Phase 2

Trade of Motor Mechanic

Module 6

Unit 2

Manual Transaxle System

Produced by

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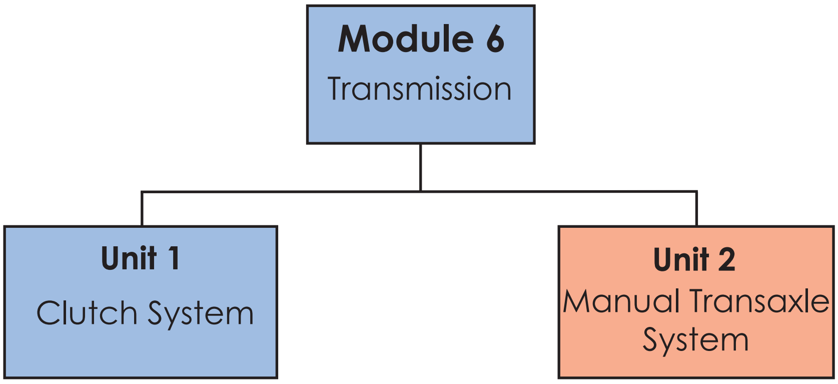
Introduction

Module 6 of this course cover the Transmission aspect of automotive technology. This is the second unit in module 6 and introduces the Manual Transaxle System so that you will be able to understand its application in automotive technology and the operation the components associated with it.



In light vehicle applications the engine operates over a wide speed range, but produces maximum torque only within a relatively narrow RPM band. A relatively large turning effort must be applied to the driving road wheels to move the vehicle.

A manual transmission allows the driver to directly vary the gear ratio, between the engine and the driving road wheels. This allows engine torque to be varied, to suit load and speed requirements. Health and safety issues related to this unit will also be covered.

Unit Objective

By the end of this unit each apprentice will be able to:

- State and apply the safety and precautionary procedures applicable to working on the manual transaxle system
- State the purpose of the manual transmission system
- Differentiate between front-wheel-drive (FWD) and rear-wheel-drive (RWD) transmission and drivetrain configurations
- Explain the principles of simple and compound gear trains
- Outline the elementary internal structure and fundamental principles of operation of the 5-speed constant mesh manual transaxle system
- Calculate the gear ratios of a transaxle gearbox
- Remove and refit a training unit transaxle gearbox
- State the purpose of the Constant Velocity (CV) joints and halfshafts in the transaxle drivetrain
- Remove and refit training unit CV joints and gaiters
- State the fundamental purpose of the final drive and differential units in the transaxle system
- Outline the NCT/DoT VTM requirements applicable to the transmission system
- Carry out the equivalent of the NCT/DoT VTM 'Transmission' test on the components of the automotive transmission system

1.0 Safety and Precautionary Procedures

Key Learning Points

- Safety and precautionary procedures applicable to working on the manual transaxle system including safe use of vehicle lifts, engine support beam and gearbox jacks, use of eye protection and latex gloves, safe removal of clutch dust, use of suitable face mask to avoid respiratory problems, working with appropriate transmission tools, prevention of clutch fluid spillage, assistance for gearbox removal and refitting using industry-recommended manual handling methods, avoidance of damage to CV joints and wheel speed sensors/reluctor rings

1.1 Health and Safety

If the proper safety procedures are not adhered to when working on Manual Transaxle systems this could lead to serious injury/health problems e.g. Respiratory problems to personnel.

Instruction is given in the proper safety procedures applicable to working on clutch systems which include Safe use of:

- Vehicle lifts
- Engine support beams
- Gearbox jacks
- Use of suitable eye protection
- Latex gloves
- Safety foot wear
- Safe removal of clutch dust
- Use of suitable face mask to avoid respiratory problems
- Working with appropriate transmission tools
- Prevention of clutch fluid spillage
- Assistance for gearbox removal and refitting using industry recommended manual handling methods
- Avoidance of damage to CV joints and wheel speed sensors/ reluctor rings etc.

Refer to motor risk assessments, Environmental policy and Material Safety Data Sheets (MSDS)

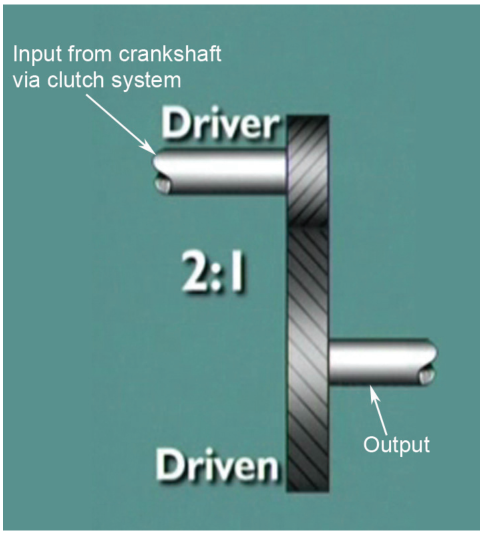
2.0 The Manual Transmission System

Key Learning Points

- Purpose of the manual transmission system

2.1 Purpose of Manual Transmission

In light vehicle applications, the engine operates over a wide speed range, but produces maximum torque only within a relatively narrow RPM band. A relatively large turning effort must be applied to the driving road wheels to move the vehicle. Then the turning effort must vary, to overcome air and gradient resistance and rolling resistance.



