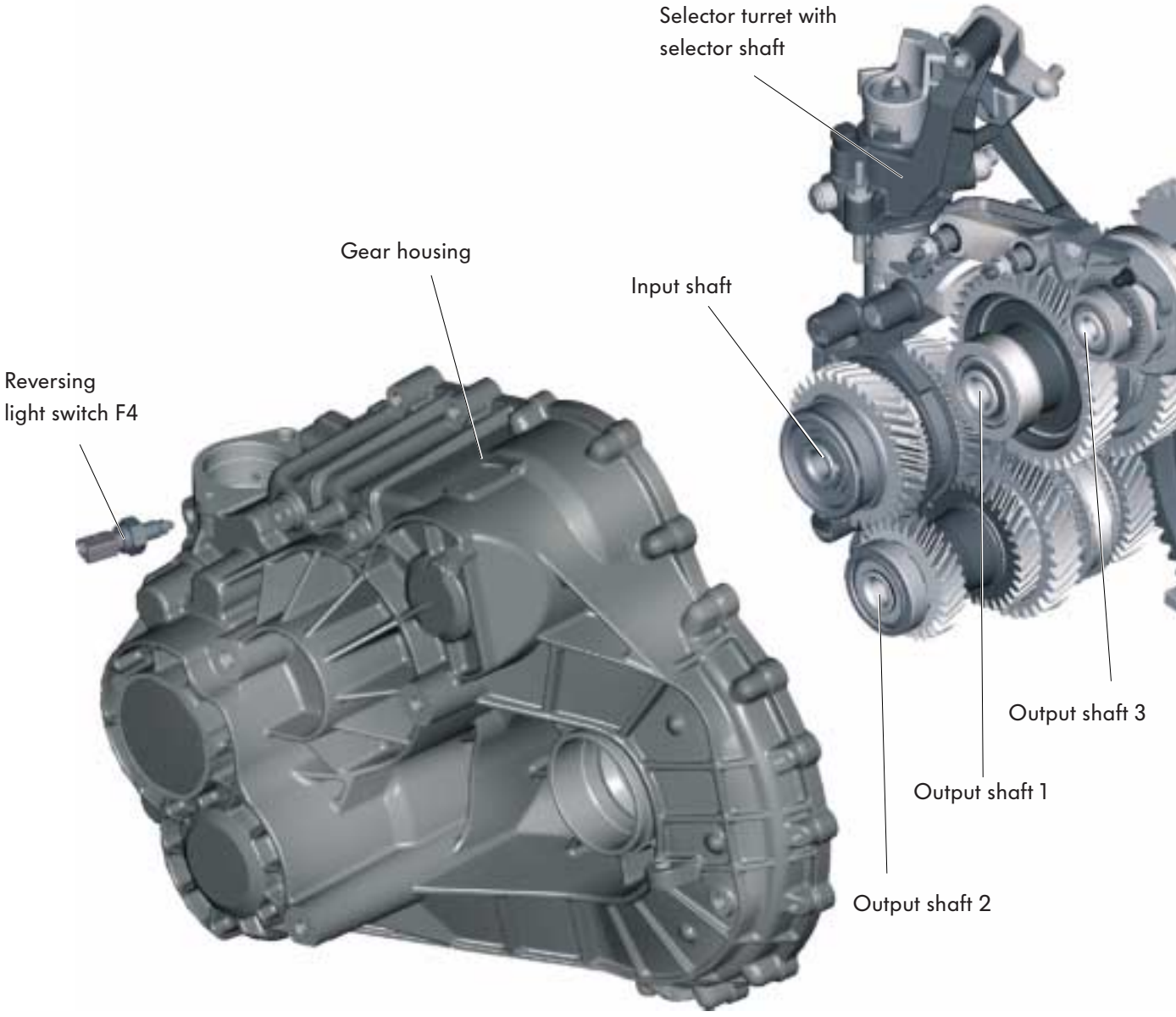
Fitted with a bevel box and Haldex coupling, the gearbox will later also be installed in a four-wheel drive version.

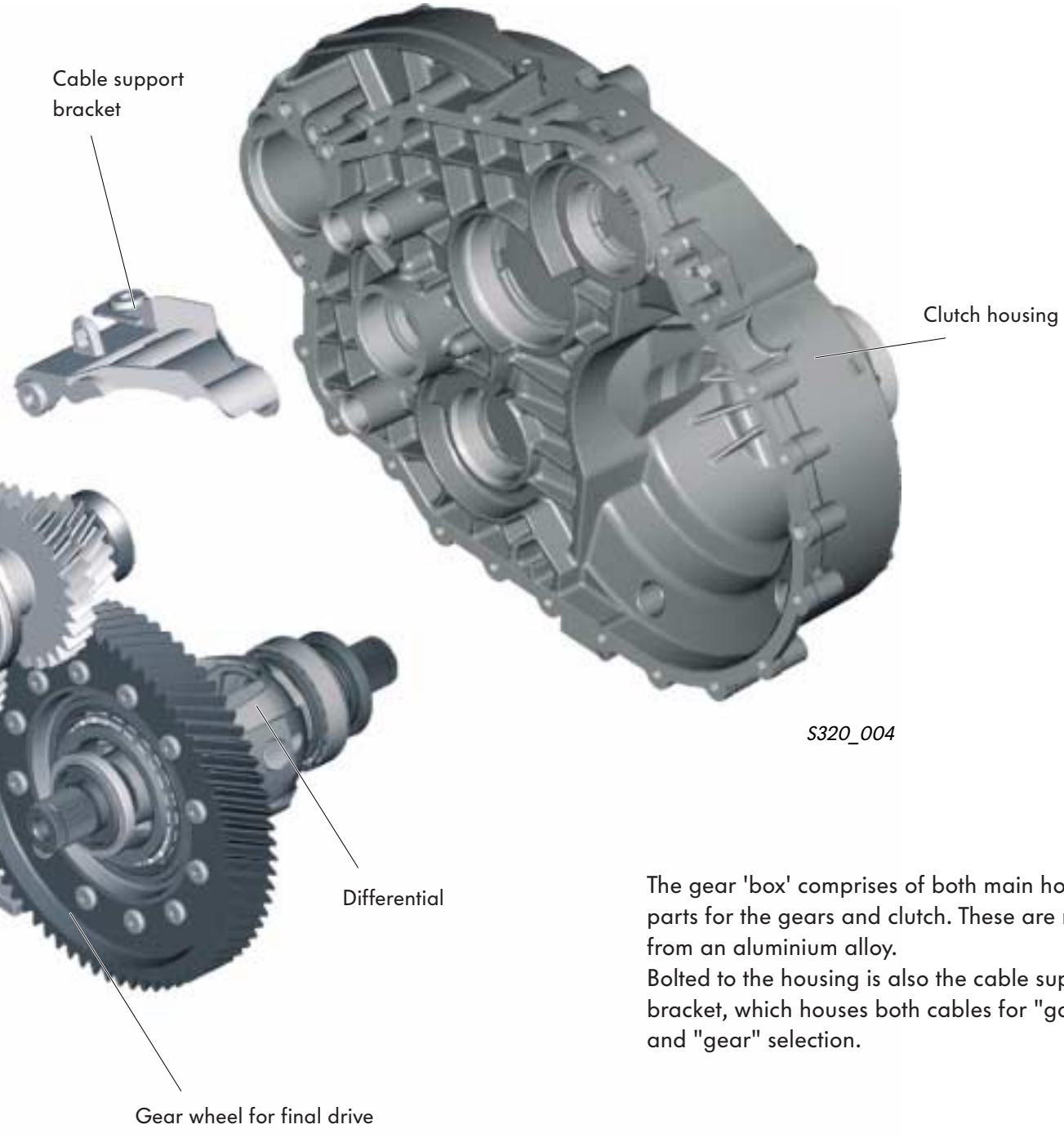
Gearbox mechanics

Construction

On conventional gearboxes, fitted mostly with two or three shafts, it is very difficult to shorten the design. Two opposing and meshed gear wheels form a gear wheel pair. The more gear wheel pairs there are on the shafts, as is the case for example on a 6-speed gearbox, the greater the overall length of the gearbox.

With its 4 shafts, the 0A5 gearbox belongs to a generation of short transmission units.
The very short overall length of 374 mm was achieved in this way; bringing with it considerable advantages for installation.





S320_004

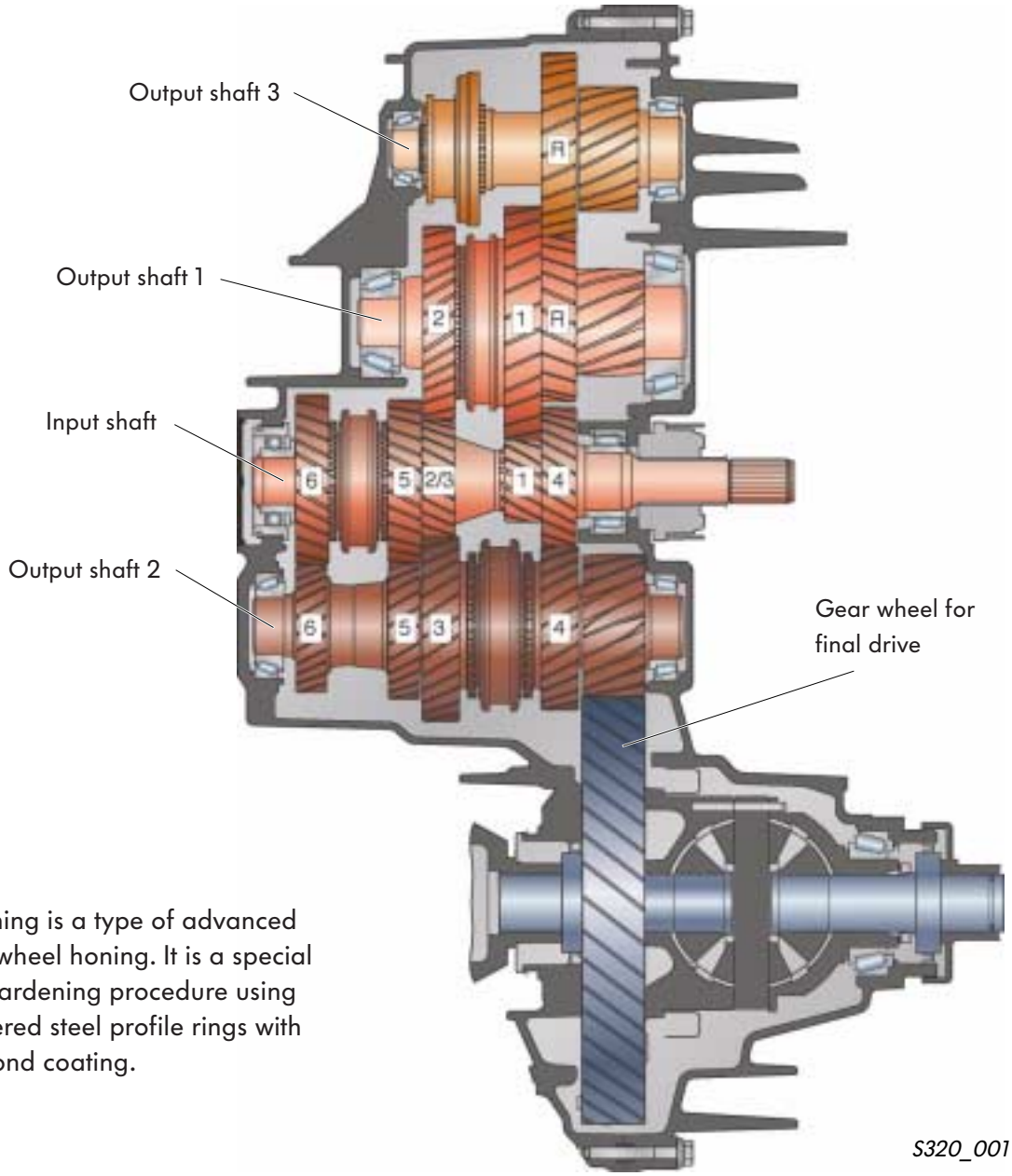
The gear 'box' comprises of both main housing parts for the gears and clutch. These are made from an aluminium alloy.
Bolted to the housing is also the cable support bracket, which houses both cables for "gate" and "gear" selection.

Gearbox mechanics

Gear layout diagram

The selector gears for 5th and 6th gear are located on the input shaft. 1st and 2nd gear are selected on output shaft 1, 3rd and 4th gear are selected on output shaft 2. The selector gear for reverse can be found on output shaft 3.

To minimise noise generation, the gear wheel pairs for 2nd to 4th gears and the gear wheel pair for the final drive have been subjected to an additional honing measure to improve gear meshing.
The gear wheels for 2nd, 3rd and 4th gear have been ground, the selector gear for 4th gear has been coroned.



