98mm ENGINES

TRACTORS

255
270
285
485
2100
4100

Workshop Manual Supplement

Truck and Bus Division
Leyland Scotland Plant
Bathgate West Lothian Scotland

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English

(2nd Edition)

98mm ENGINES AND ANCILLARY EQUIPMENT
INTRODUCTION

This Supplement is intended to assist the skilled mechanic in carrying out repairs and replacements in a minimum time. The information at the front of the book includes general data, recommended lubricants, and maintenance. Each major assembly or system is dealt with in a group, using the number applied to it in the Schedule of Repair Times, each group being sub-divided into parts for easy reference:

A Description, Testing, and Adjusting (where applicable).
B Removing and Refitting Components.
C Overhauling.

An index is provided at the front of each group.

DISCLAIMER

(i) Purchasers are advised that the specification details set out in this Supplement apply to a range of engines and not to any particular engine. For the specification of any particular engine Purchasers should consult their Distributor or Dealer.

(ii) The Manufacturers reserve the right to vary their specifications with or without notice, and at such times and in such manner as they think fit. Major as well as minor changes may be involved in accordance with the Manufacturer's policy of constant product improvement.

(iii) Whilst every effort is made to ensure the accuracy of the particulars contained in this Supplement, neither the Manufacturer nor the Distributor or Dealer, by whom this Supplement is supplied, shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

REPAIRS AND REPLACEMENTS

When service parts are required it is essential that only genuine British Leyland replacements are used.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories:

Safety features embodied in the vehicle may be impaired if other than genuine parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the vehicle manufacturer's specification. Torque wrench setting figures given in this Supplement must be strictly adhered to. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal, it must be renewed. When purchasing accessories while travelling abroad ensure that the accessory and its fitted location on the vehicle conform to requirements existing in their country of origin. The vehicle warranty may be invalidated by the fitting of other than genuine British Leyland parts.

All British Leyland replacements have the full backing of the factory warranty.

British Leyland Distributors and Dealers are obliged to supply only genuine service parts.

SERVICE PARTS

Genuine BRITISH LEYLAND Service Parts are designed and tested for your vehicle and have the full backing of the British Leyland Factory Warranty. ONLY WHEN GENUINE BRITISH LEYLAND SERVICE PARTS ARE USED CAN RESPONSIBILITY BE CONSIDERED UNDER THE TERMS OF THE WARRANTY. Genuine parts are supplied in cartons bearing this symbol:

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ABBREVIATIONS

Across flats (bolt head size)	A.F.
After bottom dead centre	A.B.D.C.
After top dead centre	A.T.D.C.
Alternating current	a.c.
Amperes	amp
Ampere-hour	Ah
Atmospheres	Atm
Before bottom dead centre	B.B.D.C.
Before top dead centre	B.T.D.C.
Bottom dead centre	B.D.C.
Brake horse power	b.h.p.
British standards	B.S.
Centigrade (Celsius)	C
Centimetres	cm
Centimetres of mercury	cmHg
Cubic centimetres	cm^3
Cubic inches	in^3
Degree, minute, second (angle)	°, ′, ″
Degree (temperature)	°
Diameter	dia.
Direct current	d.c.
Fahrenheit	F
Feet	ft
Gallons (Imperial)	gal
Grammes	g
Inches	in
Inches of mercury	inHg
Internal diameter	i.dia
Kilogrammes (force)	kgf
Kilogrammes (mass)	kg
Kilogramme centimetre (force)	kgf cm
Kilogramme metres (force)	kgf m
Kilogrammes per square centimetre (force)	kgf/cm^2
Kilometres	km
Kilonewtons per square metre	kN/m^2
Left-hand	L.H.
Left-hand drive	L.H.D.
Maximum	max.
Metres	m
Microfarad	mfd
Millimetres	mm
Minimum	min.
Minus (of tolerance)	—
Negative (electrical)	—
Ohms	ohm or Ω
Ounces	oz
Outside diameter	o.dia
Pints (Imperial)	pt
Plus or minus	±
Plus (of tolerance)	+
Positive (electrical)	+
Pounds (force)	lbf
Pounds (mass)	lb
Pounds feet (torque)	lbf ft
Pounds inches (torque)	lbf in
Pounds force per square inch	lbf/in^2
Ratio	:
Revolutions per minute	rev/min
Right-hand	R.H.
Right-hand drive	R.H.D.
Society of Automobile Engineers	S.A.E.
Specific gravity	sp. gr.
Square centimetres	cm^2
Square inches	in^2
Standard wire gauge	s.w.g.
Top dead centre	T.D.C.
United Kingdom	U.K.
Volts	V
Watts	W
Screw Threads:	
British Association	B.A.
British Standard Fine	B.S.F.
British Standard Pipe	B.S.P.
Metric (millimetres)	M
Unified Coarse	U.N.C.
Unified Fine	U.N.F.

INDEX

NOTE.—The dismantling and assembly procedures in this Supplement are presented assuming the engine has been removed from the vehicle.

GENERAL DATA

ENGINE

Types	4.98DT, 4.98NT, 6.98DT, 6.98NT
Number of cylinders: 4.98DT and 4.98NT	4
6.98DT and 6.98NT	6
Compression ratio	16·8 : 1 (17·8 : 1—4.98DT)
Bore	98·00 to 98·02 mm (3·8583 to 3·859 in)
Stroke	125 mm (4·921 in)
Capacity: 4.98DT and 4.98NT	3·77 litres (231 in³)
6.98DT and 6.98NT	5·66 litres (345 in³)
Max. power: 4.98DT	55 b.h.p. at 2200 rev/min
4.98NT	70 b.h.p. at 2200 rev/min
6.98DT	85 b.h.p. at 2100 rev/min
6.98NT	100 b.h.p. at 2100 rev/min
Max. torque: 4.98DT	22·1 kgf m (160 lbf ft) at 1200 rev/min
4.98NT	26·3 kgf m (190 lbf ft) at 1300 rev/min
6.98DT	35·25 kgf m (253 lbf ft) at 1300 rev/min
6.98NT	38·2 kgf m (276 lbf ft) at 1300 rev/min
Injection order: 4.98DT and 4.98NT	1, 3, 4, 2
6.98DT and 6.98NT	1, 5, 3, 6, 2, 4
Valve rocker clearance (engine hot or cold):	
Inlet and exhaust	0·33 mm (0·013 in)
Static injection timing: 4.98DT	12° B.T.D.C.
4.98NT	16° B.T.D.C.
6.98DT	12° B.T.D.C.
6.98NT	14° B.T.D.C.
Oil pressure (engine hot):	
Idling	2·11 to 2·46 kgf/cm², 207 to 241 kN/m² (30 to 35 lbf/in²)
Normal running speed	3·87 to 4·22 kgf/cm², 380 to 414 kN/m² (55 to 60 lbf/in²)

