

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: OMT-2

OVERHAUL A MANUAL TRANSMISSION



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OBJECTIVE.

What you must be able to do:

Given a manual transmission you must be able to :

- Dismantle, assess and assemble the transmission.
- Complete the attached condition report on the transmission.

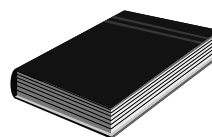
HOW WELL YOU MUST DO IT.

- The transmission must be stripped without damage to any parts.
- The condition report must be correctly completed.
- The unit must be assembled correctly and without damage to any parts or fasteners.
- All the bolts and nuts must be torqued to specifications.
- All clearances must comply with specifications given in the workshop manual.
- All the locking devices must be fitted.
- It must be possible to select all the gear ratios.

WHAT YOU WILL BE GIVEN.

- All the necessary tools and equipment.

SOURCES REFERENCE.



- A demonstration by a competent person, e.g. your instructor.
- Workshop manual. [OEM “Original Equipment Manufacturer”] Specification and operational manual.
- Audio-visual aids, if available.



HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM



OMT-2

OVERHAUL A MANUAL TRANSMISSION

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
<ul style="list-style-type: none"> Drain Gearbox oil 	<ul style="list-style-type: none"> Oil spillage can be slippery and can cause slip and fall accidents Oil spillage can cause environmental hazards 	<ul style="list-style-type: none"> Always use Personal Protective Equipment Always use an oil container to store and protect oil from spilling. Clean-up oil spillages immediately <p>Note: Oil is a hazardous substance and must be traded according the environmental procedures [As your Instructor to assist with information regards the treatment of all hazardous materials]</p>
<ul style="list-style-type: none"> Clean Gearbox outer casing Use hand tools 	<ul style="list-style-type: none"> Cleaning materials can be hazardous, consult your OEM or MSDS Using damaged tools or wrong tools for the job can cause injury and damage to equipment. 	<ul style="list-style-type: none"> Use approved PPE Always use the correct tool for the job. Use specialized tools and equipment prescribed by the OEM Use tools correctly. Always take good care of tools. Maintain, clean , inspect and store them properly.
<ul style="list-style-type: none"> Disposal of oil 	<ul style="list-style-type: none"> Environment impact 	<ul style="list-style-type: none"> Oil to be dispose at authorized recycle centres.



NOTE: Before doing the practical work contained in this module, the learner must 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: _____



1. INTRODUCTION TO MANUAL TRANSMISSIONS

ITEM / TASK: The MANUAL TRANSMISSION

DESCRIPTION:

1. INTRODUCTION

These notes will cover the dismantling of a manual transmission in a sequence that would normally be followed after the unit is removed from the vehicle and is going to be completely overhauled. The notes should be used together with the maintenance or service manual.

2. DISMANTLING THE MANUAL TRANSMISSION

CAUTION: Cleanliness is very important and an absolute must when repairing and overhauling this unit. Before attempting any repairs, the exterior of the unit must be thoroughly cleaned to prevent the possibility of any dirt entering the mechanism.

Typical four speed transmission

a) Operation of synchromesh

The transmission shown in Fig. 1 (**on the next page**), provides synchromesh for all the gears except reverse gear. In this synchronizer design, the synchronizer hub does not move. When the clutch hub sleeve is shifted, it forces the cone-shaped blocking ring with it. The blocking ring engages the other part on a similar taper and synchronizes the two. Additional pressure on the clutch sleeve causes it to slip on the clutch hub inserts. These inserts move the blocking rings and engages the splines on the other part. When disengaged, it snaps back into the notch in the middle of the hub inserts, causing them to release pressure on the blocking ring.