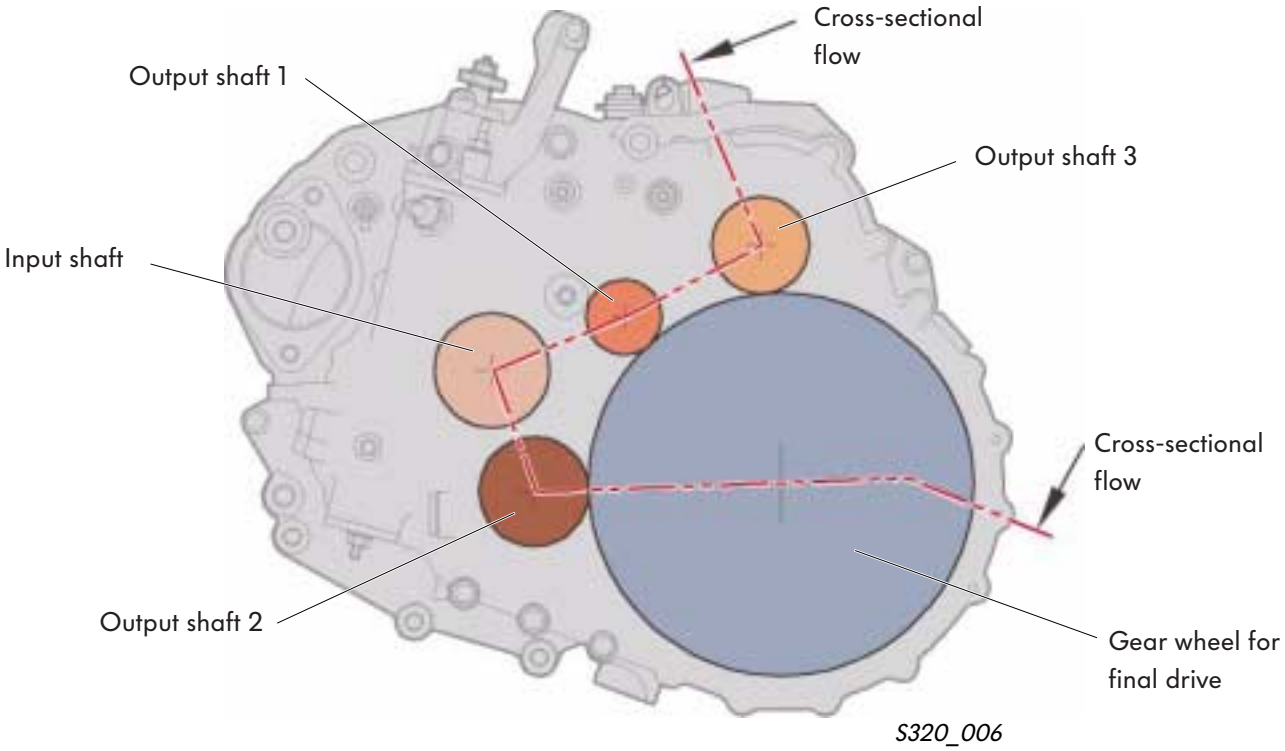
Coroning is a type of advanced gear wheel honing. It is a special fine hardening procedure using tempered steel profile rings with diamond coating.

Shaft layout diagram

For reasons of clarity, the shafts in the gear layout diagram are shown on one level. The actual shaft layout can be seen in the cross-section below.

Forward gears 1 to 4 feature 3-cone synchronisation (Smith synchronisation).
Gears 5 and 6 have simple synchronisation. Reverse gear has simple outer ring synchronisation.

The torque is transmitted via three output shafts that are continually meshed with the final drive gear wheel. The torque is transmitted from the input shaft via either one of the output shafts to the final drive.

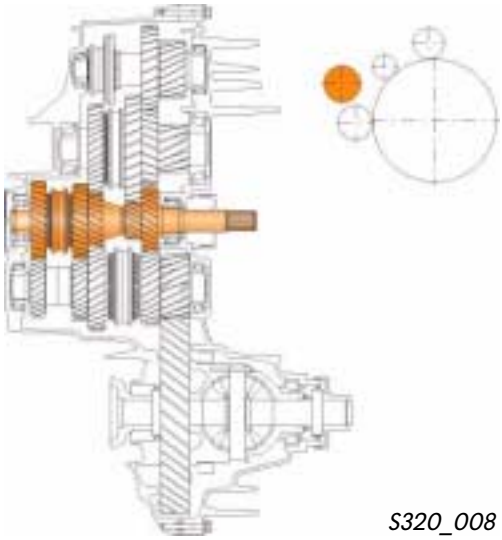


When reverse gear is selected, the torque flows via the selector gear for 1st gear, located on output shaft 1. Welded to this selector gear is the reverse gear wheel, from which torque is transmitted to output shaft 3 and then to the final drive.

Gearbox mechanics

Input shaft

The input shaft is mounted in the gear 'box' with a grooved ball bearing and in the clutch housing with a roller bearing.
In this way, a fixed/floating type mounting is achieved. This fixed/floating type mounting improves selection when the gears are cold and avoids excessive play when the gears are hot.



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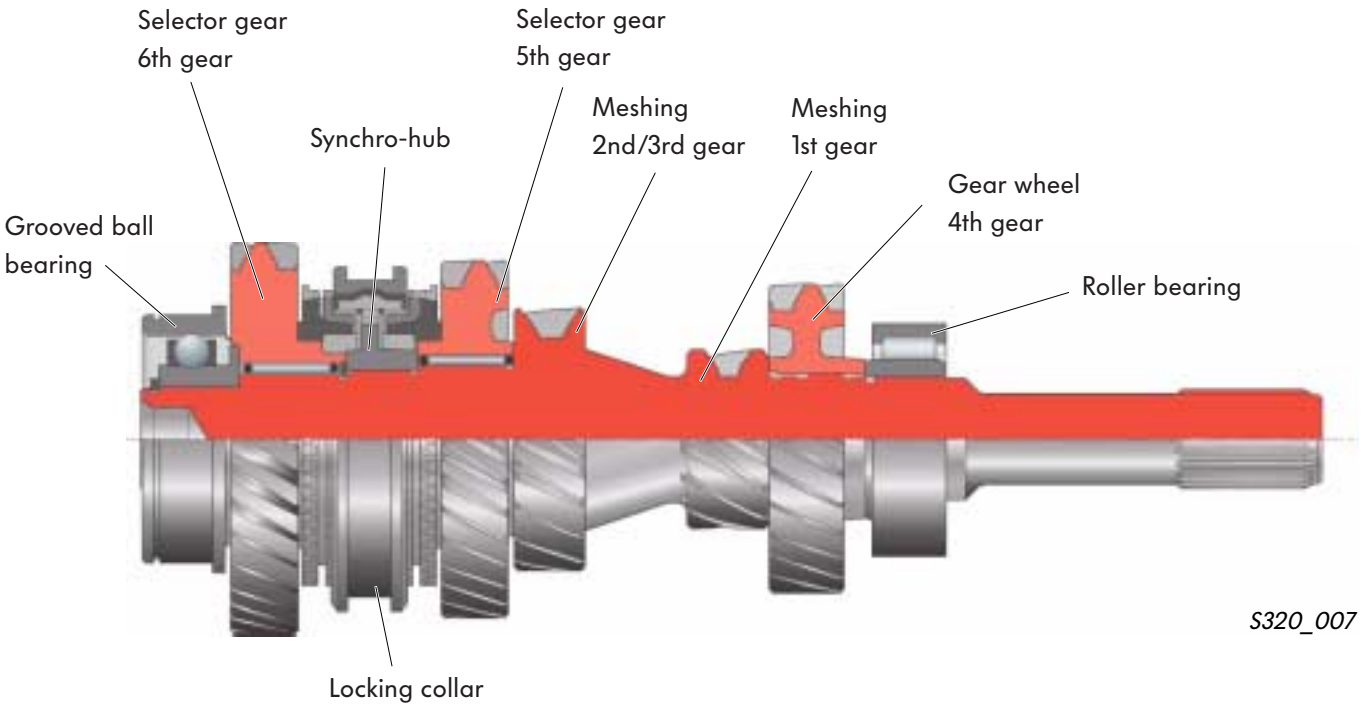


S320_007

The selector gears for 5th and 6th gear are of the floating type, mounted on a needle roller bearing.

The 1st gear is designed to provide meshing for the input shaft.

A further common meshing on the input shaft is used by both 2nd and 3rd gears.

The gear wheel for 4th gear is pressed in place on the shaft.

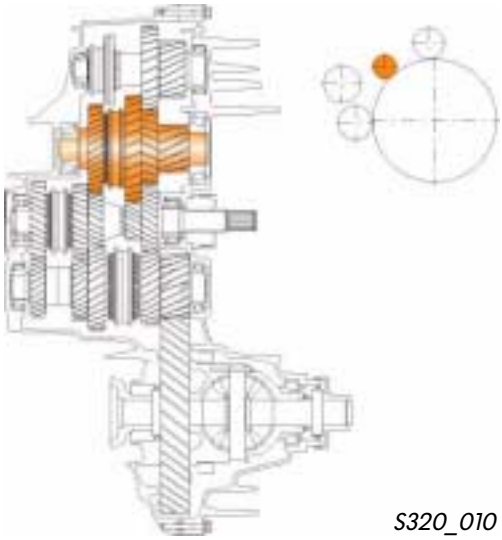
For the selector gears of 5th and 6th gear there is a simple synchronisation system.

The synchro-hub for 5th and 6th gear is fixed firmly in place on the input shaft via an inner spline connection.

Output shaft 1

Output shaft 1 is mounted in the gear 'box' and in the clutch housing with a taper roller bearing at each end.

Oil is supplied by means of a hollow in the output shaft. This hollow was also introduced as a weight reduction measure.



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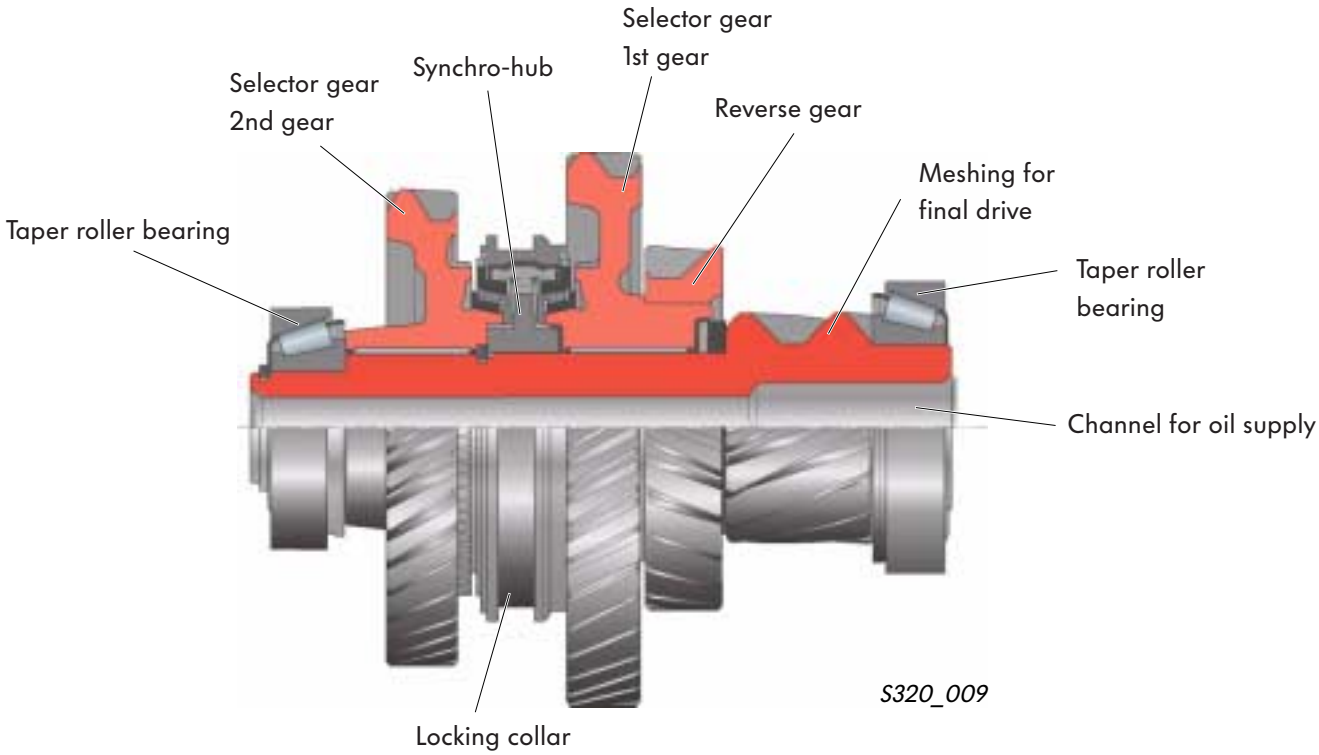


S320_009

On output shaft 1, the selector gears for 1st and 2nd gear are mounted on a needle roller bearing (floating type).
Reverse is welded to the selector gear for 1st gear.

The meshing for the final drive is fixed on output shaft 1.

For the selector gears of 1st and 2nd gear there is a 3-cone synchronisation system.

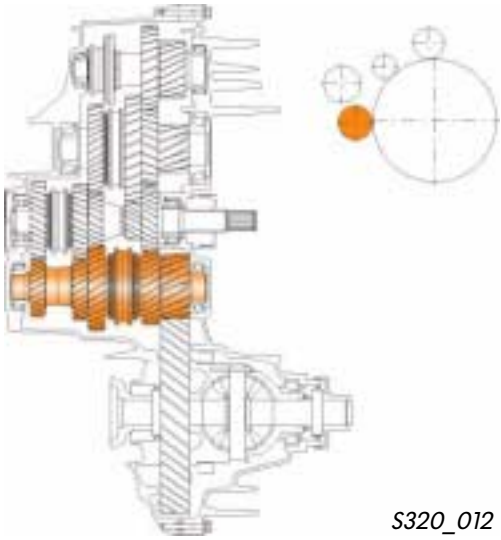
The synchro-hub for 1st and 2nd gear is fixed firmly in place on output shaft 1 via an inner spline connection.

