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DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

OMT-1

SELECT THE GEAR RATIOS ON A MANUAL TRANSMISSION

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INDEX

The following elements are contained in this learning guide:

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OBJECTIVE:

WHAT YOU MUST DO

1. Position the gears on a model of a transmission (gear box) to show the gear trains for 1st gear, 2nd gear, 3rd gear, 4th gear 5th gear and reverse gear.

2. Describe the function and operation of a synchronizing mechanism.

WHAT YOU WILL BE GIVEN

1. A cut-away model of a transmission (gear box)

2. All the necessary tools and equipment.

HOW WELL YOU MUST DO IT

1. All the gear positions must be selected.

2. The function of the synchronizing mechanism must be described correctly.

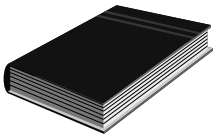
3. The operation of the synchronizing mechanism must be described correctly.

ADDITIONAL RESOURCES:

1. A demonstration by a competent person, e.g. your instructor.

2. Workshop manual.

3. Audio-visual aids, if available.



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HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

OT

OVERHAUL AND MAINTAIN TURBO CHARGERS

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS(BY RESPONSIBLE PERSON)
• Use hand tools	• Using damaged tools or wrong tools for the job can cause injury and damage to equipment.	• Always use the correct tool for the job. • Ensure tools are in good condition. • Use tools correctly. • Wear appropriate PPE where necessary. • Always take good care of tools. Maintain, clean and store it properly.

NOTE:Before doing the practical work contained in this module, the learnermust study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of Learner: _____

Signature of Training Officer: _____

Date: _____

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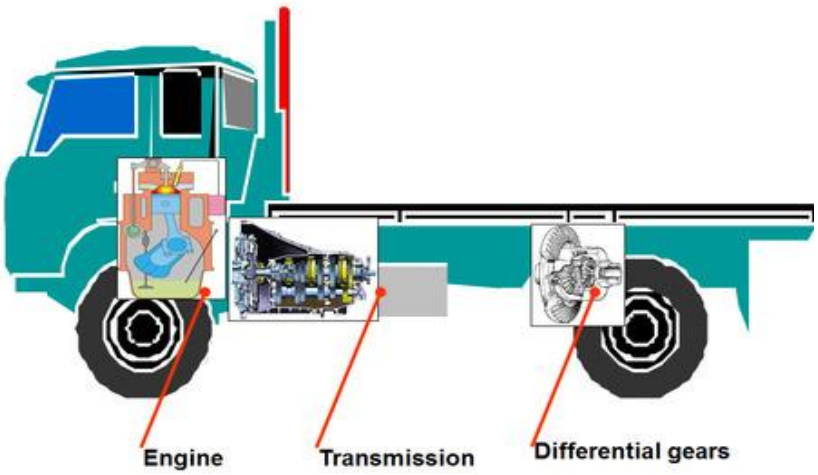
SELECT THE GEAR RATIOS ON A MANUAL TRANSMISSION

ITEM/TASK: Introduction

DESCRIPTION:

A normal engine will have enough power to move a vehicle without a transmission, provided that the vehicle only runs on reasonably level roads and at set speeds. However, when the vehicle must be moved from a stationary position up a steep incline, the engine will not provide sufficient power to do it, and will stall.

A transmission enables changes in the speed of the drive wheels to be made in relation to the engine speed.



This allows slower speeds when starting off the machine and faster speeds to match various loads and conditions.

In motor vehicles, more turning force (torque) is needed on the rear wheels to start moving than is needed for cruising along a good freeway. The transmission gives this increased torque and also allows the engine to be accelerated. This is important because the engine does not develop very much power at low engine speeds. When the vehicle has gained speed, the transmission is shifted to change the speed ration between the engine and the wheels and eventually is shifted into direct drive.

In tractors and other earthmoving machines, there is an even greater speed of reduction to give more torque for traction and for pulling loads.

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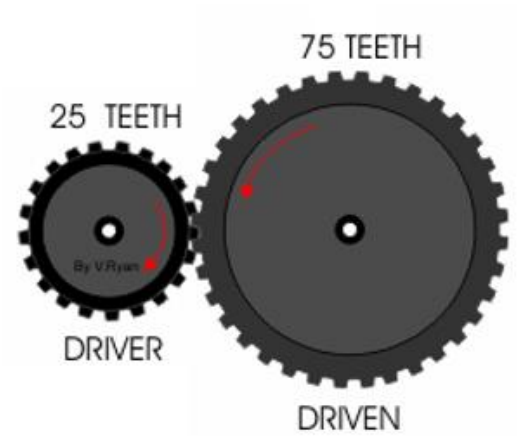
The transmission is a system of gears. Suppose there is a small gear with 25 teeth driving a larger gear with 75 teeth as shown in Fig. 1.

Fig 1



When the small gear has made one complete revolution, it has gone around the equivalent of 25 teeth. The larger gear has moved the same distance (25 teeth) but this is only one-third of a revolution for it. As a result, the larger gear and its shaft turns at one-third the speed of the small gear and its shaft.

The gear **Ratio** is the number of revolutions a drive gear must turn before the driven gear completes one revolution. Gear ration is calculated by dividing the number of teeth on the driven gear by the number of teeth on the driver.
If the driven gear has 75 teeth and the driver has 25 teeth, then the gear ratio is 3:1

The first number in the ratio is usually the gear to which power is applied. In an automobile the first number is the gear receiving power from the engine.

NB: The smaller gears always turn at a faster rate.

This is the principle of a transmission. Several combinations of gears are arranged so that the speed required at any time can be selected.

For low or first gear, a small gear on the input shaft drives a large gear on another shaft (Fig. 2 on the next page).

