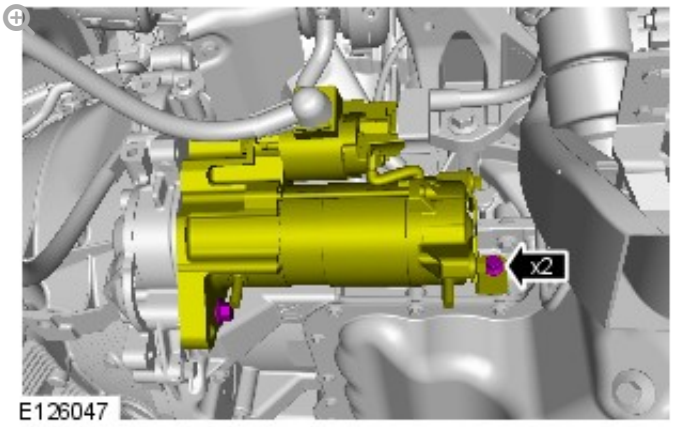
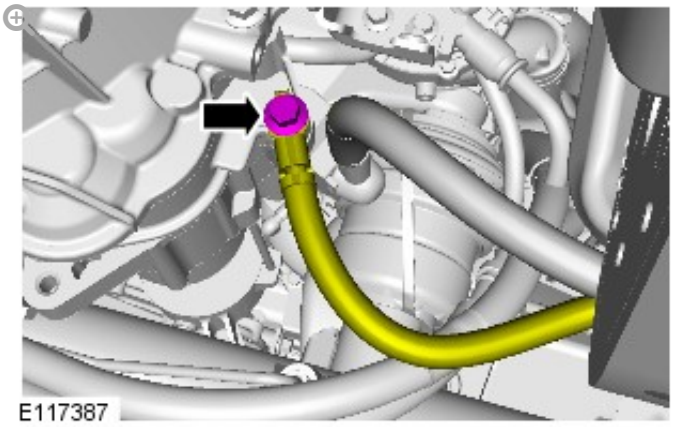
Torque: **23 Nm**

21.



Torque: **48 Nm**

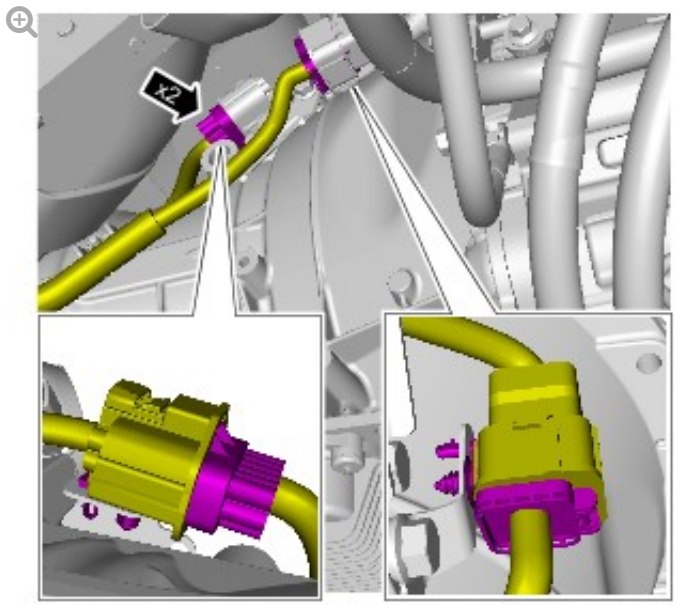
22.



Torque: **30 Nm**

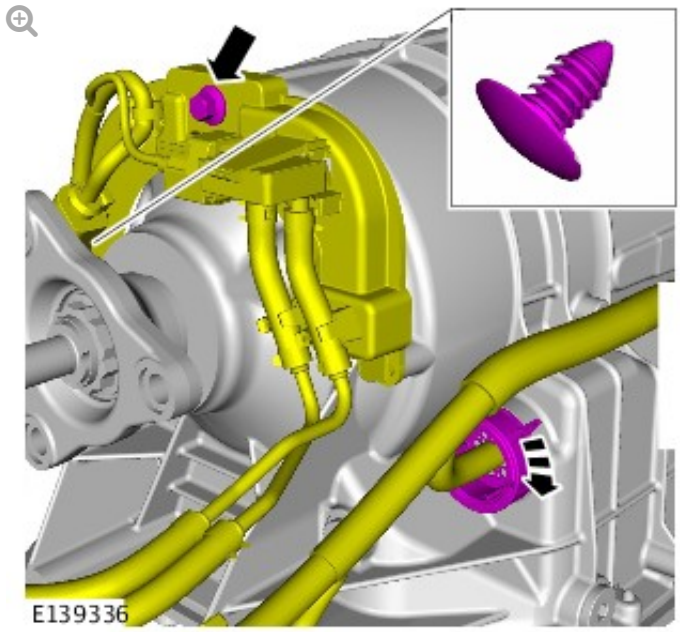
23. Refer to: Exhaust Manifold Cross-over Pipe (303-01A Engine - TDV6 3.0L Diesel, Removal and Installation).

24.



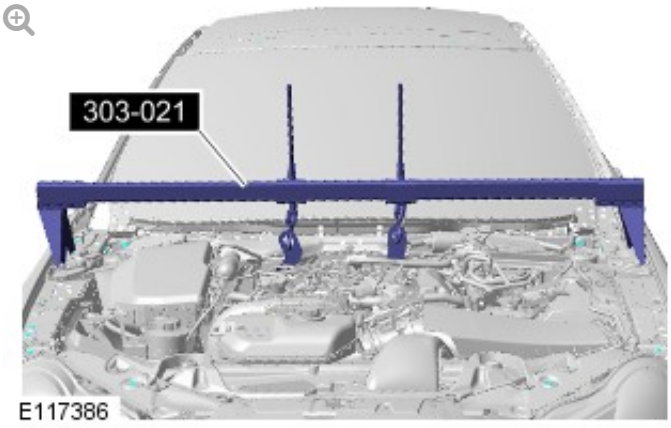
E117393

25.


E139336

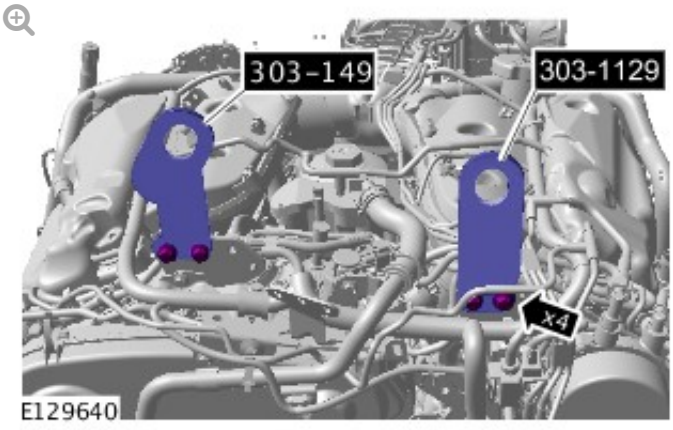
26. Lower the vehicle.

27.



- Remove the special tool supporting the engine.
- *Special Tool(s):* 303-021

28.

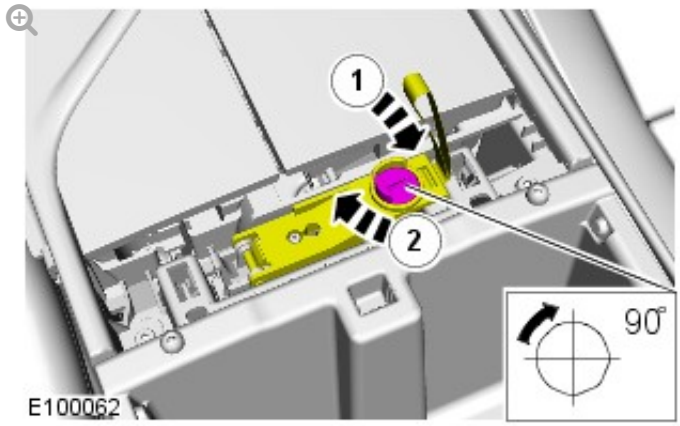


- Remove the special tools from the engine.
- *Special Tool(s):* 303-1129, 303-1497

29. Refer to: Engine Cover - TDV6 3.0L Diesel (501-05 Interior Trim and Ornamentation, Removal and Installation).

30. Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

31.



32.

33. Check and top up the cooling system as required.

34. Set the heater controls to HOT.

35.

> Observe the engine temperature warning light. If the warning light is displayed, switch off immediately and allow to cool. Failure to follow this instruction may cause damage to the vehicle.

Start the engine and allow to idle until hot air is emited at the face registers.

36.

> Observe the engine temperature warning light. If the warning light is displayed, switch off immediately and allow to cool. Failure to follow this instruction may cause damage to the vehicle.

Raise the engine speed to 2000 RPM and maintain at 2000 RPM until the engine cooling fan operates.

37.

> Switch off the engine and allow the coolant temperature to go cold.

Switch the engine off and allow to cool.

38. Visually check the engine and cooling system for signs of coolant leakage.

39.

> - When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.
> - Since injury such as scalding could be caused by escaping steam or coolant, make sure the vehicle cooling system is cool prior to carrying out this procedure.

- Make sure the coolant level remains above the "COLD FILL RANGE" lower level mark.
- Anti-freeze concentration must be maintained at 50%.

When the cooling system is warm, the coolant will be approximately 10mm above the upper level mark on the expansion tank with the cap removed.

Check and top-up the coolant if required.

40. Refer to: Transmission Fluid Level Check (307-01 Automatic Transmission/Transaxle, General Procedures).

AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION CONTROL MODULE AND MAIN CONTROL VALVE BODY [G1271943]

REMOVAL

The transmission control module (TCM) is part of the main control valve body and cannot be serviced separately.

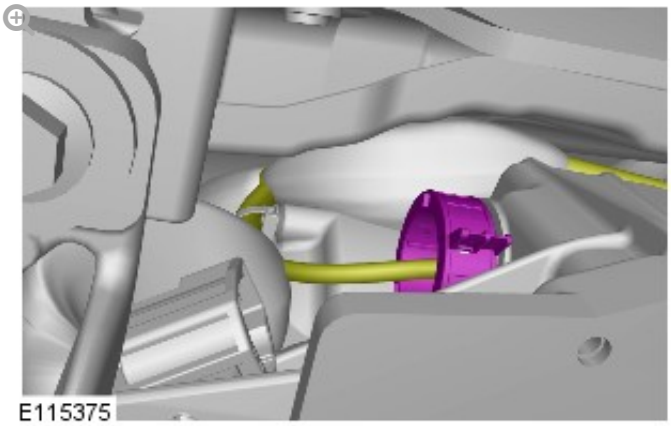
1. Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

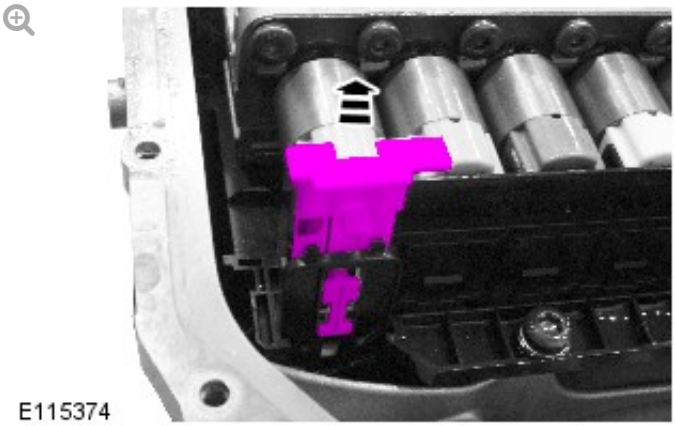
2.

   Make sure to support the vehicle with axle stands.

   Raise and support the vehicle.

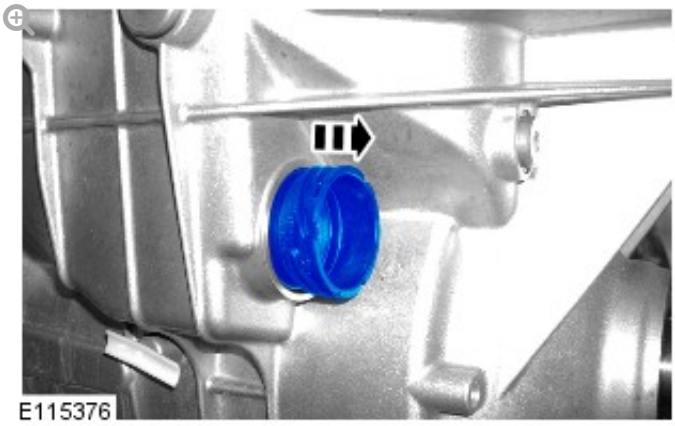
3. Refer to: Transmission Fluid Pan, Gasket and Filter (307-01 Automatic Transmission/Transaxle, Removal and Installation).

4. 

5. 

6.