Gearbox mechanics

Output shaft 2

Output shaft 2 is mounted in the gear 'box' and in the clutch housing with a taper roller bearing at each end.

Oil is supplied by means of a hollow in the output shaft. This hollow was also introduced as a weight reduction measure.



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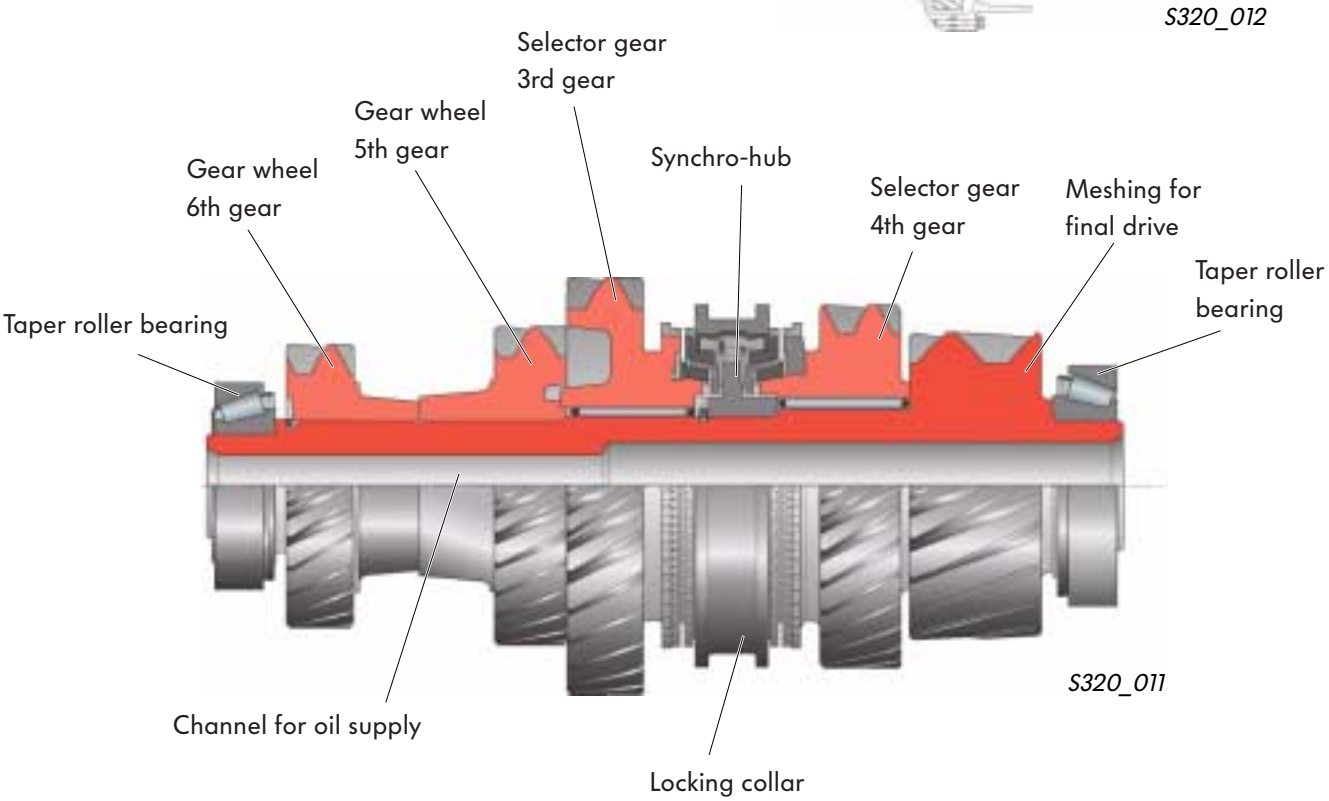


S320_011

On output shaft 2, the selector gears for 3rd and 4th gear are mounted on a needle roller bearing (floating type).

The gear wheels for 5th and 6th gear are shrink-fitted on the output shaft.

The meshing for the final drive is fixed on output shaft 1.

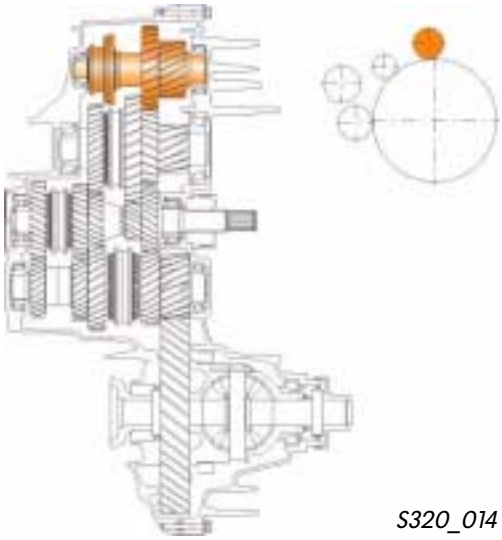
For the selector gears of 3rd and 4th gear there is a 3-cone synchronisation system.

The synchro-hub for 3rd and 4th gear is fixed firmly in place on output shaft 2 via an inner spline connection.

Output shaft 3

Output shaft 3 is also mounted in the gear 'box' and in the clutch housing with a taper roller bearing at each end.

Oil is supplied by means of a hollow in the output shaft. This hollow was also introduced as a weight reduction measure.



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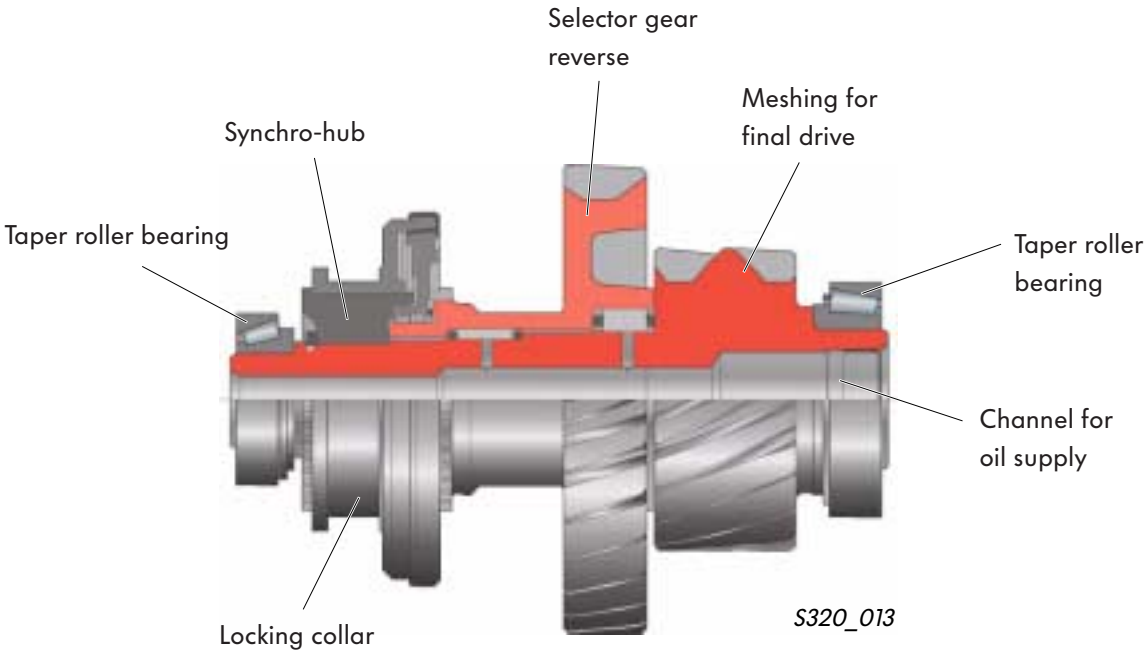


S320_013

Located on output shaft 3 is a selector gear and locking collar for the reverse gear.
The selector gear for reverse gear is mounted on a needle roller bearing (floating type).

The meshing for the final drive is fixed on output shaft 1.

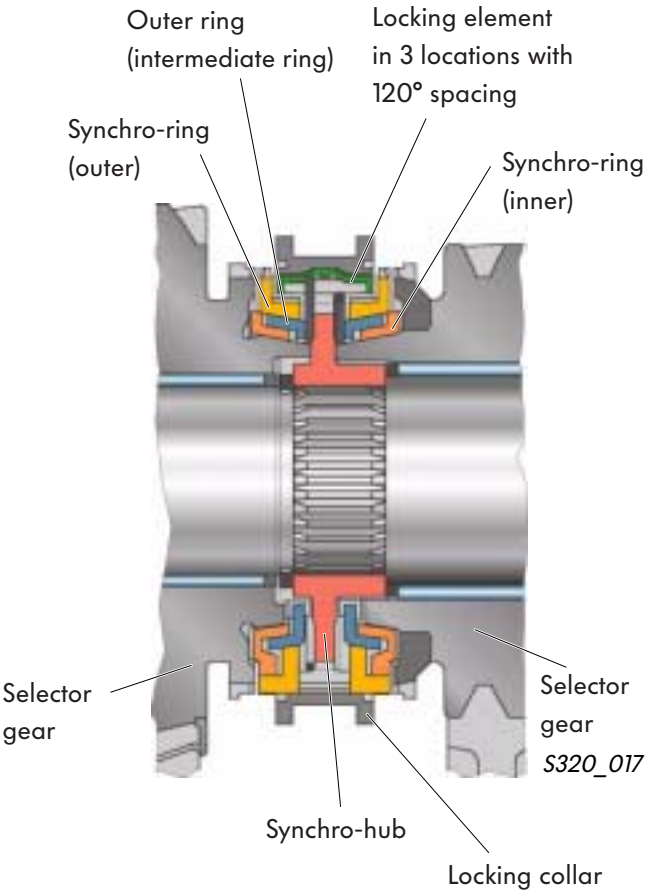
For the selector gear there is a simple outer ring synchronisation.

The synchro-hub for reverse gear is fixed firmly in place on output shaft 3 via an inner spline connection.

Gearbox mechanics

3-cone synchronisation (1st to 4th gear)

Before a gear wheel on the input shaft can be engaged with a gear wheel on the output shaft by way of the synchro-hub and locking collar, the gear wheels have to be brought to the same rotation speed. This procedure is referred to as synchronisation.
It occurs during the gear selection process via a friction cone on the selector gear and friction cones on the synchro-rings.



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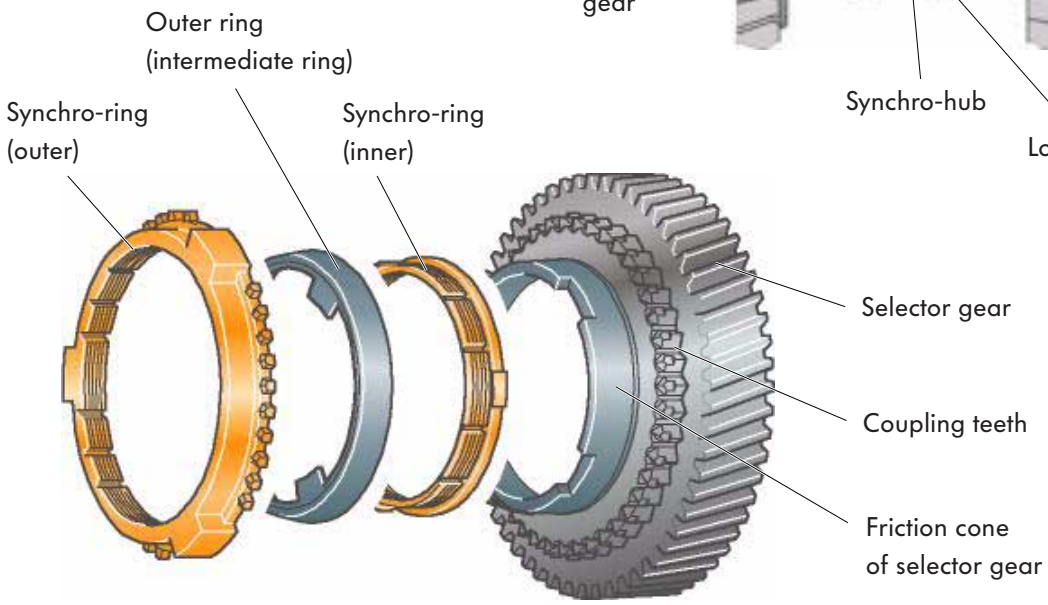


S320_018

With an increase in the number of friction cone pairs, a greater overall friction area is given for synchronisation. In this way, the efficiency of the cones is increased considerably and the force required for gear engagement is reduced.

This results in an improvement in gear synchronisation.

Each 3-cone synchronisation comprises of:

- a selector gear friction cone
- a synchro-ring (inner)
- an outer ring (intermediate ring)
- a synchro-ring (outer).

Locking and synchronisation positions

When a gear is selected, the locking collar is moved by a selector fork from the neutral central position in direction of the selector gear in question. When doing this, it takes 3 locking elements with it. These move the synchro-ring (outer) axially. With the outer ring (intermediate ring) and the synchro-ring (inner ring), the locking elements press the friction cone on the selector gear.

If the locking collar and the selector gear are not rotating at the same speed, a friction torque is built up between the friction cones. This turns the outer ring until the side protrusions come into contact with the recesses in the synchro-hub. The tooth peaks of the inner teeth then come into contact with the sloped parts of the synchro-ring locking teeth, thus preventing the locking collar from moving axially in direction of the synchro-ring.