A manual transmission allows the driver to directly vary the gear ratio between the engine and the driving road wheels. This allows engine torque to be varied to suit load and speed requirements.

The transmission also provides a means of reversing the vehicle and it has a neutral position, which disconnects the engine from the driving wheels.

3.0 Transmission and Drivetrain Configurations

Key Learning Points

- Differentiation between front-wheel-drive (FWD) and rear-wheel-drive (RWD) transmission and drivetrain configurations

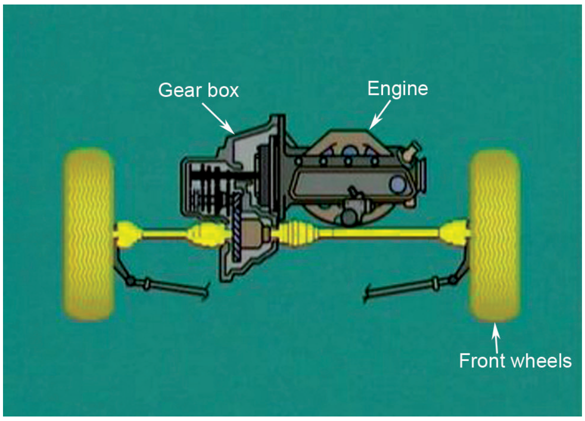
3.1 Front-Wheel Drive Layout

In front-wheel drive vehicle layouts the engine can be mounted transversely or longitudinally. Drive is transmitted to the front wheels through a transaxle.

In transverse applications the transaxle is normally mounted at the rear of the engine and a primary shaft engages with the splines of the clutch centre plate.

When a gear is engaged, drive is transferred to a secondary shaft and through a secondary shaft pinion to a helical ring gear attached to the differential case.

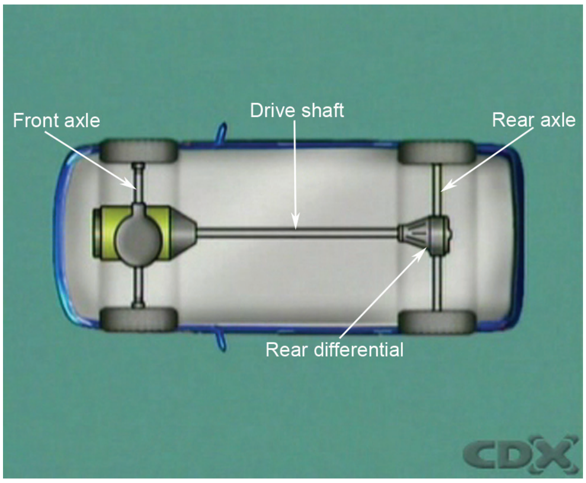
Drive is then transferred through the differential gears to each drive shaft and into each front wheel. Universal joints are fitted at the inner and outer ends of the shafts to allow for suspension and steering movement.



In this case the engine crankshaft transaxle shafts and drive shafts all rotate in-line which simplifies the final drive arrangement. Mounting the engine longitudinally means the drive must be turned through ninety degrees. A crown wheel and pinion is commonly used for this purpose.

3.2 Rear-Wheel Drive Layout

Beam-type rear-axle assemblies enclose the final drive gears, differential gears and axle shafts in one housing. Vehicles with independent suspension have the final drive unit on the chassis frame and transfer the drive to each driving road wheel through external drive shafts. Vehicles with rear or mid-mounted engines normally use a transaxle and transfer the drive to the driving road wheels by independent drive shafts.



In beam axle applications, suspension action makes the final drive assembly rise and fall relative to the vehicle frame. This produces continuous change in the distance from the transmission output shaft to the final drive pinion and in the angle between the propeller shaft and its connections. In addition, the pinion nose is forced up on acceleration and down when the brakes are applied. Despite these movements, the propeller shaft must transfer the drive smoothly. Change in length is accommodated by a sliding spline in the shaft. Angle changes are provided for by a universal joint at each end.

For independent suspension universal joints help align the transmission and final drive and a sliding spline is still included to allow for slight variations in length.

The external drive shafts to each road wheel have universal joints at their connecting points and often a sliding spline or a plunge type joint.

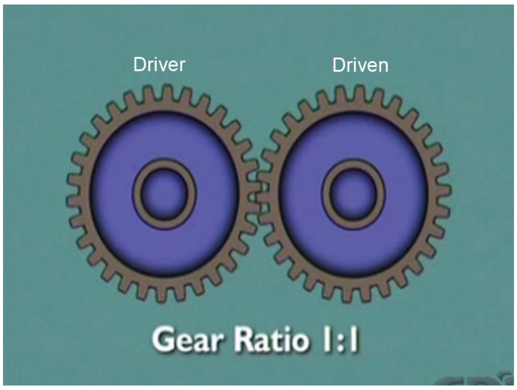
4.0 The Principles of Simple and Compound Gear Trains

Key Learning Points

- Principles of simple and compound gear trains (including gear ratios, effects of gear ratios on output torque and shaft speed)

4.1 Gear Ratios

In light vehicle applications the engine operates over a wide speed range but produces maximum torque only within a relatively narrow RPM band. A relatively large turning effort must be applied to the driving road wheels to move the vehicle. Then the turning effort must vary to overcome air and gradient resistance and rolling resistance. A manual transmission allows the driver to directly vary the gear ratio between the engine and the driving road wheels. This allows engine torque to be varied to suit load and speed requirements.