FUEL SYSTEM

Engine	*Injection pump*	*Injectors*		
		Nozzle type	*Nozzle holder type*	*Nozzle opening pressure*
4.98NT	Simms	BDLL 150S 6476	BKBL 67S 5153	175 atm
4.98DT	C.A.V. DPA	BDLL 150S 6582	BKBL 67S 5153	150 atm
4.98NT	C.A.V. DPA	BDLL 150S 6582	BKBL 67S 5153	175 atm
6.98DT	C.A.V. DPA	BDLL 150S 6582	BKBL 67S 5153	175 atm
6.98NT	C.A.V. DPA	BDLL 150S 6310	BKBL 67S 5153	175 atm

Injector securing bolt tightness	1·65 kgf m (12 lbf ft)
Fuel lift pump	A.C. mechanical
Main fuel filter	Twin sedimenter with paper elements

CAPACITIES

Engine oil:	
4.98NT and 4.98DT with alloy sump	11·7 litres (20·5 pints, 24·6 U.S. pints)
with alloy sump and balancer	11·1 litres (19·5 pints, 23·4 U.S. pints)
with steel sump	11·1 litres (19·5 pints, 23·4 U.S. pints)
with steel sump and balancer	9·7 litres (17·0 pints, 20·4 U.S. pints)
6.98NT and 6.98DT with steel sump	10·5 litres (18·5 pints, 22·2 U.S. pints)

TORQUE WRENCH SETTINGS

Engine	
Connecting rod bolts	8·3 kgf m (60 lbf ft)
●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft)●
Cylinder head nuts	13·8 kgf m (100 lbf ft)
Exhaust manifold nuts	4·1 kgf m (30 lbf ft)
Fan hub (and water pump pulley) bolts	2·7 kgf m (20 lbf ft)
Flywheel bolts	13·8 kgf m (100 lbf ft)
Injector securing bolts	1·65 kgf m (12 lbf ft)
Main bearing nuts	13·8 kgf m (100 lbf ft)
Main bearing studs	4·1 kgf m (30 lbf ft)
Oil filter centre bolt	1·25 to 1·38 kgf m (9 to 10 lbf ft)
●Oil pump drive gear nut (gear without key)	11·06 kgf m (80 lbf ft)●
Rocker bracket bolts:	
$\frac{5}{16}$ in diameter	2·1 kgf m (15 lbf ft)
$\frac{3}{8}$ in diameter	4·1 kgf m (30 lbf ft)
Laycock clutch	
Clutch to flywheel securing bolts	4·1 kgf m (30 lbf ft)
Power steering pump	
Through-bolts	3·47 to 4·15 kgf m (25 to 30 lbf ft)
Reservoir stud	1·11 to 2·77 kgf m (8 to 20 lbf ft)
Reservoir nut	0·28 to 0·41 kgf m (2 to 3 lbf ft)
Alternator: 16ACR	
Pulley nut	4·1 kgf m (30 lbf ft)
Starter motor: M50	
Through-bolts	1·38 kgf m (10 lbf ft)
Solenoid securing bolts	0·62 kgf m (4·5 lbf ft)
Brush gear screws	0·34 kgf m (2·5 lbf ft)
Pivot pin locknut	2·21 kgf m (16 lbf ft)

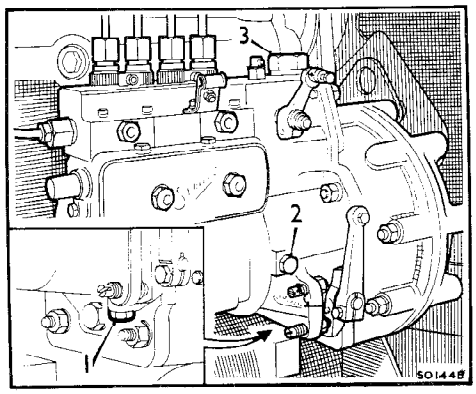
LUBRICATION

The correct oil recommendations for this range of engines are listed on page 'Lubrication 1'.

ENGINE. Withdraw the dipstick to check the level of oil in the sump. The oil level should register at the 'MAX' mark on the dipstick.

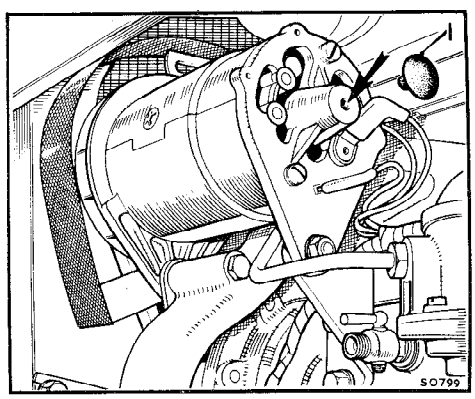
To fill or top up the sump, remove the oil filler cap and add new oil until the correct level registers on the dipstick.

To drain the sump, remove the sump plug. The sump is best drained when the engine is at its working temperature.

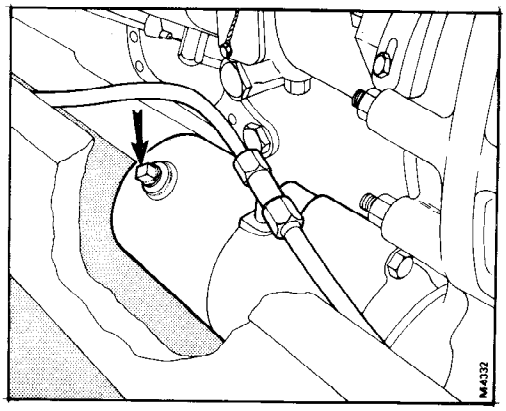


FUEL INJECTION PUMP (Simms). To drain the pump, remove the drain plug (1). Remove the level plug (2) and the filler plug (3). Fill the pump with new oil till it spills from the level plug hole.

THROTTLE LINKAGE. Lubricate the moving parts of the linkage with a few drops of engine oil.

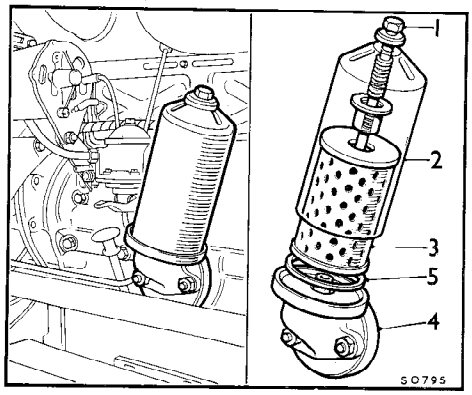


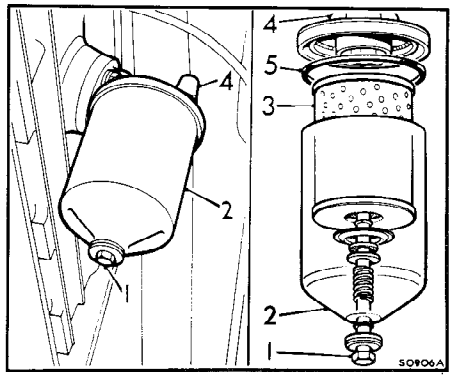
DYNAMO. Remove the rubber plug (1), insert two drops of oil to the central hole (arrowed) in the end plate.



