LAND-ROVER

Workshop Manual Supplement

covering the

2¼ Litre Diesel Engine

To be used in conjunction with the Land-Rover Series II Workshop Manual.

THE ROVER Co. LTD · SOLIHULL · WARWICKSHIRE · ENGLAND

PART No. 4410

Technical Publication No. TP/291/A

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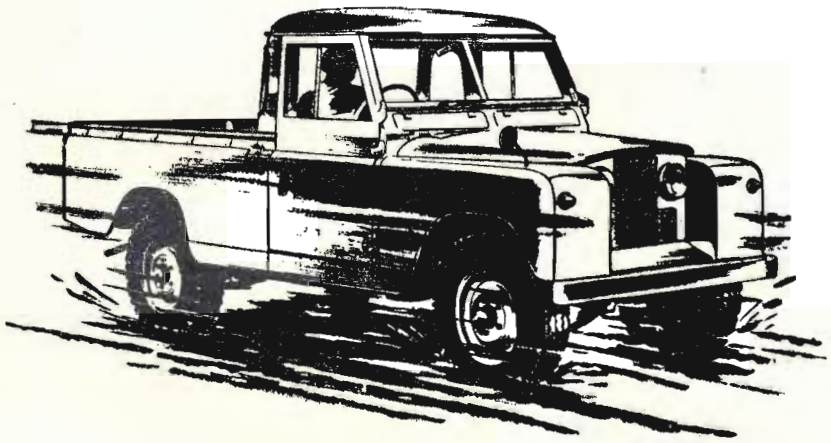

This publication deals with maintenance and workshop procedure for the Land-Rover 2¼ litre Diesel engine only.

Information concerning the remainder of the vehicle will be found in the Land-Rover Series II Workshop Manual; for latest circuit diagram, see Owner's Instruction Manual.

THE ROVER COMPANY LTD.

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PART No. 4410

NOVEMBER, 1961

VEHICLE AND UNIT NUMBERING

LAND-ROVER SERIES IIA DIESEL MODELS

Model	Vehicle and Chassis commencing numbers	Engine commencing numbers	Gearbox commencing numbers	Front Axle commencing numbers	Rear Axle commencing numbers
Home R.H.D. Export R.H.D. C.K.D. R.H.D. Export L.H.D. C.K.D. L.H.D. — Series II 88 2¼ litre Diesel	27100001a 27200001a 27300001a 27400001a 27500001a	27100001a	25100001a	24100001a R.H.D. 24400001a L.H.D.	24100001a
Home R.H.D. Export R.H.D. C.K.D. R.H.D. Export L.H.D. C.K.D. L.H.D. — Series IIA 109 2¼ litre Diesel	27600001a 27700001a 27800001a 27900001a 28000001a	27600001a	27600001a	25100001a R.H.D. 25400001a L.H.D.	25100001a
Home R.H.D. Export R.H.D. C.K.D. R.H.D. Export L.H.D. C.K.D. L.H.D. — Series IIA 109 2¼ litre Diesel Station Wagon	28100001a 28200001a 28300001a 28400001a 28500001a	27600001a	27600001a	25100001a R.H.D. 25400001a L.H.D.	25100001a

Section A—ENGINE—$2\frac{1}{4}$ LITRE—DIESEL

INDEX TO OPERATIONS WITH ENGINE REMOVED

THE INDEX TO OPERATIONS WITH ENGINE IN THE CHASSIS IS ON PAGE A-417

LIST OF ILLUSTRATIONS

ENGINE REMOVAL AND DISMANTLING PROCEDURE

Removing engine **Operation A/402**

1. If fitted remove the spare wheel from bonnet.
2. Disconnect the bonnet support stay and remove the bonnet.
3. Disconnect the hose from inlet manifold, unscrew the securing wing nut and lift the air cleaner and hose clear.
4. Disconnect the battery leads.
5. Drain the coolant from system (one tap at bottom L.H. side of radiator and one tap at L.H. side of cylinder block).
6. Disconnect the side lamp leads at each side of the grille panel assembly and the front lamp harness from the junction box at R.H. side of dash, then pull the wiring clear to front of engine.
7. Detach the top hose at radiator header tank and the bottom hose from water pump inlet.
8. Remove the fan blades.
9. Remove bolts securing the front apron. Remove the bolts securing the grille panel to front cross-member and front wings.
10. Lift the radiator, grille panel and headlamps assembly upward, then forward to clear the vehicle.
11. Disconnect the exhaust pipe from exhaust manifold.
12. Disconnect the heater pipes (if fitted) at the engine side of dash.
13. Disconnect the wiring from starter motor, dynamo, oil pressure warning switch and glow-plug lead at resistance on dash.
14. Disconnect the fuel inlet and outlet pipes from fuel lift pump and injection pump, also the fuel return pipe (filter to tank) at union of injector leak-off pipe. Remove fuel return pipe from clip on camshaft cover and also speedometer cable from clip on lift pump housing.
15. Remove the accelerator control rod, then the cut-off control cable from the steady bracket on engine and from the lever on injection pump.
16. Fit the engine sling to the support brackets at front and rear of cylinder head and with suitable lifting tackle just take the strain.
17. Remove the front floor and gearbox cover.
18. Remove the gear lever and clutch inspection plate.
19. Support the gearbox assembly with a jack or packing blocks.
20. Remove the clutch slave cylinder bracket from the flywheel housing and pull back the complete assembly as far as possible.
21. Remove the remaining nuts and washers securing the gearbox to the flywheel housing.
22. Remove the bolts from engine front support brackets, allow the engine to move forward and thus clear the gearbox input shaft. Ensure that the speedometer cable, etc., and all wires are clear, then hoist the engine gently from the vehicle.
23. Drain the engine oil and remove the sump.
24. Bolt the engine to a suitable stand, securing by the sump fixing studs.

ENGINE, TO DISMANTLE

Externals **Operation A/404**

1. Disconnect the fuel spill gallery pipe from injectors and remove the fuel feed pipes—injection pump to injectors.
2. Remove the securing straps, then withdraw the injectors and seating washers. Make sure the small steel washer is also removed from out of the orifice in the cylinder head.
3. Release the accelerator pull-off spring and remove the injection pump; disconnect the wiring, then remove heater plugs carefully to avoid damage to element.
4. All items of injection equipment should be stored in dustproof containers or submerged in clean Diesel fuel.

   See Section M for details of all fuel injection equipment.
5. If necessary, remove the inlet and exhaust manifolds, then the starter, fan belt and dynamo.

   See Section P for overhaul of starter and dynamo.
6. Disconnect the heater pipes and water tap from cylinder head if fitted.
7. The rearmost tappet chamber cover and fuel lift pump may be removed as one unit; remove the foremost tappet chamber cover and oil filler pipe.

   See Section M for details and overhaul of fuel filters and lift pump.
8. Remove the external full-flow oil filter complete with oil pressure warning switch.

   See Section AO for details of oil filter.
9. Disconnect the oil feed pipe—gallery to cylinder head.

   Remove the rocker cover, dipstick and dipstick tube.

Clutch and flywheel, to remove **Operation A/406**

1. Mark the cover plate and flywheel, so that on reassembly the plate may be fitted in the same relative position, to retain the original balance of the unit.

2. Remove the clutch, flywheel and housing.
   See Section B for overhaul of clutch and flywheel.

Oil pump, to remove Operation A/408

1. Remove the securing bolts and withdraw the pump assembly.
2. Withdraw the driving shaft from the pump upper casing.
   See Section AO for overhaul of oil pump.

Water pump, to remove Operation A/410

1. Remove the water pump assembly and pulley.
   See Section L for overhaul of water pump.

Vibration damper, to remove Operation A/412

1. Remove the starting dog and tab washer, using special tool, No. 530102. Then withdraw the vibration damper assembly from crankshaft.
   See Section A2 for overhaul of vibration damper.

Rocker shaft and cylinder head, to remove Operation A/414

1. Remove the rocker shaft cover, unscrew the bolts securing the rocker shaft support brackets, and lift the rocker shaft assembly complete from the cylinder head.
2. Ensure the component parts of the rocker shaft remain in their correct relative positions.
3. Withdraw the push-rods and insert them in a piece of cardboard pre-pierced and numbered 1 to 8.
4. Loosen the securing bolts evenly and lift the cylinder head clear, complete with manifolds and thermostat.

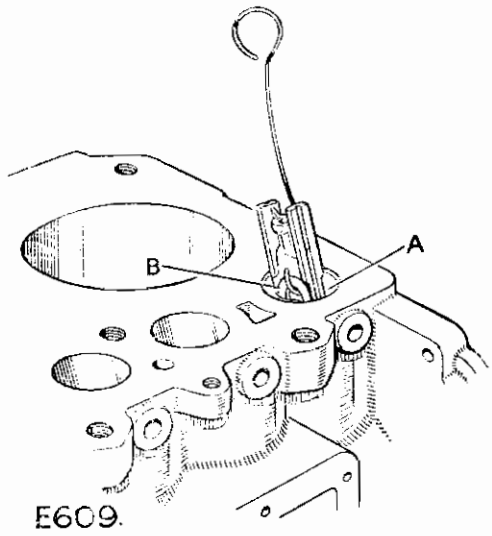

Fig. A-401—Removing tappet and roller
A—Tappet guide. B—Roller

Tappet assembly, to remove Operation A/416

1. Remove the tappet locating bolts from the right-hand side of the cylinder block.
2. Hook out the roller and brass tappet slide with a piece of wire, ensuring the tappet guide does not move. If the guide moves this may allow the roller to fall down into the camshaft chamber.

   Remove tappet guide, using special tool, Part No. 530101. Insert the tool into the tappet, turn 90° then withdraw the tappet guide.

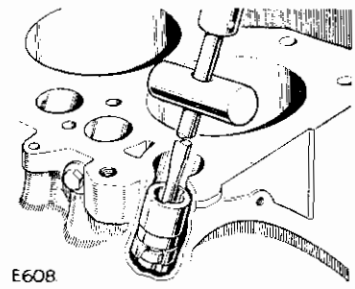

Fig. A-402—Removing tappet guide

The tappet assemblies are marked to ensure correct refitment.

(*a*) The front of the roller is indicated by a chamfer on its inside diameter. On late models the roller is countersunk ⅝ in. (16 mm) on one side and ½ in. (12,5 mm) on the other. The larger ⅝ in. (16 mm) diameter must be to the front.

(*b*) The brass tappet is clearly marked "FRONT".

(*c*) The guide can only be fitted the correct way due to the bolt locating hole. See Fig. A-403.

