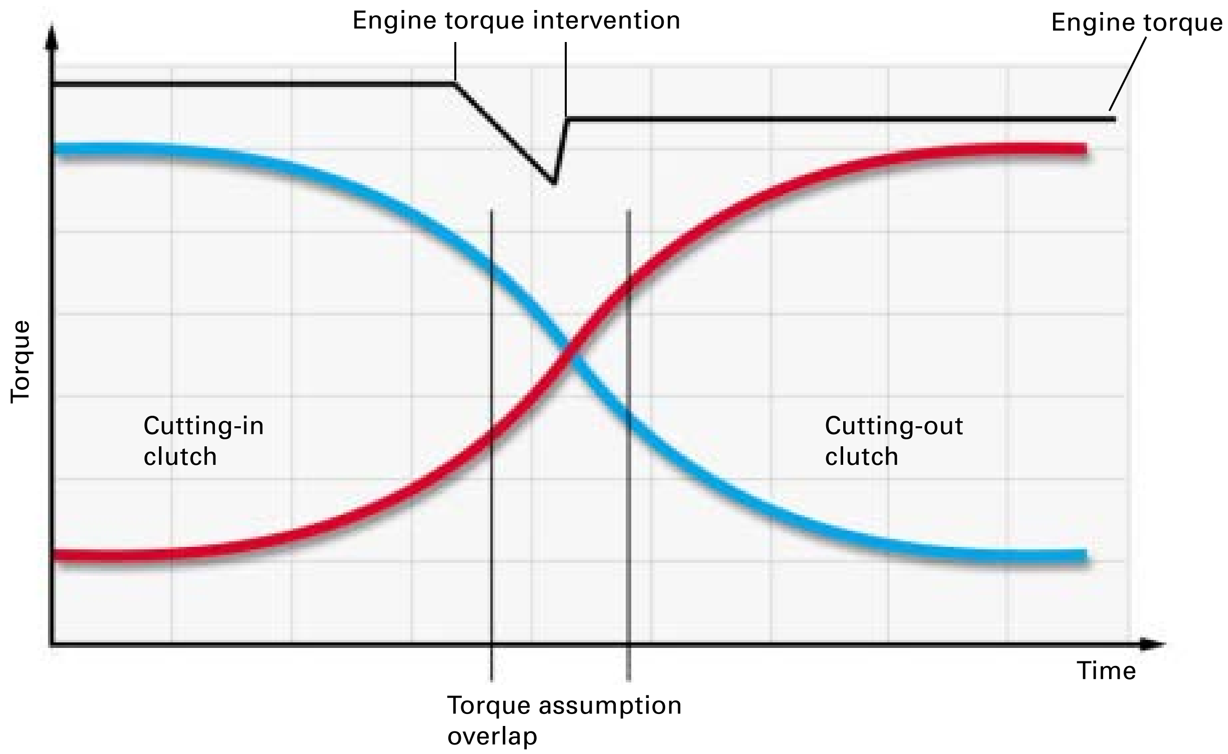
Notes

Overlapping gearshift operations/control

All gearshift operations (from 1st to 6th gear and from 6th to 1st gear) are so-called overlapping gearshift operations. In other words: During gearshift, the clutch in the process of transmitting power retains its transmission capacity with reduced pressure until the corresponding clutch cutting in assumes the torque being applied.

The gearshift operation is assisted by a brief reduction in engine torque on changing up or an increase in engine torque on changing down (with effect from new control unit generation, refer to Part 2 SSP 284, Page 15).



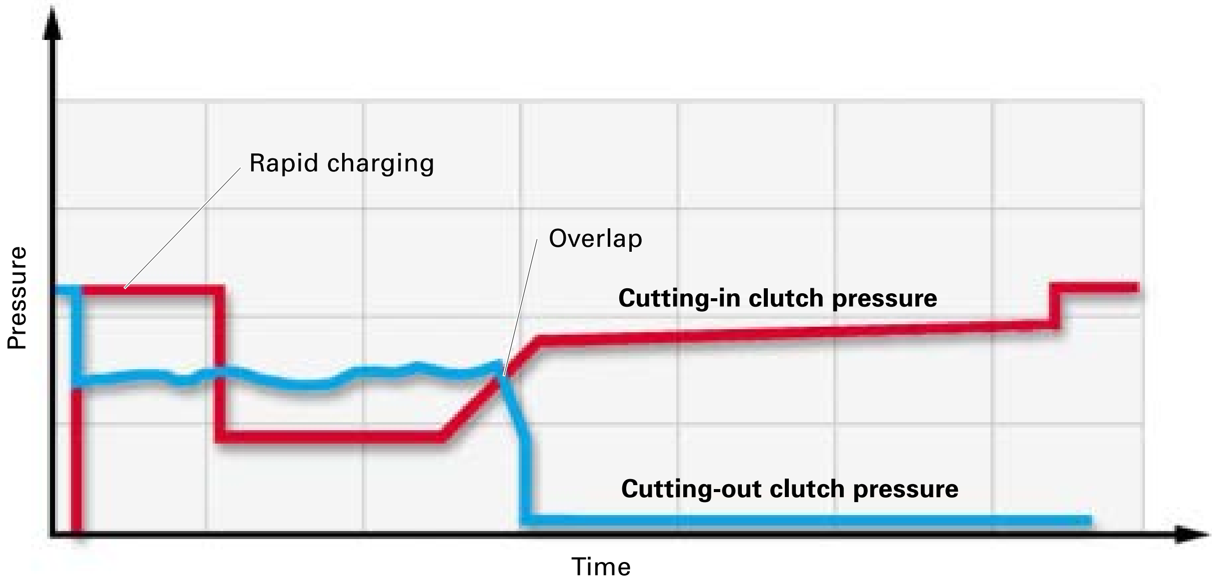
283_032

By using overlapping gearshift operations, it is possible to effectively replace free-wheeling by electrohydraulic clutch control, leading to great savings in terms of weight and space.

The gearshift operations are monitored by evaluating the gearbox input speed profile (G182), enabling appropriate action to be taken as necessary (e.g. shift pressure increase, gear retention or implementation of emergency operation).

Evaluation of the speed profile during the gearshift operation permits continuous adaption of the overlap control. Charging and the pressure build-up process in the clutch are influenced by appropriately adapting the control current of the pressure regulating valves.

For further information, refer to Part 2 SSP 284, Page 7 onwards.



283_055

Gearbox Assemblies

Planetary gearbox

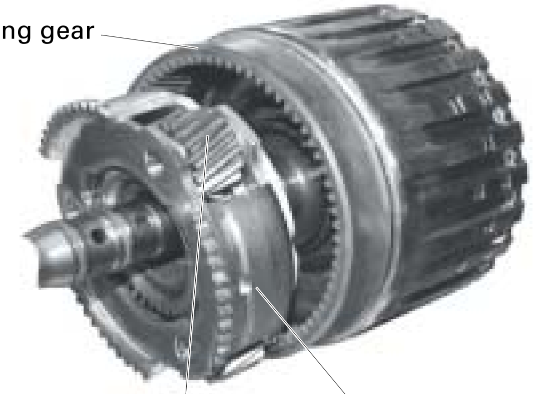
A new feature is the use of the so-called Lepelletier planetary gear train. This permits the implementation of six forward gears and one reverse gear employing only five selector elements (three clutches and two brakes).

Principle:

A single planetary gear train is fitted upstream of the Ravigneaux double planetary gear train and provides 2-speed drive for the Ravigneaux gear train.

Output is always via the ring gear of the Ravigneaux gear train.
A further feature is multiple utilisation of brakes and clutches.

Primary planetary gear train, single planetary gear train



283_036

Secondary planetary gear train, Ravigneaux gear train

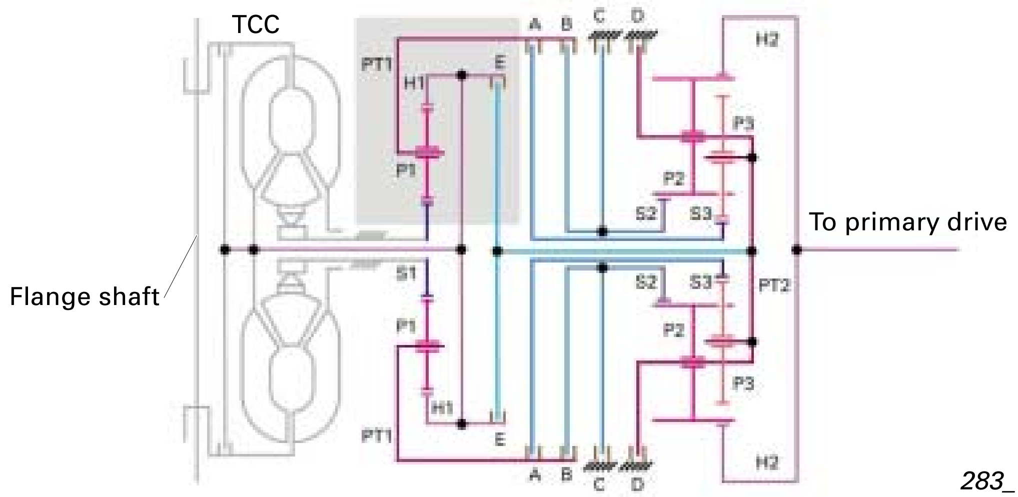
283_126

Advantages of Lepelletier planetary gear train:

- The extremely compact design allows for a reduction in overall length despite a greater spread, more gear ratio steps and high torque transmission.
- The use of far fewer components not only significantly reduces weight but also lowers manufacturing costs.

Power flow and the different ratios of the individual gears are achieved by torque being channelled via various elements of the planetary gear trains with the other elements in each case being held stationary or two elements of a gear train being connected with one another.