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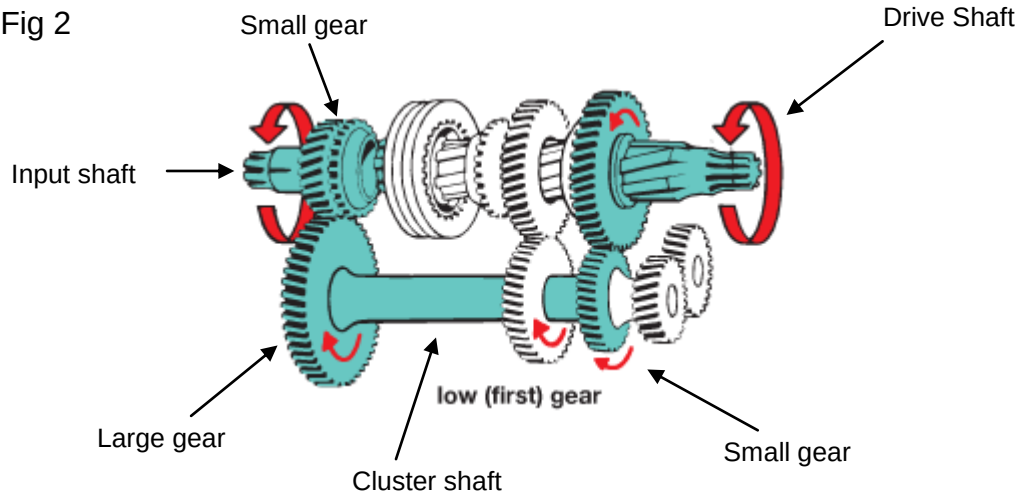
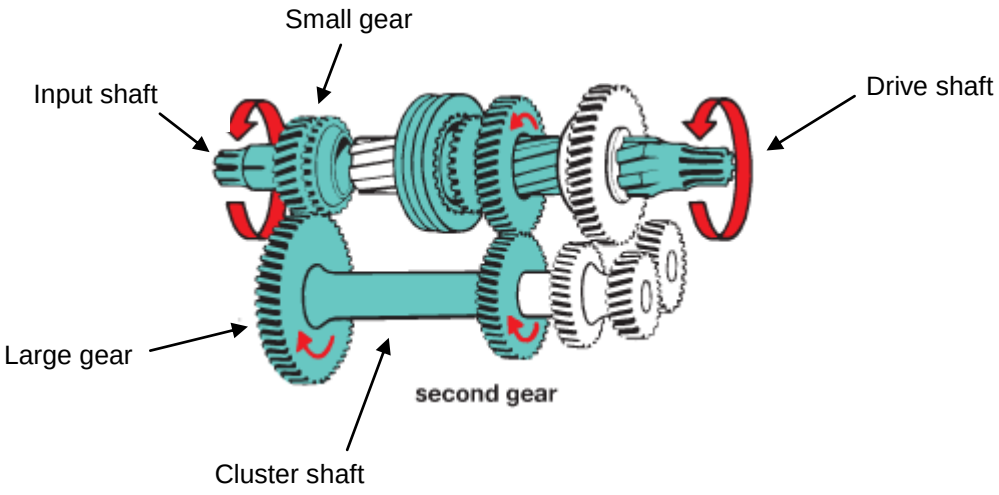
Fig 2



This will reduce the speed and increase the torque. A small gear on the cluster shaft, in turn, drives a larger gear on the drive shaft which goes to the driving wheels. This reduces the speed and increases the torque still more, giving a lower gear ration for starting off or heavy pulling.

For second gear, another pair of gears as in low gear is used. However, the first pair of gears is disconnected and the drive takes place through two other gears (Fig.3)

Fig 3



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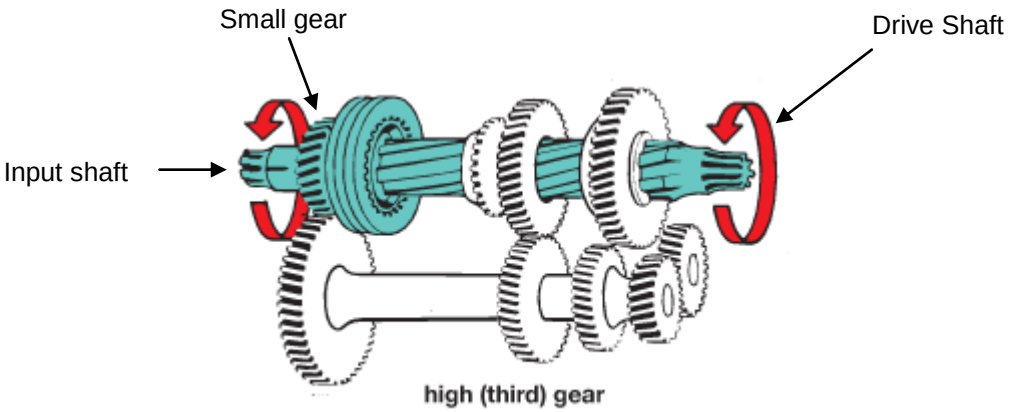
Gears are arranged so that the larger one drives the smaller, and therefore there is less overall speed reduction than in the first gear.

For higher gears, the gear ratio is changed further by using other gear combinations. In fact, high gear for an automobile is normally a direct drive with no reduction. (Fig 4)

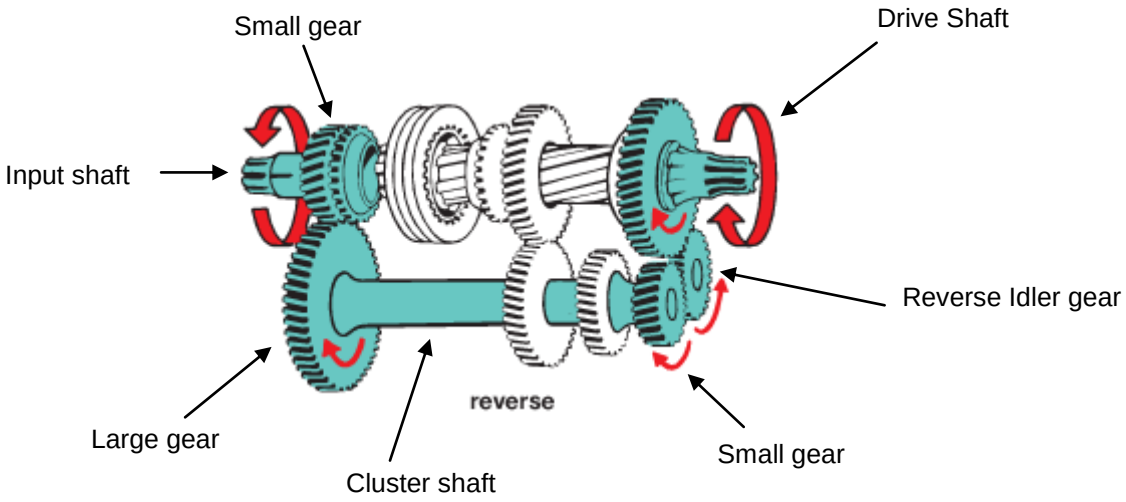
Fig 4



NB: Lower gear range = less speed but more torque.
Higher gear range = less torque but more speed.

