Chapter 8 Differential unit

For modifications, and information applicable to later models, see Supplement at end of manual

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Specifications

Note: *The differential unit on all Mini variants with manual transmission is identical, with the exception of the final drive ratio which varies according to model. A different differential unit is fitted to models equipped with automatic transmission.*

Final drive ratio

848cc (all models)	3.76 : 1
998cc except Van and Pick-up:	
Manual	3.44 : 1
Automatic	3.27 : 1
998cc Van and Pick-up	3.76 : 1
1098cc (all models)	3.44 : 1
1275 Cooper S Mk III:	
Standard	3.65 : 1
Optional	3.93 : 1, 4.26 : 1, 4.35 : 1
1275 GT	3.44 : 1

Differential bearing preload

Early bearings	0.001 to 0.002 in (0.025 to 0.050 mm)
Later thrust bearings	0.004 in (0.10 mm)

Torque wrench settings

	lbf ft	Nm
End cover bolts	18	25
Driveshaft flange nut	70	96
Driveshaft flange bolt	40	55
Differential case to drivegear bolts	60	83
Retaining stud nuts $\frac{5}{16}$ in UNF	18	25
Retaining stud nuts $\frac{3}{8}$ in UNF	25	34
Kickdown linkage retaining bolts	5	7
Rubber coupling U-bolts	10	14
Swivel hub balljoint nut	38	52

1 General description

The differential unit is of the two-pinion design and is contained within a housing bolted to the rear of the transmission casing. The differential gears are located in the differential case, which is bolted to the spur-type drivegear. The drivegear pinion is mounted on the end of the mainshaft in the gearbox.

Repair or overhaul of the differential unit can only be carried out after first removing the engine/transmission unit from the car. If it is wished to attend to the drivegear pinion, it will be necessary to separate the engine from the transmission. This is not recommended on vehicles equipped with automatic transmission as considerable dismantling is necessary to provide access to the pinion. As this work requires specialist knowledge and equipment, it is best left to your BL main dealer.

2 Differential unit – removal and refitting (manual transmission models)

Note: *The design of the differential housing varies slightly according to model year and the type of gearchange mechanism fitted. The removal procedure is basically the same for all models; however, if working on the latest rod change type transmission, omit paragraphs 2, 3 and 4.*

1 Remove the engine/transmission assembly as described in Chapter 1.

2 On models not fitted with a remote control gearchange, undo and remove the four bolts securing the cover plate to the underside of the gearchange extension and lift off the plate.

3 Undo and remove the pinch-bolt securing the shaft lever to the remote control shaft and then withdraw the shaft downwards and out

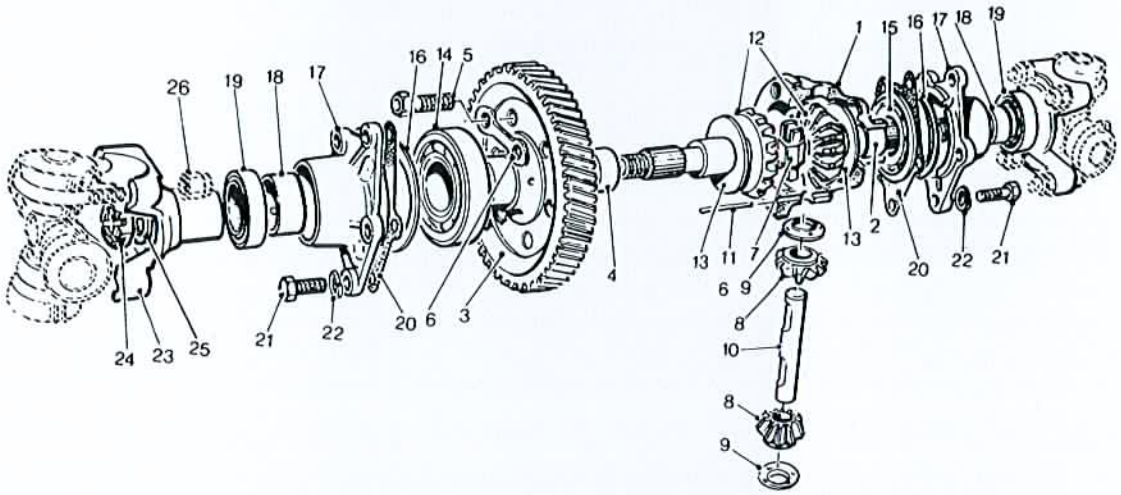


Fig. 8.1 Exploded view of the differential assembly – manual transmission (Sec 1)

1	*Differential case*	8	*Differential pinion*	14	*Drivegear bearing*	21	*End cover bolt*
2	*Case bush*	9	*Pinion thrust washer*	15	*Case bearing*	22	*Washer*
3	*Drivegear*	10	*Centre pin*	16	*Bearing shim*	23	*Driving flange*
4	*Gear bush*	11	*Pin peg*	17	*End cover*	24	*Flange nut*
5	*Gear bolt*	12	*Differential gear*	18	*Cover bush*	25	*Washer*
6	*Lockwasher*	13	*Thrust washer*	19	*Oil seal*	26	*Locknut*
7	*Thrust block*			20	*Cover joint*		

of the differential housing (photo).

4 Extract the split pins and then undo and remove the two driveshaft flange castellated retaining nuts. The flanges can be prevented from turning during this operation by wedging a block of wood between the flange and gearbox casing (Note that on Cooper S models, bolts instead of nuts are used to retain the driveshaft flanges). Now slide the flanges off the gearshafts.

5 Undo and remove the five bolts and spring washers which secure the two end covers to the sides of the differential housing (photo). Lift off the two end covers together with their gaskets, and recover the shim fitted behind the end cover furthest away from the flywheel housing (photo). On later models lift out the selector shaft detent sleeve, spring and ball (photos).

6 Tap back the locktabs and undo and remove the nuts securing the differential housing to the gearbox casing.

7 Carefully withdraw the differential housing and differential assembly rearwards and off the mounting studs (photo).

8 Before refitting the differential, scrape away all traces of old gaskets and ensure that the mating faces of all the components are scrupulously clean and dry.