Block diagram of Lepelletier planetary gear train in the 09E gearbox



283_125

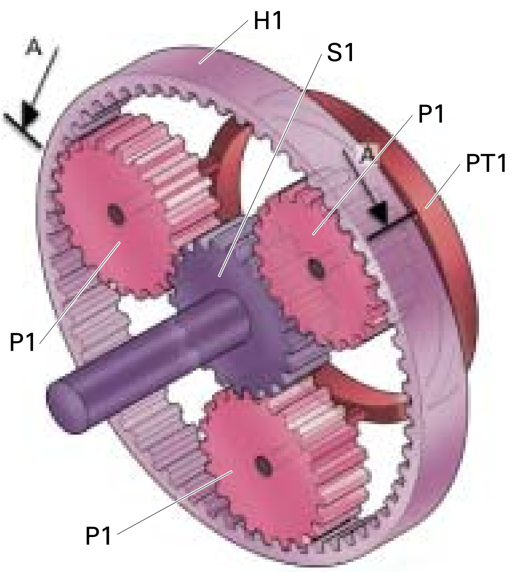
Single planetary gear train:

Sun gear (S1)	=	Stationary
Planet carrier (PT1)	=	Clutch A/B
Ring gear (H1)	=	Turbine shaft/ clutch E Input

Ravigneaux gear train:

Large sun gear (S2)	=	Clutch B Brake C
Small sun gear (S3)	=	Clutch A
Planet carrier (PT2)	=	Clutch E Brake D
Ring gear (H2)	=	Output

Explanation of block diagram 283_125 based on section with grey background



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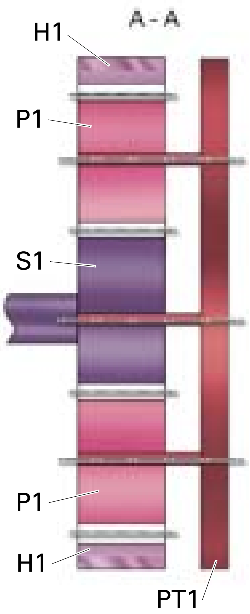

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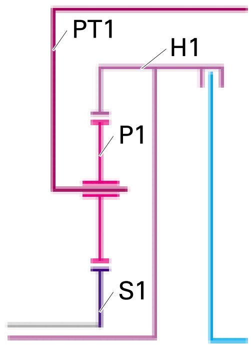


283_087

Gear description/torque profile

Power flow in 1st gear

Selector elements:	Clutch	A
	Brake	D

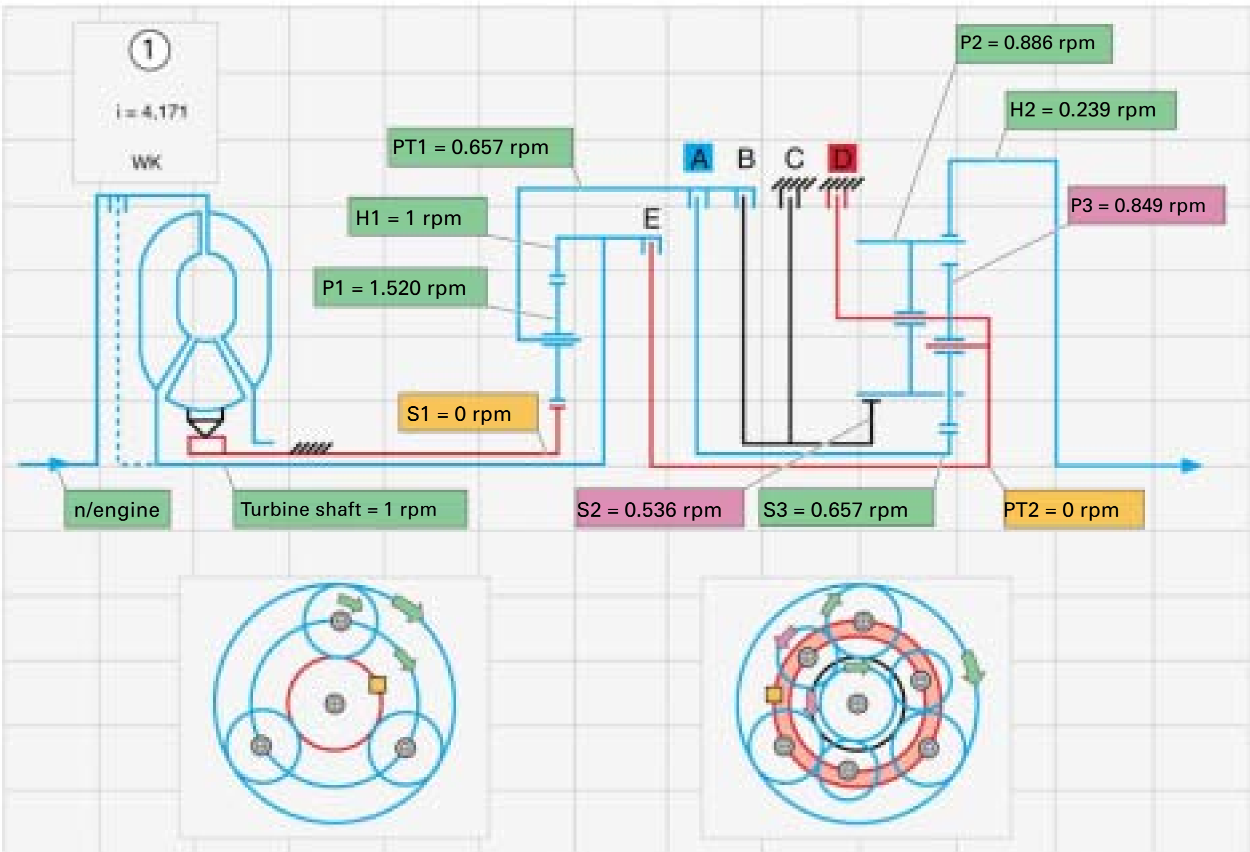
The turbine shaft drives the ring gear H1 of the primary planetary gear train.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch A connects PT1 to the sun gear S3 and thus channels the torque into the secondary planetary gear train.

The brake D blocks the planet carrier PT2. The torque is transmitted from the sun gear S3 to the short planet gears P3 and from there to the long planet gears P2. Supported by the planet carrier PT2, the torque is transmitted to the ring gear H2, which is connected to the output shaft.

In the interests of clarity, the torque profile is shown in the form of a block diagram. The following illustrations only show the upper half of the planetary gearbox in each case.



283_070

Power flow in 2nd gear

Selector elements: Clutch A
Brake C

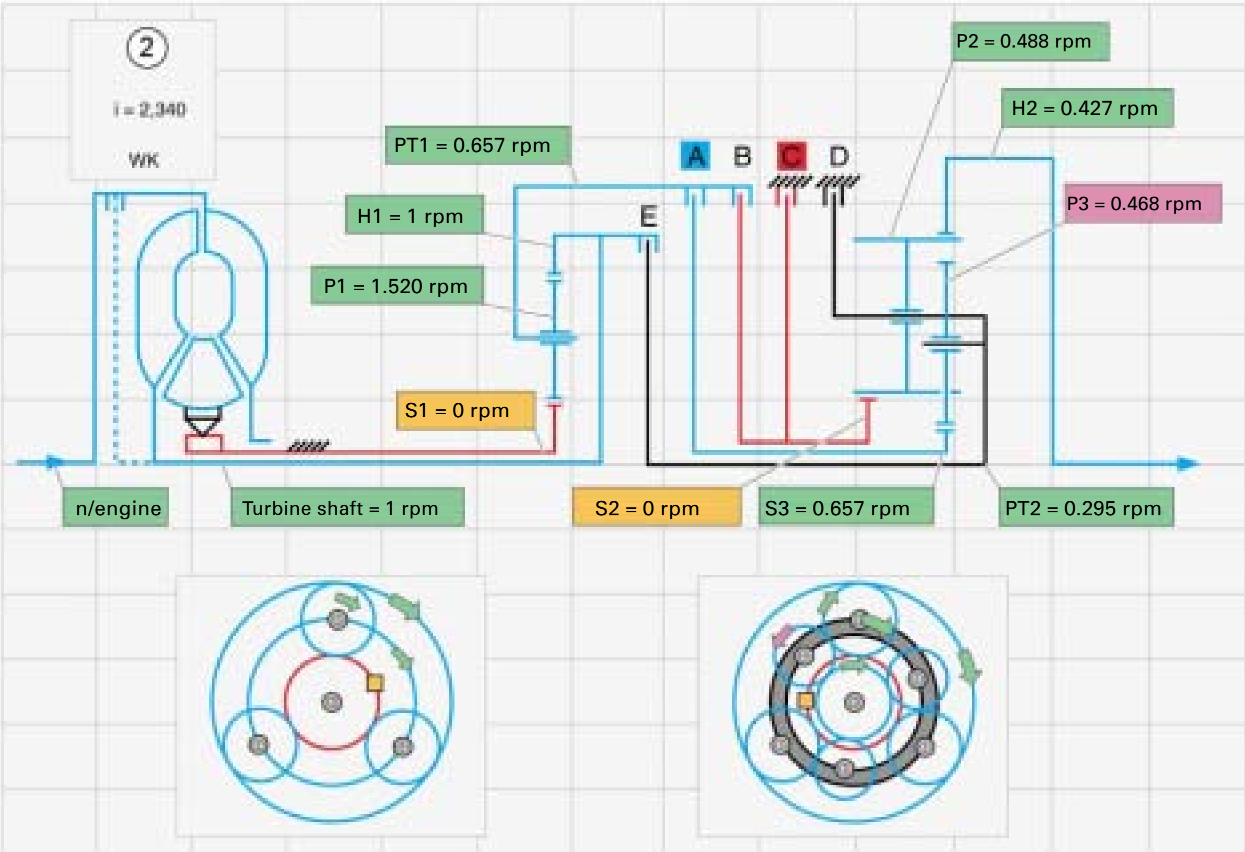
The turbine shaft drives the ring gear H1 of the primary planetary gear train.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch A connects PT1 to the sun gear S3 and thus channels the torque into the secondary planetary gear train.

