

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: ODF-2

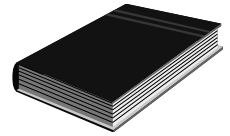
ASSEMBLE A

DIFFERENTIAL AND FINAL DRIVE

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SOURCE REFERENCES

Demonstration by a competent person, e.g. a Training Officer.

Makers' catalogues and service manuals.

Models in the training centre.

OBJECTIVE

You will be learning towards the outcome “Assemble the differential and final drive”. Whilst learning towards the outcome you will be required to achieve the following:

- Assemble and adjust the differential and final drive.

On completion of this module, the learner must be able to:

- Assemble the differential.
- Assemble the final drive.
- Adjust the differential to specification.
- Adjust the final drive to specification.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A practical test will be set at the end of the module and must be completed without using references.
- For the practical test, the learner will be given a rear axle with a differential and final drive and all the necessary tools and equipment.
- The following standards must be achieved:
 - a. The backlash between the ring gear and pinion must be within the limits specified in the workshop manual.
 - b. Pre-load on the pinion shaft bearings must be within the limits specified in the workshop manual
 - c. Pre-load in the ring gear bearings must be within the limits specified in the workshop manual.
 - d. The tooth contact area when the gears are loaded must be within the limits specified in the workshop manual.
 - e. All the adjustable clearances on the final drive must be within the limits specified in the workshop manual.
 - f. All the bolts and nuts must be torqued to specifications.

- g. There must not be any damage to parts.
- h. There must not be any damage to any fasteners.
- i. There must not be any damage to any equipment.
- j. All the bolts and nuts with locking devices must be locked.
- k. There must not be any damage to tools and equipment.
- l. All safety procedures must be adhered to.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM**ODF-2****ASSEMBLE AND ADJUST A DIFFERENTIAL AND FINAL DRIVE**

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Use hand tools.	<ul style="list-style-type: none"> Using damaged tools or wrong tools for the job can cause injury and damage to equipment. 	<ul style="list-style-type: none"> 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.
2. Work on machinery.	<ul style="list-style-type: none"> Injury to person if working on moving machinery. 	<ul style="list-style-type: none"> Ensure that power to the machine is switched off, and if possible, physically locked out. Place a warning sign stating: "Men at work. Do not switch on" in a prominent position. Ensure that machinery is stationary before commencing work. Replace machine guards after completing the task and before starting the machine.

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:

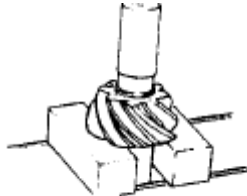
REASSEMBLING THE DIFFERENTIAL

ITEM / TASK: Reassembling the differential and carrier assembly

DESCRIPTION:

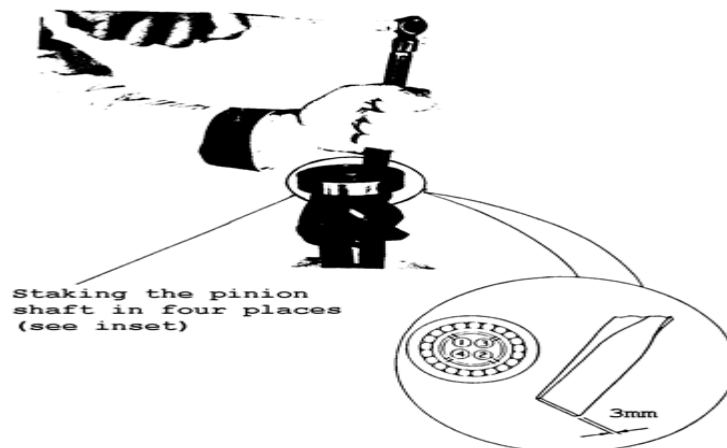
- a) Press the center pinion bearing on the pinion using steel tubing for a driver (Fig.1).

Fig 1



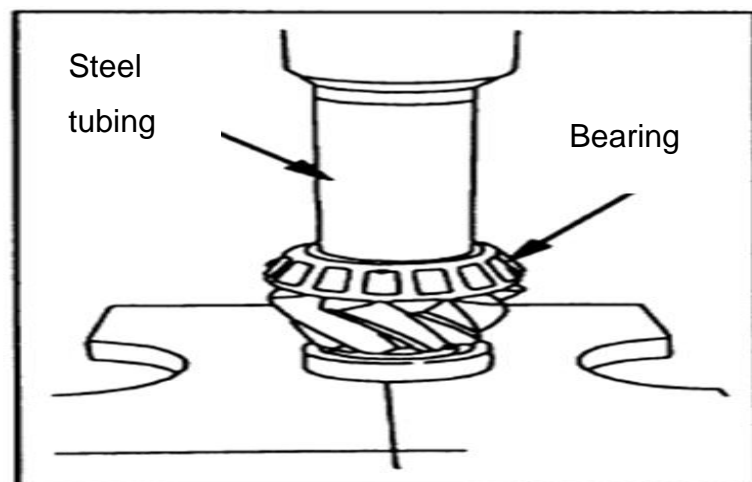
- b) Install the center pinion bearing retaining ring.
c) If the pinion shaft has no retaining ring groove, stake the pinion shaft in four places.
Refer to Fig. 2

Fig 2



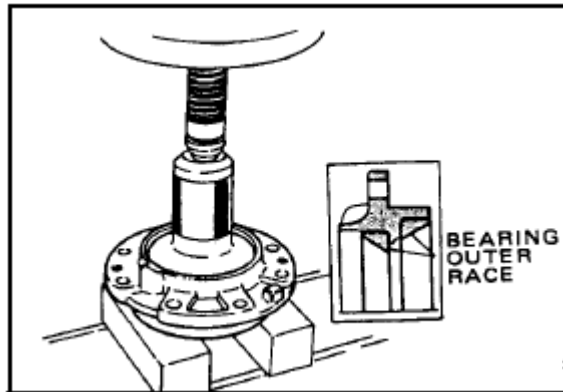
- d) Press the inner pinion bearing cone onto the pinion shaft. Refer to Fig. 3.