The transmission also provides a means of reversing the vehicle. And it has a neutral position, which disconnects the engine from the driving wheels. When two gears are in mesh, one is a driven or "output" gear. The other, providing the turning action, is the driver or "input gear".

Gear ratio calculation formula:

$$\frac{\text{Driven}}{\text{Driver}}$$

A gear ratio is the number of turns of the input gear, necessary to achieve one turn of the output gear. Here it is 1 to 1 since the gears have the same number of teeth.

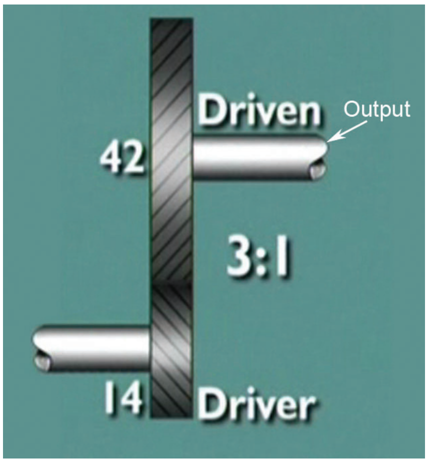
In rotation they also turn at the same speed and the turning effort of the output gear will equal the effort applied by the input gear. The gear ratio can also be calculated, by dividing the number of teeth on the driven gear. In this case, the driven gear has 30 teeth and the driver gear has 10. So the ratio is 3 to 1.

The driver gear has to turn three times to turn the driven gear once. In continuous rotation, the driven gear turns three times slower than the driver. Lower speed produces higher torque. So torque at the output is higher. For this gear ratio of 3-to-1, if input torque is 100 Newton Meters, then output torque is 3 times that: 300 Newton Meters. When three gears are in mesh, the input and output gears is meshed with an "idler" or intermediate gear.

The idler transfer's movement between the input and output gears, but has no effect on the ratio, or the torque multiplication. These remain unchanged.

4.2 Compound Gear Trains

Compound gear trains have two or more pairs of gears in mesh so that they rotate together. This compound gear train has gears on three shafts. The gear on the input shaft meshes with a larger gear on a counter-shaft or cluster gear. The counter-shaft has a smaller gear formed on it in mesh with the output shaft gear.



The motion of the input is transferred through the large gear along the counter-shaft to the smaller gear to the output. The output turns in the same direction as the input but at a reduced ratio depending on the sizes of the gears. Since two pairs of gears are involved, their ratios are "compounded", or multiplied together.

The input gear, with 12 teeth, drives its mating gear on the counter-shaft which has 24 teeth. This is a ratio of 2 to 1.

This ratio of *driven* over *driver* at the Input - 2 to 1 - is then multiplied by the Output ratio, which has a DRIVEN to DRIVER ratio of 3 to 1.

Formula for calculating compound gear ratio is as follows;

$$\frac{\text{Driven}}{\text{Driver}} \times \frac{\text{Driven}}{\text{Driver}} = \frac{\overset{2}{\cancel{24}}}{\underset{1}{\cancel{12}}} \times \frac{\overset{3}{\cancel{42}}}{\underset{1}{\cancel{14}}} = 2 \times 3 = 6:1$$

This gives a gear ratio of 6 to 1 between the input and the output, resulting in a speed reduction and a corresponding increase in torque.

Gear reductions in the lower gears of manual transmissions can be provided by compound gear trains. Typical ratios are; 1st gear - 4.41 to 1 2nd gear - 2.63 to 1 and 3rd gear - 1.61 to 1. Fourth gear is normally a ratio of 1 to 1. The input and output shafts turn at the same speed. There is no torque multiplication. A fifth gear is normally an overdrive ratio, typically with a value of .87 to 1.

Then the output shaft turns faster than the input but the output torque is reduced. A further reduction is always provided by the final drive gears. Their ratio is included when calculating overall gear reduction.

The overall gear ratio is the gearbox ratio multiplied by the final drive ratio. A gearbox ratio of 3 to 1 with a final drive ratio of 4 to 1, gives an overall ratio of 12 to 1. 12 revolutions of the crankshaft result in 1 turn of the driving road wheels. Assuming 100% efficiency, the torque applied is 12 times the engine torque, although this is divided equally between the driving wheels.

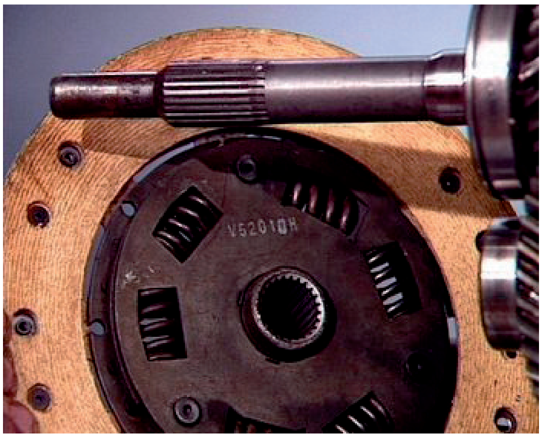
5.0 The 5-Speed Constant Mesh Manual Transaxle System

Key Learning Points

- Elementary internal structure and fundamental principles of operation of the 5-speed constant mesh manual transaxle system, including internal shaft and gear layout and identification, power path identification, gear types, purpose and operation of synchromesh mechanism, reverse gear operation etc.