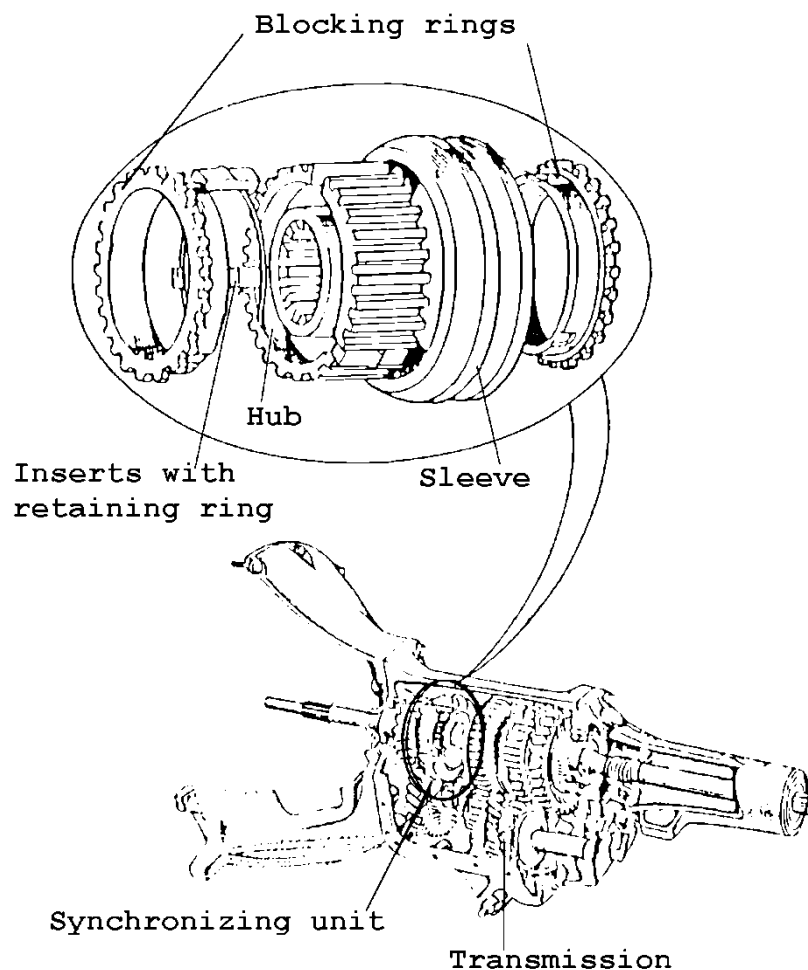


FIG. 1

b) Dismantling

- Position the transmission assembly in a suitable holding fixture (stand).
- Make sure that the transmission has been drained. If not, ask for a suitable oil pan to drain the oil.

NEVER DRAIN OIL ONTO THE FLOOR.

- Remove the gear shift assembly and cover (Fig. 2).



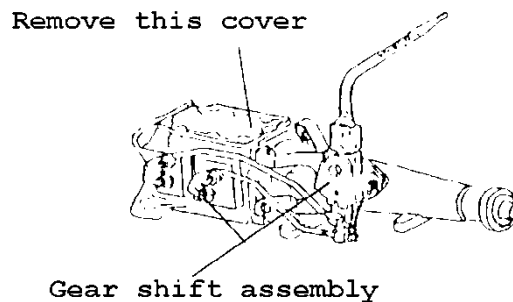
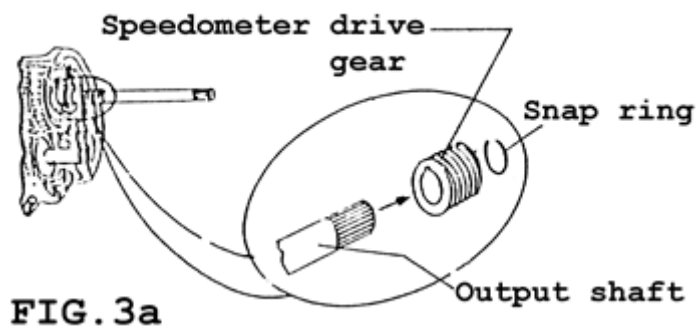


FIG. 2

Lock the transmission in tow gears, then remove the U-joint flange (yoke) and oil seal. Refer to Fig. 3.

- Remove the speedometer driven gear (Fig. 3).
- Remove the speedometer drive gear snap ring and slide the speedometer drive gear off the output shaft (Fig. 3(a)).



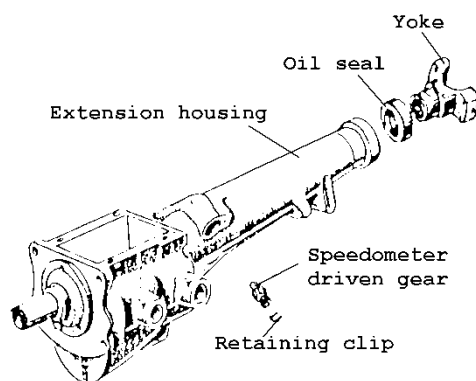


FIG. 3

Remove the output shaft bearing snap rings from the output shaft and from the bearing (Fig. 4).

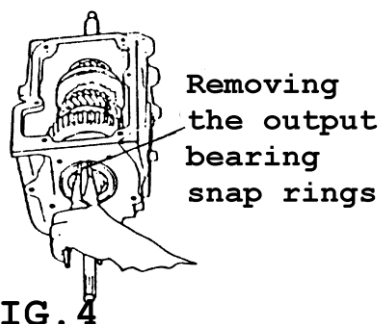


FIG. 4

Install the bearing extractor tool on the output shaft and over the output shaft bearing (Fig. 5). Remove the output shaft bearing

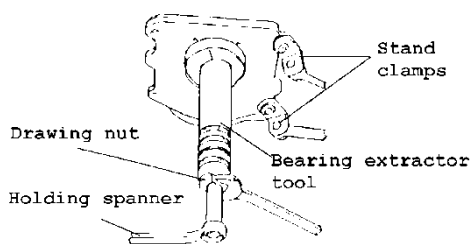
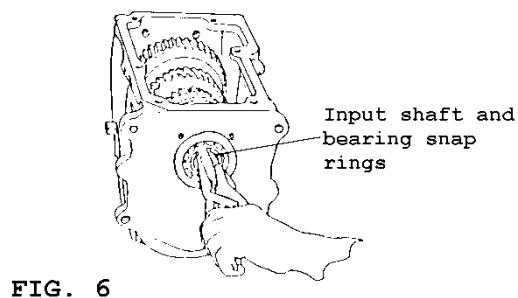