Fig 3



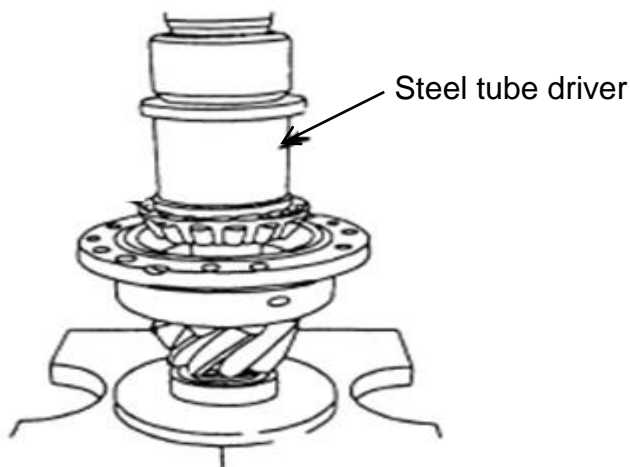
- e) Press the bearing cups into the pinion bearing cage

Fig 4



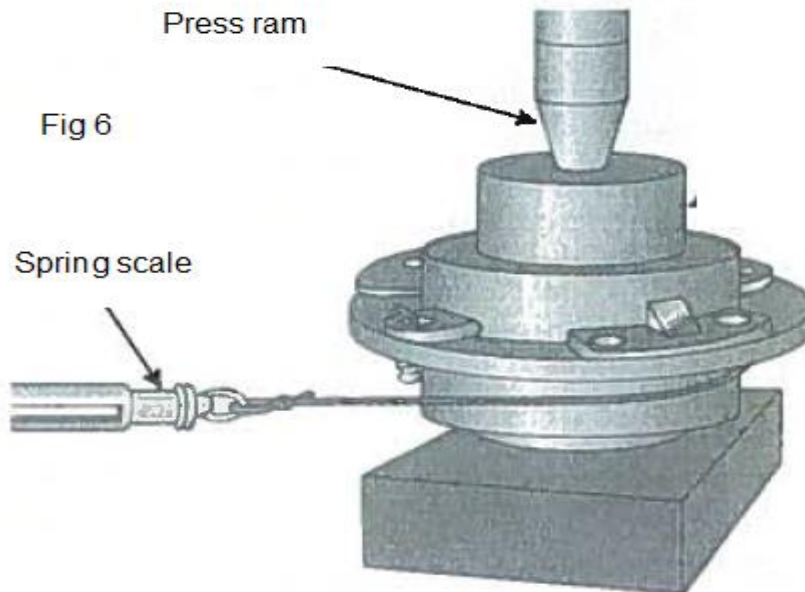
- f) Position the pinion bearing cage assembly on the pinion shaft.
- g) Position the outer pinion bearing cone on the pinion shaft and press into place using steel tubing as a driver. Refer to Fig. 5.

Fig 5



- h) Keep the pinion and cage assembly in the press with approximately 200 kg of pressure exerted on the driver.
- i) Wrap several turns of soft wire or string around the pinion cage and pull in a horizontal direction with a spring scale.
- j) While pulling in straight line (90° from the centre line of shaft), read the spring scale and measure the rotating torque, (pinion preload).
- k) Multiply the reading on the spring scale by the radius of bearing cage to obtain preload torque.

- I) If preload is not within specifications, remove shims to increase preload or add shims to decrease preload (Fig. 6). Alternatively check pinion bearing preload with a torque-wrench.

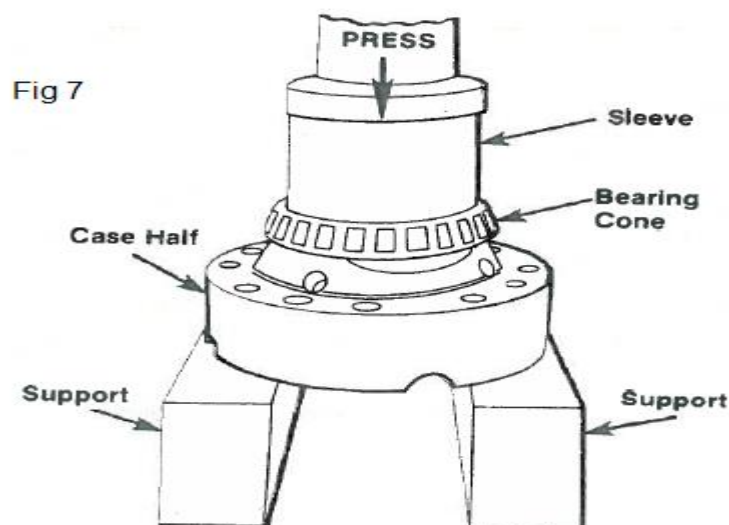


NB: This is a preliminary check. The final bearing preload check must be made with the pinion shaft and bearing cage assembly in the differential housing.

Reassembling the differential ring gear and differential case

NB: Lubricate all differential bearings, gears and thrust washers with SAE90 EP or equivalent lubricant

- * Press the differential bearing cones on to the case halves Fig. 7



Check the ring gear mounting surface of the flanged half of the differential case for burrs.

- * If there are any burrs, remove them with a file.

Install the ring gear.