The brake C blocks the large sun gear S2. The torque is transmitted from the sun gear S3 to the short planet gears P3 and from there to the long planet gears P2.

The long planet gears P2 roll around the stationary sun gear S2 and drive the ring gear H2.



283_071

Power flow in 3rd gear

Selector elements: Clutch A
Clutch B

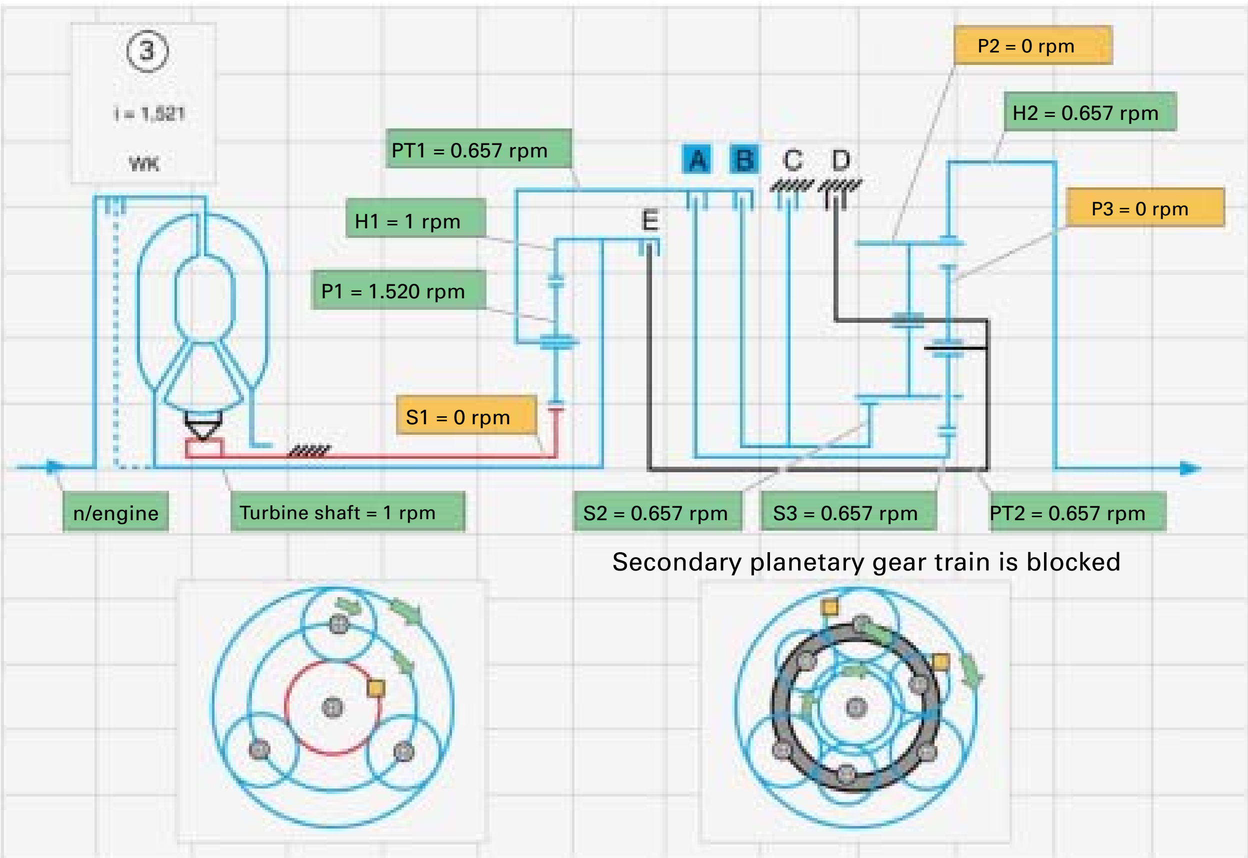
The turbine shaft drives the ring gear H1 of the primary planetary gear train.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch A connects PT1 to the sun gear S3 and thus channels the torque into the secondary planetary gear train.

The clutch B also channels the torque to sun gear S2 in the secondary planetary gear train.

Closing of the two clutches A and B blocks the secondary planetary gear train. The torque is then transmitted directly from the primary planetary gear train to the output shaft.



283_072

Power flow in 4th gear

Selector elements: Clutch A
Clutch E

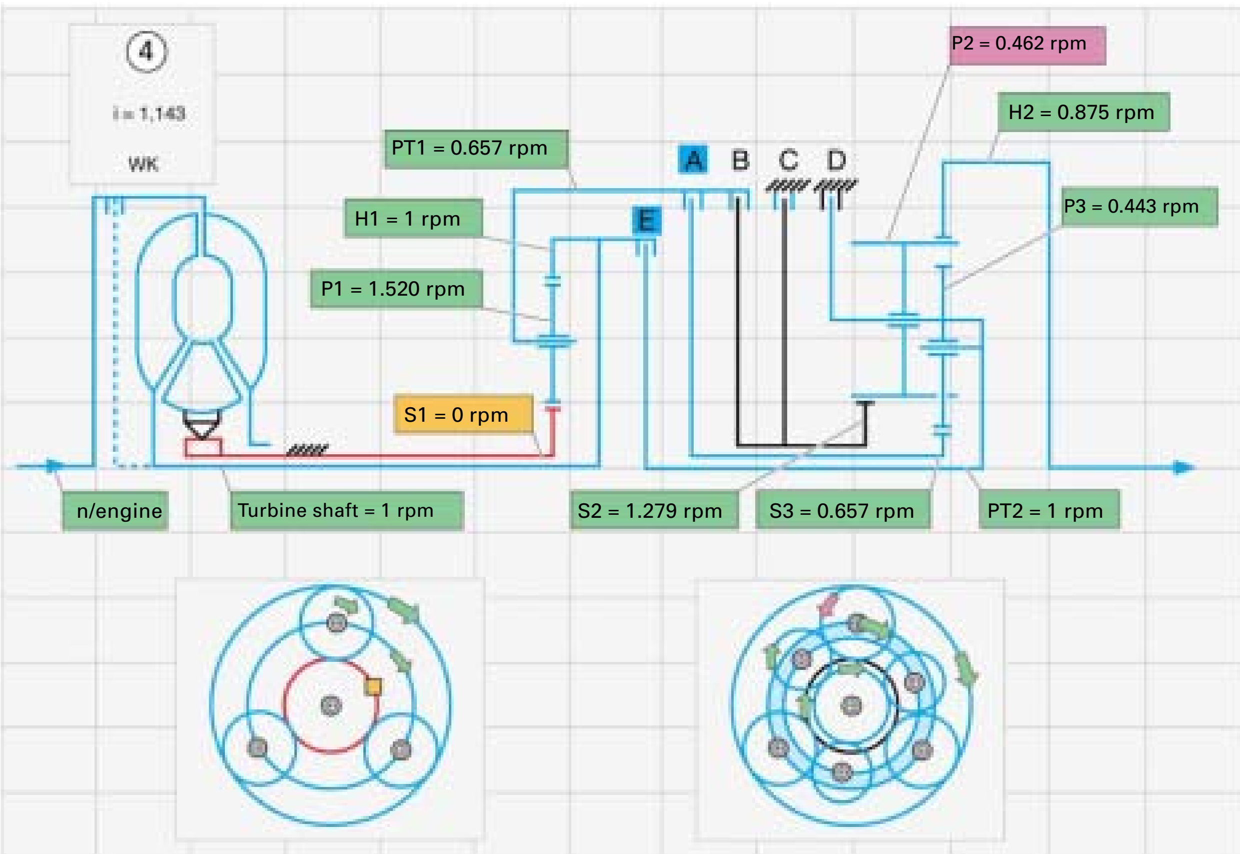
The turbine shaft drives the ring gear H1 of the primary planetary gear train and the outer plate carrier of clutch E.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch A connects PT1 to the sun gear S3 and thus channels the torque into the secondary planetary gear train.

The clutch E connects the turbine shaft to the planet carrier of the secondary planetary gear train PT2 and thus also channels the torque into the secondary planetary gear train.

The long planet gears P2, meshed with the short planet gears P3, drive the ring gear H2 together with the planet carrier PT2.