5.1 Gearbox Operation

In a rear-wheel drive manual transmission, the splines on the input shaft engage with the splines of the clutch-driven plate. With engine rotation and the clutch engaged, the input shaft transfers its motion through the counter-shaft, to rotate the gears on the main shaft.



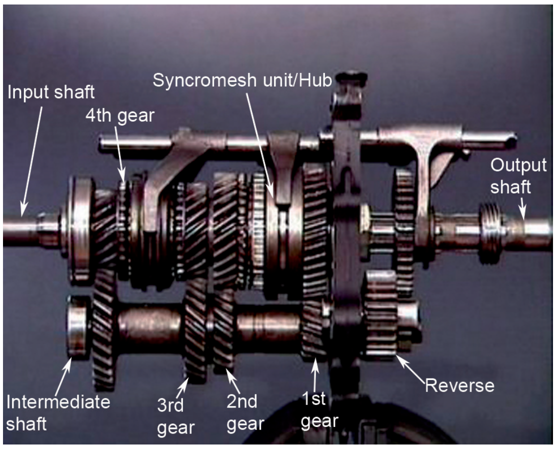
In this neutral condition, the engagement sleeves and hubs splined to the output shaft are stationary. No drive is transmitted to the output.

Depressing the clutch pedal removes the engine load from the input. This allows an engagement sleeve to be moved into engagement with the external teeth on the gear selected. This locks the gear to the main shaft. When the clutch is released, the drive is transmitted to the input gears, along the counter-shaft to the gear selected.

Since this gear is now locked to the main shaft, the main shaft rotates and transfers the drive to the final drive unit. The speed ratio and the torque transferred depend on which gear is selected.

5.2 Gearbox Layout

In a manual transmission for a rear-wheel drive vehicle, the gear train is built up on three shafts. The input shaft extends from the front of the transmission. An external parallel-splined section engages with internal splines on the clutch-driven plate. A main-drive gear is an integral part of the shaft. It meshes constantly with a mating gear on a counter-shaft which has a number of gears formed on it.



These gears mesh with mating gears on the main shaft, or output. These main shaft gears are supported on bearings on the shaft. They can rotate without turning the output. Each main shaft gear has an external toothed section on one side. The teeth face an internally-toothed engagement sleeve located on a central hub, which is itself splined to the main shaft.

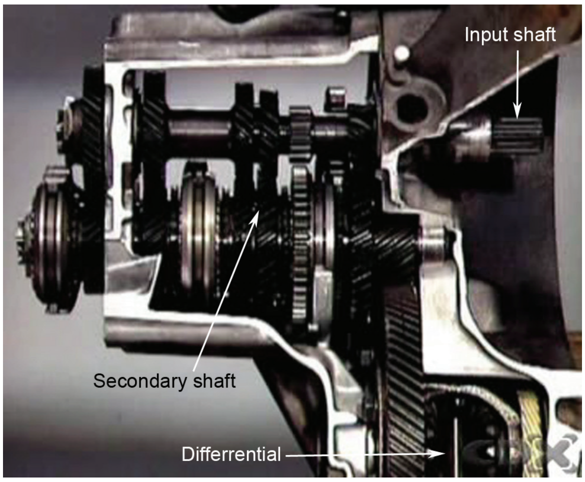
The engagement sleeve can slide in either direction to engage the external teeth on the appropriate gear. This locks the gear through the sleeve and hub, to the main shaft. Before engagement of the components occurs, a synchromesh device between the sleeve and gear synchronizes them.

The gears constantly in mesh have their teeth cut on a helix, at an angle to the gear centre line. This reduces gear noise and distributes load more evenly, as several teeth are in contact at any one time.

Teeth on the reverse idler are normally straight cut or spur gears, cut parallel to the gear centre line. When reverse is selected, this connects the reverse idler with mating gears on the countershaft and main shaft. The reverse idler rotates on a plain shaft fixed in the casing. It transfers the drive from one shaft to the other and reverses the direction of rotation of the main shaft.

5.3 Transaxle Designs

In trans-axle designs, the drive is transferred through the clutch unit to a primary shaft. In this example, the primary shaft carries gears of different sizes, meshed with gears on the secondary shaft.



Each pair has one gear fixed to the primary shaft and one free to rotate on bearings on the secondary shaft. An engagement sleeve and hub, with a synchromesh unit facing each gear, is on the secondary shaft between first and second and similarly between third and fourth. The engagement sleeve moves to engage the dog teeth of the relevant gear when a gear is selected. This locks the gear to the shaft, so drive can be transmitted.

A drive pinion gear fixed to the end of the secondary shaft is constantly in mesh with a final drive ring gear. The drive is transferred through these gears to the differential unit.