FIG. 5



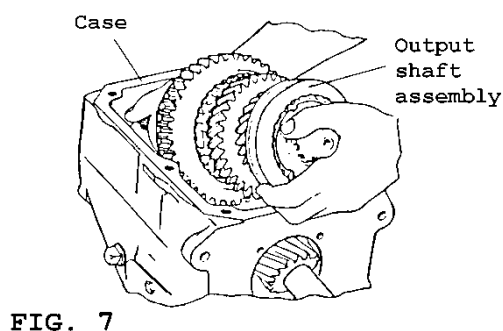
Remove the input shaft bearing cover and bearing snap rings from the input shaft and from the bearing (Fig. 6)



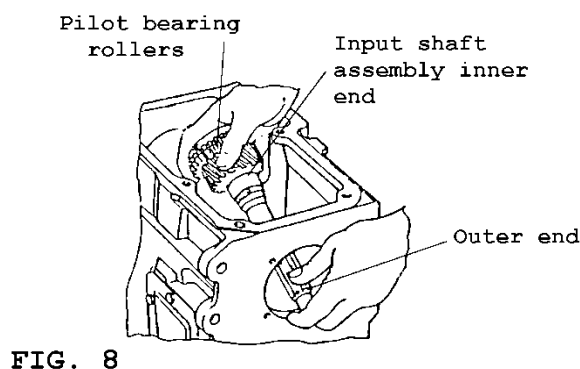
Install the tool on the input shaft and over the input shaft bearing. Remove the input shaft bearing.

- Remove the input shaft oil baffle (oil slinger), if provided.

Remove the output shaft assembly from the case. See Fig. 7

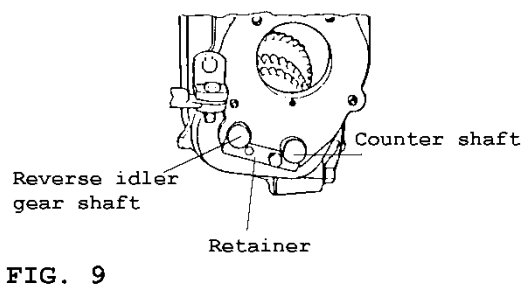


- Remove the input shaft assembly from the case (Fig. 8). do not let the pilot bearing rollers fall from the inner end of the shaft

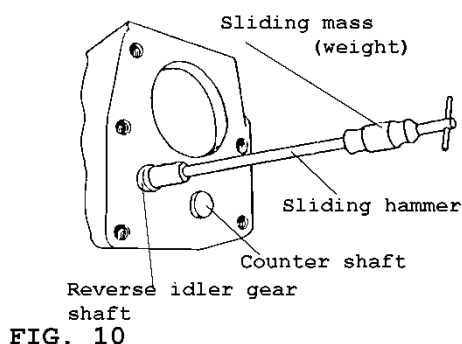


CAUTION: Store the pilot bearing rollers in a safe place, i.e. a box, tin or packet that is well marked for identification, when required at a later stage for re-assembly.

- Remove the reverse idler gear and counter shaft retainer from the end of the transmission case (Fig. 9)



Tap the reverse idler gear shaft out of the case using a sliding hammer (Fig. 10).



Remove the counter shaft with the same tool used to remove the reverse idler gear shaft.

- Remove the counter shaft gear assembly from the case.

CAUTION: Store the roller bearings and spacers which remained in the counter shaft in a safe place, i.e. a box, tin or packet that is well marked for identification, when required at a later stage for re-assembly.

c) Output shaft

- Remove the third and high speed synchronizer hub snap ring from the output shaft, and slide the third and high speed synchronizer assembly and the third speed gear off the shaft (Fig. 11 **on the next page**).



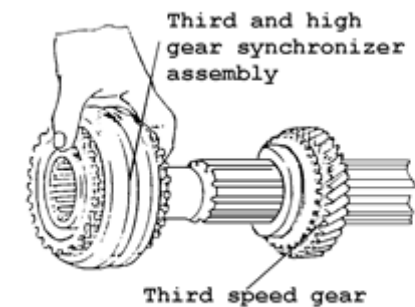


FIG. 11

NB: Check the endplay of the second speed gear before removing the snap rings from the ends of the hubs. (Refer to the manual for specifications).

- Remove the synchronizer sleeve and the inserts from the hub (Fig. 12).

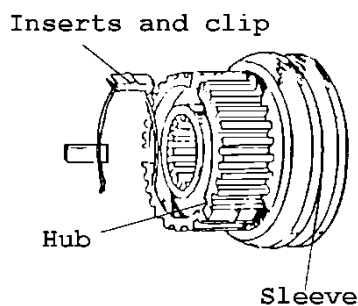


FIG. 12

- Remove the second speed synchronizer snap ring and slide the second speed synchronizer assembly off the shaft and strip it. Refer to Fig. 13 **on the next page**.



CAUTION: Store all the balls, springs, plates and the anti-rattle spring and ball in a safe place, i.e. a box, tin or packet that is well marked for identification, when required at a later stage for re-assembly.

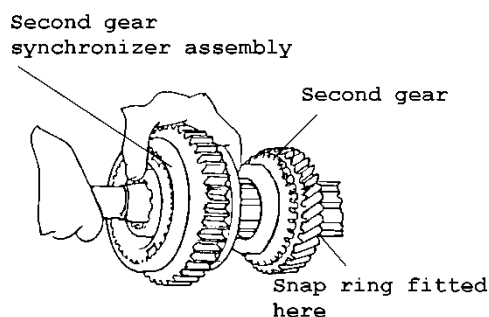


FIG. 13

Remove the snap ring from the rear of the second speed gear and remove the gear and the thrust washer from the output shaft (Fig. 14).