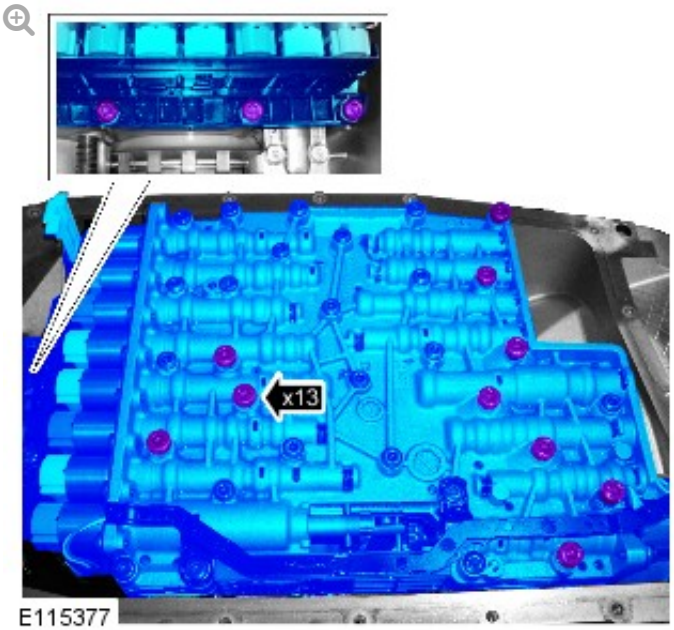
Discard the component.



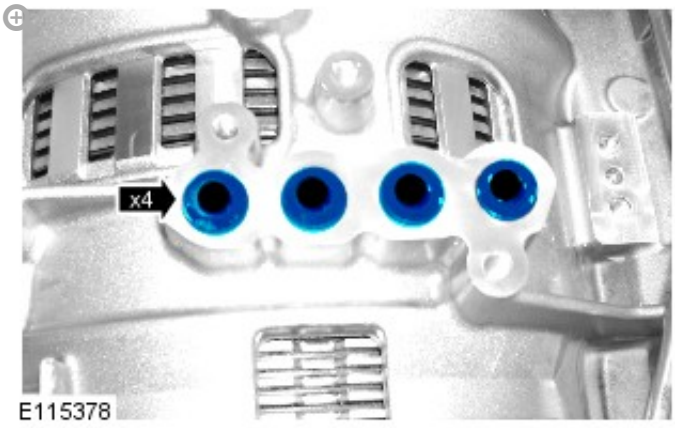
7.

Be prepared to collect escaping fluids.

Note the position of the manual park brake release.



8.



9.

INSTALLATION

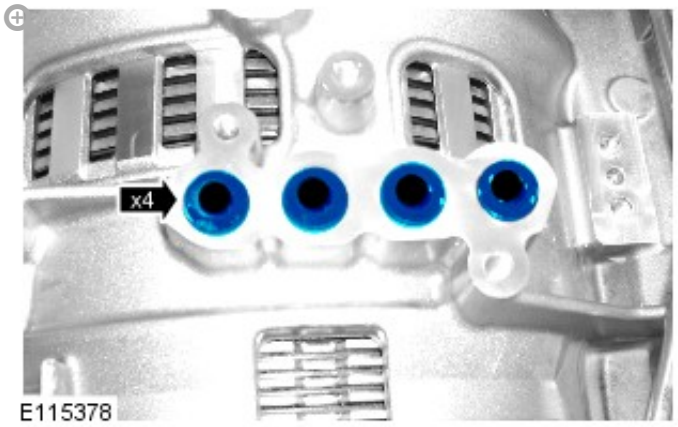
1.

- Make sure that when fully fitted, all seals protrude by the same amount.
- Install the new seals.

- Install a new seal block.

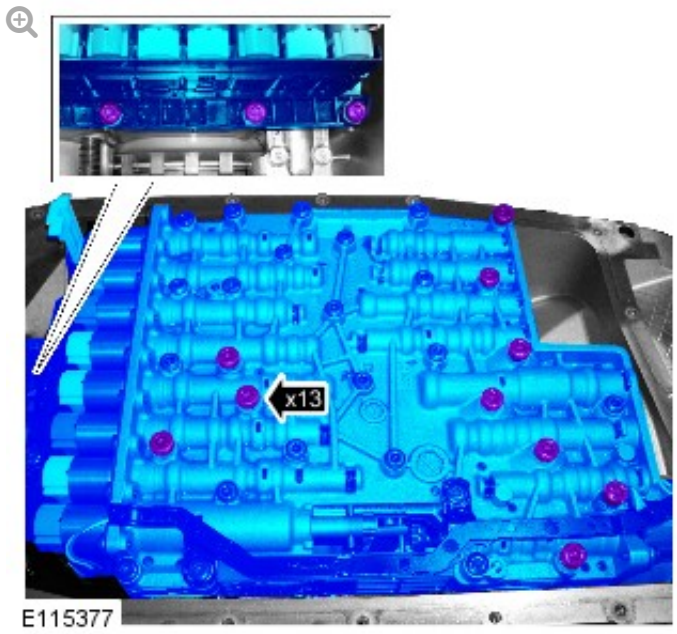
2.

- Install the new seals.
- Make sure that when fully fitted, all seals protrude by the same amount.



3.

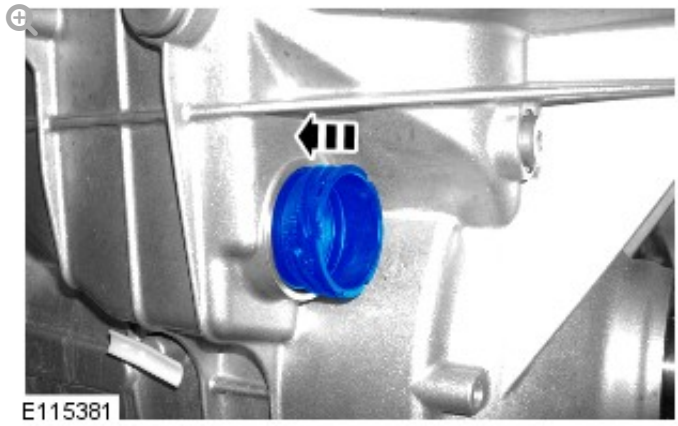
Make sure the manual park release is correctly engaged.



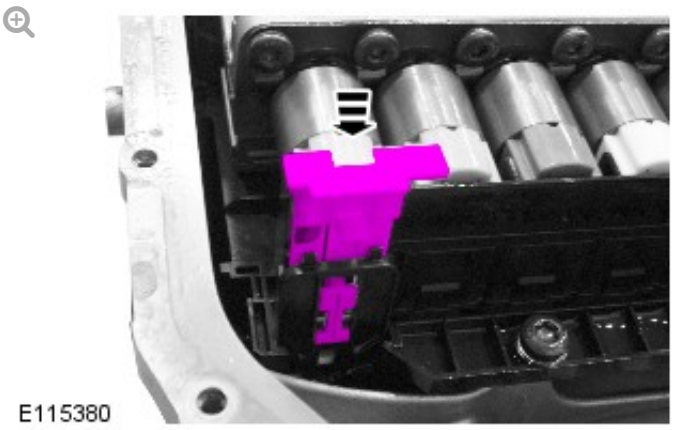
Torque: **8 Nm**

4.

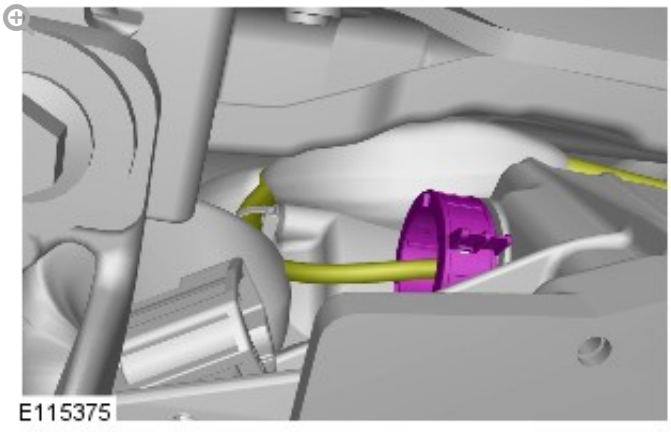
Make sure that a new component is installed.



5.



6.



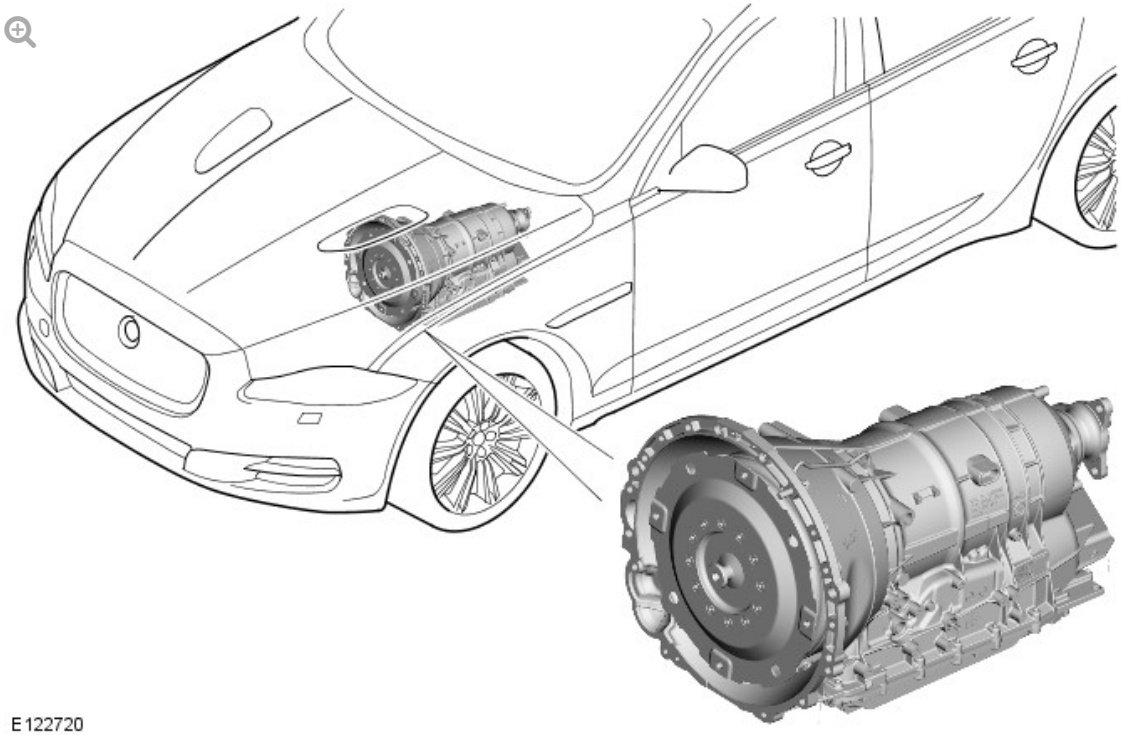
7. Refer to: Transmission Fluid Pan, Gasket and Filter (307-01 Automatic Transmission/Transaxle, Removal and Installation).

8. Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

9. If a new component has been installed, configure using Jaguar approved diagnostic equipment.

AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION DESCRIPTION - COMPONENT LOCATION [G1245449]



E122720

AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION DESCRIPTION - OVERVIEW

[G1245450]

OVERVIEW

The ZF 6HP28 transmission is an electronically controlled, hydraulically operated, six speed automatic unit. The hydraulic and electronic control elements of the transmission, including the TCM (transmission control module), are incorporated in a single unit located inside the transmission and is known as 'Mechatronic'.

5.0L SC (supercharger) and 3.0L diesel models use an uprated derivative of the ZF 6HP28 transmission used in the 5.0L naturally aspirated models.

The ZF 6HP28 transmission has the following features:

- Designed to be maintenance free
- Transmission fluid is 'fill for life'
- The torque converter features a controlled slip feature with electronically regulated control of lock-up, creating a smooth transition to the fully locked condition
- Shift programs controlled by the TCM
- Electronic park lock, controlled by the TCM, with a mechanical emergency

release

- ASIS (adaptive shift strategy), to provide continuous adaptation of shift changes to suit the driving style of the driver, which can vary from sporting to economical.
- Connected to the ECM (engine control module) via the high speed CAN (controller area network) bus for communications
- Default mode if major faults occur
- Diagnostics available from the TCM via the high speed CAN bus.

The transmission selections are made using the rotary JaguarDrive selector in the floor console and two paddle switches on the steering wheel. Refer to: External Controls (307-05, Description and Operation).