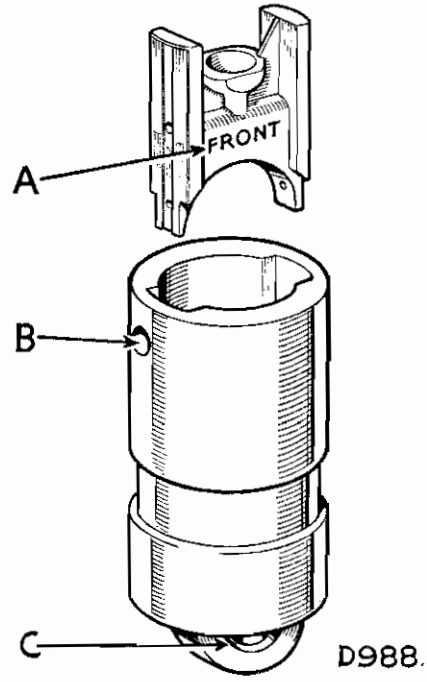

Fig. A-403—Tappet guide and roller

A—Brass tappet slide marked "Front"

B—Tappet guide bolt location hole

C—Roller with chamfer or ⅝" (16 mm) diameter to the front

Vertical drive shaft gear, to remove **Operation A/418**

1. Remove the locating screw from the external filter adaptor joint face.
2. Lift the drive shaft gear and external bush assembly clear with a pair of snipe-nosed pliers.

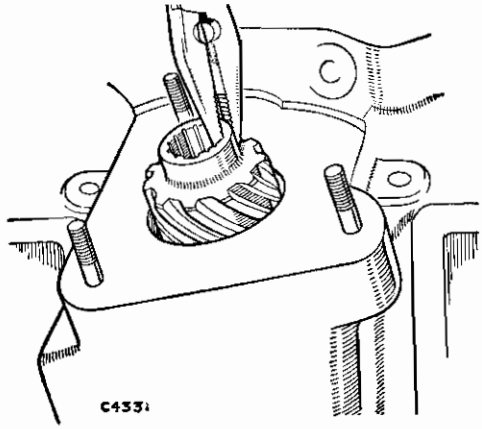

Fig. A-404—Removing the vertical drive shaft gear

3. The split bush may be removed by tapping to release the dowels. Do not remove the aluminium plug in the gear unless absolutely necessary. A new plug must be fitted if the old one has been removed.

Front cover, chain tensioner and chainwheels, to remove **Operation A/420**

1. Remove the front cover.
2. Remove the ratchet securing bolt and withdraw the ratchet and spring. Compress the chain tensioner spring and unscrew the lower fixings and remove the chain tensioner assembly.
3. Lift off the timing chain and remove the chainwheels.
4. Remove chain vibration damper.

Camshaft removal **Operation A/422**

1. Remove the camshaft front thrust plate, then withdraw the camshaft.

Pistons and connecting rods, to remove **Operation A/424**

1. Turn the crankshaft until the pistons of numbers 1 and 4 cylinders are at B.D.C. Remove the big-end bolt securing nuts of numbers 1 and 4 connecting rods, then withdraw the piston and connecting rod assemblies from the top of cylinder block.

   Repeat for numbers 2 and 3 assemblies.

Crankshaft, main bearings and seals, to remove **Operation A/426**

1. Remove the main bearing caps, lift the crankshaft clear and place in a suitable stand.

   Retain the shell bearings in pairs adjacent to the journal from which they were removed.
2. The rear bearing seal may be removed from the cylinder block, crankshaft, and bearing cap.

Cylinder block checks **Operation A/428**

1. Check that the main bearing caps have not been filed, in the following manner.
2. Assemble the caps without bearing shells to the crankcase, ensuring that they are correctly located by means of the dowels. Tighten both securing bolts for each cap, then slacken one bolt of each pair right off. There should be no clearance at the joint face.

   If the main bearing caps have been filed, the cylinder block is scrap.

ENGINE, TO REBUILD

Checking piston fit in bore

Low and high grade pistons of standard size are available for replacement purposes. This does not apply to oversize pistons. The grade letter which is stamped on the piston crown represents a difference in diameter of .0005 in. (0,012 mm) as shown below.

ZAB/L	....	3.5575 in. (90,361 mm)
BCD/L	....	3.5580 in. (90,373 mm)

When fitting standard pistons in a comparatively new engine, a graded piston, corresponding to the piston removed, should be fitted. However, a check must be made to ensure that the clearance falls within the limits laid down. For example:

If the vehicle has done little mileage and there is no appreciable bore wear, a graded piston of the same size as that taken out should be used; however if a certain amount of bore wear is apparent it may be necessary to fit a high grade piston. In the case of a high grade piston fitted as original equipment it may be necessary to rebore to the first oversize to obtain the correct piston fit.

The grade size of any particular bore is also stamped on the cylinder block at the sump joint face, using the same letters as stamped on the piston crown.

Camshaft bearing, to renew **Operation A/430**

When new camshaft bearings are to be fitted, the front and front intermediate bearings must be removed and new ones fitted **before** removing the rear bearings.

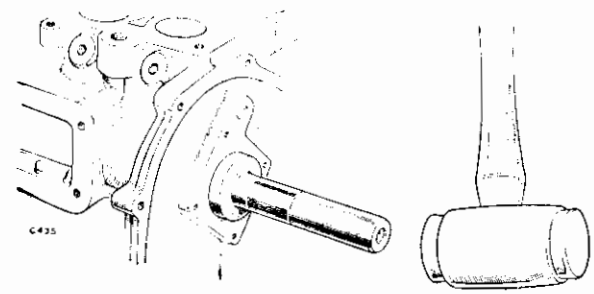

Fig. A-405—Outer camshaft bearing removal
A—Cylinder block B—Drift

1. Unscrew the 3½ in. (89 mm) long stud from the joint face at front of cylinder block.
2. Drift the front camshaft bearing into the foremost tappet chamber, using tool, Part No. 274388, then withdraw the bearing from the chamber aperture. Fig. A-405.
3. The front intermediate bearing is removed by drifting it into the fuel injection pump drive chamber, using the same tool, but it must be collapsed before withdrawing from the drive aperture as illustrated in Fig. A-406.

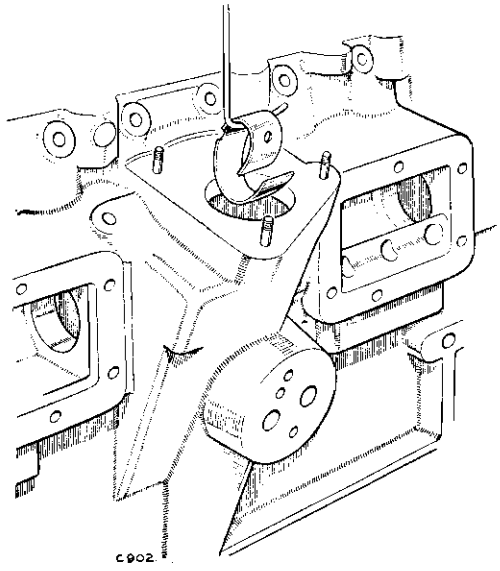

Fig. A-406—Inner camshaft bearing removal

4. Fit a guide tool, Part No. 274385, into the two **old** rearmost bearings with the part of flange marked "TOP" uppermost, then insert three end cover set bolts loosely for location purposes. Position a new bearing on to the handle end of bearing fitting bar, Part No. 274382, and locate by means of the peg and semi-circular cut-out, then slide a spacer, Part No. 274383, on to the fitting bar and engage the locating shoulder.
5. Place a new bearing on spigot, Part No. 274384, and position it inside the foremost tappet chamber with the bearing nearest the front intermediate housing.
6. Insert the bearing fitting bar into the front bearing housing and feed the spigot on to the bar; withdraw the spigot handle. Turn the spigot to engage the locating shoulder in the spacer, then press the fitting bar inward, turning as necessary to engage the bar slot with the peg in guide tube.
7. When the fitting bar has been pressed in as far as possible by hand, ensure that all locating points are properly engaged, then drive the bearings into position with a hide-faced hammer.

   The bearings must now be aligned with the oil holes, proceed as follows:—

   Partially withdraw bearing fitting bar and remove spigot, Part No. 274384. Slide adaptor, Part No. 531760, on to bar and re-insert bar and drive in until flange of bar abuts on cylinder block. This will align the oil holes on the intermediate bearing.

   Withdraw bar and adaptor and remove spacer, then refit adaptor, Part No. 531760, and align front bearing oil holes by gently tapping tool as required.

   Remove the bearing fitting tools and check the oil holes for alignment. Remove the two rearmost bearings.
8. Fit new camshaft **rear** bearings in the same manner as for front bearing fitment, but remove the spacer from fitting bar and use guide tool, Part No. 274386, instead of the guide tube used when fitting front bearings.
9. Locate a guide plug, Part No. 274394, in the new front camshaft bearing and locate, using the end-plate screws. Do not tighten these screws until the reamer, Part No. 274389, is put into position and the guide collar immediately in front of the cutter is entered into the rearmost bearing, which is first to be cut. This precaution is to ensure correct alignment of the reamer. Before commencing the reamering operation it is necessary to turn the engine block to a

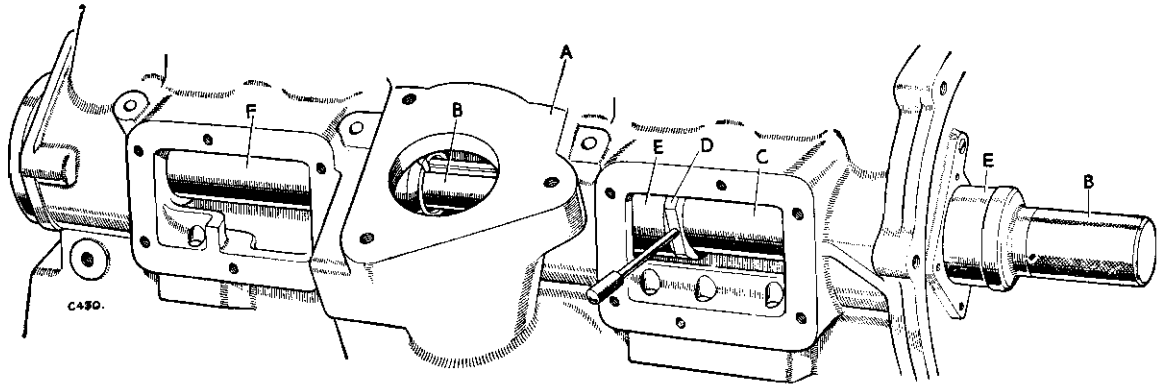

Fig. A-407—Fitting camshaft front bearings

A—Cylinder block
B—Bearing fitting bar
C—Spacer
D—Spigot
E—New bearings
F—Guide tube

