2002-05 TRANSMISSIONS

Overview - MINI

TRANSMISSION (COOPER)

The MINI COOPER is available with either a manual or automatic transmission. COOPER S is available only with a manual transmission. All of the transmissions are mounted in line with the engine on the drivers side of the engine bay. The final drive/differential assembly is integral with the transmission housing and provides drive to the front wheels.

MANUAL TRANSMISSION

The manual transmission and final drive assembly installed in the MINI COOPER is known as the R65. This transmission has 5 forward speeds and a maximum torque input of 160 N.m. The shift pattern is of a conventional design with reverse gear opposite 5th gear, and neutral in the 3rd/4th gear plane. See **Fig. 1** and **Fig. 2** .

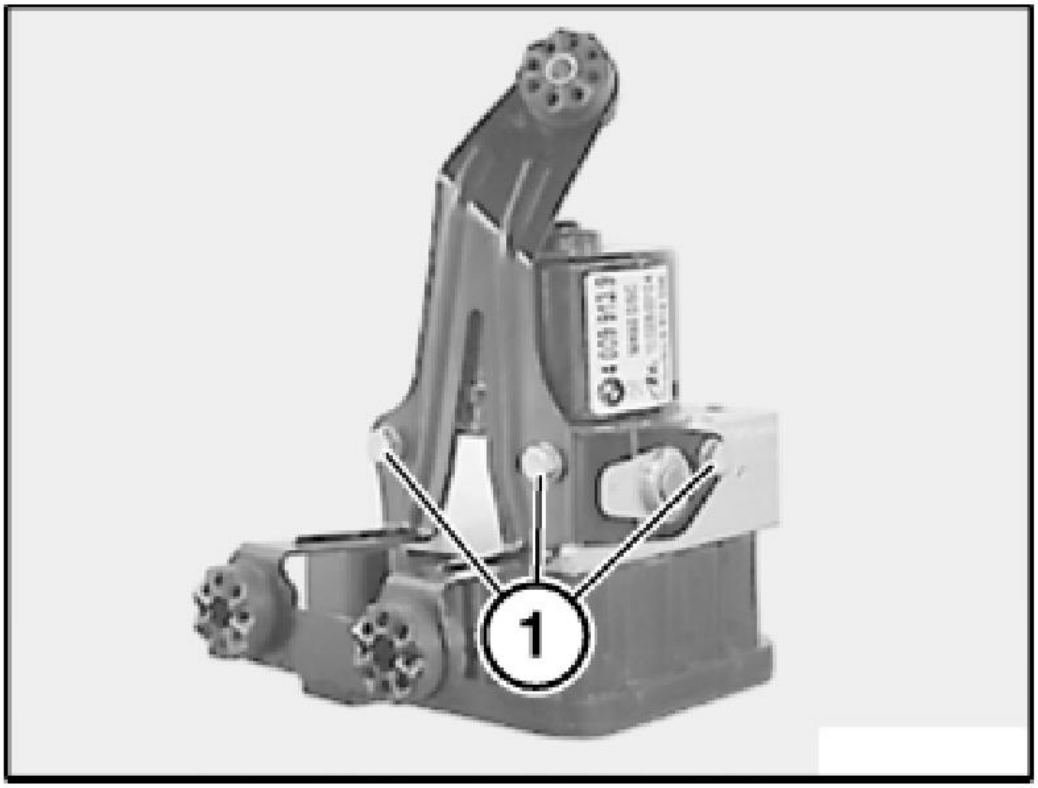

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Fig. 1: Identifying R65 Transmission Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

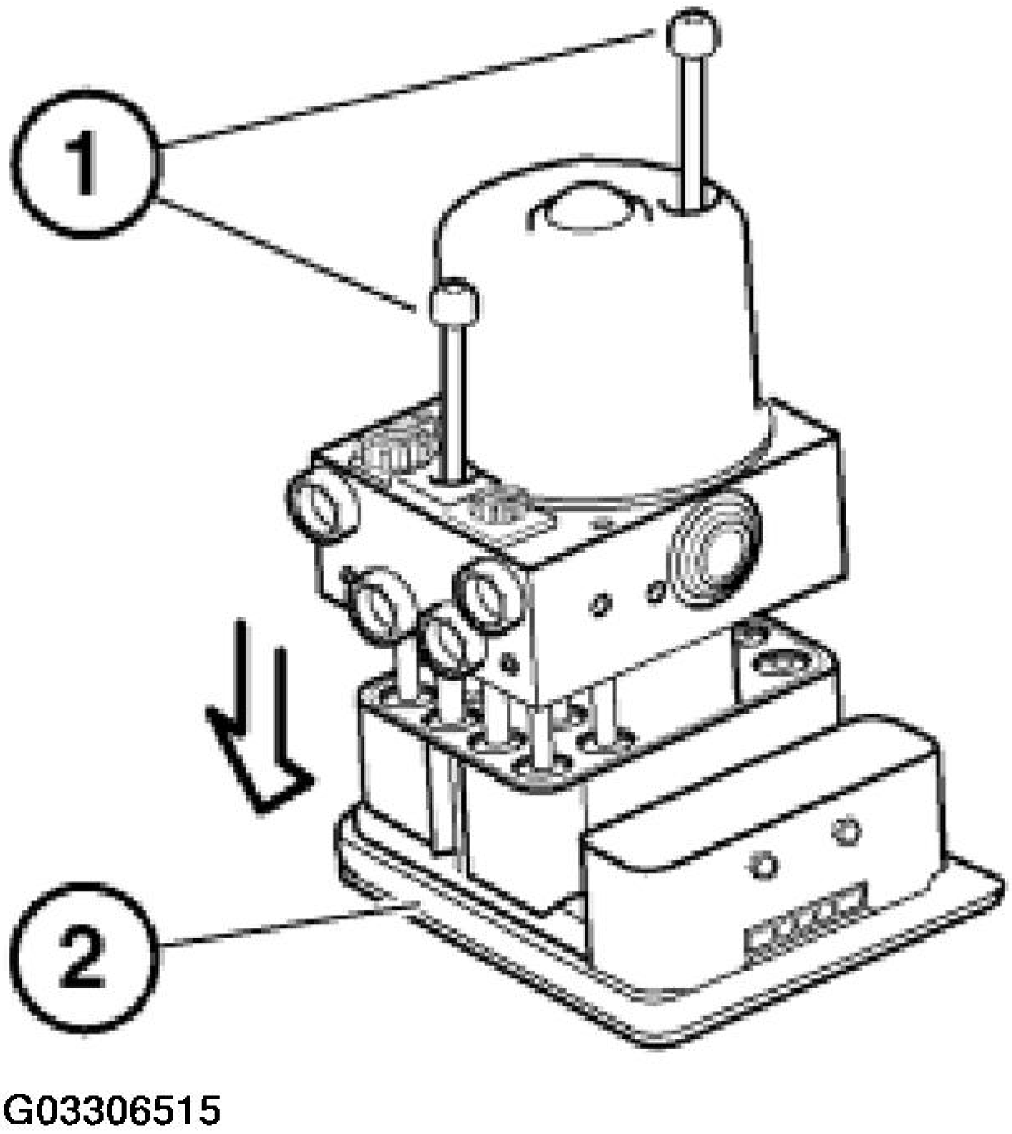

Fig. 2: Identifying R65 Shift Pattern
Courtesy of BMW OF NORTH AMERICA, INC.

Features of the R65 transmission assembly include:

- Two shaft design.

- Input shaft incorporating four fixed input gears and 5th gear located by splines and a lock nut.
- All output gears free to rotate on the output shaft.
- Overall length of just 395 mm including the clutch housing.
- All forward gears have synchromesh with dual cone synchromesh on 1st, 2nd and 3rd gears.
- Aluminum die cast housings with the exception of the rear cover that is pressed steel.
- All housings are sealed with liquid sealer except the rear housing that has a rubber seal.

Primary components of the R65 transmission are:

- Gears and shafts.
- Clutch housing.
- Main housing.
- Shift mechanism.

Gears & Shafts

The gear tooth design has been optimized for gearbox smoothness and efficiency. The fine tooth design allows more teeth to be in mesh with each other at any moment. There will be three teeth in mesh as opposed to two in conventional gearboxes. This greatly reduces gear noise.

The input shaft incorporates fixed 1st, 2nd, 3rd and 4th speed input gears forming a single component. Fifth gear is splined to the input shaft and secured with a lock nut. The output shaft assembly contains all free rotating output gears and synchronizer assemblies.

The differential is mounted on two tapered roller bearings. The need to take preload measurements is negated by the use of very close machining tolerances on the various components. This accuracy is achieved with a new machining technique that employs the very latest technological advances. Automated machines take temperature readings from the aluminum block being machined, the cutting head and cutting fluid and make necessary adjustments to compensate for temperature fluctuations. See **Fig. 3** .

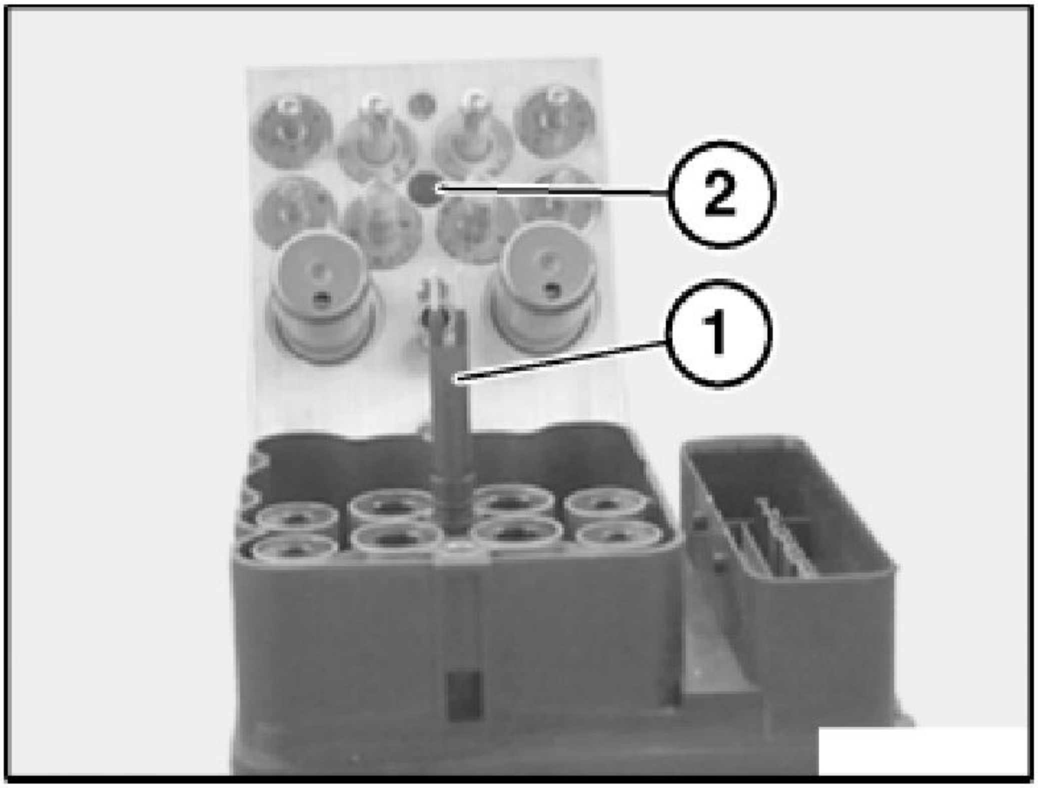

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Fig. 3: Identifying R65 Main Internal Components
Courtesy of BMW OF NORTH AMERICA, INC.

Clutch Housing

The clutch housing is bolted and doweled to the rear of the engine. It houses the flywheel, clutch, clutch release fork, clutch release bearing guide and input shaft seal. It also provides space for the differential, a differential bearing, and a seal housing for the right hand drive shaft. See **Fig. 4** and **Fig. 5** .

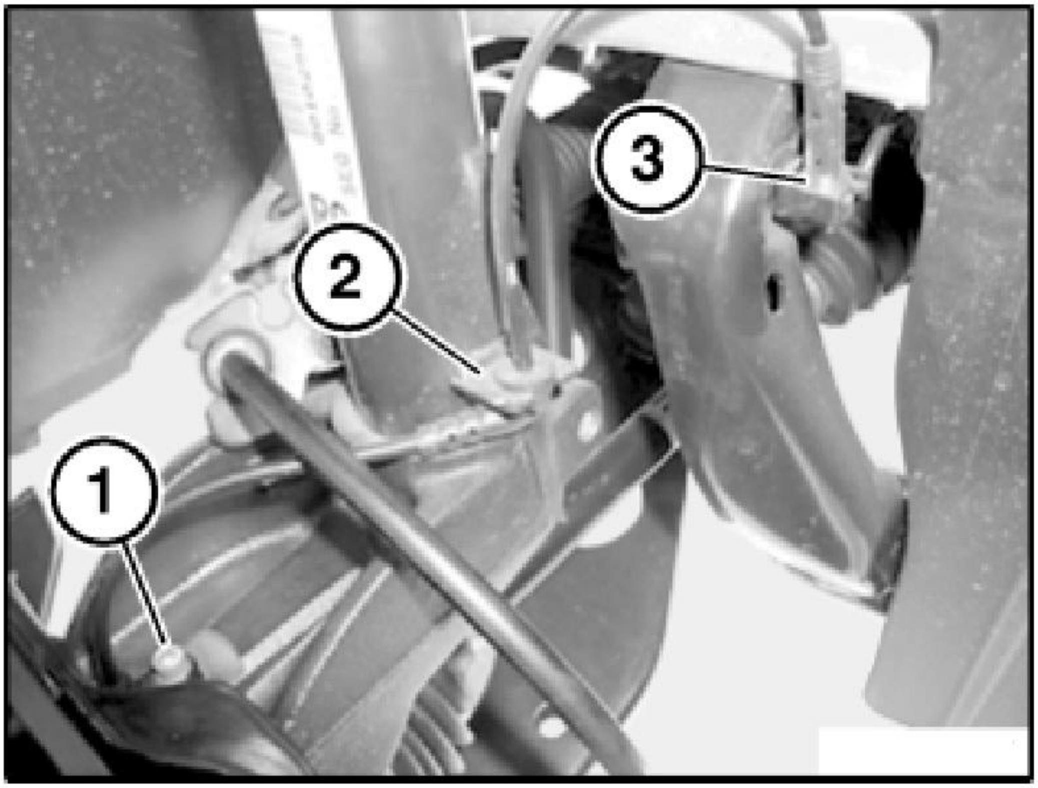

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Fig. 4: Identifying R65 Housing Engine Side
Courtesy of BMW OF NORTH AMERICA, INC.

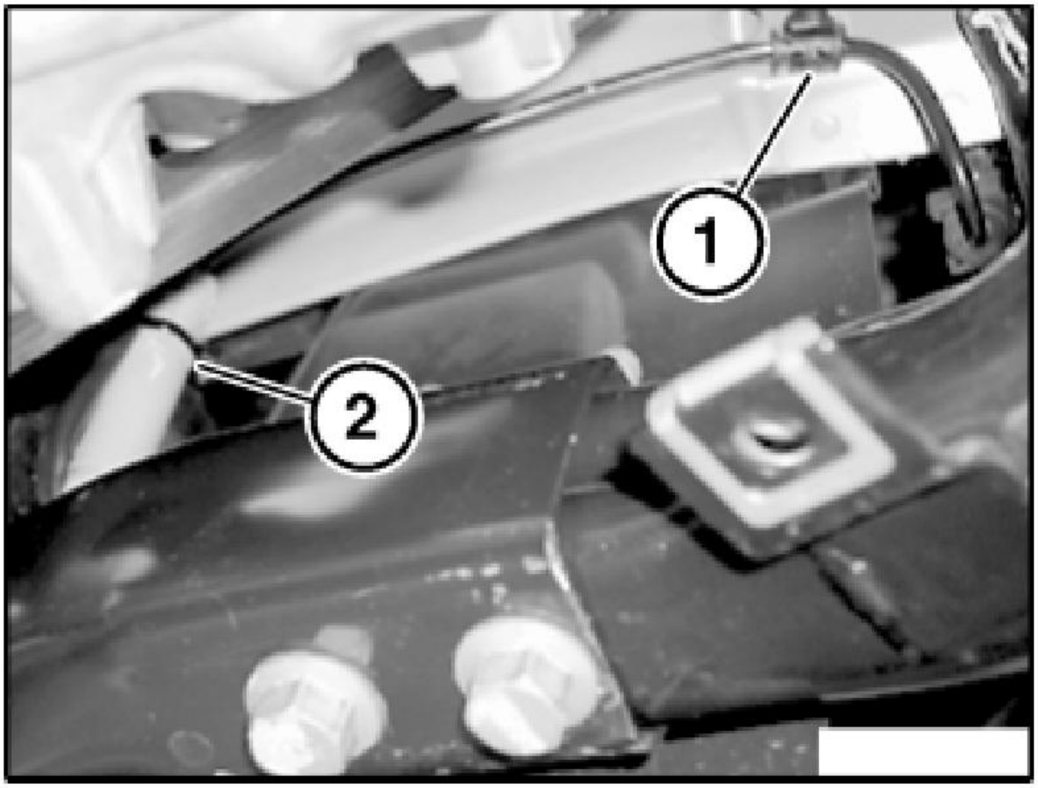

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Fig. 5: Identifying Clutch Housing Transmission Side
Courtesy of BMW OF NORTH AMERICA, INC.

Main Housing

The main housing houses the gearbox breather, reverse light switch, selector shafts, input shaft and output shaft, all gears except 5th and the reverse gear idler shaft. See **Fig. 6** and **Fig. 7** .

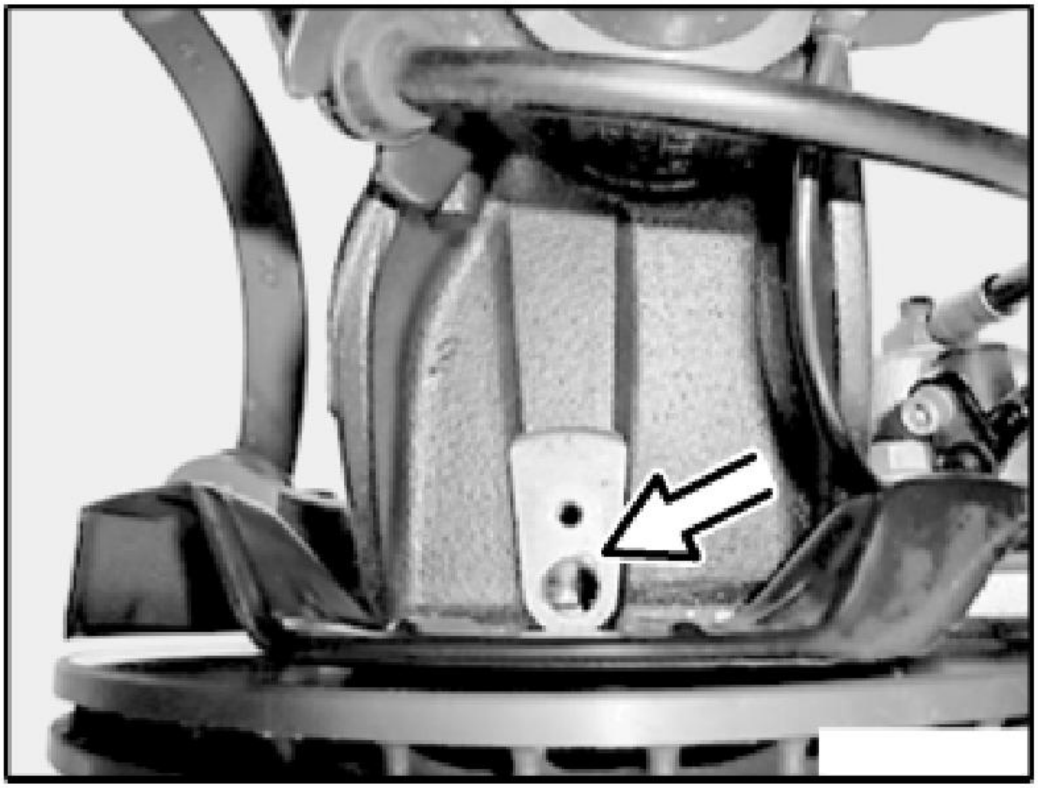

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Fig. 6: Identifying Main Housing
Courtesy of BMW OF NORTH AMERICA, INC.

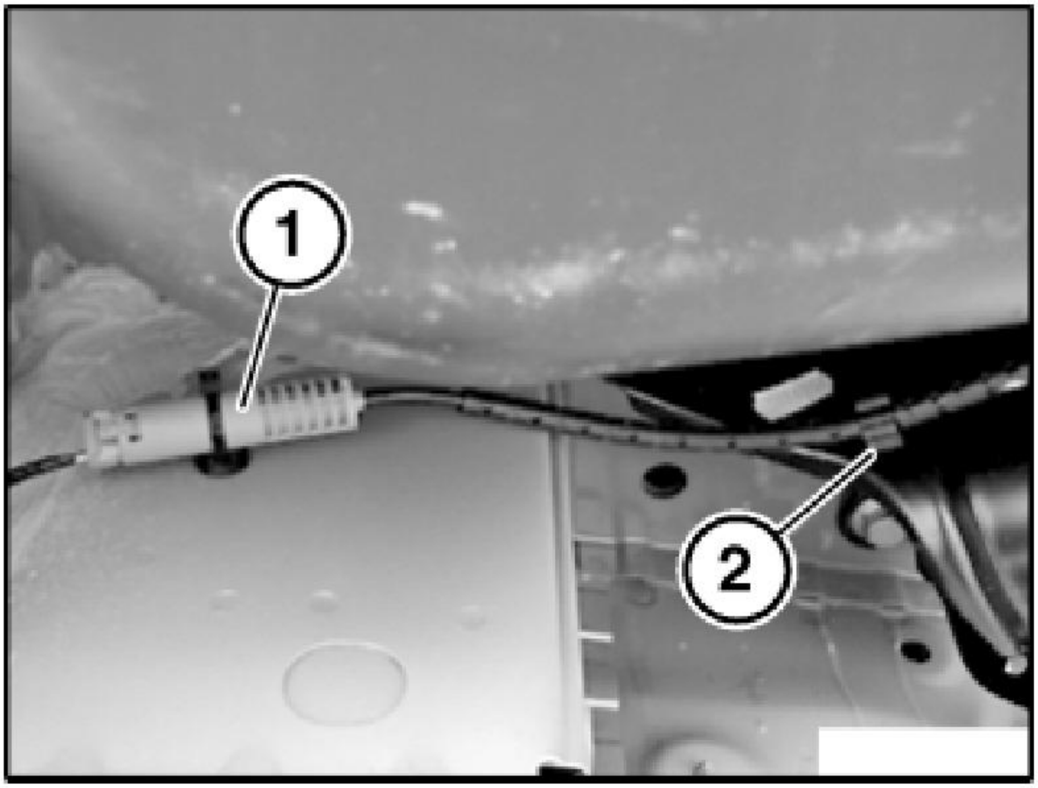

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Fig. 7: Identifying Intermediate Plate
Courtesy of BMW OF NORTH AMERICA, INC.

The intermediate plate assembly is situated on the gearbox side of the clutch housing. It provides support for the gear selector lever and input and output shaft bearings.

Rear Cover

The rear cover is an extension to the main housing providing a housing for 5th gear, 5th gear synchromesh hub and the selector fork. The rear cover also houses an oil trap and guide to supply oil to the hole inside the output shaft. Cross drilled holes in the shaft provide lubrication for the gears. See **Fig. 8** and **Fig. 9** .