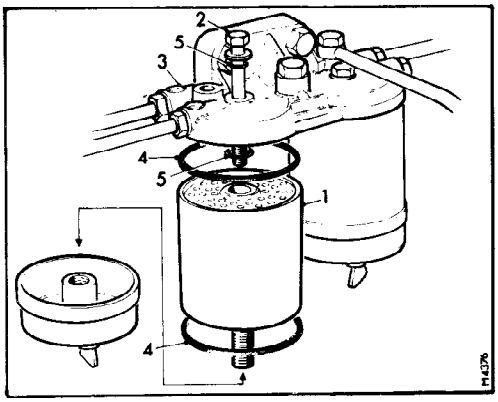
POWER-ASSISTED STEERING RESERVOIR. Remove the filler/level plug indicated to check the fluid level. Top up as necessary to the bottom of the filler/level plug hole.
NOTE.—When replenishing the reservoir ensure that the front wheels are in the 'full right lock' position, and the engine is running.

REPLACEMENTS AND ADJUSTMENTS



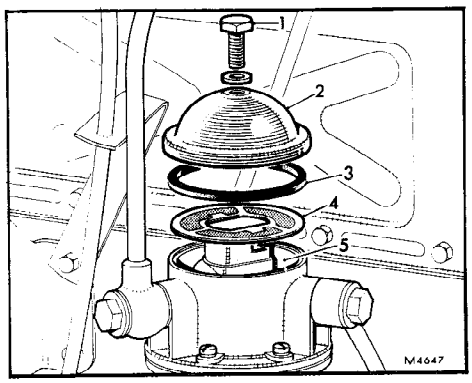


ENGINE OIL FILTER. Remove the centre bolt (1) and detach the bowl (2). Remove and discard the filter element (3). Clean the filter bowl and components. Fit a new element and bowl sealing gasket (5), and assemble the bowl to the filter head (4).



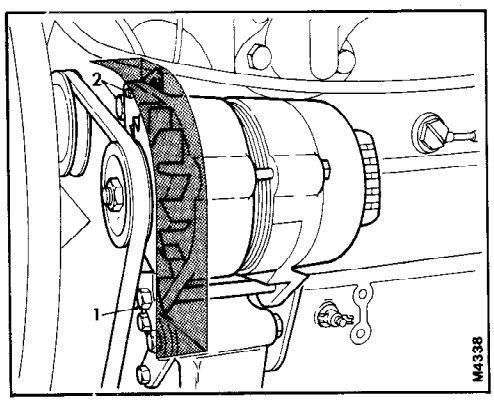
MAIN FUEL FILTER ASSEMBLY. To remove the filter elements (1), support the filter bases and unscrew the centre bolts (2). Detach the filter bases and twist the elements to separate them from the filter head (3).

●Remove the sealing washers (4) and 'O' rings (5) from the head and base. Clean the filter bases and assemble the filter unit using new elements, washers and 'O' rings. Bleed air from the system (refer to Group 26, **'DIESEL FUEL SYSTEM'**).●

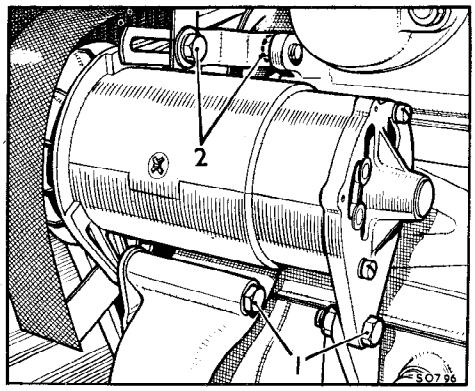


FUEL LIFT PUMP FILTER. Remove the cap screw (1). Lift off the cap (2), gasket (3), and filter gauze (4). Clean the gauze in a suitable solvent using a stiff brush. Clean the fuel chamber (5). Check that the gasket is serviceable or renew.

●Assemble the components. Do not overtighten the cap screw. Bleed air from the system (refer to Group 26, **'DIESEL FUEL SYSTEM'**).●

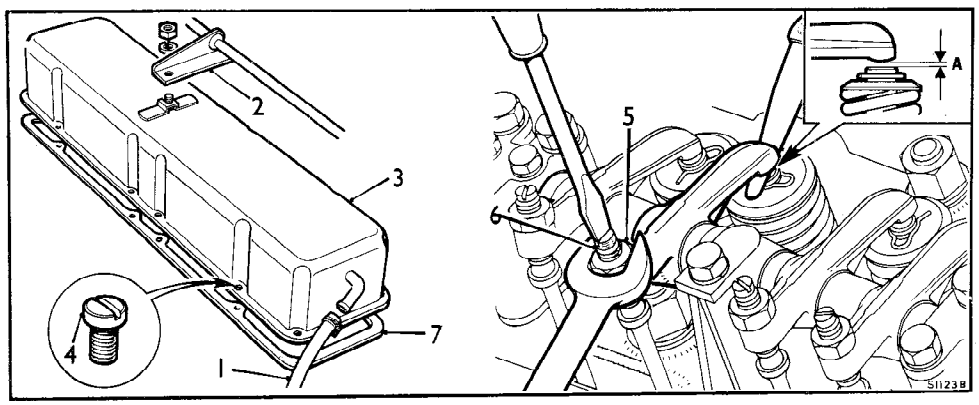


ALTERNATOR AND WATER PUMP DRIVE BELT. Slacken the nut and bolt (1). Slacken the two bolts (2) securing the adjusting link. Lever the generator away from the engine (apply leverage only to the generator drive-end bracket) until the belt can be pressed in approximately 19 mm ($\frac{3}{4}$ in) at the centre of its vertical run by thumb pressure. Tighten bolts (2) and the nut and bolt (1).



DYNAMO AND DRIVE BELT. Slacken the dynamo mounting bolts (1) and the adjusting link bolts (2). Ensure that the belt is correctly seated in the pulleys and lever the dynamo away from the engine (apply leverage only to the dynamo drive-end bracket) until the belt can be pressed in approximately 19 mm ($\frac{3}{4}$ in) at the centre of its vertical run by thumb pressure.