9 Begin assembly by placing the differential assembly into the gearbox casing, biased slightly towards the flywheel side (photo).

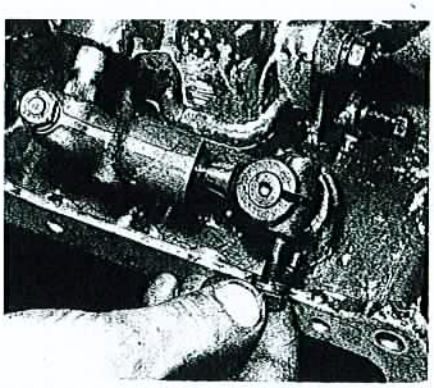
10 Lightly smear both sides of the differential housing gaskets with jointing compound and place them in position over the mounting studs (photo).

11 Refit the differential housing (photo) and secure it in position with the retaining nuts and washers. Tighten the nuts sufficiently to hold the differential bearings and yet still allow sideways movement of the complete assembly.

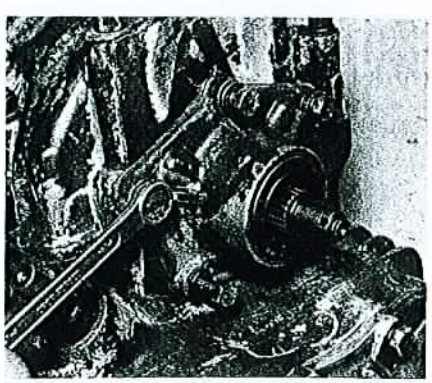
12 Refit the selector shaft detent spring, sleeve and ball (later models), lightly smear a new gasket on both sides with jointing compound, and position it on the flywheel side end cover. Position the cover on the differential housing and refit the retaining bolts. Progressively and evenly tighten the bolts, to displace the differential assembly away from the flywheel side, finally tightening to the specified torque.

13 Now fit the left-hand side end cover *without* the gasket or shims. Tighten the cover bolts evenly until the register just contacts the differential bearing outer race. Do not overtighten the bolts as this could distort the end cover.

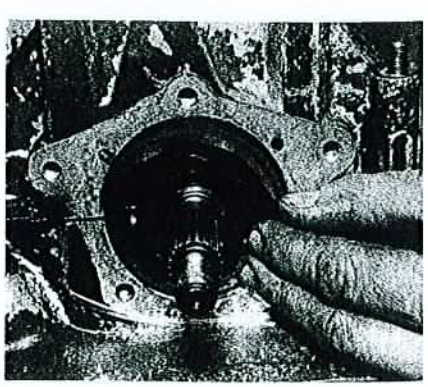
14 Measure the gap between the end cover and the differential housing in several places, using feeler gauges, to ensure that the end cover is seating squarely on the differential assembly (photo). Variations in measurement indicate that the cover bolts have not been tightened evenly. If this is the case adjust the tightness of the end cover bolts to give a uniform gap.



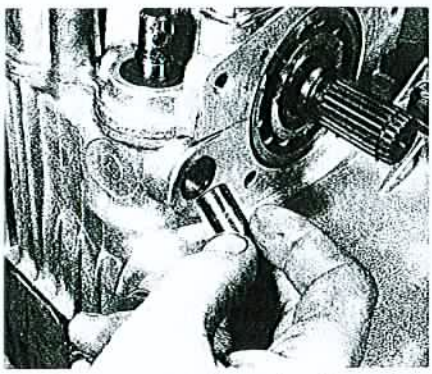
2.3 Remove the remote control shaft lever pinch-bolt



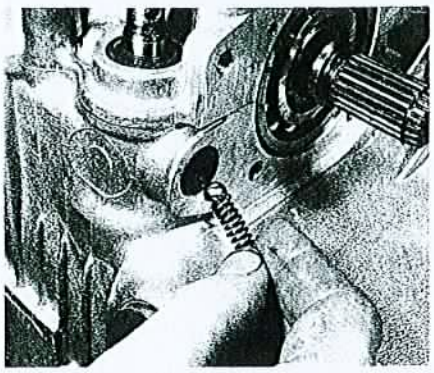
2.5a With the driving flanges removed, undo the end cover retaining bolts...



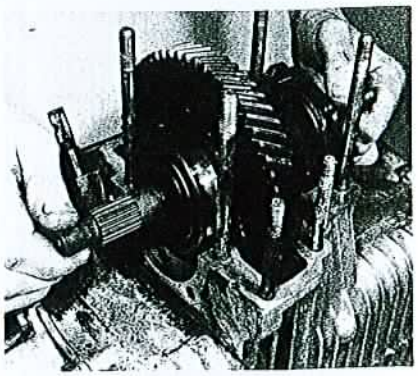
2.5b ...and recover the shims



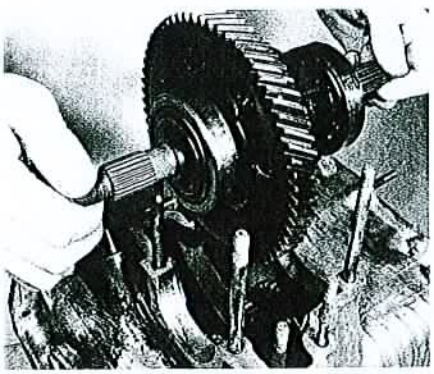
2.5c On later models lift out the selector shaft detent sleeve...