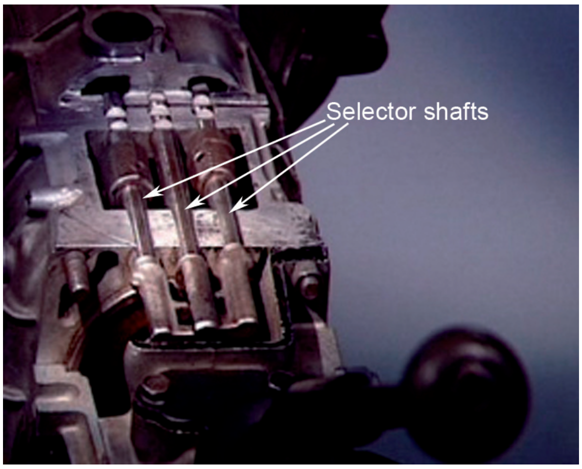
A reverse idler transmits the drive from the primary to the secondary shaft when reverse is selected. A five-speed transmission has an extra fixed gear on the primary shaft, meshed with a mating free gear on the secondary shaft.

The free gear has its own engagement sleeve and synchromesh unit beside it. Selecting fifth gear locks the gear to the shaft. The gear on the primary shaft is larger than the gear on the secondary, so an overdrive ratio is provided. The secondary shaft rotates faster than the primary.

Gears constantly in mesh use helical gearing. Having the gearbox and final drive gears in one casing provides a compact and noise-free unit.

5.4 Gear Selection

A gearshift lever allows the driver to manually select gears via a gearshift mechanism. The lever can be mounted remote from the gearbox, on the floor or on the steering column and connected to the gearbox by a rod linkage or cables. It can also be mounted in the top of the gearbox where it acts through a ball pivot in the top of the extension housing. In this design, the lower end of the gear lever fits into a socket in a control shaft, inside the transmission extension housing.



A short lever on the other end of the shaft is located in a selector gate, formed by slots in the three selector shift rails. They are supported in the casing and are moved backwards or forwards by the lever. One rail moves to engage first or second gear, another serves to engage third or fourth and the other operates fifth or reverse.

A selector fork is attached to the first and second shift rail. It sits in a square section groove on the outside of the first and second engagement sleeve, similarly for the selection of third and fourth gears. The reverse selector fork engages in a groove in the reverse engagement sleeve. Lateral movement of the gear lever positions the control rod in line with the appropriate selector rail. Longitudinal movement is transferred through the control rod and selector rail, to the fork and the engagement sleeve.

Each rail has a detent mechanism, usually in the form of a spring loaded steel ball, held in the casing. The ball engages in a groove in the rail when the gear lever is in neutral and in a similar groove when a gear is selected. This holds the gear, in detention, in the selected position.

When a gear is changed or selected, an interlock mechanism prevents more than one gear being engaged at the same time. In this design, two steel balls locate in the casing, between the centre and the outside shift rails and in alignment with grooves machined in the shift rails. A small plunger is captive in a hole drilled in the centre rail.

In the neutral position, the balls and plunger can move laterally. But when an outside rail is moved, the ball is pushed sideways to contact the plunger and move the opposite ball into the groove of the other outside rail.

The two balls held in the casing prevent movement of the interlocked rails and hold them in the neutral position. When the centre rail is moved, the balls move into the grooves of the outside rails and hold them in a similar manner. All gearboxes are fitted with interlock and detent mechanisms, although designs vary according to manufacture.

5.5 Baulk-Ring Synchromesh Unit

A baulk-ring type of synchromesh unit is commonly used to synchronize the speeds of two gears before engagement. Three metal inserts, with a ridge, fit into slots in the hub. A radial spring at each end holds them out, so that the ridges locate in a groove inside the sleeve and hold it centrally on the hub. When the synchronizer is assembled, the hub is splined to the main shaft and the engagement sleeve is splined to the hub.

A bronze baulk ring, with recesses to accommodate the ends of the inserts, is located in each end of the hub and a conical inner surface faces a matching steel cone on the gear. Fine grooves are machined on the conical surface and the teeth on the outer edge are the same size as the dog teeth on the gear and the spline on the sleeve.

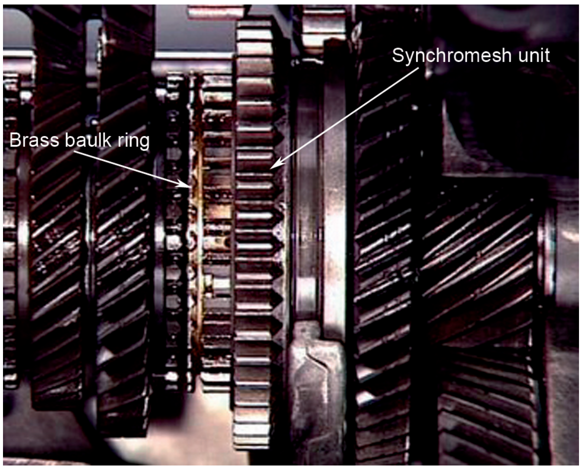
The recesses are wider than the inserts, to allow the baulk ring to move radially. Then the teeth on the baulk ring can be out of register with the teeth on the sleeve. When the sleeve is moved to select a gear, the spring-loaded inserts move the baulk ring into contact with the conical face of the gear. The grooves in the face of the baulk ring help to break through the oil film and the difference in speed of the two components causes the baulk ring to be dragged around with the gear to the limit of the recesses, where it is held by the inserts. Since the teeth of the baulk ring are now out of alignment with the teeth of the sleeve, this baulks, or prevents, the sleeve from moving over the ring into engagement.

The force exerted by the driver now presses the sleeve against the teeth of the baulk ring and forces the conical face against the cone of the selected gear, until the friction created, causes the two components to rotate at the same speed. The baulk ring teeth can now come into alignment and the sleeve slides over them and into engagement. This is assisted by a chamfer on the teeth, which helps to guide the sleeve into position. Smooth and rapid gear changes are thus ensured.