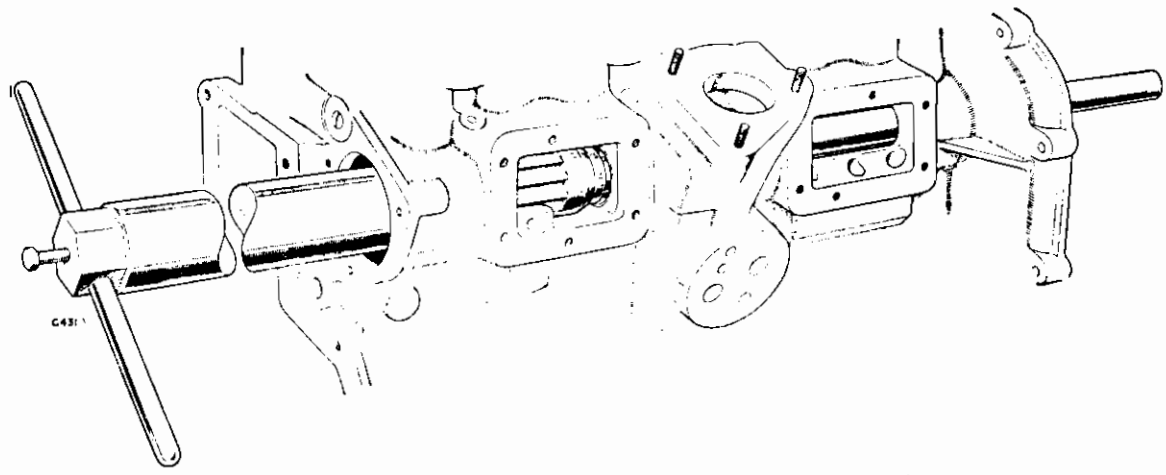

Fig. A-408—Reamering camshaft bearings (Engine must be in vertical position)

vertical position, front end facing downwards, in order that the weight of the reamer will assist in the cutting operation. As each bearing is cut the reamer should be held steady by the operator whilst an assistant, using a high pressure airline, blows away the white metal cuttings, before allowing the reamer to enter the next bearing.

10. After the rearmost and the two intermediate bearings have been cut, remove the guide plug, Part No. 274394, before cutting the foremost bearing. Remove the reamer handle and carefully remove the reamer, turning it in the same direction as for cutting. Care must be taken to prevent the reamer damaging the foremost bearing as the reamer is removed.

    No lubricant is necessary for the reamering operation, best results are obtained when the bearings are cut dry.

11. Remove the plugs from the ends of oil gallery passage and clean the gallery and oil feed passages to camshaft and crankshaft bearings, using compressed air. Refit the plugs and lock in position.

    The cylinder block must be thoroughly cleaned at this stage.

Crankshaft main bearings and seals
Operation A 432

1. Remove the bearing caps and fit the bearing shells, locating by means of the tags. Tighten the caps down and slacken off one bolt of each pair. Check the bearing nip, as illustrated in Fig. A-409, ensuring that the clearance does not exceed .004 to .006 in. (0,10 to 0,15 mm). The nip can be corrected by selective assembly of bearing shells; these are available in slightly varying thicknesses.

2. When the bearing nip has been checked, remove the caps and bearing shell bottom halves. Position a standard size thrust bearing at each side of centre bearing shell—top half, and fit the crankshaft.

3. Refit the bearing shell bottom halves and bearing caps. Tighten the securing bolts evenly and check each bearing in turn for correct clearance. The crankshaft should resist rotation when a feeler paper, .0025 in. (0,06 mm) thick, is placed between any one bearing shell and crankshaft journal, and turn freely by hand when the feeler paper is removed. Adjust by selective assembly of bearing shells.

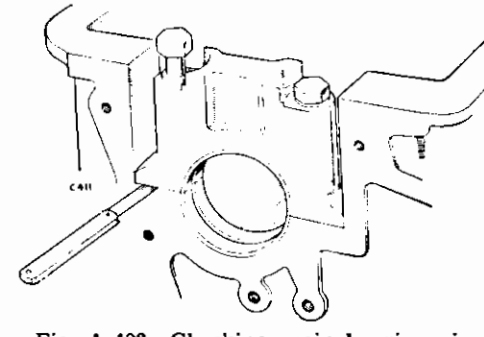

Fig. A-409—Checking main bearing nip

4. Mount a dial test indicator, then check and note the crankshaft end-float reading which should be .002 to .006 in. (0,05 to 0,15 mm).

5. If the crankshaft end-float reading obtained is not within the limits, fit suitable oversize thrust bearings. The variation of thrust bearing thickness at each side must not exceed .003 in. (0,07 mm) to ensure that the crankshaft remains centralised.

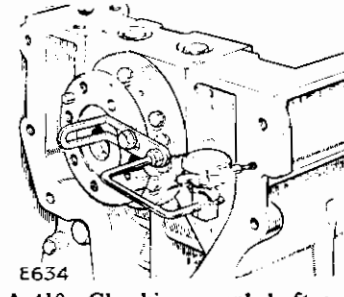

Fig. A-410—Checking crankshaft end-float

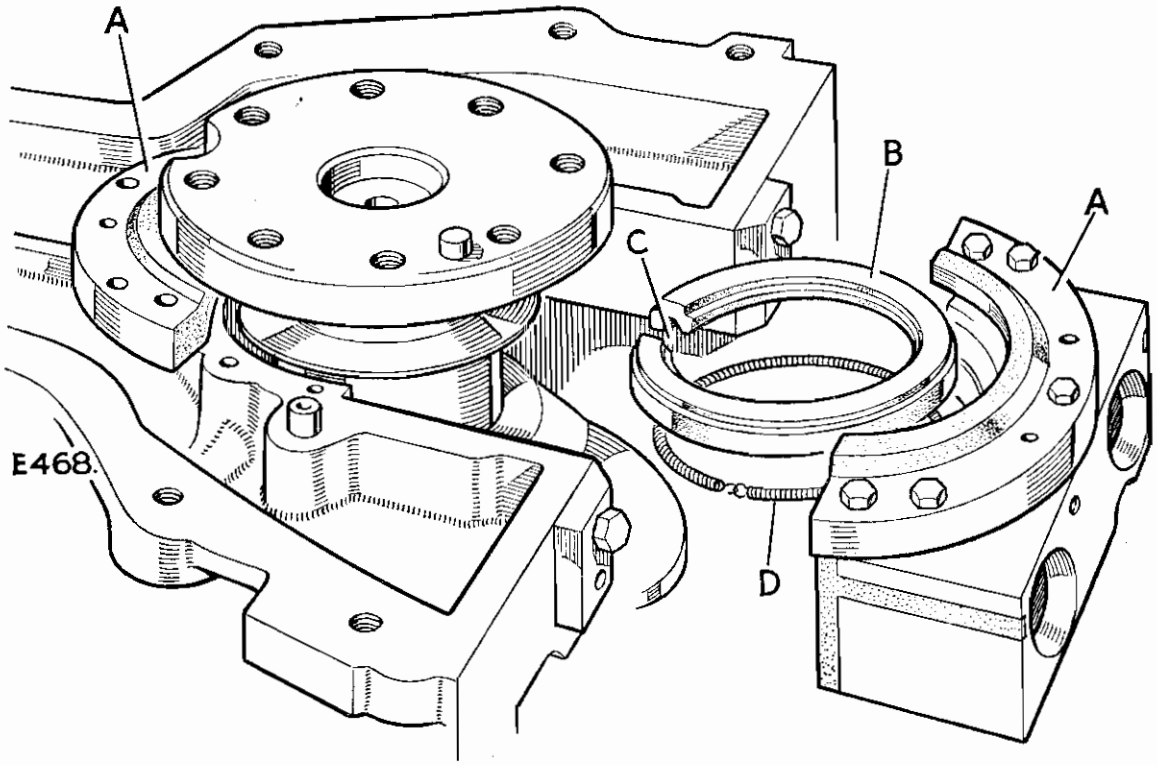

Fig. A-411—Retainer halves, oil seal and garter spring

A—Retainer halves.
B—Split oil seal
C—Split line of seal must be towards top of engine
D—Garter spring, hook and eye midway between split and hinge of oil seal

6. Remove the bearing caps, bottom half shells and crankshaft.

7. To the rear main bearing cap fit neoprene seals in recess at each side.

Fitting four-piece oil seal

8. With the crankshaft in the engine, assemble the garter spring on the oil seal journal of the crankshaft, by laying the spring around the journal; this will bring the two ends, the hook and the eye, adjacent to one another, then insert the hook into the eye.

   Care must be taken to ensure that during this operation the spring is not stretched at all. The spring should be moved along the journal until it is against the thrower flange.

9. Apply Silicone Grease MS4, obtainable in tubes under Part No. 270656, to the crankshaft oil seal journal and to both sides of the split oil seal sealing lip.

10. Open the split seal sufficiently to allow it to be fitted over the crankshaft oil seal journal. Recess in oil seal must be towards thrower flange and garter spring. The oil seal must not be repeatedly fitted and removed from the crankshaft, as this can damage the sealing lip.

11. Ensure that the hook and eye of the garter spring are located mid-way between the split and hinge of the oil seal. Then, using a small screwdriver or similar tool, gently ease the spring into the recess in the oil seal. See Fig. A-412.

12. Rotate the oil seal until the split is on the vertical axis pointing towards the cylinder head; this position is important.

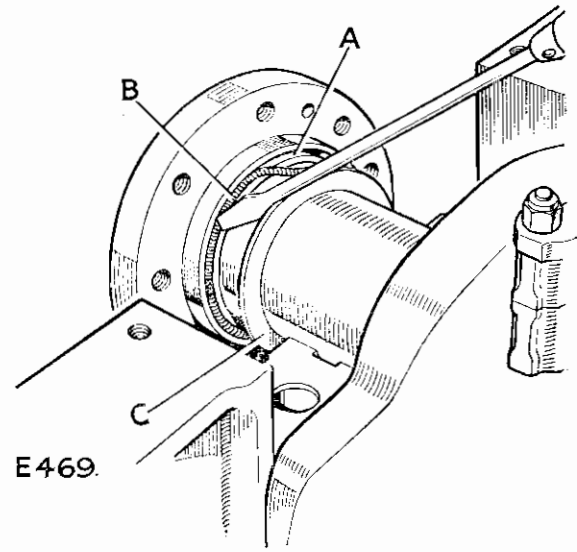

Fig. A-412—Fitting garter spring to oil seal recess

A—Oil seal recess. B—Garter spring. C—Thrower flange

13. Fit one half of the oil seal retainer on to the crankcase dowels. The oil seal should be compressed to assist assembly.