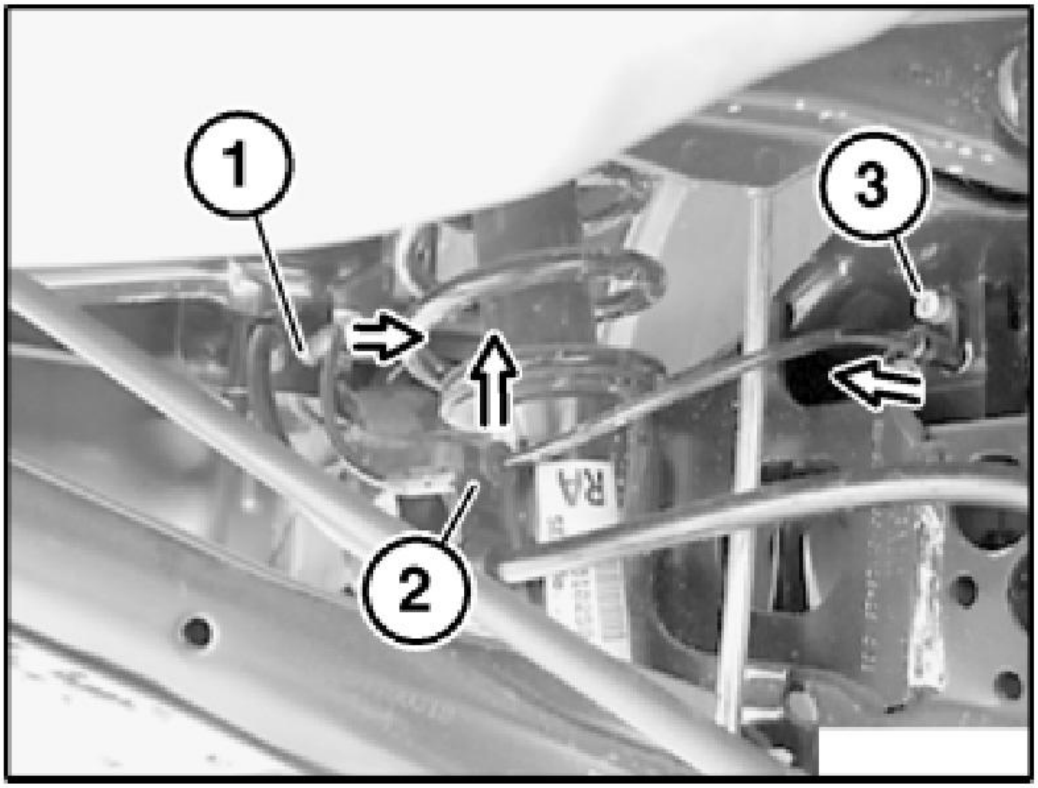

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Fig. 8: Identifying Rear Cover Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

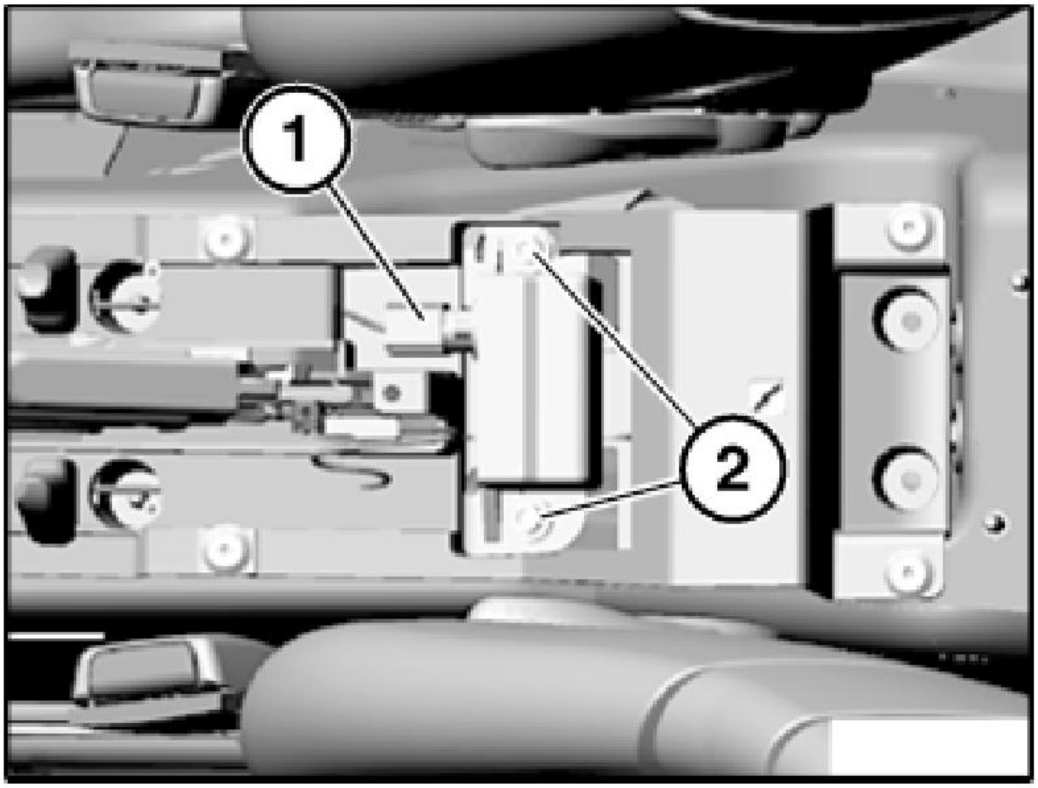

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Fig. 9: Identifying Gear Change Rod
Courtesy of BMW OF NORTH AMERICA, INC.

Shift Mechanism

See **Fig. 10** .

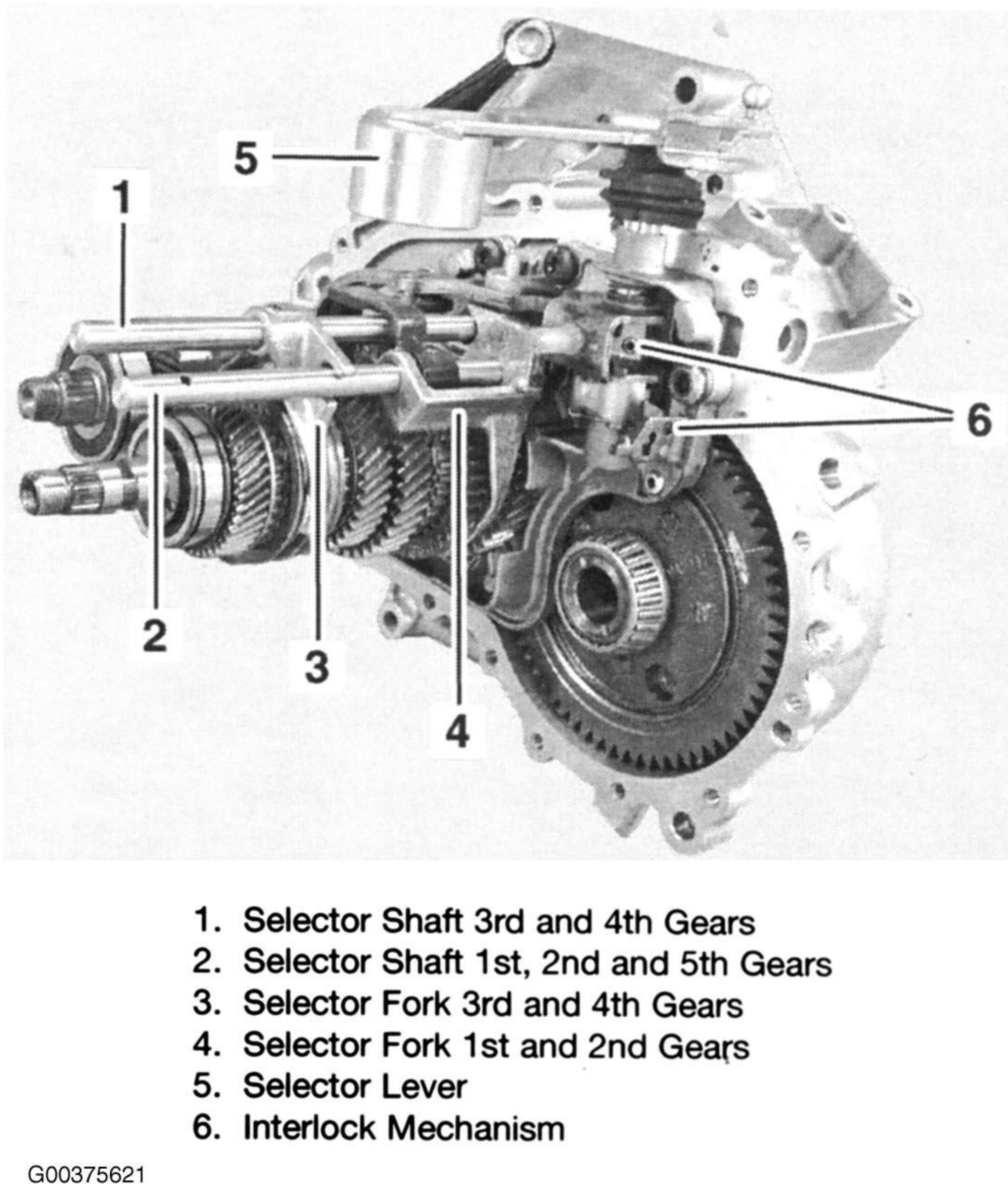

Fig. 10: Identifying R65 Internal Shift Mechanism
Courtesy of BMW OF NORTH AMERICA, INC.

PRINCIPLE OF OPERATION

The input shaft incorporates fixed 1st, 2nd , 3rd and 4th speed input gears forming a single component. 5th gear is splined to the input shaft and secured with a lock nut. The output shaft assembly contains all free rotating output gears and synchronizer assemblies.

First Gear

The first gear synchromesh hub is fixed to the output shaft. The synchromesh cones synchronize the speed of first gear on the output shaft to the speed of the input shaft. The hub then locks first gear to the output shaft and drive is transmitted.

Second Gear

The second gear synchromesh hub is fixed to the output shaft. The synchromesh cones synchronize the speed of second gear on the output shaft to the speed of the input shaft. The hub then locks second gear to the output shaft and drive is transmitted.

Third Gear

The third gear synchromesh hub is fixed to the output shaft. The synchromesh cones synchronize the speed of third gear on the output shaft to the speed of the input shaft. The hub then locks third gear to the output shaft and drive is transmitted.

Fourth Gear

The fourth gear synchromesh hub is fixed to the output shaft. The synchromesh cones synchronize the speed of fourth gear on the output shaft to the speed of the input shaft. The hub then locks fourth gear to the output shaft and drive is transmitted.

Fifth Gear

The fifth gear synchromesh hub is fixed to the output shaft. The synchromesh cones synchronize the speed of fifth gear on the output shaft to the speed of the input shaft. The hub then locks fifth gear to the output shaft and drive is transmitted.

Reverse Gear

Reverse gear is incorporated into the 1st and 2nd gear hub, which is fixed to the output shaft. When reverse gear is selected the 1st and 2nd selector shaft is moved, a fixed arm on the shaft interlocks with the reverse gear arm, moving the gear into mesh with the fixed hub.

NOTE: **1st and 2nd selector fork does not move during reverse engagement. An interlock mechanism includes an inhibitor to physically prevent reverse gear from being inadvertently selected directly from 5th gear.**

SERVICE INFORMATION R65

The oil drain and filler level plugs on the R65 gearbox are both positioned in the differential housing on the main gearbox housing. Both plugs have an external hexagonal 17 mm head. See **Fig. 11** . With the vehicle on level ground, the gearbox is filled until the oil is level with the bottom of the filler/level plug hole. There is no requirement for maintenance at any of the service intervals:

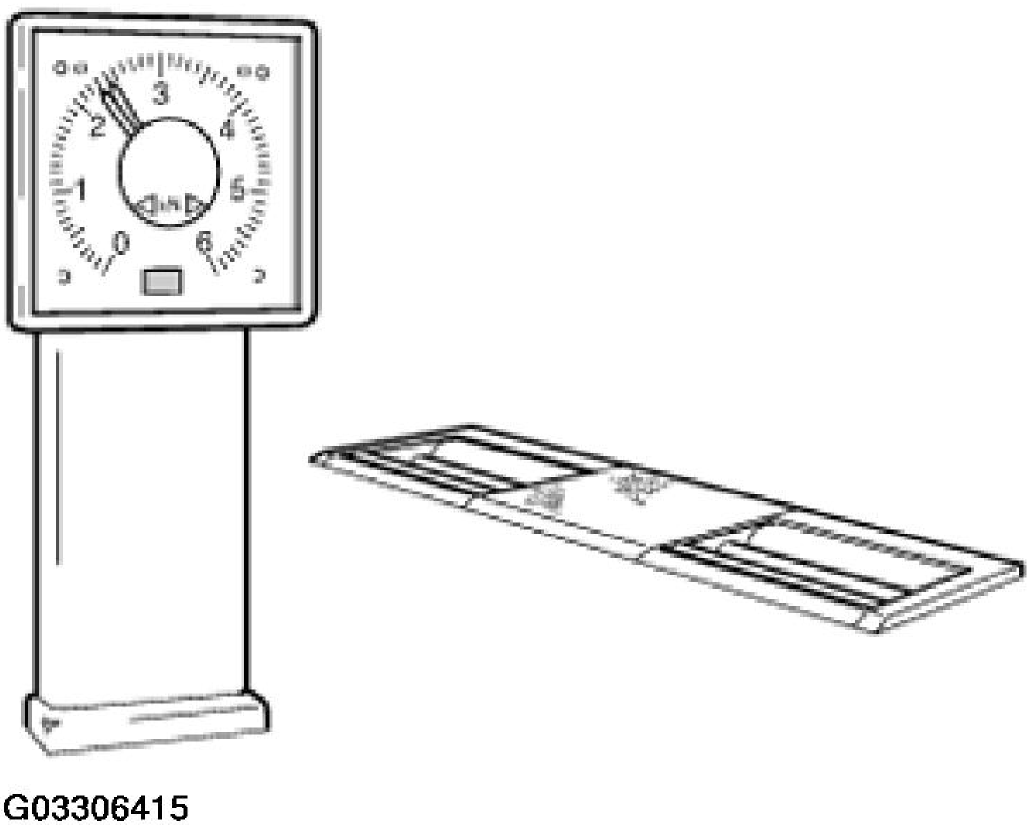

Fig. 11: Identifying R65 Drain & Fill Plugs
Courtesy of BMW OF NORTH AMERICA, INC.

- Oil type MTF 94 (fill for life) capacity (service fill) 2 liters.
- Drain plug torque 32-40 N.m.
- Filler plug torque 20-30 N.m.
- Gearbox housing to clutch housing Loctite 5900 sealer.
- Clutch housing to intermediate plate Loctite 549 sealer. See **Fig. 12** .

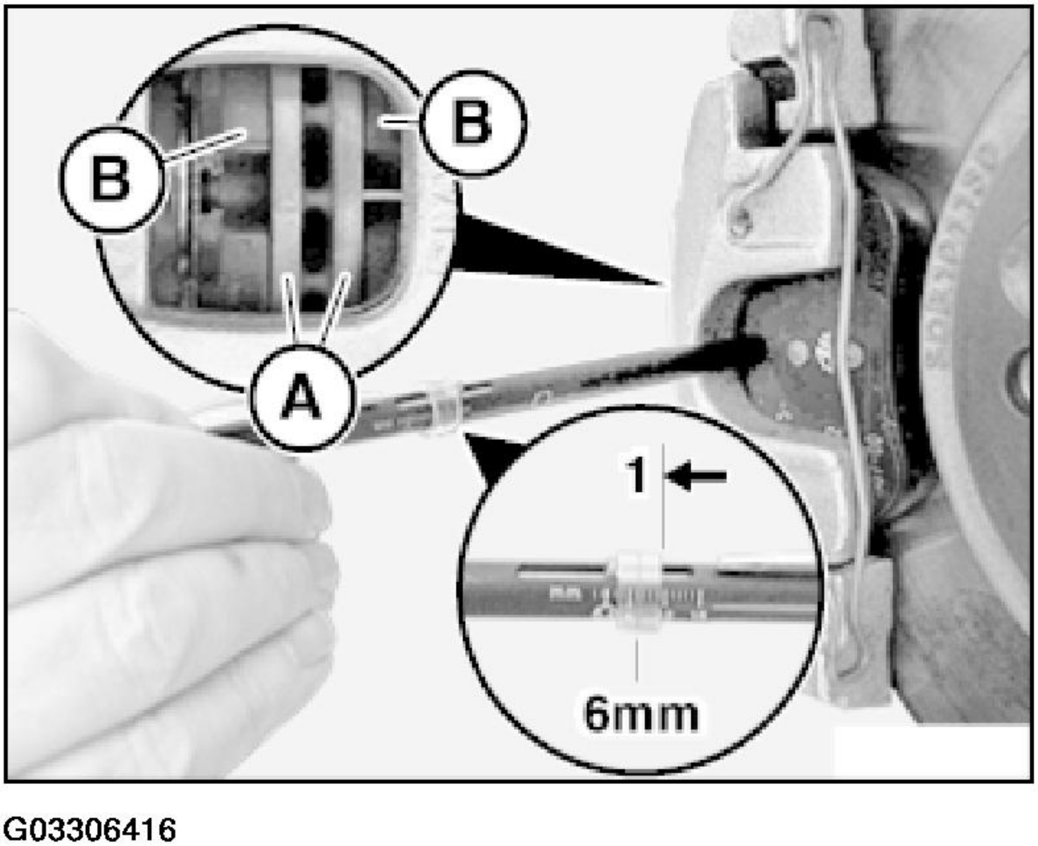

Fig. 12: R65 Transmission Identification Label
Courtesy of BMW OF NORTH AMERICA, INC.

TRANSMISSION (COOPER S)

The manual transmission and final drive assembly fitted to the COOPER S has been specifically manufactured by Getrag for this application. This transmission has 6 forward speeds and is rated for a maximum torque input of 210 N.m, enough to handle the output of the supercharged engine. The gearshift pattern has reverse to the left of 1st gear. 6th gear is opposite 5th gear. The neutral position is in the 3rd /4th gear plane. The gearbox uses the reference code "285". See **Fig. 13** and **Fig. 14** .

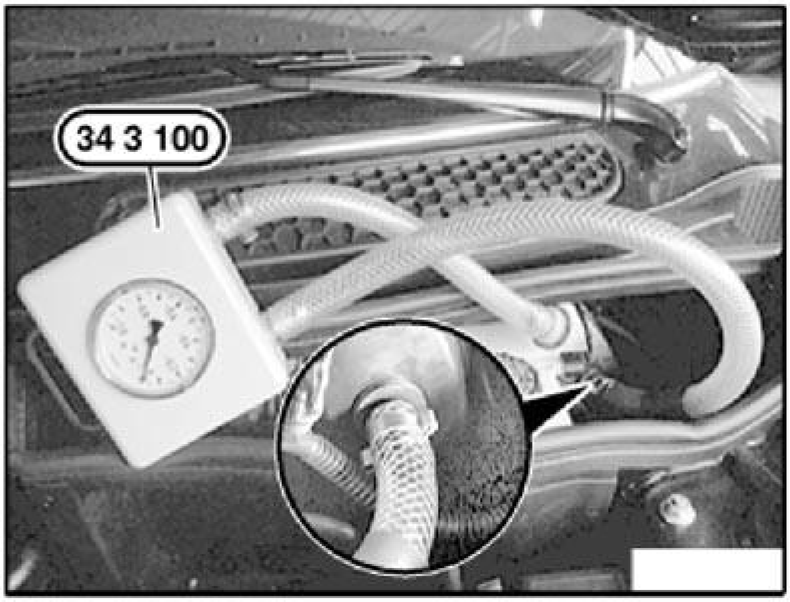

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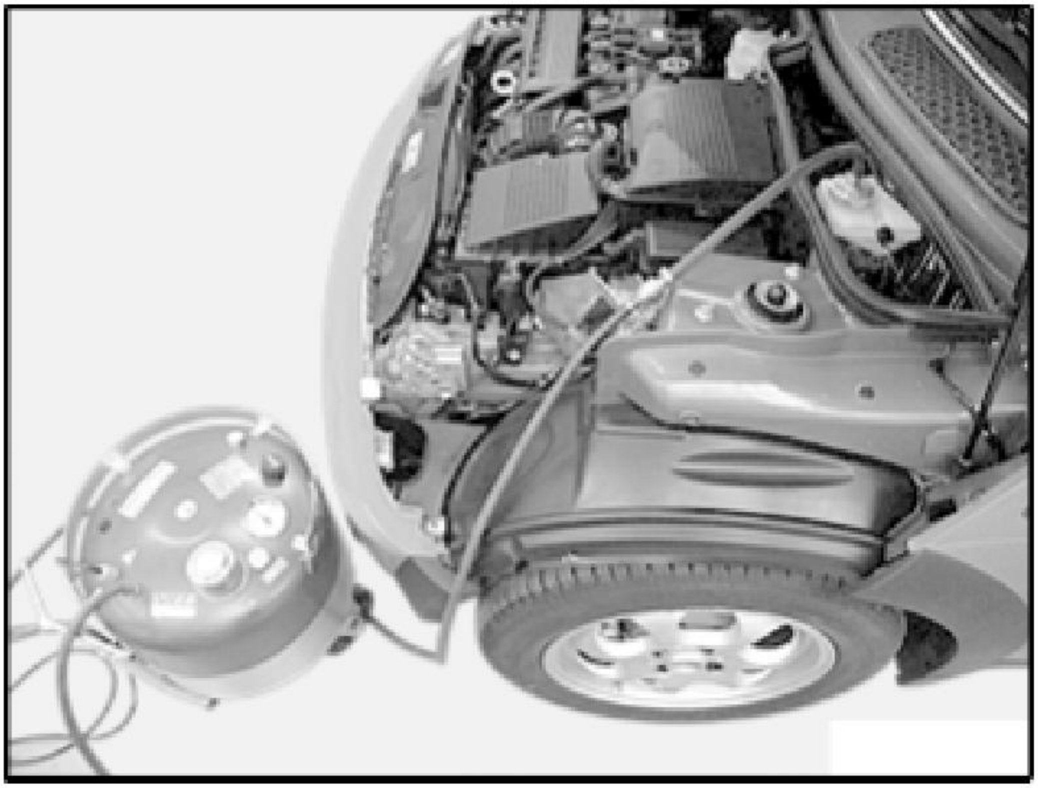
Fig. 13: Identifying Getrag 285 Transmission Assembly
Courtesy of BMW OF NORTH AMERICA, INC.



G03306418

Fig. 14: Identifying Getrag 285 Shift Pattern
Courtesy of BMW OF NORTH AMERICA, INC.

Features of the Getrag 285 Transmission include:

- Three shaft design with four fixed gears on the input shaft.
- Seven gears on two output shafts.
- Overall length of 322 mm including the clutch housing.
- All gears have synchromesh.
- Aluminum die cast housings.
- All housings sealed with liquid sealer.

Primary components of the 285 transmission are:

- Gears and shafts.
- Clutch housing.

- Gearbox housing.
- Gear change housing.
- Shift mechanism.

GEARS & SHAFTS

The 285 transmission contains two output shafts in addition to the one input shaft. The input shaft is supported on a roller bearing in the clutch housing and a sealed ball bearing race in the gear case. The output shafts are both supported by roller bearings in the clutch housing and sealed ball bearing races in the gear case. All speed gears with the exception of first are supported on needle roller bearings. First gear is supported on a roller bearing. The differential assembly is supported on a pair of tapered roller bearings. Output shaft 1 provides Reverse, 3rd and 4th gears. Output shaft 2 contains 1st, 2nd, 5th and 6th gears. See **Fig. 15** . Both output shafts are meshed with the final drive output gear:

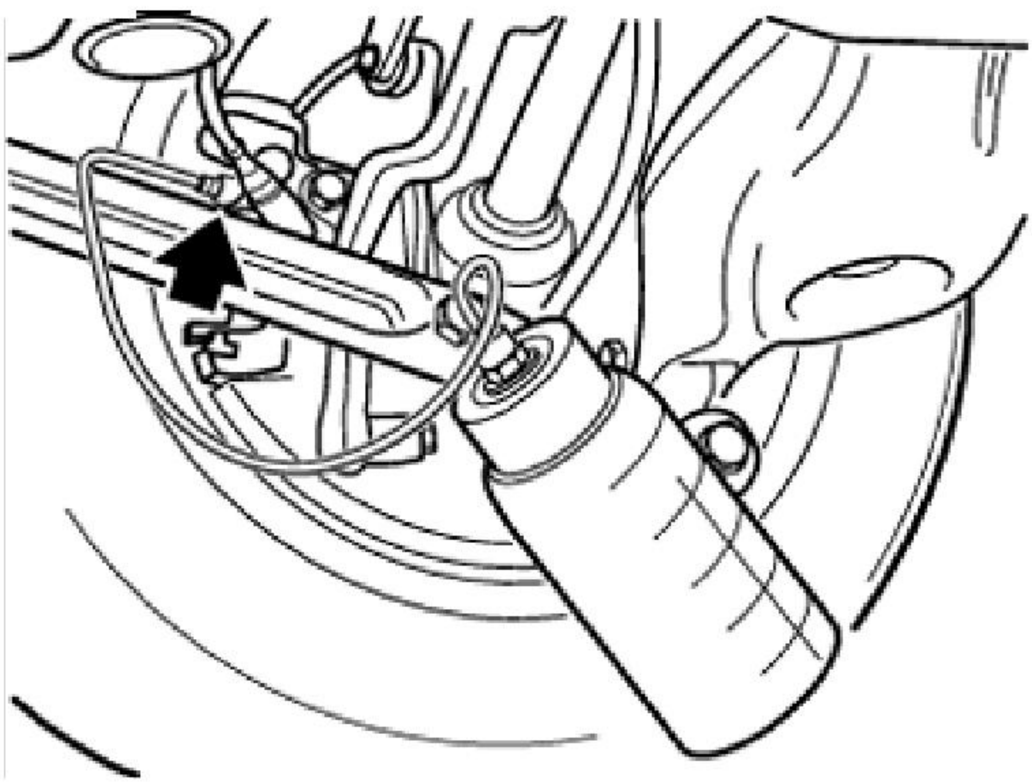


Fig. 15: Identifying Getrag Output Shafts
Courtesy of BMW OF NORTH AMERICA, INC.

- Differential Bearing
- Differential Housing
- Crown Wheel
- Output Shaft 1/Output Shaft 2

GEAR BOX HOUSING

The gearbox assembly is constructed from four die cast aluminum housings. See **Fig. 16** -**Fig. 17** .