5.6 Transaxle Synchromesh Unit

In transaxle designs, the synchromesh unit is located between the end of each engagement sleeve and the gear. The engagement hubs and sleeves may be located on the primary or on the secondary shaft, depending on design.

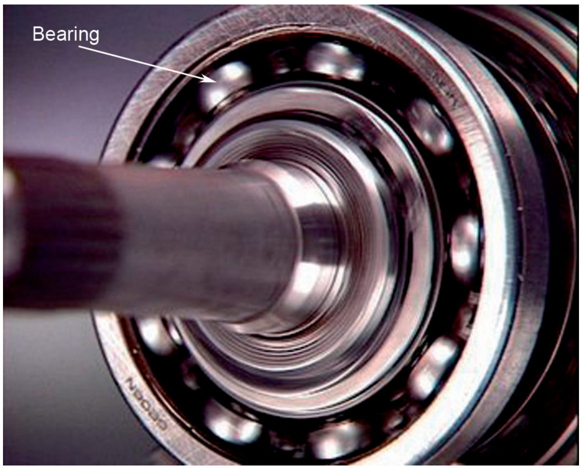
The engagement hub and sleeve for first and second gears is on the secondary shaft, as is the third and fourth speed hub. The fifth gear engagement hub is at the end of the secondary shaft, furthest from the main drive pinion.



When first gear is selected, the engagement sleeve locks the first gear to the secondary shaft. When the clutch is released, the drive is transferred through the fixed first gear on the primary shaft, to the locked gear on the secondary shaft. The secondary shaft rotation transfers the drive through the main drive pinion to the final drive ring gear and the differential case.

5.7 Bearings

In a manual transmission, the gears and shafts are supported on bearings or bearing surfaces. This allows for rotation and also maintains the alignment of the components. The type of bearing used at each locating point depends on the load which must be sustained. Radial loads try to force the gears and shafts apart. The bearing therefore carries the load along its radius.



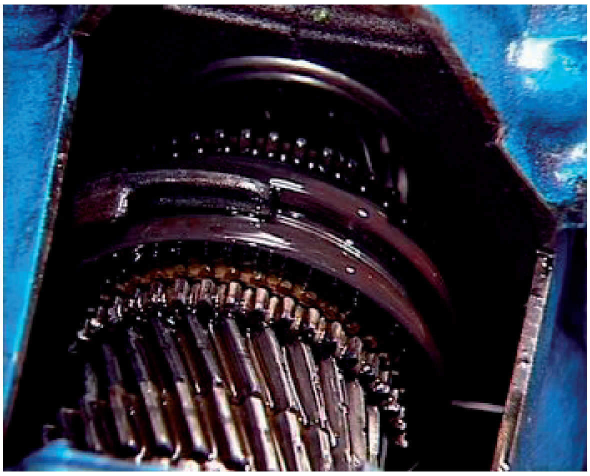
Thrust loads are applied along the length of the components, so the bearing must cater for side thrusts. In many cases these loads are combined and some bearings designed for radial loads will also accept light thrust loads. This applies to most ball bearings.

Single-row, deep-groove ball bearings normally support the input shaft and main shaft in conventional rear-wheel drives. They can also be used at each end of the countershaft.

5.8 Oil seals & Gaskets

The bearings can be lubricated by being submerged in gear oil, or by oil splashed about inside the casing. Where the shafts extend from the casing, oil seals prevent oil leakage and the ingress of dirt and moisture.

Garter spring lip-type seals are normally used. They can be single or double-lipped, depending on the application. They can also be hydro-dynamic type seals, with helical flutes moulded into the sealing lip.



The flutes create a pumping action as the shaft rotates, so any oil at the sealing edge is drawn back inside the casing. Since the flutes are moulded in one direction during manufacture, care must be taken to ensure they are correctly applied, considering the direction of shaft rotation.

O-ring type seals are mostly used for static locations such as the speedometer drive gear housing, while gaskets are used to seal the mating surfaces between the casing and retaining plates or housings.

In some cases, the gaskets may be used as selective thickness shims or spacers, in addition to their sealing function.

6.0 Gear Ratios of a Transaxle Gearbox

Key Learning Points

- Calculation of transaxle gear ratios using specified formula

Note: The formula for calculating compound gear ratio is as follows:

$$\frac{\text{Driven}}{\text{Driver}} \times \frac{\text{Driven}}{\text{Driver}}$$

7.0 Removing and Refitting a Training Unit Transaxle Gearbox

Key Learning Points

- Removal and refitting of a training unit transaxle gearbox

Practical Task

This is a practical task. Please refer to your instructor for additional information, which is available from the automotive technical manuals.