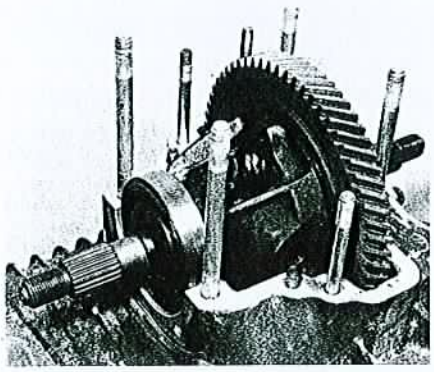
2.5d ...spring and ball



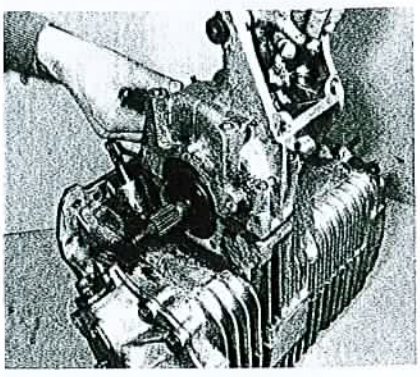
2.7 Lift off the housing and differential assembly



2.9 Refit the differential biased toward the flywheel side



2.10 Place a new gasket in position...



2.11 ...and lower the housing into place

15 The required bearing preload on earlier models is as shown in the Specifications and the compressed thickness of the gasket when installed is 0.007 in (0.18 mm). Therefore the clearance now being measured, without the gasket, must be between 0.008 and 0.009 in (0.20 and 0.23 mm). Any deviation from this figure must be rectified by fitting the appropriate sized shims between the end cover register and the bearing outer race in accordance with the table below:

Measured gap (No gasket) – see lower table for shim thickness	
(a) Zero to 0.001 in	*(Zero to 0.0254 mm)*
(b) 0.001 to 0.002 in	*(0.0254 to 0.0508 mm)*
(c) 0.002 to 0.003 in	*(0.0508 to 0.0762 mm)*
(d) 0.003 to 0.004 in	*(0.0762 to 0.1016 mm)*
(e) 0.004 to 0.005 in	*(0.1016 to 0.1270 mm)*
(f) 0.006 to 0.007 in	*(0.1524 to 0.1778 mm)*
(g) 0.007 to 0.008 in	*(0.1778 to 0.2032 mm)*
(h) 0.008 to 0.009 in	*(0.2032 to 0.2286 mm)*

Shim thickness	
(a) 0.008 in	*(0.2032 mm)*
(b) 0.006 to 0.007 in	*(0.1524 to 0.1778 mm)*
(c) 0.005 to 0.006 in	*(0.1270 to 0.1524 mm)*
(d) 0.004 to 0.005 in	*(0.1016 to 0.1270 mm)*
(e) 0.003 to 0.004 in	*(0.0762 to 0.1016 mm)*
(f) 0.002 to 0.003 in	*(0.0508 to 0.0762 mm)*
(g) 0.001 to 0.002 in	*(0.0254 to 0.0508 mm)*
(h) None necessary	

Note: *On later differential assemblies having the word THRUST stamped on the bearing outer race, the bearing preload is increased (see Specifications) and therefore the measured clearance without the gasket must be 0.011 in (0.28 mm).*

16 When the correct gap has been obtained, remove the end cover, lightly smear the gasket with jointing compound and refit the cover, gasket and retaining bolts. Tighten the bolts to the specified torque (photos).

17 Now fully tighten the differential housing retaining nuts and tap over the lockwashers (photo).

18 Refit the two driveshaft flanges, washers and castellated nuts or bolts. Tighten the nuts or bolts to the specified torque, and in the case of the castellated nuts, continue tightening until the split pin hole is in line with the next castellation and then fit a new split pin (photos).

19 Refit the remote control shaft (photo), the shaft lever and the extension cover plate (where fitted).

20 The engine/transmission unit can now be refitted to the car as described in Chapter 1.

3 Differential unit – dismantling, examination and reassembly (manual transmission models)

1 With the aid of a bearing extractor or universal puller, pull off the two bearings from the right and left-hand gearshafts. The bearings on some models are marked THRUST on the outside face.

2 Mark the differential case and the drivegear so that they can be reassembled in their original positions.

3 Knock back the tabs of the three lockwashers and unscrew the six set bolts which hold the drivegear to the differential case.

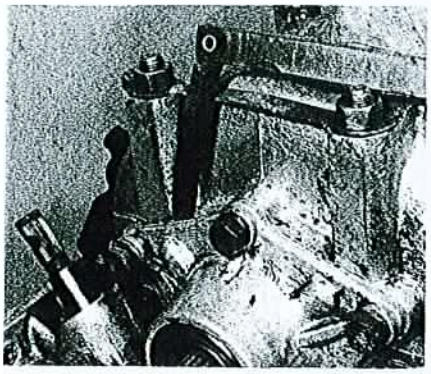
4 Remove the drivegear complete with the left gearshaft. Pull the drivegear off the shaft together with the thrust washer.

5 Gently tap out the tapered peg roll pin which holds the centre pin in place.

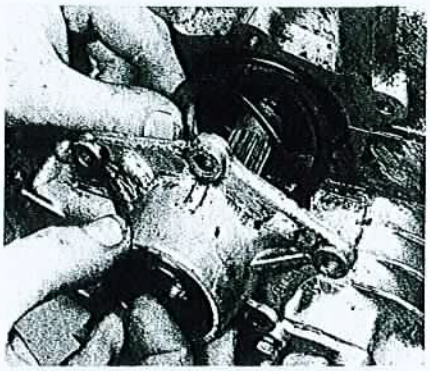
6 Remove the centre pin and the component parts of the differential case. The differential case can now be removed from the right gearshaft.

7 Check the bearings for side play and the rollers and races for general wear. Examine the centre pin, the thrust block, and the thrust washers for score marks, and pitting, and renew these components as necessary.

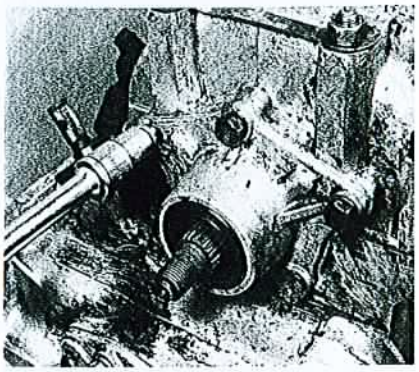
8 Examine the differential pinion gear for pitting, score marks, chipping and general wear. If wear is evident on any of the gears, they must all be renewed as a complete set. Similarly inspect the drivegear; if its condition is suspect, it must be renewed as a matched assembly with the drive pinion. If necessary renew the end cover oil seals (photo).