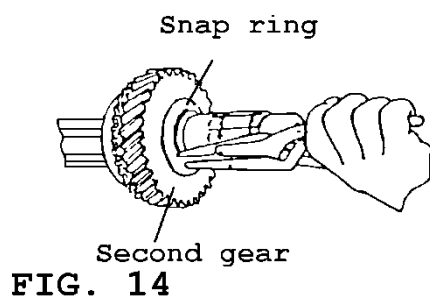


FIG. 14

d) Countershaft gear

- Remove the dummy shaft, pilot bearing rollers, bearing spacers and the centre spacer from the countershaft gear.



e) Gear shift housing

- Remove the gear shift lever.
- Position the three shift rails and forks so that the three shift rails and forks so that the three shift gates are in the normal "neutral" position in the gear shift housing assembly.
- Remove the expansion plugs from the shift housing (Fig. 15).

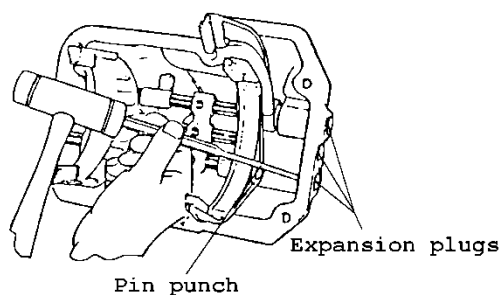


FIG. 15

Push the shifter shaft or shafts forward out of the housing while holding a towel over the poppet balls.

- Remove the shift forks and shift gates.
- Remove the poppet balls and springs from the housing, then remove the interlock plungers from the housing.

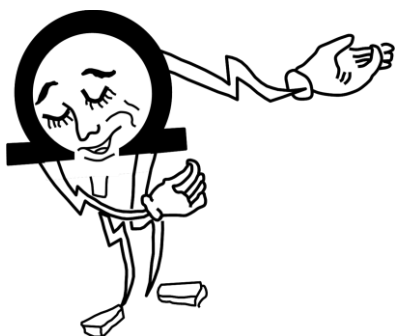


PRACTICE

Referring to these notes and the workshop manual, dismantle the conventional transmission.

Call your instructor to check your work and ask him to sign you off when it is correct, then go on to the next section

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

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



3. CLEANING AND INSPECTION

a) Cleaning

After the transmission has been disassembled:

- Soak the parts, except the bearings, in clean solvent until all the old lubricant is dissolved or loosened.
- Brush or scrape all foreign matter from the parts. Be careful not to damage any of the parts with the scraper.

NB: An excessive amount of foreign material usually results from bearing failure, gear seizure, tooth breakage, extreme synchronizer wear, or clashing gears. In such cases, the input and output shaft bearings should be carefully inspected and, if necessary, replaced. Since counter-shaft bearings, output shaft pilot bearings and reverse idler bearings are not so susceptible to damage from foreign material in the lubricant, they need not be replaced if they seem satisfactory.

- Wipe the parts or blow compressed air on them until they are thoroughly dry.

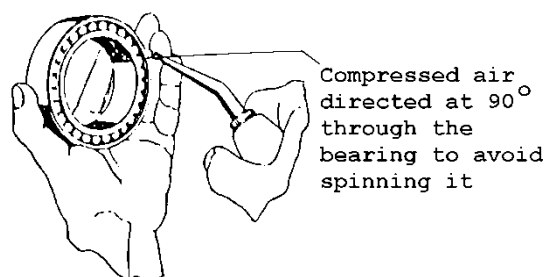


FIG. 16



- Clean the bearings by rotating them in clean solvent until all lubricant is removed.
- Hold the bearing assembly to prevent it from rotating and dry it with compressed air. Refer to Fig. 16
- When the bearings are dry, lubricate them with transmission lubricant and cover them with a clean lint-free cloth until ready for use

b) Inspection

i) Gearshift housing

- Check the operation and condition of the shift levers, forks and shift rails.
- If binding occurs when the levers are operated, disassemble the housing assembly and replace the worn or damaged parts.
- Lubricate the shift lever ball seat and trunnion.
- Replace the cover if it is bent or distorted, making sure the vent hole is open.

ii) Transmission case

- Inspect the case for cracks, worn or damaged bearing bores or damaged threads. Cases may be welded or brazed if the cracks do not extend into bearing bores or bolt holes in machined surfaces.
- Inspect the front face of the case and file or grind off any minor nicks or burrs that could cause misalignment of the transmission with the clutch housing.

iii) Bearings

- Examine the bearing assemblies for cracked cups or races.
- Check the races for roughness.
- Inspect the balls and rollers for looseness, wear, chipping, flaking or other damage.
- Check the bearings for binding on the shafts or looseness in the bores.

If any of these conditions are present, replace the bearings.



iv) Gears

- Some forms of grind marks and tooth wear contact patterns are unacceptable and should not be considered as a source of gear noise. Grind marks are distinct from defects which are local swellings (polished raised projections), nicks and chips.