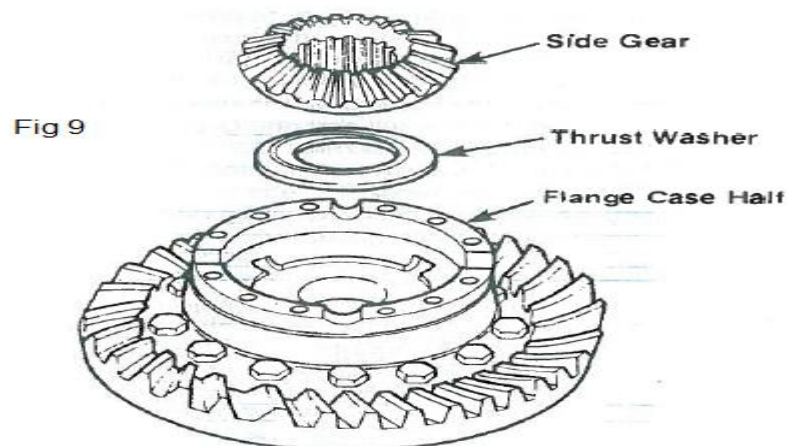
- * Install the bolts so that the internal diameter of the ring gear prevents turning of the hex head.
- * Install the ring gear bolt nuts and torque to specifications (Fig. 8 on the next page).

Fig 8

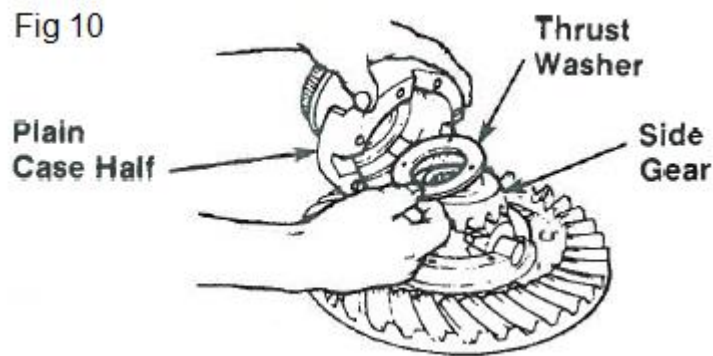


If rivets are used, rivet the ring gear to case half with new rivets. Rivets should not be heated, but always formed cold. When the correct rivet is used, the head being formed will be at least 3mm larger in diameter than the rivet hole.

- * Lubricate and install the thrust washer and the side gear in the differential case and ring gear assembly.
- * Engage the holes in the thrust washer on the dowels (if provided) projecting from the thrust washer bearing surface in the differential case (Fig. 9).

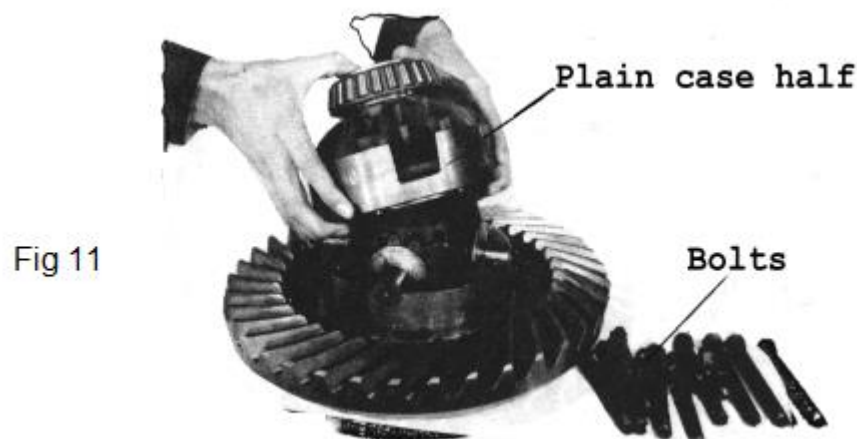


- Place the pinions and thrust washers on the differential spider, lubricate and set in position on the installed gear (Fig. 10).



It is very important that if the pinion thrust washers are provided with a tang, that the tang engages the groove in the case halves - consult the workshop manual.

- * Position the assembled side gear, thrust-washer and case half, on the assembled parts.
- * Ensure that all thrust washers are properly seated and gear teeth are properly meshed.
- * Ensure that the match marks made on case halves during disassembly, are aligned.
- * Install the bolts securing the case halves together, and tighten them to the specified torque (Fig. 11).



Wire lock the bolts in pairs if the bolts are not fitted with self locking nuts (See Fig 12 on next page)

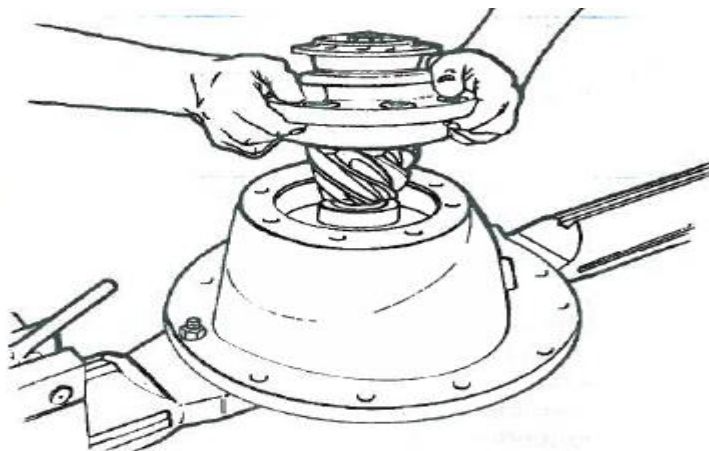
Fig 12



Reassembling the differential and carrier

- * Install the bearing cage and pinion shaft assembly in the differential carrier assembly without the bearing cage shims.
- * Use four pinion oil seal retainer bolts with flat washers to pull the pinion shaft assembly fully into the carrier assembly. Refer to Fig. 13.

Fig 13



Ensure that the oil passages are aligned.