Tighten the adjusting link bolts (2) and the mounting bolts (1).



VALVE ROCKERS. Release the breather hose (1) and the pipe bracket (2) from the rocker cover (3). Remove the securing screws (4) and lift off the rocker cover. Adjust the valve/rocker clearances (A) to the figure given in **'GENERAL DATA'**, in the following sequence:

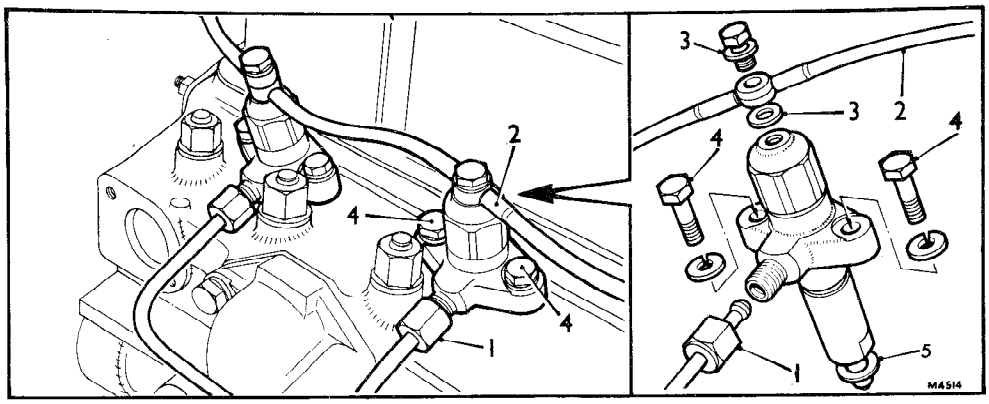
Four-cylinder engine

Check No. 1 valve with No. 8 valve fully open.
" " 3 " " " 6 " " "
" " 5 " " " 4 " " "
" " 2 " " " 7 " " "
" " 8 " " " 1 " " "
" " 6 " " " 3 " " "
" " 4 " " " 5 " " "
" " 7 " " " 2 " " "

Six-cylinder engine

Check No. 1 valve with No. 12 valve fully open.
" " 7 " " " 6 " " "
" " 9 " " " 4 " " "
" " 2 " " " 11 " " "
" " 5 " " " 8 " " "
" " 10 " " " 3 " " "
" " 12 " " " 1 " " "
" " 6 " " " 7 " " "
" " 4 " " " 9 " " "
" " 11 " " " 2 " " "
" " 8 " " " 5 " " "
" " 3 " " " 10 " " "

To adjust the clearance, slacken the locknut (5) and turn the adjusting screw (6) until the clearance is correct. Hold the screw against rotation and tighten the locknut. Assemble, ensuring that the rocker cover gasket (7) is serviceable.

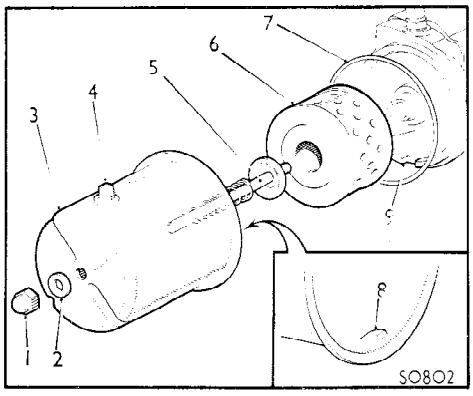


FUEL INJECTORS. Injector cleaning and spray testing can only be carried out with specialized equipment, therefore this work should be done by a Distributor or Dealer (refer to Group 26, **'FUEL INJECTION EQUIPMENT'.**

Disconnect the feed pipe (1) and the spill rail (2). Note the sealing washer (3) on each side of the spill rail banjo union. Remove the injector securing bolts (4) and withdraw the injector. Renew the injector sealing washer (5). Assemble and tighten the injector securing bolts to the torque figure given in **'GENERAL DATA'.**

AIR CLEANER. Clear the element by lightly tapping it on a solid object, or, alternatively, by blowing air at a pressure of not more than 7·0 kgf/cm² (690 kN/m², 100 lbf/in²) through the element from the inside.

Clean the element by agitating it for 10 minutes in hand-hot water using 'Cooper Kleen' Detergent Air Filter Compound or 'Pat' low lather detergent. Dry the element at normal room temperature. Clean the air cleaner with a damp cloth before replacing the element. Assemble the air cleaner, renewing damaged gaskets.



POWER STEERING FILTER. Remove the filler/level plug (4), slacken the reservoir securing nut (1) and rotate the reservoir (3) to drain the fluid. Remove the nut (1), sealing washer (2), and remove the reservoir. Unscrew the reservoir mounting stud (5) (using nuts screwed to the end of the stud) from the pump rear cover. Remove and discard the filter element (6). Clean the reservoir bowl in a suitable solvent. Fit a new filter element and sealing washer (7). Assemble the filter ensuring that the components are correctly positioned and the projection in the reservoir bowl (8) is located in the slot (9) in the rear cover.

Tighten the reservoir stud (5), and securing nut (1), to the torque specified in **'GENERAL DATA'.**

NOTE.—Replenish the reservoir with oil, with the engine installed in the vehicle, the front wheels in the full right-lock position, and the engine running.

Fill the reservoir with new oil to the bottom of the filler/level plug hole, and fit the filler/level plug.

MAINTENANCE SUMMARY

The following table contains a summary of the routine maintenance, and the periods at which it should be carried out, to maintain the efficient and economic running of the engine in normal operating and climatic conditions. In abnormal conditions it may be necessary to adjust the recommended servicing intervals. Consult your Distributor or Dealer for advice when such conditions prevail.