Reverse gear is very much like first gear giving about the same ratio and using the same four gears. However, it also uses an extra gear called a reverse idler gear. (Refer to Fig. 5)

Fig 5



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This idler gear causes the drive shaft to turn in the opposite direction.

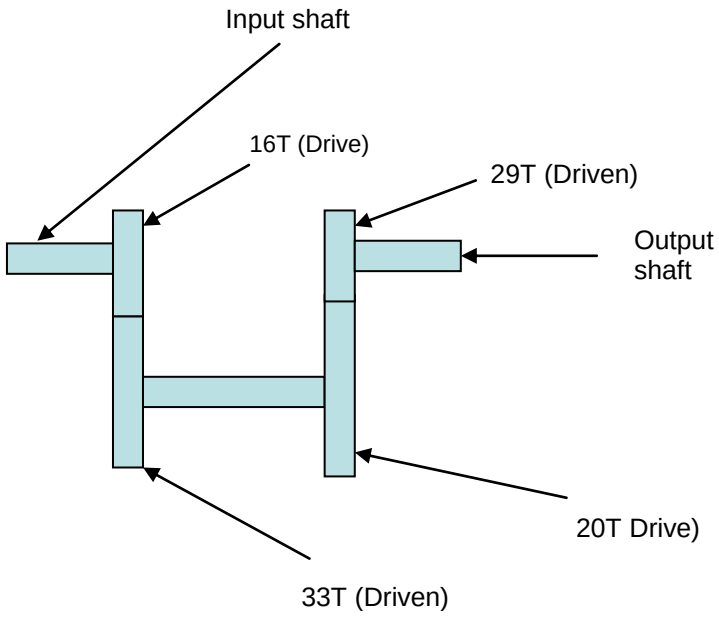
All the gears are mounted in a metal case filled with a high viscosity grade e.g. 80W90 GL4 oil which lubricates the gears and bearings.

GEAR RATIO

Automobile drive trains generally have two or more areas where gearing is used: one in the transmission, which contains a number of different sets of gearing that can be changed to allow a wide range of vehicle speeds, and another at the differential, which contains one additional set of gearing that provides further mechanical advantage at the wheels.
In other words, the gear ratio is proportional to ratio of the gear diameters and inversely proportional to the ratio of gear speeds.

To determine the gear ratio of a selected gear in a manual transmission, you need to do the following calculation. The product of number teeth of the **Driven** gears, divided by product of the number of teeth of the **Drive** gears of that specific gear selection, remembering that there are two sets of gears involved. (Fig. 6)

Fig 6



The formula then for this gear selection is:

Driven Gears	33 X 29	**957**	**Gear ratio is 2.99:1**
Drive Gears	16 X 20	**320**	

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Typical Gear ratios of a motor vehicle:

Gear	1st gear	2nd gear	3rd gear	4th gear
Ratio	4.8 : 1	2.9 : 1	1.5 : 1	1 : 1

SUMMARY

The function of the transmission is to permit changing the speed, torque and the direction of rotation of the drive wheels. See table 1.

Table 1.

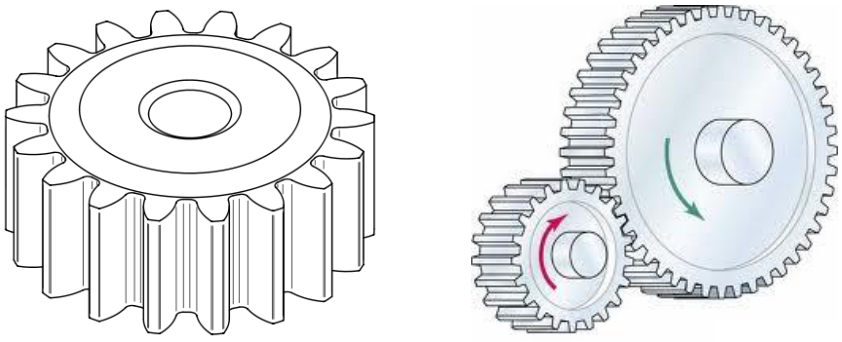
Gear	**Ratio**	**RPM at Transmission Output Shaft with Engine at 3,000 rpm**
1st	2.315:1	1,295
2nd	1.568:1	1,913
3rd	1.195:1	2,510
4th	1.000:1	3,000
5th	0.915:1	3,278

TRANSMISSION GEARS

Transmission gears are made of high quality tough steel. After the gears have been machined, the teeth are heat treated to produce a smooth and hard wearing surface.

The teeth of transmission gears are of two principal types, i.e. spur and helical (Fig. 7)

Fig 7



Spur gears

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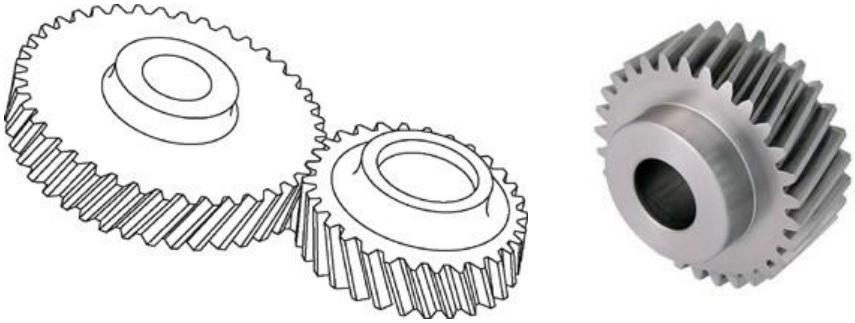
The gear with the helical teeth is superior in that it runs quieter and is stronger because more tooth area is in contact at the same time. Helical gears must be mounted firmly as there is a tendency for them to slide apart due to their spiral shape. (Fig. 8)

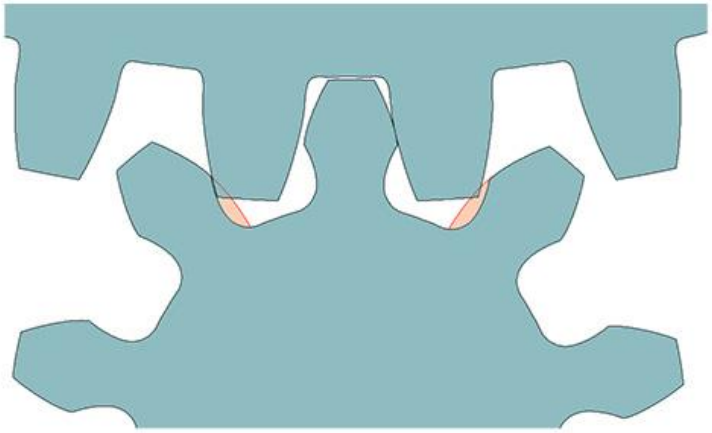
Fig 8



Helical gears

There is a small amount of clearance between the gear teeth to allow for lubrication, expansion and possible size irregularity (Fig. 9). This clearance is very small, only a few hundreds of a millimetre.