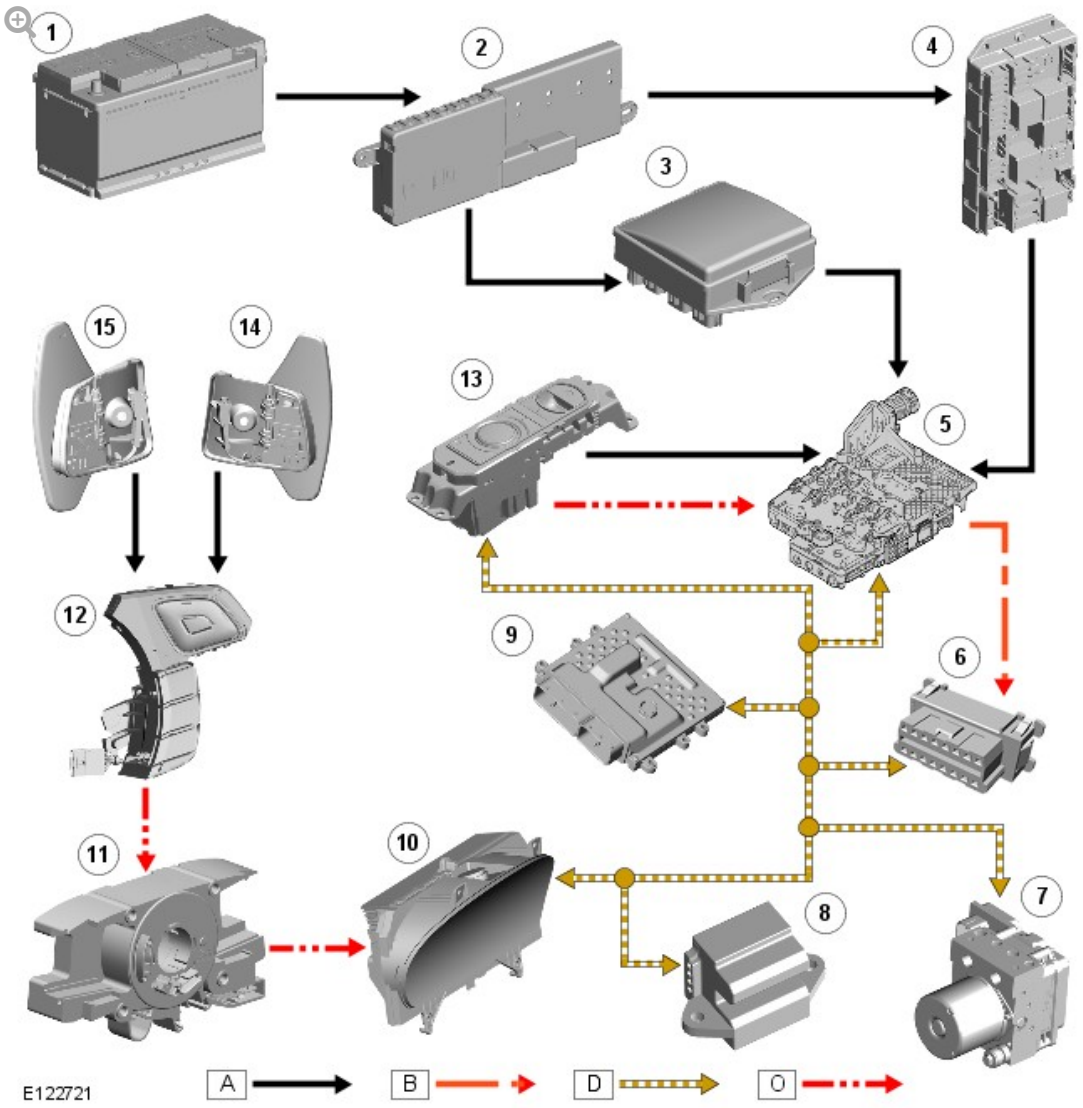
AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION DESCRIPTION - SYSTEM OPERATION AND COMPONENT DESCRIPTION

[G1245451]

CONTROL DIAGRAM

A = Hardwired; B = K bus; D = High speed CAN (controller area network) bus; O = LIN (local interconnect network) bus.



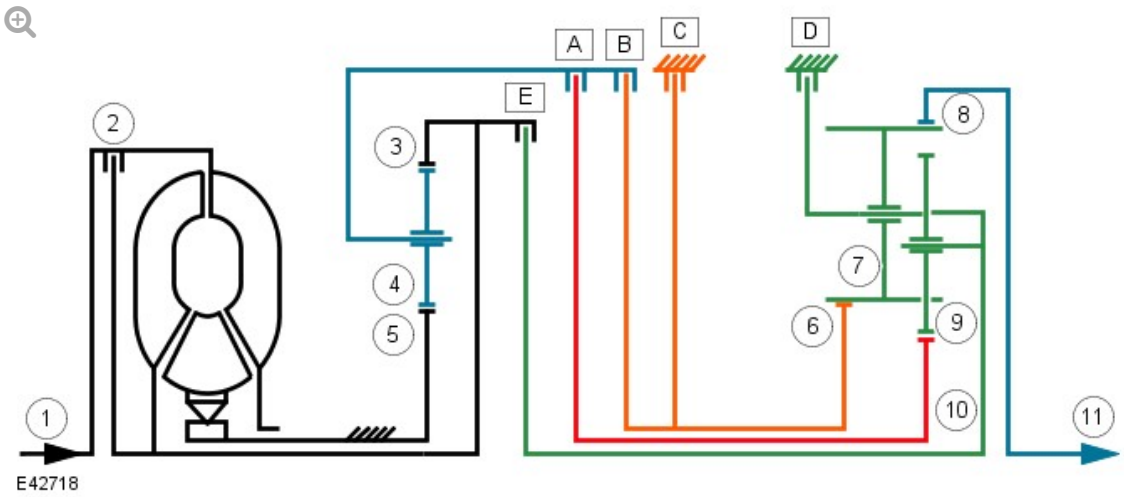
1	Battery
2	BJB (battery junction box) (250 A megafuse for EJB supply; 50 A megafuse for CJB supply)
3	EJB (engine junction box)
4	CJB (central junction box)
5	TCM (transmission control module)
6	Diagnostic socket
7	ABS module
8	Steering angle sensor
9	ECM (engine control module)

10	Instrument cluster
11	Clockspring
12	Steering wheel RH switchpack
13	JaguarDrive selector
14	Upshift paddle switch
15	Downshift paddle switch

SYSTEM OPERATION

POWER FLOWS

Operation of the transmission is controlled by the TCM (transmission control module), which electrically activates various solenoids to control the transmission gear selection. The sequence of solenoid activation is based on programmed information in the TCM memory and physical transmission operating conditions such as vehicle speed, throttle position, engine load and JaguarDrive selector position.

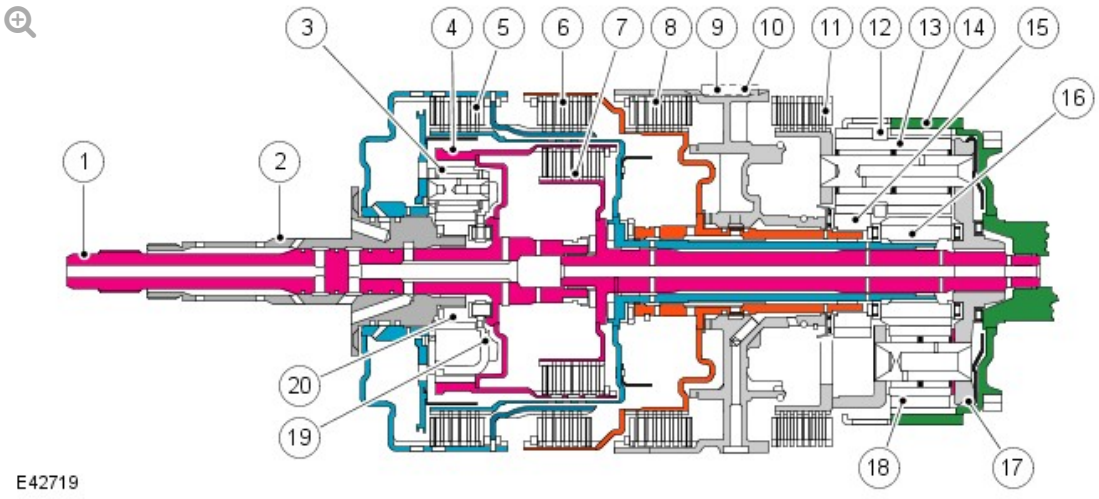


1	Torque input from engine
2	Torque converter lock-up clutch

3	Single web planetary gear carrier
4	Single web planetary gears
5	Single web sunwheel 1
6	Double web sunwheel 2
7	Double web planetary gears - long
8	Double web planetary gear carrier
9	Double web planetary gears - short
10	Double web sunwheel 3
11	Torque output from transmission
A	Multiplate clutch
B	Multiplate clutch
C	Multiplate brake
D	Multiplate brake
E	Multiplate clutch

Engine torque is transferred, via operation of single or combinations of clutches to the 2 planetary gear trains. Both gear trains are controlled by reactionary inputs from brake clutches to produce the 6 forward gears and 1 reverse gear. The ratios are as follows:

Ration	4.171	2.340	1.521	1.143	0.867	0.691	3.403

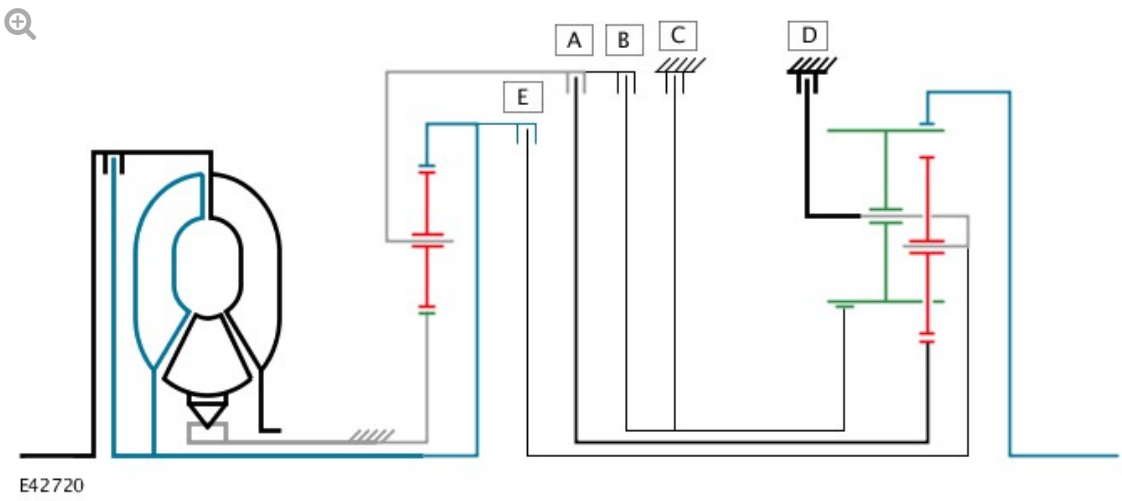


1	Turbine shaft
2	Stator shaft
3	Single web planetary gear train
4	Ring gear 1
5	Clutch A
6	Clutch B
7	Clutch E
8	Brake clutch C
9	Fixed connection to transmission housing
10	Shaft key
11	Brake clutch D
12	Double web planetary gear train
13	Planetary gears - long
14	Ring gear 2
15	Sunwheel 2
16	Sunwheel 3
17	Double web planetary gear carrier
18	Planetary gears - short

19	Single web planetary gear carrier
20	Sunwheel 1

The shift elements are three rotating multiplate clutches (A, B and E) and two fixed multiplate brakes (C and D). All shifts from 1st to 6th gears are power-on overlapping shifts. Overlapping shifts can be described as one of the clutches continuing to transmit drive at a lower main pressure until the next required clutch is able to accept the input torque.

The shift elements, clutches and brakes are actuated hydraulically. Fluid pressure is applied to the required clutch and/or brake, pressing the plates together and allowing drive to be transmitted through the plates. The purpose of the shift elements is to perform power-on shifts with no interruption to traction and smooth transition between gear ratios.