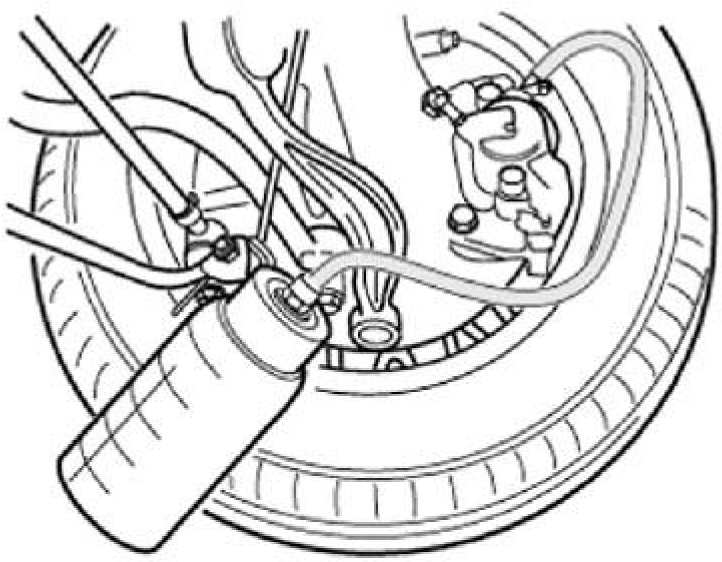


Fig. 16: Identifying Getrag 285 Gear Box Housings
Courtesy of BMW OF NORTH AMERICA, INC.

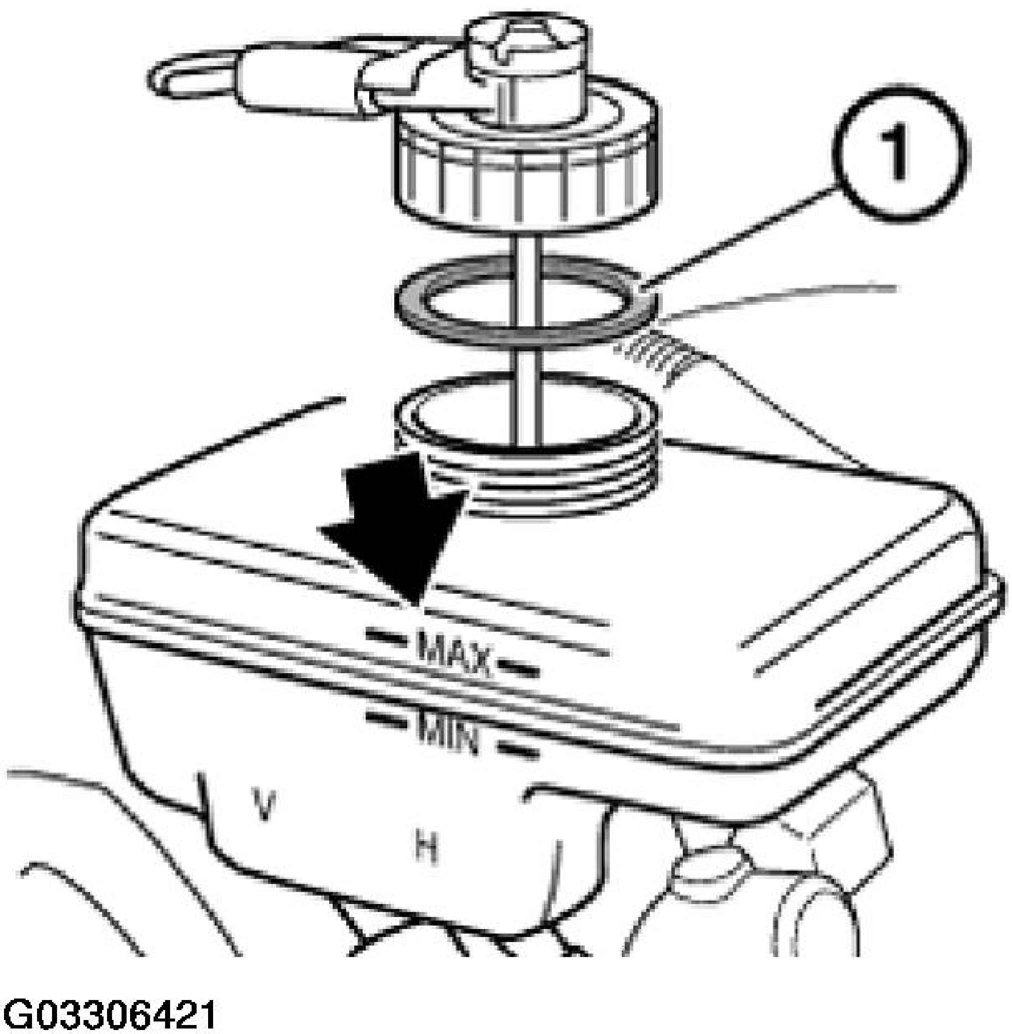


Fig. 17: Identifying Getrag 285 Clutch Housing
Courtesy of BMW OF NORTH AMERICA, INC.

SHIFT MECHANISM

The shift mechanism consists of a single shift shaft and four shift rods. The shift shaft is supported by roller bearings. The shift forks are manufactured from die cast aluminum. See **Fig. 18** -**Fig. 19** .

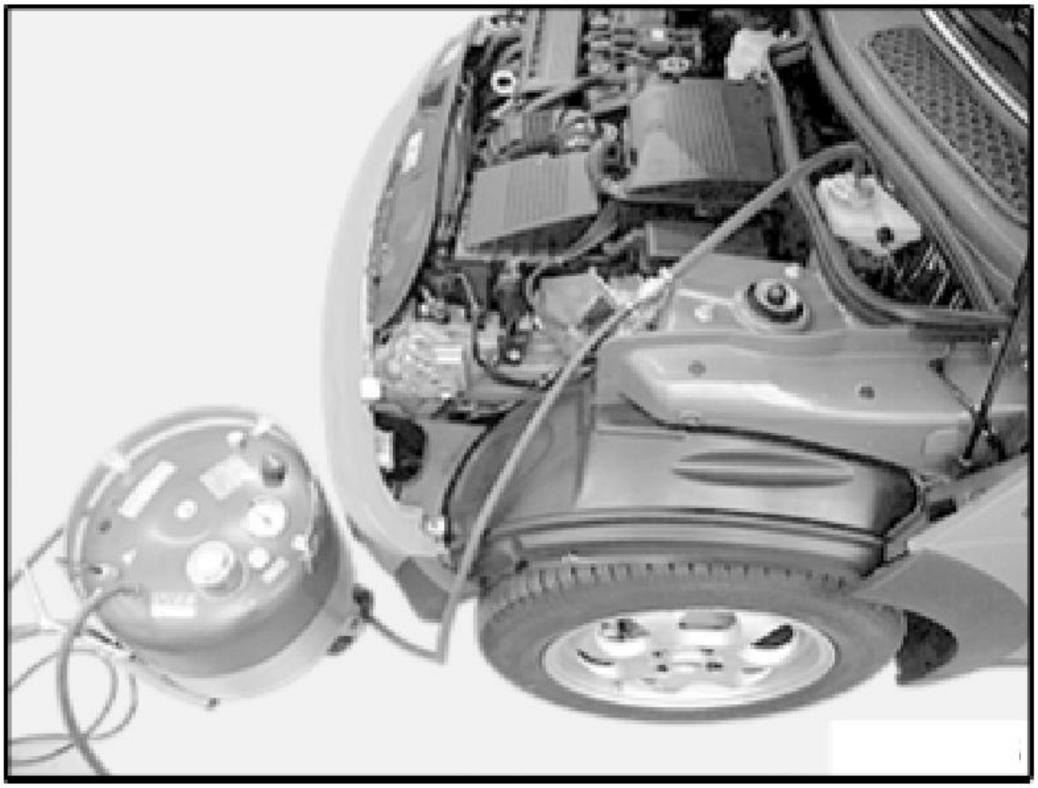


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Fig. 18: Identifying Getrag Shift/Selector Mechanism
Courtesy of BMW OF NORTH AMERICA, INC.

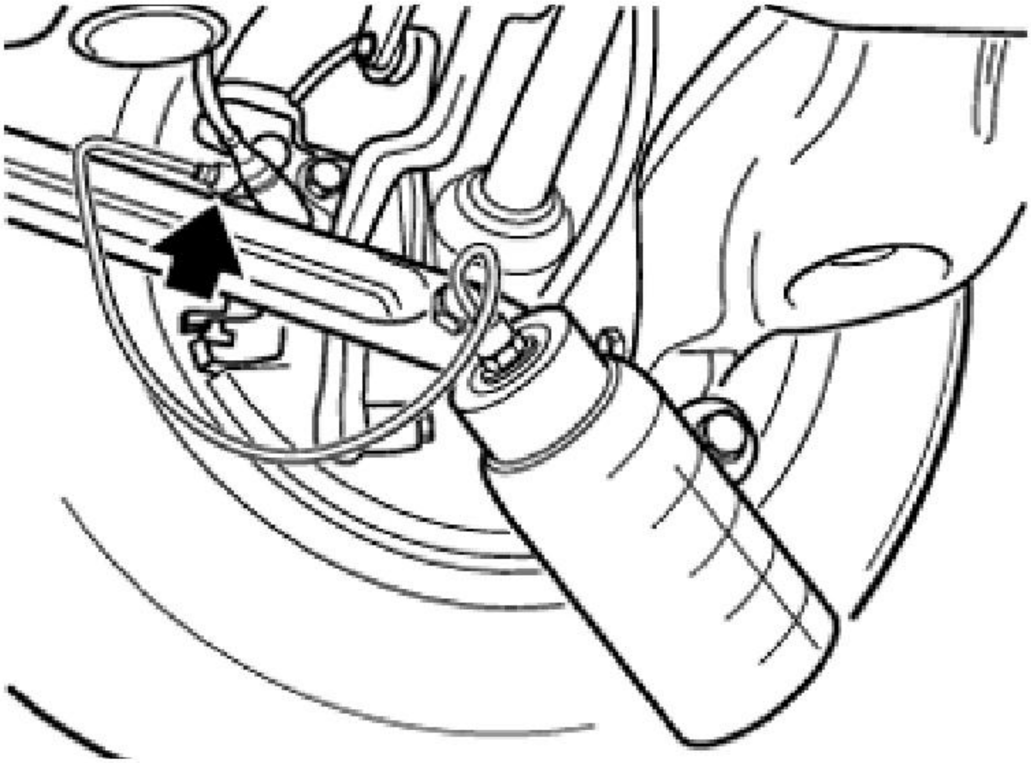
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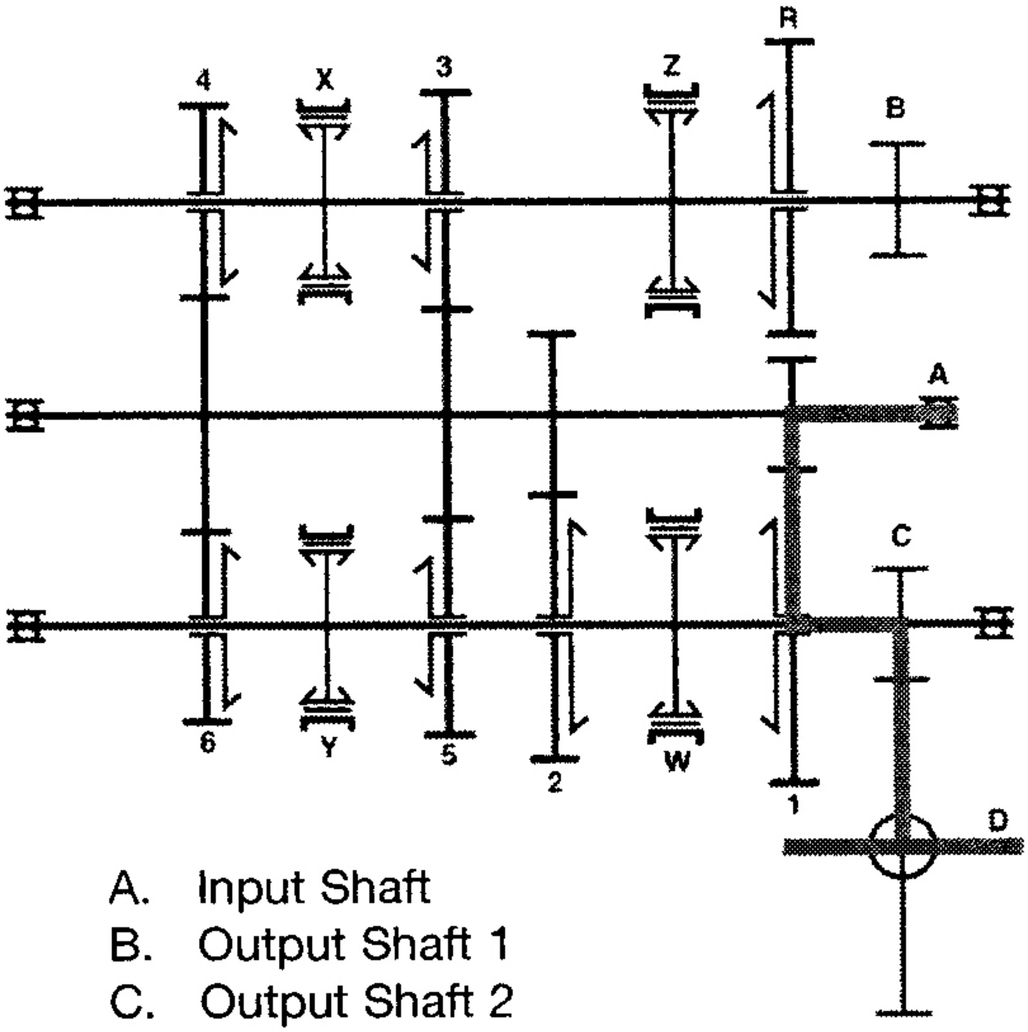
Fig. 19: Identifying Getrag Internal Selector Mechanism
Courtesy of BMW OF NORTH AMERICA, INC.

PRINCIPLE OF OPERATION

First Gear Power Flow

The first gear synchromesh hub is fixed to the output shaft "C", the hub synchronizes the speed of the hub (output shaft "C") and the speed of the first gear. The hub then locks the first gear to the output shaft "C" and drive is transmitted out through the final drive "D". See **Fig. 20** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

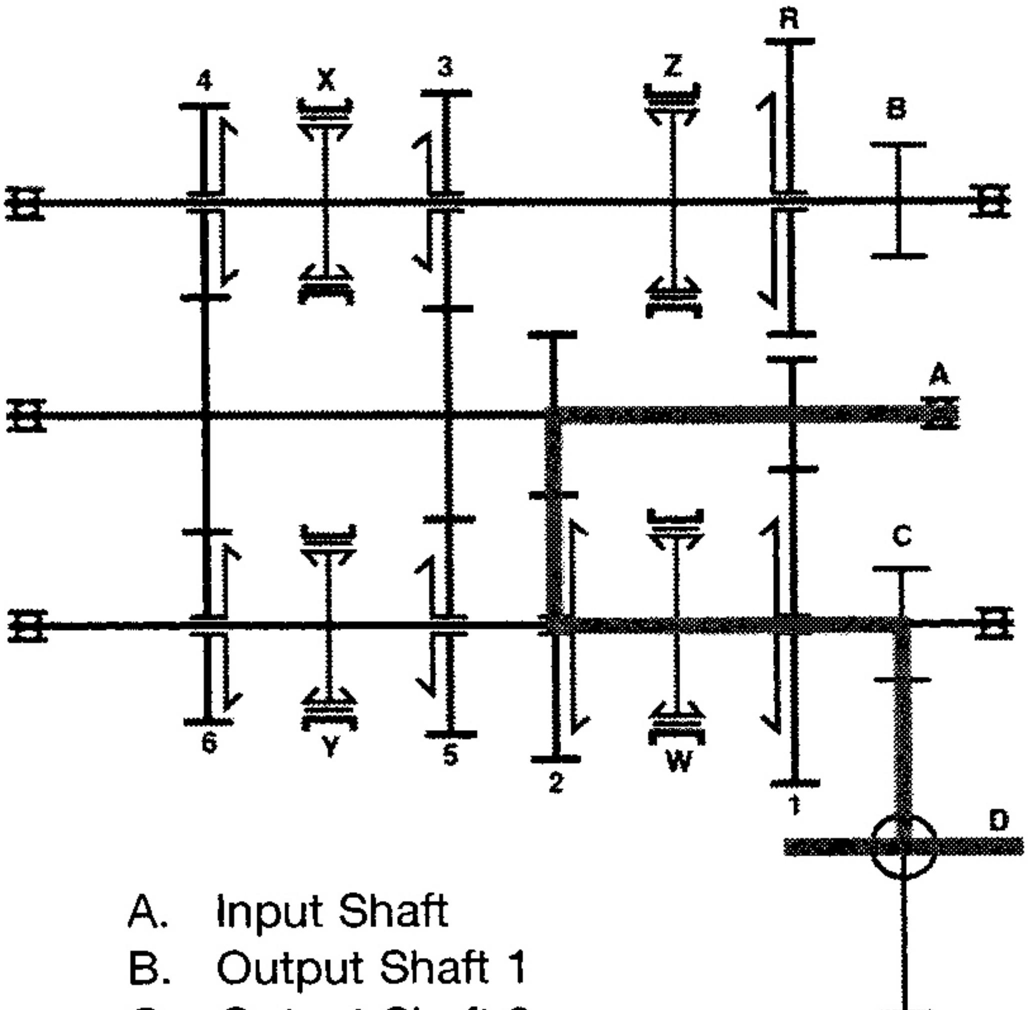
1-6. Gears
R. Gear

G00375631

Fig. 20: Identifying First Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Second Gear Power Flow

The second gear synchromesh hub is fixed to the output shaft "C", the hub synchronizes the speed of the hub (output shaft "C") and the speed of the second gear. The hub then locks the second gear to the output shaft "C" and drive is transmitted out "D". See **Fig. 21** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

1-6. Gears
R. Gear

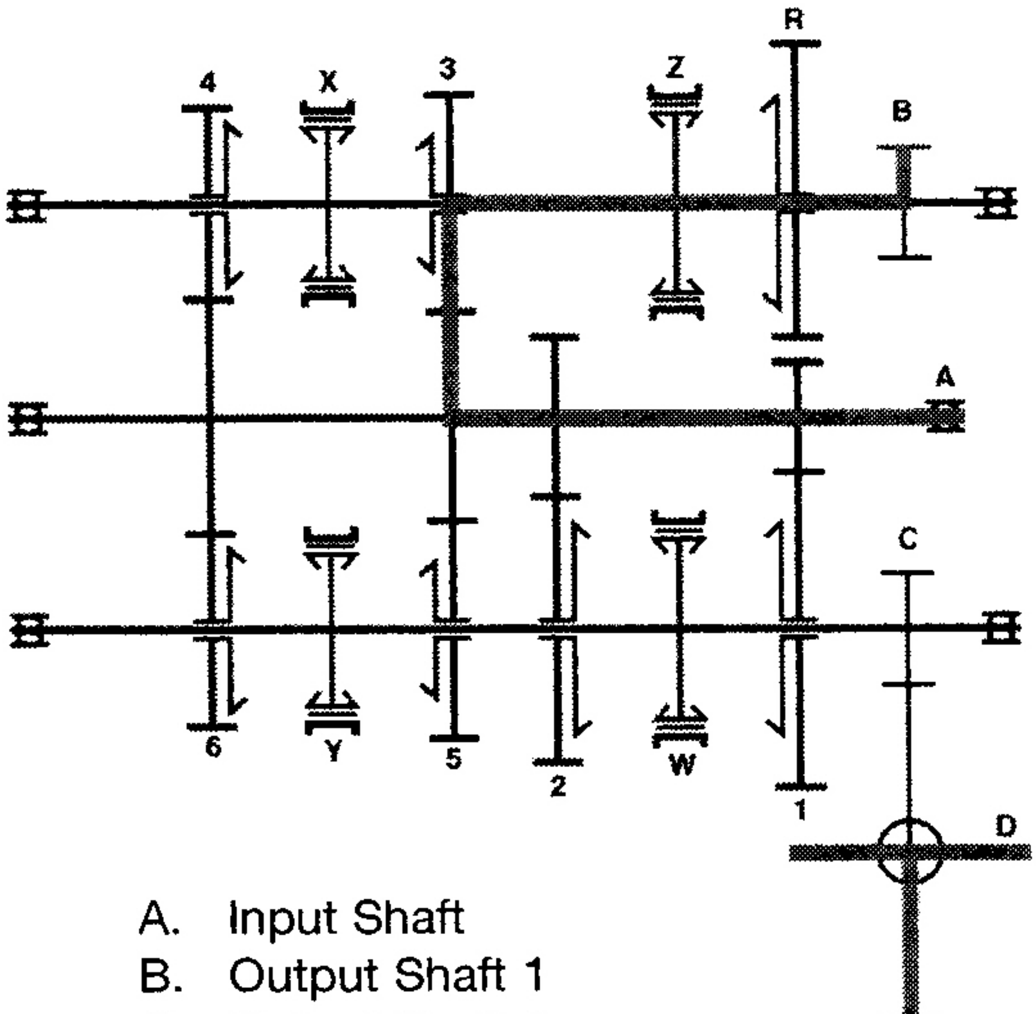
G00375632

Fig. 21: Identifying Second Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Third Gear Power Flow

The third gear synchromesh hub is fixed to the output shaft "B", the hub synchronizes the speed of the hub (output shaft "B") and the speed of the third gear. The hub then locks the third gear to the output shaft "B" and drive is transmitted out through the final drive "D". See **Fig. 22** .

Note: Output shaft "B" is in mesh with the final drive output drive "D".



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

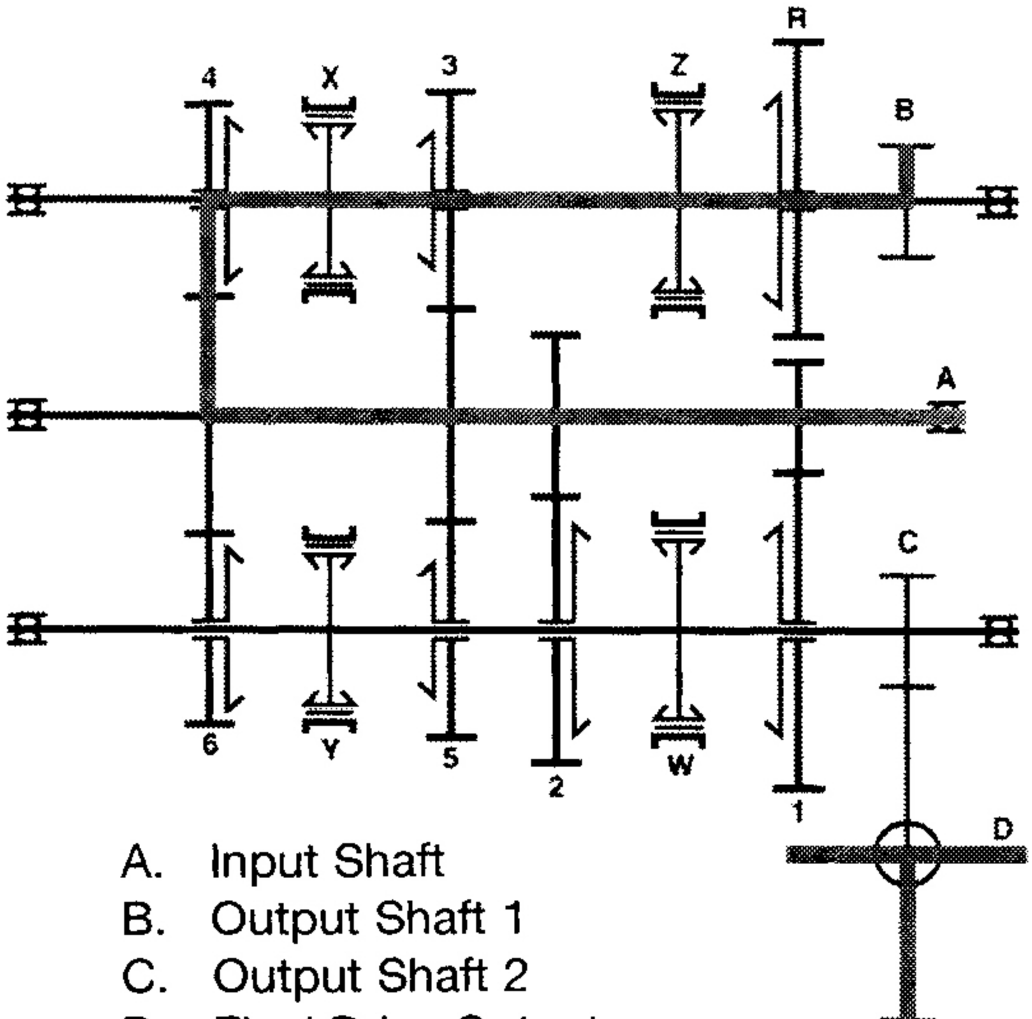
1-6. Gears
R. Gear

G00375633

Fig. 22: Identifying Third Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Fourth Gear Power Flow

The fourth gear synchromesh hub is fixed to the output shaft "B", the hub synchronizes the speed of the hub (output shaft "B") and the speed of the fourth gear. The hub then locks the fourth gear to the output shaft "B" and drive is transmitted out through the final drive "D". Output shaft "B" is in mesh with the final drive output drive "D". See **Fig. 23** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