Fig 9



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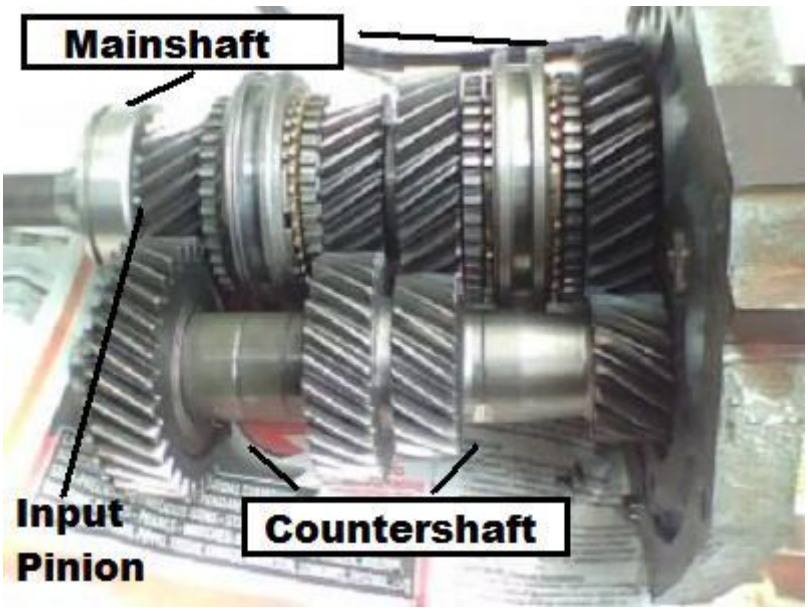
SYNCHRONIZING MECHANISM

When a vehicle is in motion, the rear wheels will turn the output shaft and any gears connected to it continuously. On the other side of the transmission the input shaft and any gears attached to it will turn at a different speed and will slow down or stop altogether when the clutch is depressed. (Fig. 10)

Fig 10



The gear teeth will be subjected to damaging impact if an attempt is made to mesh a gear on the input shaft with a gear on the output shaft. The sound of "grinding" gears when "changing gears", results from the sliding gear teeth literally smashing against the cluster gear.

For one gear to mesh with another quietly and without any damage, both gears must rotate at the same speed. Most standard transmissions are equipped with a device called a synchronizer. Its function is to move ahead of the gear that is to be meshed, and by frictional force to bring the rotational speed of both gears to the same speed. Once both gears are rotating at the same speed, it is possible to mesh the gears without damaging them.

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a) Examples of synchronizing device. (Fig. 11 (a) (b) (c))

Fig 11 (a)

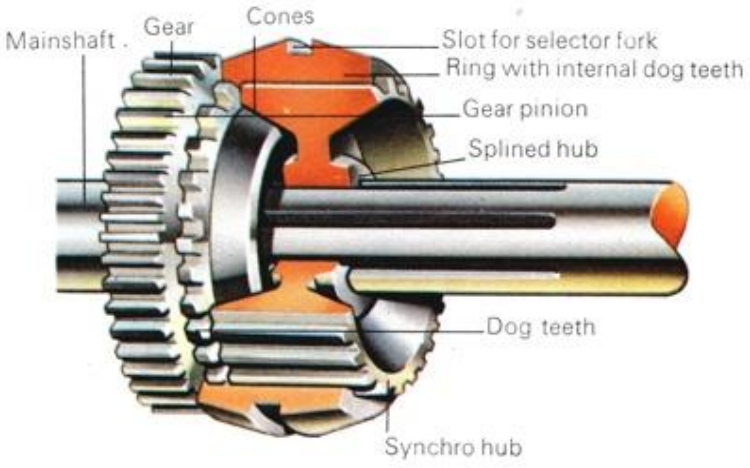


Fig 11 (b)

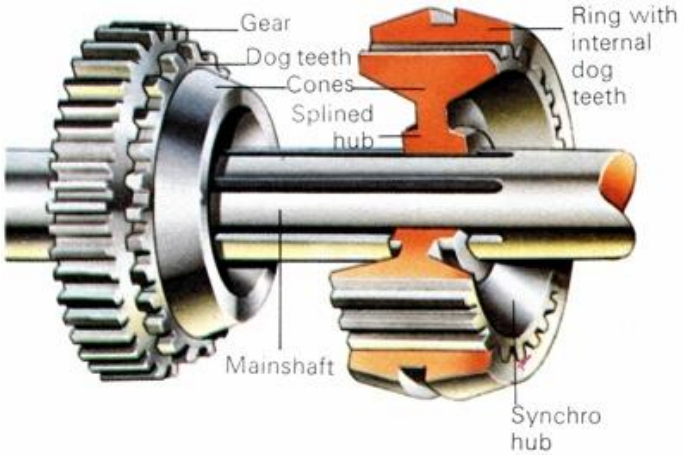
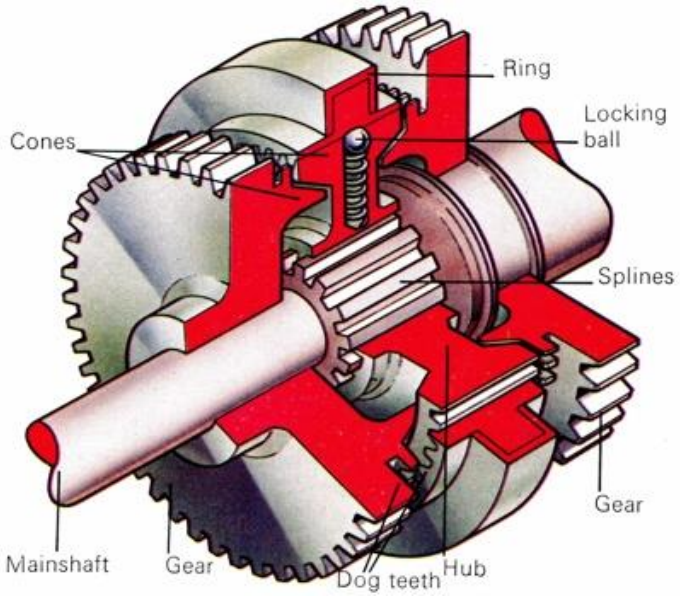