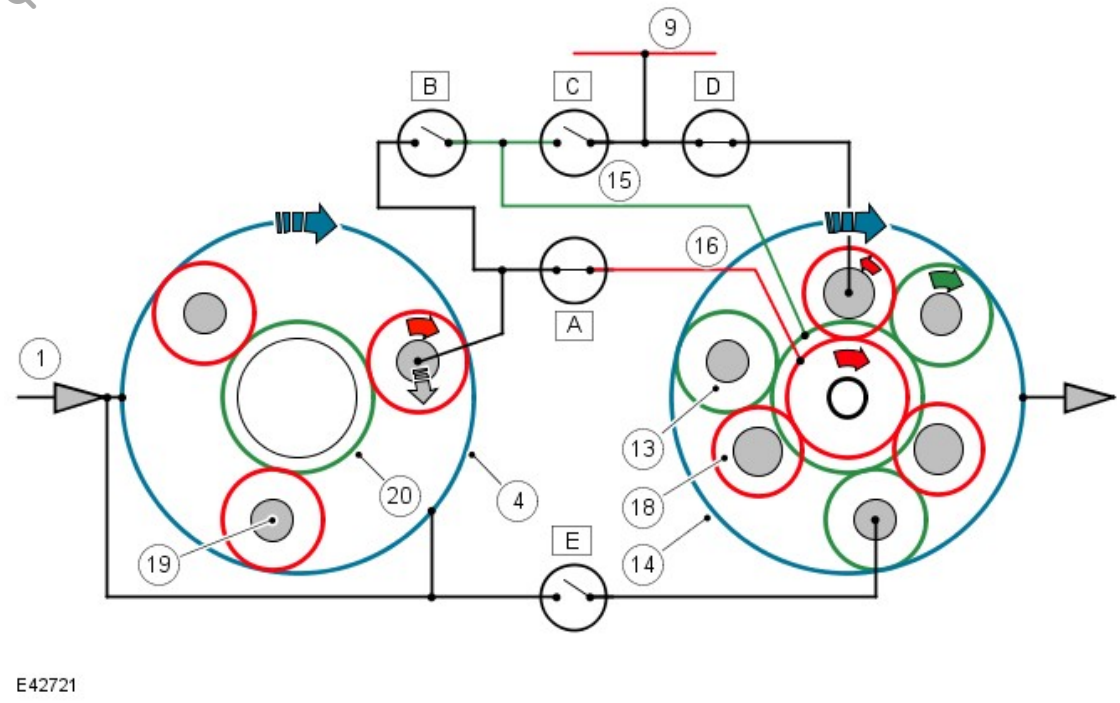
The JaguarDrive selector and the selector valve spool are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to the ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

Ring gear 1 drives the planetary gears which rotate around sunwheel 1. This drives the planetary gear carrier 1 and also the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

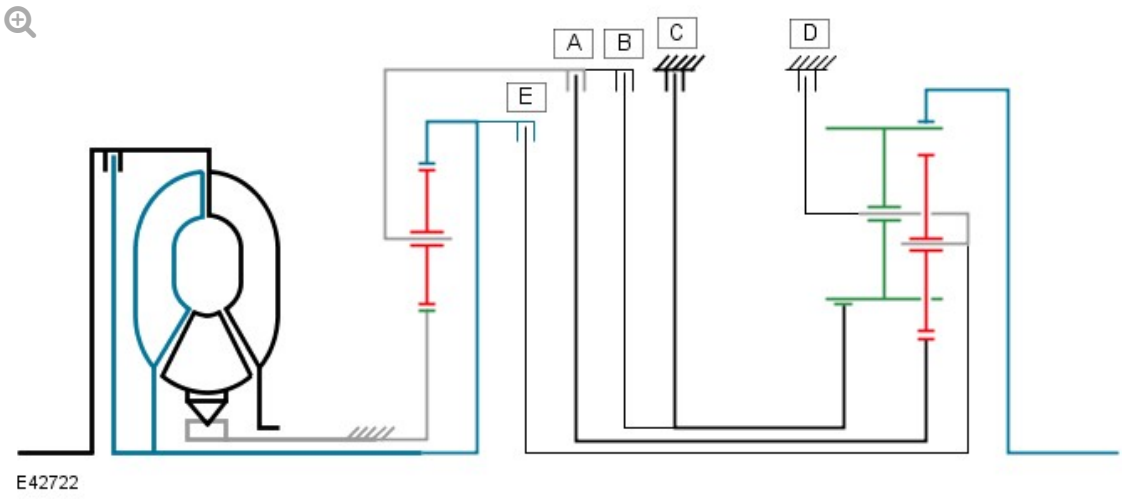
When clutch 'A' is engaged, sunwheel 3 in the double web planetary gear train is driven and meshes with the short planetary gears.

The double web planetary gear train is locked against the transmission housing by brake 'D'. This allows ring gear 2 (output shaft) to be driven in the same direction as the engine via the long planetary gears.

Refer to 'Shift Elements' illustration for key



E42721



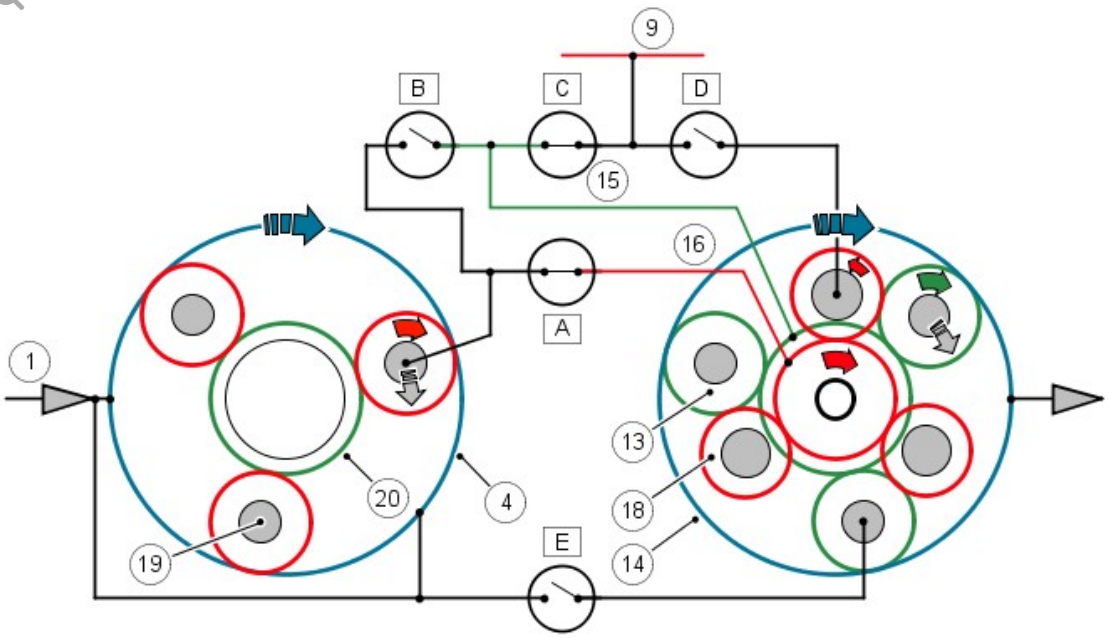
The JaguarDrive selector and the selector spool valve are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to the ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

Ring gear 1 drives the planetary gears which rotate around sunwheel 1. This drives the planetary gear carrier 1 and also the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

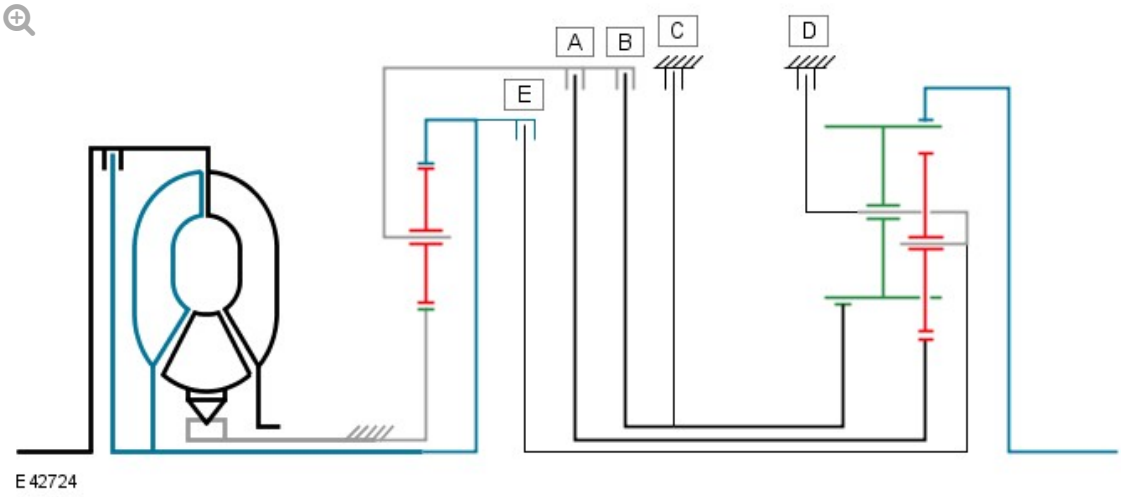
When clutch 'A' is engaged, sunwheel 3 in the double web planetary gear train is driven and meshes with the short planetary gears.

Sunwheel 2 is locked to the transmission housing by brake clutch 'C'. The long planetary gears, which are also meshed with the short planetary gears, roll around the fixed sunwheel 2 and transmit drive to the double web planetary gear train carrier and ring gear 2 in the direction of engine rotation.

Refer to 'Shift Elements' illustration for key



E42723



E42724

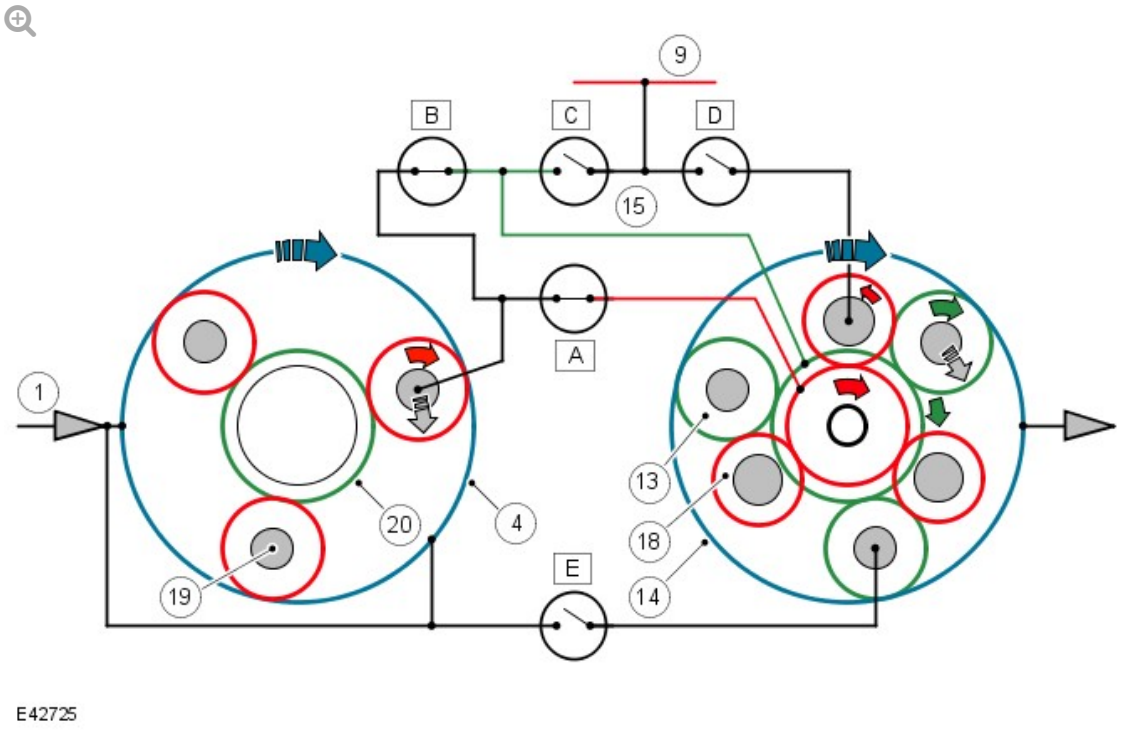
The JaguarDrive selector and the selector spool valve are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to the ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

Ring gear 1 drives the planetary gears which rotate around sunwheel 1. This drives the planetary gear carrier 1 and also the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

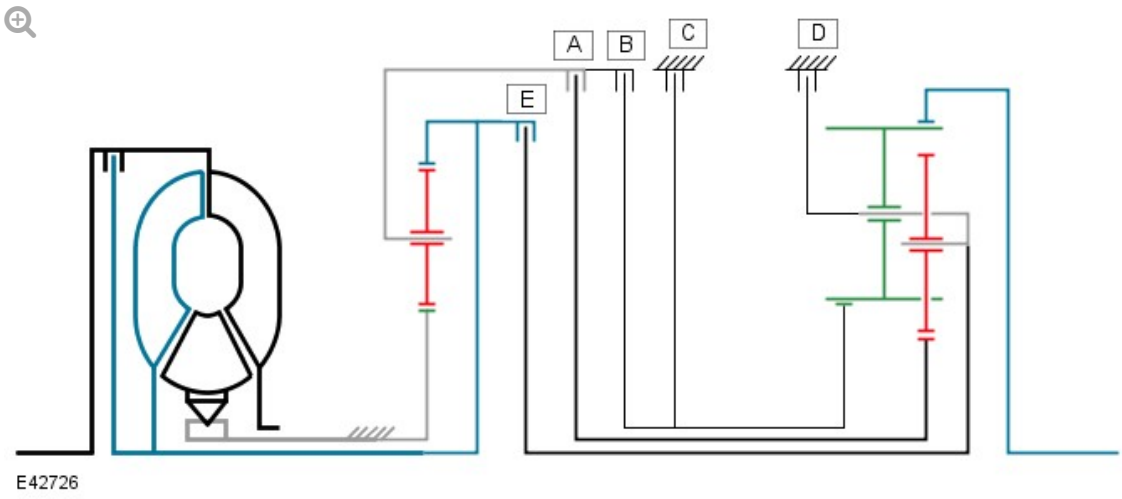
When clutch 'A' is engaged, sunwheel 3 in the double web planetary gear train is driven and meshes with the short planetary gears.