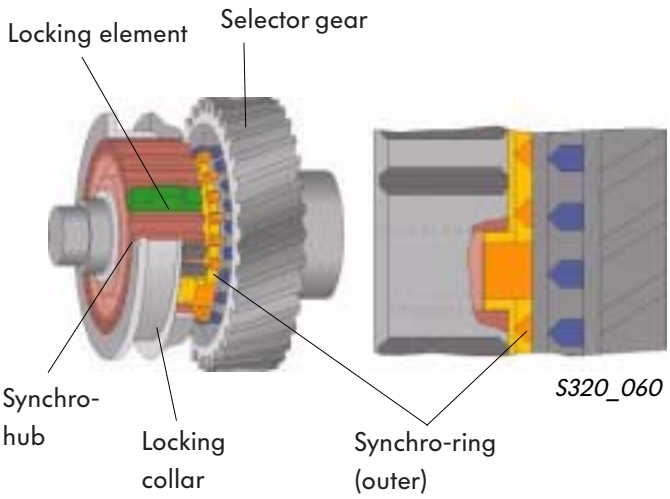
Friction torque between the
- synchro-ring (outer) / outer ring (intermediate ring)
- outer ring (intermediate ring) / synchro-ring (inner ring) and
- synchro-ring (inner ring) and friction cone of selector gear

causes rotation speed to be increased or decreased until motion is synchronised between locking collar and selector gear.

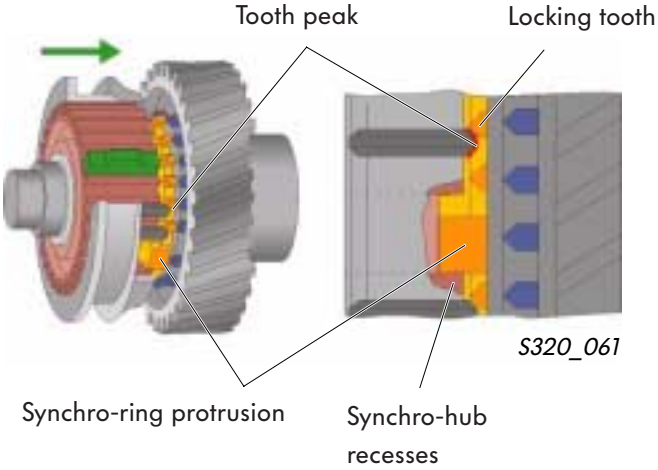
Engagement position

As soon as motion has been synchronised, force is no longer exerted around the outside of the synchro-ring (outer). This is now rotated by the tooth peaks from the inner teeth of the locking collar. Rotation continues until the locking collar is no longer "engaged" and can be pushed into the coupling teeth of the selector gear. Once this has occurred, power is transmitted between the gearbox shaft and selector gear.

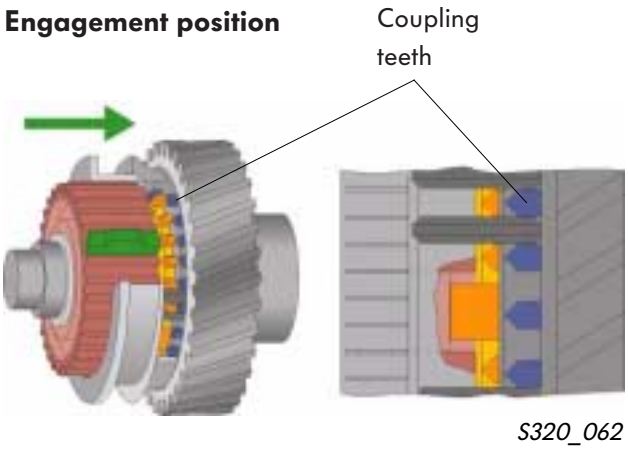
Neutral position



Locking and synchronisation positions



Engagement position

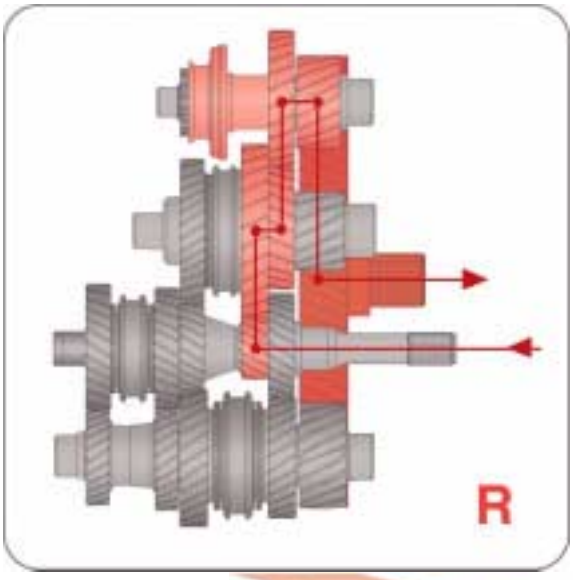


Gearbox mechanics

Transmission route

The engine torque is transmitted via the input shaft into the gearbox and, depending on which gear is engaged, through one of the three output shafts to the final drive gear wheel.

For reverse gear, the same occurs via output shaft 3 (reverse gear shaft). Direction is reversed via the selector gear for 1st gear, which in this instance has no positive connection with output shaft 1.



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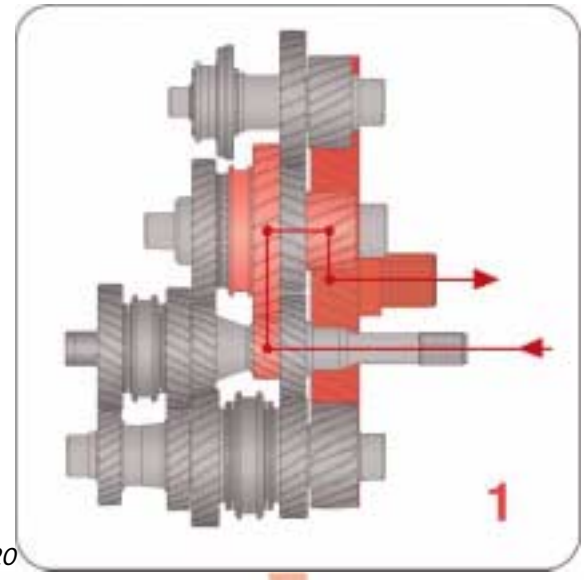

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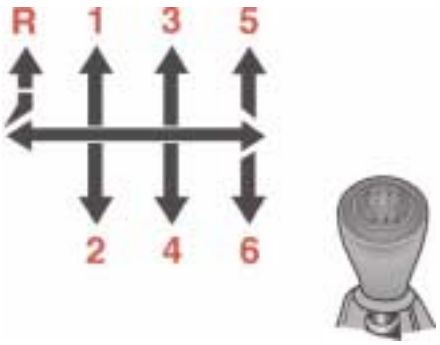

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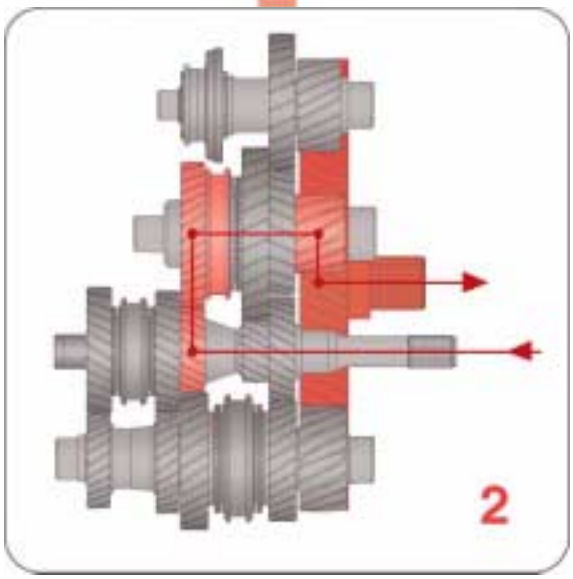

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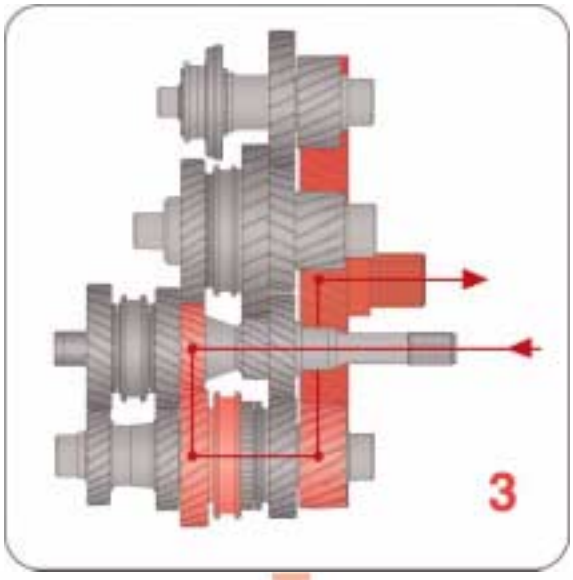

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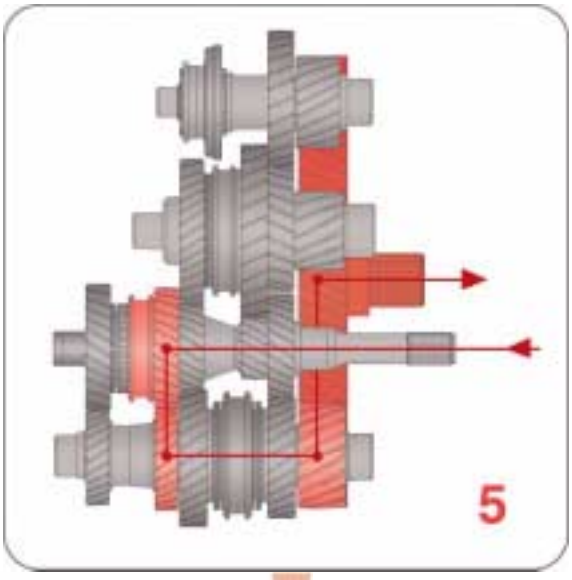

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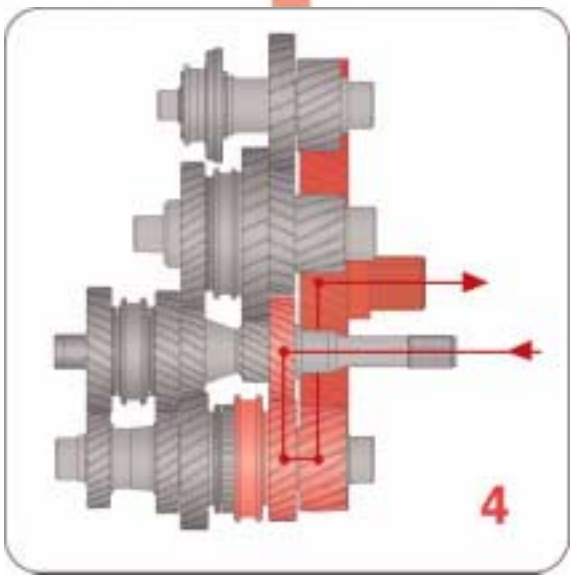

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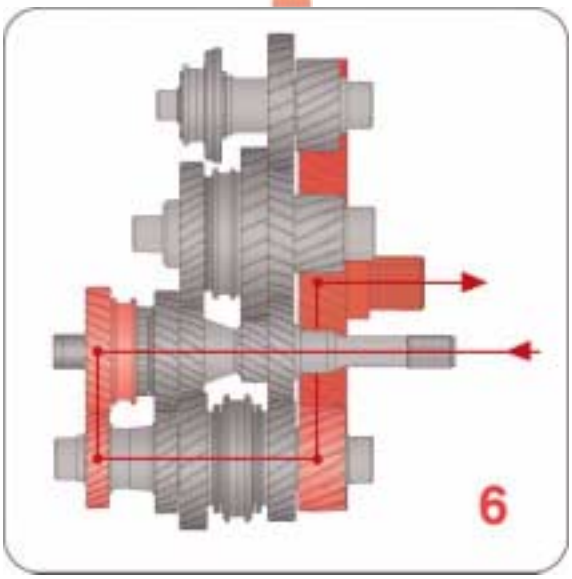


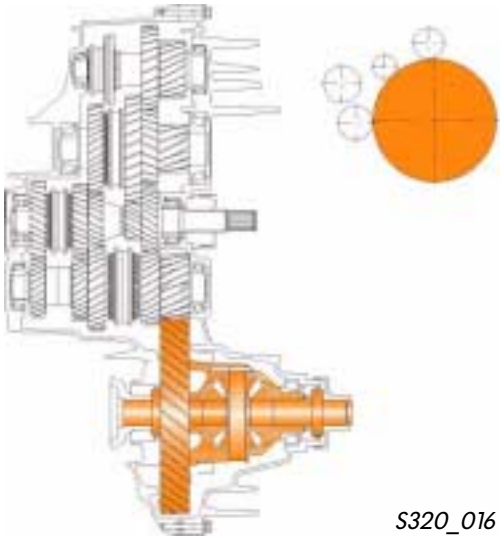
S320_026

Gearbox mechanics

Differential

The differential is mounted in the gear 'box' via taper roller bearings. The final drive gear wheel is fixed to the differential housing by rivets and is permanently meshed with all three output shafts.

The flanged shafts are sealed to the outside by two radial shaft O-rings of identical design.