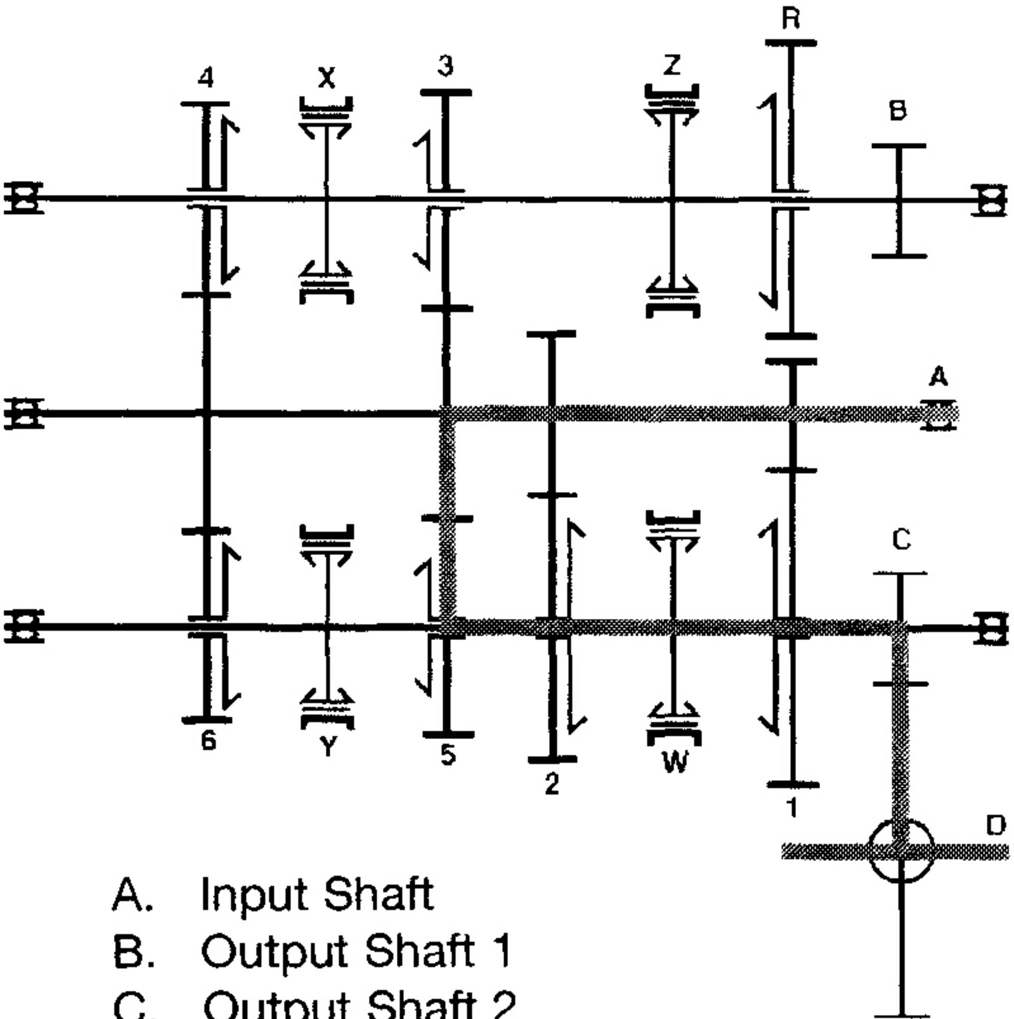
1-6. Gears
R. Gear

G00375634

Fig. 23: Identifying Fourth Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Fifth Gear Power Flow

The fifth gear synchromesh hub is fixed to the output shaft "C", the hub synchronizes the speed of the hub (output shaft "C") and the speed of the fifth gear. The hub then locks the fifth gear to the output shaft "C" and drive is transmitted out through the final drive "D". See **Fig. 24** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

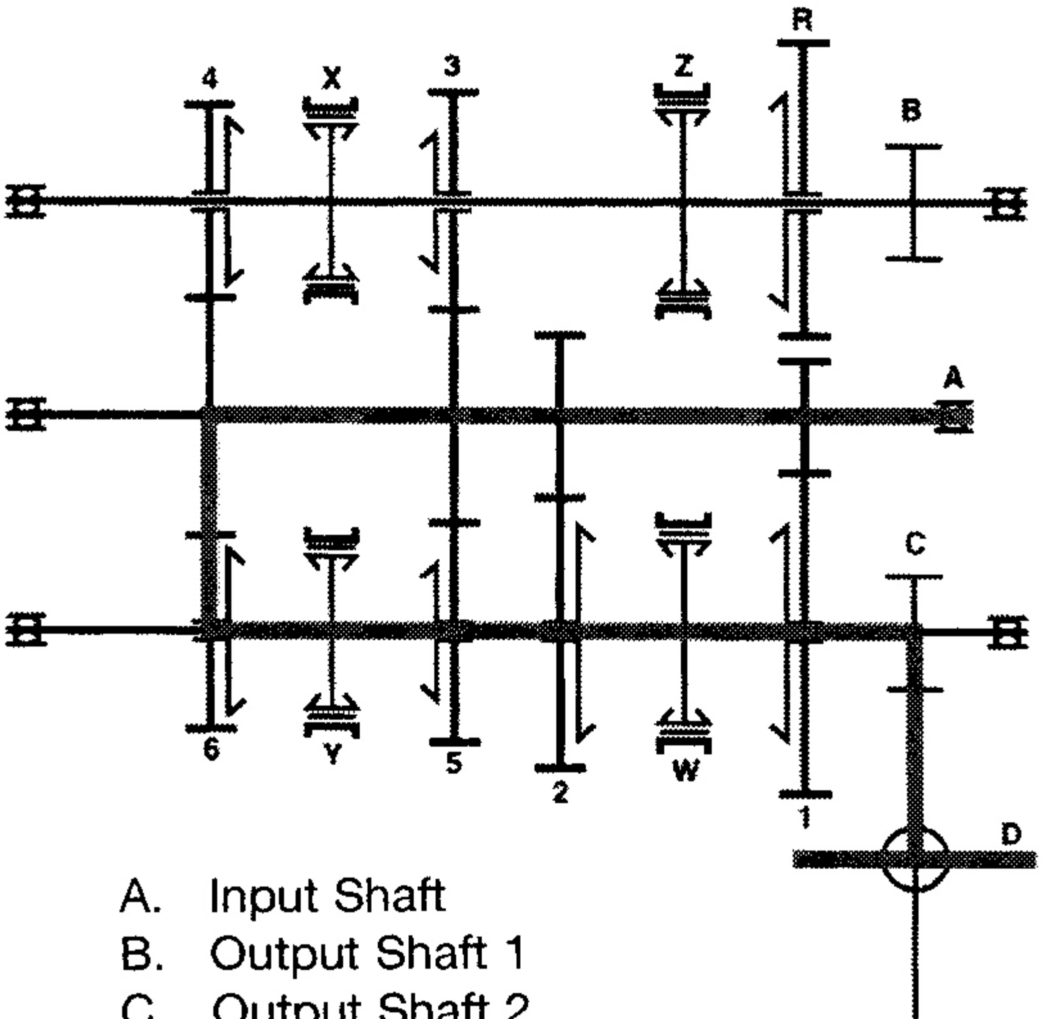
1-6. Gears
R. Gear

G00375635

Fig. 24: Identifying Fifth Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Sixth Gear Power Flow

The sixth gear synchromesh hub is fixed to the output shaft "C", the hub synchronizes the speed of the hub (output shaft "C") and the speed of the sixth gear. The hub then locks the sixth gear to the output shaft "C" and drive is transmitted out through the final drive "D". See **Fig. 25** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

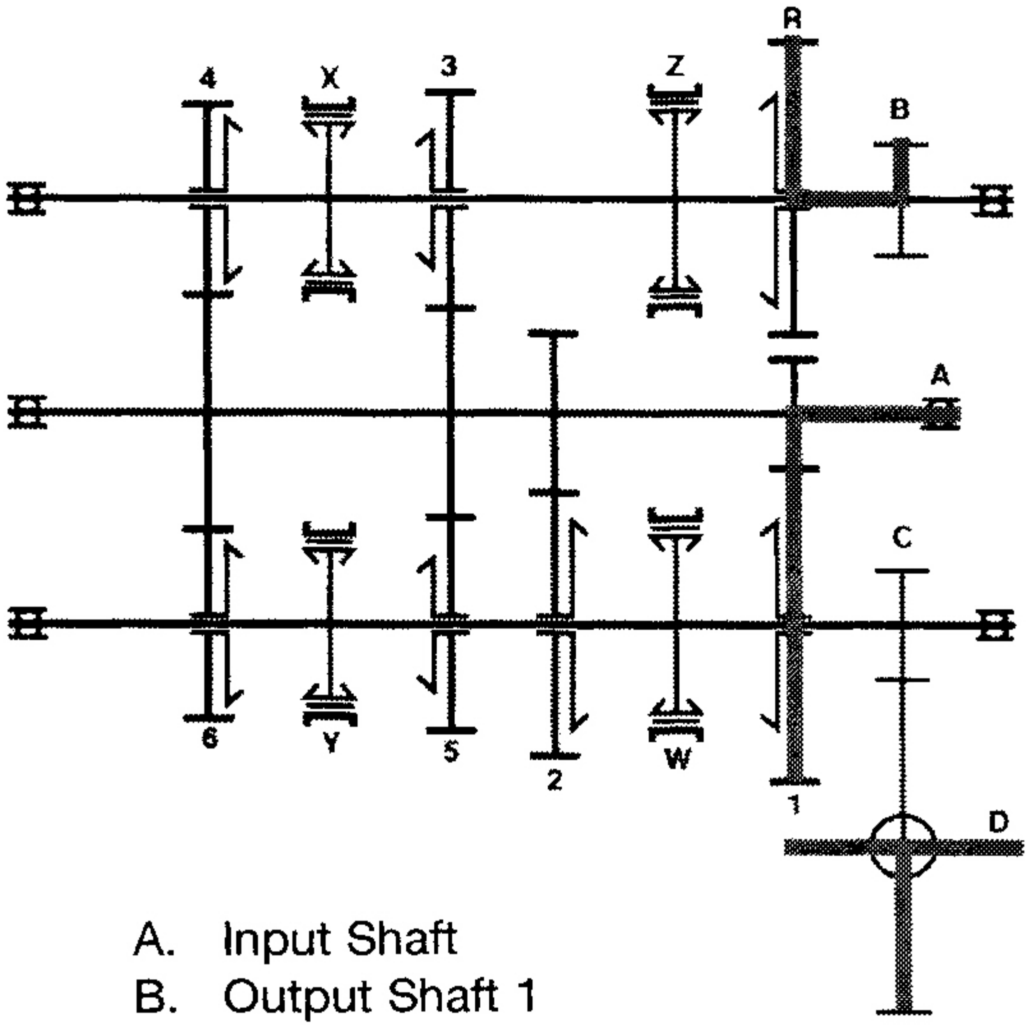
1-6. Gears
R. Gear

G00375636

Fig. 25: Identifying Sixth Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

Reverse Gear Power Flow

The reverse gear is meshed with and is driven by the first gear which rotates freely around the output shaft "C". The reverse gear synchromesh hub is fixed to the output shaft "B", the hub synchronizes the speed of the hub (output shaft "B") and the speed of the reverse gear and first gear. The hub then locks the reverse gear to the output shaft "B" and drive is transmitted out through the final drive "D". See **Fig. 26** .



A. Input Shaft
B. Output Shaft 1
C. Output Shaft 2
D. Final Drive Output
W. 1st/2nd Synchromesh
X. 3rd/4th Synchromesh
Y. 5th/6th Synchromesh
Z. Reverse Synchromesh

1-6. Gears
R. Gear

G00375637

Fig. 26: Identifying Reverse Gear Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

SERVICE INFORMATION (GETRAG 285)

The oil drain and filler level plugs on the Getrag "285" are both positioned in the differential housing on the main gearbox casing. Both plugs have an 8 mm Allen key. See **Fig. 27** and **Fig. 28** . There is no requirement for maintenance at any of the service intervals:

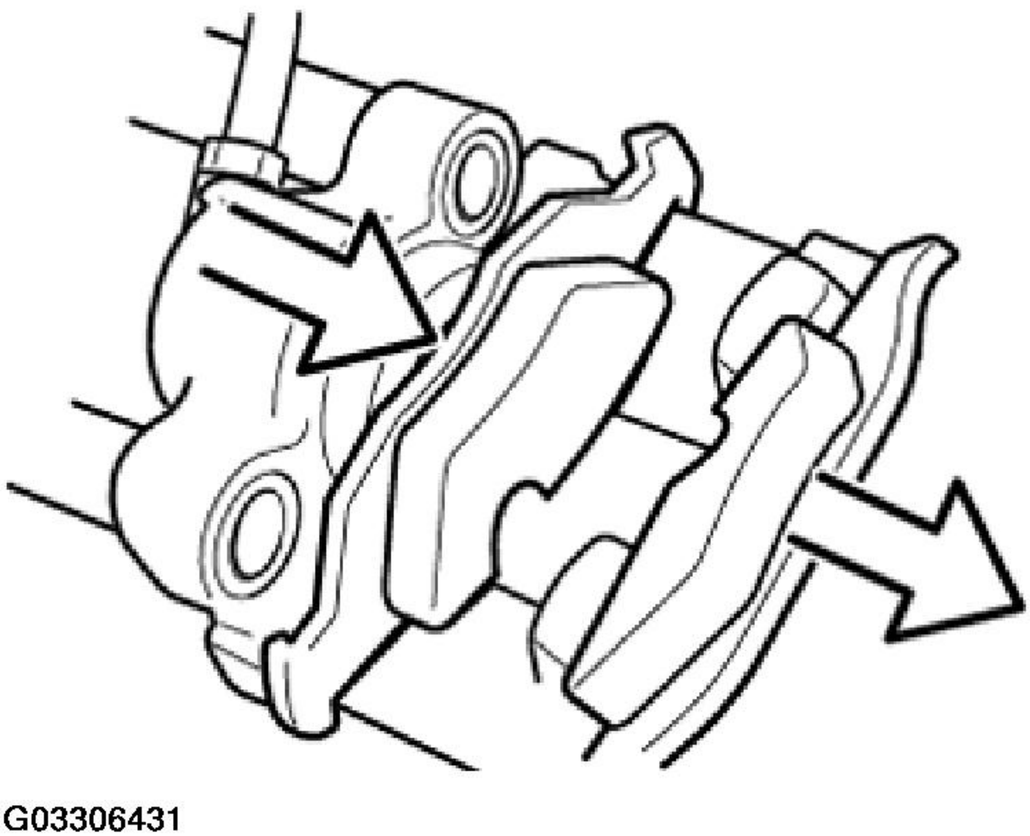


Fig. 27: Getrag 285 Drain & Fill Plugs
Courtesy of BMW OF NORTH AMERICA, INC.

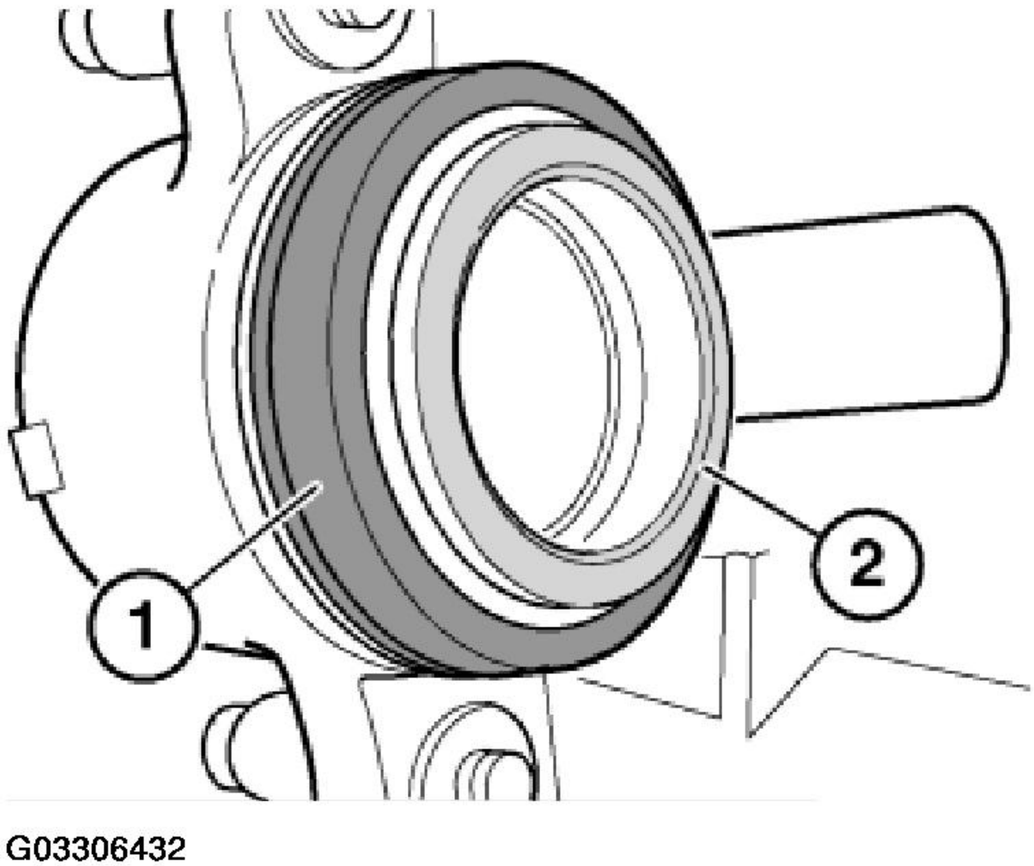


Fig. 28: Getrag Transmission Identification Label
Courtesy of BMW OF NORTH AMERICA, INC.

- Oil type - MTF 94 (fill for life).
- Oil capacity (dry fill) - 1.71 liters.
- Oil capacity (drain and fill) - 1.51 liters.

AUTOMATIC TRANSMISSION (MINI COOPER)

The ECVT (Electro Constantly Variable Transmission) is available on the MINI COOPER. The origins of the Continuously Variable Transmission (CVT) manufactured by ZF dates back to 1974 with, at that time, a revolutionary rubber drive belt. After several years of development, a new generation of CVT has evolved, incorporating the use of a steel drive belt.

PURPOSE OF THE SYSTEM

The stepless shifting pattern of the transmission provides a very comfortable drive, as well as having full vehicle performance, available at any time.

The advantages of using an automatic transmission of this type are:

- Low engine revolutions at constant speeds.
- Improved emission control/fuel consumption.
- Low noise, vibration and harshness levels.
- Smooth acceleration.
- Flexible driving on mountain roads.

The ECVT consists of a number of elements that are divided into three groups, depending upon their function.

GROUP ONE

Elements providing the mechanical torque flow through the transmission. These elements are:

- Planetary Gear Set
- Multiplate Clutches
- Primary Pulley
- Steel Drive Belt
- Secondary Pulley
- Pinion Shaft
- Differential Unit

GROUP TWO

These elements relate to the hydraulic system. This system enables the transmission to transmit power and to vary the ratio in a proper way, according to load conditions and driver demand.

- Hydraulic Pump
- Hydraulic Control Unit

GROUP THREE

These elements are externally connected to other systems.

- Ratio Control Motor
- Park/Neutral Switch
- Output Shaft Speed Sensor
- Instrument Cluster Display
- Selector Shift Mechanism
- Steering Wheel Remote Buttons (Optional)

- GIU (Gearbox Interface Unit)

The Ratio Control Motor, Park/Neutral Switch and Output Shaft Speed Sensor are inside the transmission.

SYSTEM COMPONENTS

Group One

Planetary Gear Set

The planetary gear set enables the transmission to provide a drive torque in two directions, forward and reverse, to the drive shafts. Engine torque always enters the transmission through the planet carrier via the input shaft. This carrier can be directly connected to the sun-wheel by the forward multi-plate clutches. When it does, the epicyclic gear set rotates as one unit, and engine torque is transmitted directly to the primary pulley. The planet gears do not transmit any torque, therefore no mechanical loss will occur in the planetary gear set and the primary pulley will rotate in the same direction as the engine. This is the forward drive mode. See **Fig. 29** .

In reverse mode, the annulus of the planetary gear set is held stationary by the reverse multi-plate clutches. Three pairs of planet gears are driven by the planet carrier, forcing the sun-wheel to rotate in the opposite direction.

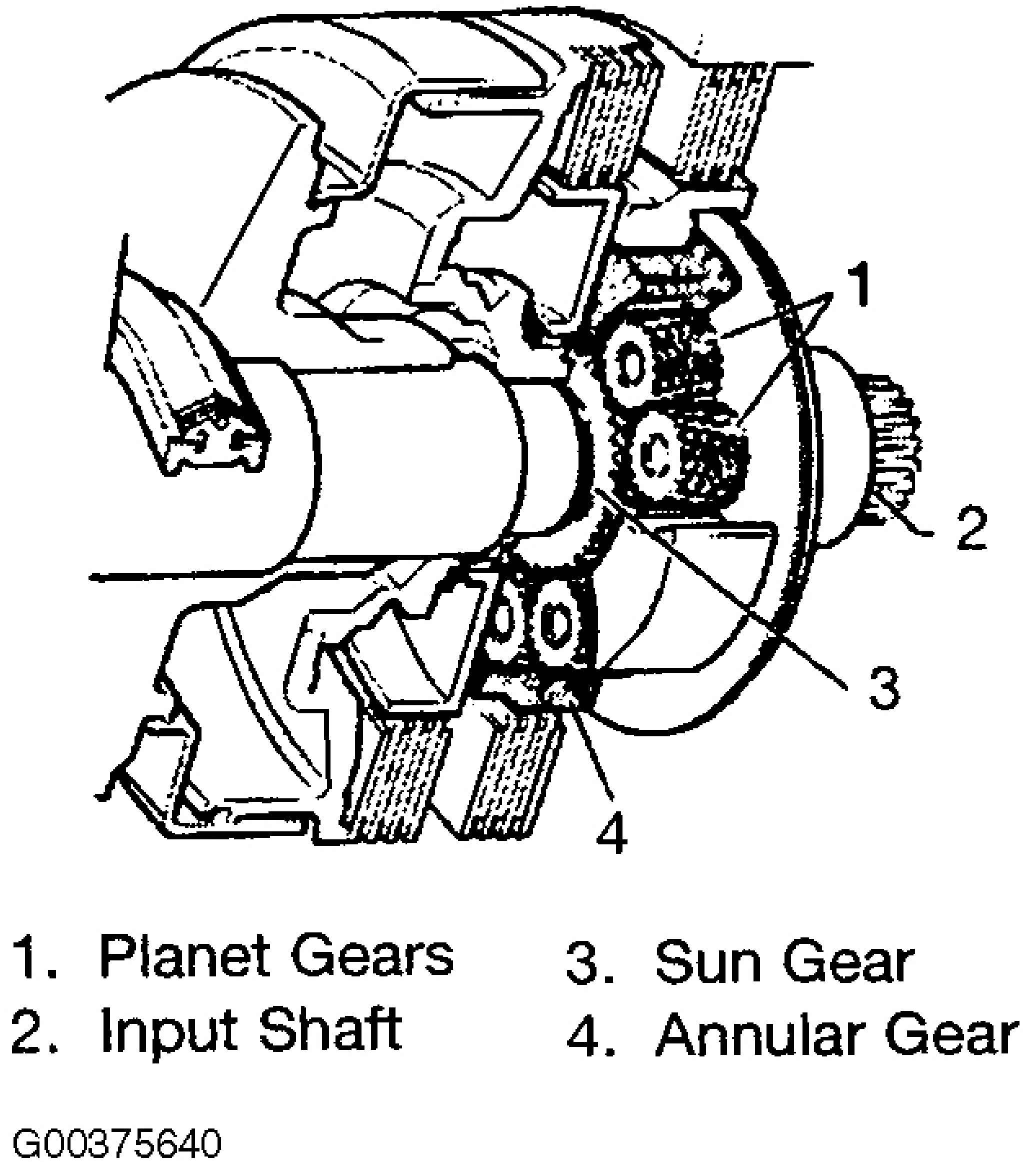


Fig. 29: Identifying Planet Gears
Courtesy of BMW OF NORTH AMERICA, INC.

Multiplate Clutches

There are two Multiplate wet clutch packs; one forward and one reverse. Each pack has three friction plates providing six friction surfaces. Hydraulic pressure controls the clutches to allow the vehicle to move away smoothly regardless of the degree of throttle opening and by controlling the slip, allow the vehicle to be held stationary after a drive gear is engaged. Oil from the oil cooler is directed to the clutch plates to prevent overheating of the friction surfaces. See **Fig. 30** .