Fig.17. Shows acceptable and unacceptable gear tooth contact patterns










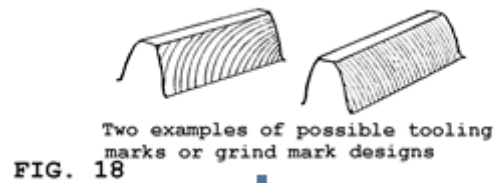
TOOTH CONTACT PATTERN	ACCEPTABLE	UNACCEPTABLE
End contact pattern		
Travelling contact pattern moves from side to side on the face of the tooth		
High contact pattern		
Low contact pattern		
Desired tooth contact pattern		

FIG. 17



All gears may have normal tooling marks or possible factory repair grind marks as shown in Fig. 18 below.

Also see the display board.



Check gear teeth for wear and grind marks.

- Remove chips/nicks as described in Fig. 19, if necessary.

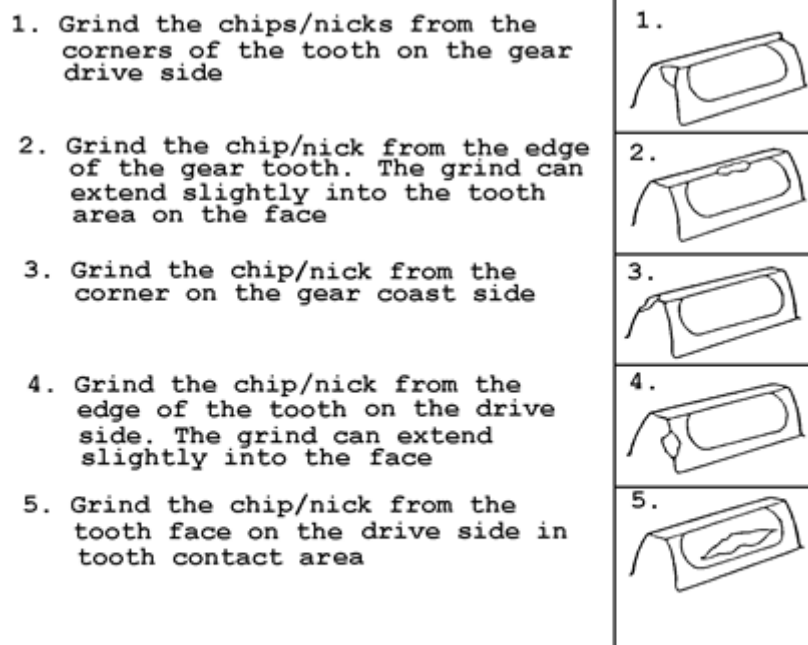


FIG. 19



v) Reverse idler gear

- Replace the reverse idler gear if the gear or bushing is badly worn or if the teeth are chipped or burred.
- Replace the reverse idler gear shaft if it is excessively worn or scored.

vi). Input shaft

- Replace the input shaft if it is worn, bent or twisted, or if the gear has chipped, worn or missing teeth, or if the cone surface is damaged.
- Replace the gear and gear rollers if the pilot bearing bore is scored.

vii) Output shaft

- Replace all output shaft gears that are chipped, burred or badly worn.
- Check the intermediate gear endplay and replace the gear if the endplay is not within specifications.
- Replace the output shaft if it is out of round or worn, or if the pilot bearing surface is scored.
- Replace the speedometer drive gear if gear teeth are worn or broken. Ensure that the correct replacement gear is installed.

viii) Thrust washers, synchronizer discs, bearing covers

- Check the surfaces of all thrust washers. Replace washers that are scored and/or reduced in thickness.
- Replace synchronizer discs that are scored, burred or warped. Also replace bearing covers that are grooved or showing wear from the thrust of adjacent bearings.
- Check the oil return threads in the bearing covers.



If the sealing action of the threads has been destroyed by contact from the input or output shafts, replace the covers.

ix) Synchronizer blocking rings

- Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surfaces. See Fig. 20.

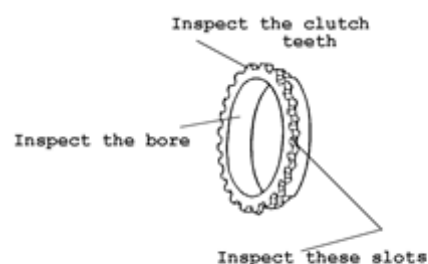


FIG. 20

With the blocking ring on the cone, the distance between the face of the gear and the face of the ring must not be less than specifications. See Fig. 21 on the next page. (Refer to the workshop manual for the correct specifications).

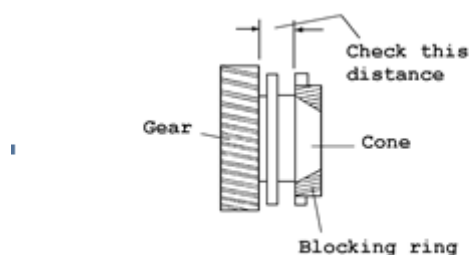


FIG. 21

- Check the synchronizer sleeves for movement on the hubs. Make sure the alignment marks (etched marks) are properly indexed.
- Replace the seal in the input shaft retainer.
- Replace the seals on the cam and shafts.



x) **Seals and gaskets**

- Examine and replace the input and output shaft bearing retainer seals and gaskets if necessary.