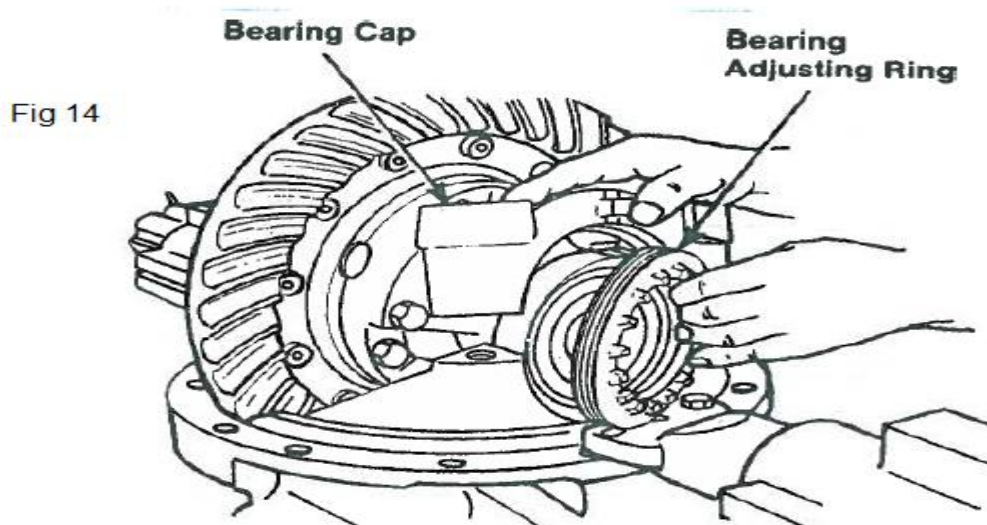
- * Temporarily install the companion flange on the end of the pinion shaft without installing the pinion oil seal retainer.
- * Install the companion flange retaining tool on the companion flange and torque the companion flange nut to specifications
- * Use a torque wrench or pull scale to check the bearing preload.

- * If bearing preload is not to specifications, disassemble the parts and add shims to decrease the preload, or remove shims to increase the preload.
- * When the correct preload is attained, remove the companion-flange and the seal retainer bolts used to hold the bearing cage to the housing.
- * Press the seal into the oil seal retainer. The lip of the seal must face towards the pinion.
- * Install the gasket and pinion oil seal retainer.
- * Secure with bolts and tighten to specified torque
- * Install the companion flange on the end of the pinion shaft with its flat washer and nut.
- * Tighten the nut to specifications.
- * Position the differential carrier and pinion assembly in a differential stand so that the pinion shaft is down.
- * Insert a bar through the differential to facilitate hoisting.
- * Position the differential into the carrier
- * Position the differential bearing cup and adjusting nut on the lifting bar on one side of the differential and lift the bar slightly.
- * Move the bearing cup and adjusting nut into position on the carrier.
- * Repeat the procedure and install the opposite bearing cup and adjusting nut.

NB: TAKE CARE TO PREVENT CROSS THREADING OF NUTS.

If bearing caps do not position properly, the adjusting nuts may be cross threaded.

- * Remove the caps and reposition the adjusting nuts (Fig. 14).

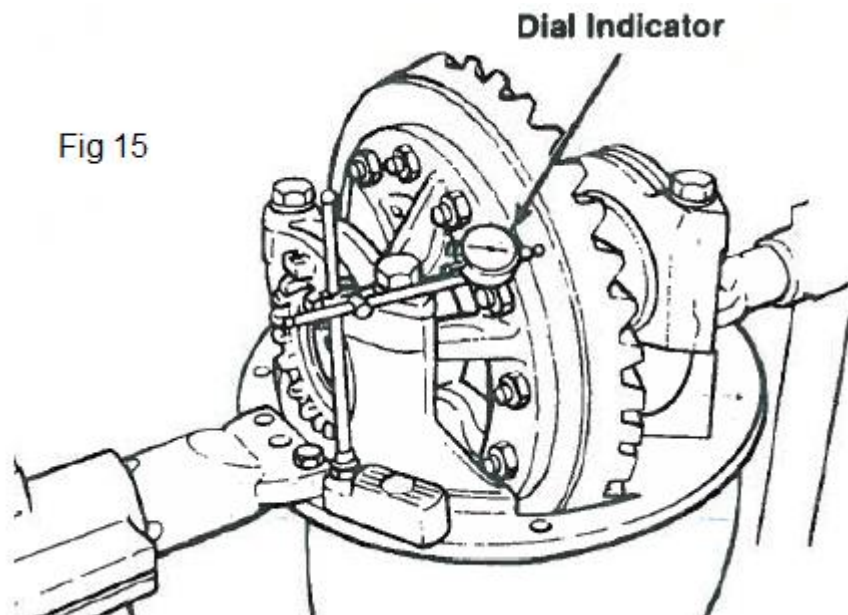


- * Position the bearing caps on the bearing nuts, making sure that the match marks made during disassembly are properly aligned.
- * Install the bearing cap bolts and tighten until snug, but do not fully torque.

NB: Forcing the caps into position will result in irreparable damage to the carrier housing or bearing caps.

Adjusting the differential bearing pre-load

- * Using a dial indicator, at the back face of gear (Fig. 22), loosen the bearing adjusting nut on the side opposite the gear only sufficiently to notice endplay on the indicator.

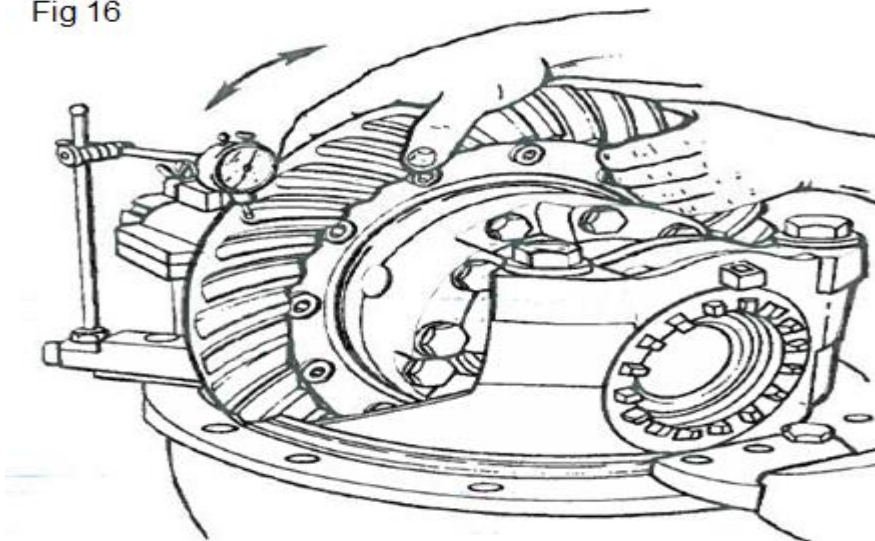


- * Tighten the same adjusting nut only sufficiently to obtain zero endplay.
- * Check the gear for side runout. If runout exceeds specifications remove the differential and ascertain the cause.
- * Tighten the adjusting nuts one notch each from zero endplay to pre-load the bearings.