Fig 11 (c)



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b) Operation of a synchronizing device. (Fig. 12)

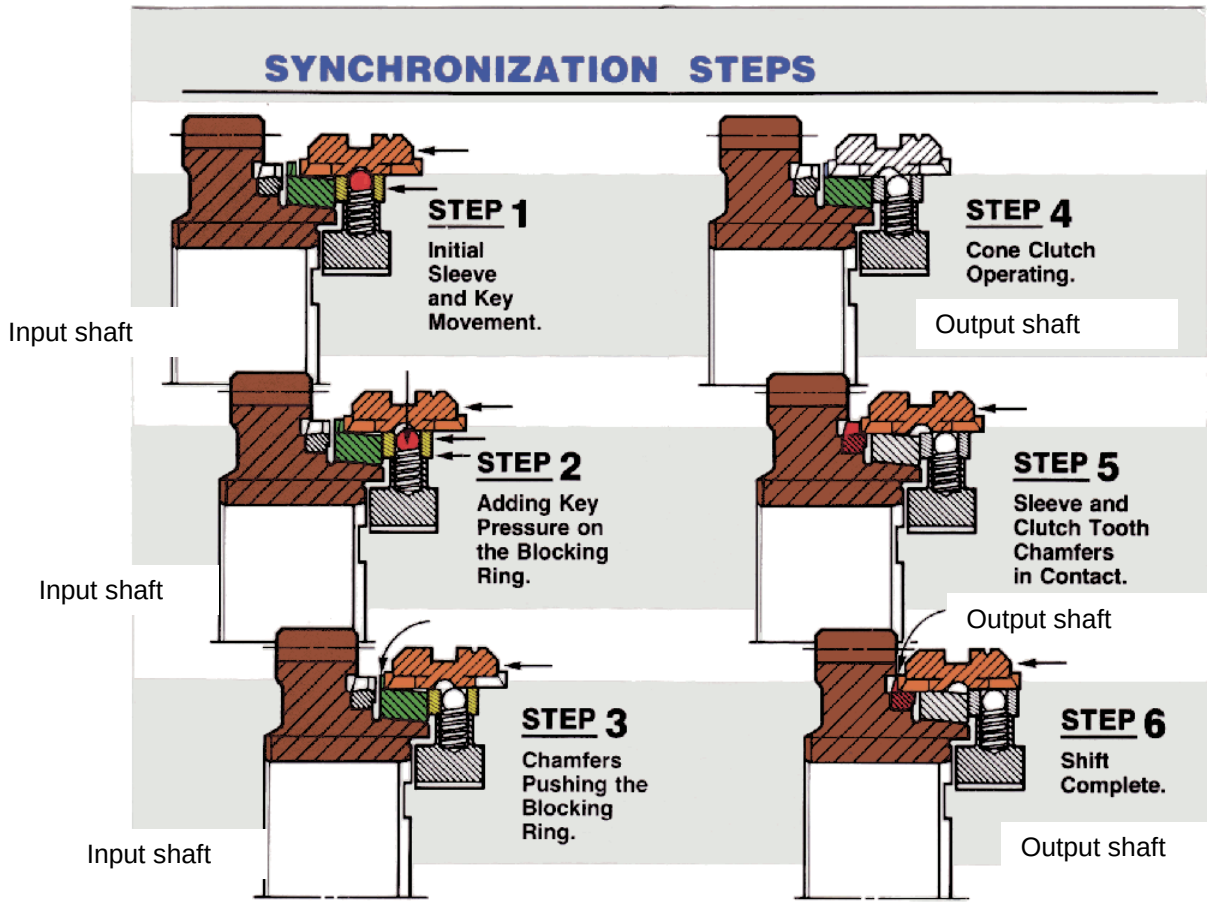

Fig 12

The input shaft is stopped when the clutch is disengaged. The output shaft is driven by the rear wheels of the vehicle (Fig.12)

In order to mesh the splined hub with the splined recess in the gear on the input shaft, it is necessary to turn the input shaft at the same speed as the output shaft. This is done by means of the cone ring which is an extension of the hub. The ring is supported on spring loaded pins which fit into the holes in the hub.

Step 1

When the splined hub is moved towards the splined recess, the cone ring will touch the cone-shaped bottom of the recess.

Step 2

As the hub moves closer to the recess, the springs will exert a force on the cone ring to push it tightly against the bottom of the cone recess.

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Since the cone ring is turning with the output shaft it will impart torque to the input gear and start to turn it.

Step 3 and 4

As the hub moves closer, the spring pressure will increase and the cone ring will be jammed into the cone recess with enough force to spin the input shaft at the same speed as the output shaft.

Step 5

The hub can now be meshed into the recess without any grinding or shock.

Step 6

Shift complete. (Engaged)

Low gear is generally used for starting off, and since all gears are stopped when the vehicle is not in motion and when the clutch is depressed, synchronizing the low gear is not absolutely necessary. This permits low or first gear to be engaged while the vehicle is still in motion.

NB: There are several different types of synchronizer units used in manual transmissions, but most of them have the same principle parts, i.e. **synchronizing sleeve** =clutch sleeve and synchronizing cones = **blocking rings**.

GO ON TO THE NEXT PAGE TO DO THE SELF TEST.

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SELF TEST 1

Without referring to your notes, answer the following questions:

1. What is the function of a transmission in a vehicle?

_____

_____

_____

2. What is the function of a synchronizing mechanism?

_____

_____

_____

3. Describe the operation of a synchronizing mechanism?

_____

_____

_____

_____

4. How is power multiplied through a gearbox?

_____

_____

5. Name and describe all shafts in the transmission.

_____

_____

_____

_____

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6. What is the purpose of the blocking rings in a synchro unit?