283_073

Power flow in 5th gear

Selector elements:	Clutch	B
	Clutch	E

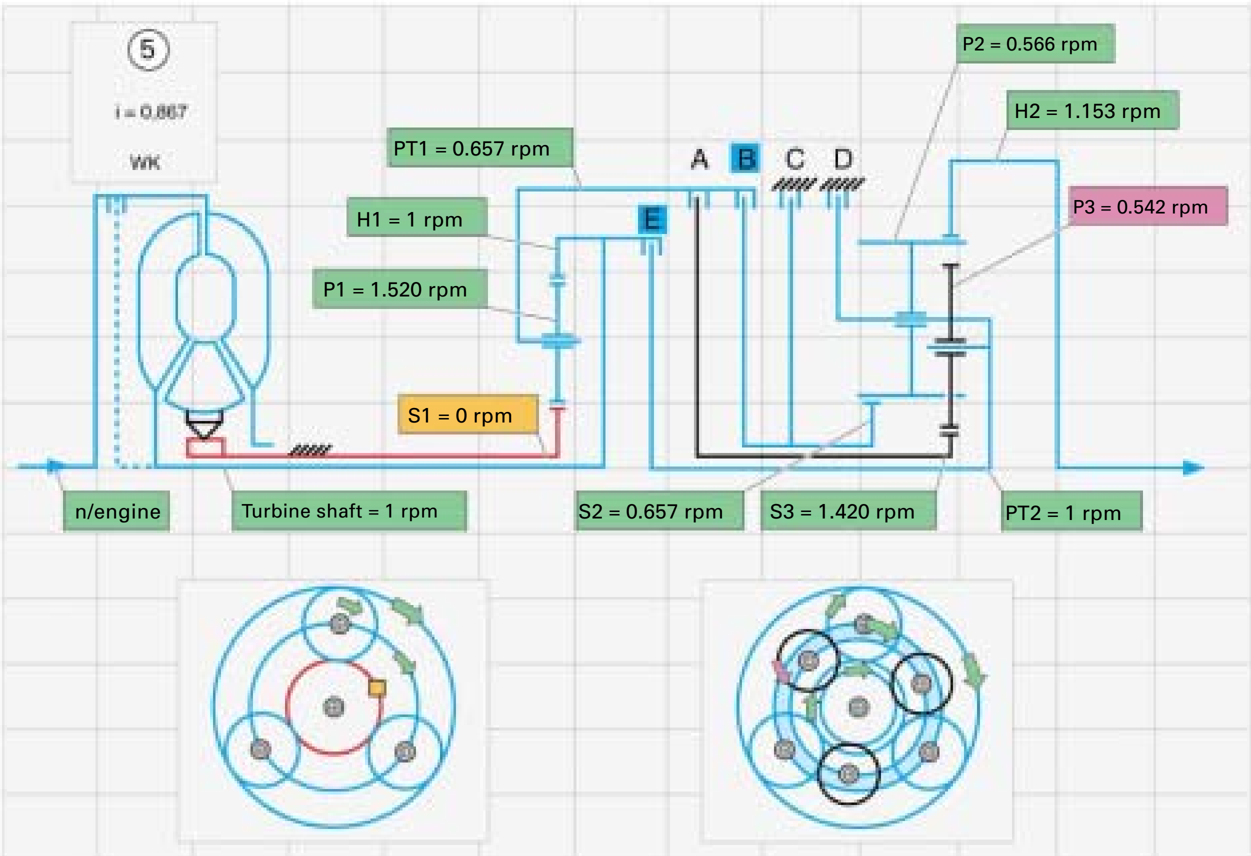
The turbine shaft drives the ring gear H1 of the primary planetary gear train and the outer plate carrier of clutch E.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch B connects PT1 to the sun gear S2 and thus channels the torque into the secondary planetary gear train.

The clutch E connects the turbine shaft to the planet carrier of the secondary planetary gear train PT2 and thus also channels the torque into the secondary planetary gear train.

The long planet gears P2 drive the ring gear H2 together with the planet carrier P2 and the sun gear S2.



283_074

Power flow in 6th gear

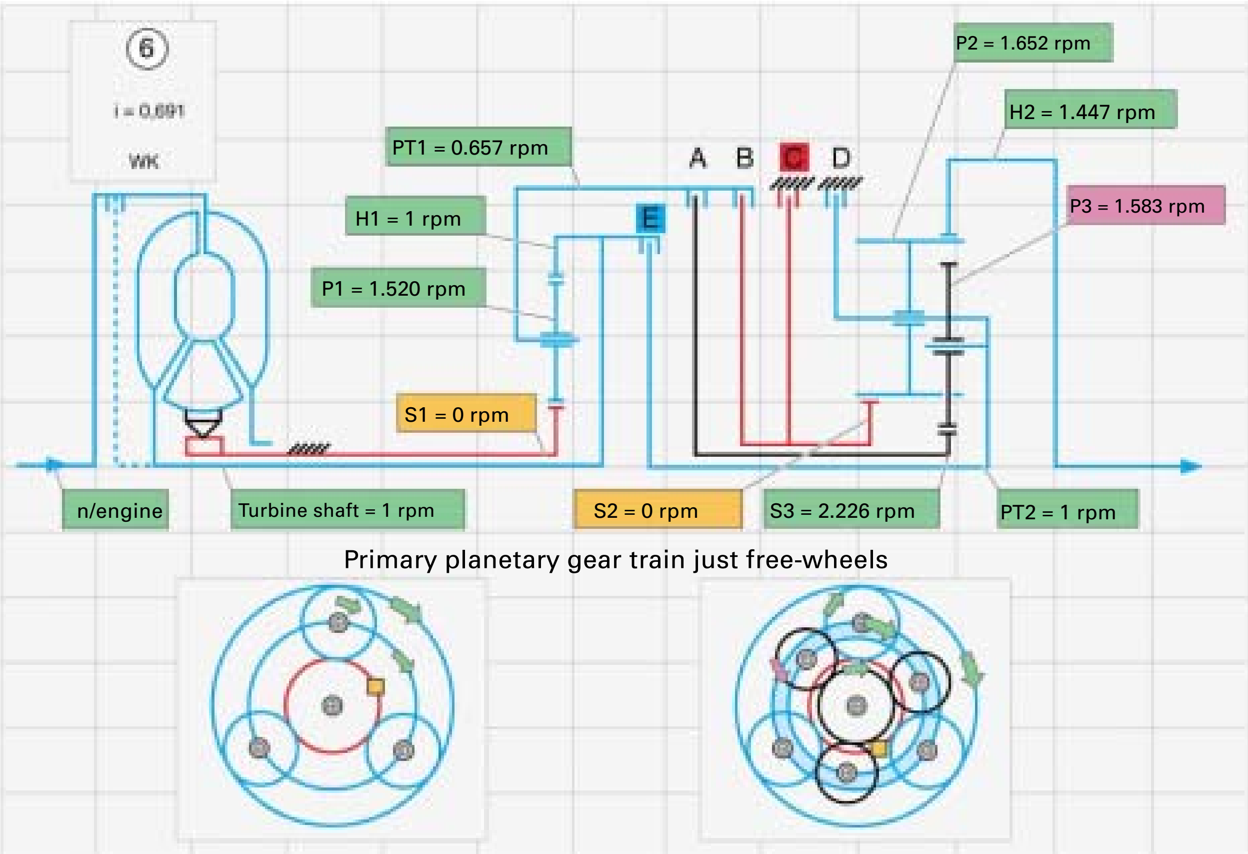
Selector elements:	Brake	C
	Clutch	E

The brake C blocks the sun gear S2.

The clutch E connects the turbine shaft to the planet carrier of the secondary planetary gear train PT2 and thus channels the torque into the secondary planetary gear train.

The long planet gears P2 roll around the stationary sun gear S2 and drive the ring gear H2.

Clutches A and B are open. The primary planetary gear train is not involved in power transmission.



283_075

Power flow in reverse gear

Selector elements: Clutch B
Brake D

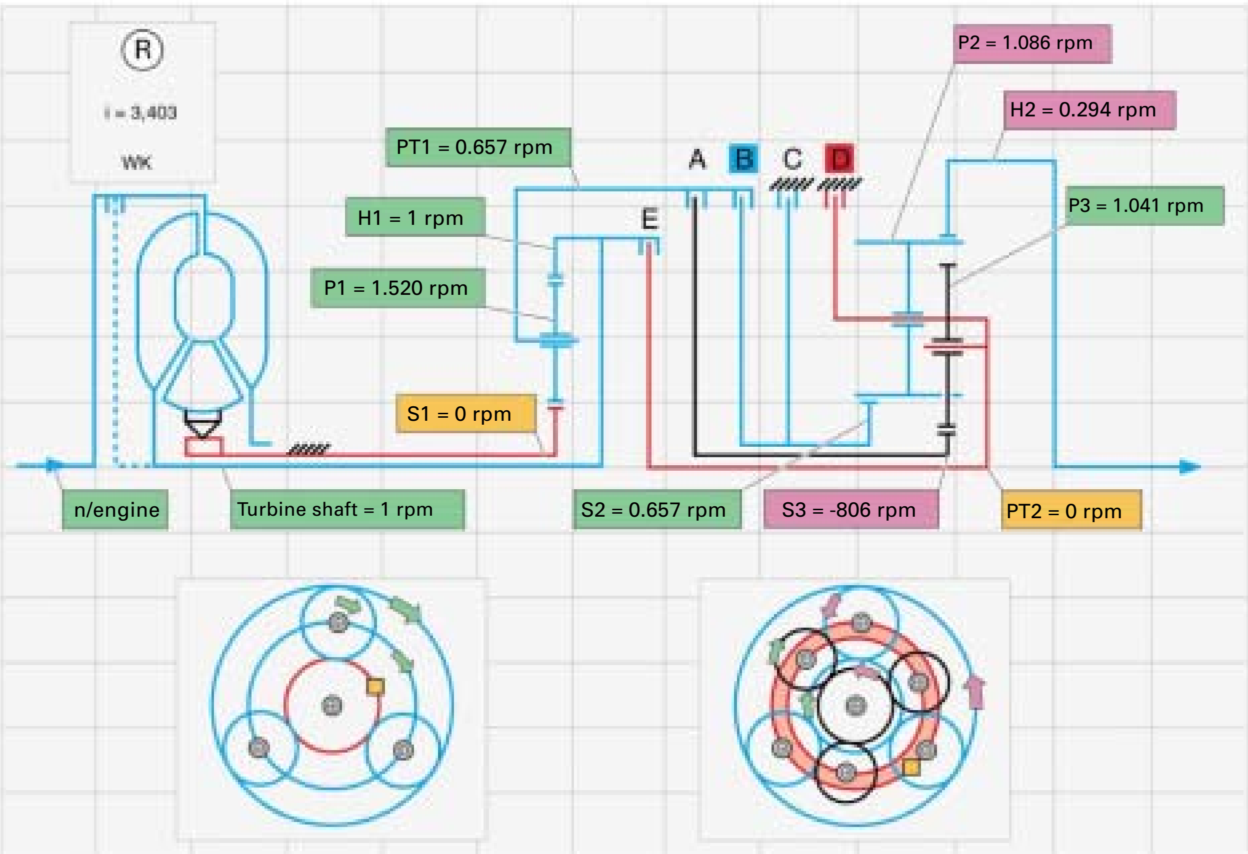
The turbine shaft drives the ring gear H1 of the primary planetary gear train.