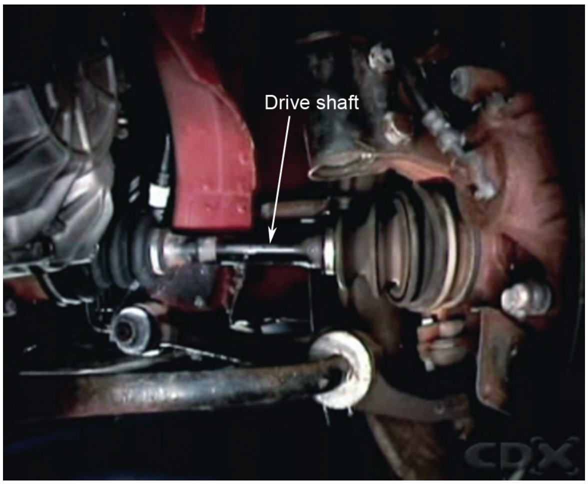
8.0 Constant Velocity (CV) Joints and Halfshafts in the Transaxle Drivetrain

Key Learning Points

- Purpose of the CV joints and halfshafts in the transaxle drivetrain

8.1 Front-Wheel Drive Shafts

In front wheel drive vehicles, the drive shafts transfer the drive directly from the differential to the front wheels.



A short inner stub shaft is splined to the differential side gear and an outer stub shaft is splined to the front wheel hub. Each stub shaft has a yoke, or housing, to accommodate a universal joint, at each end of a connecting intermediate shaft.

Universal joints let the shaft keep rotating while allowing for changes due to suspension movement - such as shaft length and horizontal angle and shaft angle as the steering turns.

Constant-velocity (CV) universal joints are normally used to transfer power smoothly between the components.

The inner universal can be a plunge or tripod type joint. The tripod is splined to the intermediate shaft and held by a circlip.

A ball, supported on needle roller bearings, is fitted to each post of the tripod and these slide in a trunion inside the yoke. This caters for changes in shaft length and horizontal angle. The drive is transferred through the trunion and balls to rotate the shaft. The outer universal joint allows greater angular changes but not changes in shaft length. It is normally a ball and cage type with an inner race splined to the intermediate shaft. An outer race is formed in the yoke. The cage retains the balls in location in grooves in both races. The balls transfer the drive from the shaft to the hub and allow for changes in horizontal angle and for a wide steering angle to be achieved.

A flexible rubber boot fitted to each joint retains grease and keeps out dirt and moisture. Where the differential is not located in the centre line of the vehicle, an intermediate shaft can be fitted to maintain equal length drive shafts on each side. This keeps drive shaft angles equal on both sides and helps prevent steering irregularities and vibration. The outer end of the intermediate shaft is supported by a bearing secured to the transaxle case and a universal joint assists with alignment. In some cases a longer drive shaft is used on one side. A rubber dynamic damper may be fitted to absorb vibrations.

9.0 Removing and Refitting Training Unit CV Joints and Gaiters

Key Learning Points

- Removal and refitting of training unit CV joints and gaiters using manufacturers recommended procedures

Practical Task

This is a practical task. Please refer to your instructor for additional information, which is available from the automotive technical manuals.

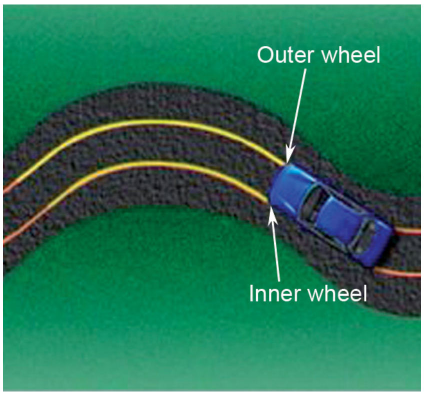
10.0 Final Drive and Differential Units in the Transaxle System

Key Learning Points

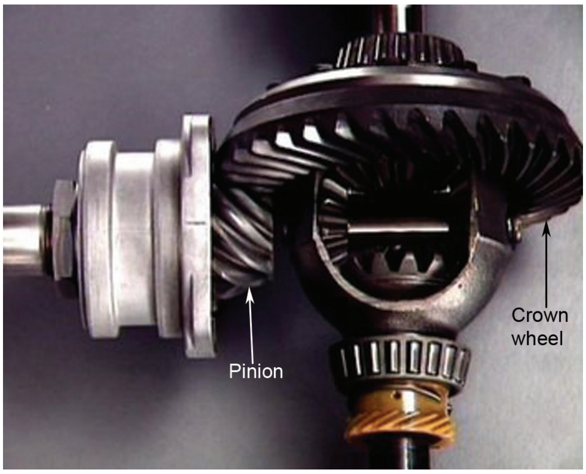
- Fundamental purpose of the final drive and differential units in the transaxle system

10.1 Front-Wheel Differentials

When a vehicle turns, the outer wheel travels a greater distance than the inner wheel, so it turns through more revolutions. The differential allows the 2 drive shafts and the driving road wheels to rotate at different speeds when turning, while still applying an equal turning effort to both. Differential gears are bevel gears, at right angles to each other inside a case, which is supported on bearings in the final drive housing.



Note: Inner wheel has smaller angle than the outer wheel.



The ring gear is bolted to the case, so when it rotates, so does the case and the differential gears inside it. The two smaller bevel gears, or pinions, are mounted on a driving pin which passes through the case. Two side gears mesh with the pinions and are in recesses in the differential case. The drive shafts are splined to these side gears.