Daily or every 10 hours
Check engine oil level
Check coolant level

Operation	Weekly or every 50 hours	Hours			
		200	400	800	1200
Air cleaner					
Remove and clear element by tapping it on a solid object	X	X	X	X	X
Remove and clean the element		X	X	X	X
Renew the element					X
Engine					
Check oil level, and top up if necessary	X	X	X	X	X
●Change engine oil and fit a new oil filter element		X	X	X	X ●
Check level of coolant in overflow tank, and top up if necessary	X	X	X	X	X
Check fan belt tension, and adjust if necessary	X	X	X	X	X
Check valve rocker clearance, and adjust if necessary			X	X	X
Fuel system					
Clean fuel lift pump filter gauze		X	X	X	X
Renew fuel filter elements				X	
Change oil in Simms fuel injection pump			X	X	X
●Clean fuel injectors (refer to Group 26, **'FUEL INJECTION EQUIPMENT'**)			X	X	X ●
Power steering					
Check fluid level, and top up if necessary	X	X	X	X	
Drain and refill reservoir					X
Renew filter element					X
Electrical					
Check starter and dynamo commutator and the brush gear					X
Lubricate dynamo end bearing		X	X	X	X
Check wiring terminals, renew or tighten as necessary					X
General					
Check that all exposed nuts and bolts and drain plugs are tight	X	X	X	X	X

RECOMMENDED LUBRICANTS

	ENGINE AND POWER-ASSISTED STEERING RESERVOIR		
	Above 27°C (80°F)	**−1°C (30°F) to 27°C (80°F)**	**Below −1°C (30°F)**
BP	BP Tractor Oil Universal		
	BP Vanellus S.A.E. 30	BP Vanellus S.A.E. 20W	BP Vanellus S.A.E. 10W
CASTROL	Agricastrol Multi-use		
	Castrol/Deusol CRB 30	Castrol/Deusol CRB 20	Castrol/Deusol CRB 10
DUCKHAMS	Duckhams Fleetol Multilite		
	Duckhams Farmadcol/Fleetol HDX 30	Duckhams Farmadcol/Fleetol HDX 20	Duckhams Farmadcol/Fleetol HDX 10W
ESSO	Esso Tractorlube Universal		
	Essolube HDX 30	Essolube HDX 20W	Essolube HDX 10W
FILTRATE	Filtrate Unifarm		
	Filtrate/Farm HDX 30	Filtrate/Farm HDX 20	Filtrate/Farm HDX 10W
MOBIL	Mobiland Universal		
	Mobil Delvac Special 20W/50		Delvac Special 10W/30
	Mobil Delvac 1230	Mobil Delvac 1220	Mobil Delvac 1210
SHELL	Shell Tractor Oil Universal		Shell Rotella TX 10W/30
	Shell Rotella TX 30	Shell Rotella TX 20/20W	Shell Rotella TX 10W
STERNOL	Sternol Elixir Multigrade		
	Sternol Elixir 30	Sternol Elixir 20W/20	Sternol Cougar 10W

The approved engine oils listed above meet the requirement of the U.S. Ordnance Specification MIL-L-2104B.