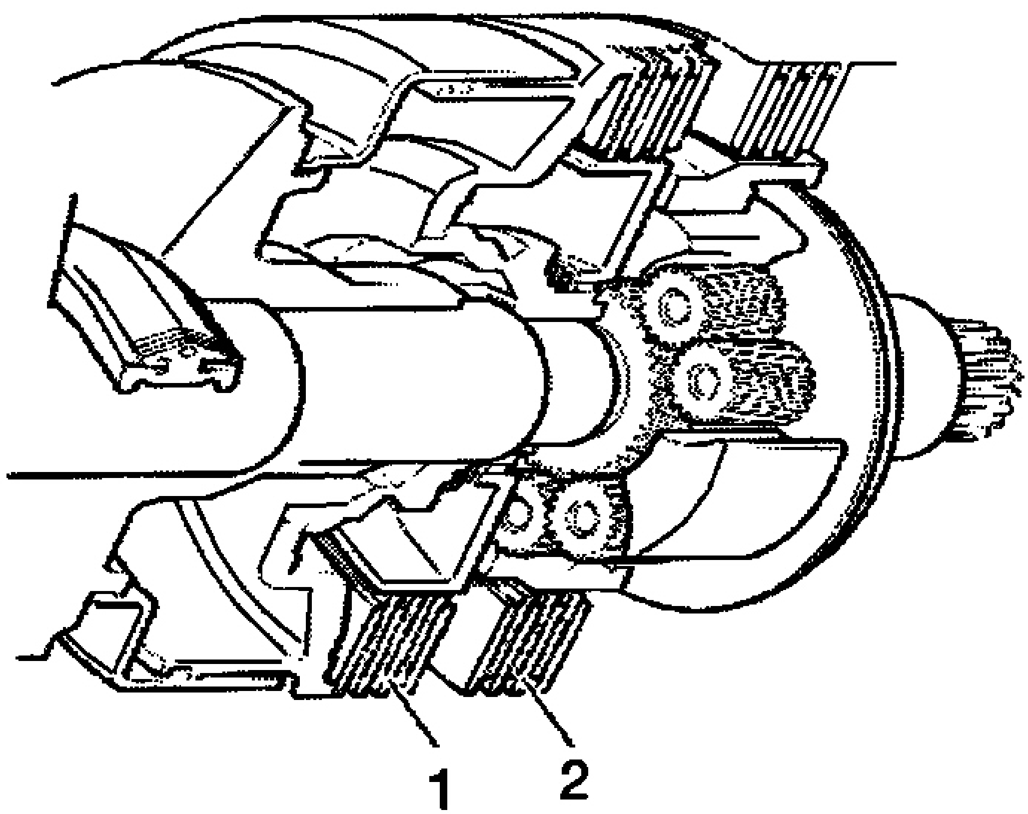


Fig. 30: Identifying Multiplate Clutches
Courtesy of BMW OF NORTH AMERICA, INC.

Primary Pulley, Secondary Pulley & Steel Belt

The main design feature of the CVT is a pair of steel "V" shaped pulleys connected by a steel drive belt. The distance between centers of the primary and secondary pulley is 155 mm. Each pulley consists of one fixed half and one movable half, both having 11 degree sloping sides. A 24 mm wide "Van Doorne" push type drive belt is used to transfer torque between the pulleys. The belt is lubricated and cooled by an oil jet from a nozzle. Both moving halves are situated diagonally opposite to each other in order to reduce misalignment of the drive belt during shifting. See **Fig. 31** and **Fig. 32** .

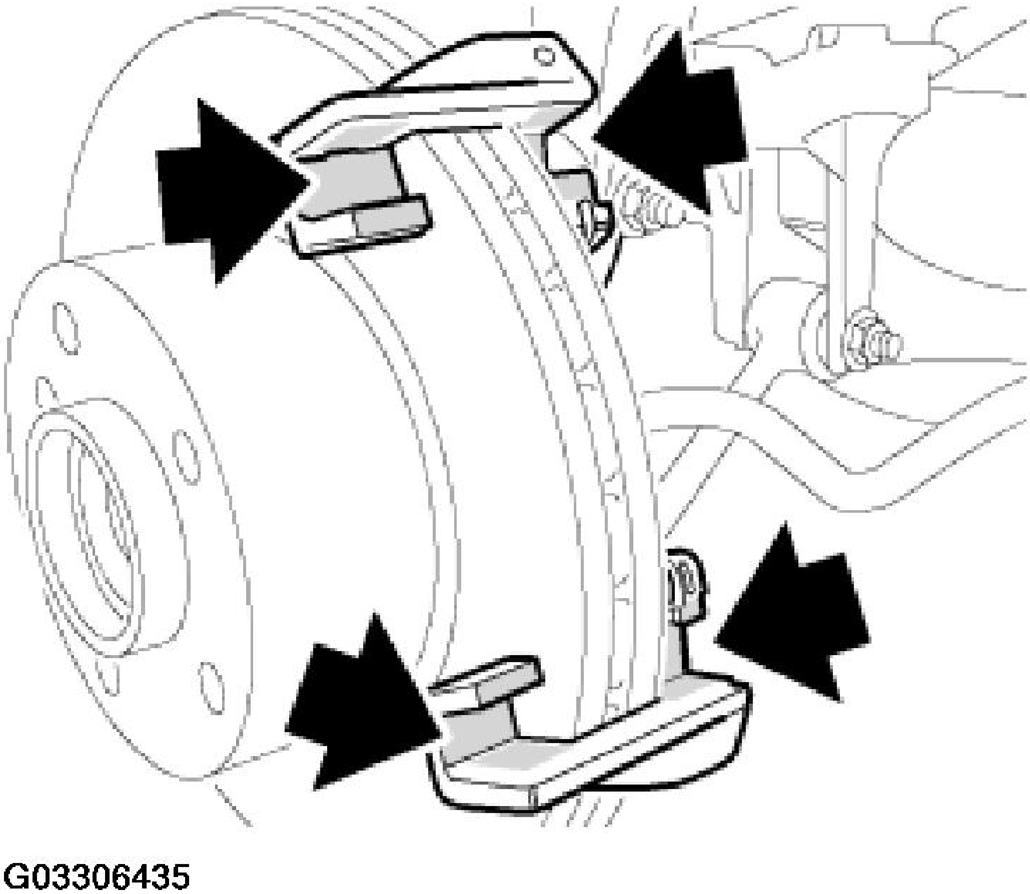


Fig. 31: Identifying ECVT Drive Belt
Courtesy of BMW OF NORTH AMERICA, INC.

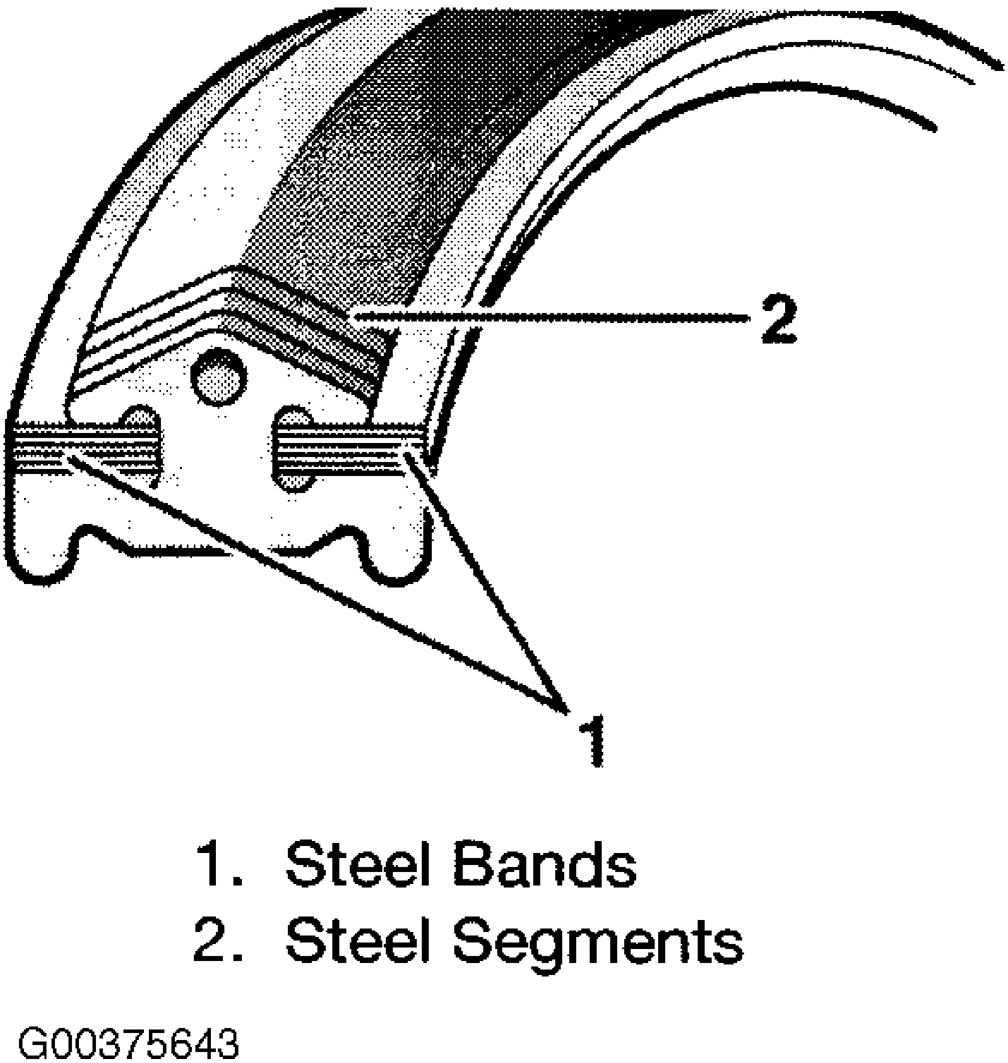


Fig. 32: Identifying ECVT Drive Belt Bands & Segments
Courtesy of BMW OF NORTH AMERICA, INC.

The steel drive belt has approximately 450 segments and is held together by 24 steel bands, 12 on each side. All the segments are of the same thickness.

Pinion Shaft

The pinion shaft creates a two-set helical gear reduction between the secondary pulley and the crown wheel. In this way, the rotational direction of the drive shafts will be correct. The reduction between the secondary pulley and the drive shafts can be made large enough to give good vehicle performance. The pinion shaft is supported by two conical bearings, one in the clutch housing and one in a separate bearing support. See **Fig. 33** .

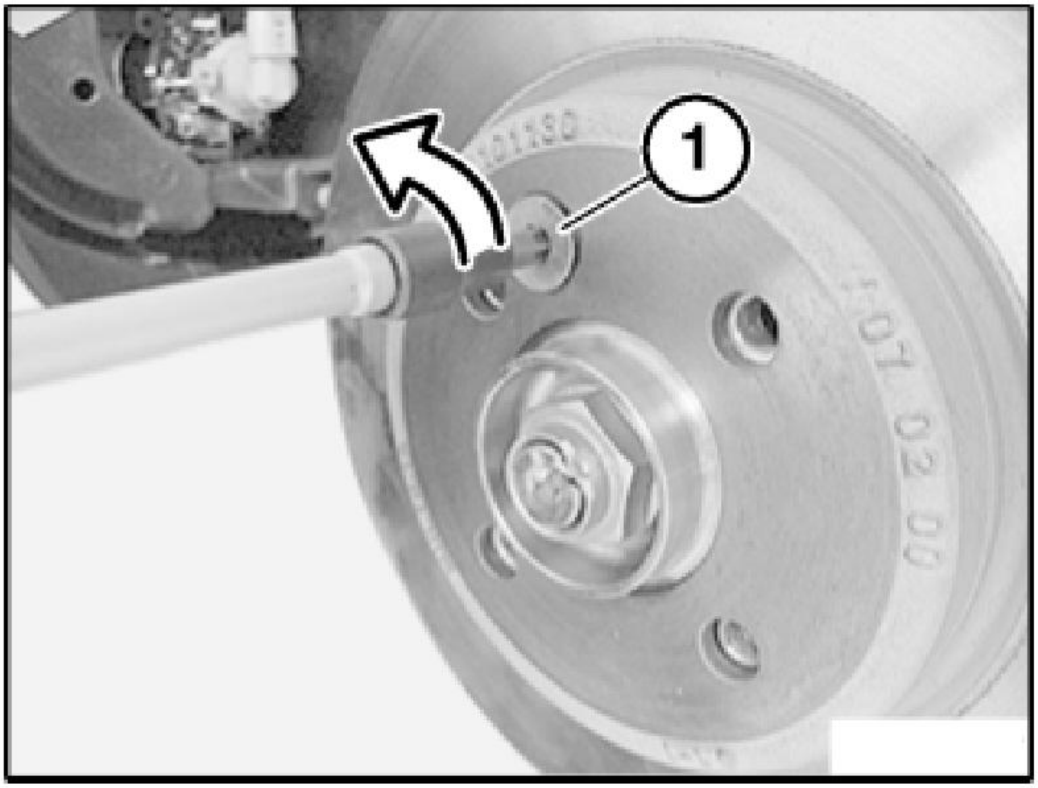


Fig. 33: Identifying Pinion & Crown Wheel
Courtesy of BMW OF NORTH AMERICA, INC.

Differential

Drive torque on the crown wheel is transmitted to the vehicle wheels via a bevel gear differential, just as in a manual transmission. The crown wheel is bolted to the differential case with 8 bolts. The drive shafts are fitted to the differential with conventional CV joints and seals. Conical bearings are used to support the differential. See **Fig. 34** .

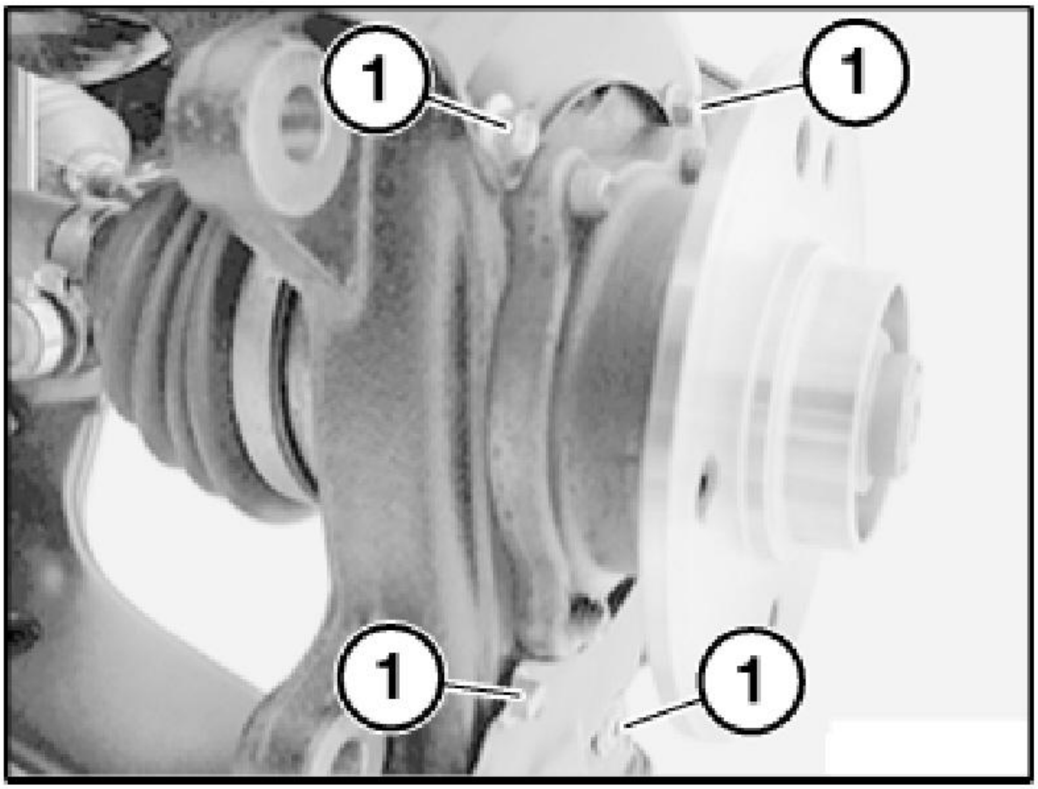


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Fig. 34: Identifying Differential
Courtesy of BMW OF NORTH AMERICA, INC.

Group Two

Oil Pump

The pump within the transmission is an externally toothed gear pump. The engine drives it via a shaft through the hollow primary pulley shaft. The pump shaft is splined to the planet carrier, which always runs at engine speed. System pressure reaches 40 bar. The oil pressure is used both for controlling the transmission hydraulically, and for lubrication purposes. See **Fig. 35** .

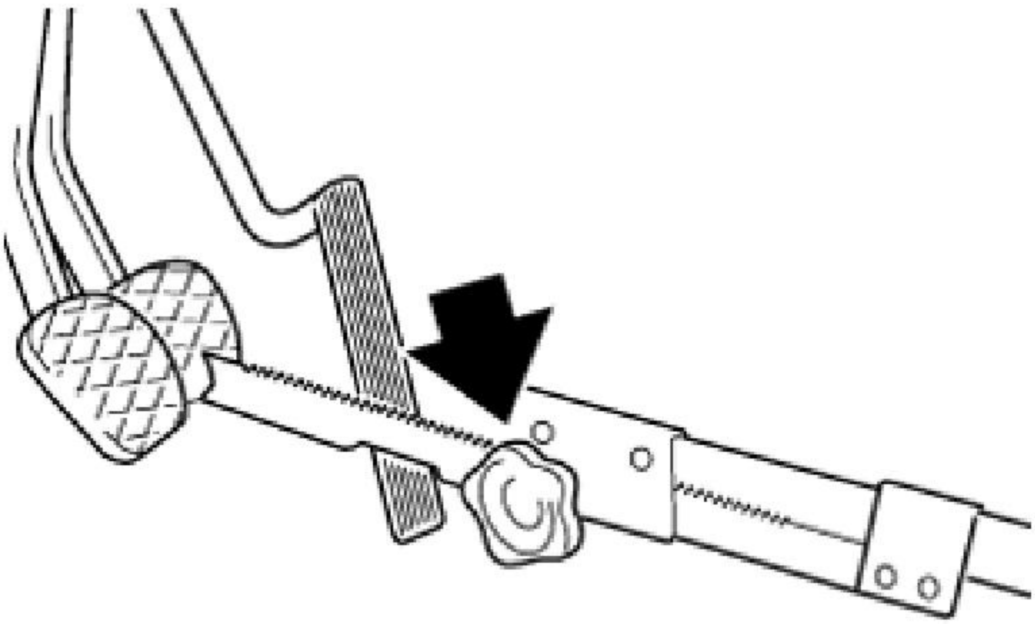

Fig. 35: Identifying Oil Pump Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

Hydraulic Control

The CVT is controlled by a number of valves that respond to mechanical, electrical and hydraulic inputs. The control system is designed to control the pulleys and the clutches in the following three ways:

1. Flow to and from the primary pulley is controlled to command the correct transmission ratio for all driving conditions.
2. Secondary pressure is supplied to the secondary pulley to ensure that there is always adequate clamping force onto the belt for all load conditions. A solenoid valve influences the secondary pressure control valve, optimizing the pressure and hence the belt tension between the primary and secondary pulleys. This pressure optimization improves fuel consumption.
3. The clutch control consists of:
   - Selection of the correct clutch (forward or reverse). Engagement of forward or reverse gear via the selector mechanism operates the manual valve directing oil to the appropriate clutch.
   - Control of the operation needed for take off. A solenoid valve acting on the clutch valve controls the clutch application pressure to ensure smooth clutch engagement and drive away at all throttle openings.

Pitot Pressure

Engine speed and hydraulic pressure monitoring is accomplished through two Pitot Pressure Systems. Each system consists of a pitot chamber and a pitot pipe. The pipe is stationary while the chamber, which is filled with oil and rotating at the speed to be measured.

Hydraulic Control Valves

The Hydraulic Control System consists of the following valves:

- Primary Valve
- Exhaust Secondary Valve
- Cooler Flow Valve
- Constant Pressure Valve
- PWM Solenoid Clutch Valve
- Manual Valve
- Secondary Valve
- PWM Solenoid Secondary Valve
- Exhaust Valve Clutch Pressure
- Supply Valve
- Reverse Inhibitor Valve

Primary Valve

The function of the primary valve is to regulate primary pressure, controlling the primary pulley, and changing the transmission ratio. The pressure in the primary cylinder defines the position of the primary pulley mobile half. The greater the distance between the pulley halves the smaller the primary radius of the belt and the higher the transmission ratio.

Secondary Valve

The secondary valve determines the clamping force on the secondary pulley by regulating the pump pressure. The higher the clamping force, the higher the torque that can be transmitted.

Exhaust Secondary Valve

The exhaust secondary valve regulates overall maximum pressure and controls the secondary pressure in "Low" for engine speeds up to 1600-2000 RPM. This valve improves creep quality that is better at lower secondary pressures. It also creates a smooth transition from the level in creep to the level in low at higher engine speeds. The valve is closed if not in low ratio.

PWM Solenoid Secondary Valve

The PWM solenoid secondary valve influences secondary valve movement, hence belt tension via secondary pulley chamber pressure. The secondary pressure solenoid further modulates the pressure acting on the secondary pressure valve. This optimizes the secondary pressure and hence minimizes losses and improves fuel consumption.

Cooler Flow Valve

The cooler flow valve controls the oil flow through the cooler when D position is engaged. The valve ensures enough oil flow during stall conditions or driving in high ratio for cooling, while ensuring sufficient system pressure is maintained at low engine speeds even under extreme temperatures.

Clutch Valve

This valve regulates the clutch pressure and allows for the adjustment of stall speed. The clutch pressure is derived from the secondary pressure and is controlled by the engine speed pitot, the primary pressure pitot and the clutch PWM solenoid pressure. The clutch valve consists of 1 valve, 2 springs and a plunger.

Exhaust Valve Clutch Pressure

The exhaust valve clutch pressure has two main functions:

- Limit the maximum clutch pressure.
- Protection of the gearbox from abuse.

The clutch pressure is bled into the exhaust valve, otherwise, with increasing engine speed; the pressure would limit the minimum secondary pressure too much, which would adversely affect fuel economy and could lead to damage within the gearbox.

Constant Pressure Valve

The Constant Pressure Valve establishes a base pressure that is used to supply the supply valve. The constant pressure valve acts as a filter for the supply valve and reduces disturbances in the secondary pressure. The constant pressure is also used for the ratio control depending on locking of the clutches. As the ratio approaches overdrive the constant pressure will be supplied to the clutch valve instead of the clutch PWM solenoid pressure.

Supply Valve

The Supply Valve controls the pressure function of the two pitot pressures. A higher engine pitot pressure will cause a higher supply valve pressure and a lower primary pitot pressure will cause a lower supply valve pressure. If both pitot pressures rise by the same amount the supply pressure will also increase. The supply pressure forms an input to the clutch PWM solenoid and is also used for belt lubrication and oil supply to the pitot systems.

PWM Solenoid Clutch Valve

Influences clutch application pressure by biasing the clutch valve. Permits a variety of strategies to be applied to the engagement process.

Reverse Inhibitor Valve

The Reverse Inhibitor Valve prevents the reverse clutch from being energized above a specified forward speed.

Manual Valve

The manual valve has four positions, each corresponding to a position of the selector lever inside the vehicle. Choosing reverse or drive activates one of the two clutches whereas in the neutral and park position both clutches are released. The engine can only be started with the selector lever in the neutral or park position, in all the other positions the starter circuit is inhibited.

Group Three

Ratio Control Motor

The Ratio Control Motor is housed inside the transmission, adjacent to the oil cooler pipe connections. The motor and solenoids are connected to the main harness via a circular connector. The motor is operational in all transmission modes and controls the hydraulic control unit to adjust the primary pulley to the appropriate position. The motor which controls the transmission ratio is a linear actuator and a bi-polar stepper motor.

Park/Neutral Switch

The selector cam activates the park/neutral switch, which prevents the car from starting in reverse or drive and switches on the reverse lights when in reverse. The switch status is also used by the EMS 2000 in conjunction with the gear selector switch to establish the correct driving mode

The switch is operated by a cam, which also operates the hydraulic control unit within the transmission. The selector lever via a cable to the transmission operates the cam. The switch has two positions and performs several functions, one of which is to inform the EWS immobilization unit that the transmission is in the park or neutral positions. The EWS unit will then enable the starter relay coil to be energized, thus allowing the engine to be started.

When the selector lever is in the park or neutral position and the ignition is switched on, the EMS 2000 will energize a shift lock solenoid on the selector lever. This locks the lever in the park or neutral position. The selector lever cannot be moved from the park or neutral position until the footbrake is applied.

Output Shaft Speed Sensor

The ECVT transmission has a dedicated secondary speed sensor located in the differential housing. This sensor is a Hall effect sensor and produces a pulse train of approximately 73000 pulses per mile. The sensor allows for more precise calculation of transmission output speed that is used in the control strategy systems.

The secondary speed sensor is located so that the sensor tip is close to the crown wheel of the differential. By sensing the crown wheel, the signal is not affected by the different wheel speed signals when the vehicle is cornering. See **Fig. 36** .

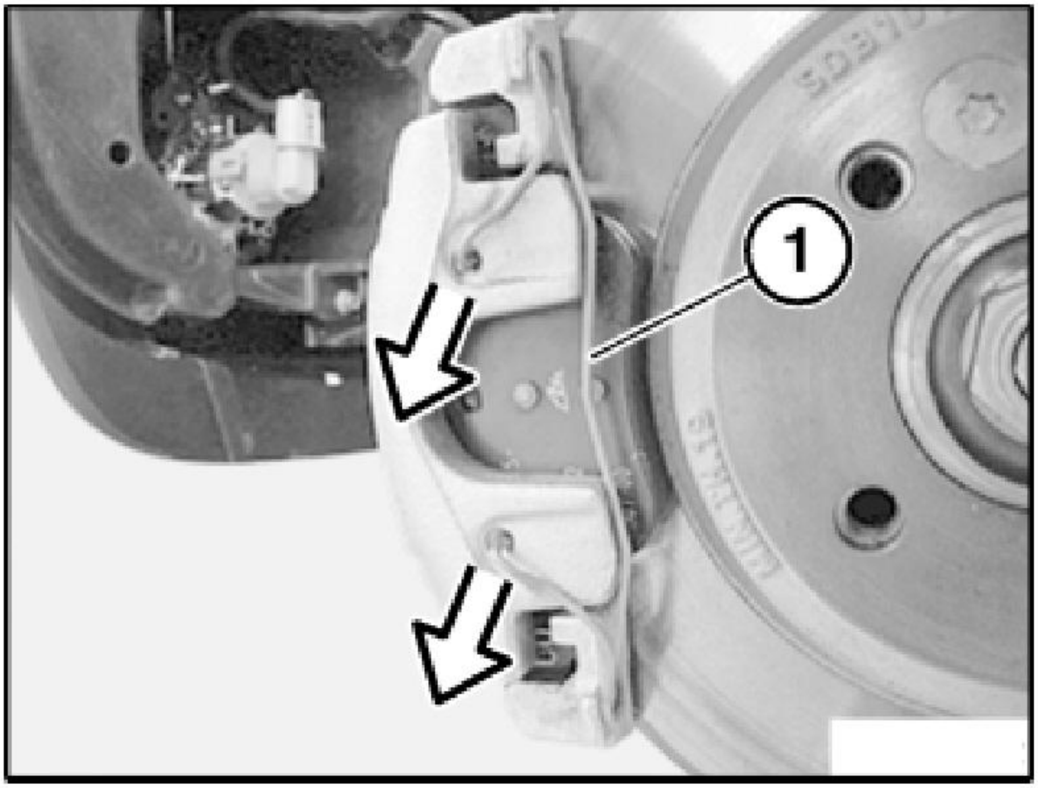

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Fig. 36: Identifying Secondary Speed Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

Instrument Cluster Display

A liquid crystal display in the instrument cluster shows the current drive mode and selected gear. The display includes the following characters, "P", "R", "N", "D", "SD", "1", "2","3", "4", "5", "6" and ER During Adaptations "X" will be displayed in front of the normal character (e.g XP). See **Fig. 37** .