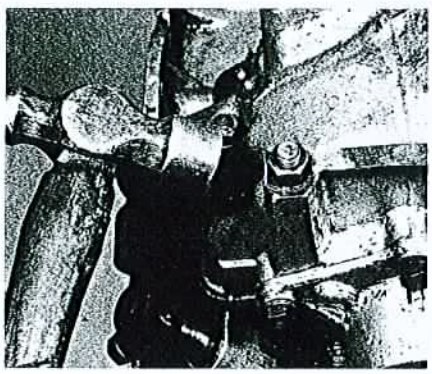
2.14 Measure the end cover clearance...



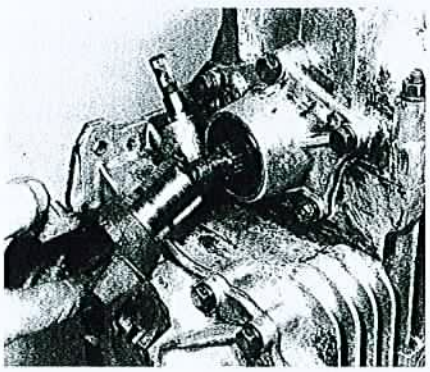
2.16a ...and then fit the selected shims and end cover



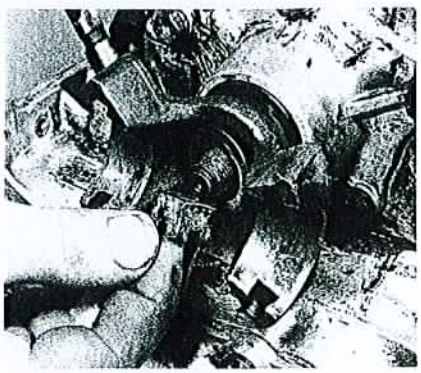
2.16b Tighten the end cover bolts...



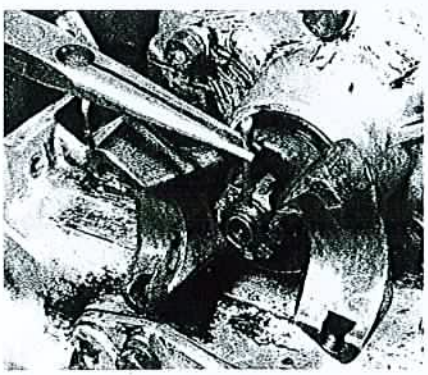
2.17 ...and with the housing bolts fully tightened, tap over the lockwashers



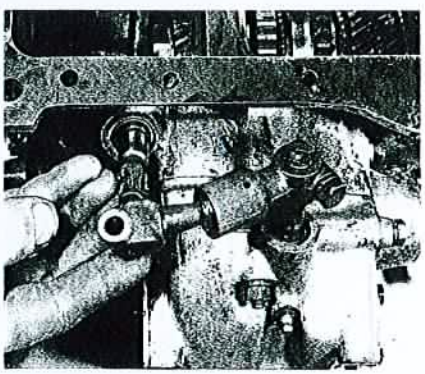
2.18a Refit the driving flanges...



2.18b ...castellated nuts...



2.18c ...and new split pins



2.19 Finally refit the remote control shaft

9 Reassembly is a straight reversal of the above sequence. Tighten all nuts and bolts to the specified torque. **Note:** *When refitting the differential gear thrust washers, ensure that the slightly chamfered bores are facing the machined faces of the differential gears, and that all components are refitting in their original positions.*

4 Final drive pinion – removal and refitting (manual transmission models)

Note: *The following procedure applies to the early type transmission, having either a direct engagement gearchange lever, or remote control gearchange and extension housing. If working on the latest rod-change type transmission, refer to paragraphs 12 to 20 inclusive. In all cases, if the final drive pinion is to be renewed, it will also be necessary to renew the differential drive gear as a matched assembly.*

Early type transmission

1 Refer to Chapter 1 and remove the engine/transmission unit from the car, and then separate the engine from the transmission.

2 Remove the differential assembly from the transmission as described in Section 2 of this Chapter.

3 Undo and remove the large hexagonal plug from the front left-hand side of the transmission casing. This plug holds the change speed reverse detent plunger in place. With the plug removed, lift out the spring and plunger.

4 Undo and remove the clamp bolt from the gearchange operating shaft selector lever. Slide the shaft up and out of the lever, withdraw the Woodruff key, and remove the shaft from the transmission casing.

5 Undo and remove the retaining bolt and lift out the speedometer pinion.

6 Undo and remove the nuts and bolts securing the engine mounting bracket and speedometer drive housing to the left-side of