Checking gear backlash

- * Use a dial indicator to check the backlash between the crown wheel and the pinion shaft gear.

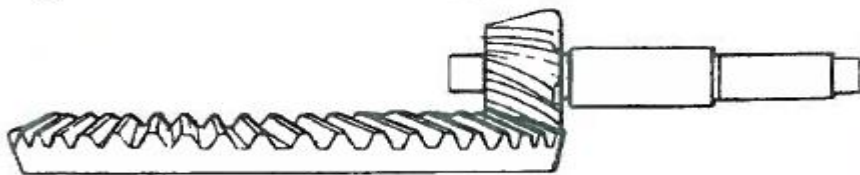
Fig 16



Backlash is adjusted by moving the ring gear (crown wheel) toward or away from the pinion shaft gear as shown in Fig. 17 and 18.

Fig 17

**Tighten adjusting ring
on this side.**



**Increase
backlash.**

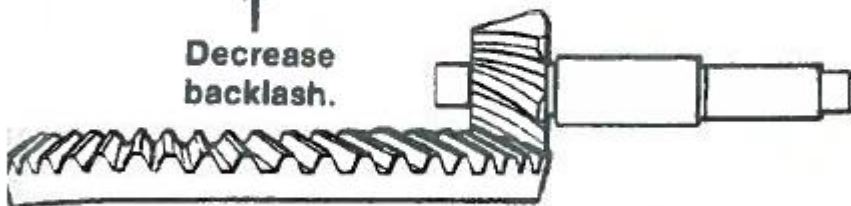


**Loosen adjusting ring
on this side.**

Fig 18

**Loosen adjusting ring
on this side.**

**Decrease
backlash.**



**Tighten adjusting ring
on this side.**

- * Move the ring gear by loosening one adjusting nut and tightening the opposite lock nut.
- * When loosening one lock nut and tightening the opposite, move each lock nut the same distance so that the bearing pre-load adjustment made earlier, is not disturbed.
- * Adjust the position until the gear backlash is to specifications.

Checking tooth contact

- * Paint the ring gear teeth with a mixture of red lead and linseed oil or mechanics blue see (Fig. 19).

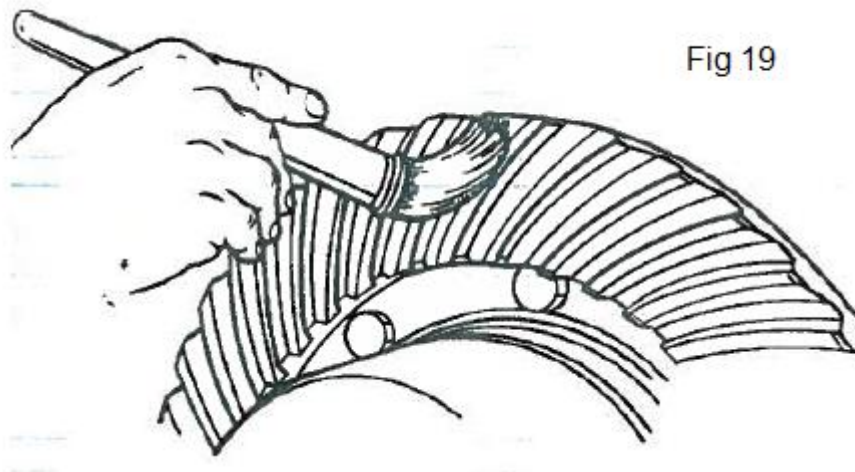


Fig 19

- * Check the Crown wheel and pinion for proper tooth contact.
As a rule, painting about 10 or 12 teeth is sufficient for checking purposes.
A sharper impression may be obtained by applying a small amount of resistance to the ring gear with a flat steel bar using a wrench to rotate the pinion.
- * Check the tooth contact pattern on the drive side (converse side) of the ring gear teeth. The coast side will automatically be correct when the drive side pattern is correct.
- * Refer to the gear tooth contact chart - Figure 20 on the next page.