Bolt the retainer on to the crankcase, leaving the two bolts adjacent to the split line finger tight, fully tighten the remaining three bolts. In order to fit the bolts it will be necessary to rotate the crankshaft; it is essential to hold the seal so that it does not rotate with the crankshaft.

14. Bolt the other half of the oil seal retainer on to the main bearing cap in the same way. The cap must be off the crankcase for this operation.
15. Fit the main bearing cap with the seal retainer, bearing shell and neoprene seals to the crankcase until there is a $\frac{1}{32}$ in. (0,8 mm) gap between the cap and crankcase.
16. Fitment of the rear main bearing cap, with side seals in position, will be facilitated by using a lead tool (Part No. 270304) fitted to the sump studs adjacent to rear bearing cap aperture. See Fig. A-413.
17. It will be found advantageous to cut a very slight lead on to the bottom edges of side seals as this will prevent them from folding under the cap during fitment, thus causing an oil leak due to the cap not seating properly. Lubricate seals with Silicone MS4 Compound.
18. Using a thin screwdriver, move the oil seal along the shaft until it is located in the housing recess.
19. Pull down the cap slowly, ensuring there is no buckling of the split seal or misalignment of the butt joint.
20. Tighten the cap bolts to 100 lb/ft. (13,80 mkg) torque and re-check that the seal is located correctly in the housing.
21. Finally tighten the four bolts securing the housings adjacent to the split line.

    The split seal and garter spring must be renewed whenever a crankshaft is removed or replaced for any reason. However it is not necessary to replace the retainers when a new seal is fitted, unless they are damaged.

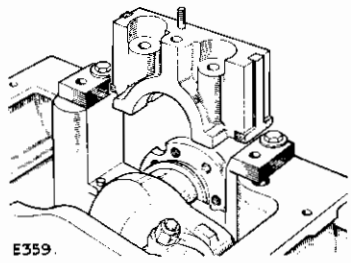

Fig. A-413—Fitting rear bearing cap and seal assembly
A—Bearing cap B—Seal C—Lead tool

Pistons and rings, to refit Operation A/434

In order to obtain the correct piston clearance with a new piston in a new or worn bore, insert a long .004 in. (0,10 mm) feeler gauge down the thrust side of the cylinder, that is the left-hand side of the cylinder looking at the engine from the front. Insert the piston upside down in the cylinder bore with the gudgeon pin in line with the centre line of the engine. Push the piston down the cylinder until the piston skirt reaches its tightest point in the bore, where the feeler gauge should require a 10 lb. (4,5 kg) pull to withdraw it.

This method of checking the piston clearance ensures that the piston has the correct clearance in its working position.

1. Check the piston ring gaps in the cylinder bores, using an old piston as illustrated in Fig. A-414, to keep the rings square in the bore.
2. The second and third compression rings are bevel edged and **must** be fitted with the side marked "T" **uppermost;** the top chromium plated compression and the oil scraper ring have square friction edges and may be fitted either way. Fit the piston rings and check the clearance in ring groove. See Data Section.

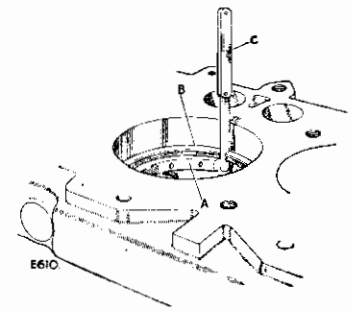

Fig. A-414—Checking piston ring gap
A—Scrap piston B—Piston ring C—Feeler gauge

It will be seen that provision is made for the fitment of two oil scraper rings. The second groove is for service purposes only.

Connecting rod checks Operation A/436

1. Check that the connecting rods and caps have not been filed, in the following manner.
2. Select the correct cap for each connecting rod, as denoted by the number stamped near the joint faces. This number also indicates the crankpin to which it must be fitted.

   Assemble the connecting rods, less shell bearings, with corresponding numbers together.

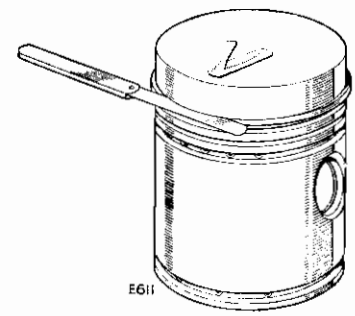

Fig. A-415—Checking ring clearance in groove

3. Tighten the securing bolts, then slacken one of them right off and check that there is no clearance at the joint face.

   If the connecting rods or caps have been filed the assemblies must be scrapped.

Connecting rod bearing nip Operation A/438

1. Check the bearing nip in the following manner.
2. Fit the bearing shells and tighten both securing bolts—slacken one bolt as before and check the nip with a feeler gauge; this should be .002 to .004 in. (0,05 to 0,10 mm).

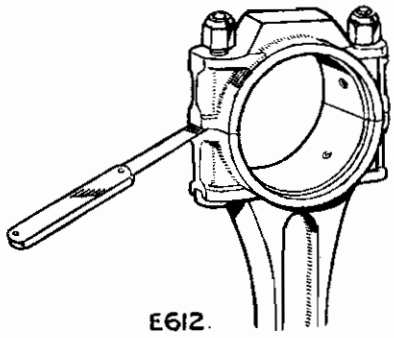

Fig. A-416—Checking the big-end bearing nip

3. The nip can be corrected by selective assembly of the bearing shells; these are available in slightly varying thickness. Do **not file the rod or cap.**
4. Assemble the big-end of each connecting rod to its respective crankpin, then check for correct clearance.

   The connecting rod should resist rotation when a .0025 in. (0,06 mm) shim paper is fitted between the crankpin and one-half of big-end bearing shell, then move freely by hand when the shim paper is removed. Adjust by selective assembly of bearing shells.

   Bearing clearance should be .001 to .0025 in. (0,025 to 0,06 mm).
5. Check the connecting rod end-float on crankpin by inserting a feeler gauge between the end face of rod and the crankpin shoulder. End-float should be .007 to .011 in. (0,20 to 0,30 mm).
6. Remove the connecting rods from crankshaft, ensuring that the bearing shells are kept with the rods to which they were fitted.

Gudgeon pin, bush and piston fitting Operation A/440

1. The oil hole in gudgeon pin bush is pre-drilled and care must be taken to ensure that the oil holes of bush and connecting rod will align when the bush is pressed into position. The gudgeon pin bushes should be a .001 to .002 in. (0,025 to 0,05 mm) interference fit in connecting rods. Ream the bush when fitted to connecting rod to allow a .0003 to .0005 in. (0,0076 to 0,0127 mm) gudgeon pin clearance. Ensure that correct alignment is maintained while reamering.

   This fit is selected to give the smallest possible clearance consistent with a smooth revolving action.
2. Fit each connecting rod to a suitable test rig and check for twist and mal-alignment.
3. The gudgeon pin, when cold and dry, should be a slight **interference** fit in both bores of the piston—see Data. It must be fitted by hand pressure but must **not** be able to fall out of either bore under its own weight.

   Lubricate the gudgeon pin when the correct size has been selected for a particular piston, but do not fit and remove the pin from piston unnecessarily thereafter, or the slight interference fit may be lost.
4. Fit the connecting rod to the piston with the oil spray hole of rod on the same side as the swirl-inducing recess in piston crown. Lock the gudgeon pin in position with circlips.
5. Turn the crankshaft until the crankpins relative to numbers 1 and 4 cylinders are at B.D.C. Insert the connecting rods and pistons for these cylinders from the top of cylinder block, with the oil spray hole in connecting rod and turbulence recess in piston towards the R.H. side of engine—towards the camshaft. Secure the big-ends to crankpins, tightening the securing nuts to 25 lb/ft (3,45 mkg).
6. Repeat Item 5 for numbers 2 and 3 cylinders.

Camshaft, to replace Operation A/442

When replacing camshafts it should be noted that 2¼ litre Diesel engine camshafts are marked "DIESEL" between No. 1 and No. 2 cam lobes. This is to differentiate between Diesel and petrol camshafts, which look similar in all respects except for the positioning of the cam lobes.

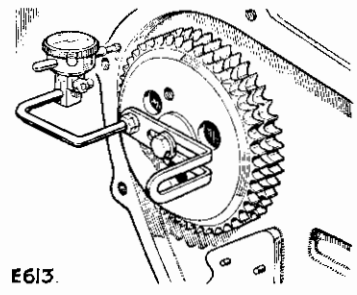

Fig. A-417—Checking camshaft end-float

1. Insert the camshaft—keyed end to extend at front of engine.

2. Fit the front thrust plate and tighten bolts—do not bend up the locking tabs at this stage.

   Fit camshaft chain wheel and then check the camshaft end-float with a dial test indicator as illustrated in Fig. A-417, ensuring that the chainwheel bolt is tightened fully. The camshaft end-float reading must be within .0025 to .0055 in. (0,06 to 0,13 mm).

   Adjust by selective assembly of the front thrust plate. Finally, bend up the locking tabs securing the front thrust plate bolts.

Tappet assembly and fitment
Operation A/444

1. Before fitting the tappet assembly into the block, thoroughly clean all parts and check that the tappet will move freely in the tappet guide when held in the hand and shaken up and down.

2. Fit tappet guides into the cylinder block, ensuring that the locating hole lines up with the hole in the cylinder block.

   The tappet guides must not be too tight in the block or they may be damaged by insertion of the locating screw in cases when they are not properly aligned.

3. Gently insert the roller into the guide. Do not drop the roller, as it is easily damaged. The front of the roller is indicated by a chamfer on its inside diameter. On late models the roller is countersunk $\frac{5}{8}$ in. (16 mm) on one side and $\frac{1}{2}$ in. (12,5 mm) on the other. The larger $\frac{5}{8}$ in. (16 mm) must be to the front.

4. Fit tappet into the guide and locate on to the roller. The tappet is marked "Front" and must be facing the front of the guide.