The ring gear H1 drives the planet gears P1, which roll around the stationary sun gear S1, thus driving the planet carrier PT1.

The clutch B connects PT1 to the sun gear S2 and thus channels the torque into the secondary planetary gear train.

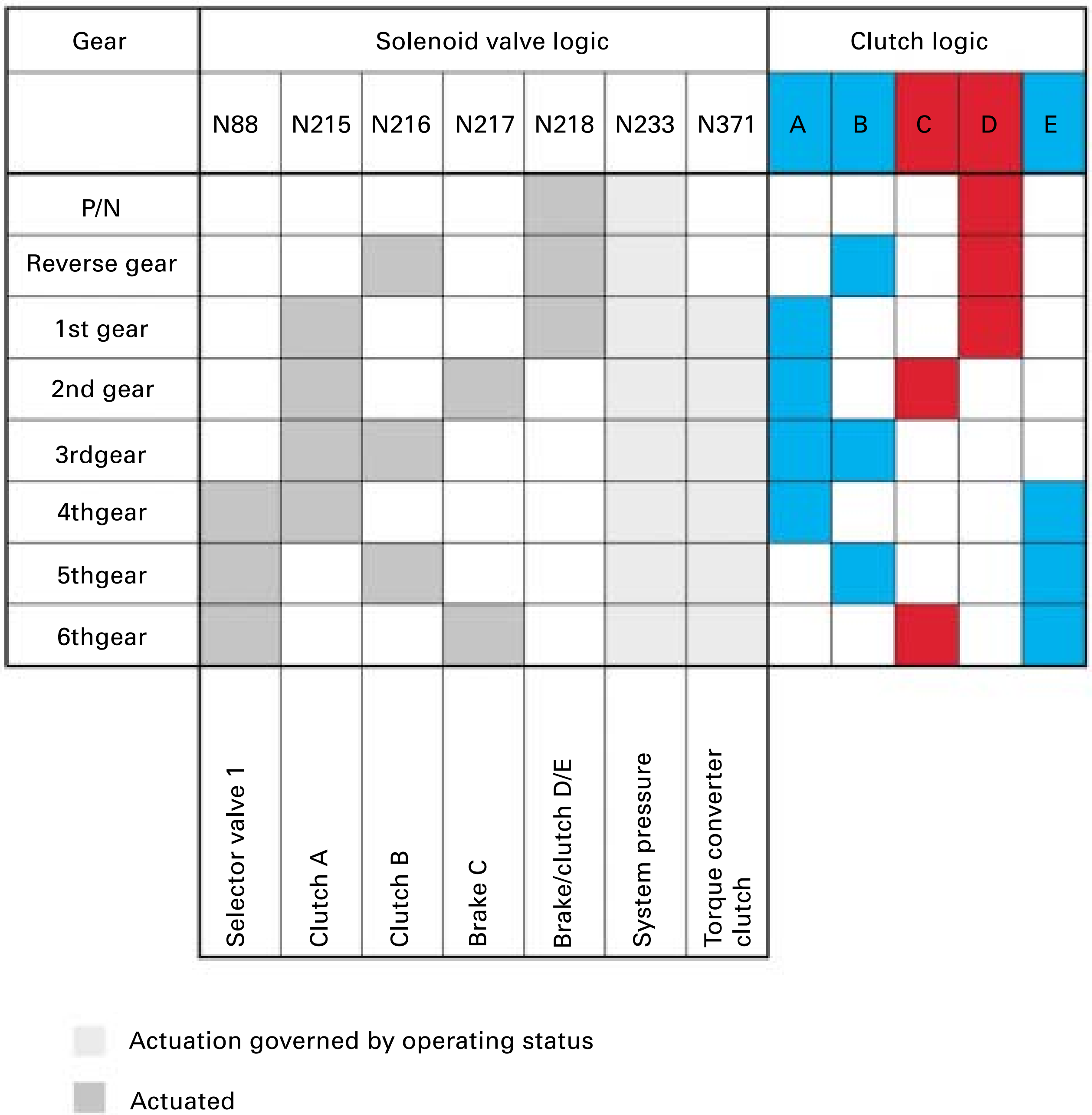
The brake D blocks the planet carrier PT2. The torque is transmitted from the sun gear S2 to the long planet gears P2. Supported by PT2, the torque is transmitted to the ring gear H2, which is connected to the output shaft.

The ring gear H2 is driven in the direction opposite to that of engine rotation.

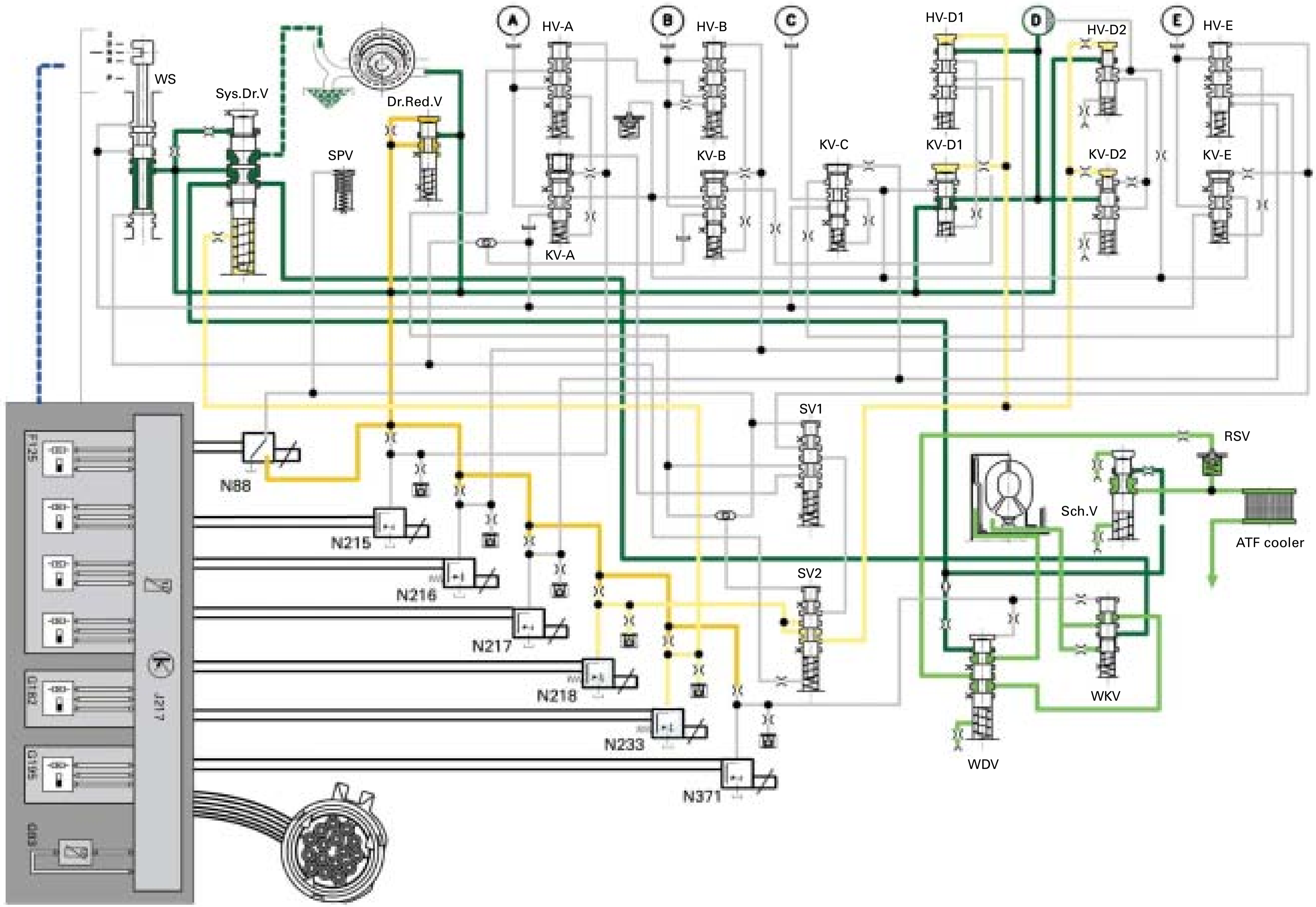


283_076

Gearshift matrix



283_149



A
HV-A
KV-A
B
HV-B
KV-B
C
KV-C
HV-D1
KV-D1
D
HV-D2
KV-D2
E
HV-E
KV-E
WS
Sys.Dr.V
Dr.Red.V
SPV
SV1
SV2
RSV
Sch.V
ATF cooler
WKV
WDV
N88
N215
N216
N217
N218
N233
N371
F125
G182
G195
G93
J217