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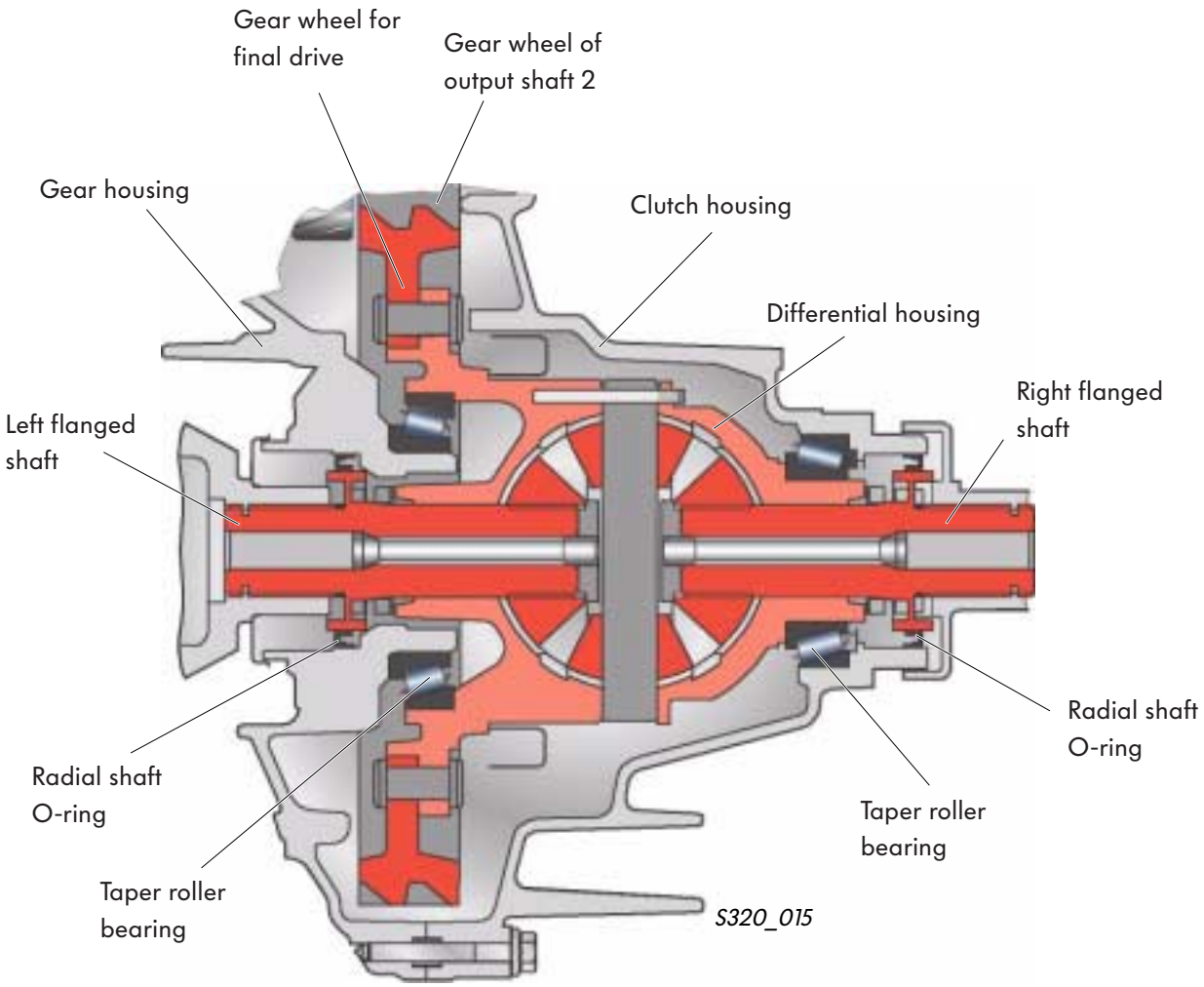
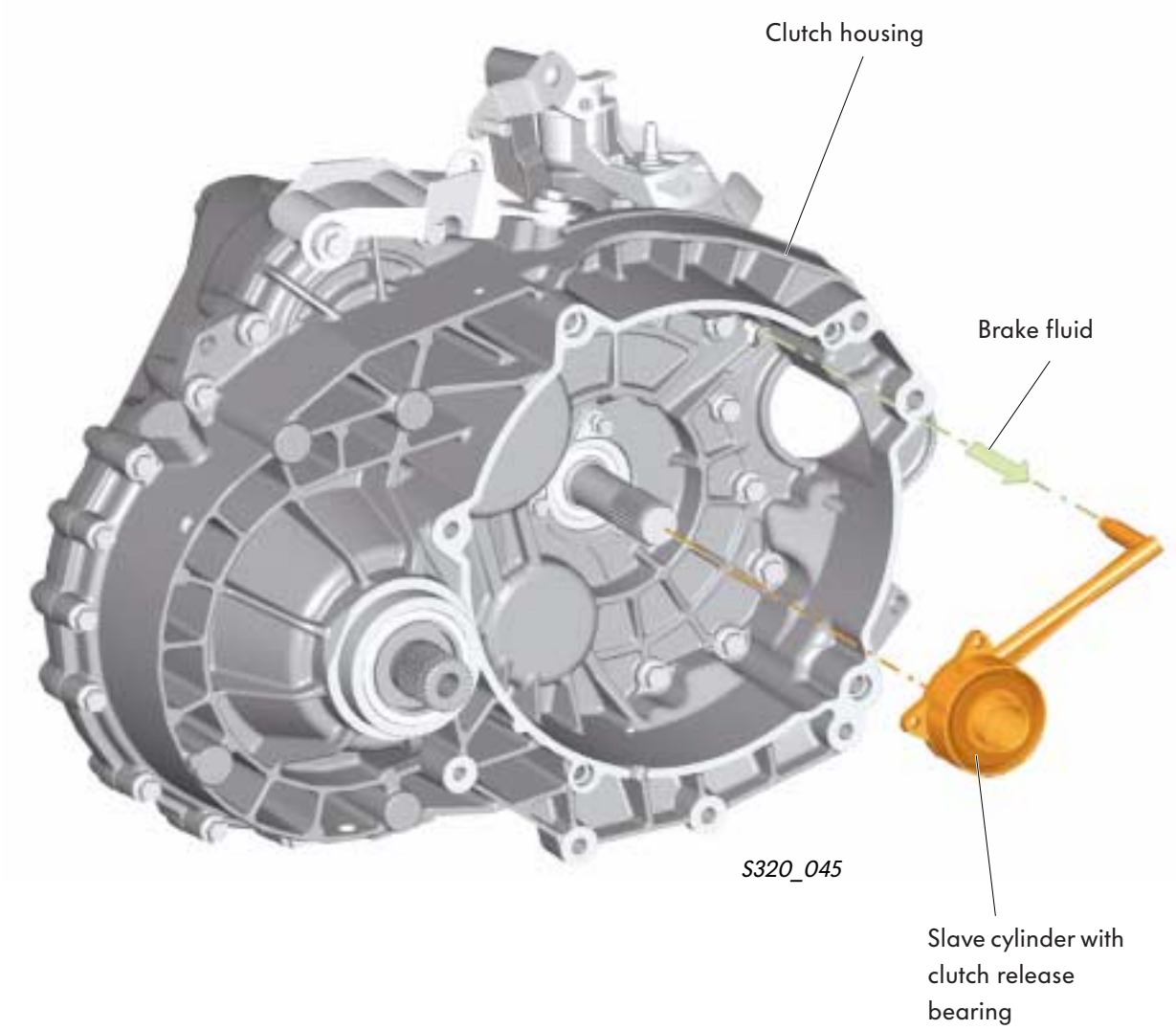


S320_015

Clutch actuation

The clutch is actuated hydraulically by a component, which is comprised of slave cylinder and clutch release bearing. This component is bolted in the clutch housing.

The clutch hydraulic system works with brake fluid and is joined to the brake fluid reservoir.



The clutch actuator mechanism can only be exchanged as a unit.

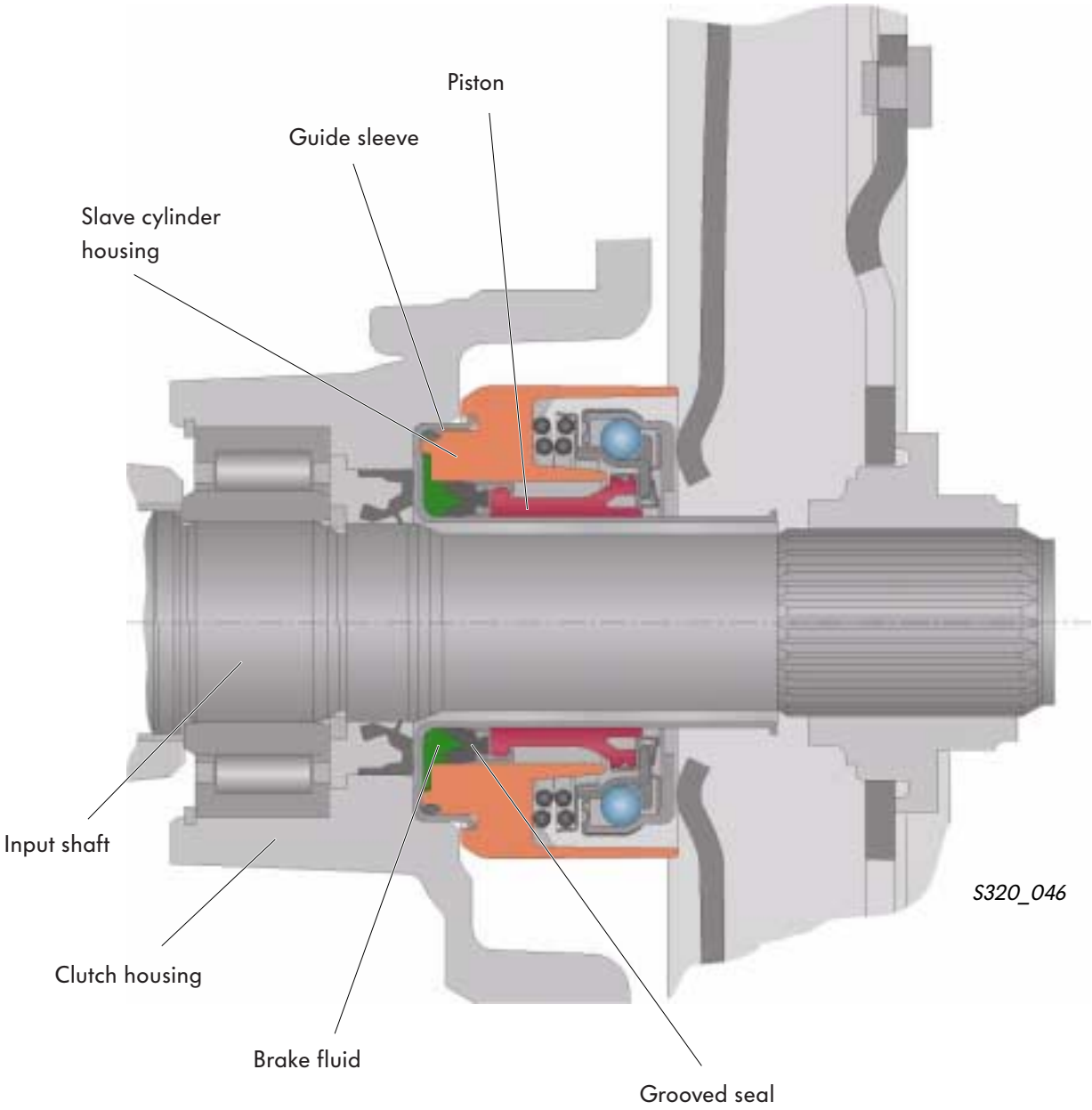
Slave cylinder with release bearing

The guide sleeve is joined permanently to the slave cylinder housing.

Located between the slave cylinder and guide sleeve is a piston, which moves axially when placed under pressure.

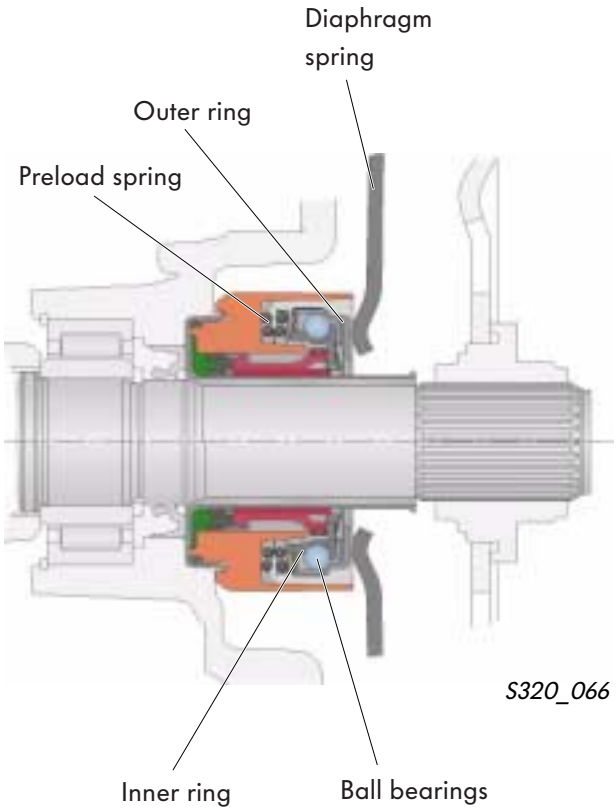
A grooved seal, which is flush fitted to the piston, seals the slave cylinder from the housing and guide sleeve.

The clutch release bearing is filled-for-life with grease.