Sunwheel 2 is driven via clutch 'B' which is engaged. The long planetary gears, which are also meshed with the short planetary gears, cannot roll around the fixed sunwheel 2 and therefore transmit drive to the locked double web planetary gear train carrier in the direction of engine rotation.

Refer to 'Shift Elements' illustration for key



E42725



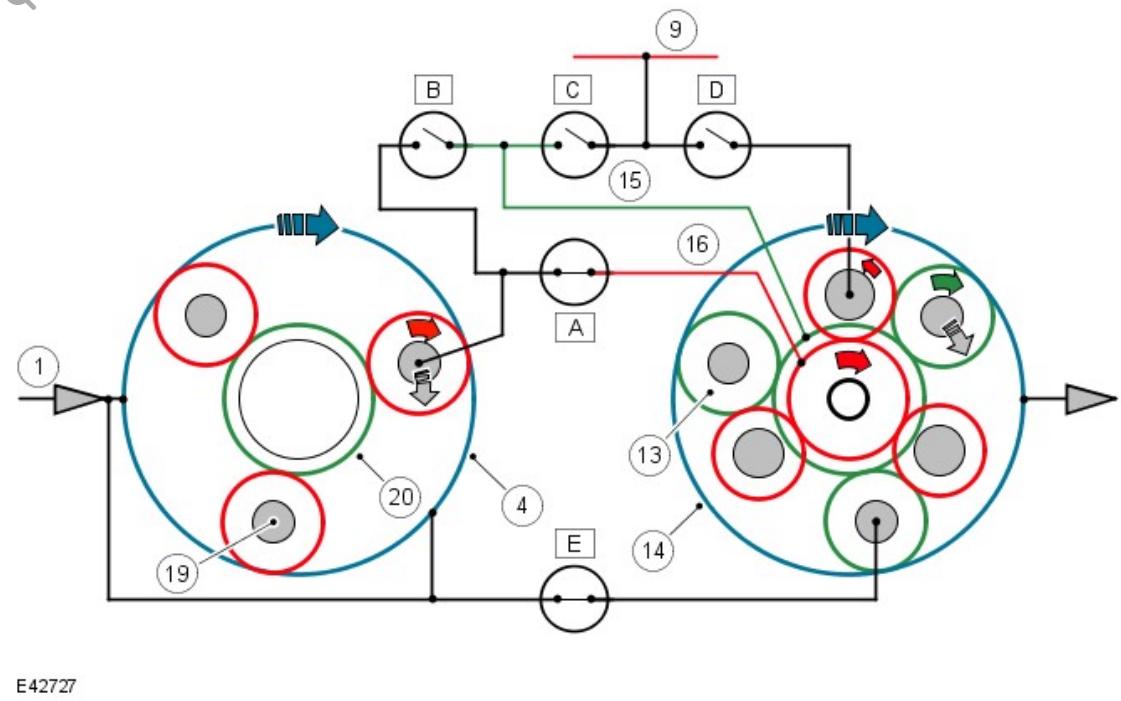
The JaguarDrive selector and the selector spool valve are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

Ring gear 1 drives the planetary gears which rotate around sunwheel 1. This drives the planetary gear carrier 1 and also the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

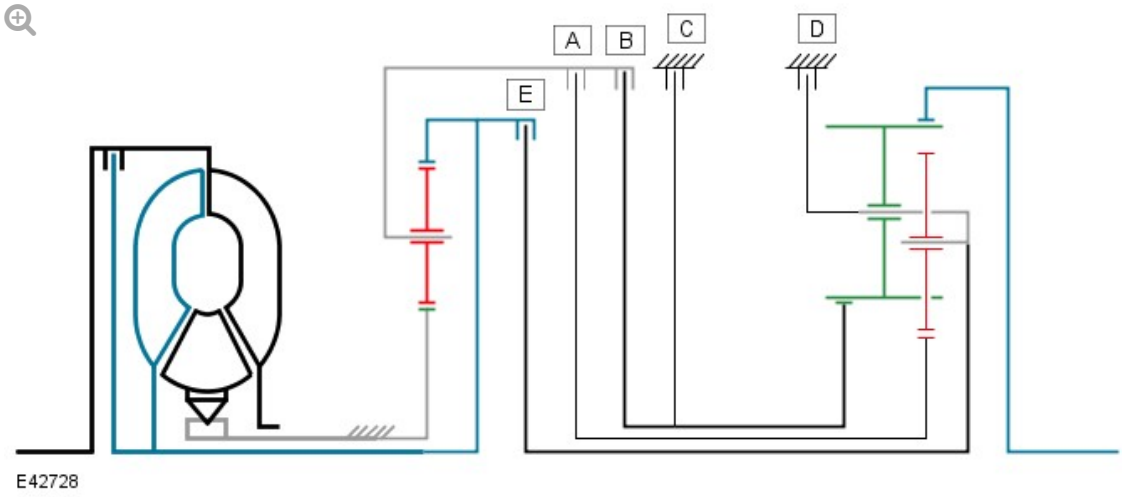
When clutch 'A' is engaged, sunwheel 3 in the double web planetary gear train is driven and meshes with the short planetary gears.

The double web planetary gear carrier is driven via clutch 'E' which is engaged. The long planetary gears, which are also meshed with the short planetary gears and the double web planetary gear carrier, drive ring gear 2 in the direction of engine rotation.

Refer to 'Shift Elements' illustration for key



E42727



E42728

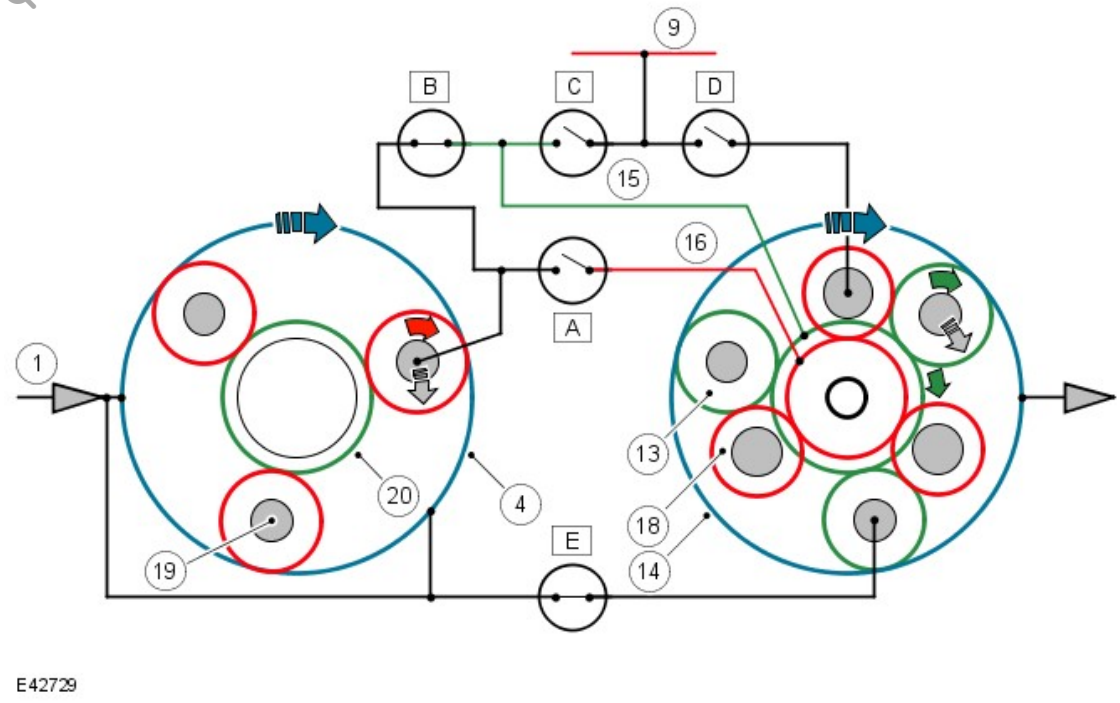
The JaguarDrive selector and the selector spool valve are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

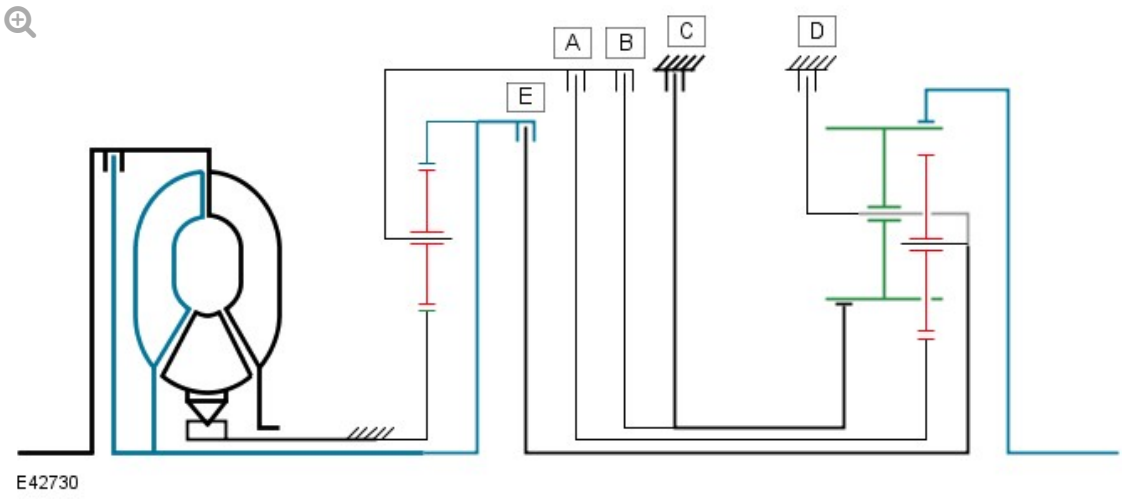
Ring gear 1 drives the planetary gears which rotate around sunwheel 1. This drives the planetary gear carrier 1 and also the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

When clutch 'A' is engaged, sunwheel 3 in the double web planetary gear train is driven and meshes with the short planetary gears.

The long planetary gears, which are also meshed with the short planetary gears and the double web planetary gear carrier, drive ring gear 2 in the direction of engine rotation.

Refer to 'Shift Elements' illustration for key





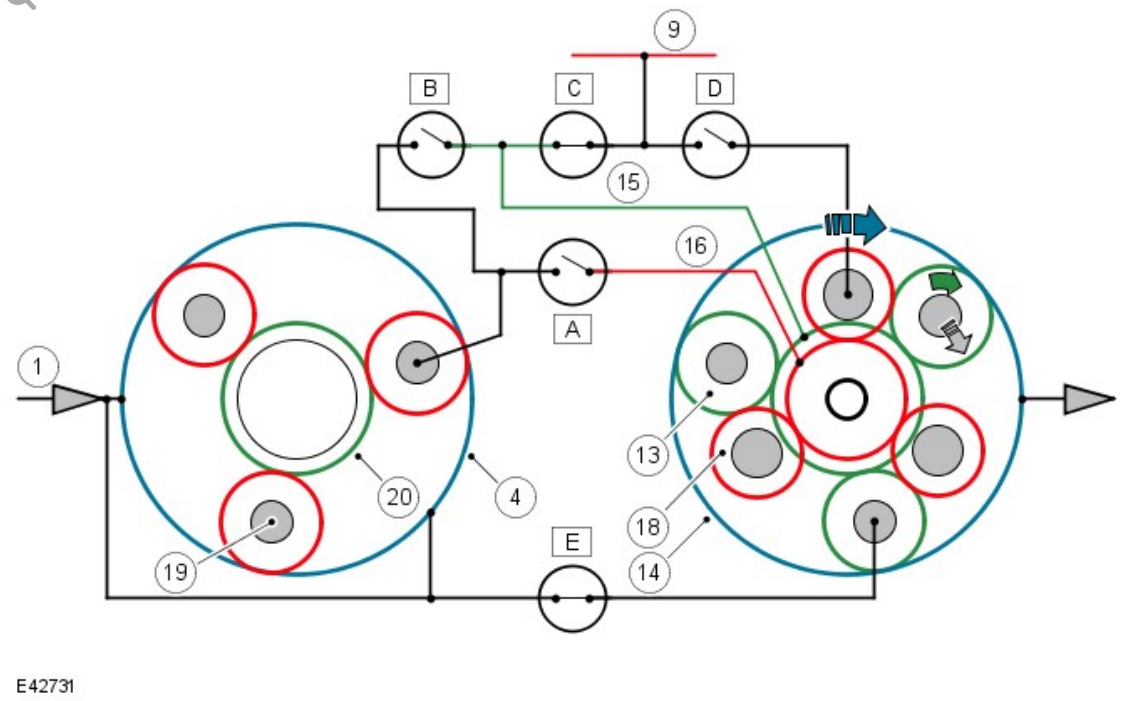
The JaguarDrive selector and the selector spool valve are in the 'D' position. Engine torque is transmitted from the torque converter turbine shaft to ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

Clutches 'A' and 'B' are released, removing the effect of the single web planetary gear train.