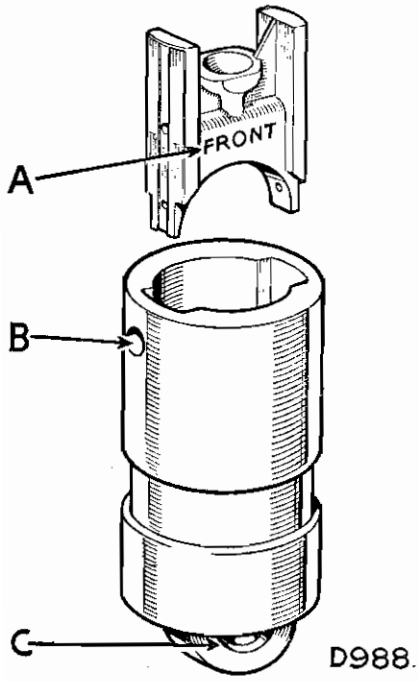

Fig. A-418—Tappet guide and roller

A—Brass tappet slide marked "front"

B—Tappet guide bolt location hole

C—Roller with chamfer or $\frac{5}{8}$ in. (16 mm) diameter to the front

5. Fit the tappet locating screws and washers; the locating screws must be screwed up with the fingers and then tightened; if they are not free, remove and investigate reason.

6. Lock the locating screws in pairs, using 20 s.w.g. (0,9 mm) iron wire.

Flywheel housing, flywheel and clutch
Operation A/446

1. Ensure that the oil seal is in good condition, then secure the flywheel housing to cylinder block. See note regarding drain plug at end of section.

2. Fit the flywheel and tighten the securing bolts to 50 lb/ft (6,9 mkg) torque.

3. Check the run-out on flywheel face as illustrated by Fig. A-419. The run-out on flywheel face must not exceed .002 in. (0,05 mm).

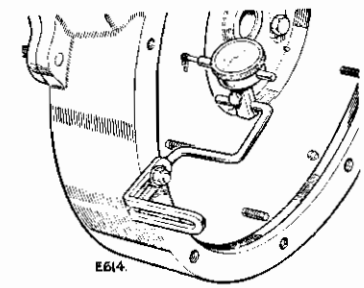

Fig. A-419—Checking run-out on flywheel face

4. Ensure that the clutch disc splines are clean, and will slide on every one of the primary shaft splines.

5. Fit the clutch assembly to the flywheel, using an old primary shaft to ensure that the clutch disc is central with the flywheel bush.

Cylinder head overhaul **Operation A/448**

1. If necessary, remove the inlet manifold, exhaust manifold and thermostat.

2. Using a valve spring compressing tool, Part No. 276102, remove the valve assemblies.

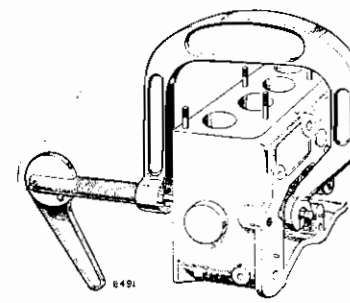

Fig. A-420—Compressing valve springs

Valve guides, to renew

3. Drift the valve guides from the cylinder head, using tools Part No. 274401 (exhaust) and 274400 (inlet).

4. In order that the new valve guides may be replaced it is necessary to machine two drifts to the dimensions illustrated in Fig. A-421. It is of utmost importance that the 10° angle is maintained, failure to do so will result in damage to the valve guide and possible collapse of the seal groove.
5. Lubricate the inlet and exhaust valve guides and carefully drift into position.

Valve seats, to renew

If it becomes necessary to renew the exhaust valve seats, proceed as follows:

6. Grind the insert away until only a thin portion remains, then, with the area suitably masked to avoid injury from flying fragments, gently tap the insert with a centre punch and remove the broken parts.
7. Remove the valve guide as detailed in "Valve guides, to renew".
8. Clean the seat recess and pull the new insert into position, using the special tool illustrated in Fig. A-422. It is not necessary to heat the cylinder head or freeze the insert, but light taps on the tool may be required to ensure that the insert enters smoothly. Drift in the new guides, as detailed in "Valve guides, to renew".

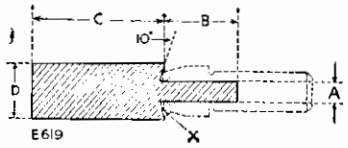

Fig. A-421—Fitting tool, inlet valve guide

A—Exhaust .343 in. (8,5 mm); inlet .312 in. (7,5 mm)
B—1 in. (25 mm)
C—1¾ in. (44 mm)
D—¾ in. (19 mm)
X—Point of impact

Valve seats, to reface

9. It is necessary to remove the very hard crust of carbon from the valve seats with a piece of emery cloth before attempting to re-face them.
10. Reface the inlet valve seats and, using a little grinding paste, lap the new or re-ground valves into the seatings

Seat angle, inlet: 45°
Seat angle, exhaust: 45°

11. When lapping is completed, remove each valve in turn and fit a new rubber seal into the valve guide. Clean off all traces of grinding paste, lubricate the valve stem.

Fit the valves, springs, cups and split cotters, ensuring that the components are retained in their original sets and positions.

A new valve seal *must* be fitted whenever a valve is removed.

The valve springs have an interference fit of .005 in. (0,01 mm). If the inner spring will slide through the outer spring, both are scrap.

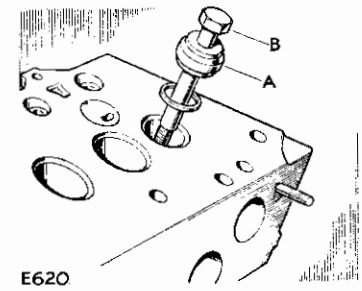

Fig. A-422—Valve seat replacement tool

Push-rod tubes — Operation A/450

1. The push-rod tubes may also be removed if necessary by drifting them out, using tool Part No. 274399.

When the tubes are removed they are scrap, and new ones must be fitted.

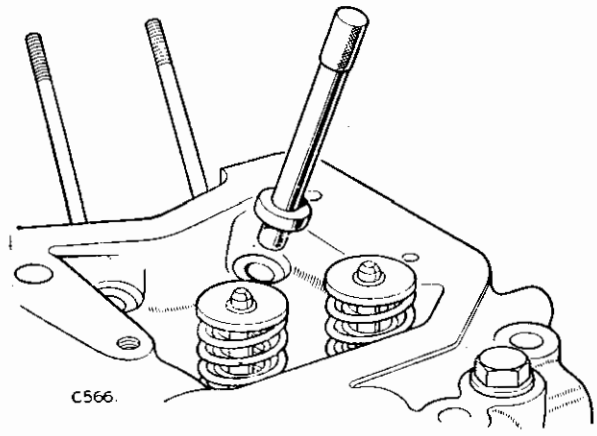

Fig. A-423—Removing push-rod tubes

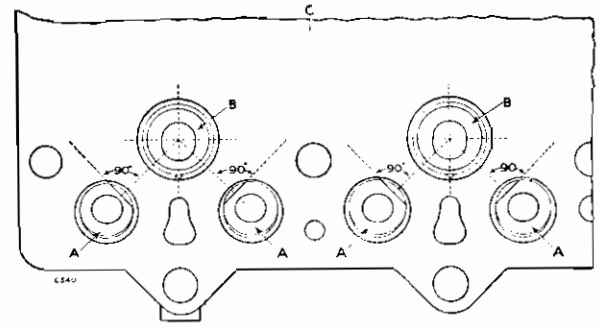

Fig. A-424—Correct position of push-rod tubes in relation to hot plugs

A—Push-rod tubes B—Hot plug
C—Cylinder head inverted

2. If the push-rod tubes were removed, new tubes complete with new sealing rings, smeared with Silicone M.S.4 Compound, should be pulled into position, using tool Part No. 274402. Ensure that the chamfers on tube and in cylinder head are in full contact and that the "flat" of tube is at right angles to a line drawn between the centre of push-rod tube and centre of hot plug, as illustrated by Fig. A-424.

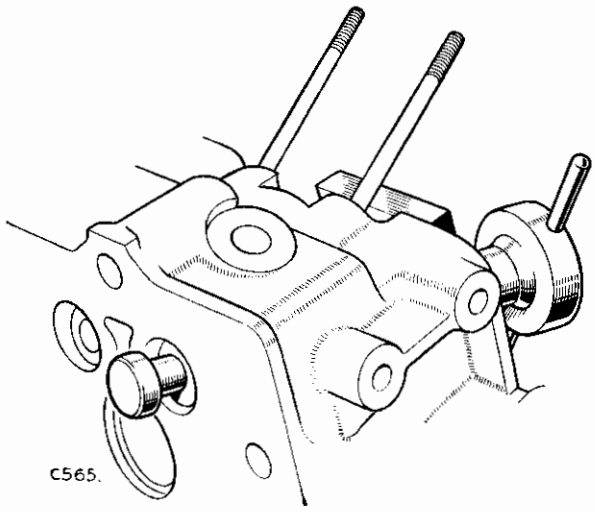

Fig. A-425—Fitting push-rod tubes

Hot plugs and injector shroud, to renew Operation A/452

In order to renew the injector shrouds it is necessary to remove the hot plugs.

1. Under normal circumstances there is no need to remove the hot plugs; however, if any surface cracking should appear on the face of the hot plug, the plug should be removed in the following manner:—

   Insert a copper drift through the injector shroud aperture, then tap evenly and gently around the inside of hot plug. Avoid using a heavy hammer if possible and thus minimise the possibility of damage.

2. If necessary, remove the injector shrouds, using a suitably shaped drift.

3. Thoroughly clean out the combustion chamber. The hole in the side of the injector shroud is for manufacturing purposes only, but at the same time can be used as a guide when refitting the shroud.

4. Smear a little oil on the shroud and insert into the cylinder head with the hole pointing towards the centre of the cylinder head, and drift into position, using tool Part No. 274399.

5. The hot plugs must now be replaced by tapping gently into position with a hide-faced hammer. When fitted they must be checked with a clock gauge to ensure that they do not protrude above the level of the cylinder head face more than .002 in. (0,05 mm) and are not recessed below the level of the cylinder head face more than .001 in. (0,025 mm).

   If the hot plugs are loose in the cylinder head they may be retained with a little grease.

6. The fitment of wooden plugs in the injector nozzle apertures will be found advantageous at this stage, to prevent entry of dirt into the combustion chamber.

7. Refit the inlet and exhaust manifolds to the cylinder head, using a new gasket.

8. Test the thermostat before fitment to cylinder head, by immersing in hot water. Expansion should commence between 161°F and 170°F and should be complete at 190°F.

   Insert the thermostat with rubber "O" ring in the housing in cylinder head and fit the joint washer and cover.

Rocker shaft, to overhaul Operation A/454

1. Remove locating set bolts from the intermediate support brackets. Remove the component parts from the rocker shaft but retain the items in their correct relative positions.

2. If necessary, press new bushes into the rockers. The oil holes in the rocker bushes are pre-drilled and care must be taken to ensure that the oil holes of bush and rocker will align when pressed into position.

3. Reamer the bush to .530 in. + .001 (13,5 mm + 0,02) to obtain the correct clearance. The reamer and rocker assembly must be held in such a manner as to ensure the correct alignment of the reamed hole.