DIESEL ENGINE

A DESCRIPTION

TESTING

B REMOVING AND REFITTING COMPONENTS

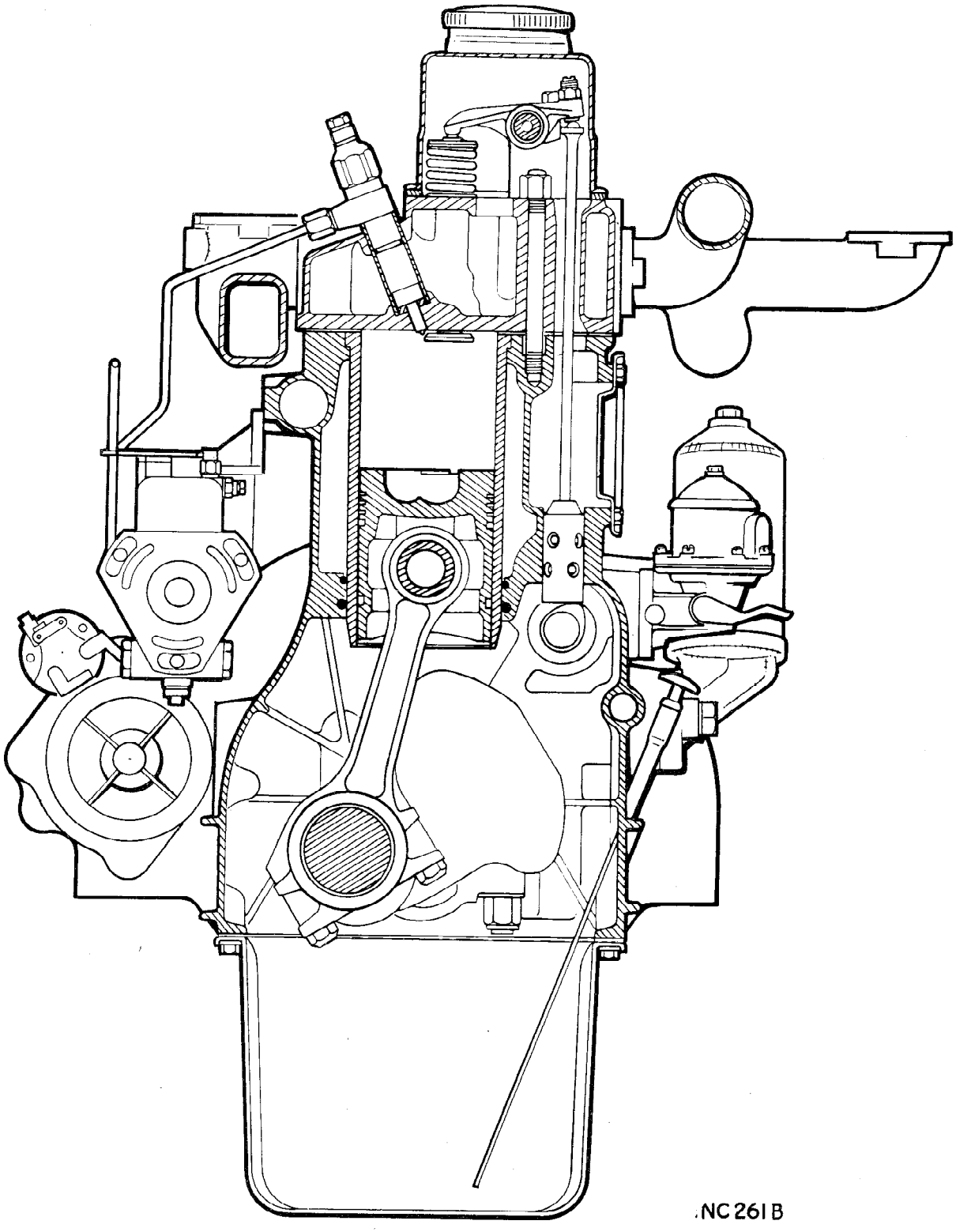
C

OVERHAULING

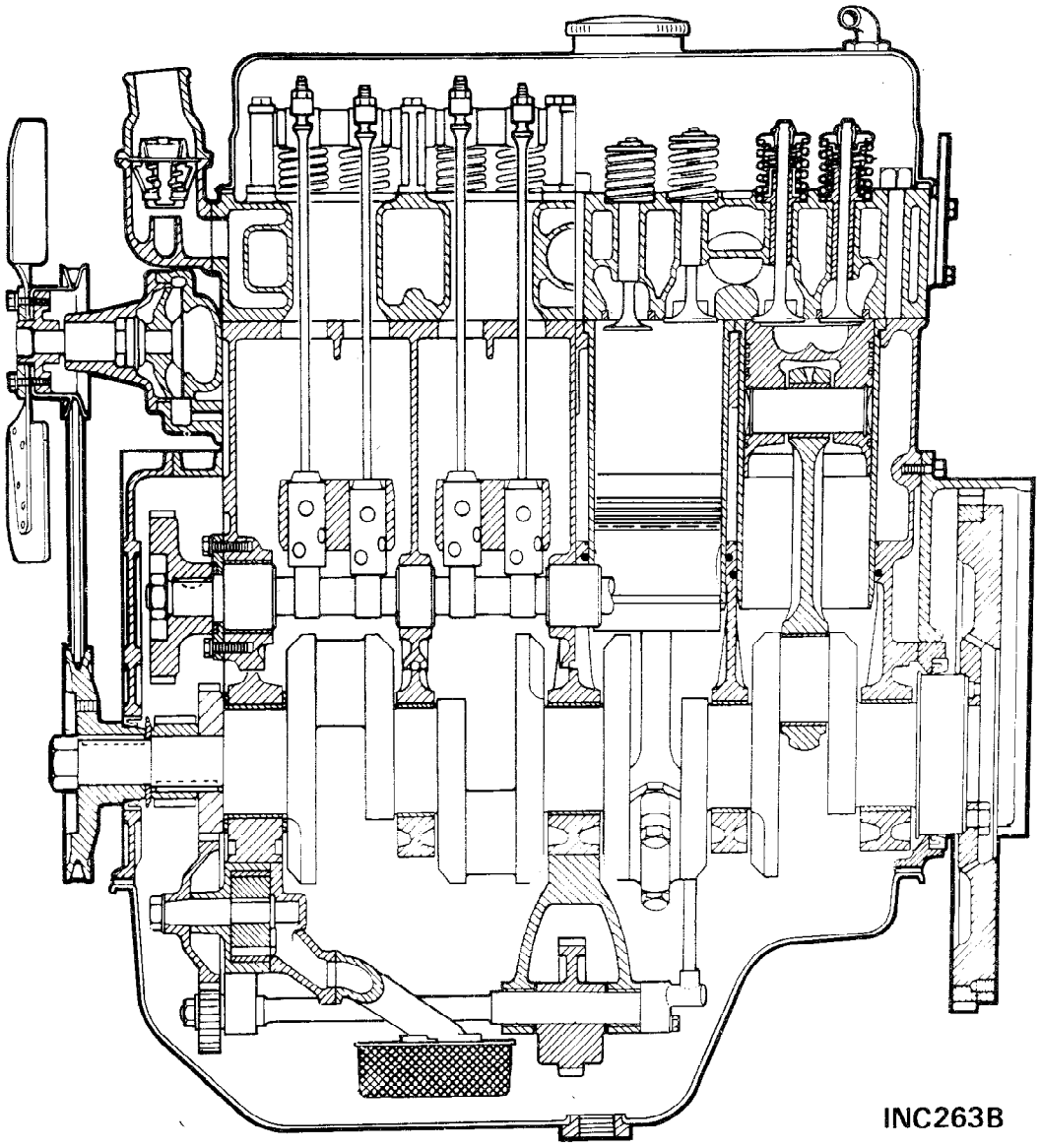
A

DESCRIPTION AND TESTING

TRANSVERSE SECTION (FOUR-CYLINDER ENGINE)

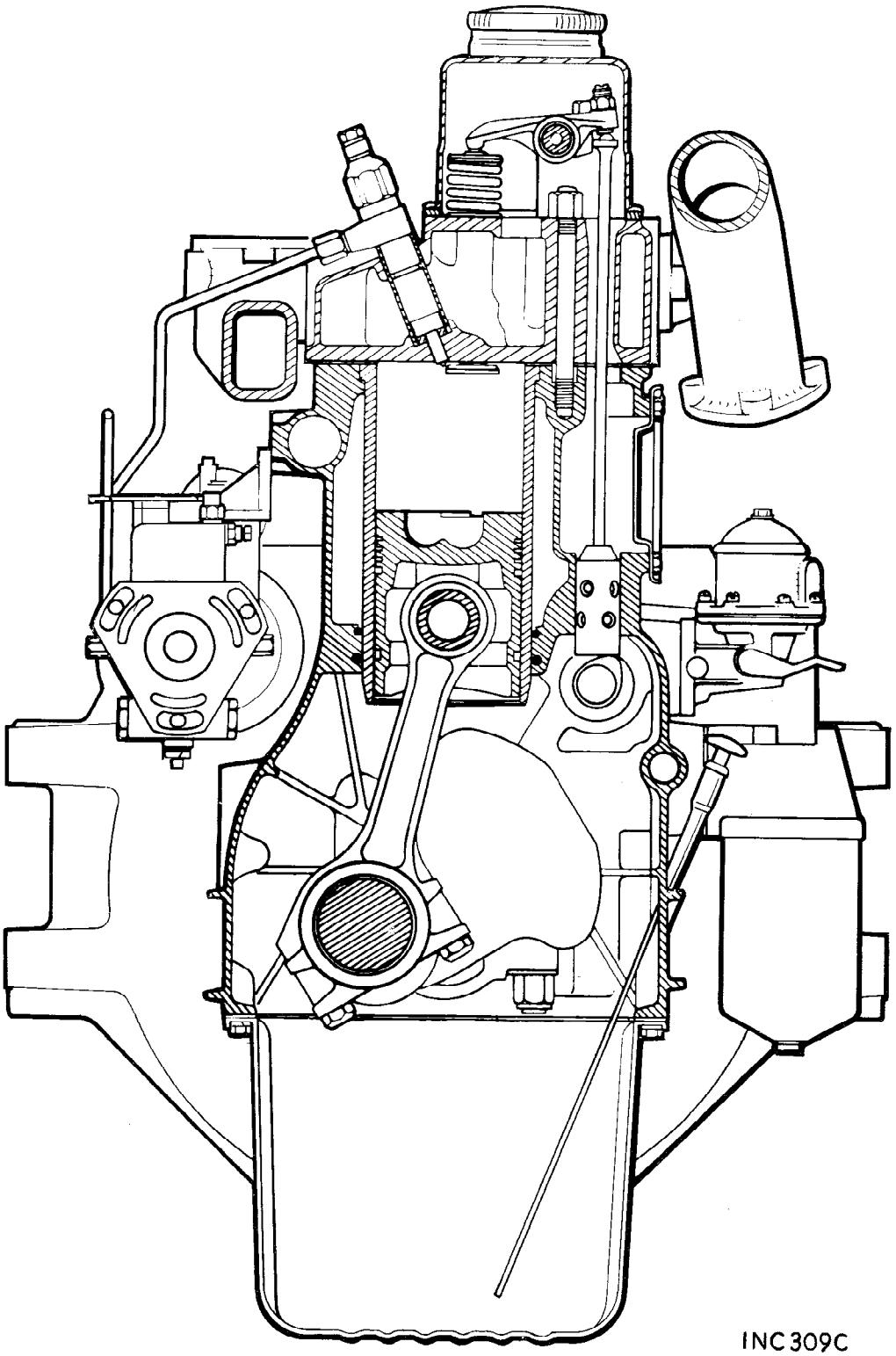


LONGITUDINAL SECTION (FOUR-CYLINDER ENGINE)