Released position

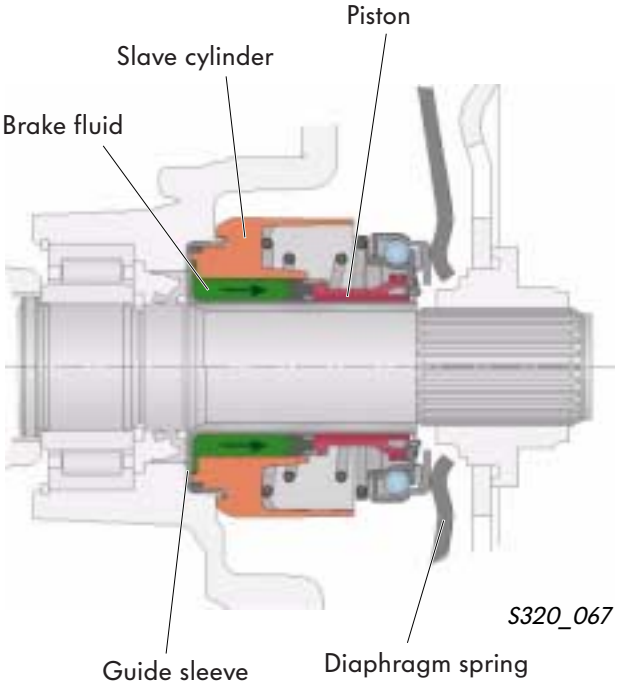
Spring pressure from the preload spring causes the outer ring to be permanently pressed against the diaphragm spring of the clutch. The outer ring, therefore, always rotates at the same speed as the clutch. The balance of speed between inner and outer ring is achieved by means of ball bearings. These rotate in a cage around the shaft.



S320_066

Clutch actuated

When the clutch pedal is pressed, pressure is generated by a master cylinder. This pressure is then transmitted to the slave cylinder by way of brake fluid. The piston is subjected to pressure and pushed along the guide sleeve in direction of the diaphragm spring. The clutch is thereby actuated.



S320_067

Gear selection

Outer gear selector mechanism

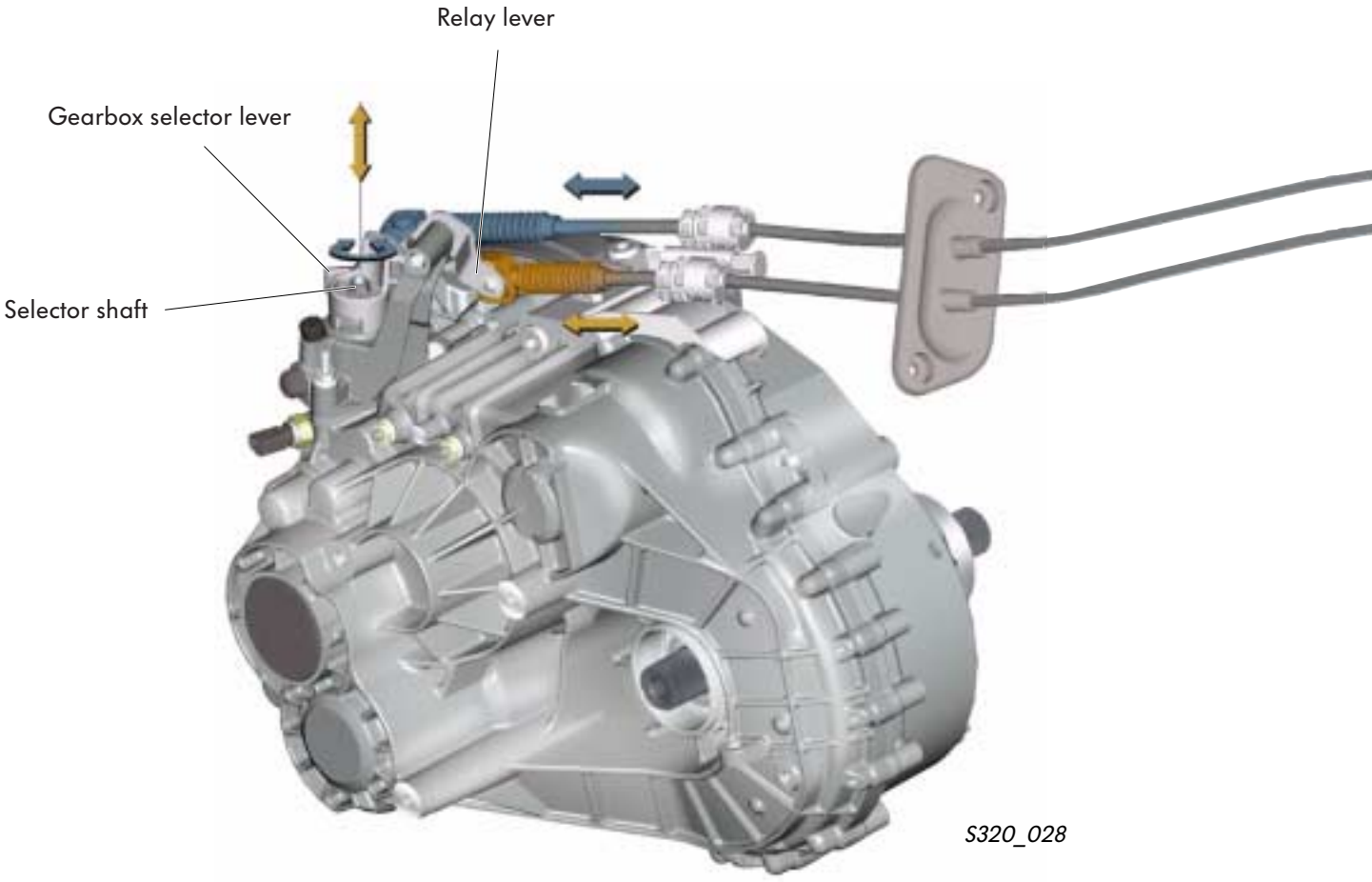
On the gearbox of the Transporter 2004, an outer gear selector mechanism with joystick and pull ring is featured for the first time in the Volkswagen Group. The example described here, therefore, is based on the selector mechanism from this gearbox.

As a measure to isolate vibrations and load change jolts from the power unit, the gearbox is equipped with a cable operated gear selector mechanism.

The cables transfer the gate and gear selection motion respectively to the gear selector shaft.

The mechanics (relay lever and gearbox selector lever with balance weight) converts the back and forth motion of the 2 cables in up and down and rotating motion of the selector shaft.

To adjust the cable selector mechanism, comprehensive information can be found in the Electronic Service Archive (ELSA).



Joystick gear selection

The joystick comprises of two main assembly groups, the gearstick and the selector housing. The gearstick is mounted on a pivot ball for freedom of movement. In this way, all of the main 'gate' and 'gear' selector positions can be reached.

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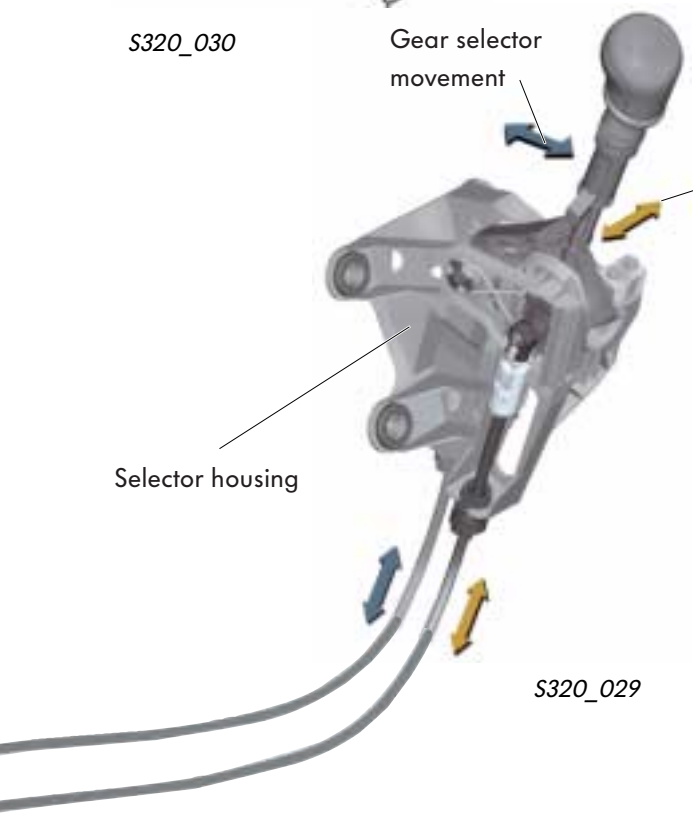

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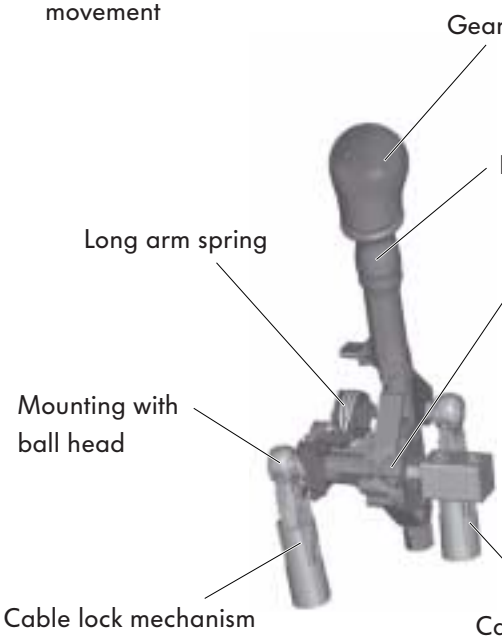


S320_058

A four gate layout was chosen for the gearbox, in which the reverse gear is located on the upper left. The position of the other gears is based on the common H principle.

As a safety measure to prevent unintentional selection of the reverse gear, a pull ring system has been installed on the gear lever in conjunction with joystick gear selection.

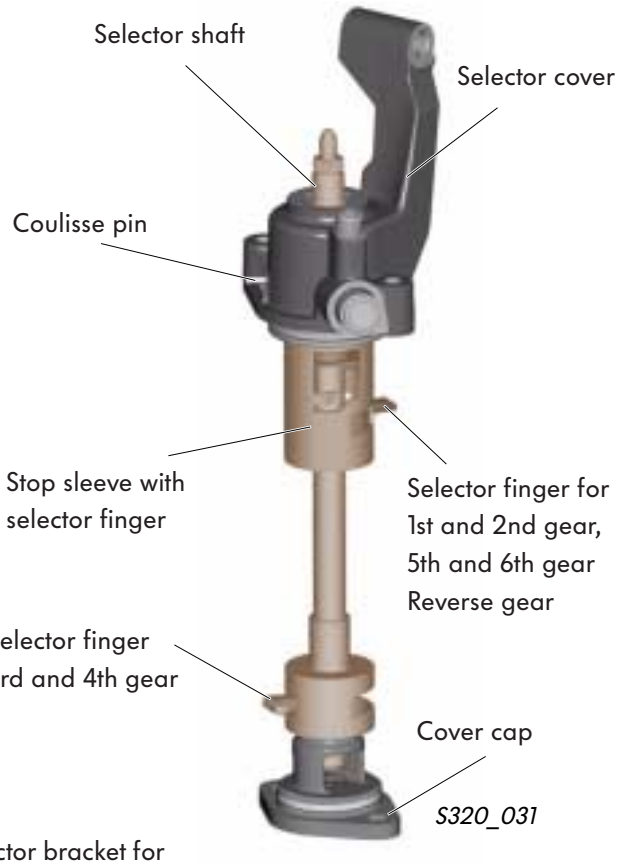
Installed on the selector lever are cable lock mechanisms for the 'gate' and 'gear' selector cables. To ensure good freedom of movement, the attachments are of the ball head type.
To hold the selector lever in the centre position, there is a long-arm spring.

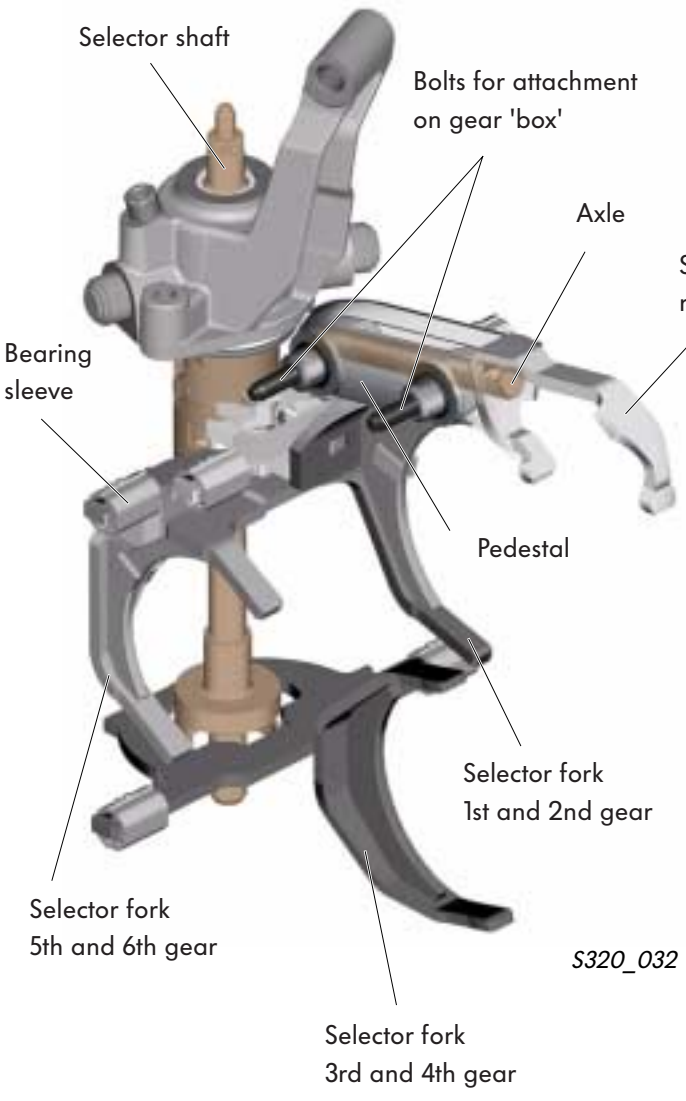
Gear selection

Inner gear selector mechanism

The gear selector movements are transferred to the gearbox via the selector shaft.