_____

_____

7. Calculate the gear ratios for the following gear selections.

Driven Gear	33	35	Gear Ratio =
Drive Gear	15	14	

Driven Gear	33	20	Gear Ratio =
Drive Gear	15	24	

Check your answers with the notes. If they are correct, ask your training officer to sign you work off. Then go on to the next section.

If your answers are not correct, read the notes over and do the test again.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

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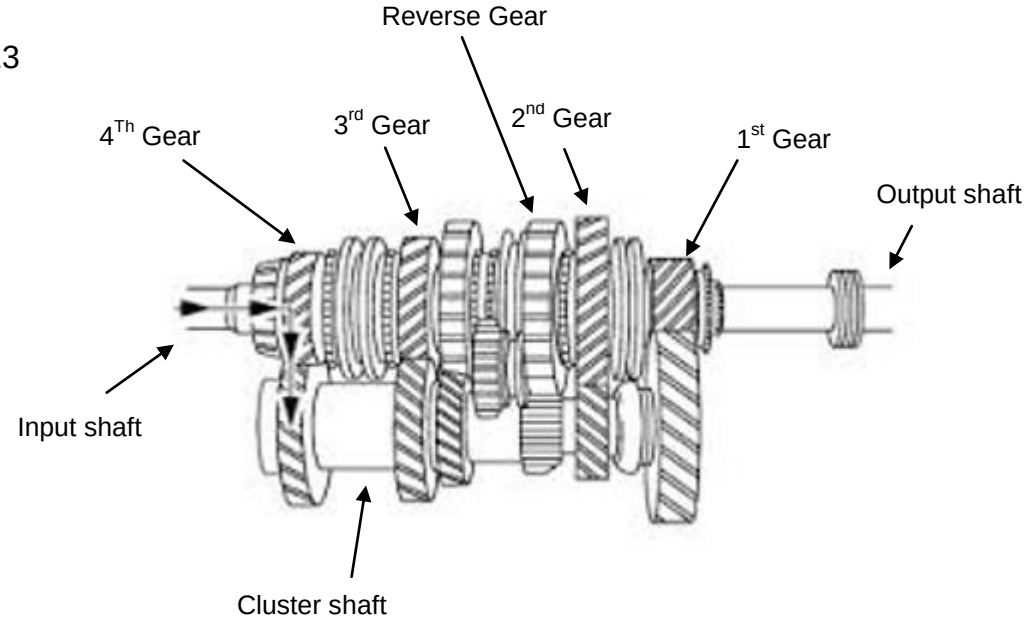
POWER FLOW IN A FIVE SPEED SYNCHROMESH TRANSMISSION

a) Neutral

In neutral, the power flow is from the input gear to the cluster drive gear then to the constant mesh gears. Since all the synchromesh clutch sleeves are in neutral, the constant mesh gears will revolve on the output shaft and no power will be transmitted (Fig. 13).

Fig 13



NEUTRAL

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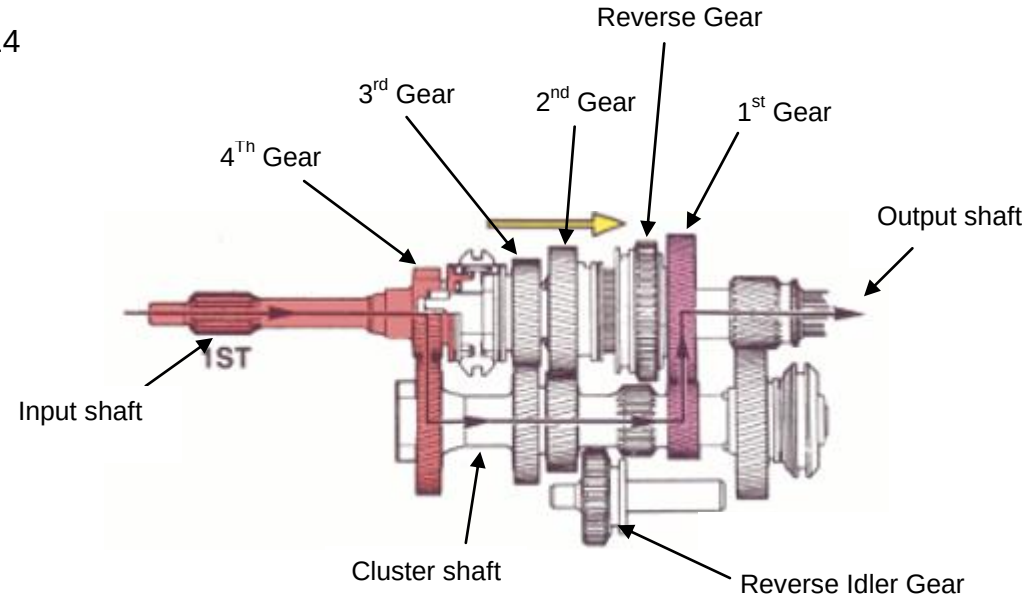
b) First gear

The third/fourth and fifth gear synchronizing sleeve is moved to the neutral position. The first and second synchronizing sleeve is moved to the right, so that the synchronizing sleeve engages with the teeth or splines on the first gear (See Fig.14)

Fig 14



FIRST GEAR

The power flow is from the input shaft to the cluster drive gear, then from the 1st cluster drive gear to the 1st gear on the main shaft, through dog teeth to the synchronizing sleeve to the hub, then through the splines in the hub to the output shaft.