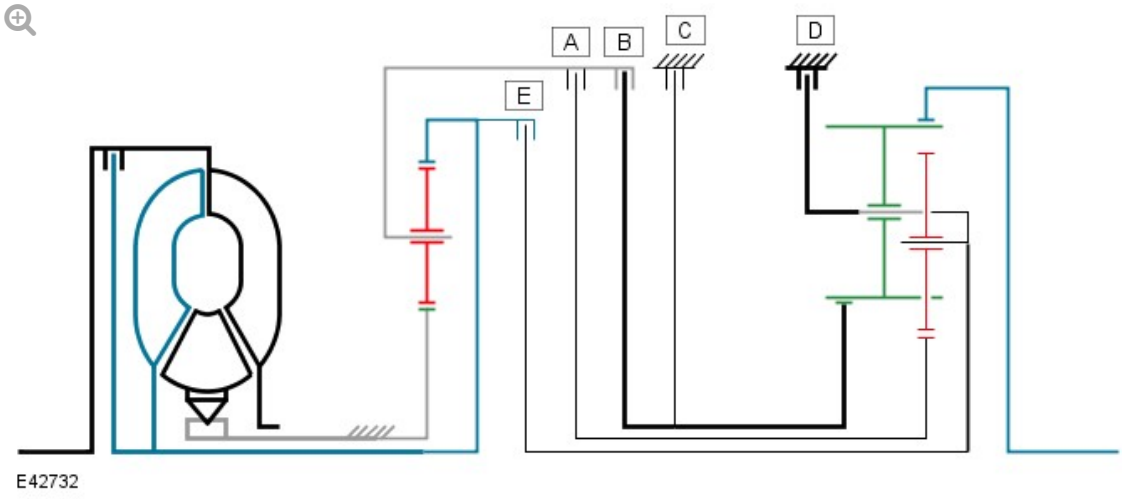
Clutch brake 'C' is applied which locks sunwheel 2 to the transmission housing.

Clutch 'E' is engaged and drives the double web planetary gear carrier. This causes the long planetary gears to rotate around the fixed sunwheel 2 and transmit drive to ring gear 2 which is driven in the direction of engine rotation.

Refer to 'Shift Elements' illustration for key



E42731



E42732

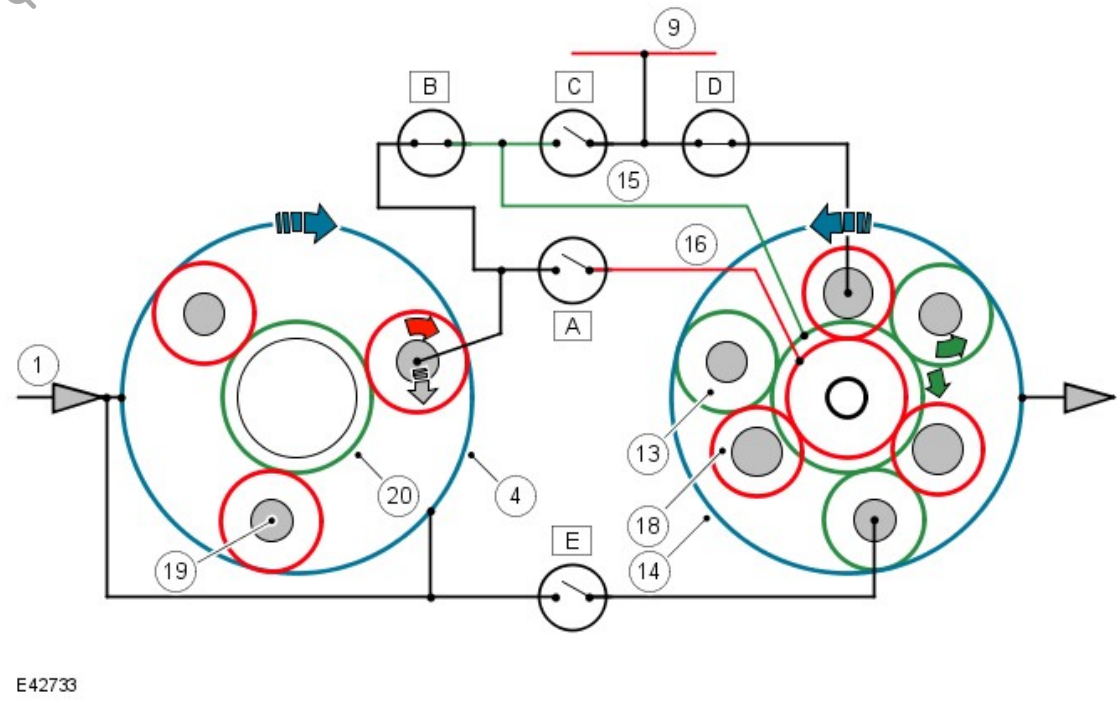
The JaguarDrive selector and the selector spool valve are in the 'R' position. Engine torque is transmitted from the torque converter turbine shaft to ring gear 1 of the single web planetary gear train and the outer plate carrier of clutch 'E'.

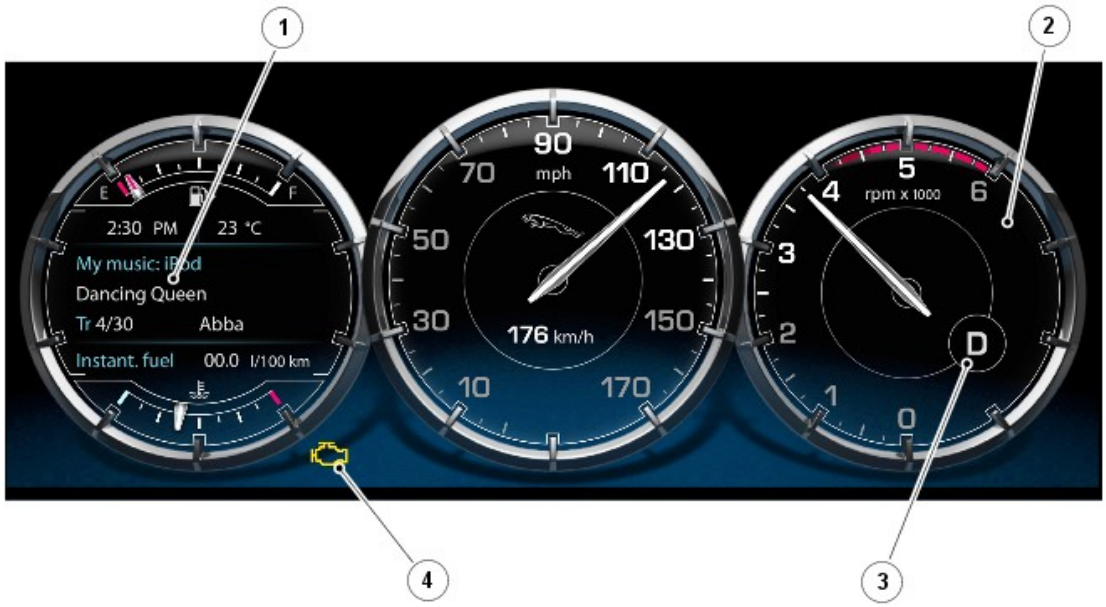
Ring gear 1 drives the planetary gears of the single web planetary gear train which rotate around the fixed sunwheel 1. This transmits the drive to the single web planetary gear carrier, the outer plate carrier of clutch 'A' and the inner plate carrier of clutch 'B'.

With clutch 'B' applied, sunwheel 2 in the double web planetary gear train is driven and meshes with the long planetary gears.

The double web planetary gear carrier is locked to the transmission housing by brake clutch 'D'. This allows ring gear 2 to be driven in the opposite direction to engine rotation by the long planetary gears.

Refer to 'Shift Elements' illustration for key





E122722

1	Information display
2	Tachometer/Message center
3	Transmission status display
4	MIL (malfunction indicator lamp)

The instrument cluster is connected to the TCM via the high speed CAN bus. Transmission status is transmitted by the TCM and displayed to the driver in the instrument cluster.
Refer to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation).

Transmission related faults that effect the vehicle emissions output will illuminate the MIL (malfunction indicator lamp). The MIL is illuminated by the ECM (engine control module) on receipt of a relevant fault message from the TCM on the high speed CAN. The nature of the fault can be diagnosed using a Jaguar approved diagnostic system, which reads the fault codes stored in the

TCM memory.

The transmission status display is located in the tachometer. The display shows the JaguarDrive selector position. When the transmission is in the Jaguar sequential shift mode the current gear is displayed in the information window.

The right side of the instrument cluster, which normally shows the tachometer, changes to a message center to display warnings and temporary alerts. If a transmission fault occurs, the message center will display the message 'GEARBOX FAULT'.

E121541

When the transmission is in the Jaguar sequential shift mode, the appearance of the instrument cluster changes to the dynamic mode and the current gear is displayed in the information window.

TRANSMISSION CONTROL MODULE

The TCM outputs signals to control the shift control solenoid valve and the EPRS (electronic pressure regulating solenoid) to control the hydraulic operation of the transmission.

The TCM processes signals from the transmission speed and temperature sensors, the ECM and other vehicle systems. From the received signal inputs and pre-programmed data, the module calculates the correct gear, torque converter clutch setting and optimum pressure settings for gear shift and lock-up clutch control.

The ECM supplies the engine management data over the high speed CAN bus. The TCM requires engine data to efficiently control the transmission operation, for example; flywheel torque, engine speed, accelerator pedal angle, engine temperature. The steering angle sensor and the ABS (anti-lock brake system) module also supply data to the TCM on the high speed CAN bus. The TCM uses data from these systems to suspend gear changes when the vehicle is cornering and/or the ABS module is controlling braking or traction control.

Using the signal inputs and the memorized data, the TCM control program computes the correct gear and torque converter lock-up clutch setting and the optimum pressure settings for gear shift and lock-up clutch control. Special output-side modules (power output stages, current regulator circuits), allow the TCM to control the solenoid valves and pressure regulators and consequently precisely control the hydraulics of the automatic transmission. In addition, the amount and duration of engine interventions are supplied to the engine management by way of the CAN bus.

The transmission has a fully electronic JaguarDrive selector with no Bowden cable connection to the transmission. The transmission selections are made using a rotary JaguarDrive selector which rises from the floor console once the engine is running. Rotation of the JaguarDrive selector to any of the five positions is sensed by the TCM via the high speed CAN bus. The TCM then reacts according to the selected position. The 'S' (sport) position selection allows the TCM to operate the transmission using the semi-automatic 'Jaguar Sequential Shift'.

Gear selections are sensed by the TCM when the driver operates the steering wheel paddle switches. Once the JaguarDrive selector position is confirmed, the TCM outputs appropriate information on the high speed CAN bus.

If the JaguarDrive selector is in 'D', 'Jaguar Sequential Shift' is temporary and will cancel after a time period or can be cancelled by pressing and holding the + paddle for approximately 2 seconds.

If the JaguarDrive selector is in 'S', 'Jaguar Sequential Shift' is permanent and can only be cancelled by pressing and holding the + paddle for approximately 2 seconds or by moving the JaguarDrive selector to the 'D' position.

The TCM can be reprogrammed using a Jaguar approved diagnostic system using a flash code. The TCM processor has a 440 kb internal flash memory. Of this capacity, approximately 370 kb are used by the basic transmission program. The remainder, approximately 70 kb is used to store vehicle-specific application data.

If the vehicle stalls it will coast down in gear, with the transmission providing drive to the engine. A restart can be attempted at this point and the engine may start and the driver can continue.

If the coast down speed reduces such that the speed of the engine is less than 600 rev/min, the transmission will go to neutral, D illumination will flash in the instrument cluster. The driver needs to select neutral or park and then press the brake pedal to restart the engine.

If the start/stop button is pressed when driving, the message ENGINE STOP BUTTON PRESSED is displayed in the message center but there will be no change to the ignition state. If the driver requires to switch off the engine, the start/stop button must be pressed for a second time. The engine will be stopped and will be back driven by the transmission as the vehicle coasts down. When the engine speed is less than 600 rev/min the transmission engages neutral (flashing D illumination in the instrument cluster). When

vehicle speed is less than 2 km/h (1.2 mph) Park is engaged. The JaguarDrive selector automatically rotates back to its lowered P position and the vehicle ignition is switched off.

The park engagement is prevented in a stall case as the ignition power is on and D was the last selected gear. The park engagement speed at ignition off is from the least value of the wheel speeds (CAN signal) and transmission output speed (internal signal).

COMPONENT DESCRIPTION

TRANSMISSION

The transmission comprises the main casing which houses all of the transmission components. The main casing also incorporates an integral bell housing.