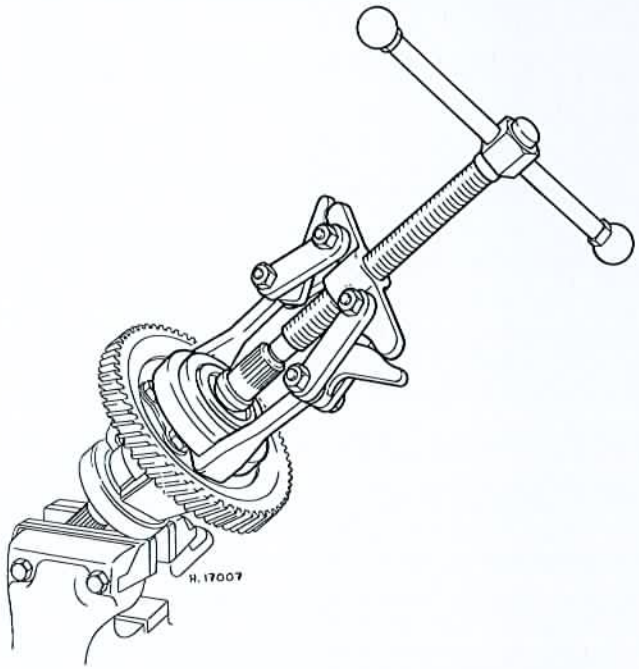
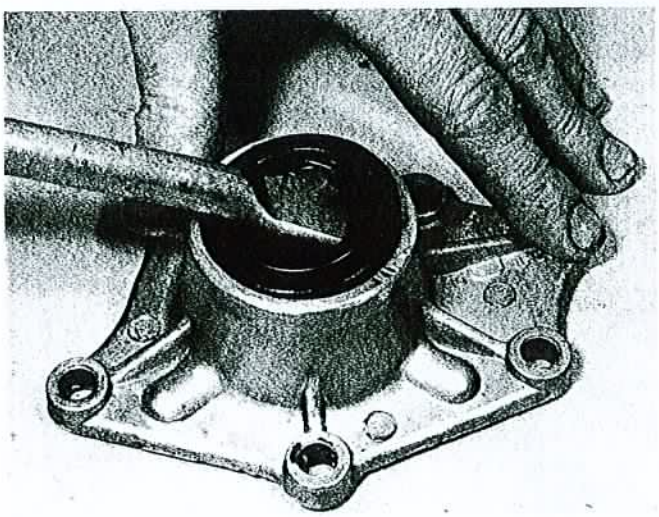


Fig. 8.2 Using a universal puller to remove differential bearing (Sec 3)



3.8 Removing an end cover oil seal

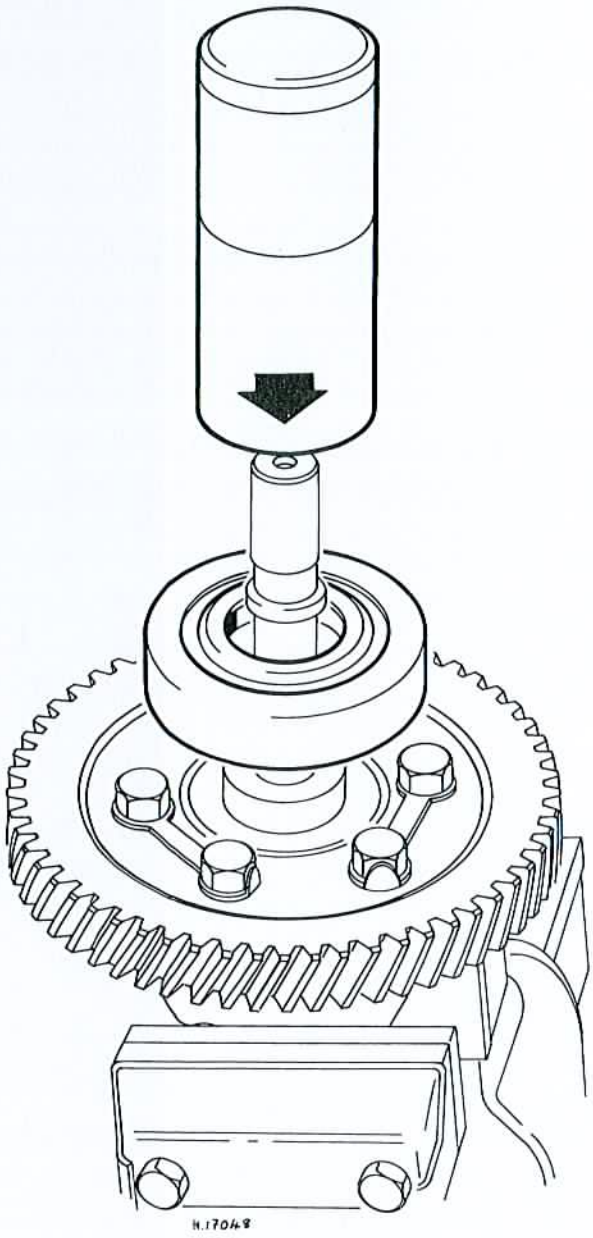


Fig. 8.3 Fitting a differential bearing (Sec 3)

the transmission casing. Lift off the bracket and housing, taking care not to damage the gasket if possible.

7 Lift out the gear selector interlocking plate from its location at the base of the transmission casing.

8 Engage two gears simultaneously by means of the selector rods to prevent the mainshaft from turning as the final drive pinion retaining nut is undone.

9 Bend back the locktab and, using a large socket and long extension bar, undo and remove the final drive pinion retaining nut.

10 Now lift off the locktab and slide the final drive pinion off the end of the mainshaft.

11 Refitting the final drive pinion is the reverse sequence to removal. Tighten all nuts and bolts to the specified torque.

Later type transmission

12 Refer to Chapter 1 and remove the engine/transmission unit from the car, and then separate the engine from the transmission.

13 Remove the differential assembly from the transmission as described in Section 2 of this Chapter.

14 Undo and remove the retaining bolt and clamp plate and lift out the speedometer pinion.

15 Undo and remove the retaining nuts and bolts, and lift off the engine mounting bracket and adaptor bracket from the speedometer drive housing. Undo and remove the remaining bolts and carefully slide the drive housing off the side of the transmission casing.

16 Using a small chisel or screwdriver, knock back the lockwasher tab securing the final drive gear pinion nut.

17 To enable the pinion nut to be undone the gearbox must be locked in two gears at once, to prevent the mainshaft from turning, as follows.

18 Rotate the selector shaft anti-clockwise to disengage the operating stub and the interlock spool from the bellcrank levers. Carefully lever the 1st/2nd gear selector fork towards the gearbox casing centre web. This will engage first gear. Carefully drift the centre bellcrank lever inwards using a screwdriver. This will engage fourth gear and lock the gearbox.

19 Using a large socket, undo and remove the final drive gear pinion retaining nut. Withdraw the lockwasher and the gear.