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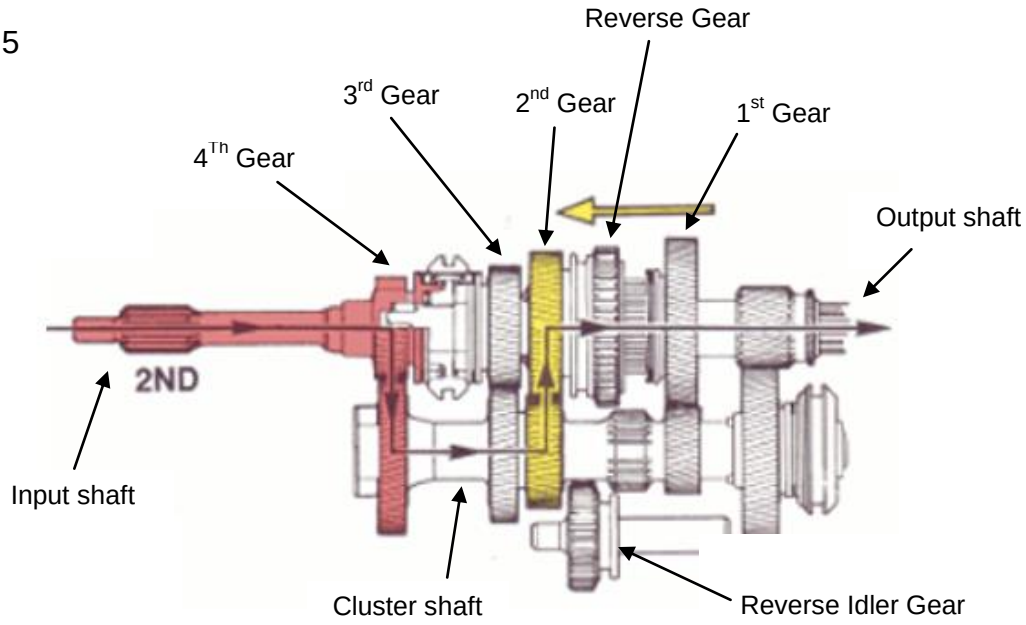
c) Second gear

The third/fourth and fifth gear synchronizing sleeve is in the neutral position. The first and second gear synchronizing sleeve is moved to the left, so that the synchronizing sleeve engages with the teeth or splines of the second gear (Fig. 15).

Fig 15



SECOND GEAR

The power flow is from the input shaft to the cluster drive gear, then from the 2nd cluster drive gear to the 2nd gear on the main shaft, through dog teeth to the synchronizing sleeve to the hub, then through the splines in the hub to the output shaft.

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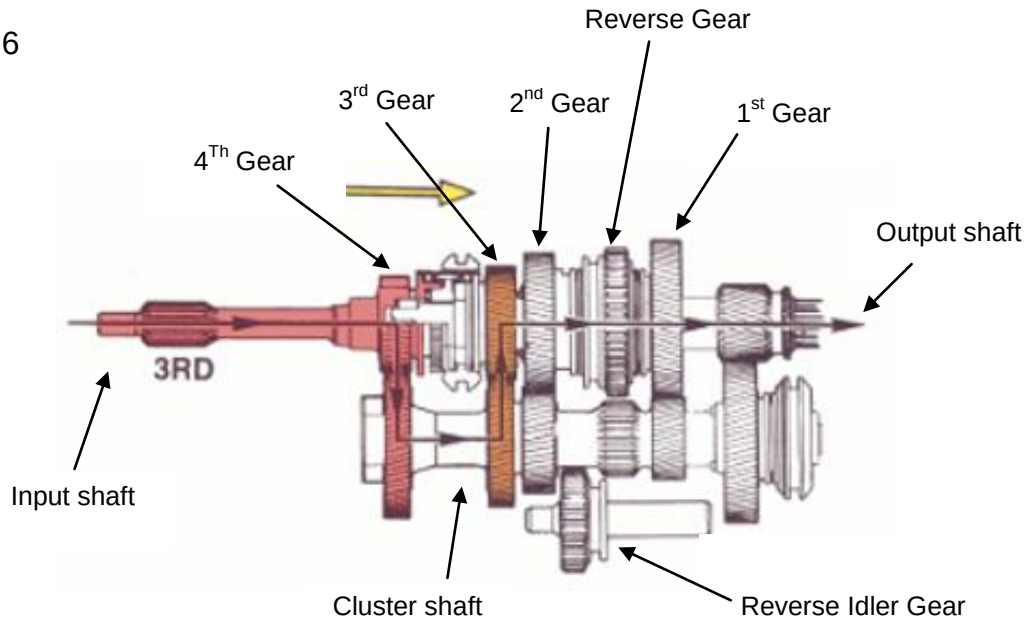
d) Third gear

The first/second and fifth gear synchronizing sleeve is in the neutral position. The third and fourth gear synchronizing sleeve is moved to the right to engage the synchronizing sleeve with the teeth or splines of the third gear. (Fig. 16)

Fig 16



THIRD GEAR

The power flow is from the input shaft to the cluster drive gear, then from the 3rd cluster drive gear to the 3rd gear on the main shaft, through dog teeth to the synchronizing sleeve to the hub, then through the splines in the hub to the output shaft.

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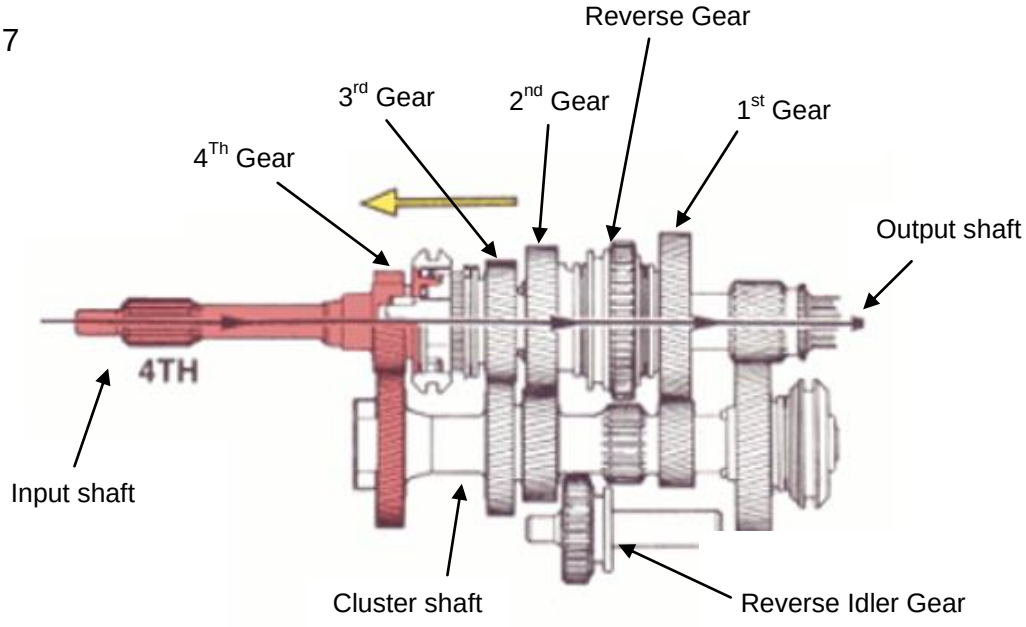
e) Fourth gear

The first/second and fifth gear synchronizing sleeve is in the neutral position. The third and fourth gear synchronizing sleeve is moved to the left to engage the synchronizing sleeve with the teeth or splines of the fourth gear (Fig. 17)

Fig 17



FOURTH GEAR

The power flow is from the input shaft to the cluster drive gear, from the cluster drive gear to the fourth gear, and then through the synchronizing sleeve to the hub, through the splines then to the output shaft. The input and output shafts are therefore now operating as a unit giving a 1:1 ratio.