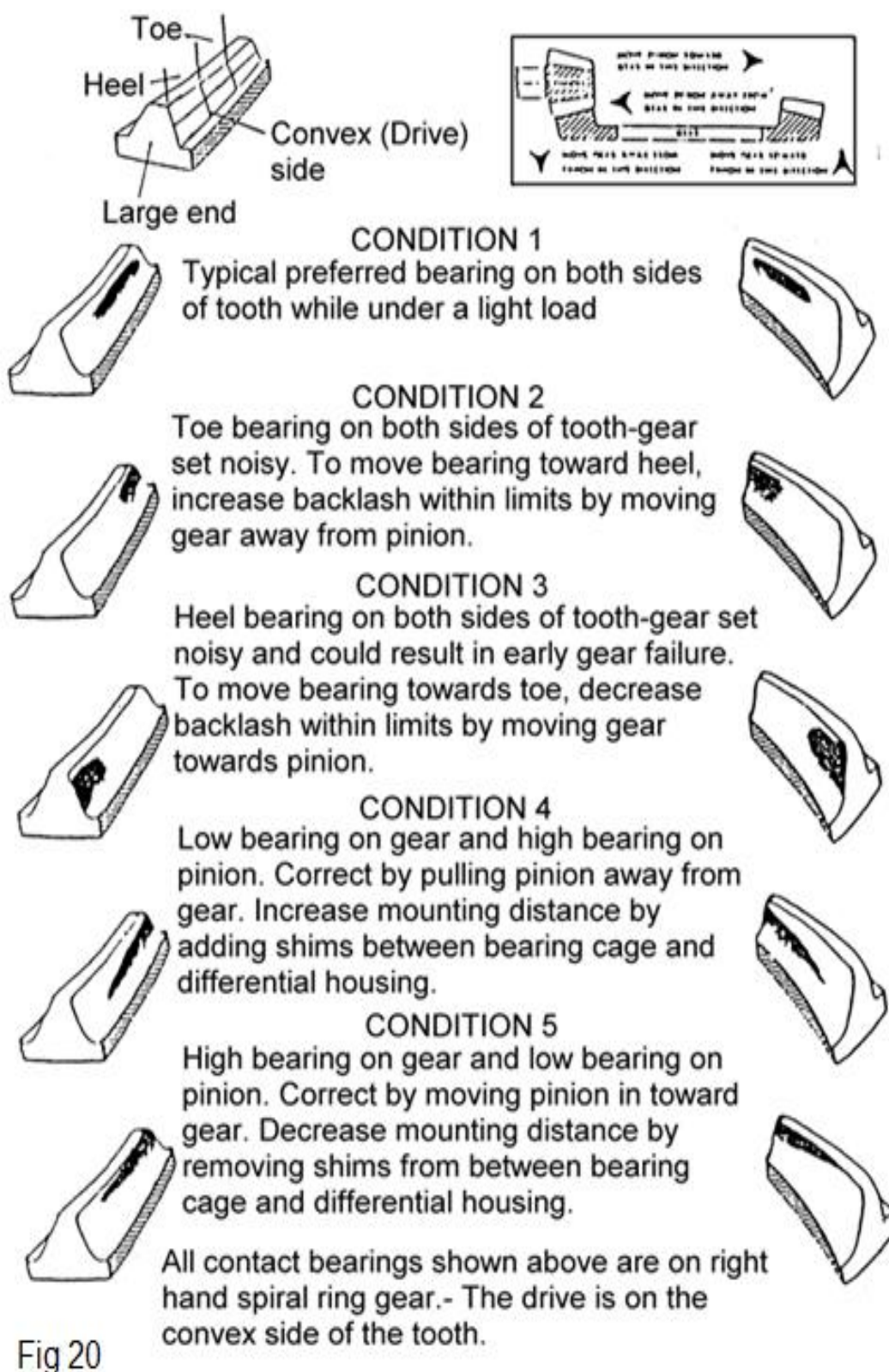


Fig 20

- * If proper tooth contact pattern is not as shown, readjust backlash or add or remove pinion bearing cage shims as necessary. Refer to Fig. 21.

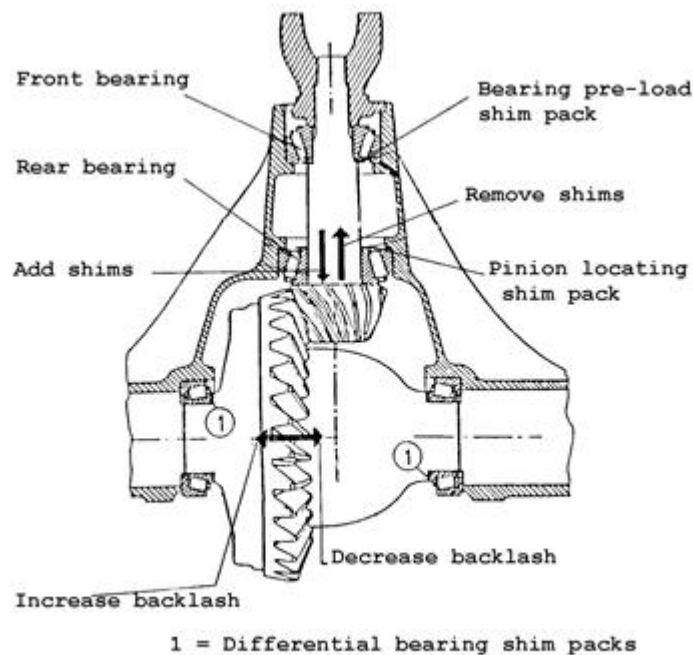


Fig 21

Acceptable tooth patterns :

Fig. 20 on the previous page shows acceptable tooth patterns. In general they should have the following characteristics :

1. The drive pattern should be fairly well centred on the tooth.
 2. The coast pattern should be fairly well centred on the tooth.
 3. Some clearance between the pattern and the top of the tooth is desirable.
 4. There should be no hard lines where the pressure is high.
- Tighten the bearing cap bolts (Fig. 22) to torque specifications.