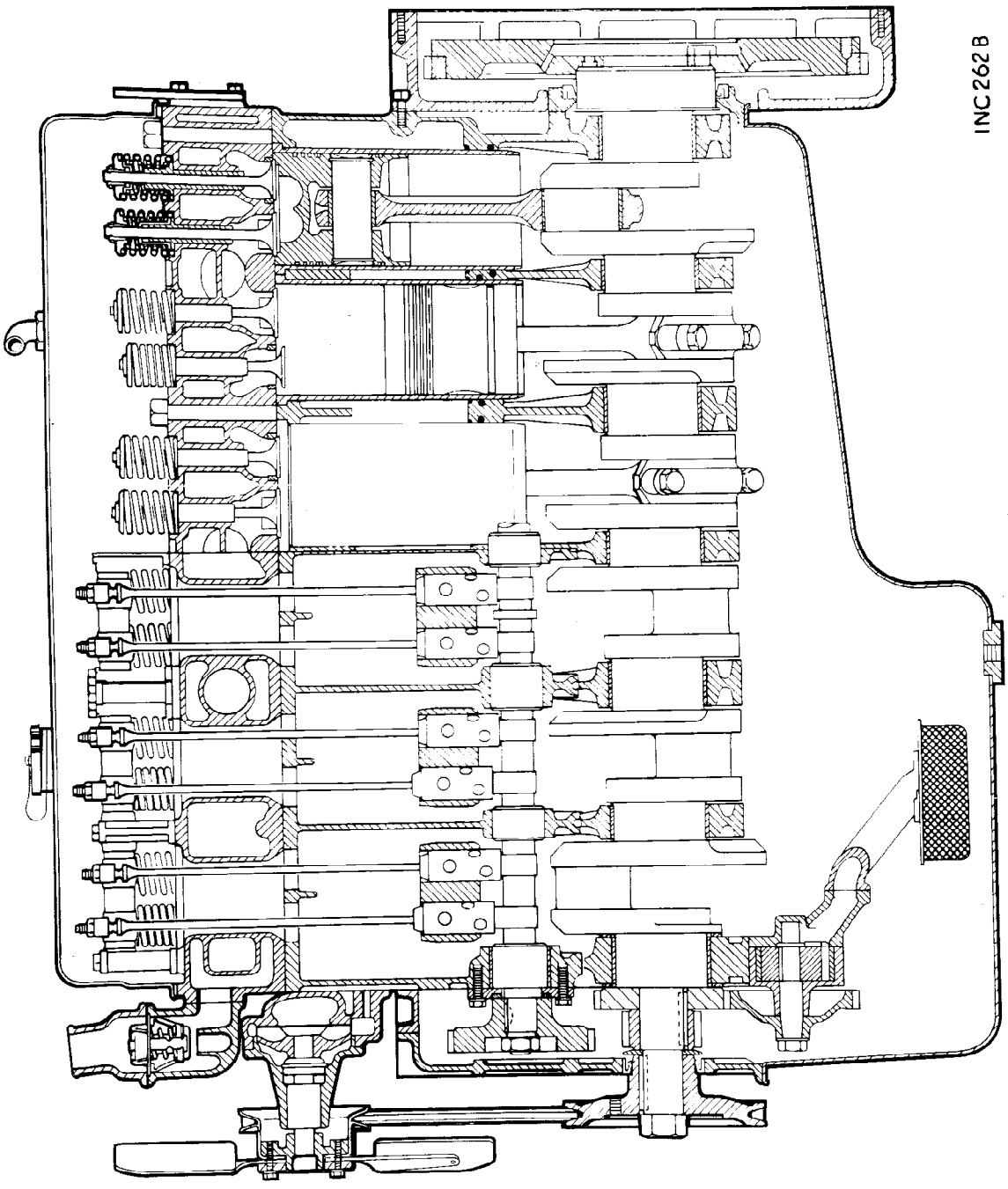
INC263B

TRANSVERSE SECTION (SIX-CYLINDER ENGINE)