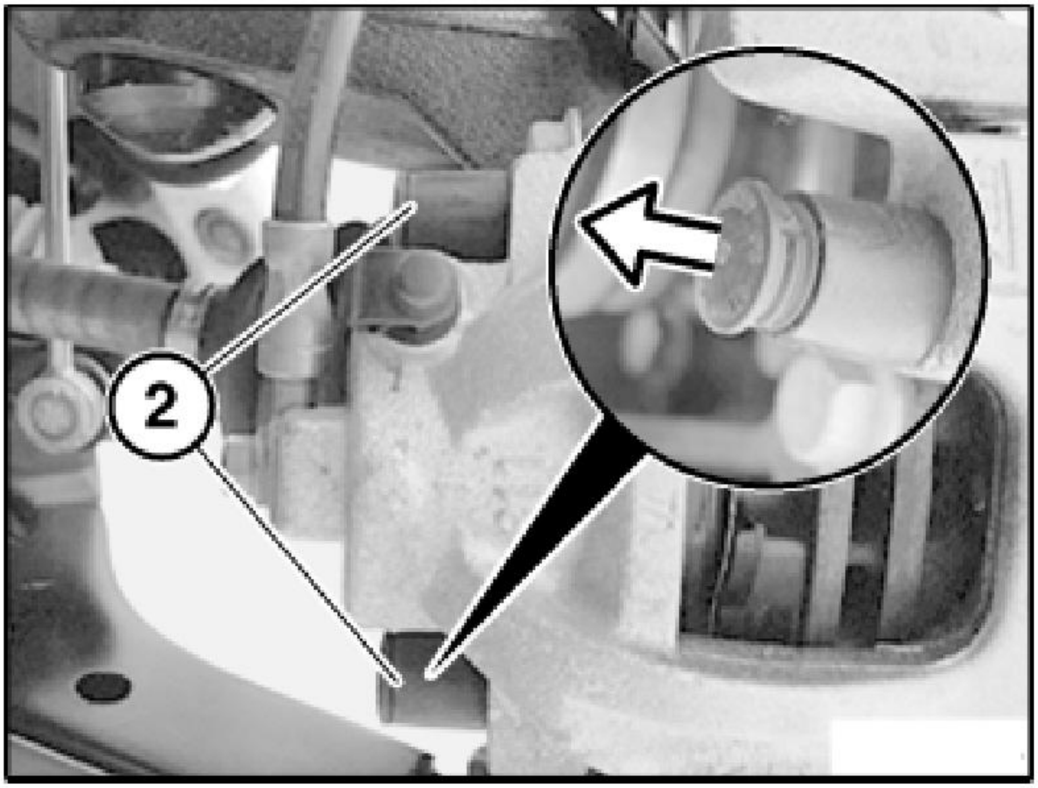

Fig. 37: Identifying Instrument Cluster Display
Courtesy of BMW OF NORTH AMERICA, INC.

Selector Mechanism

Selection of the required driving mode, through the selector lever inside the vehicle, activates a selector shaft within the transmission. A push/pull type cable connects the lever in the car and the shaft on the gearbox. A cam fitted to the selector shaft is also connected to the manual valve of the control system, and selects one of its five desired positions (PRNDS/M). Moving the selector lever across the gate trips a proximity sensor. A spring and cone operated pawl mechanically locks the secondary pulley when the selector lever is moved to the Park position. If selection of park is made at speed the pawl will rattle without engaging Park. It will not engage until the vehicle speed drops below approximately 3 mph. See **Fig. 38** .

Movement of the selector lever (or steering wheel buttons) in a forward direction, plus (+), changes the transmission up the gear ratios and movement in a rearward direction, minus (-), changes the transmission down the gear ratios. See **Fig. 39** and **Fig. 40** .

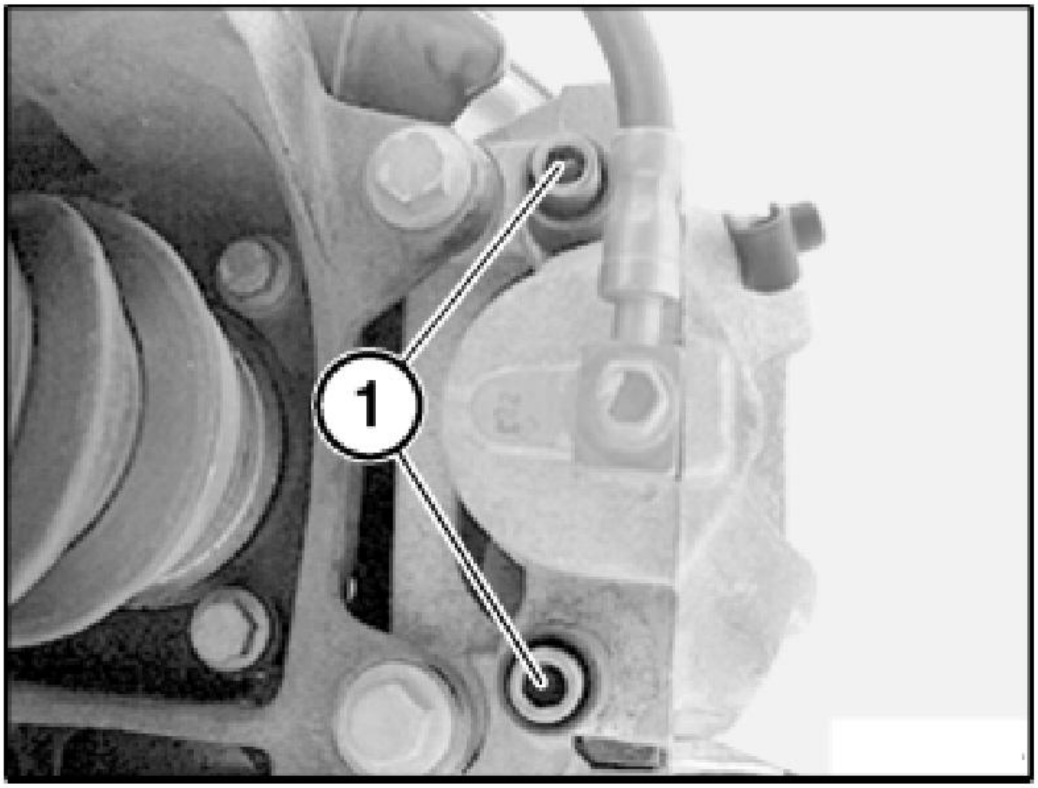

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Fig. 38: Identifying Parking Lock Components
Courtesy of BMW OF NORTH AMERICA, INC.

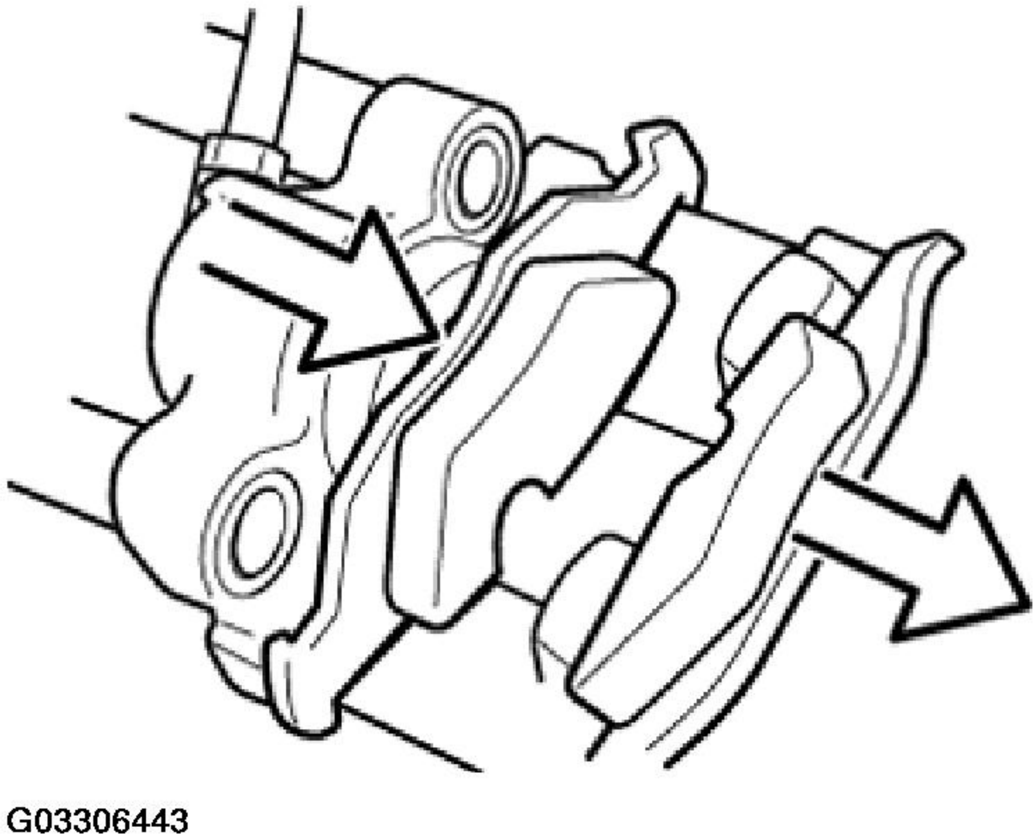

Fig. 39: Identifying ECVT Gear Positions
Courtesy of BMW OF NORTH AMERICA, INC.

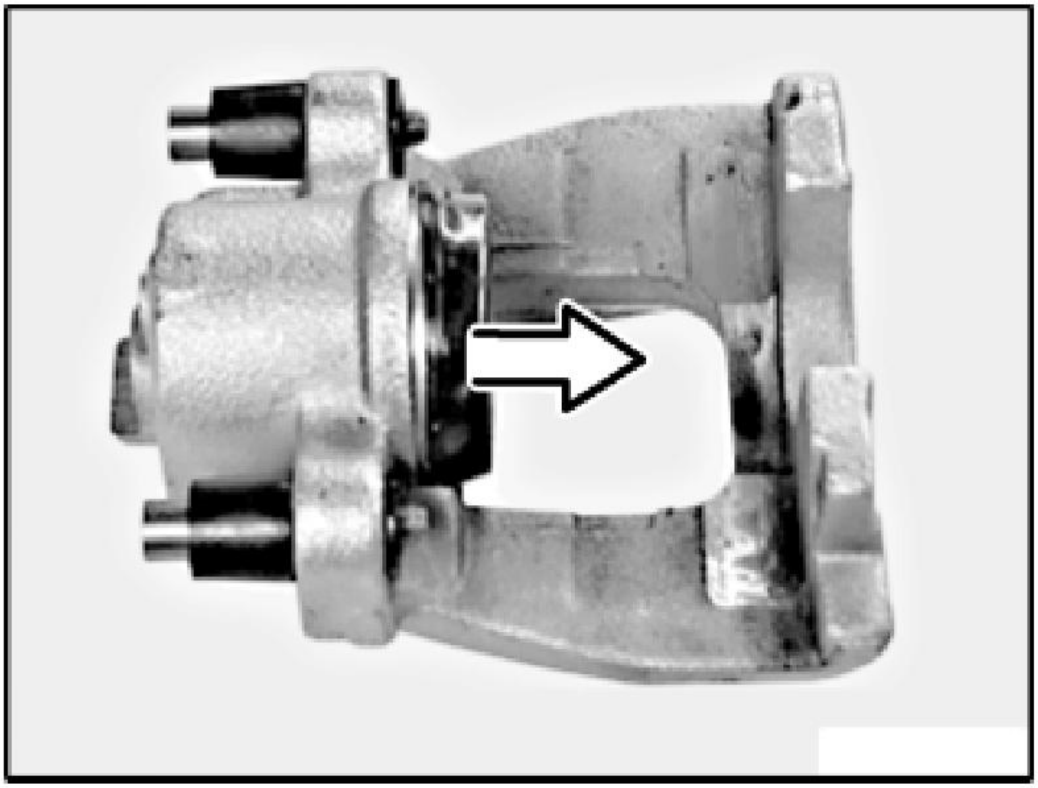
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Fig. 40: Identifying ECVT Remote Gear Change Button
Courtesy of BMW OF NORTH AMERICA, INC.

GIU (Gearbox Interface Unit)

The main function of the GIU is to allow communication between the ECVT and the EMS 2000. The GIU has the following functions:

- Conversion of inputs from the selector lever switches (and steering wheel switches if fitted) into a CAN instruction that is read by the EMS 2000.
- Drive the LED's to display transmission mode.
- Conversion of the CAN instruction for the EMS 2000 into electrical signals to drive the ratio control motor, clutch and secondary pressure solenoids.

Gearbox Interface Unit Inputs

There are many inputs the GIU requires for correct functionality:

- Selector Lever Switches
- Steering Wheel Switches (If Fitted)
- Park/Neutral Switch
- CAN Messages From The EMS 2000

Selector Lever Switches

The park, reverse, neutral and drive switch is located on the left-hand side of the selector lever, secured to the base plate with two screws. The switch is connected to the main harness by a ten-pin connector.

The park, reverse, neutral, drive and manual switch has four proximity sensors that correspond to the four selector lever positions. Two further proximity sensors correspond to the manual +/- positions. The selector lever has two targets, upper and lower. The upper target is aligned with the park, reverse, neutral, drive and manual sensors and the lower target aligns with the +/- sensors.

When the selector lever is moved to the manual/sport position, the upper target moves away from the drive proximity sensor. The GIU senses this and puts the transmission into manual/sport mode. The transmission will operate in sport mode until the GIU senses that either the + or the - proximity sensor is operated, the GIU will then operate the transmission in manual mode. See **Fig. 41** .

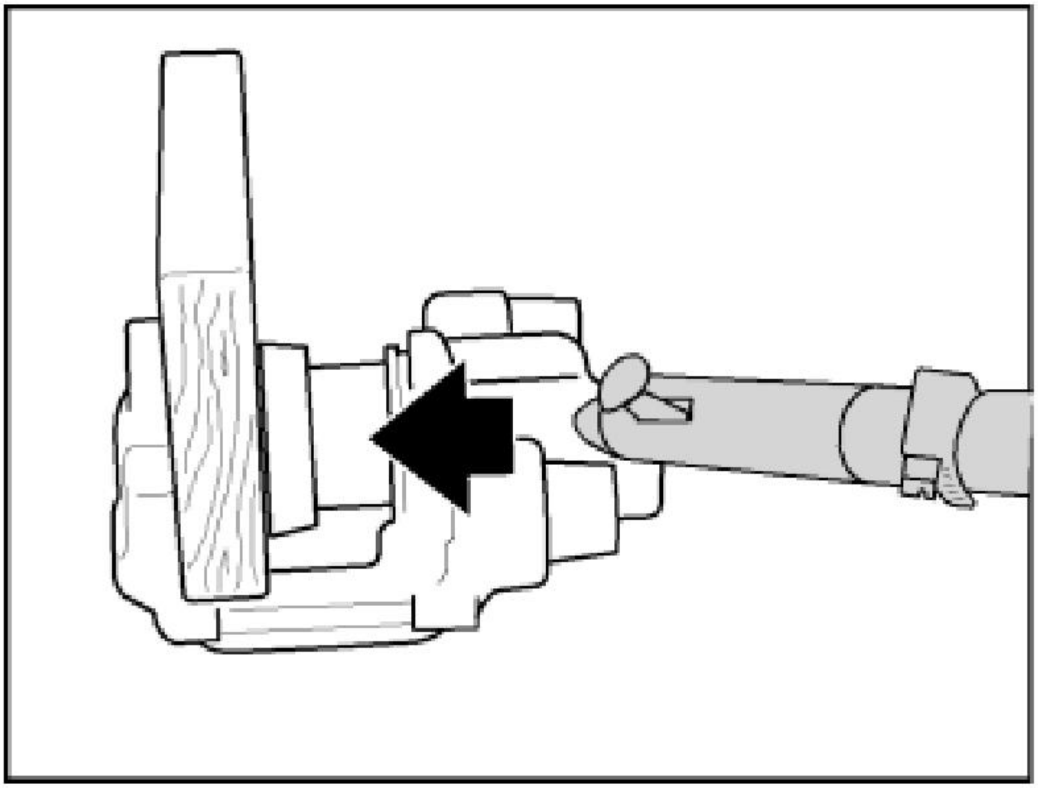

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Fig. 41: Identifying ECVT Selector Lever Mechanism
Courtesy of BMW OF NORTH AMERICA, INC.

CAN Communication

The communication between EMS 2000 and GIU is by CAN. The EMS 2000 talks directly to the ECVT interface GIU via the CAN link. The GIU sends the EMS 2000 information on the following:

- The current status of the park, reverse, neutral and drive switches.
- The current status of the sport/manual switches.
- The current status of the +/- switches (steering wheel buttons if fitted).
- The current status of the +/- switches (selector lever).
- Fault status of all active components.
- The current status of the Park/neutral switch.

The EMS 2000 provides information for the transmission GIU via a CAN-bus. The EMS 2000 controls the position of the ratio control motor indirectly (by means of instructing the GIU to control the motor to a given position).

The EMS 2000 can interrogate the GIU for fault diagnostics and to request real time data and system performance checks when the vehicle is connected to DISplus.

CVT Gear Ratios

The CVT transmission includes a final drive and a secondary reduction drive arrangement. Final drive ratio is 4.050:1 and the secondary reduction ratio is 1.423:1. Low ratio of the belt and pulleys is 2.416:1, allowing a overall low ratio of 13.924:1. Highest ratio of the belt and pulleys is 0.443:1, which provides an overall ratio of 2.553:1. Reverse has on overall ratio of 15.472:1.

PRINCIPLE OF OPERATION

CVT Principles

Unlike conventional planetary automatic transmissions that provide a limited number of gear ratios, usually three, four or five, the CVT, as its name suggests, continuously varies the gear ratio.

A low gear (low ratio) makes it easier to pull away from a rest position, the drive pulley being relatively small, while the driven pulley is large by comparison. The drive belt is used to transmit power and torque.

The CVT uses a primary pulley and a secondary pulley. Both pulleys have one fixed half and one mobile half, controlled by hydraulic pressure. The position of the drive belt on the pulleys will determine the ratio. If the mobile half of the pulley is close to its opposite half then the drive belt is forced to travel around the outer circumference. When the pulley is open wide then this circumference is reduced. The primary and secondary pulley mobile halves are diagonally opposed so when the drive belt diameter is reduced on the primary pulley, it increases on the secondary pulley. See **Fig. 42** .

To pull away, a low ratio is required. To provide this, the primary pulley is open, allowing the drive belt to sit down into the pulley and forcing it to run around the outer part of the closed secondary pulley.

As vehicle speed increases, a higher gear ratio is required. To do this, the primary pulley gradually moves towards its fixed partner, increasing the pulley circumference. At the same time the secondary pulley is forced apart reducing pulley diameter, therefore creating a higher gear ratio. See **Fig. 43** .

If acceleration continues to take place, further up-shifts may be made until the drive pulley diameter is as large as possible and the driven pulley diameter is as small as possible. Therefore, for every revolution of the drive pulley the driven pulley revolves several times.

This degree of change can be controlled to ensure that the most suitable ratio is provided. An overdrive ratio is obtained when the primary pulley is fully closed and the secondary pulley is fully open. The secondary pulley is now forced to rotate approximately two and a half times for every turn of the primary pulley.

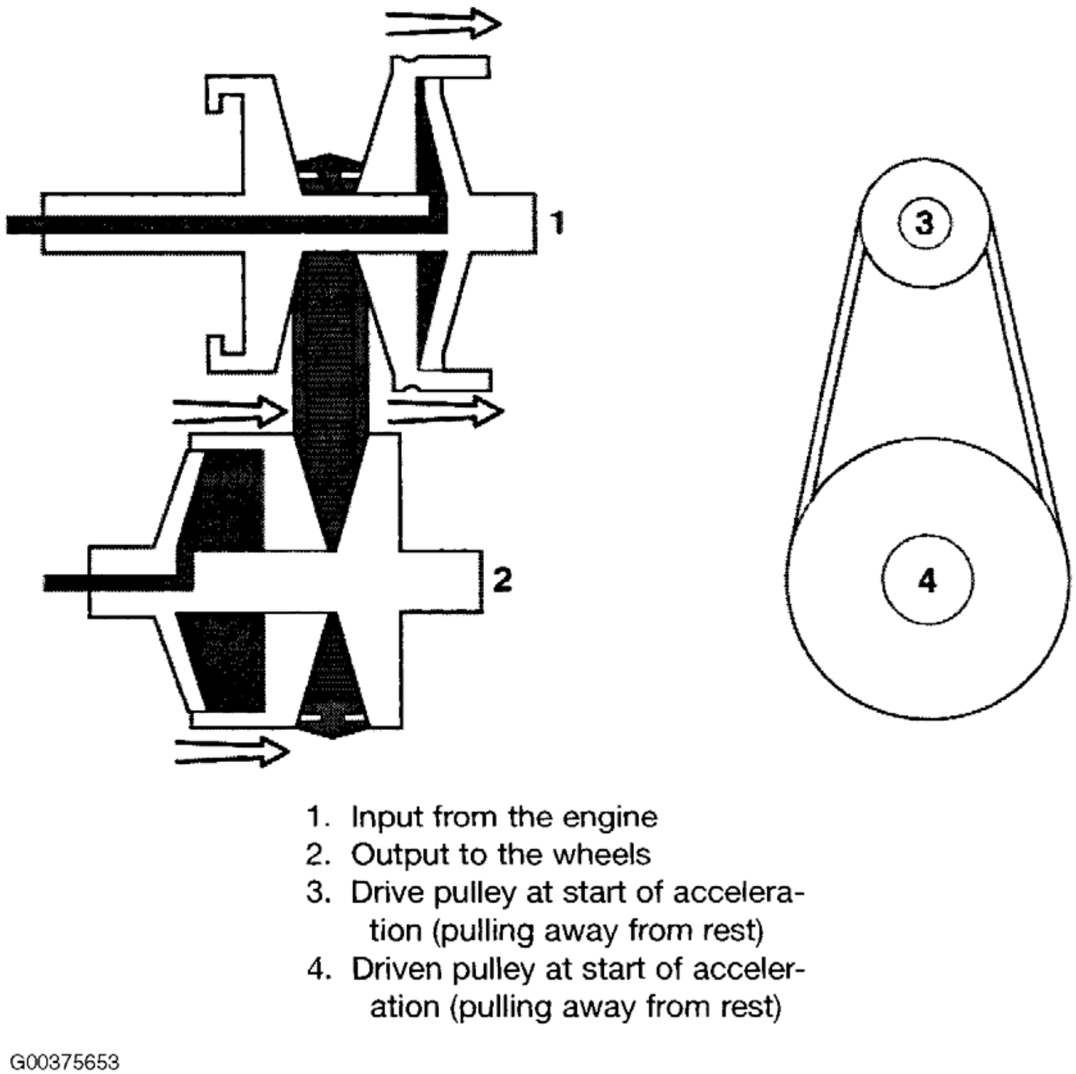

Fig. 42: Identifying ECVT Pulleys In Low Position
Courtesy of BMW OF NORTH AMERICA, INC.