PRACTICE

Clean all the parts removed when you dismantled the transmission, inspect them and complete the condition report.

Call your instructor to check your work and ask him to sign you off when it is correct. Then go on with the next section.

CONDITION REPORT ON TRANSMISSION

1. MAIN SHAFT

	ACCEPTABLE	NOT ACCEPTABLE
Splines		
Bearings		
Seal surface		
Bearing surface		

REMARKS



PILOT SHAFT

	ACCEPTABLE	NOT ACCEPTABLE
Splines		
Bearings		
Seal surface		
Bearing surface		

REMARKS

3. CLUSTER SHAFT

	ACCEPTABLE	NOT ACCEPTABLE
Bearings/bushes		
Bearing surfaces		

REMARKS



4. CONDITION OF THE FOLLOWING GEARS

	ACCEPTABLE	NOT ACCEPTABLE
Cluster gears		
1st Gear		
2nd Gear		
3rd Gear		
4th Gear		
5 th Gear		
Reverse Gear		
Reverse Idler Gear		
Pilot Shaft Gear		

REMARKS

5. GEARBOX CASING CRACKED

YES / NO

6. THREADED HOLES IN CASING STRIPPED

YES / NO



7. SYNCHRONIZER

	ACCEPTABLE	NOT ACCEPTABLE
Clutch gear sleeve		
Blocking rings		
Synchronizer springs		
Shifting plates (inserts)		

REMARKS

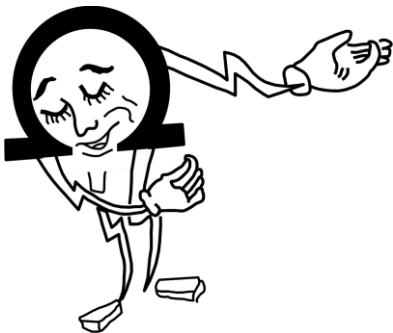
8. SELECTORS

	ACCEPTABLE	NOT ACCEPTABLE
Forks		
Shafts		
Retaining balls (Shift ball)		
Retaining springs (Shift springs)		
Interlock balls		

REMARKS



LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

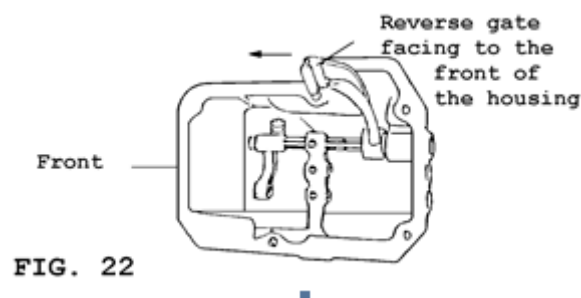
Once you have passed the entire practices,
you are now at liberty to request a Formative
Assessment from your Assessor.



4. ASSEMBLING THE CONVENTIONAL TRANSMISSION

a) Shift housing

- If the reverse gate assembly has been disassembled, install the spring and plunger in the reverse gate, press the plunger through the agate and fasten it in place with the clip.
- Place the poppet spring and ball in the reverse shifter shaft hole in the gear shift housing.
- Install the reverse shift fork on the shaft (reverse shifter).
- Press down the poppet ball and spring with a drift and position the reverse shifter ball notch so that it does not slide over the ball.
- Insert the shaft part of the way into the housing.
- Slide the reverse gate onto the shaft (usually with the long end towards the front of the housing, refer to Fig. 22 below) and drive the shaft into the housing until the ball snaps into the groove of the shaft.

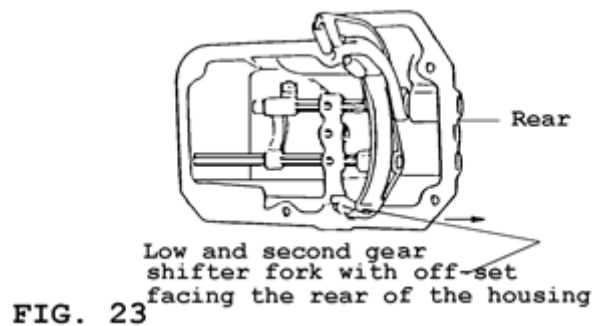


- Install the lockpin that fastens the gate to the shaft.
- Insert the interlocking plungers in the pockets between the shifter shaft holes.
- Place the poppet spring and ball in the low-and-second shifter shaft hole.



- Press down on the poppet ball and spring with a drift and insert the shifter shaft part of the way into the housing.

Slide the low-and-second gear shifter fork onto the shaft so that the off-set of the fork is towards the rear of the housing. Refer to Fig. 23 below.



Push the shaft all the way into the housing until the poppet ball snaps into the shaft groove.

- Install the lock pins that fasten the fork and gate to the shaft.
- Insert the third and fourth gear shifter shaft through the centre rear hole of the housing.
- Insert the interlock pin into the interlock pin hole in the shifter shaft.

NB: Apply a smear of grease to hole the pin in position.

- Apply a coating of grease to the interlock plungers and insert them into their respective holes in the housing.
- Place the poppet spring and ball in the centre shifter shaft hole in the housing.
- Press down on the poppet ball with a drift and carefully push the shifter shaft into the housing over the poppet ball and spring.
- Position the third-fourth gear shift gate onto the shifter shaft.