When the vehicle travels in a straight line, the ring gear rotates the case. The driving pin and pinion gears rotate end over end, turning the side gears with them and the drive shafts. There is no relative motion between the pinion gears and the side gears: each side gear turns at the same speed. As soon as the vehicle turns from a straight ahead position, the inner wheel slows down and its side gear turns more slowly than the differential case. The turning effort applied to the driving pin, forces the pinion gears to rotate slowly on the pin. They walk around the inner side gear while still being turned end over end. This rotation of the pinion gears makes the outer side gear and its road wheel, speed up by an equivalent amount. The outer side gear then turns faster than the case. This provides an equal turning effort to each drive shaft while allowing for their speed difference.

11.0 NCT/DoT VTM Requirements

Key Learning Points

- NCT/DoT VTM requirements applicable to the transmission system

11.1 NCT Requirements

Refer to Item 57 of NCT manual 2004

12.0 NCT/DoT VTM 'Transmission' Testing

Key Learning Points

- Examination of the components of the automotive transmission system to determine their compliance with NCT/DoT VTM Transmission test requirements
- Use of data manuals/manufacturer's manuals/NCT/DoT VTM Manual

Practical Task

This is a practical task. Please refer to your instructor for additional information, which is available from the automotive technical manuals.

Self Assessment

Q1: What is the purpose of the reverse idler in a manual gearbox? (Tick one box only)

❑ 1. To reverse the rotation of the gearbox at all times

❑ 2. To provide a reverse gear

❑ 3. To reverse the rotation of the gearbox in forward gears

❑ 4. To provide a neutral gear

Q2: A vehicle starting from rest needs a lot of torque. Once it is moving it needs: (Tick one box only)

❑ 1. More power

❑ 2. More torque

❑ 3. Less power

❑ 4. Less torque

Q3: Selecting a higher gear: (Tick one box only)

❑ 1. Reduces engine speed

❑ 2. Increases engine speed

❑ 3. Reduces engine power

❑ 4. Increases engine power

Q4: The oil level of a rear wheel drive gearbox is checked: (Tick one box only)

❑ 1. At the filling plug in the side of the gearbox

❑ 2. With a dipstick in the gearbox

❑ 3. Through the speedometer drive

❑ 4. Through the plug in the base of the gearbox

Q5: When replacing the filler plug it should be tightened: (Tick one box only)

❑ 1. As tight as possible

❑ 2. Finger tight

❑ 3. To manufacturer's specifications

❑ 4. With an adjustable wrench

Q6: Shafts for independent suspension designs do not need to allow for changes in shaft length. (Tick one box only)

- ❑ 1. True
- ❑ 2. False

**Q7: Vehicles with independent rear suspension transfer the drive to each driving road wheel through:
(Tick one box only)**

- ❑ 1. Flexible drive shafts
- ❑ 2. Solid drive shafts
- ❑ 3. External drive shafts
- ❑ 4. Internal drive shafts

**Q8: The oil level in a manual gearbox is correct when:
(Tick one box only)**

- ❑ 1. The oil flows freely from the filler plug opening
- ❑ 2. Fluid leaks slowly from the filler plug opening
- ❑ 3. The oil flows freely from the drain plug opening
- ❑ 4. Fluid leaks slowly from the drain plug opening

Suggested Exercises

1. Use an electronic data facility to procure manufacturer’s appropriate data for use with practical exercises
2. Calculate the gear ratios of a transaxle unit
3. Remove and refit a training unit transaxle gearbox
4. Remove and refit training unit CV joints and gaiters using manufacturer’s recommended procedures

Training Resources

- Training units with transaxle transmission, sectioned 5-speed manual transaxle units, data manuals, manufacturer's manuals, NCT/DoT VTM manual, video/multimedia resources
- Selection of transmission system components (including transaxle shafts/gears/ synchromesh units/final drive and differential units, training unit half-shafts and CV joints, gaiters)
- Torque spanners, ball joint removers, CV joint grease, trolley jacks, axle stands
- Eye protection, latex gloves, face masks, gear oil etc..

Suggested Further Reading

- Advanced Automotive Diagnosis. Tom Denton. ISBN 0340741236
- Automobile Electrical and Electronic Systems (3rd Edition). Tom Denton. ISBN 0750662190
- Automotive Mechanics (10th Edition). William H. Crouse and Donald L. Anglin. ISBN 0028009436
- Bosch Automotive Electrics Automotive Electronics: Systems and Components (4th Edition). Robert Bosch. ISBN 0837610508
- Bosch Automotive Handbook (6th Edition). Robert Bosch. ISBN 1860584748
- Bosch Automotive Technology Technical Instruction booklet series (numerous titles)
- Hillier's Fundamentals of Motor Vehicle Technology: Book One (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780823
- Hillier's Fundamentals of Motor Vehicle Technology: Book Two (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780998
- Modern Automotive Technology. James E. Duffy. ISBN 1566376106
- Motor Vehicle Craft Studies - Principles. F.K. Sully. ISBN 040800133X
- National Car Test (NCT) Manual (Department of Transport, Vehicle Testers Manual - DoT VTM). Department of Transport
- Transmission, Chassis and Related Systems (Vehicle Maintenance and Repair Series: Level 3) (3rd Edition) John Whipp and Roy Brooks. ISBN 186152806X
- Vehicle and Engine Technology (2nd Edition). Heinz Heisler. ISBN 0340691867
- http://www.cdxglobal.com/
- http://auto.howstuffworks.com/
- http://www.autoshop101.com/
- http://www.cdxetextbook.com/
- Automotive Encyclopedia and Text Book Resource (CD version of e-textbook), Available from your instructor.

Notes

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