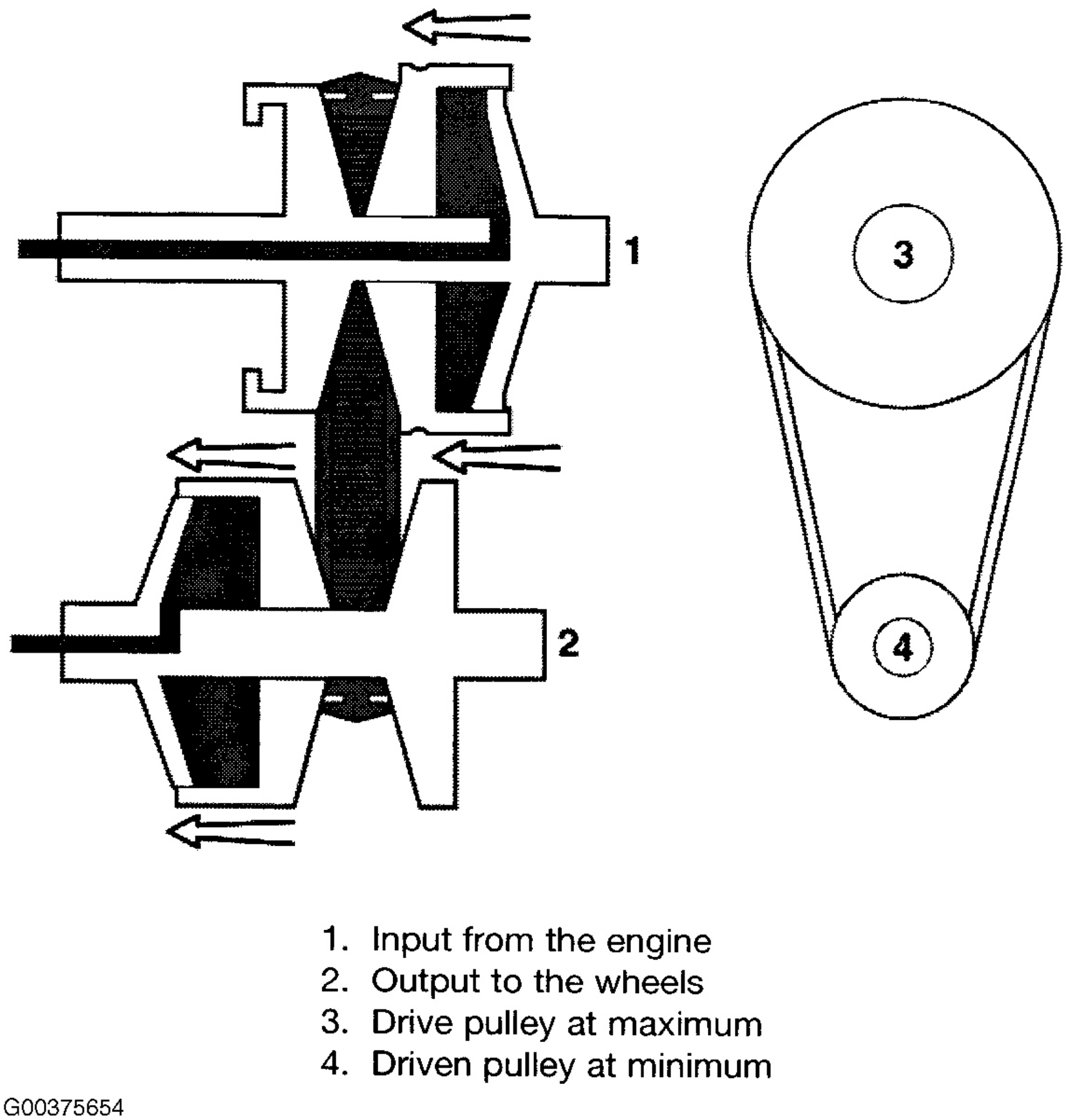

Fig. 43: Identifying ECVT Pulleys In High Position
Courtesy of BMW OF NORTH AMERICA, INC.

Drive Plate

The engine is connected to the input shaft in the transmission, via a torsional damper, instead of the torque converter used by more conventional automatic transmissions. See **Fig. 44** .

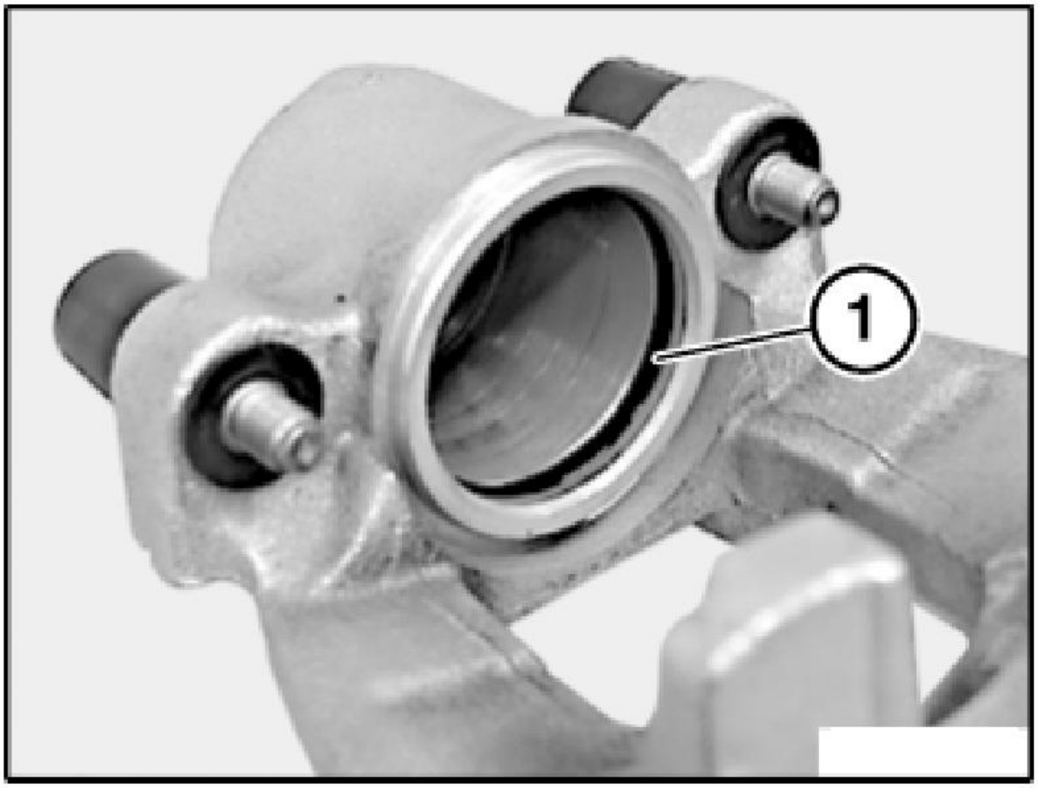

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Fig. 44: Identifying Drive Plate
Courtesy of BMW OF NORTH AMERICA, INC.

MECHANICAL OPERATION

Selector Lever In Park Or Neutral

In this condition motion is not transferred to the wheels as both clutches for reverse (2) and forward gears (4) are disengaged.

- The transmission input shaft (1) turns at the same speed as the engine.
- The reverse gear clutch (2) is disengaged.
- The forward gear clutch (4) is disengaged.
- The planetary gears (3) idle around the sun gear.
- As the sun gear does not move, neither does the primary pulley (5), the secondary pulley (7) and, subsequently, the vehicle. See **Fig. 45** .

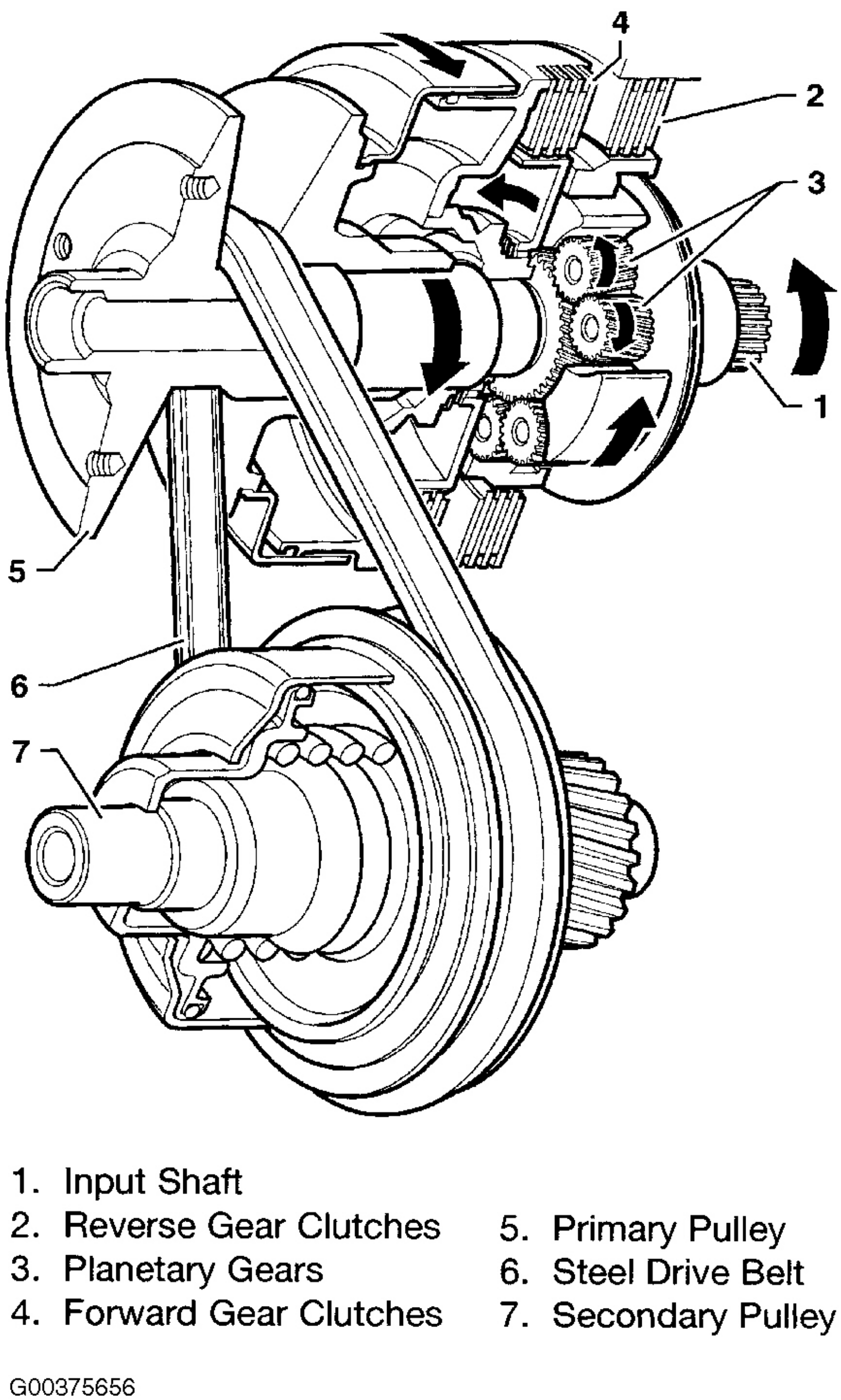


Fig. 45: ECVT In Park/Neutral
Courtesy of BMW OF NORTH AMERICA, INC.

Selector Lever In Drive Position

Under these conditions, the epicyclic set of gears, the planetary gears (3), the sun gear and the outer ring gear are held by the forward clutch (4) that is engaged.

- The transmission input shaft (1) turns at the same speed as the engine.
- The reverse clutch (2) is disengaged.
- The forward clutch (4) is engaged.
- The planetary gears (3) the sun gear and the annular ring gear of the epicyclic train will rotate together.
- The primary pulley (5) turns at the same speed as the engine in the forward gear direction.
- The secondary pulley (7) turns in the forward gear direction at a speed that depends upon the belt ratio for that operating condition. See **Fig. 46** .

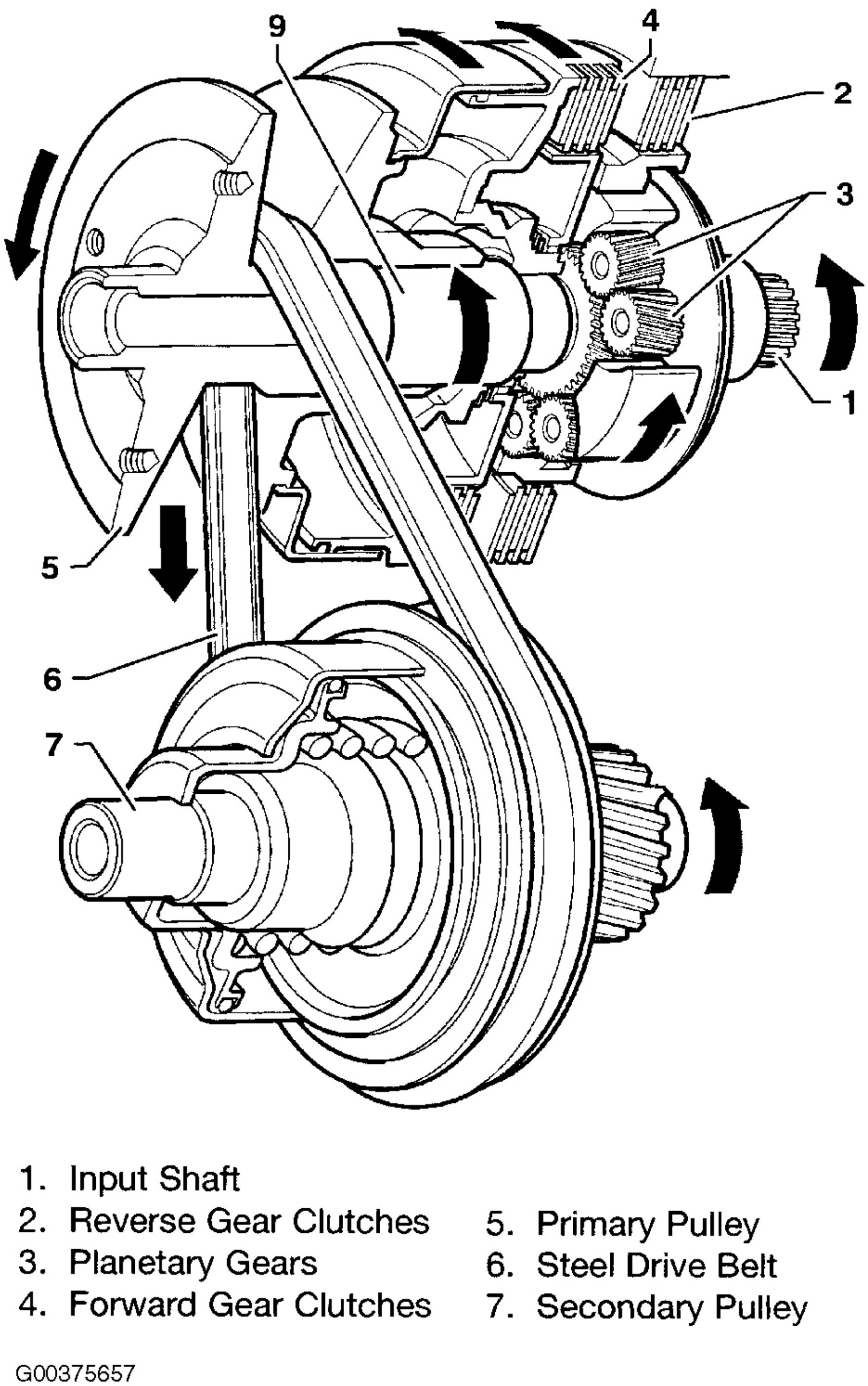


Fig. 46: ECVT In Drive Position
Courtesy of BMW OF NORTH AMERICA, INC.

Selector Lever in Reverse Position

Under this condition, the reverse clutch (2) is engaged and makes the annular ring gear (9) lock to the transmission case. The planetary gears (3) force the sun gear (10), the primary pulley (5) and the secondary pulley (7) to turn in the opposite direction to the transmission input shaft (1). Therefore reverse gear is now selected.

- The transmission input shaft (1) turns at the same speed as the engine.
- The reverse clutch (2) is engaged.
- The forward clutch (4) is disengaged.
- The annular gear (9) is held stationary with the transmission case by means of the reverse clutch (2).
- The planetary gears (3), which are driven directly by the transmission input shaft (1), turn around the annular gear (9). Therefore they force the sun gear (10), the pulley (5) and the secondary pulley (7) to turn in the reverse gear direction. See **Fig. 47** .

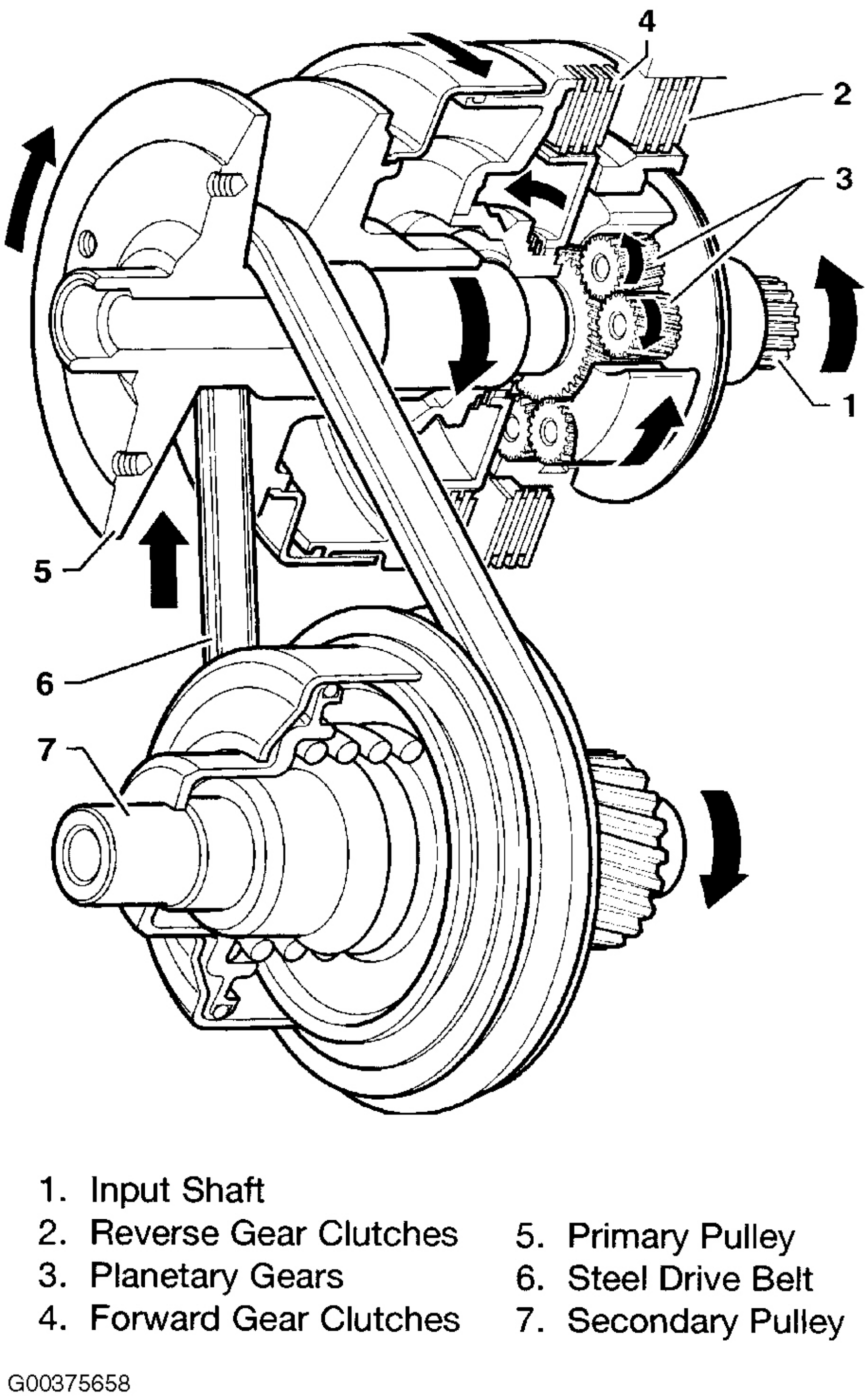


Fig. 47: ECVT In Reverse Position
Courtesy of BMW OF NORTH AMERICA, INC.

ELECTRONIC CONTROLS

The ECVT is based on a standard CVT unit with electronic components fitted to control the gear ratios, the secondary pressure and the clutch pressure. The location of the components that form the steptronic transmission vary depending upon vehicle installation.

All of the control methods associated with the transmission are run as part of the EMS 2000 software. The EMS 2000 receives inputs from the main sensors of this system, communicates with the gearbox interface unit (GIU) to control the transmission, accepts driver inputs and provides information to the driver via the instrument cluster.

The control of the transmission is integrated with the EMS 2000 and a GIU enables this integration, acting as a slave/interpreter for the EMS,

EMS 2000 can control the transmission so that the input shaft speed, relative to the output shaft speed, is fixed in one of six ratios. This gives the effect that the vehicle has a six speed manual transmission with a sequential gear change.

The system protects the transmission, while in manual mode, against shifts that could be potentially dangerous or could damage the engine, for example, shifting to first gear at 90 mph, or shifting to top gear at 10 mph. In addition, if the driver does not shift up, the next gear will be automatically selected when the engine revolutions reach approximately 6000 RPM. Equally, if the driver does not shift down when reducing vehicle speed, the system performs the down-change automatically thus ensuring the transmission is in the appropriate gear when throttle is applied. This prevents excessive clutch slip should the throttle pedal be reapplied.

Driving and ambient conditions can influence the pulley positions, these conditions include:

- Oil Temperature
- Clutch Slip
- Hydraulic Balancing Of The Controlling Cylinders
- Hydraulic Pressure Within The Control Lines

The primary and secondary pulleys alter their position to maintain the commanded transmission input/output ratio.

All inputs and outputs of the ECVT control system pass through the EMS 2000 and the GIU The EMS 2000 monitors the speed of the transmission output shaft and communicates with the GIU to select the correct gear ratio to suit the current driving conditions. The GIU drives the park, reverse, neutral, drive and sport LED module to display the selected gear next to the gear selector lever and the EMS drives the instrument cluster display. See **Fig. 48** .

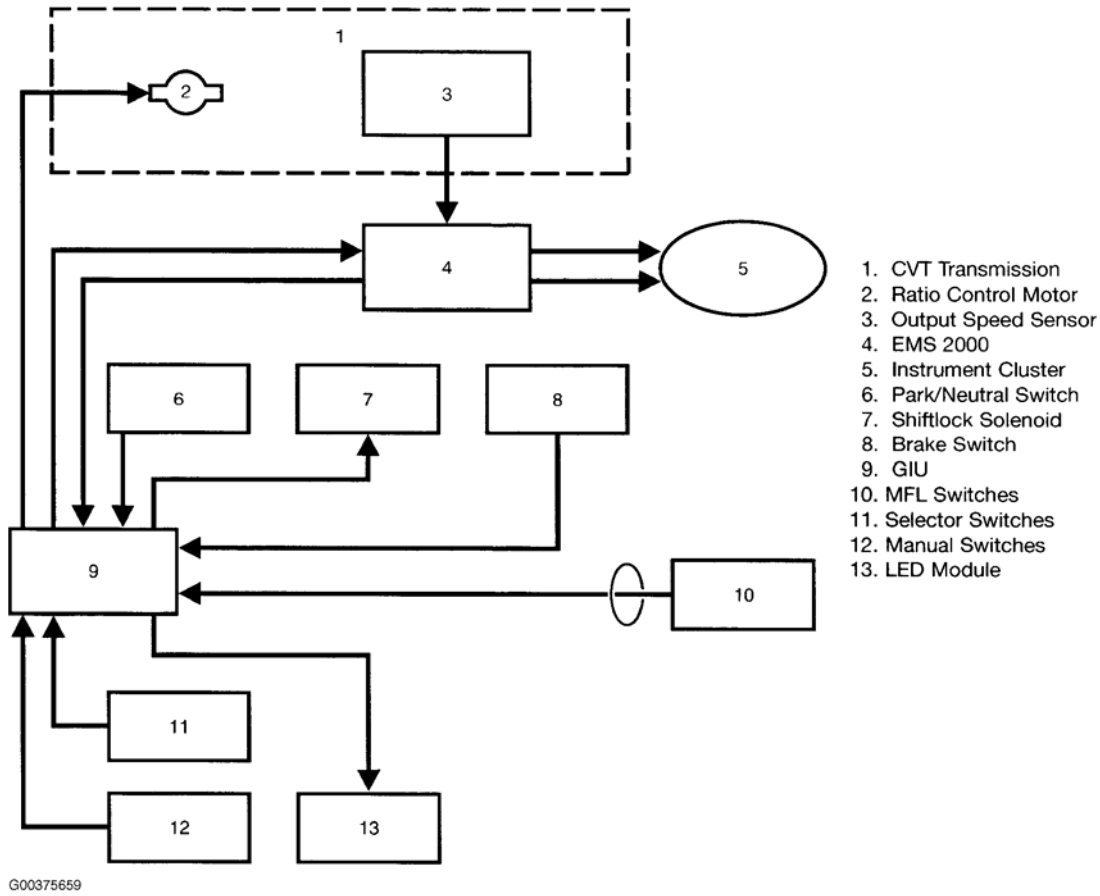


Fig. 48: Identifying ECVT Control System
Courtesy of BMW OF NORTH AMERICA, INC.

MODES OF OPERATION

The transmission control is incorporated into the EMS 2000. The EMS 2000 does not control the transmission ratio directly but does provide all of the intelligence relating to the required position of the ratio control motor. It also provides the intelligence for how fast it should be operated

The EMS 2000 controls the transmission in one of four modes:

- Drive Mode (Normal CVT Driving)
- Sport CVT Mode
- Manual Mode
- Fault Mode

In the CVT modes, the control system operates by deriving a target engine speed based on current vehicle speed and driver demand. In manual mode, the system derives a target engine speed based on the vehicle speed and the current gear ratio. Having obtained an engine speed target, the system calculates the appropriate ratio control motor position and instructs the GIU to deliver this position.