NB: It is important that the shift gate be installed on the shifter shaft with the long flat "tang" end of gate area facing the correct way to the gear shift housing, (the long flat "tang" usually faces forward of the gear shift housing). To ensure proper installation, measure the two flat "tangs" of the shift gate, note the longer dimension and apply a drop of bright paint

- Position the third and fourth gear shifter fork on the shifter shaft so that the lock pin hole in the shifter fork is toward the rear of the housing (Fig. 24 until the poppet ball seats into the second detent (neutral)).

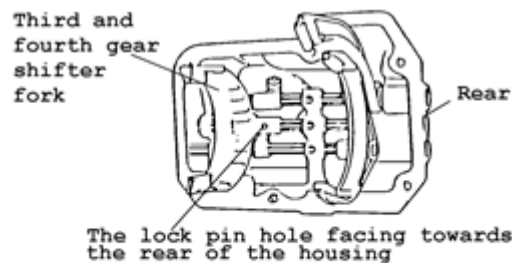


FIG. 24

- Install the lock pins attaching the shifter for, and shifter gate to the shifter rail.

NB: Install the shifter gate lock pin so that the pin is flush with the bottom of the notch in the shifter gate.

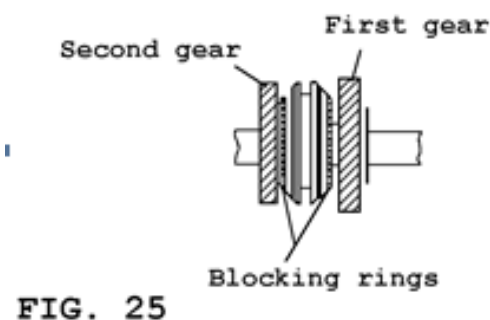
- Install the expansion plugs in the front and rear of transmission housing.

b) Output shaft

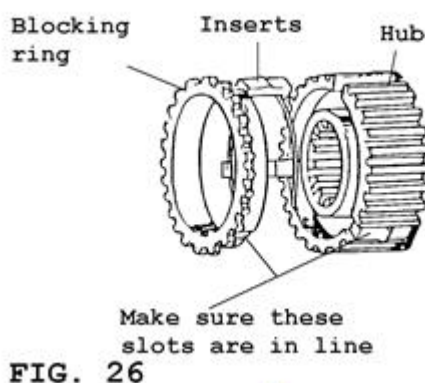
- Install the second-speed gear thrust washer and snap ring on the output shaft.
- Hold the shaft in a vertical position and slide the second-speed gear onto the shaft.
- Install the snap ring on the output shaft at the rear of the second speed gear.
- Position the blocking ring on the second speed gear.
- Press the second-speed synchronizer and hub assembly onto the shaft and install the snap ring.



- Remove the output shaft from the vice, and install the first-speed gear and synchronizer blocking ring on the shaft. See Fig. 25.



- Install the snap ring.
- Place the inserts in the synchronizer sleeve, and position the sleeve on the hub.
- Slide the synchronizer assembly onto the output shaft.
- The slots in the blocking ring must be in line with the synchronizer inserts (Fig. 26.)



- Install the snap ring at the front to the synchronizer assembly.
- Slide the long bearing spacer into the countershaft gear bore and insert a dummy shaft in the spacer.
- Apply a film of grease to the countershaft gear bore and install one of the bearing spacers.
- Position the bearing rollers in the gear bore



d) Four speed transmission

Now that the sub-assemblies have been assembled, the transmission may be assembled as follows:

- Coat all parts, especially the bearings, with the specified transmission lubricant to prevent scoring when the transmission is first put into operation.
- Position the countershaft gear assembly thrust washers in the transmission case

NB: Take care that no roller-bearings are lost, and that the thrust washers are not moved out of position.

- Carefully drive out the countershaft gear assembly dummy shaft by installing the countershaft from the rear of the transmission case.

NB: Position the slot in the rear of the countershaft so that it can be engaged by the shaft retainer.

- Check the countershaft gear assembly end play, making use of a dial indicator. Refer to the workshop manual for specifications.
- If necessary, remove the countershaft gear assembly and re-install it using thrust-washers which will provide the proper endplay.
- Position the reverse idler gear assembly in the transmission case, and install the reverse idler gear shaft.
- Position the slot in the rear of the shaft so that it can be engaged by the shaft retainer.
- Install the countershaft and reverse idler gear shaft retainer.
- Load the pilot bearing rollers in the inner end of the input shaft.

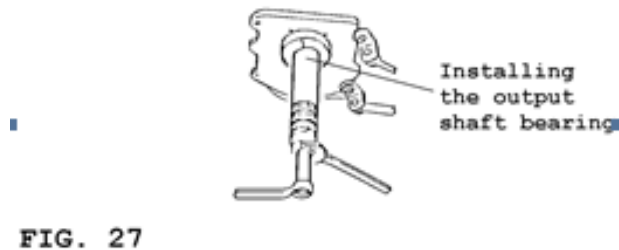
NB: Use grease to keep the pilot bearing rollers in position.

- Position the input shaft assembly in the transmission case and install the blocking ring on the input shaft.
- Install the output shaft assembly in the transmission case.

NB: Use care that the pilot bearing rollers are not permitted to drop out of the input shaft.