20 Refitting the final drive pinion is the reverse sequence to removal, ensuring that all nuts and bolts are tightened to the specified torque.

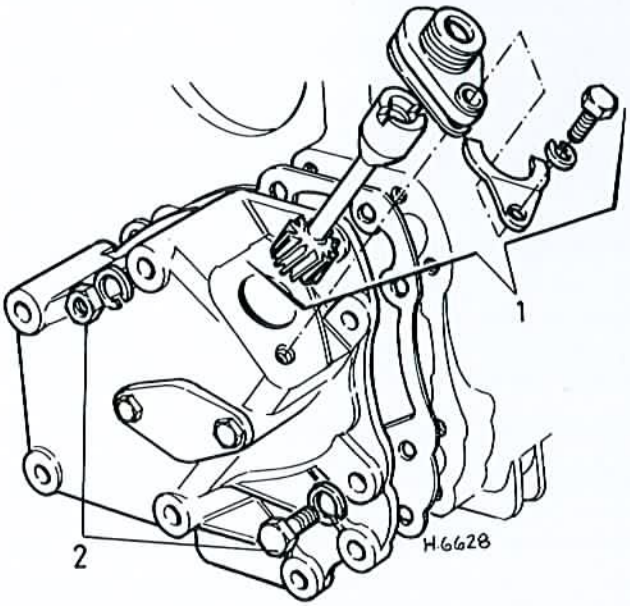


Fig. 8.4 Removing the speedometer drive housing (Sec 4)

1 Speedometer pinion assembly
2 Retaining bolts and nuts

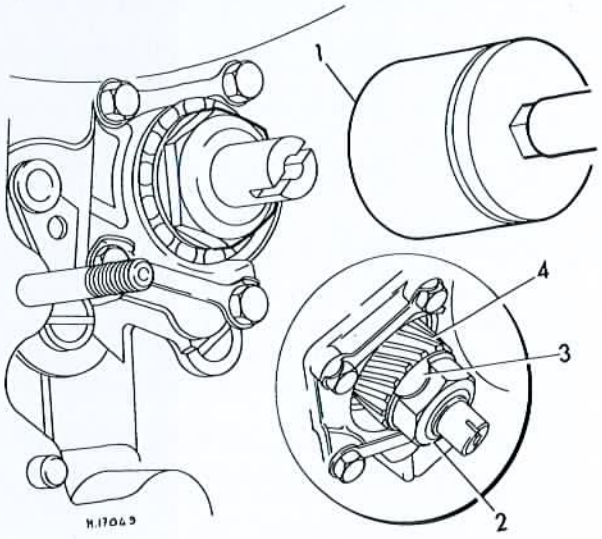


Fig. 8.5 Use of a large socket to undo the final drive pinion retaining nut (Sec 4)

1 Socket
2 Nut
3 Lockwasher
4 Final drive pinion

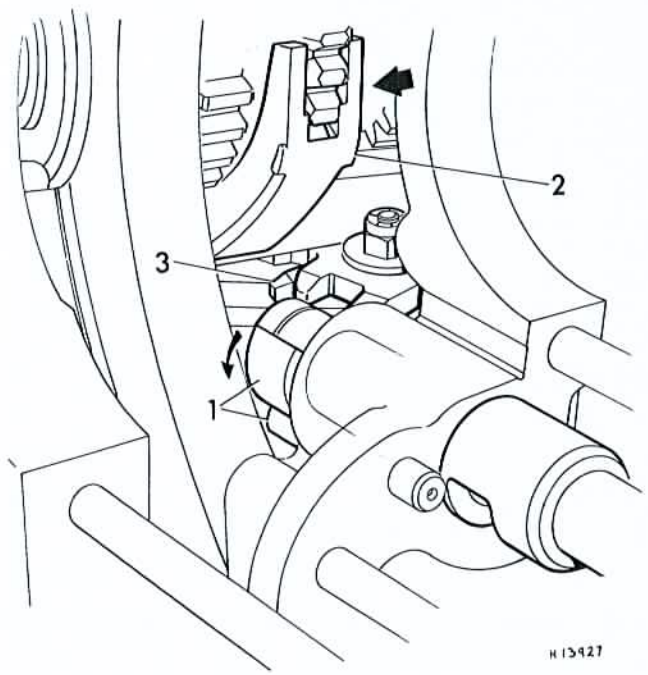


Fig. 8.6 Positioning of selector shaft – rod-change transmission (Sec 4)

1 Rotation of selector shaft to disengage operating stub and interlock spool from bellcrank levers
2 First/second selector fork
3 Centre bellcrank lever

5 Differential unit – removal and refitting (automatic transmission models)

1 Remove the engine/automatic transmission assembly from the car as described in Chapter 1.
2 Thoroughly clean the exterior of the transmission casing, paying particular attention to the area around the differential unit. Absolute cleanliness is essential when working on any components associated with the automatic transmission assembly.
3 Undo and remove the two driveshaft flange retaining bolts and washers. Prevent the flanges from turning by using a screwdriver, placed across two of the flange retaining studs. Now withdraw the flanges from the splined shafts.
4 Bend back the locktabs and undo and remove the differential unit retaining nuts.
5 Undo and remove the two retaining bolts and position the kickdown linkage clear of the transmission casing.
6 Undo and remove the four retaining screws and lift off the end cover and gasket from the left-hand side of the transmission casing. Recover the shims fitted behind the end cover.
7 Carefully lift off the differential housing and differential assembly from the transmission casing.
8 Before refitting the differential, clean off all traces of old gaskets and ensure that the mating faces of all components are scrupulously clean and dry.
9 Place the differential assembly into the transmission casing and slide it sideways towards the converter. Ensure that the slot in the spacer is in line with the dowel in the transmission casing.
10 Smear both sides of the differential housing gasket lightly with jointing compound and place them in position over the mounting studs.
11 Refit the differential housing, ensuring that the oil seal is squarely seated against the spacer as the housing is installed. Secure the housing with the nuts and locktabs, but only tighten the nuts sufficiently to hold the differential bearings and yet still allowing sideways movement of the complete assembly.
12 Refit the end cover but *without* the shims or the gasket. Tighten the cover bolts evenly until the register just contacts the shims and the bearing outer race. Do not overtighten the bolts as this could distort the end cover.
13 Now adjust the differential bearing preload using the procedure given in Section 2, paragraphs 14 to 17 inclusive.
14 Refit the driveshaft flanges ensuring that the split collets are correctly positioned inside the flanges. Place new rubber seals over the retaining bolts and refit the bolts and washers, tightening to the specified torque.
15 Refit the kickdown linkage to the transmission casing, ensuring that the linkage is positioned correctly. Refer to Chapter 6 for details.
16 The engine/automatic transmission assembly can now be reassembled and refitted to the car as described in Chapter 1.