4. Assemble components on to the rocker shaft, ensuring that one spacing washer is fitted on each side of the intermediate brackets and two spacing washers are fitted on each side of the centre bracket. Care should be taken to ensure that the valve rockers are fitted in their correct relative positions, that is, in the same order in which they were removed.

5. The locating holes in the intermediate brackets must be positioned immediately above the chamfered holes in the shaft and then secured with a locating screw and spring washer.

Cylinder head and rocker shaft, to refit Operation A/456

1. Smear the joint face of cylinder block and cylinder head gasket with engine oil, then fit the gasket with the lettering "Diesel 523143" uppermost, and cylinder head assembly to cylinder block, using the two studs to facilitate alignment.

2. Locate head and gasket with the securing bolts, fitting all bolts **except** those which also secure the rocker shaft brackets, but do not tighten at this stage.

3. Insert the push-rods into their original positions, through cylinder head and locate in the tappets.

4. Slacken off all tappet adjusting screws and offer the rocker assembly to cylinder head. Fit the bracket securing bolts, but do not tighten.
5. Tighten down the cylinder head bolts in the order indicated by Fig. A-426. The ½ in. U.N.F. bolts, including those that also secure the rocker brackets, must be pulled down to 80 lb/ft (11 mkg) whilst the $\frac{5}{16}$ in. U.N.F. bolts securing the rocker brackets only are pulled down to 12 lb/ft (1,7 mkg).

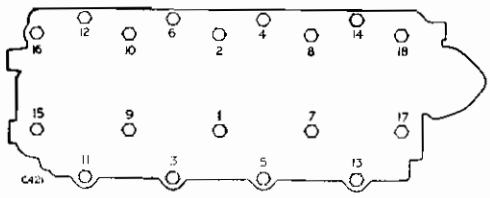

Fig. A-426—Order of tightening cylinder head bolts

Chainwheels, timing chain, adjuster and valve timing Operation A/458

1. The screwed plug and ball may be removed from the piston if necessary and the piston pressed from its housing if unduly worn.
2. The tensioner cylinder and bush must be renewed complete if the bush is unduly worn.

   The bushes in idler wheel and ratchet arm should also be removed if worn beyond reasonable limits.
3. If the rubber on the camshaft chain vibration damper is grooved, a new component should be fitted.
4. Fit the crankshaft chainwheel on to shaft and key.
5. Turn the crankshaft in direction of rotation until the E.P. mark on flywheel is in line with the timing pointer.

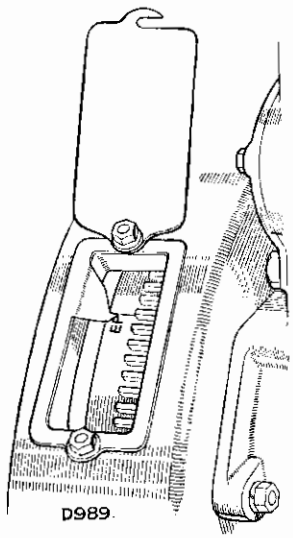

Fig. A-427—Timing pointer

6. Fit a dial test indicator so that the "fully open" position of the valve can be ascertained in the following manner:—
7. Fit chainwheel to camshaft, but do not bend up locking tabs at this stage.

   Turn the camshaft in direction of rotation until the lobe of cam has nearly opened the valve fully, then stop rotation and mark the chainwheel and timing casing to record the position.
8. Note the reading on dial test indicator, then continue to turn the chainwheel slowly in direction of rotation until the needle has again reached the same position.

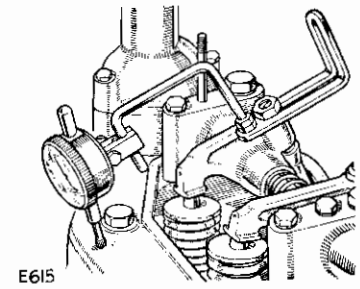

Fig. A-428—Checking exhaust valve "fully open" position

9. Mark the chainwheel at a point opposite to the mark on timing casing and make a third mark on the chainwheel, exactly between those made previously.
10. Turn the camshaft against direction of rotation until the third mark is in line with that on timing casing, whereon the valve should be fully open.

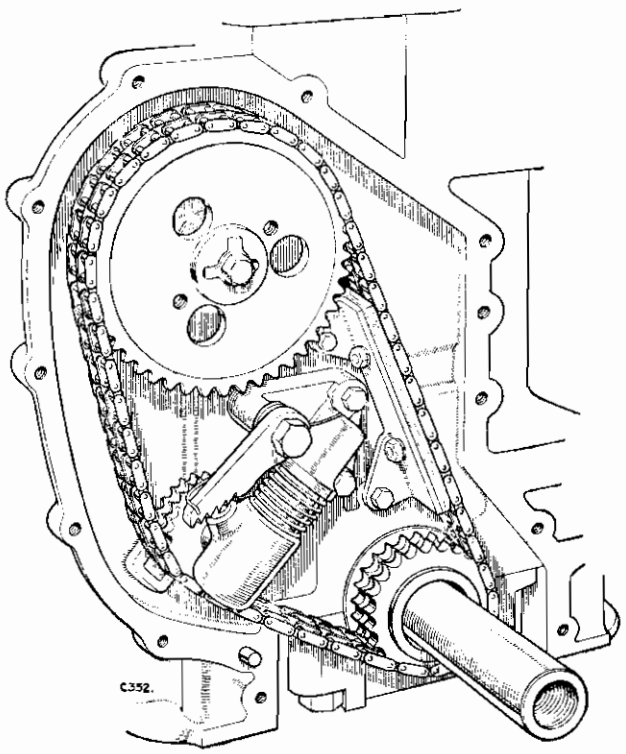

Fig. A-429—Timing gear arrangement

11. Fit the timing chain with **"no slack"** on the driving side. It may be necessary to remove and re-position the camshaft chainwheel to obtain this "no slack" condition on the driving side when the flywheel and camshaft are correctly positioned.
12. Fit new bushes to the chain tensioner components as necessary; ensure that the fits and clearances are in accordance with those laid down in the Data Section. Position the ball in chain tensioner piston and secure with the retaining clip. Fit the compression spring over piston, locate the cylinder assembly, compress the spring and hold in compressed position.

    Place the idler wheel on piston spindle and offer the assembly to the cylinder block, locating by means of the dowels. Also ensure that the spigot for the idler wheel spindle on the piston is correctly located in the slot in the cylinder block. Screw the stepped bolt with ratchet and spring in position into cylinder block, then finally secure with set bolt and nut. Release the spring and allow the idler wheel to take up the chain slack.
13. Turn the flywheel **against** direction of rotation approx. 90° then slowly **in** direction of rotation, checking that the exhaust valve reaches the "fully open" position, as indicated by the dial test indicator, exactly when the "E.P." mark on flywheel is in line with the pointer on flywheel housing.
14. Adjust if necessary by means of the six irregularly spaced keyways in the timing chainwheel. This arrangement allows a variation of 2° between each position.
15. Lock the set bolt securing camshaft chainwheel when timing has been set satisfactorily.

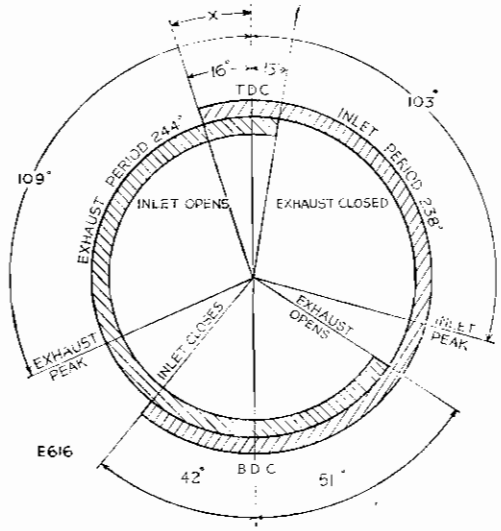

Fig. A-430—Timing diagram
X—Injection point is 16°

Front cover to cylinder block
Operation A/460

1. Examine the crankshaft oil seal and replace if necessary, using a little sealing on the outside of the seal.
2. Position new joint washers and fit the front cover.

Vibration damper, to refit
Operation A/462

1. Locate the vibration damper on crankshaft and key, then secure with the starting dog and tab washer.

   For overhaul of vibration damper see Section A2.

Vertical drive shaft gear assembly
Operation A/464

1. Fit the circlip to groove dividing the upper and lower internal splining and enter the tapered splined plug in the end furthest from gear teeth, small end first.
2. Drift the plug into the gear until it abuts on the circlip.
3. Lubricate the split bush and fit it to the gear with the reduced diameter nearest the teeth.

Injection pump timing
Operation A/466

The line against the 16° mark which is stamped on the flywheel, when set opposite the pointer, indicates the position at which injection starts.

The injection pump timing must be carried out with the utmost precision, therefore the following procedure must be executed methodically.

1. Turn the crankshaft in the direction of rotation until both valves of number 1 cylinder are closed and the piston is ascending the bore on the compression stroke, continue to turn the crankshaft slowly until the 16° timing mark is visible through the timing aperture in the flywheel housing. Carefully align the timing mark with the pointer. If the flywheel is inadvertently turned too far and the timing mark goes past the pointer, do not turn the flywheel back, but repeat the above operation.

   Ensure that a correct line of vision is taken when lining up the timing marks. An incorrect line of vision can result in the timing being 1° to 2° out.
2. Insert the driving gear assembly for injection and oil pumps complete with split bushes, then mesh with camshaft gear so that when fully engaged, the master spline is approx. 20° from the centre line of engine (measured from front end) and the locating holes are correctly aligned. See Fig. A-431. Lock the driving gear assembly in position with a grub screw.
3. Remove the inspection cover from the injection pump and rotate the spindle in direction of rotation until the line marked "A" on driving plate aligns with the mark on the timing ring.
4. Offer the pump to the engine and engage in the splined drive shaft. With a small mirror observe the markings through inspection aperture in injection pump and make any final necessary adjustment by turning the pump body to align the timing ring with the "A" mark. See Fig. A-432.