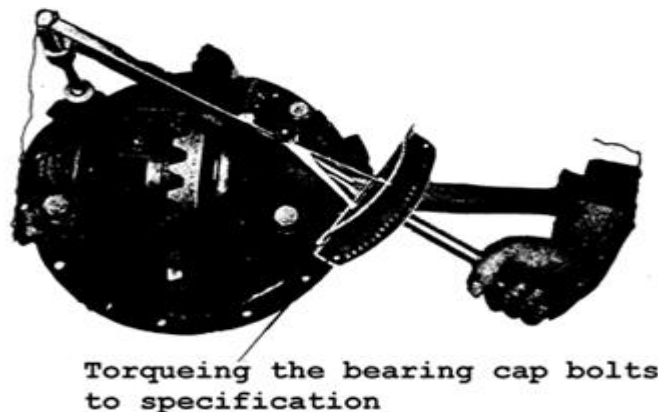
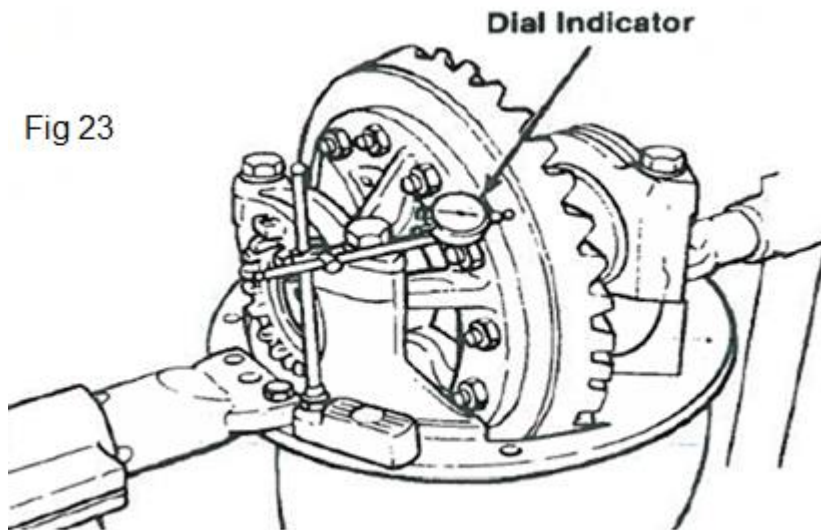


Fig 22

- * With a dial indicator, re-check the ring gear and pinion backlash
- * Re-check the differential bearings for endplay as described previously.
- * Use a dial indicator to check the back face of the ring gear (side runout) (Fig. 23) rotate the ring gear at least one full turn.

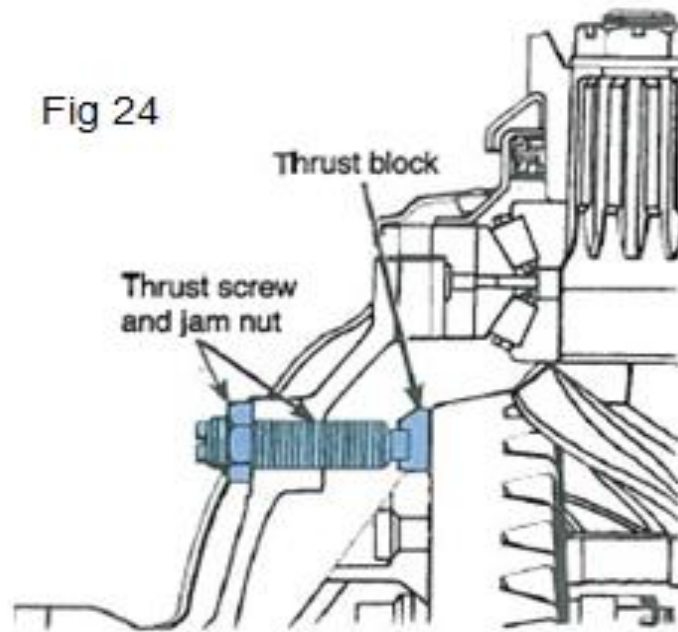


- * Runout must not exceed specifications. If runout is excessive, remove assembly and check for burrs and dirt under mounting surface of ring gear.
- * Install the adjuster locking device and tighten to specified torque.
- * Wire lock bearing cap bolts and adjusting nut lock bolt together.

Adjusting the thrust screw

- * If the differential is equipped with a differential thrust screw, turn the screw until it just contacts the back of the ring gear, then back off 1/4 turn (0,25mm clearance).

See figure 24 on the next page.



- * Tighten the lock nut and secure it by bending the tang of the lock washer against the flat of the nut to secure the adjustment.

PRACTICE

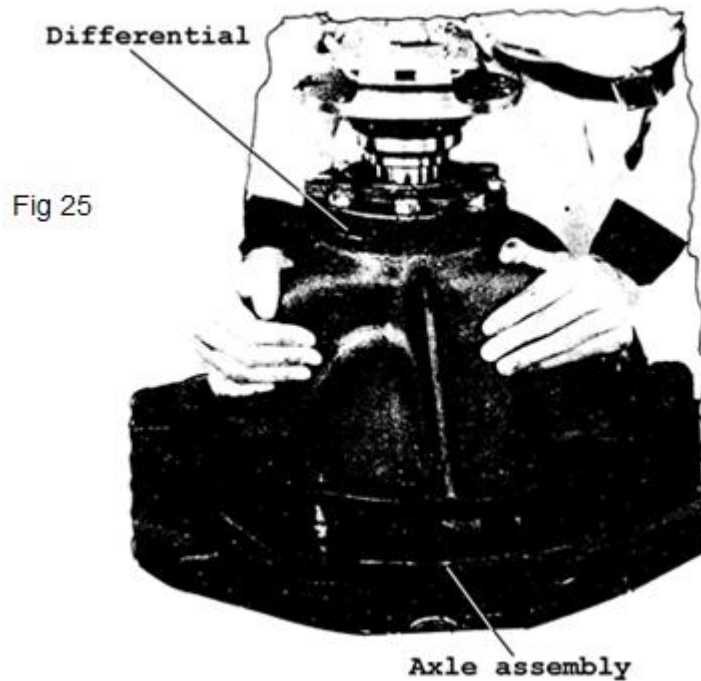
Referring to these notes and the workshop manual, practice assembling and adjusting the differential.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

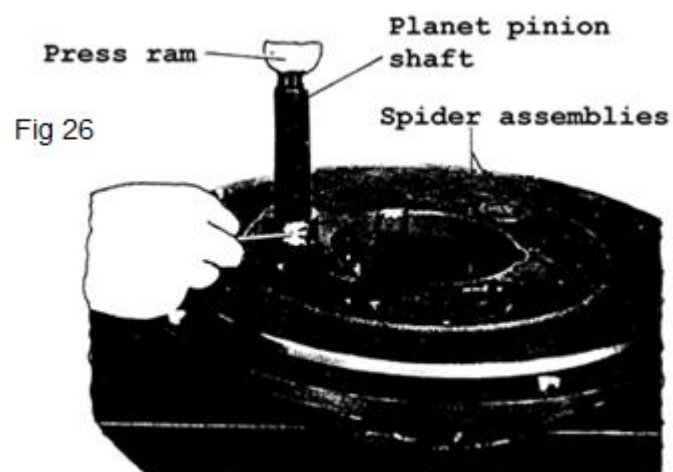
LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

Assembling the axle assembly

- * Replace the differential into the axle assembly (Fig. 25).