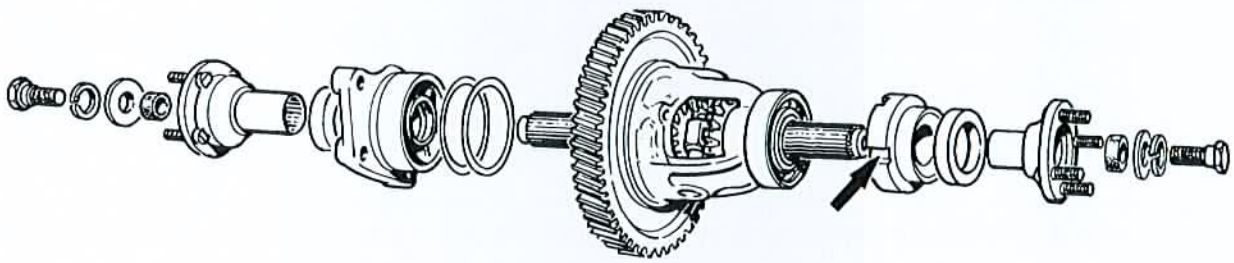


Fig. 8.7 Exploded view of differential assembly – automatic transmission (Sec 5)
Arrow shows alignment slot in the spacer

6 Differential unit – dismantling, examination and reassembly (automatic transmission models)

1 With the differential unit on the bench, first withdraw the spacer and then, using a bearing extractor or universal puller, pull off the two bearings from the right and left-hand gearshafts. Note that on later units the bearings are marked THRUST on the outside face.
2 Mark the differential case and drivegear so that they can be reassembled in their original positions.
3 Knock back the locktabs and undo and remove the bolts securing the drivegear to the differential case.
4 Separate the drivegear and case and lift out the left-hand gearshaft and thrust washer from the drivegear.
5 Gently tap out the tapered peg roll pin which secures the centre pin in position in the differential case.
6 Withdraw the centre pin, both pinions and their thrust washers and the pinion spacer. Slide out the right-hand gearshaft from the differential case.
7 Check the bearings for side play and the rollers and races for general wear. Examine the centre pin, pinion spacer and the thrust washers for score marks and pitting, and renew these components as necessary.
8 Examine the pinion gears for pitting, score marks, chipping and general wear. If wear is evident on any of these gears, they must all be renewed as a complete set. Similarly inspect the drivegear; if its condition is suspect it must be renewed as a matched assembly with the final drive pinion. As removal of the final drive pinion requires considerable dismantling of the automatic transmission assembly, it is recommended that if renewal of these gears is necessary, the work should be entrusted to your BL main dealer who will have the necessary special tools and equipment to dismantle the automatic transmission.
9 Inspect the two oil seals and renew them if necessary.
10 Reassembly is a straightforward reversal of the above sequence. Tighten all nuts and bolts to the specified torque. **Note:** *When refitting the differential gear thrustwashers, ensure that the slightly chamfered bores are facing the machined faces of the differential gears. Also ensure that all components are refitted in their original positions.*

7 Driveshaft flange oil seals – removal and refitting(manual transmission models)

Note: *The driveshaft flange oil seals, located in the differential end covers, can be renewed with the engine/transmission assembly installed in the car as described below.*

Models with driveshaft inner rubber coupling or Hardy-Spicer universal joint

1 Place a suitable container beneath the transmission and drain the oil.
2 Apply the handbrake, jack up the front of the car and support it on axle stands.
3 Withdraw the wheel trim and remove the appropriate front wheel.
4 Undo and remove the retaining nut and spring washer securing the swivel hub balljoint to the upper suspension arm.
5 Using a universal balljoint separator, release the taper of the balljoint shank from the upper suspension arm. Alternatively, refit the retaining nut two turns to protect the threads, and using a medium hammer, strike the end of the suspension arm with a few sharp blows until the taper is released. Now remove the retaining nut.
6 From underneath the car, undo and remove the rubber drive coupling retaining U-bolts and locknuts then lift off the coupling. On Cooper S models, undo and remove the universal joint flange retaining nuts and separate the flanges.
7 Move the driveshaft as far as possible away from the differential to provide sufficient clearance to enable the driveshaft flanges to be removed.
8 Extract the split pin, where fitted, and then undo and remove the driveshaft flange castellated retaining nut or bolt. Prevent the flange from turning by placing a block of wood between the flange and transmission casing, or where applicable, use a screwdriver across the retaining studs and against the casing.
9 Now slide the driveshaft flange off the splined gearshaft.

Models with driveshaft inner offset sphere type joint

10 Place a suitable container beneath the transmission and drain the oil.
11 Apply the handbrake, jack up the front of the car and support it on axle stands. Remove the appropriate front roadwheel.
12 From underneath the car, ease the offset sphere joint out of the differential using BL special tool 18G1240. If this tool cannot be borrowed, it is possible to make do with a tyre lever or similar strip of thick metal. Engage the end of the lever between the differential end cover and the body of the joint. Pivot the lever against the bolt head directly beneath the end cover. Strike the other end of the lever with a few sharp hammer blows until the joint is released and moves out slightly.
13 Undo and remove the retaining nuts securing both the upper and lower swivel hub balljoints to the suspension arms. Separate the balljoint tapers using the procedure described in paragraph 5.
14 Support the swivel hub to avoid stretching the flexible brake hose and withdraw the driveshaft, complete with inner offset sphere joint, out of the differential sufficiently to allow removal of the end cover. Temporarily locate the upper balljoint into the suspension arm and refit the nut loosely to support the swivel hub.