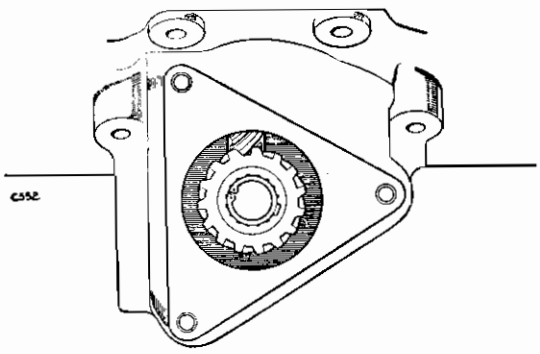

Fig. A-431—Driving gear in correct timing position

As the final adjustment is made to the timing by turning the pump body, this action in itself is sufficient to cause a slight error in the timing, due to the backlash in the pump drive skew gear. It is therefore essential that the pump drive plate and thus the skew drive gear is held back against the driving side of the teeth whilst final adjustment is made and the pump secured.

5. Re-check the timing by turning the crankshaft in the direction of rotation until both valves of number 1 cylinder are closed and the piston is ascending the bore on the compression stroke; continue to turn the crankshaft slowly.

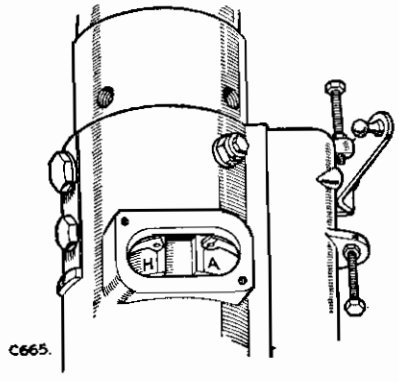

Fig. A-432—Injection pump timing marks correctly aligned

6. With a small mirror observe that the timing mark "A" on the pump drive plate aligns with the mark on the timing ring. See Fig. A-432. When the "A" mark is exactly in line with the mark on the timing ring, the 16° flywheel timing mark should be exactly in line with the flywheel housing pointer. In this way any slight timing error is magnified by the 2 : 1 ratio of the camshaft to crankshaft. An error of a given width on the pump marking will be 12 times that width if transferred to the flywheel.

   If the flywheel is inadvertently turned too far and the timing mark on the pump drive plate goes past the mark on the timing ring, do not turn back, but repeat the above operation.

Tappet adjustment **Operation A/468**

1. Turn the crankshaft in direction of rotation until number 8 valve (counting from front end of engine) is fully open. In this position the tappet for number 1 valve is on the dwell of its cam and the tappet clearance may be set with a .010 in. (0,25 mm) feeler inserted between the rocker and valve stem. Re-check the clearance after tightening the locknut.

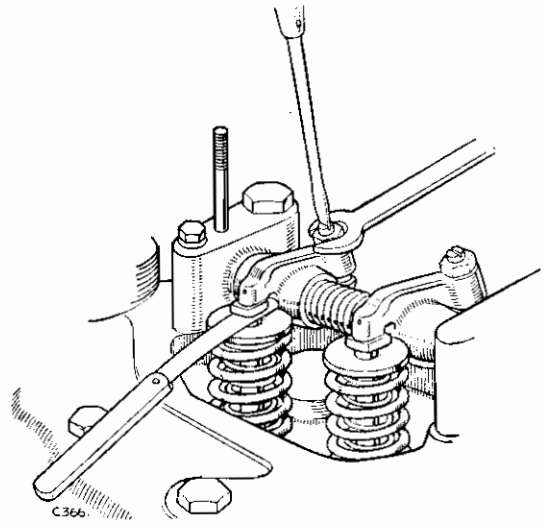

Fig. A-433—Adjusting tappets

The tappets should be set in the following order:

Set No. 1 tappet with No. 8 valve fully open.
Set No. 3 tappet with No. 6 valve fully open.
Set No. 5 tappet with No. 4 valve fully open.
Set No. 2 tappet with No. 7 valve fully open.
Set No. 8 tappet with No. 1 valve fully open.
Set No. 6 tappet with No. 3 valve fully open.
Set No. 4 tappet with No. 5 valve fully open.
Set No. 7 tappet with No. 2 valve fully open.

Oil pump **Operation A/470**

See Section AO for overhaul of oil pump.

1. Insert the longer splined end of driving shaft into the pump and locate in the driving gear.
2. With the inlet port rearward, and the splined upper end of driving shaft aligned to the vertical drive gear, offer the pump to engine and secure in position.

   No provision is made for oil pressure adjustment.

Water pump, to replace **Operation A/472**

1. See Section L for overhaul of water pump.
2. Renew the joint washer, then locate and secure the pump to front cover.

Externals **Operation A/474**

1. Fit the lubricating oil filter, complete with new filter element and joint washer.

2. Secure the breather pipe and oil filler assembly over the forward tappet chamber aperture, and to steady bracket on top of cylinder block.
3. Mount and secure the fuel lift pump and cover plate assembly over the rear tappet chamber aperture.
4. Fit the starter motor.
5. Fit the dynamo driving belt and adjust the tension to allow the belt to move $\frac{3}{16}$ to $\frac{1}{4}$ in. (4 to 6 mm) when pressed by thumb between the camshaft and water pump pulleys.
6. Connect the oil feed pipe between cylinder head and cylinder block rear end.
7. Secure the coolant pipe to thermostat and water pump casings.
8. Position the joint washer and fit the rocker and valve gear cover.

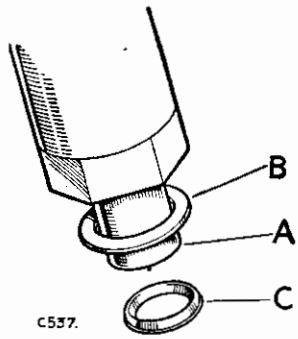

Fig. A-434—Position of injection nozzle washers
A—Nozzle B—Copper washer C—Steel washer

9. Fit the oil sump.
10. Smear new injector copper joint washers with grease and fit one to each injector. Insert a new corrugated sealing washer into each injector nozzle recess in cylinder head, with the raised portion upward, then locate the injector nozzles; do **not** tighten the clamping bar fully at this stage.

    Ensure that the bottom steel washer (corrugated) is replaced correctly, when refitting injectors. See Fig. A-434.

    For injector assembly and check, see Section M.
11. Connect the injector pipes to the injector pump. Turn the injectors to align with the pipes and connect.
12. Tighten each clamp bar alternately an equal amount to ensure that the injector goes into position evenly. The nuts must be tightened only to a torque figure of 6-8 lb/ft (0,8-1,1 mkg). Alternatively a $\frac{1}{2}$ in. A.F. open-ended spanner of not more than 4 in. (100 mm) in length can be used. Failure to carry out the above precautions when replacing injectors may result in nozzle distortion, giving rise to rough and uneven running.
13. Fit the heater plugs to cylinder head and tighten to 25 lb/ft (3,45 mkg).

Engine, to refit **Operation A/476**

1. Reverse removal procedure—fit new mounting rubbers if necessary. Refill with lubricating oil, 14 Imperial pints, 16½ U.S. pints (7,75 litres) and coolant, 17 Imperial pints, 20½ U.S. pints (9,75 litres).

   If the oil filter element has not been renewed and filter therefore drained, lubricating oil capacities are 11 Imperial pints, 13 U.S. pints (6 litres).
2. See Section M, Fuel Section, for method of priming injection pump, then Section Q for resetting controls and slow-running adjustment procedure.
3. Check for oil and water leaks—rectify as necessary.

At all times when the engine is running, it is necessary to ensure that the oil bath air cleaner is fastened securely in the vertical position.

If adjustments are made with the engine running and the oil bath cleaner balanced on top of the engine, it is possible, should the cleaner tip to one side, for oil to be drawn into the intake manifold and hence into the engine, where it will act as a fuel and cause the engine to overspeed out of control and serious damage may result.

Should it be necessary to run the engine with the air cleaner out of the normal position, the rubber hose should be disconnected from the inlet manifold and the whole oil bath removed from the vehicle.

OVERHAULS TO ENGINE IN CHASSIS

Decarbonise and grind in valves, carry out the following operations:

Page	Operation	Items
A-402	A/402	1 to 5
A-402	A/404	1, 2, 4 and 9
A-403	A/414	All
A-410	A/448	All
A-412	A/456	All
A-415	A/468	All
A-415, A-416	A/474 and A/476	As necessary

Hot plugs, injector shrouds and push-rod tubes to renew, carry out the following operations:

Page	Operation	Items
A-402	A/402	1 to 5
A-402	A/404	1, 2, 4 and 9
A-403	A/414	All
A-411	A/450	All
A-412	A/452	All
A-412	A/456	All
A-415	A/468	All
A-415, A-416	A/474 and A/476	As necessary

Camshaft or roller tappets, to renew, carry out the following operations:

Page	Operation	Items
A-402	A/402	1 to 12
A-402	A/404	1, 2, 4 and 9
A-404	A/410 to A/422	All
A-410	A/442 and A/444	All
A-414, A-415	A/464 to A/468	All
A-415	A/472	All
A-415, A-416	A/474 and A/476	As necessary

Renewing pistons, little-end or big-end bearings, carry out the following operations:

Page	Operation	Items
A-402	A/402	1 to 5
A-402	A/404	1, 2, 4 and 9
A-403	A/414	All
A-404	A/424	All
A-408, A-409	A/434 to A/440	All
A-412	A/456	All
A-415	A/468	All
A-415, A-416	A/474 and A/476	As necessary

Rocker shaft to overhaul, carry out the following operations:

Page	Operation	Items
A-403	A/414	1 to 3
A-412	A/454	All
A-412	A/456	As necessary
A-415	A/468	All

Oil pump and filters .... **Section AO**

Water pump and thermostat.... **Section L**

Flywheel and clutch .... **Section B**

Starter, dynamo .... **Section P**

Injection pump and filters .... **Section M**

Vibration damper .... **Section A-2**

Flywheel housing drain plug

The drain plug should not be fitted to the housing, unless the vehicle is expected to operate under very muddy conditions, or to wade. The plug should be screwed into the stowage bracket.