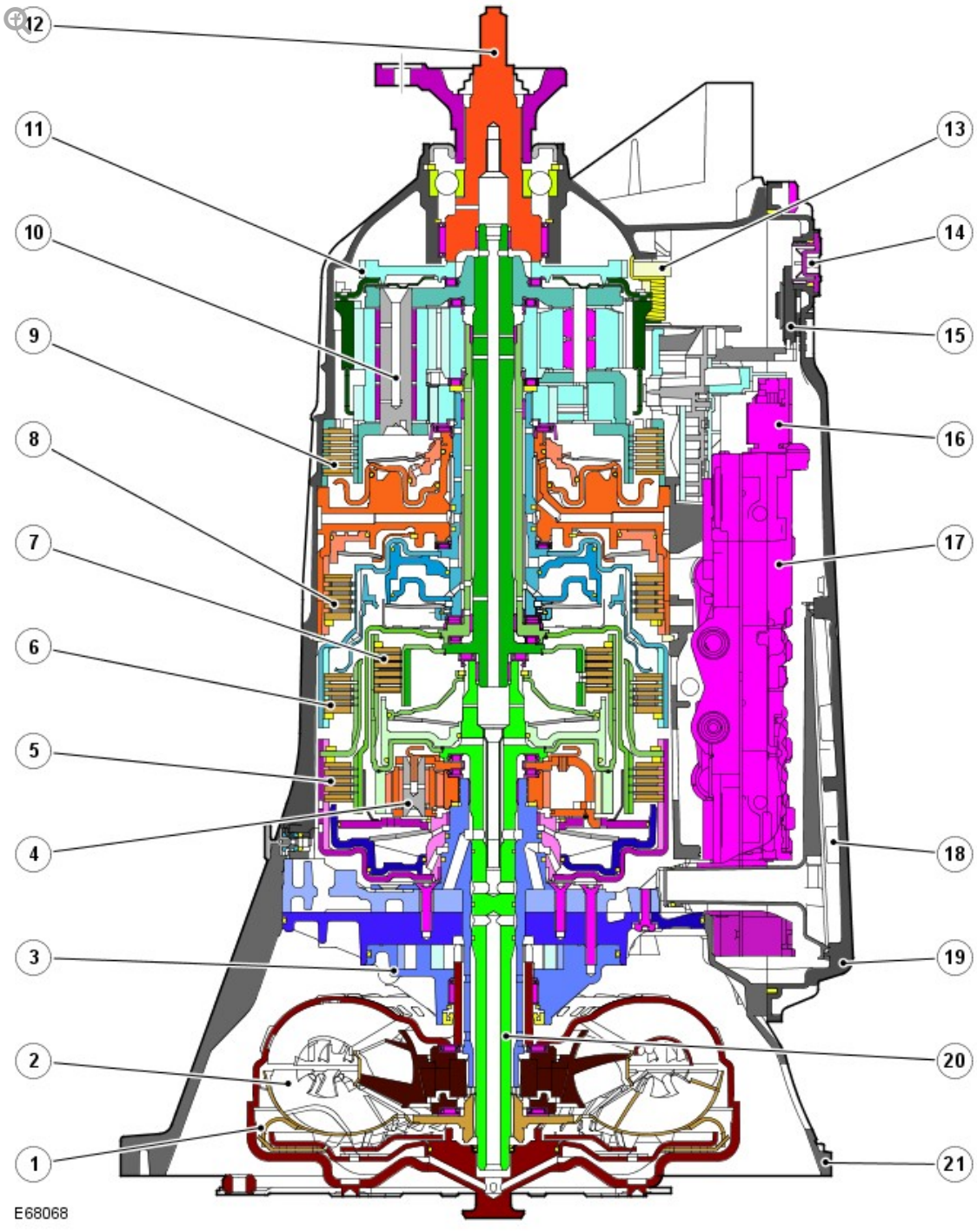
A fluid pan is attached to the lower face of the main casing and is secured with bolts. The fluid pan is sealed to the main casing with a gasket. Removal of the fluid pan allows access to the Mechatronic valve block. The fluid pan has a magnet located around the drain plug which collects any metallic particles present in the transmission fluid.

A fluid filter is located inside the fluid pan. If the transmission fluid becomes contaminated or after any service work, the fluid pan with integral filter must be replaced.

The integral bell housing provides protection for the torque converter assembly and also provides the attachment for the gearbox to the engine cylinder block. The torque converter is a non-serviceable assembly which also contains the lock-up clutch mechanism. The torque converter drives a crescent type pump via drive tangs. The fluid pump is located in the main casing, behind the torque converter.

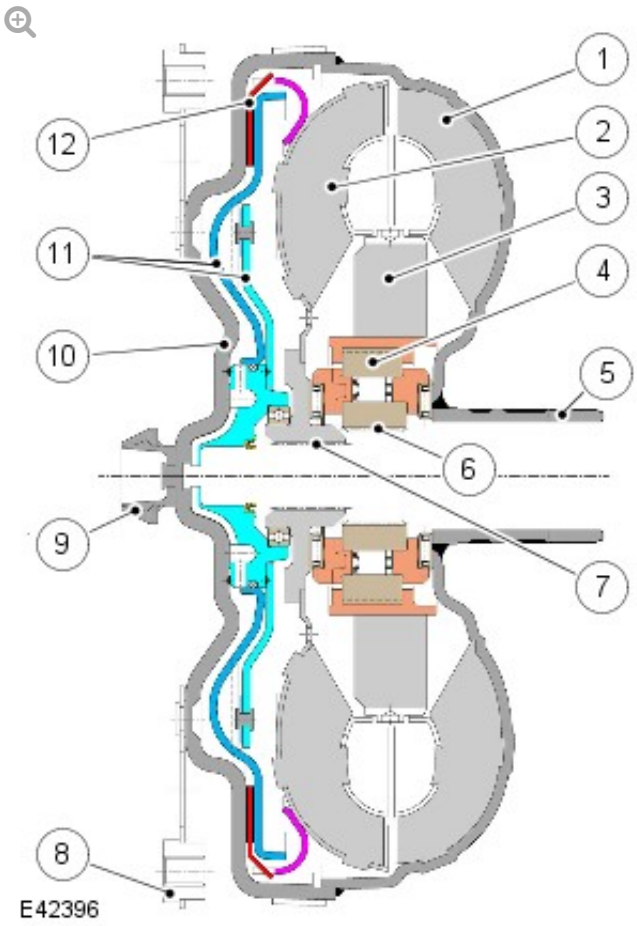
The main casing contains the following major components:

- Input shaft
- Output shaft
- Mechatronic valve block which contains the solenoids, speed sensors and the TCM
- Three rotating multiplate drive clutches
- Two fixed multiplate brake clutches
- A single planetary gear train and a double planetary gear train.



1	Torque converter lock-up clutch
2	Torque converter
3	Fluid pump
4	Single planetary gearset
5	Clutch A
6	Clutch B
7	Clutch E
8	Brake C
9	Brake D
10	Double planetary gearset
11	Park lock gear
12	Output shaft
13	Park lock pawl
14	Drain plug
15	Magnet
16	Pressure regulator
17	Mechatronic valve block
18	Fluid filter
19	Fluid pan
20	Input shaft
21	Bell housing

TORQUE CONVERTER

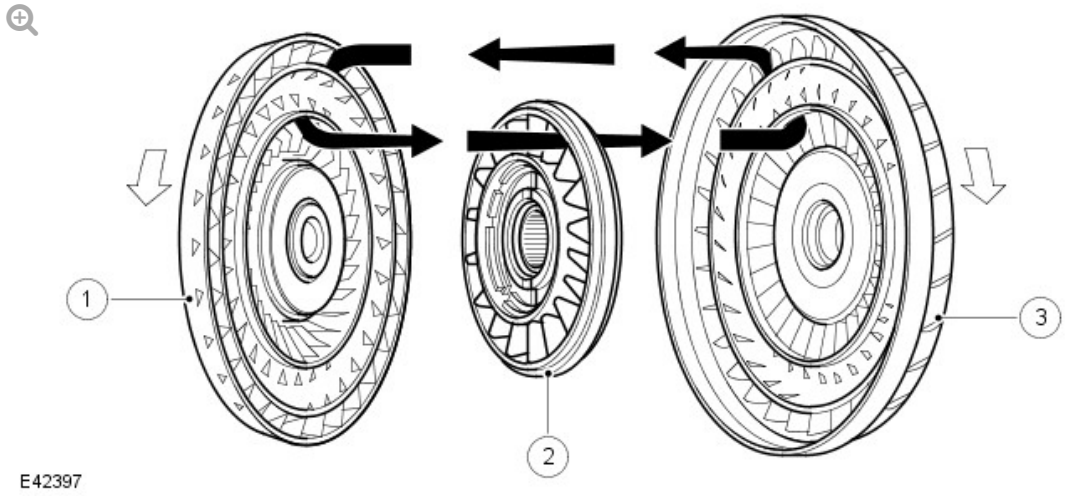


1	Impeller
2	Turbine
3	Stator
4	Freewheel clutch
5	Torque converter hub
6	Stator shaft
7	Turbine shaft
8	Drive plate
9	Journal - Drive plate/crankshaft location
10	Torque converter cover
11	Lock-up clutch piston
12	Lock-up clutch plate

The torque converter is the coupling element between the engine and the transmission and is located in the bell housing, on the engine side of the transmission. The driven power from the engine crankshaft is transmitted hydraulically and mechanically through the torque converter to the transmission. The torque converter is connected to the engine by a drive plate attached to the rear of the crankshaft.

The torque converter comprises an impeller, a stator and a turbine. The torque converter is a sealed unit with all components located between the converter housing cover and the impeller. The two components are welded together to form a sealed, fluid filled housing. With the impeller welded to the converter housing cover, the impeller is therefore driven at engine crankshaft speed.

The converter housing cover has four threaded bosses, which provide for attachment of the engine drive plate. The threaded bosses also provide for location of special tools which are required to remove the torque converter from the bell housing.



1	Turbine
2	Stator

3	Impeller

When the engine is running the rotating impeller acts as a centrifugal pump, picking up fluid at its center and discharging it at high velocity through the blades on its outer rim. The design and shape of the blades and the curve of the impeller body cause the fluid to rotate in a clockwise direction as it leaves the impeller. This rotation improves the efficiency of the fluid as it contacts the outer row of blades on the turbine.

The centrifugal force of the fluid leaving the blades of the impeller is passed to the curved inner surface of the turbine via the tip of the blades. The velocity and clockwise rotation of the fluid causes the turbine to rotate.

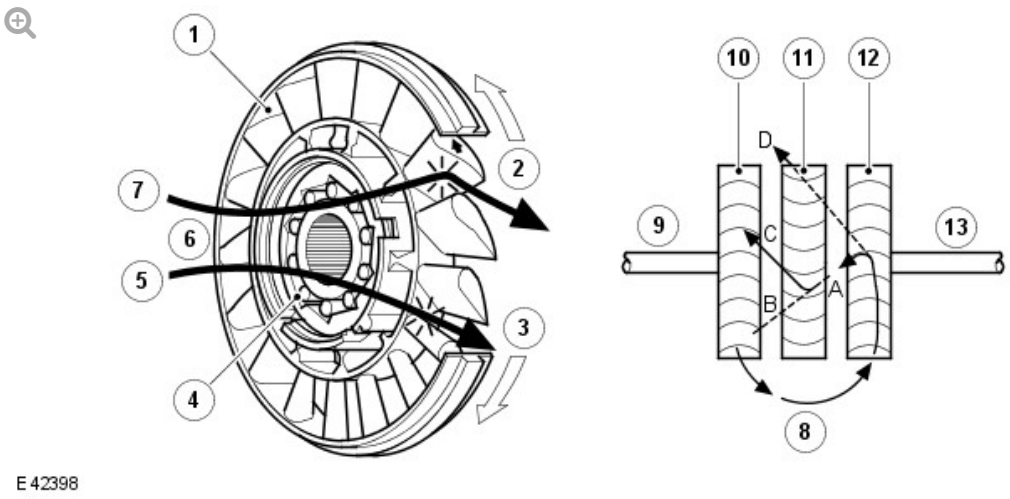
The turbine is similar in design to the impeller with a continuous row of blades. Fluid from the impeller enters the turbine through the tip of the blades and is directed around the curved body of the turbine to the root of the blades. The curved surface redirects the fluid back in the opposite direction to which it entered the turbine, effectively increasing the turning force applied to the turbine from the impeller. This principle is known as torque multiplication.

When engine speed increases, turbine speed also increases. The fluid leaving the inner row of the turbine blades is rotated in a counter-clockwise direction due to the curve of the turbine and the shape of the blades. The fluid is now flowing in the opposite direction to the engine rotation and therefore the impeller. If the fluid was allowed to hit the impeller in this condition, it would have the effect of applying a brake to the impeller, eliminating the torque multiplication effect. To prevent this, the stator is located between the impeller and the turbine.

The stator is located on the splined transmission input shaft via a freewheel clutch. The stator comprises a number of blades which are aligned in an opposite direction to those of the impeller and turbine. The main function of

the stator is to redirect the returning fluid from the turbine, changing its direction to that of the impeller.

The redirected fluid from the stator is directed at the inner row of blades of the impeller, assisting the engine in turning the impeller. This sequence increases the force of the fluid emitted from the impeller and thereby increases the torque multiplication effect of the torque converter.