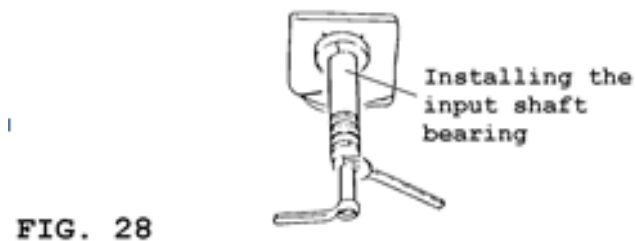
- Install the input shaft oil baffle.
- Install a dummy bearing on the transmission input shaft.
- This is necessary to keep the input and output shafts in alignment when installing the output shaft bearing.
- Install the output shaft bearing using the tool as shown in Fig. 27.



- Install the output shaft bearing retainer snap rings.

NB: Use the thickest select fit snap rings which will fit on the bearing.

- Remove the dummy bearing from the input shaft.
- Install the input shaft bearing using the tools shown in Fig. 28 and install the snap ring.



- Install a dummy bearing on the transmission input shaft.

This is necessary to keep the input and output shafts in alignment when installing the output shaft bearing.

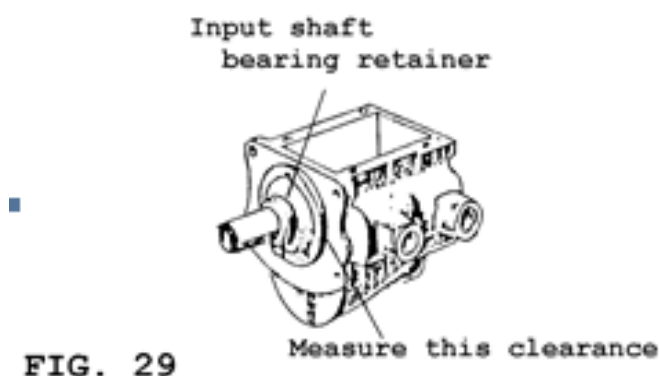
- Install the output shaft bearing using the tool as shown in Fig. 27 on the previous page.



- Install the output shaft bearing retainer snap rings.

NB: Use the thickest select fit snap rings which will fit on the bearing.

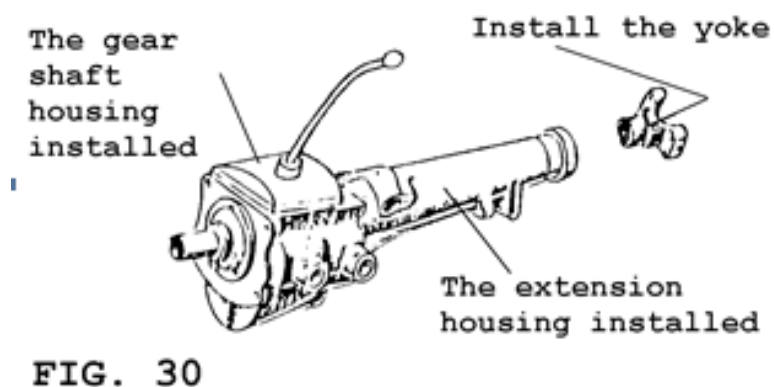
- Remove the dummy bearing from the input shaft.
- Install the input shaft bearing using the tools shown in Fig. 28. and install the snap ring.
- Install the input shaft retainer with no gasket or cap screws and measure the clearance between the retainer and the case (Fig. 29).



- Install a gasket shim pack between the retainer and the case to obtain the required input shaft end play.
- Tighten the front retainer bolts, and then re-check the end play. Refer to the workshop manual for specifications.
- Re-check the synchronizer clearance when the input shaft end play has been established. It should be to specifications. Adjust it if required.
- Position the speedometer drive gear (and spacer, if used) on the output shaft over the lock ball and install the speedometer drive gear retaining snap ring.



- Using a new gasket install the output shaft extension housing (Fig. 29). Tighten the bolts to specification.
- Lubricate the extension housing bushing and seal and the U-joint flange.
- Install the U-joint flange (yoke) as shown in Fig. 30 **on the next page**.

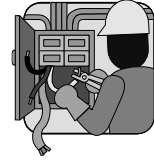


Lock the transmission in two gears and tighten the retaining nut to specifications.

- Shift the gear shift housing into the "second gear" position.
- Place the gear shift housing onto the transmission housing and tighten the cover bolts to specification as shown in Fig. 27 .



PRACTICE

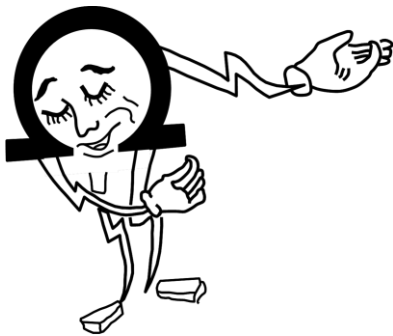


Referring to these notes and to the workshop manual, assemble the conventional transmission.

Call your instructor to check your work and ask him to sign you off when it is correct.

LEARNER	ASSESSOR
Date:	Date
Signature:	Signature:

Ask for the assessment when you feel ready.



REMEMBER ALWAYS WORK SAFE

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