The selector shaft bearing points are at the top in the selector cover and in the bottom in a cover cap, which is bolted to the gear 'box'.





Depending on the gear selected, the selector lever engages with its selector fingers in one of the selector forks for 1st to 6th gear, or in the selector bracket for reverse gear, and actuates the selector fork, or bracket. The selector forks are mounted on both sides by bearing sleeves in the gearbox and clutch housing. They can thereby be moved axially to select a gear.

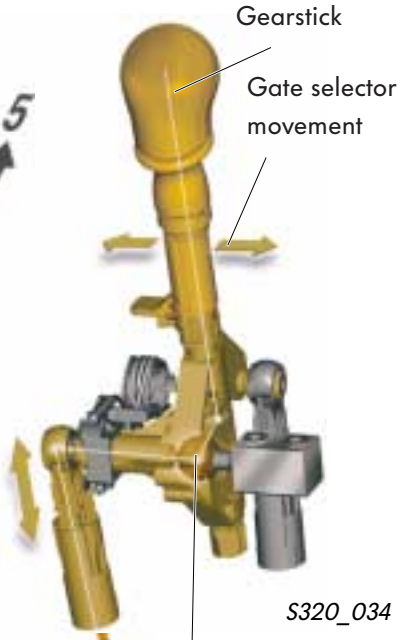
Reverse gear is selected via a selector bracket. The bracket is bolted to the gear 'box' via a pedestal and has rotational movement on an axle.

Gate selector movement

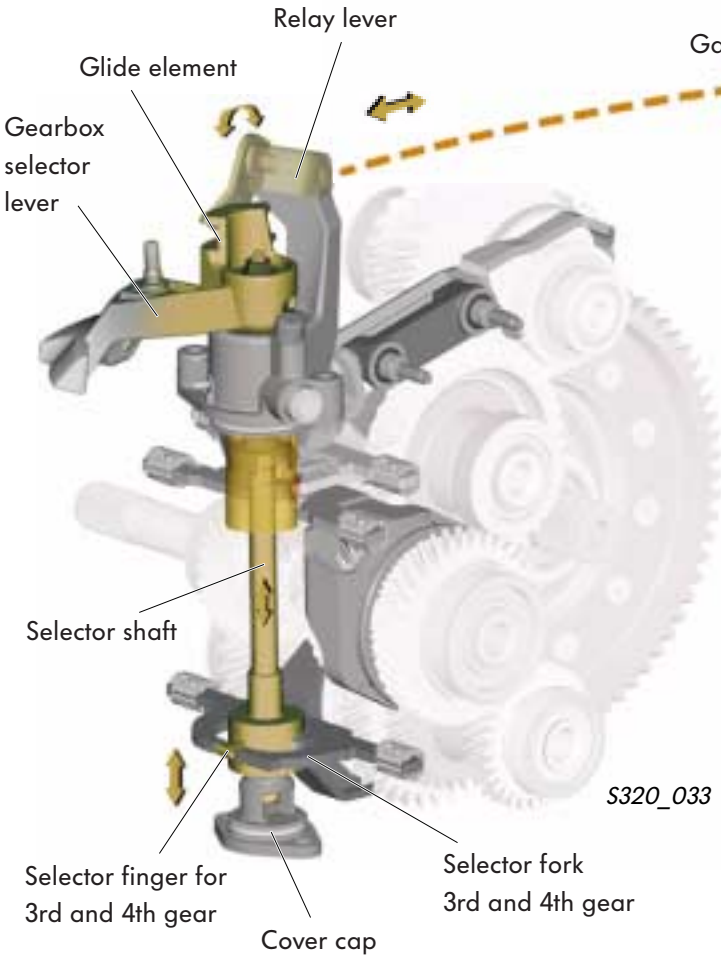
The gate selector movement (left and right movement of gearstick) is converted to back and forth movement at the selector cable.

The gearstick is mounted with rotational movement on a pivot ball, which is attached to the selector housing.

S320_035



S320_034



S320_033

Back and forth motion of the gate selector cable is converted, by way of a relay lever mounted on the gearbox, to up and down motion of the selector shaft. To do this, the gate selector cable is attached to the relay lever.

This is joined with freedom of movement to the gearbox selector lever via a glide element.

The up and down motion brings the selector lever into the correct position for gear engagement. The respective selector finger is thereby at the correct height for engagement in the chosen selector fork/bracket.

Gear selection

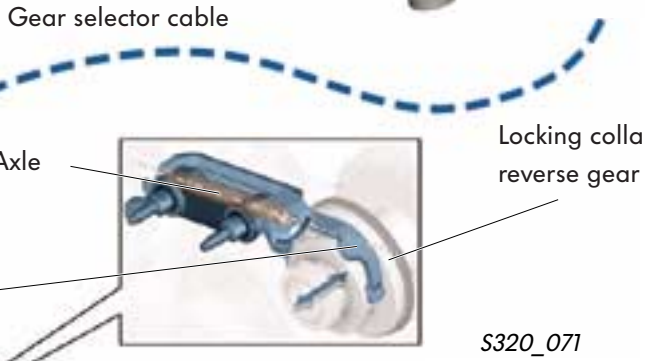
Gear selector movement

The gear selector movement (back and forth motion of gearstick) is transmitted to the gear selector cable.

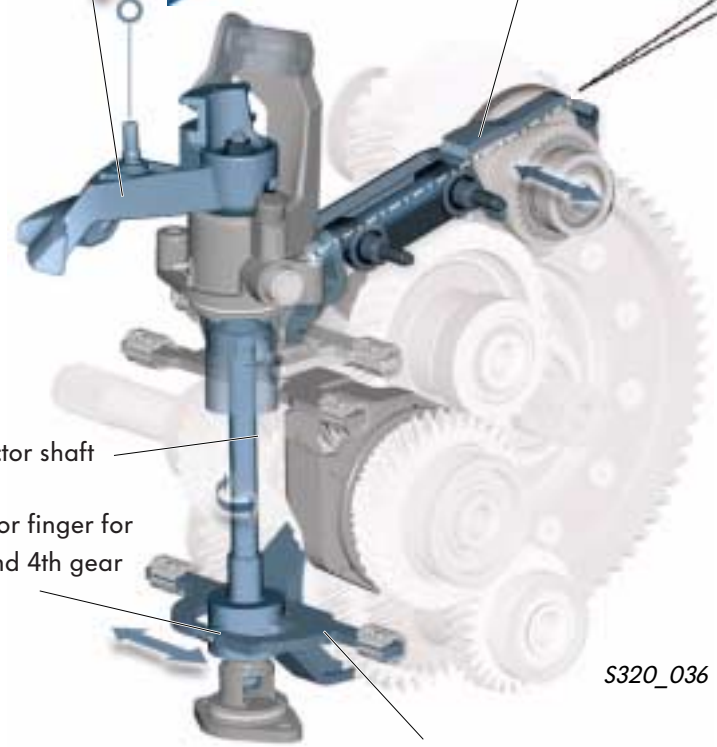
When a gear is selected with the gearstick, the tilting motion is converted into back and forth movement at the selector cable.

S320_038

S320_037



S320_071



S320_036

The back and forth motion of the gear selector cable turns the selector lever about its axis. This rotational movement causes the selector finger to move the respective selector fork connected to it. For reverse gear, the rotational movement is converted into a swing motion at the selector bracket (axle rotation).

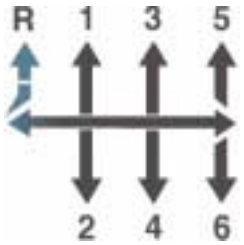
The relay lever, for transmission of the gate selector movement on the gearbox, is connected to the gearbox selector lever and remains in its selected position due to glide element movement.
The affected selector fork/selector bracket engages in the locking collar and converts the movement to axial motion of the locking collar. The gear is selected.

Reverse gear

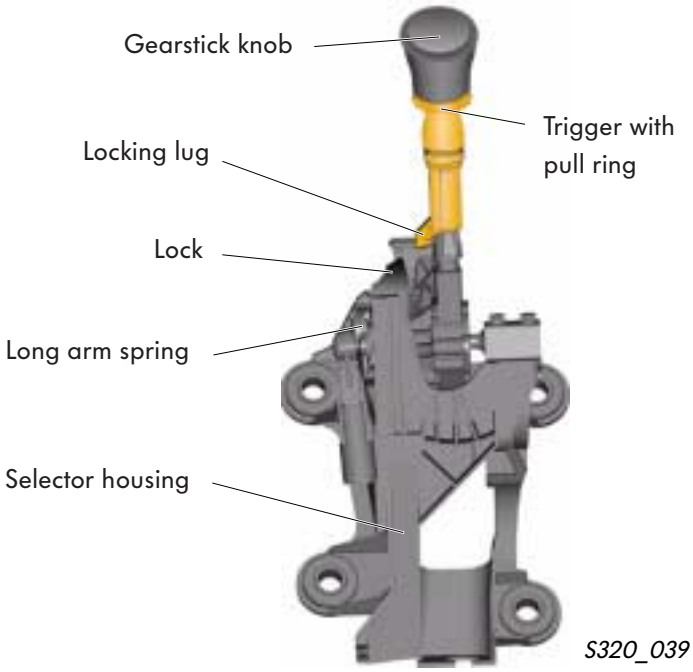
In conjunction with the joystick selector mechanism, a reverse gear lock with pull ring is installed for the first time in a Volkswagen.

The reverse gear lock is integrated in the trigger.

To engage reverse gear, the pull ring of the trigger should be pulled in direction of the gearstick knob.

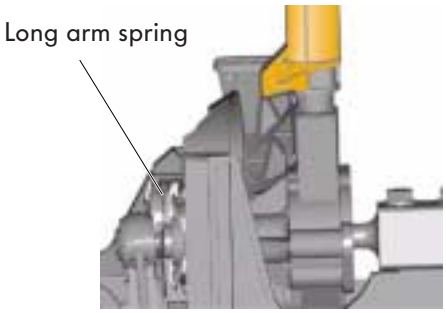


S320_040

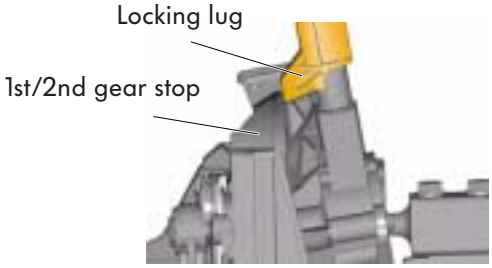


S320_039

The gearstick is held centrally in the start position (3rd/4th gear gate) by a long arm spring.



S320_041



S320_042

When 1st gear is selected, the locking lug prevents unintentional selection of the reverse gear. The lug hits the 1st/2nd gear stop (part of selector housing).

S320_043

By lifting the pull ring, the locking lug is raised over the 1st/2nd gear stop and selection of reverse gear becomes possible.

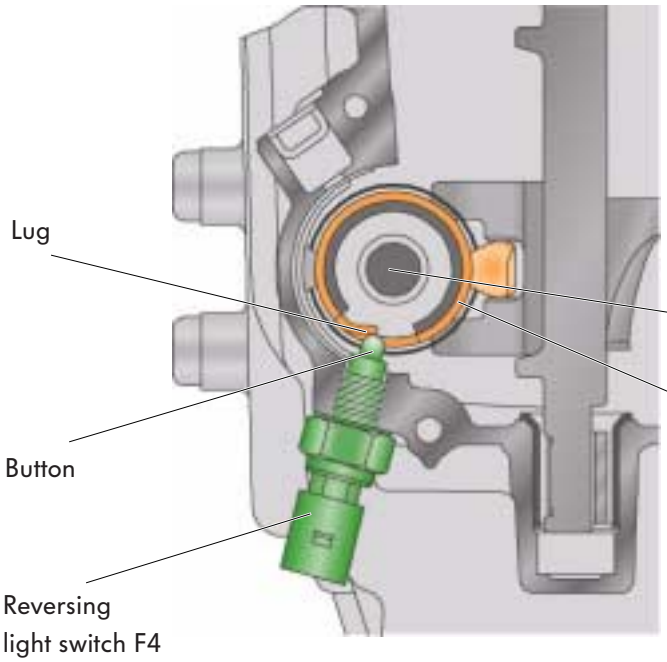
Sensors

Reversing light switch

The reversing light switch is screwed in on the side of the gear housing.

S320_069

Reversing light switch F4



S320_054

During selection of gears 1 to 6, the button of the reversing light switch F4 engages in a recess in the stop sleeve.