283_088

Hydraulic system diagram

Dr.Red.V	Pressure reduction valve
EDS1 (N215)	Solenoid pressure control valve 1
EDS2 (N216)	Solenoid pressure control valve 2
EDS3 (N217)	Solenoid pressure control valve 3
EDS4 (N218)	Solenoid pressure control valve 4
EDS5 (N233)	Solenoid pressure control valve 5
EDS6 (N371)	Solenoid pressure control valve 6
HV - A	Holding valve - Clutch A
HV - B	Holding valve - Clutch B
HV - D1	Holding valve - Brake D
HV - D2	Holding valve - Brake D2
HV - E	Holding valve - Clutch E
KV - A	Clutch valve - Clutch A
KV - B	Clutch valve - Clutch B
KV - C	Clutch valve - Brake C
KV - D1	Clutch valve - Brake D1
KV - D2	Clutch valve - Brake D2
KV - E	Clutch valve - Clutch E
MV1 (N88)	Solenoid valve 1
RSV	Non-return valve
Sch.V	Lubrication valve
SPV	Compensation valve
SV1	Selector valve 1
SV2	Selector valve 2
Sys. Dr.V	System pressure valve
WDV	Torque converter pressure valve
WKV	Torque converter clutch valve
WS	Selector slide

Depressurised

Torque converter pressure

System pressure

Control pressure

Pilot pressure

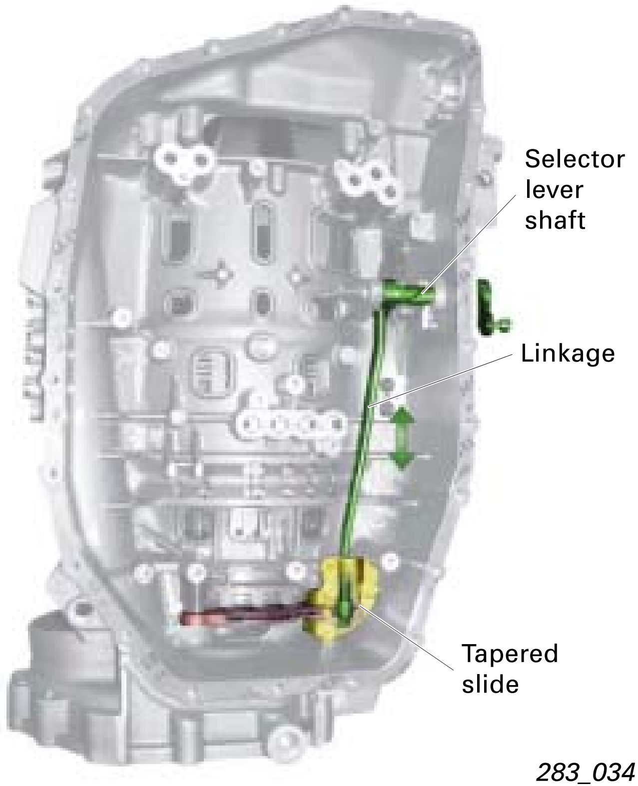
Parking lock

The parking lock is designed to stop the vehicle rolling away.

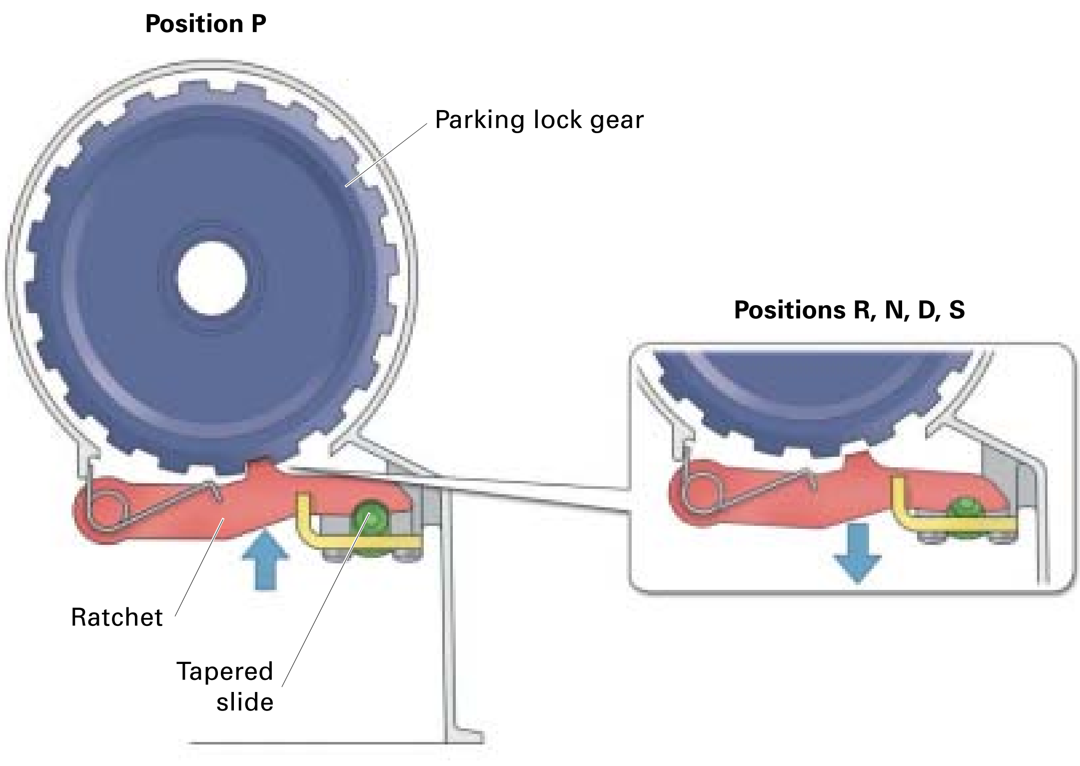
It is of conventional design, i.e. it is actuated (purely mechanically) by the selector lever with a Bowden cable.
The parking lock gear is connected to the ring gear 2 and the output shaft.

The ratchet which engages in the toothing of the parking lock gear thus blocks output to the transfer case. Front and rear axle are locked. If one axle is raised, compensation can be achieved via the Torsen differential if the raised wheels are free to turn. This does however result in destruction of the Torsen differential when towing the vehicle, for example.

To facilitate release of the parking lock, the handbrake should be applied before engaging the parking lock.