- * Replace the planet pinions into the spider assembly. Refer to Fig. 26



Slide the axle shaft into position in the axle so that the splines engage with the differential.

- Replace the axle housing - see Fig. 27.

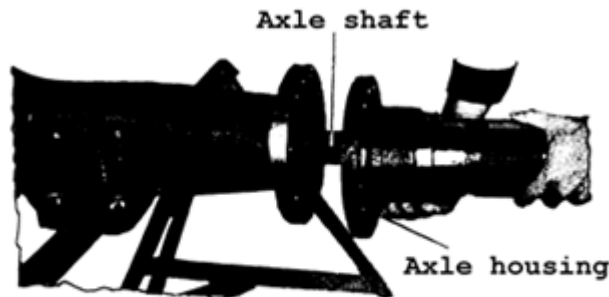


Fig 27

- * Replace the brake assembly (Fig. 28).

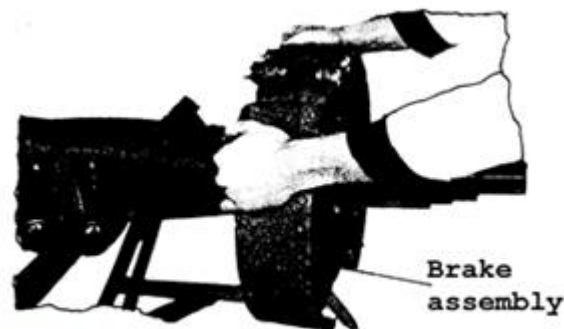


Fig 28

- * Replace the hub and drum .

Replace the internal gear and tighten the inner spindle nut lightly (Fig. 29).

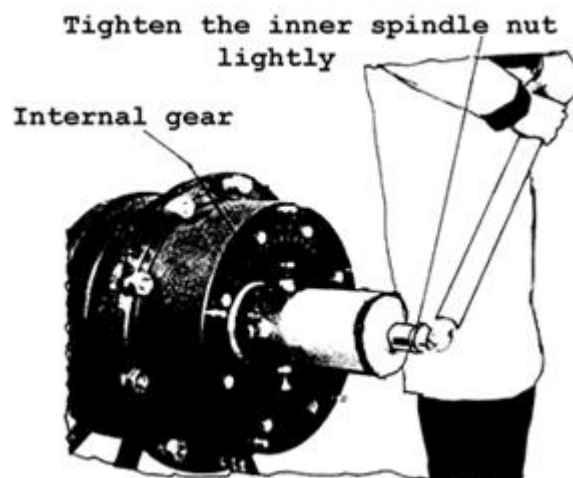
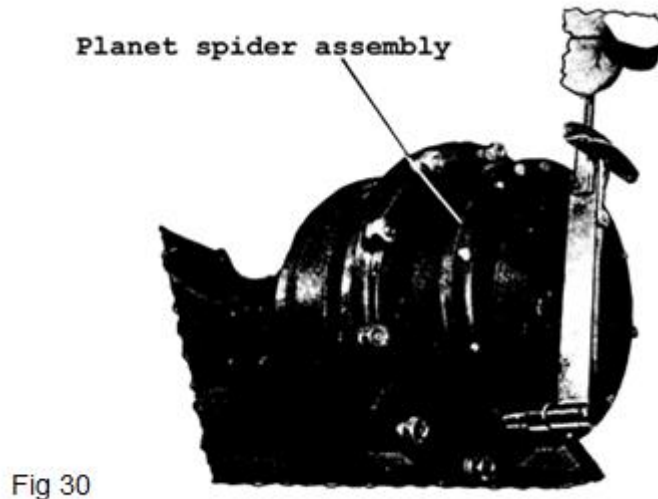


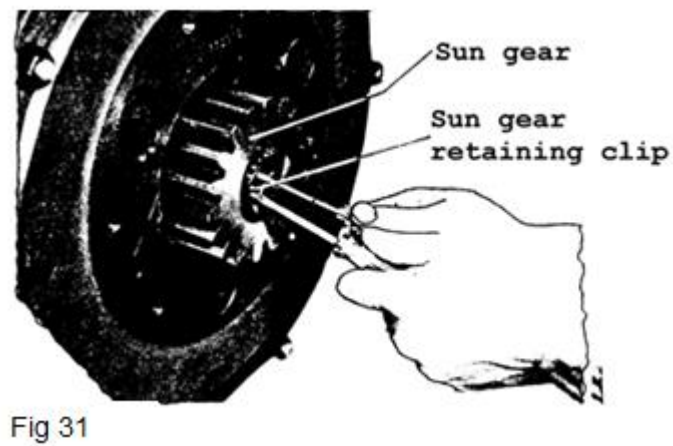
Fig 29

Tighten the inner nut until the pre-load of the bearing is within the specifications in the manual.

- * Replace and tighten the locknut and bend the tangs of the lockwasher over.
- * Replace the planet spider (Fig. 30).

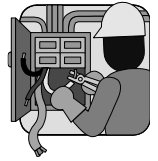


- * Replace the sun gear (Fig. 31).



- * Replace the gear thrust cap .

GO ON TO THE NEXT PAGE FOR THE PRACTICE.



PRACTICE

Referring to these notes and the workshop manual, practice assembling the rear axle assembly.

Ask your Training Officer to check your work and if it is correct, to sign below.

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.