1	Blades
2	Stator held – fluid flow redirected
3	Stator rotates freely
4	Roller
5	Converter at coupling speed
6	Fluid flow from turbine
7	Converter multiplying
8	Fluid flow from impeller
9	Drive from engine
10	Impeller
11	Stator

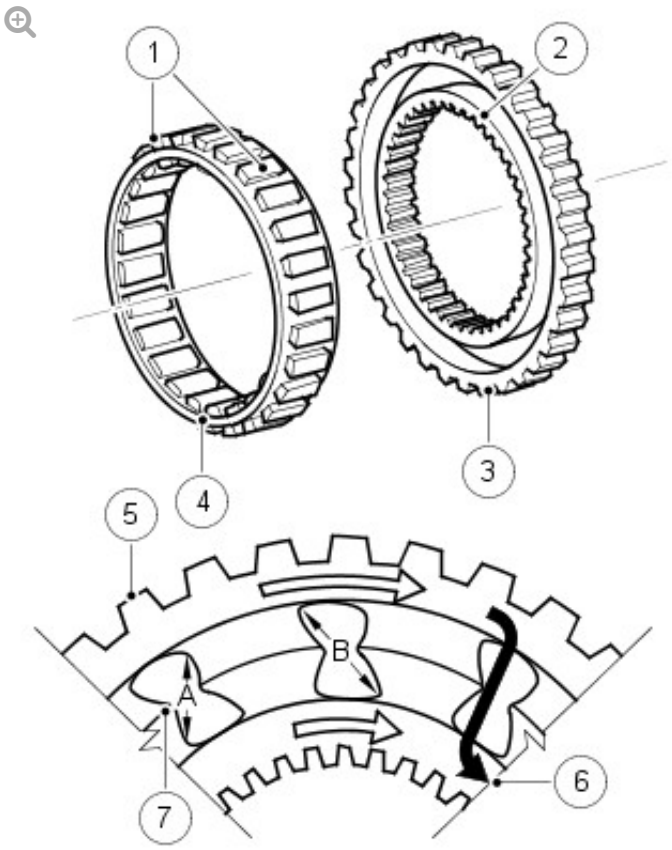
12	Turbine
13	Output to transmission

Fluid emitted from the impeller acts on the turbine. If the turbine is rotating at a slower speed than the fluid from the impeller, the fluid will be deflected by the turbine blades in the path **'A'**. The fluid is directed at and deflected by the stator blades from path **'B'** to path **'C'**. This ensures that the fluid is directed back to the pump in the optimum direction. In this condition the sprag clutch is engaged and the force of the fluid on the stator blades assists the engine in rotating the impeller.

As the rotational speed of the engine and therefore the turbine increases, the direction of the fluid leaving the turbine changes to path **'D'**. The fluid is now directed from the turbine to the opposite side of the stator blades, rotating the stator in the opposite direction. To prevent the stator from resisting the smooth flow of the fluid from the turbine, the sprag clutch releases, allowing the stator to rotate freely on its shaft.

When the stator becomes inactive, the torque converter no longer multiplies the engine torque. When the torque converter reaches this operational condition it ceases to multiply the engine torque and acts solely as a fluid coupling, with the impeller and the turbine rotating at approximately the same speed.

The stator uses a sprag type, one way, freewheel clutch. When the stator is rotated in a clockwise direction the sprags twist and are wedged between the inner and outer races. In this condition the sprags transfer the rotation of the outer race to the inner race which rotates at the same speed.



E 42712

1	Sprags
2	Inner race
3	Outer race
4	Sprag and cage assembly
5	Sprag outer race
6	Sprag inner race
7	Retaining ring

The free wheel clutch can perform three functions; hold the stator stationary, drive the stator and free wheel allowing the stator to rotate without a drive output. The free wheel clutch used in the ZF 6HP28 transmission is of the sprag type and comprises an inner and outer race and a sprag and cage assembly. The inner and outer races are pressed into their related

components with which they rotate. The sprag and cage assembly is located between the inner and outer races.

The sprags are located in a cage which is a spring which holds the sprags in the 'wedge' direction and maintains them in contact with the inner and outer races.

Referring to the illustration, the sprags are designed so that the dimension **'B'** is larger than the distance between the inner and outer race bearing surfaces. When the outer race rotates in a clockwise direction, the sprags twist and the edges across the dimension **'B'** wedge between the races, providing a positive drive through each sprag to the inner race. The dimension **'A'** is smaller than the distance between the inner and outer race bearing surfaces. When the outer race rotates in an anti-clockwise direction, the dimension **'A'** is too small to allow the sprags to wedge between the races, allowing the outer race to rotate freely.

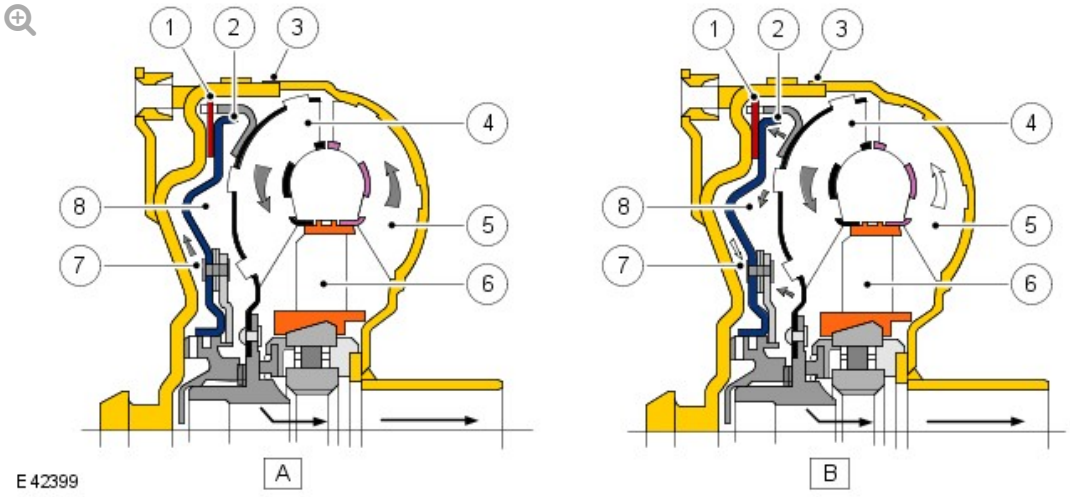
On the illustration shown, when the outer race is rotated in a clockwise direction, the sprags twist and are 'wedged' between the inner and outer races. The sprags then transfer the rotation of the outer race to the inner race, which rotates at the same speed.

The TCC (torque converter clutch) is hydraulically controlled by an EPRS, which is controlled by the TCM. This allows the torque converter to have three states of operation as follows:

- • Fully engaged
- • Controlled slip variable engagement
- • Fully disengaged.

The TCC is controlled by two hydraulic spool valves located in the valve block. These valves are actuated by pilot pressure supplied via a solenoid valve which is also located in the valve block. The solenoid valve is operated by PWM (pulse width modulation) signals from the TCM to give full, partial or no

lock-up of the torque converter.



A	Unlocked condition
B	Locked condition
1	Clutch plate
2	Clutch piston
3	Torque converter body
4	Turbine
5	Impeller
6	Stator
7	Piston chamber
8	Turbine chamber

The lock-up clutch is a hydro-mechanical device which eliminates torque converter slip, improving fuel consumption. The engagement and disengagement is controlled by the TCM to allow a certain amount of controlled 'slip'. This allows a small difference in the rotational speeds of the impeller and the turbine which results in improved shift quality. The lock-up clutch comprises a piston and a clutch friction plate.

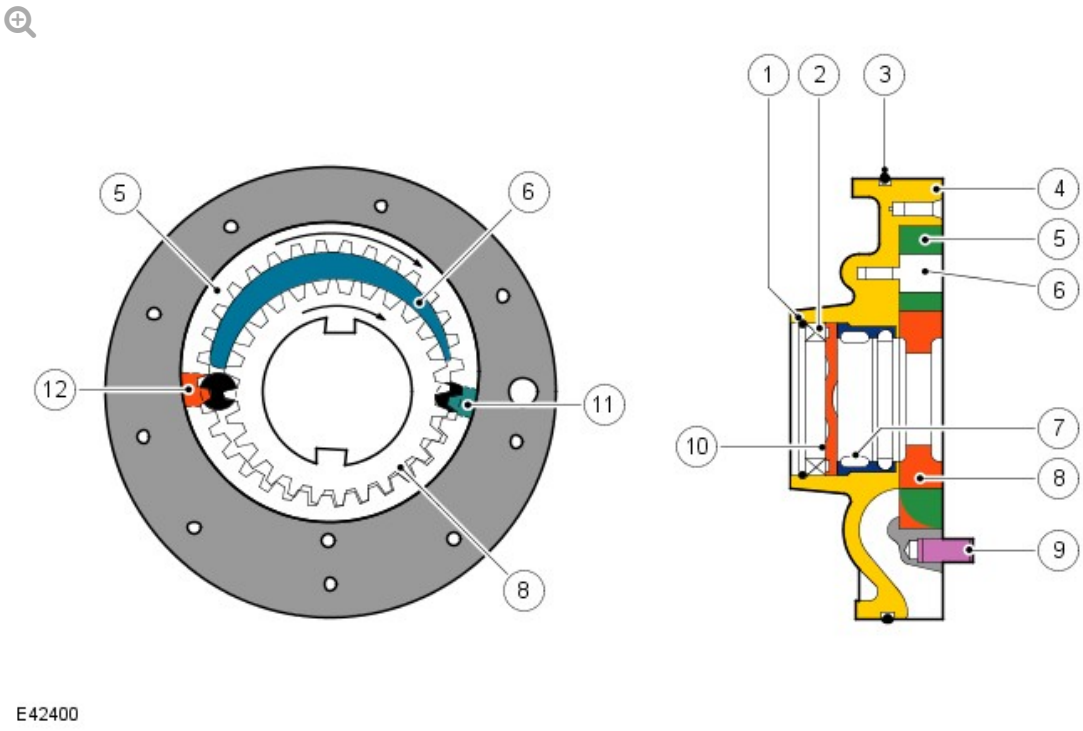
In the unlocked condition, the oil pressure supplied to the piston chamber and the turbine chamber is equal. Pressurized fluid flows through a drilling in the turbine shaft and through the piston chamber to the turbine chamber. In this condition the clutch plate is held away from the torque converter body and torque converter slip is permitted.

In the locked condition, the TCC spool valves are actuated by the EPRS. The fluid flow in the unlocked condition is reversed and the piston chamber is vented. Pressurized fluid is directed into the turbine chamber and is applied to the clutch piston. The piston moves with the pressure and pushes the clutch plate against the torque converter body. As the pressure increases, the friction between the clutch plate and the body increases, finally resulting in full lock-up of the clutch plate with the body. In this condition there is direct mechanical drive from the engine crankshaft to the transmission planetary gear train.

FLUID PUMP

The fluid pump is an integral part of the transmission. The fluid pump is used to supply hydraulic pressure for the operation of the control valves and clutches, to pass the fluid through the transmission cooler and to lubricate the gears and shafts.

The ZF 6HP28 fluid pump is a crescent type pump and is located between the intermediate plate and the torque converter. The pump has a delivery rate of 16 cm^3 per revolution.



1	Securing ring
2	Shaft oil seal
3	O-ring seal
4	Pump housing
5	Ring gear
6	Crescent spacer
7	Roller bearing
8	Impeller
9	Centering pin
10	Spring washer
11	Outlet port (high pressure)
12	Inlet port (low pressure)

The pump comprises a housing, a crescent spacer, an impeller and a ring gear. The housing has inlet and outlet ports to direct flow and is located in the

intermediate plate by a centering pin. The pump action is achieved by the impeller, ring gear and crescent spacer.

The crescent spacer is fixed in its position by a pin and is located between the ring gear and the impeller. The impeller is driven by drive from the torque converter hub which is located on a needle roller bearing in the pump housing. The impeller teeth mesh with those of the ring gear. When the impeller is rotated, the motion is transferred to the ring gear which rotates in the same direction.

The rotational motion of the ring gear and the impeller collects fluid from the intake port in the spaces between the teeth. When the teeth reach the crescent spacer, the oil is trapped in the spaces between the teeth and is carried with the rotation of the gears. The spacer tapers near the outlet port. This reduces the space between the gear teeth causing a build up of fluid pressure as the oil reaches the outlet port. When the teeth pass the end of the spacer the pressurized fluid is released into the outlet port.

The fluid emerging from the outlet port is passed through the fluid pressure control valve. At high operating speeds the pressure control valve maintains the output pressure to the gearbox at a predetermined maximum level. Excess fluid is relieved from the pressure control valve and is directed, via the main pressure valve in the valve block, back to the pump inlet port. This provides a pressurized feed to the pump inlet which prevents cavitation and reduces pump noise.

MECHATRONIC VALVE BLOCK

The Mechatronic valve block is located in the bottom of the transmission and is covered by the fluid pan. The valve block houses the TCM, electrical actuators, speed sensors and control valves which provide all electro-hydraulic control for all transmission functions. The Mechatronic valve block comprises the following components:

- TCM