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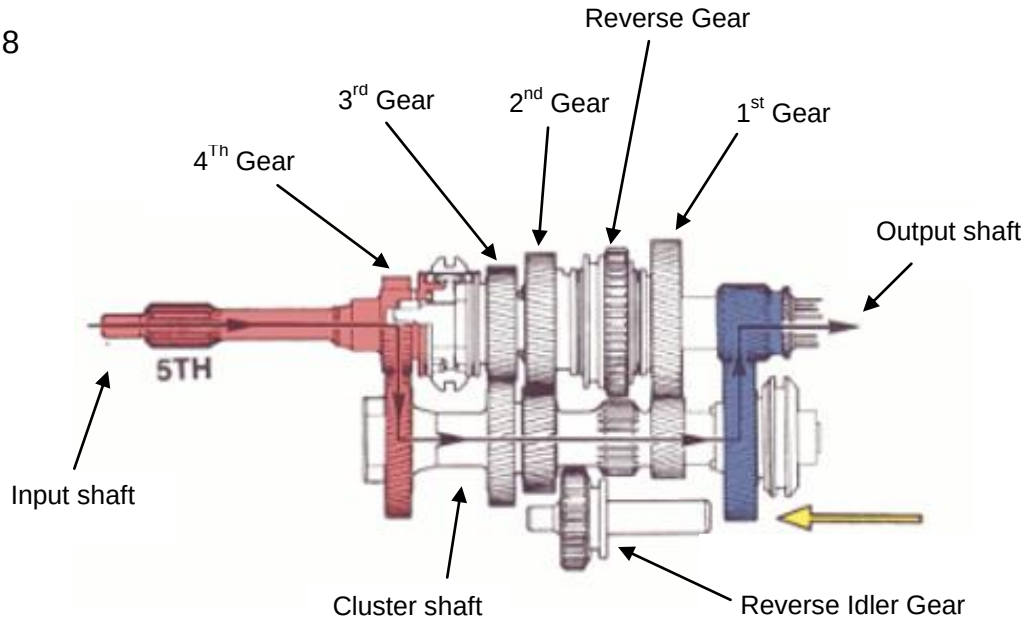
f) FIFTH GEAR

Both the first/second and the third/fourth gear synchronizing sleeves are in the neutral position. The fifth gear synchronizing sleeve is moved to the left to engage the synchronizing sleeve with the teeth or splines of the fifth gear (Fig. 18)

Fig 18



FIFTH GEAR

The power flow is from the input shaft to the cluster drive gear, then from the fifth cluster drive gear to the fifth gear on the main shaft, through dog teeth to the synchronizing sleeve to the hub, then through the splines in the hub to the output shaft.

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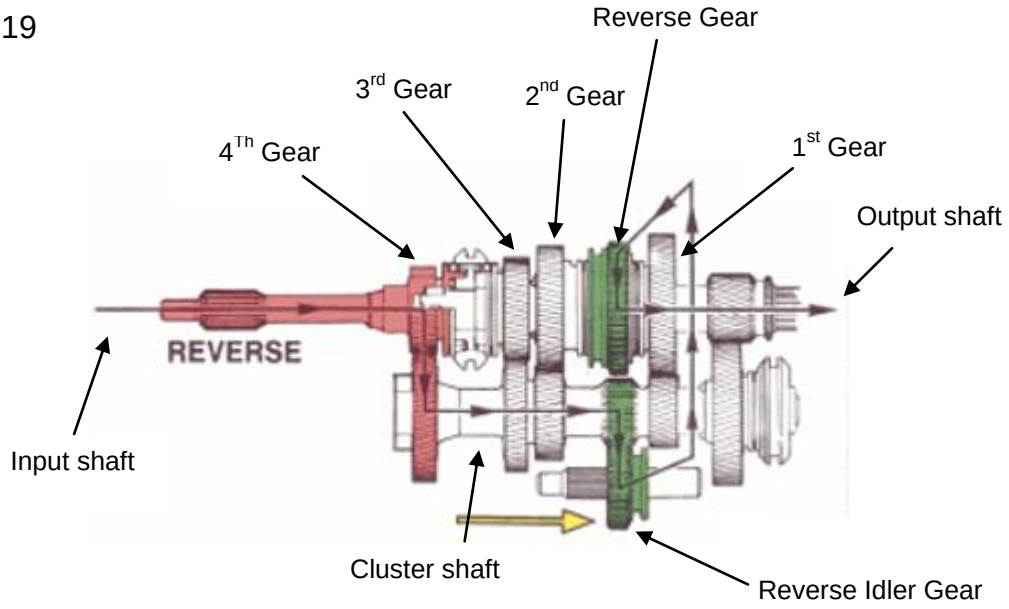
g) Reverse

The first/second, third/fourth and fifth gear synchronizing sleeves are in the neutral position. The reverse idler gear, which moves to the left and mesh with the reverse gear (Fig. 19)

Fig 19



REVERSE GEAR

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SELF TEST 2

Without referring to your notes, answer the following questions:

1. Draw and describe the power flow for the following gear positions:

1st Gear

_____

_____

2nd Gear

_____

_____

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3rd Gear

_____

_____

4th Gear

_____

_____

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5th Gear

_____

_____

Reverse Gear

_____

_____

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

GO ON TO THE NEXT PAGE FOR THE PRACTICE.

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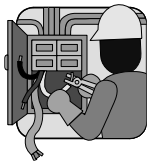

PRACTICE

Go to the model and position the gears in the gear train for 1st, 2nd, 3rd, 4th, 5th and Reverse gears.

Call your training officer to check your work and ask him to sign you off if it is correct.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

REMEMBER ALWAYS WORK SAFE

Once you have passed the entire self tests and practices, you are now at liberty to request a Formative Assessment from your Assessor.