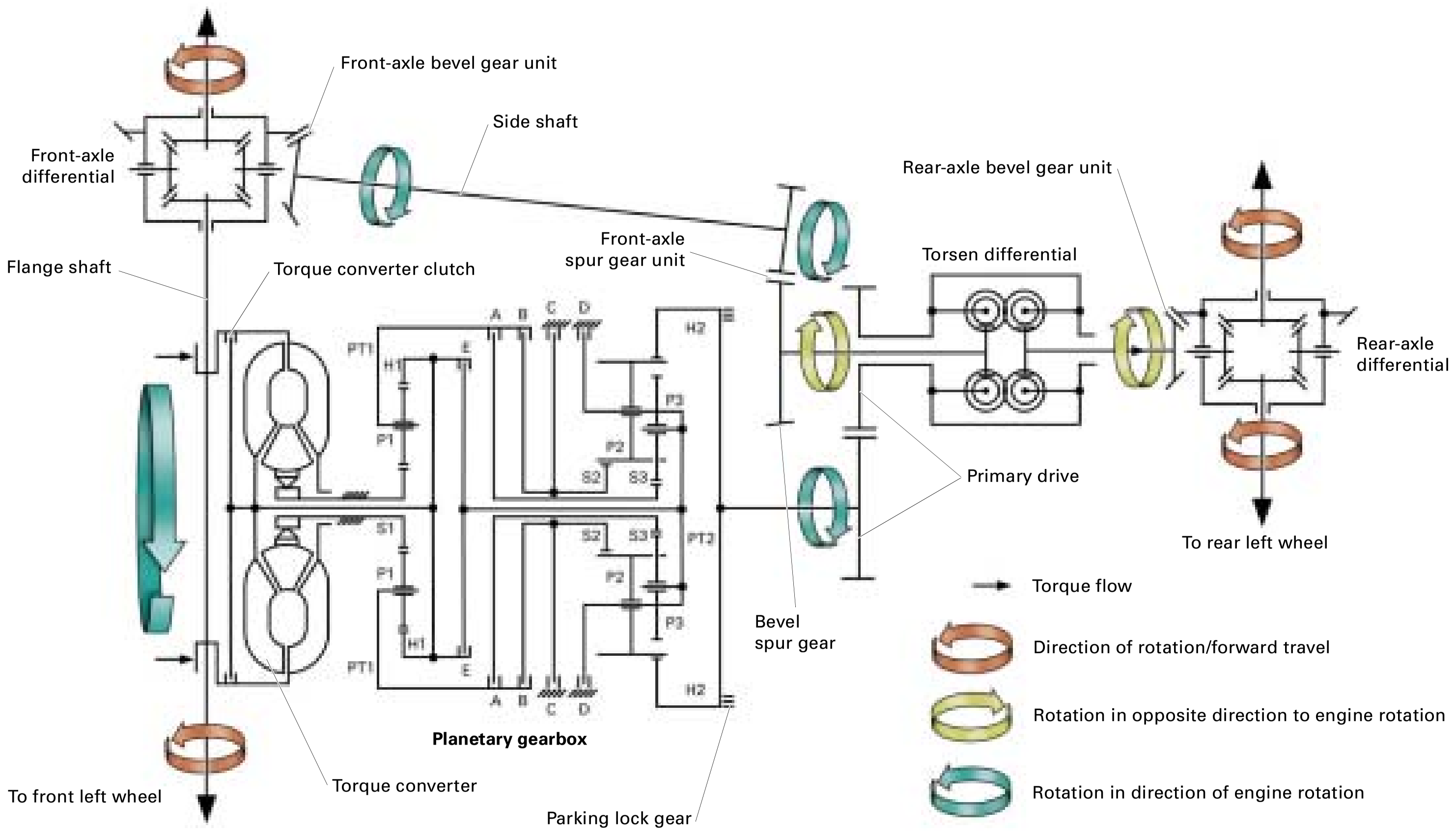


283_034

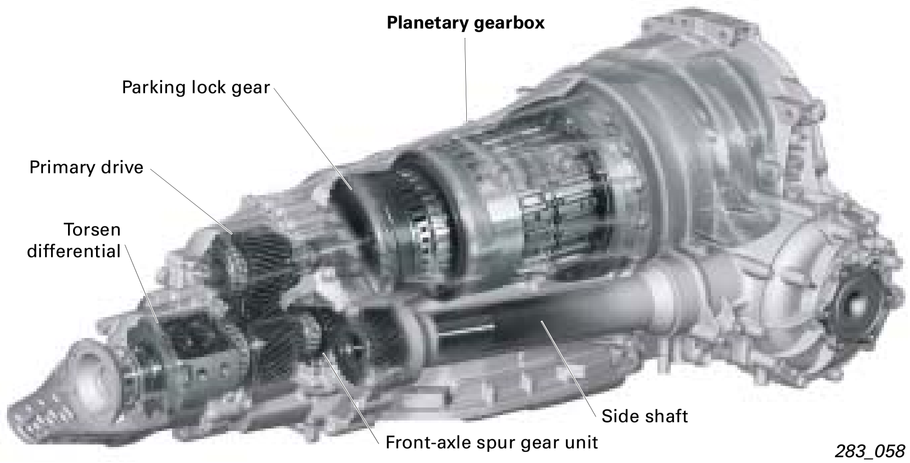


283_085

Torque profile / Four-wheel drive



283_038



283_058

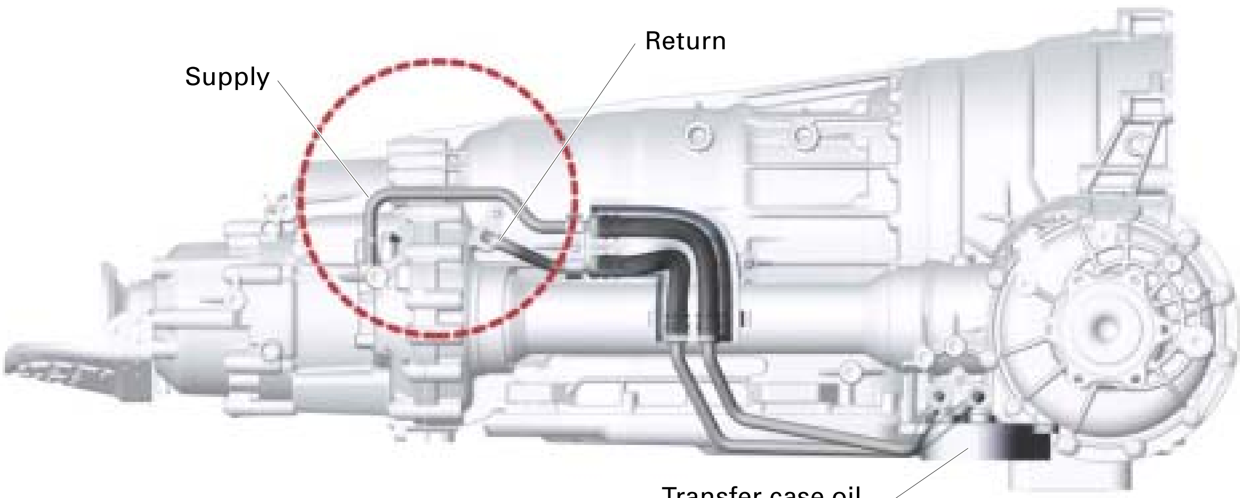
A special feature of the 09E gearbox is the angled position of the input shaft (side shaft) with respect to the front axle.

The torque is transmitted by a bevel spur gear (beveloid teeth) at an angle of 8° to the side shaft spur gear.

Transfer case cooling

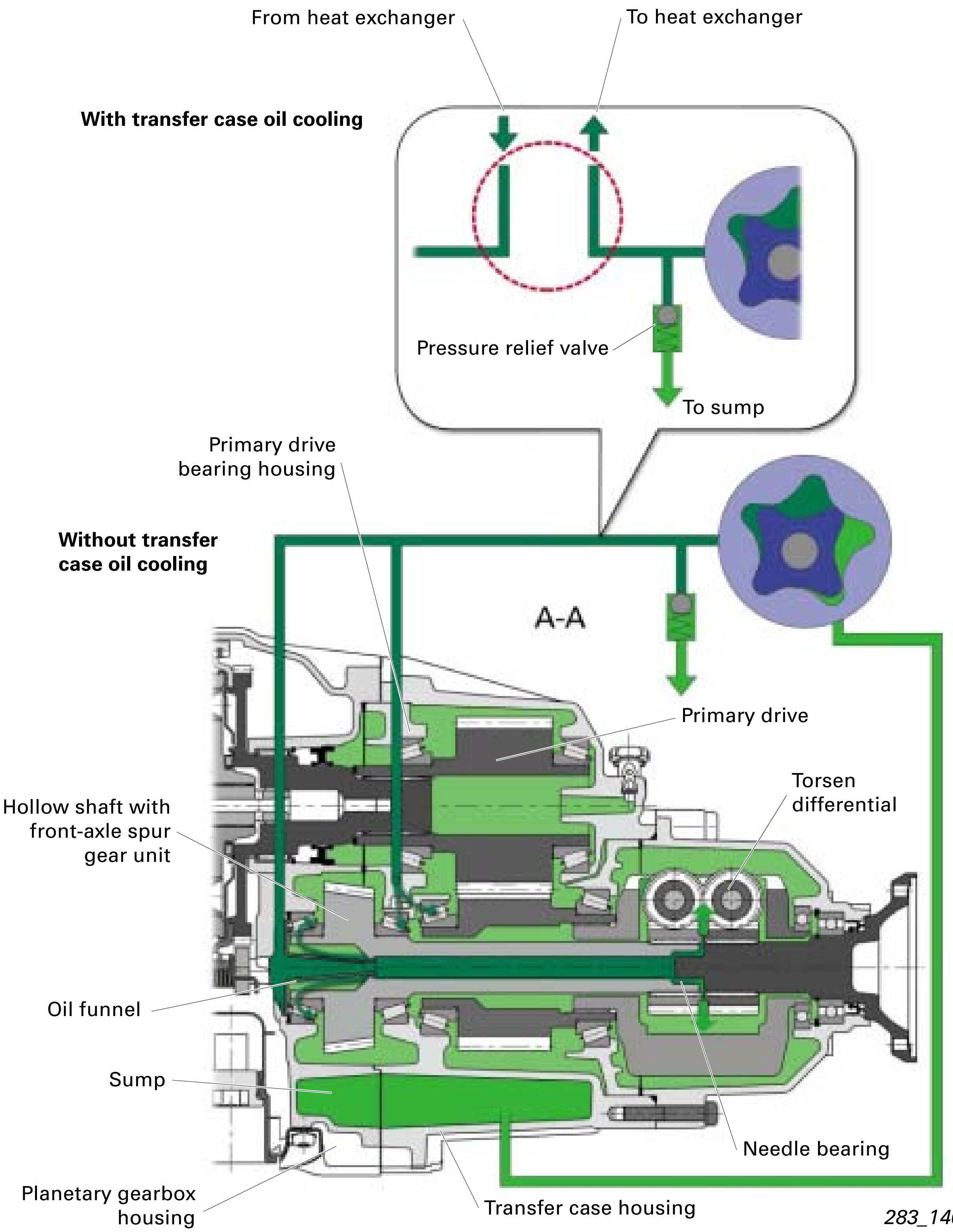
To accommodate future versions, the 09E is already designed with connections for transfer case oil cooling.

For such purposes, the transfer case oil pump is not only responsible for lubricating the transfer case but also for the flow through an optional heat exchanger.