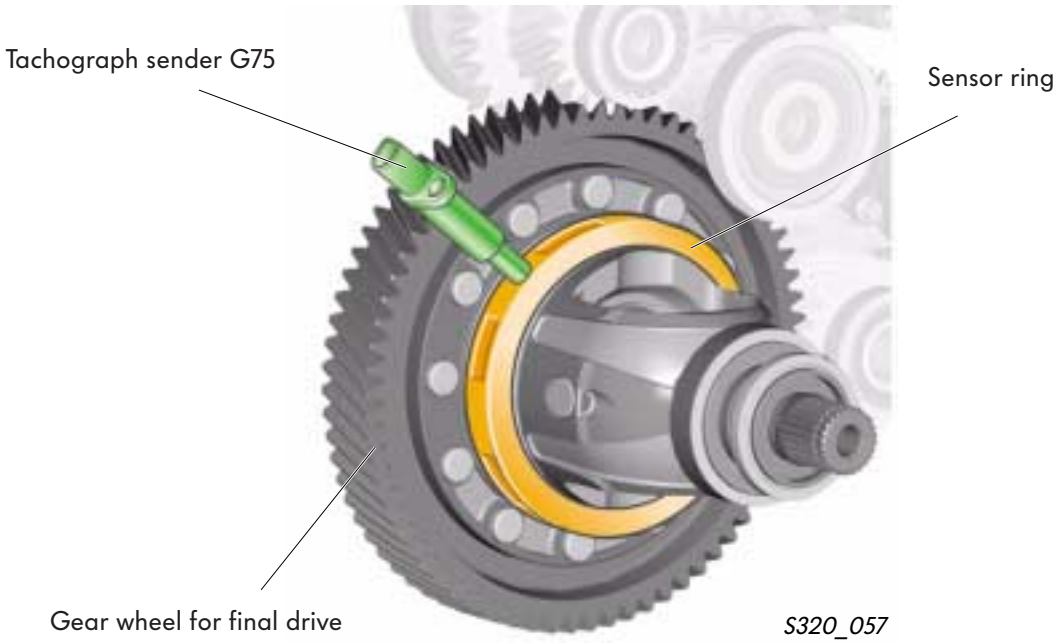
When reverse gear is selected, the stop sleeve is moved upwards axially together with the selector lever. When doing this, the button reaches a horizontal position at the same height as a lug in the window of the stop sleeve.

During gear selection, the button of the reversing light switch comes into contact with the lug. The button is activated and the electrical circuit is closed.

S320_055

Tachograph sender

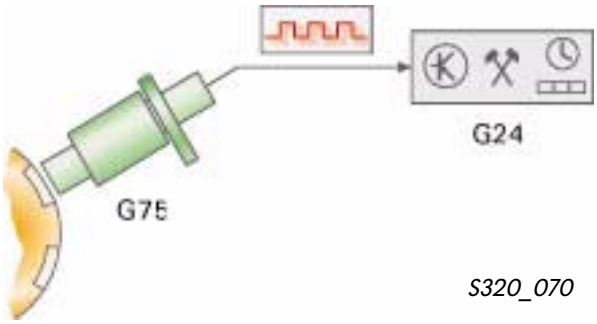
If the gearbox is installed in a vehicle with tachograph, the differential is supplemented with a tachograph sender G75.



S320_057

The signals for the tachograph sender G75 are generated at a sensor ring located in the differential housing by means of an impulse sender wheel. These are sent to the tachograph G24 for evaluation.

The sender is installed externally in an opening in the clutch housing.



S320_070

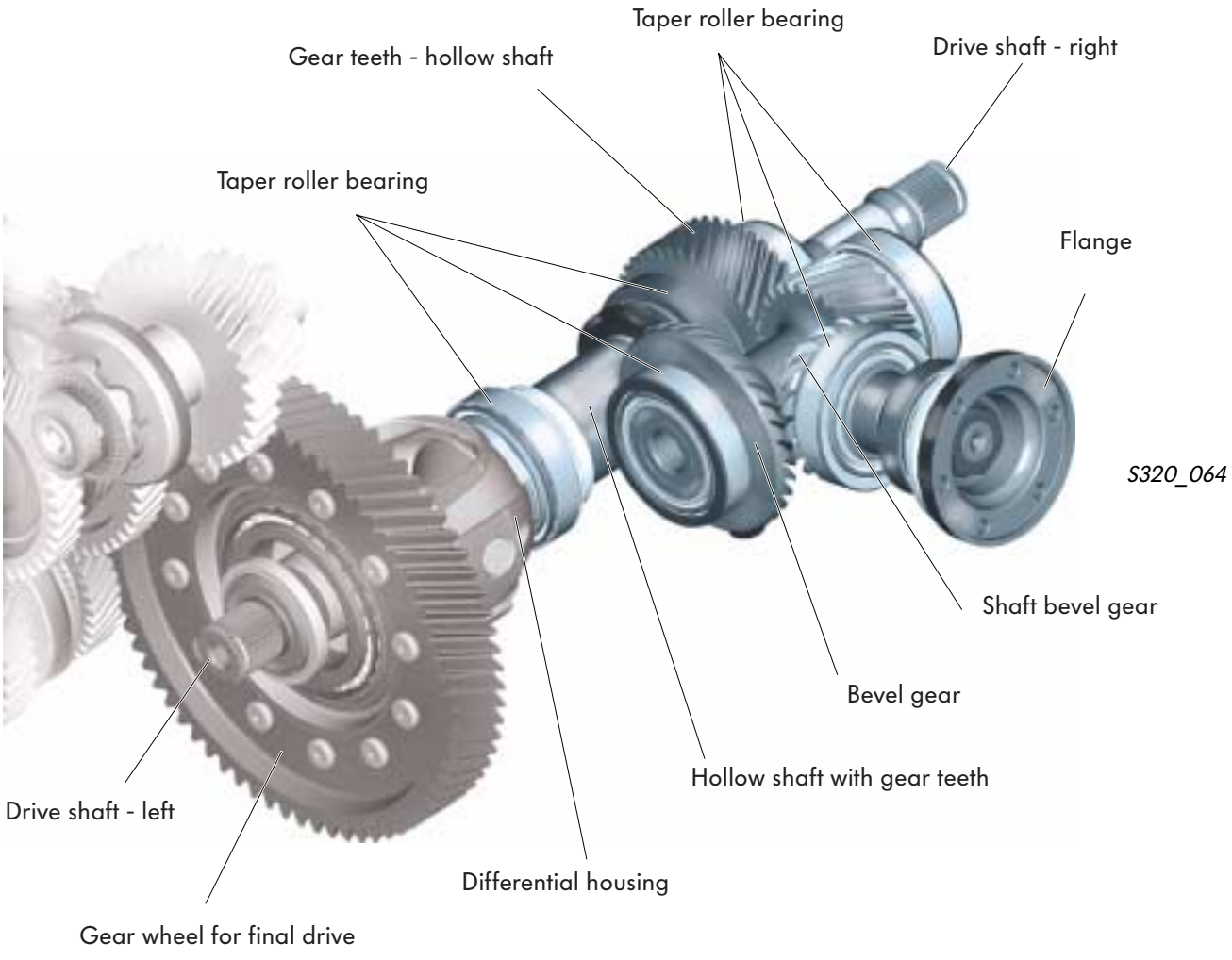
The sensor ring and tachograph sender are not installed during series production. No provision has been for retrofitting.

4motion version

Bevel box

The gearbox will later also be installed in a four-wheel drive version in conjunction with a bevel box and Haldex coupling.

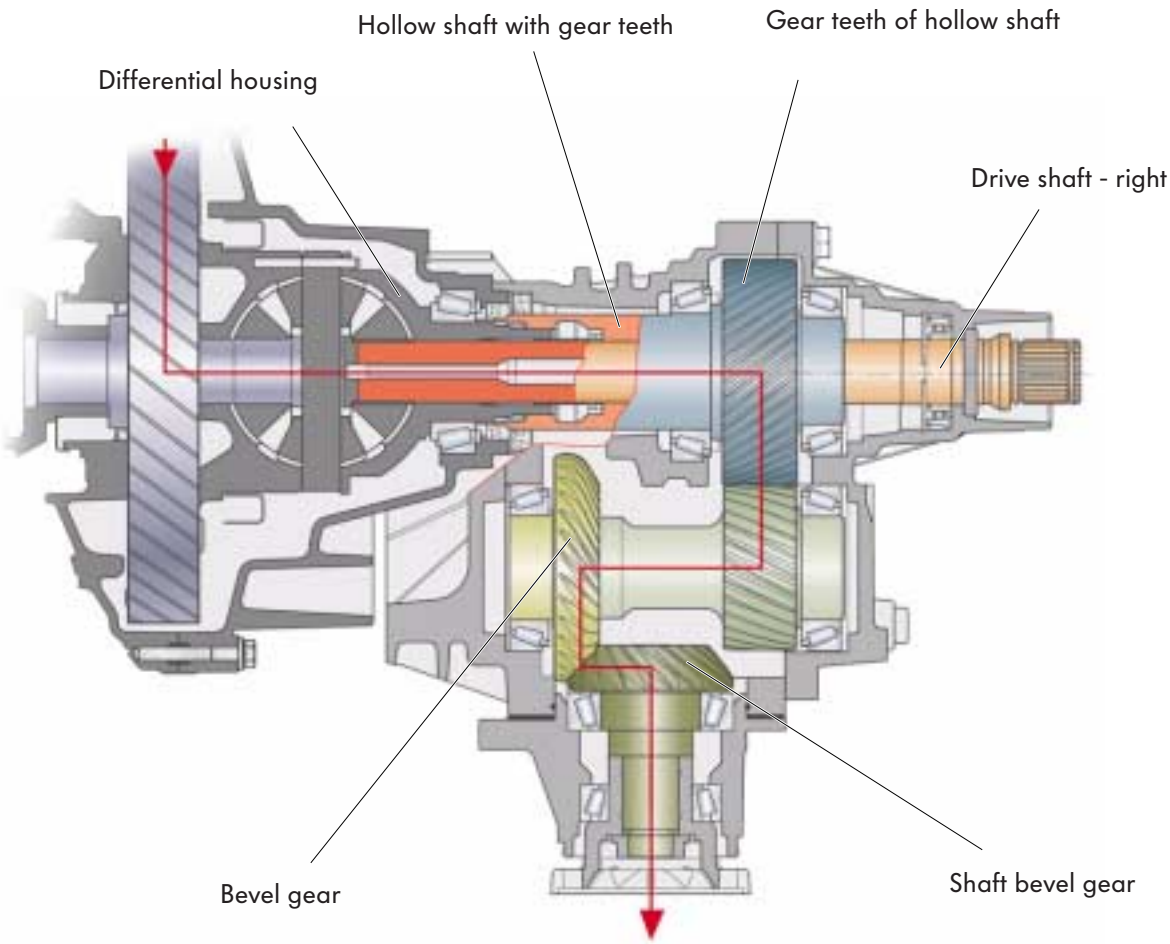
In this instance, the manual gearbox forms a unit with the bevel box. The bevel box is connected to the differential of the manual gearbox, via which drive torque is transmitted to the rear axle.



Design and function

Drive for the bevel box is transmitted to a hollow shaft, which features gear teeth to drive the bevel box. This hollow shaft is joined to the differential housing. Within the shaft runs the drive shaft for the front right final drive.

From the gear teeth of the hollow shaft, torque is transmitted further to a shaft, which has gear teeth to form a bevel gear. The bevel gear is meshed at 90 degrees to the shaft bevel gear and redirects the transmission route to the rear final drive.



S320_068

Test yourself

Which answers are correct?

One or more or all answers could be correct.

1. What are the advantages of the 4-shaft gearbox principle?

☐ a) Smoother running
☐ b) Requires less space
☐ c) Greater environmental compatibility

2. Which gears are engaged with the selector gears on output shaft 1?

☐ a) 5th/6th gear
☐ b) 1st/2nd gear
☐ c) 3rd/4th gear

3. Mark the transmission route for 5th gear in this diagram.

S320_059

4. Which gears have 3-cone synchronisation?

☐ a) 5th/6th gear
☐ b) Reverse gear
☐ c) 1st to 4th gear

5. What does the "3" mean with regards to the type of synchronisation?

☐ a) The gearbox has synchronisation systems for three gears.
☐ b) One synchronisation system with three cones.
☐ c) Synchronisation is carried out in three stages.

6. What fine hardening procedure is used on the gear wheels of the gearbox?

☐ a) Lapping
☐ b) Coroning
☐ c) Grinding

7. The reverse gear lock on joystick gear selection ...

☐ a) is of the push down type, common within the Group.
☐ b) is a modified push down type.
☐ c) is actuated via a pull ring.

8. The hollow design of the gearbox shaft serves as a means of

☐ a) increasing torsional rigidity.
☐ b) assuring smooth running.
☐ c) supplying oil.

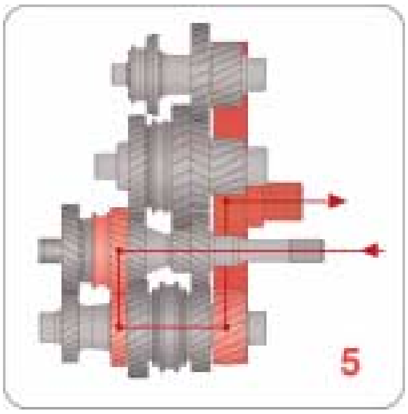
9. The clutch is actuated

☐ a) hydraulically via a clutch release lever and separate clutch release bearing with bearing bush.
☐ b) via a hydraulic unit, comprising of slave cylinder and clutch release bearing.
☐ c) mechanically via a clutch release lever, which moves a clutch release bearing mounted on the input shaft in axial direction.

Answers

1. b.; **2.** b.;

3. Transmission route diagram;



S320_025

4. c.; **5.** b.; **6.** b., c.; **7.** c.; **8.** c.; **9.** b.

Test yourself

Notes

320

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