All models

15 Undo and remove the appropriate end cover retaining bolts and lift off the cover. **Note:** *If working on the right-hand side end cover of the later rod-change type transmission, take care not to lose the selector shaft detent spring which will be released as the cover is withdrawn.*
16 Using a drift or tube of suitable diameter, tap out the oil seal from the end cover. Carefully press in a new seal or tap it in using a flat block of wood to distribute the load. Ensure that the seal enters the end cover squarely and that the open side of the seal faces inwards.
17 Clean off all traces of old gasket from the mating faces of the end cover and differential housing, and ensure that the faces are clean and dry.
18 Refitting is the reverse sequence to removal, bearing in mind the following points:

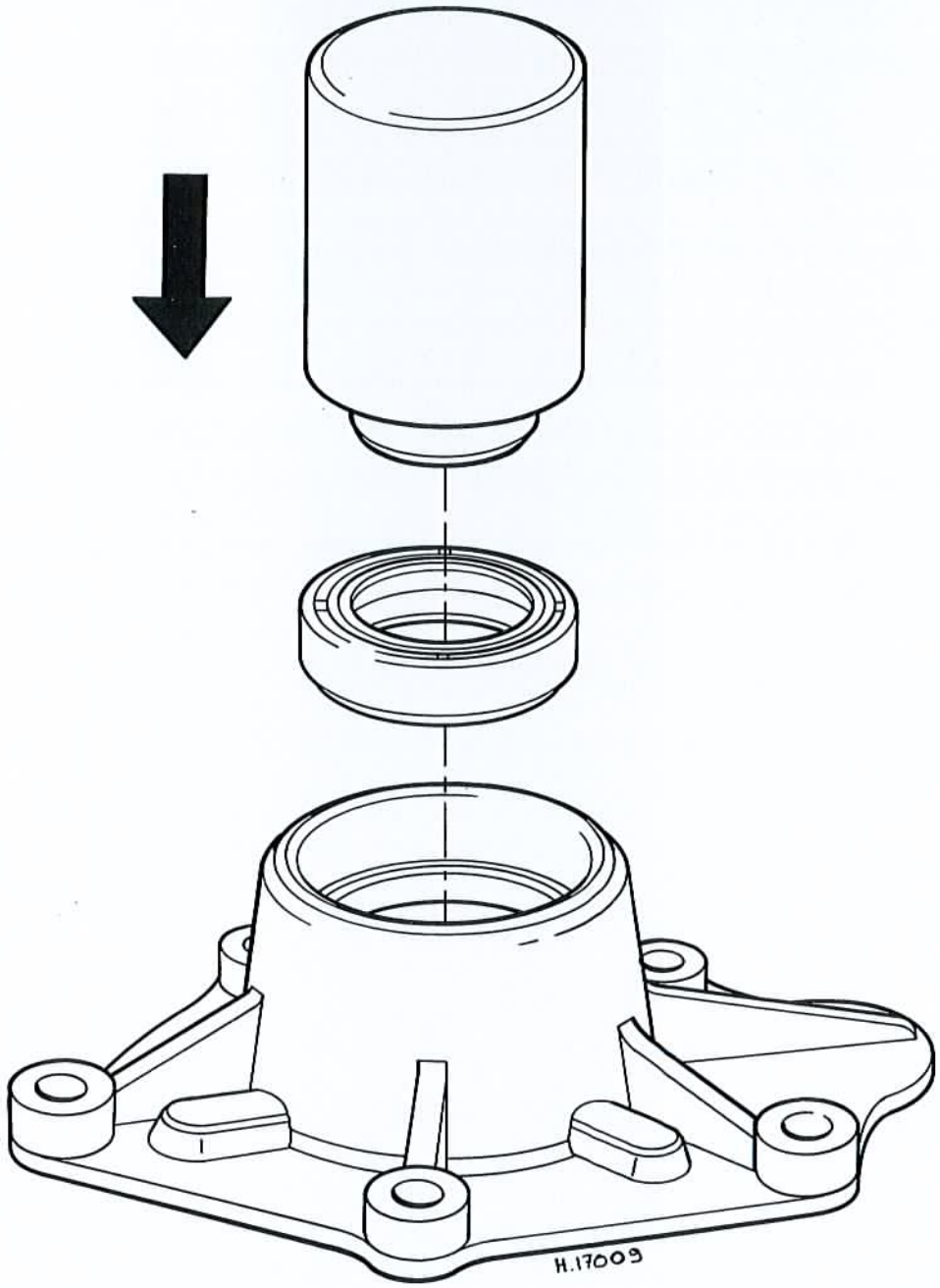


Fig. 8.8 Fitting a new oil seal to the differential end cover (Sec 7)

(a) Use a new gasket lightly smeared on both sides with jointing compound
(b) Tighten all nuts and bolts to the specified torque, and in the case of the castellated nuts, align the next split pin hole
(c) When refitting an offset sphere driveshaft joint, ensure that the joint is fully engaged on the differential gearshaft. If necessary wrap a long jubilee clip around the joint and tap the head of the clip with a mallet until the joint is fully home
(d) Remember to refill the engine with oil on completion of the reassembly

8 Fault diagnosis – differential unit

Because of the position of the differential unit, it is not practical to attempt fault diagnosis with the unit in situ. Clonks on acceleration or deceleration may be attributable to the driveshafts or their joints; noise when cornering may be due to defective wheel bearings. The DIY mechanic is advised to leave the differential alone unless definite evidence of malfunction has been obtained, or other dismantling renders the unit accessible.