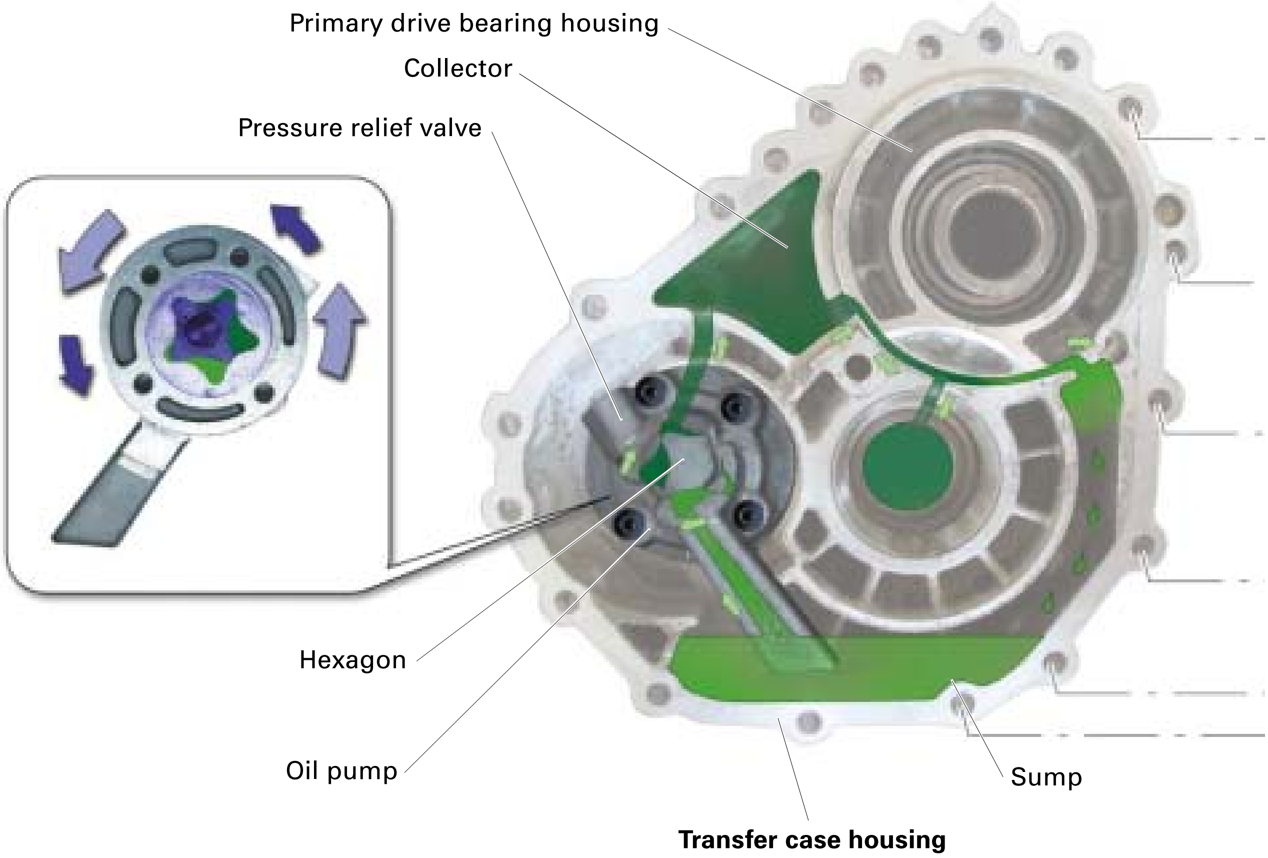
283_050

The transfer case oil cooling diagram shown does not correspond to the final series status, as the design had still to be finalised at the time of compilation of this SSP.


From heat exchanger
To heat exchanger
With transfer case oil cooling
Pressure relief valve
To sump
Primary drive
bearing housing
Without transfer
case oil cooling
A-A
Primary drive
Torsen
differential
Hollow shaft with
front-axle spur
gear unit
Oil funnel
Sump
Needle bearing
Planetary gearbox
housing
Transfer case housing

283_140

Transfer case oil pump



The oil pump (rotor-type pump) provides efficient lubrication of all transfer case components.

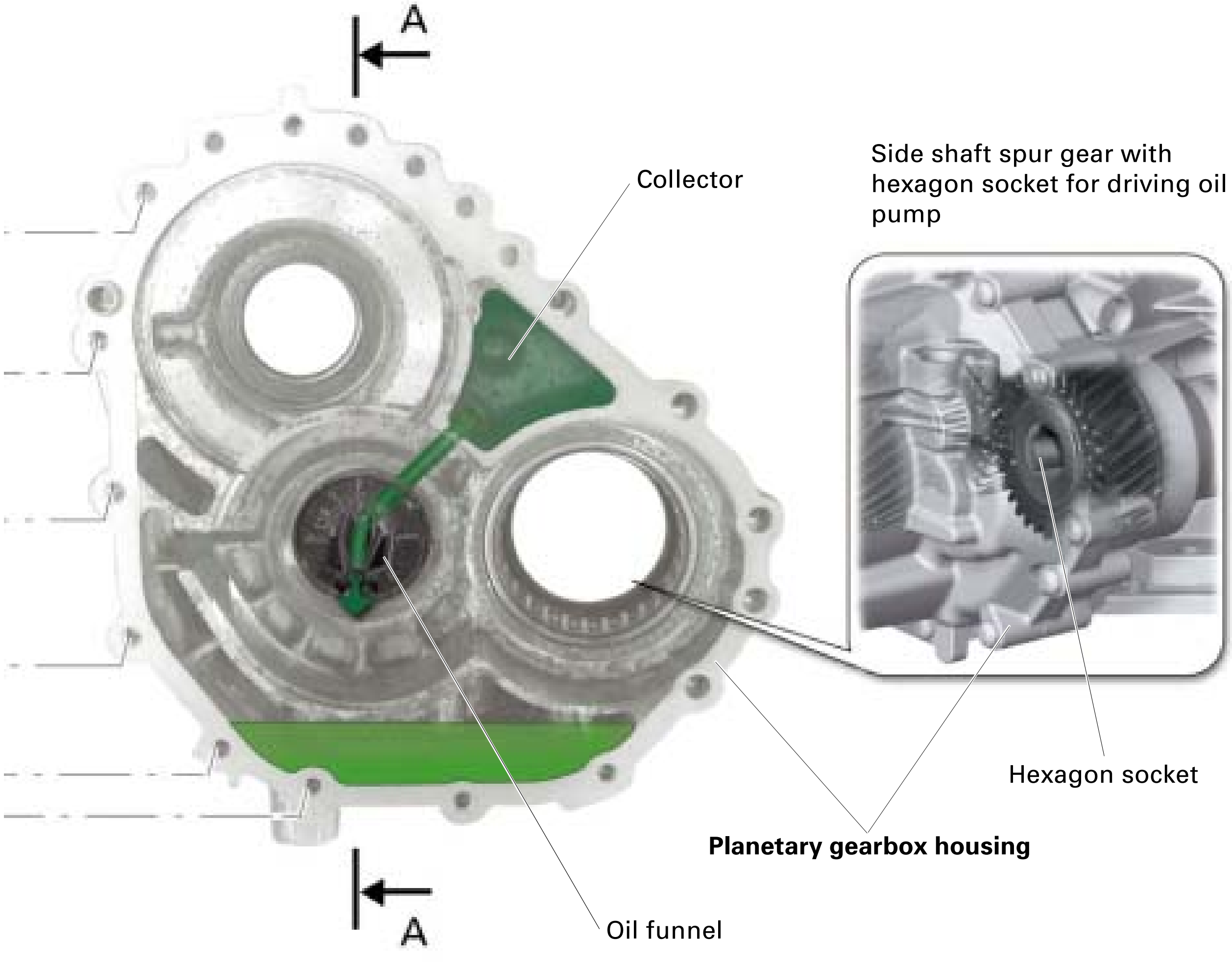
The pump is located in the front housing section of the transfer case and is driven by the side shaft by means of a hexagon connection.

From the sump, the pump conveys the oil into a collector. The oil is routed via a duct in the primary drive bearing housing to the lower primary drive mount and some of the oil is returned to the sump.

The pressure relief valve in the oil pump protects the components against excessive pressure.

From the collector, the oil is conveyed in a further duct to the oil funnel, which routes the oil into the hollow shaft of the front-axle spur gear unit. From there, it is transferred to the front shaft bearing and via the needle bearing of the rear-axle flange shaft into the Torsen differential.

Such a design permits reliable lubrication with a low oil level, which in turn minimises hydraulic losses and foaming.



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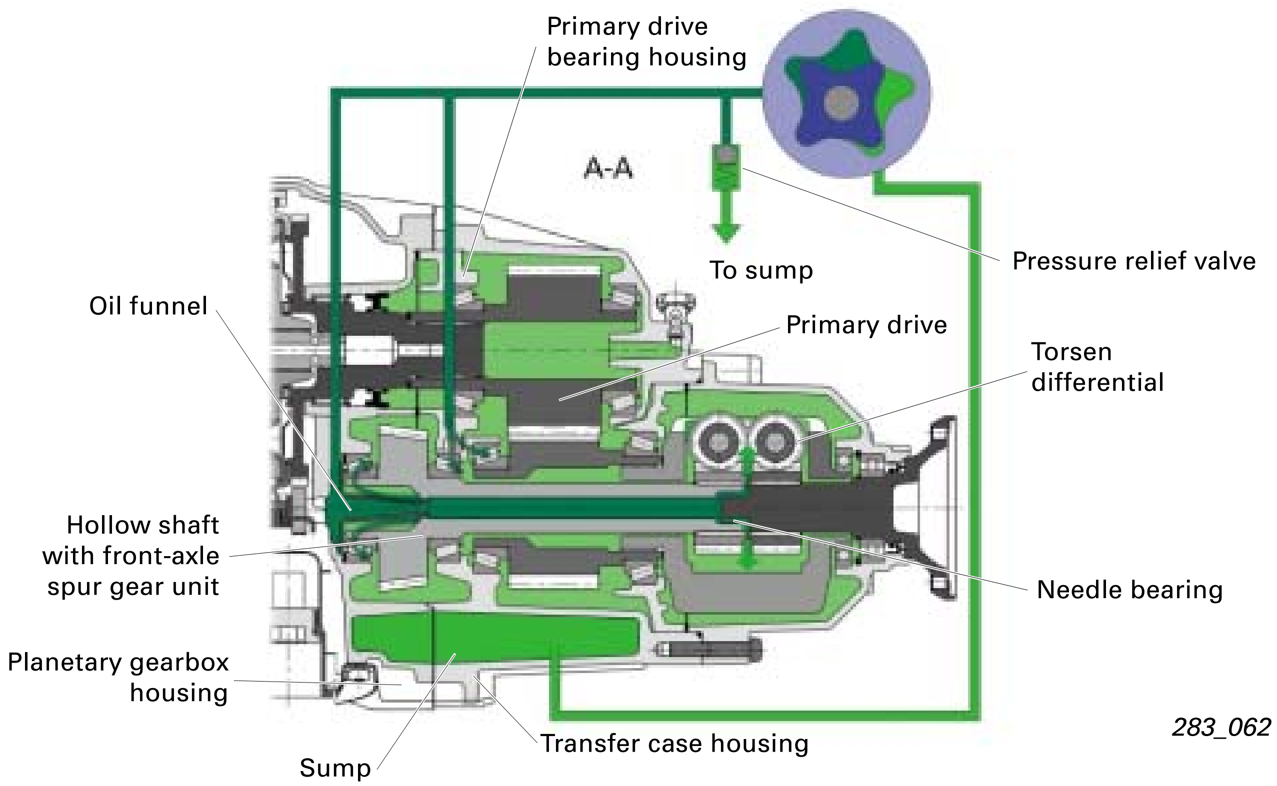

283_062

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