The engine load calculation will depend on two factors:

1. The vehicles road speed.
2. The driver's demand (throttle position).

The EMS 2000 also needs to control the speed of the ratio control motor in order to protect the transmission from damage due to drive belt slippage. This is more likely to occur at low transmission oil temperatures, and when the transmission is delivering a large change in ratio (for example, after a manual gear change, or sudden throttle movement in Drive mode).

Four speeds are used by the Ratio Control Motor. The motor is accelerated as appropriate to ensure the motor does not lose its reference, thereby compromising system control. The EMS 2000 also knows the maximum torque that the belt can transfer across all possible ratio ranges. It is extremely important that the belt is not allowed to slip on the pulleys, as this would cause excessive wear.

TARGET ENGINE SPEED

The target engine speed is critical in deciding the position of the ratio control motor. The EMS 2000 will keep changing the ratio of the motor to achieve the target engine speed. The target engine speed is mapped inside the EMS 2000 against Road speed and Driver demand (throttle angle).

The map is not linear. To achieve good driving characteristics the engine target speed map is programmed to overcome:

- The initial engine speed required to build pressure within the hydraulic clutch.
- The hydraulic profile of the transmission itself.
- The engines power and torque profile.

When the transmission is operating in the D mode (drive), the driver does not experience full engine power until the road speed reaches 50 mph.

SPORTS MODE

The EMS 2000 uses the same map programmed into the EMS 2000 as it uses for normal Drive mode but applies a scalar function to the throttle angle. For example if the driver selects sports mode and has the throttle applied by 40%, the scalar function will be applied so that the EMS 2000 uses a throttle angle of 60 percent to calculate its target engine speed. The instrument cluster display will change from "D" to "SD".

MANUAL MODE

As soon as the EMS 2000 receives one of the "+ or - "switched inputs via the GIU, the EMS 2000 stops displaying "S", and changes to one of six gear position displays.

FAULT MODE

When the EMS 2000 or GIU detects a fault, the EMS 2000 will try to position the ratio control motor so that the engine speed in most driving conditions is around 2800-3200 RPM. In this position the vehicle still has reasonable driving characteristics. For certain failure modes, where the EMS 2000 cannot command the position of the motor, the GIU will set the motor position to 130 steps (full range of travel is 0-214 steps). In this case, the engine speed in most driving conditions will be 3750-4000 RPM.

The EMS 2000 will instruct the instrument cluster to display "EP", or the Engine MIL depending on legislative requirements. There are certain faults that when stored will not cause the EMS 2000 to default the transmission into its limp home position.

These are:

- Gear lever + switch failure.
- Gear lever - failure.
- Steering wheel + switch failure (if fitted).
- Steering wheel - switch failure (if fitted).
- Shift interlock system fault.
- Centre Console LED fault.

A gearbox default is not necessary for these failures because the control of the gearbox is not compromised; it is only necessary to warn the driver. The EMS 2000 will not operate the sequential gear changes in manual mode if these switches are faulty.

TRANSMISSION ADAPTATION

Due to manufacturing tolerances in the transmission, and since the ECVT system is subject to many strict legislative requirements, it is essential to put the control system through a learning procedure, before the transmission can be controlled effectively.

The "learn" mode can be recognized because the LCD gear display will display an "X" character in addition to the current drive mode. The "X" stands for fast adaptation - the control system is being adapted to adjust its control thus optimizing the performance of the transmission within the particular vehicle. If the transmission or EMS 2000 is changed, the fast adaptation procedure must be repeated.

There are two procedures that must be completed before the star on the display is removed.

CLUTCH ADAPTATION

A dealer diagnostic procedure has been written for this function. It is essential that this procedure be followed for a reliable clutch adaptation. Follow the instructions given by the procedure. Having completed the instructions, the ratio adaptation drive cycle can be completed.

RATIO ADAPTATION

The transmission hydraulic/mechanical characteristics can be mapped inside the EMS 2000. The curve of the input shaft speed verses output shaft speed looks like a straight line up to approximately 2,500 RPM. It then plateau's before rising in a curved manner. This profile will be a similar shape for all transmissions but its position plotted against engine speed will vary.

The EMS 2000 knows the shape of the profile and monitors the actual engine speed relative to the mapped engine speed. The EMS 2000 learns, through historical control, a new profile that is more representative of the actual transmission characteristics. The EMS, 2000 also monitors the amount this line moves from the mapped line, as long as this difference is within its tolerance band, the EMS 2000 accepts the value and learns from it. If the actual value goes beyond the adaptive tolerance the EMS 2000 will perform a reset. If the value still exceeds the adaptive tolerance band, the EMS 2000 will store a fault code and place the transmission into its default position.

The figures quoted are only representative, due to the nature of the adaptation, these may or may not be correct. When setting the fast adaptation, the control system will initially target 5000 RPM in order to learn the ratio control motor position at this engine speed. Once the vehicles power train is stable enough for an adaptation to take place, the ratio control motor position is noted and the control system will target 4500 RPM. This process continues subsequently targeting 4000, 3500, 3000, 2500, 2000, 1900, 1800, 1700, 1600,1500, 1400. When the 1400 RPM point has been adapted, normal operation will commence.

To set the fast adaptation procedure drive the car, on a level road, at around 60 km/h in ECVT drive mode, and then lift off the throttle.

As the vehicle decelerates (do not use the brakes) the adaptations will occur. If the vehicle speed drops too far before the process is complete, the engine speed will drop from its targeted speed back towards idle.

The instrument cluster display will continue to display the "X" character, and the transmission will not operate normally. If this happens, simply repeat the process by accelerating back to 60 km/h and lift off the throttle again to give the software a chance of learning the remaining points. When the procedure is complete, the display will return to normal.

On the completion of a fast adaptation, the lifetime adaptation strategy will commence, fine tuning the response of the control system for the transmission attached to a particular vehicle.

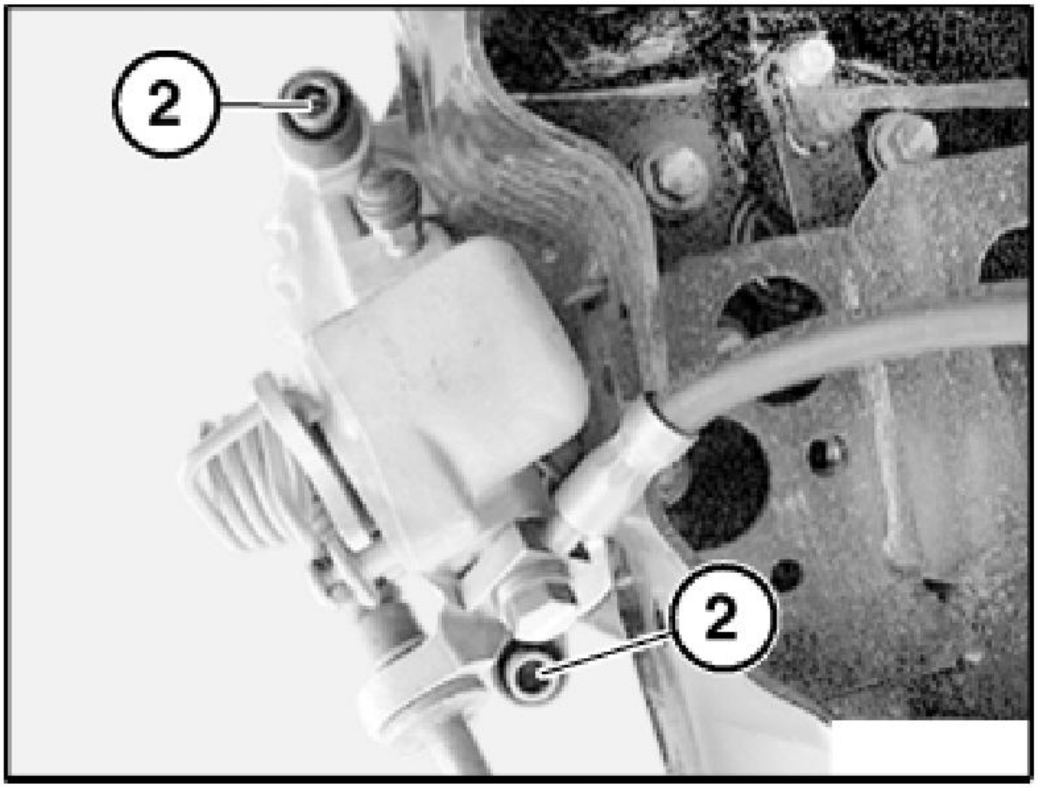
If either the EMS 2000 or transmission is changed during the service life of the vehicle, the fast adaptation strategies must be reset, which in turn will reset the lifetime strategy so it starts learning from the new base point.

DRAIN & REFILL PROCEDURE

The ECVT gearbox contains three plugs, one is used for draining, one is used for fill/level and the other for fill only. On the MINI it is recommended that the oil fill takes place from the underside of the gearbox through the fill/level plug. There is another oil fill plug on the top of the gearbox that is used in other applications but is not suitable for MINI due to lack of access.

The ECVT oil change is carried out at every MINI Inspection I Service

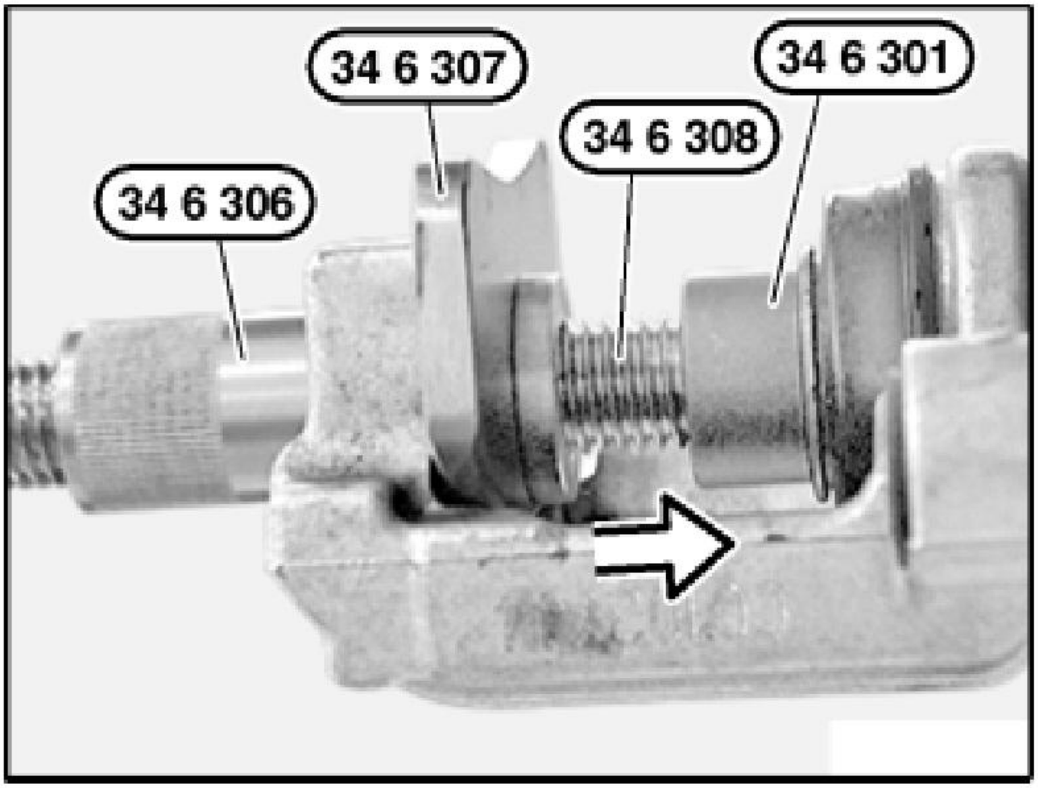
With the vehicle on a hoist, remove the drain plug from the sump pan using an 8 mm Allen key. Caution is required when the gearbox oil is hot to prevent scalding. See **Fig. 49** .



G03306453

Fig. 49: Identifying Drain Plug
Courtesy of BMW OF NORTH AMERICA, INC.

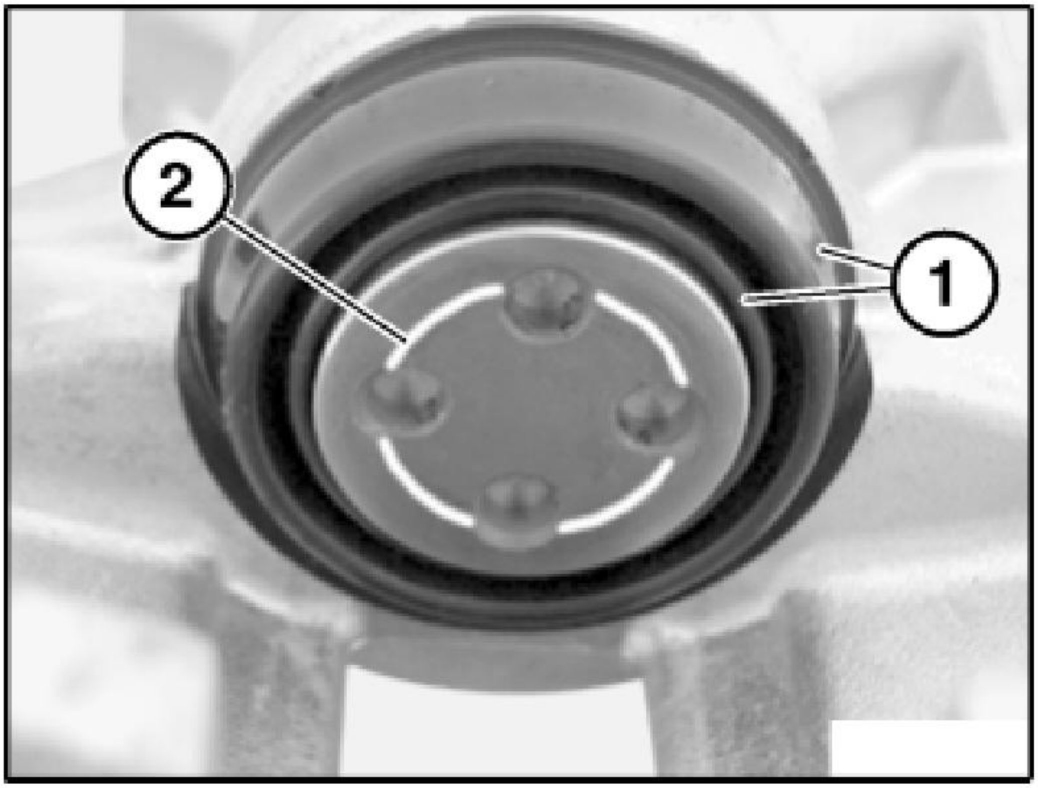
While the oil is draining, to gain access to the fill/level plug remove the small undercar panel, loosen the 3 bolts on lower valance and unlock the 2 screws on the cross frame. See **Fig. 50** .



G03306454

Fig. 50: Identifying Undercar Panel
Courtesy of BMW OF NORTH AMERICA, INC.

Remove the fill/level plug, (6 mm Allen key) this will drain off excess fluid retained in the level tube. Reinstall drain plug. See **Fig. 51** and **Fig. 52** .



G03306455

Fig. 51: Identifying Refill/Level Plug
Courtesy of BMW OF NORTH AMERICA, INC.

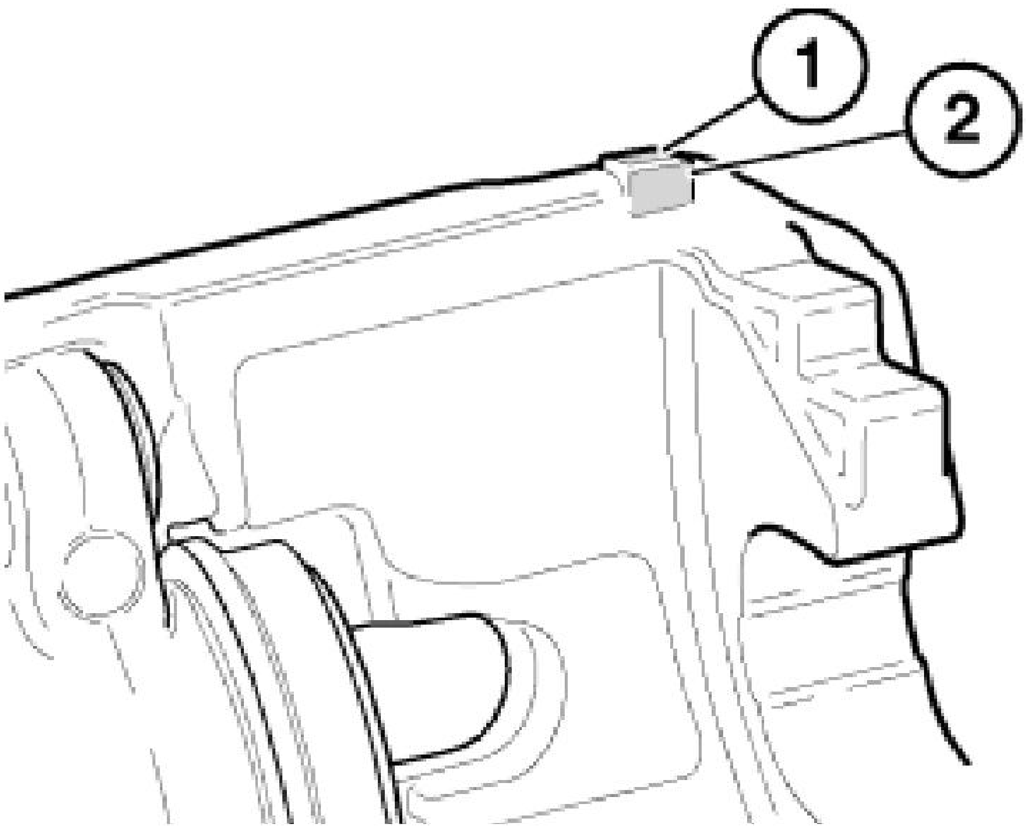


Fig. 52: Identifying Adapter In Fill Plug
Courtesy of BMW OF NORTH AMERICA, INC.

Using Special Tool No 24 8 100 connect to the fill/level plug and pump 4.5 liters of oil into the gearbox.

Shut the valve of the hydraulic equipment, to ensure no oil flow takes place in either direction. Lower the vehicle sufficiently. Ensure road wheels are approximately 15 cm off the ground, as it is necessary to operate the vehicle in drive mode. Ensure the parking and foot brake are applied firmly, start the engine and allow 10 seconds of engine running time before moving the gear lever from P (park). Shift the gear lever into each position and allow the gear lever to rest in each of its positions for 5 seconds before progressing to the next position. The final part of this process will require the gear lever to be moved into the Drive position and the foot brake released. A light throttle application will be sufficient to shift the gearbox through the various ratios, this should be carried out 2 times, after completion apply the foot brake and return the gear lever to the park position. Keep the engine running and raise the vehicle.

With the oil temperature between 30°C and 50°C remove the hydraulic equipment and special tool. Use care to prevent scalding. Should the filler tube run dry very quickly, the gearbox is likely to be under filled. See **Fig.**

53 . Reinstall special tool and pump an additional amount of oil into the gearbox. Remove special tool and wait until the oil flow begins to slow and then refit the fill/level plug:

- Drain plug torque 40 N.m.
- Fill/Level plug torque 21 N.m.
- Use only Esso CVT EZL 799 fluid for top-off or replacement.
- Replace sealing washers on drain and fill plugs.

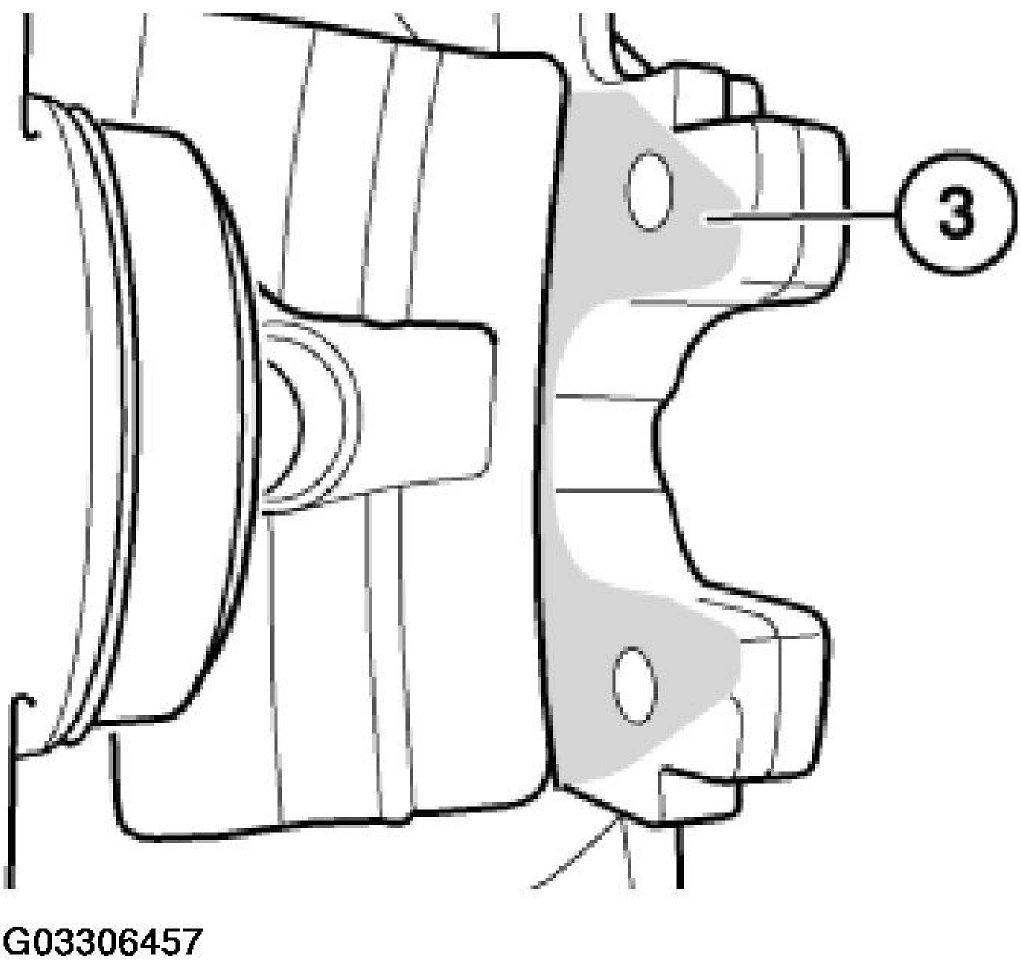


Fig. 53: View Of Filler Tube Inside Transmission
Courtesy of BMW OF NORTH AMERICA, INC.

SERVICE INFORMATION

At present repair/replacement is limited to:

- Drain and refill.
- Inhibitor switch and "O" ring.
- Selector shaft oil seal.
- Input shaft and drive shaft oil seals.
- Primary cover.
- Secondary cover "O" rings.
- Sump gasket.
- Oil cooler pipe and unions.

All diagnostics of the ECVT are carried out via the EMS. Using DISplus, the EMS can request actions from the GIU and monitor these actions for the correct performance. A requirement has been identified for the GIU to perform an integrity check on its output drives. This mode will be engaged as part of the end of line testing during production, and also for the technician performing diagnostic testing. In response to these signals, the GIU shall perform the following:

- Perform a test on LED drives.
- Test both clutch and pressure solenoids.
- Attempt to move motor through a complete cycle.

Once the operation of the EMS 2000 has been established, the GIU operation should be established. The CAN link between the GIU and the EMS 2000 can be verified by observing the LCD display in the instrument cluster. The display should change in accordance with the gear lever selector and is an indication that the selector switches are operational and the drive from the EMS 2000 to the instrument cluster is operational. If the ratio control motor is suspected to be faulty the following procedure can be carried out to confirm its state. See **Fig. 54** .

- Turn the ignition off and wait 5 minutes for the EMS 2000 to power down.
- Unplug the connector from the GIU and using a multi-meter measure phase coils across pins No. 5 & 6 and then 7 & 8. The reading should be between 18-30 Ohms.
- When a reading cannot be obtained, try reading the phase coils on the transmission connections by probing the connection directly on the transmission.
- When readings can not be obtained at the transmission, the motor is assumed to be faulty.

Fault/Symptom	Most Likely Causes
Transmission stays in highest ratio. Vehicle pulls away as normal, but engine speed does not rise as normal	- Road speed sensor fault - Road speed sensor interfrence - Fault with EMS 2000 or Drive-by-wire system - Ratio Control Motor fault
Vehicle pulls away and accelerates sluggishly	- Transmission malfunction
Transmission stays in lowest ratio. Vechicle pulls away as normal, but engine speed rises rapidly to around 6000 rpm at 30 KPH	- Sticking Primary valve - Ratio Control Motor Fault - Ratio Control Motor Wiring - Transmission malfunction
Engine speed stuck at a constant speed for most driving conditions	- Selector switch fault - Selector cable fault - Link lost between EMS 2000 and GIU - Ratio Control Motor Fault - Road Speed Sensor Fault
No Creep in D	- Transmission is overheating - Clutch solenoid fault - GIU Fault - Transmission Fault
High engine load in D	- Open or Short Circuit LED drives - GIU Fault - Transmission Fault
No centre console LEDs with ignition On	- Open or Short Circuit LED drives - GIU Fault - EMS 2000 Main Relay fault (No power to GIU) - Invalid Selector Position/Selector Fault

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Fig. 54: Checking Ratio Control Motor
Courtesy of BMW OF NORTH AMERICA, INC.