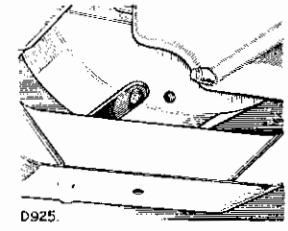

Fig. A-435—Flywheel housing drain plug and stowage bracket

DEFECT LOCATION

(Symptom, Cause and Remedy)

A—ENGINE FAILS TO START

1. Incorrect starting procedure—*See Instruction Manual.*
2. Starter motor unserviceable—*Section P.*
3. Batteries in low state of charge—*Remove and charge.*
4. Heater plug circuit broken—*Section P.*
5. Foreign matter in fuel system—*Section M.*
6. Supply of fuel to injection nozzles restricted—*Section M.*
7. Insufficient compression—*Check tappet clearance, cylinder head for tightness, cylinder head gasket, valve seats, valve springs, pistons, and piston rings for wear.*
8. Injection nozzle setting incorrect—*Reset. Section M.*
9. Injection nozzle auxiliary spray hole blocked—*Clean. Section M.*

B—ENGINE STALLS

1. Slow-running incorrectly adjusted—*See Section Q.*
2. Incorrect tappet clearance—*Adjust.*
3. Injection nozzle setting incorrect—*Reset. Section M.*
4. Injection nozzle auxiliary spray hole blocked—*Clean. Section M.*
5. Insufficient compression—*See item 7 of "A" above.*

C—REDUCED POWER AND ROUGH RUNNING

1. Broken valve spring—*Renew.*
2. Incorrect tappet clearance—*Reset.*
3. Burnt valve—*Renew, reset tappet clearance and tighten injection nozzles.*
4. Broken piston rings—*Renew damaged parts as necessary.*
5. Compression uneven—*See Item 7 of "A" above.*
6. Injection nozzles burnt—nozzle valve seating badly—*Service. Section M.*
7. Incorrectly timed injection pump—*Check and adjust.*
8. Fuel supply restricted—*Clean filters. Section M.*
9. Injection nozzles incorrectly tightened—*Check sealing washer and re-tighten.*
10. Fuel pump not delivering properly—*Section M.*

D—ENGINE OVERHEATING

1. Defective coolant system—*See "Defect Location". Section L.*
2. Defective lubrication system—*See "Defect Location". Section AO.*
3. Defective injection nozzles—*See "Defect Location". Section M.*
4. Incorrect injection pump timing—*Check and adjust.*
5. Restricted fuel supply—*Section M.*

E—LOW OIL PRESSURE

1. Defective lubrication system—*See "Defect Location". Section AO.*

F—BLACK SMOKE ISSUES FROM EXHAUST

1. Defective fuel injection nozzle—*Section M.*
2. Injection pump incorrectly timed—*Check and adjust.*

G—WHITE VAPOUR ISSUES FROM EXHAUST

1. Coolant leaking into combustion chamber—*Ascertain cause.*

   Do not confuse with the issue of vapour immediately after starting and caused by condensation in the exhaust pipe.

GENERAL DATA

Capacity (piston displacement)	2,286 cc (139.5 cu.in.)
Number of cylinders	4
Bore	3.562 in. (90,49 mm)
Stroke	3.5 in. (88,9 mm)
Compression ratio	23 to 1
B.H.P.	62 at 4,000 r.p.m.
B.M.E.P.	111 lb.sq.in. (7,8 Kg/cm²) at 1,750 r.p.m.
Maximum torque	103 lb.ft (14,00 mKg) at 1,750 r.p.m.
Firing order	1 - 3 - 4 - 2
Piston speed at 4,000 r.p.m.	2,333 ft./min.

DETAIL DATA

Camshaft

Journal diameter	1.842 in. — .001 (46,8 mm — 0,02)
Clearance in bearing	.001 to .002 in. (0,02 to 0,05 mm)
End-float	.0025 to .0055 in. (0,06 to 0,13 mm)
Cam lift—inlet	.262 in. (6,65 mm)
Cam lift—exhaust	.279 in. (7,10 mm)

Camshaft bearing

Type	Split—steel backed, white metal lined
Internal diameter (line reamed in position)	1.843 in. + .0005 (46,81 mm + 0,012)

Connecting rods

Bearing fit on crankpin	.001 to .0025 in. (0,02 to 0,06 mm) clearance
Bearing nip	.002 to .004 in. (0,05 to 0,10 mm)
End-float at big-end	.007 to .011 in. (0,20 to 0,30 mm)
Gudgeon pin bush fit in small end	.001 to .002 in. (0,02 to 0,05 mm) interference
Gudgeon pin bush internal diameter—reamed in position	1.1875 in. + .0005 (30,15 mm + 0,012)
Fit of gudgeon pin in bush	.0003 to .0005 in. (0,007 to 0,012 mm) clearance

Crankshaft

Journal diameter	2.5 in. — .001 (63,5 mm — 0,02)
Crankpin diameter	2.313 in. — .001 (51,6 mm — 0,02)
End-float (controlled by thrust washers at centre bearing)	.002 to .006 in. (0,05 to 0,15 mm)

Regrind sizes:

Undersize	Journal dia.	Crankpin dia.
.010 in. (0,25 mm)	2.490 in. (63,24 mm)	2.303 in. (58,49 mm)
.020 in. (0,50 mm)	2.480 in. (62.99 mm)	2.293 in. (58,24 mm)
.030 in. (0,76 mm)	2.470 in. (62,73 mm)	2.283 in. (57,98 mm)
.040 in. (1,01 mm)	2.460 in. (62,48 mm)	2.273 in. (57,73 mm)

Flywheel

Number of teeth	100
Thickness at pressure face	1.484 in. (38 mm)
Maximum permissible run-out on flywheel face	.002 in. (0,05 mm)
Maximum refacing depth	.030 in. (0,76 mm)
Minimum thickness after grinding	1.454 in. (36,9 mm)

Markings

T.D.C.	When opposite pointer, No. 1 piston is at top dead centre
E.P.	When opposite pointer, No. 1 exhaust valve should be fully open
16° mark	When opposite pointer, with both valves on No. 1 cylinder closed, indicates start of injection

Primary pinion bush Fit in flywheel	.001 to .003 in. (0,02 to 0,07 mm) interference
Internal diameter—reamed in position	.875 in. + .002 (22,23 mm + 0,05)
Fit of shaft in bush	.001 to .0035 in. (0,02 to 0,08 mm) clearance

Gudgeon pin

Fit in piston	Zero to .0002 in. (0,005 mm) interference
Fit in connecting rod bush	.0003 to .0005 in. (0,007 to 0,012 mm) clearance

Injection pump

Type	Distributor, self-governing
Injection takes place	16°
Injector	
Type	C.A.V. Pintaux
Nozzle size	BDNO/SPC6209

Main bearings

Clearance on crankshaft journal	.001 to .0025 in. (0,02 to 0,06 mm)
Bearing nip	.004 to .006 in. (0,10 to 0,15 mm)

Oil pump assembly

See Section AO.

Pistons

Type	Light alloy, with swirl-inducing recess in crown
Clearance in bore, measured at bottom of skirt at right angles to gudgeon pin	.004 to .005 in. (0,10 to 0,12 mm)
Fit of gudgeon pin in piston	Zero to .0002 in. (0,005 mm) interference
Gudgeon pin bore	1.187 in. + .002 (30,14 mm + 0,05)

Piston rings

Compression No. 1	
Type	Square friction edge—chromium plated
Gap in bore	.014 to .019 in. (0,40 to 0,50 mm)
Clearance in groove	.0025 to .0035 in. (0,06 to 0,08 mm)
Compression—Nos. 2 and 3	
Type	Bevelled friction edge. Marked 'T' on upper side
Gap in bore	.010 to .015 in. (0,25 to 0,40 mm)
Clearance in groove	.0025 to .0035 in. (0,06 to 0,08 mm)
Scraper No. 4	
Type	Slotted, square friction edge, double landed
Gap in bore	.010 to .015 in. (0,25 to 0,40 mm)
Clearance in groove	.0025 to .0035 in. (0,06 to 0,08 mm)

Push-rod tubes

Fit in cylinder head	.0005 to .002 in. (0,01 to 0,05 mm) interference on large diameter Full contact fit at chamfered edges of tube and cylinder head

Rocker gear

Bush internal diameter (reamed in position)	.530 + .001 in. (13,4 + 0,02 mm)
Shaft clearance in rocker bush	.001 to .002 in. (0,02 to 0,04 mm)
Tappet clearance	.010 in. (0,25 mm) hot or cold

Timing chain tensioner

Fit of bush in cylinder	.003 to .005 in. (0,07 to 0,12 mm) interference
Fit of bush in idler wheel	.001 to .003 in. (0,02 to 0,07 mm) interference
Fit of idler wheel on stub shaft	.001 to .003 in. (0,02 to 0,07 mm) clearance
Fit of piston in cylinder bush	.0005 to .001 in. (0,01 to 0,02 mm) clearance

Thrust bearings, crankshaft

Type	Semi-circular, steel back, tin plated on friction surface
Standard size, total thickness	.093 in. — .002 (2,36 mm — 0,05)
Oversizes	.0025 in. (0,06 mm) .005 in. (0,12 mm) .0075 in. (0,18 mm) .010 in. (0,25 mm)

Torque loadings

Connecting rod bolts	25 lb.ft (3,45 mkg)
Cylinder head (½ in. U.N.F.)	80 lb.ft (11 mkg)
Main bearing bolts (⅜ in. U.N.F.)	100 lb.ft (13,8 mkg)
Rocker shaft support bracket bolts (⅝ in. U.N.F.)	12 lb.ft (1,7 mkg)
Flywheel securing bolts	50 lb.ft (6,9 mkg)

Valves

Inlet valve	
Diameter (stem)	.312 in. — .001 (7,92 mm — 0,02)
Face angle	45° — ¼
Exhaust valve	
Diameter (stem)	.343 in. — .001 (8,71 mm — 0,02)
Face angle	45° — ¼
Fit of inlet and exhaust valves in guides	.0005 to .003 in. (0,01 to 0,07 mm) clearance
Valve seat	
Seat angle (inlet and exhaust)	45° + ¼

Valve springs

Inner	
Length—free	1.61 in. (40,9 mm)
Length under 12 lb. (5,44 Kgs) load	1.454 in. (36,9 mm)
Outer	
Length—free	1.768 in. (44,9 mm)
Length under 33 lb. (14,96 Kgs.) load	1.579 in. (40,1 mm)

Valve timing

Inlet opens	16° B.T.D.C.
Inlet closes	42° A.B.D.C.
Inlet peak	103° A.T.D.C.
Exhaust opens	51° B.B.D.C.
Exhaust closes	13° A.T.D.C.
Exhaust peak	109° B.T.D.C.

Vertical drive shaft gear

Backlash	.006 to .010 in. (0,15 to 0,25 mm)
Internal diameter of bush	1.00 in. + .001 (25,4 mm + 0,02)
Fit of gear in bush	.001 to .003 in. (0,02 to 0,07 mm) clearance

Vibration damper

Fit of bushes in flywheel and back plate	.002 to .004 in. (0,05 to 0,10 mm)
Internal diameter of bushes (reamed in position)	1.917 in. + .001 (48,7 mm + 0,02)
Fit of bushes on driving flange	.001 to .003 in. (0,02 to 0,07 mm) clearance
Maximum permissible run-out of flywheel	.005 in. (0,12 mm)

PRINTED IN ENGLAND BY
JOSEPH WONES LIMITED
WEST BROMWICH, STAFFS
11427