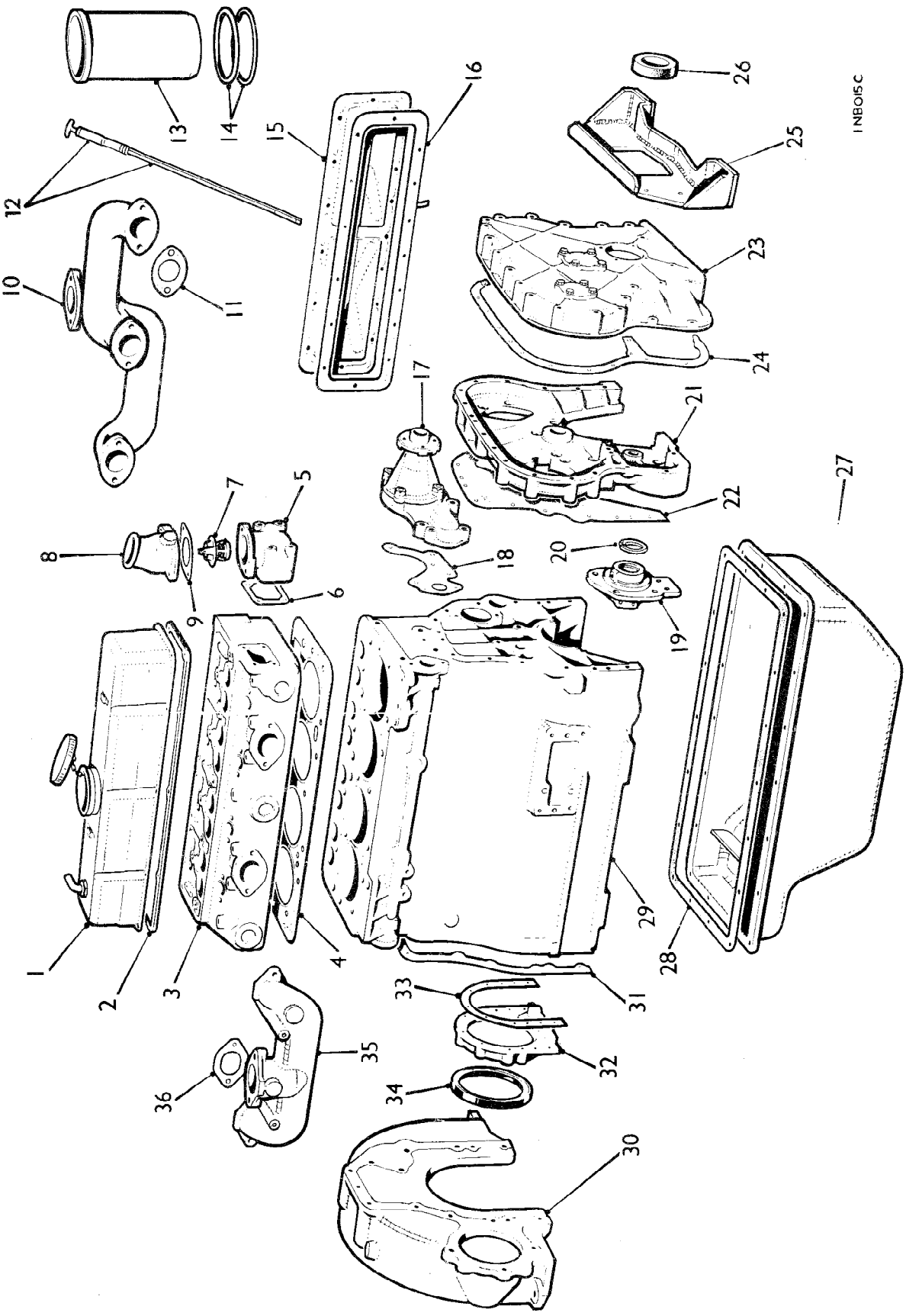
INC 309C

LONGITUDINAL SECTION (SIX-CYLINDER ENGINE)



INC 262 B

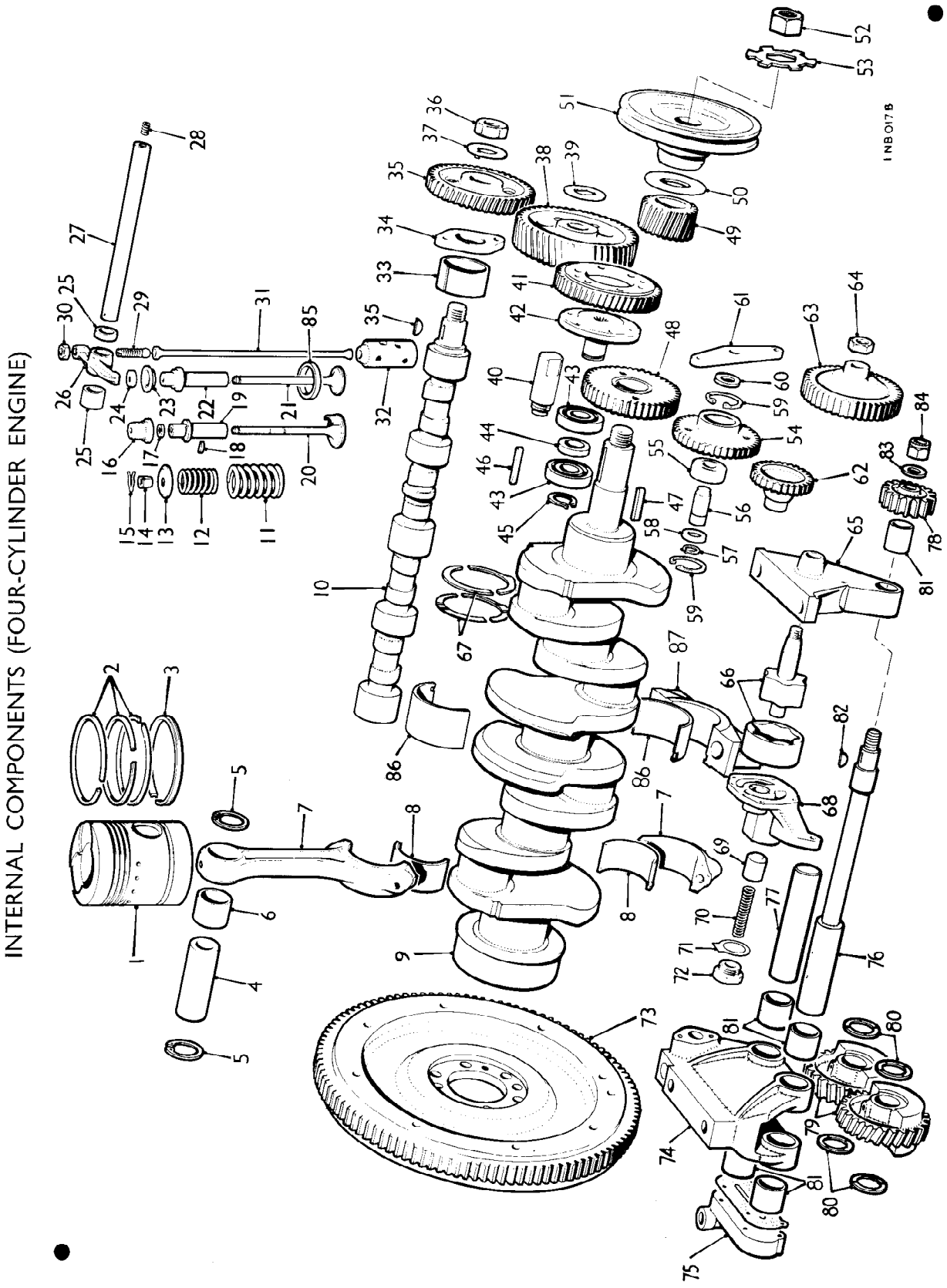
EXTERNAL COMPONENTS (FOUR-CYLINDER ENGINE)



KEY TO EXTERNAL COMPONENTS (FOUR-CYLINDER ENGINE)

1. Rocker cover
2. Gasket
3. Cylinder head
4. Gasket
5. Thermostat housing
6. Gasket
7. Thermostat
8. Water outlet pipe
9. Gasket
10. Exhaust manifold
11. Gasket
12. Oil dipstick and guide tube
13. Cylinder liner
14. Sealing rings
15. Tappet cover
16. Gasket
17. Water pump
18. Gasket
19. Bearing housing
20. Circlip
21. Timing case
22. Gasket
23. Timing cover
24. Gasket
25. Engine front mounting plate
26. Crankshaft front oil seal
27. Sump
28. Gasket
29. Cylinder block
30. Flywheel housing
31. Gasket
32. Crankshaft rear oil seal housing
33. Gasket
34. Crankshaft rear oil seal
35. Inlet manifold
36. Gasket

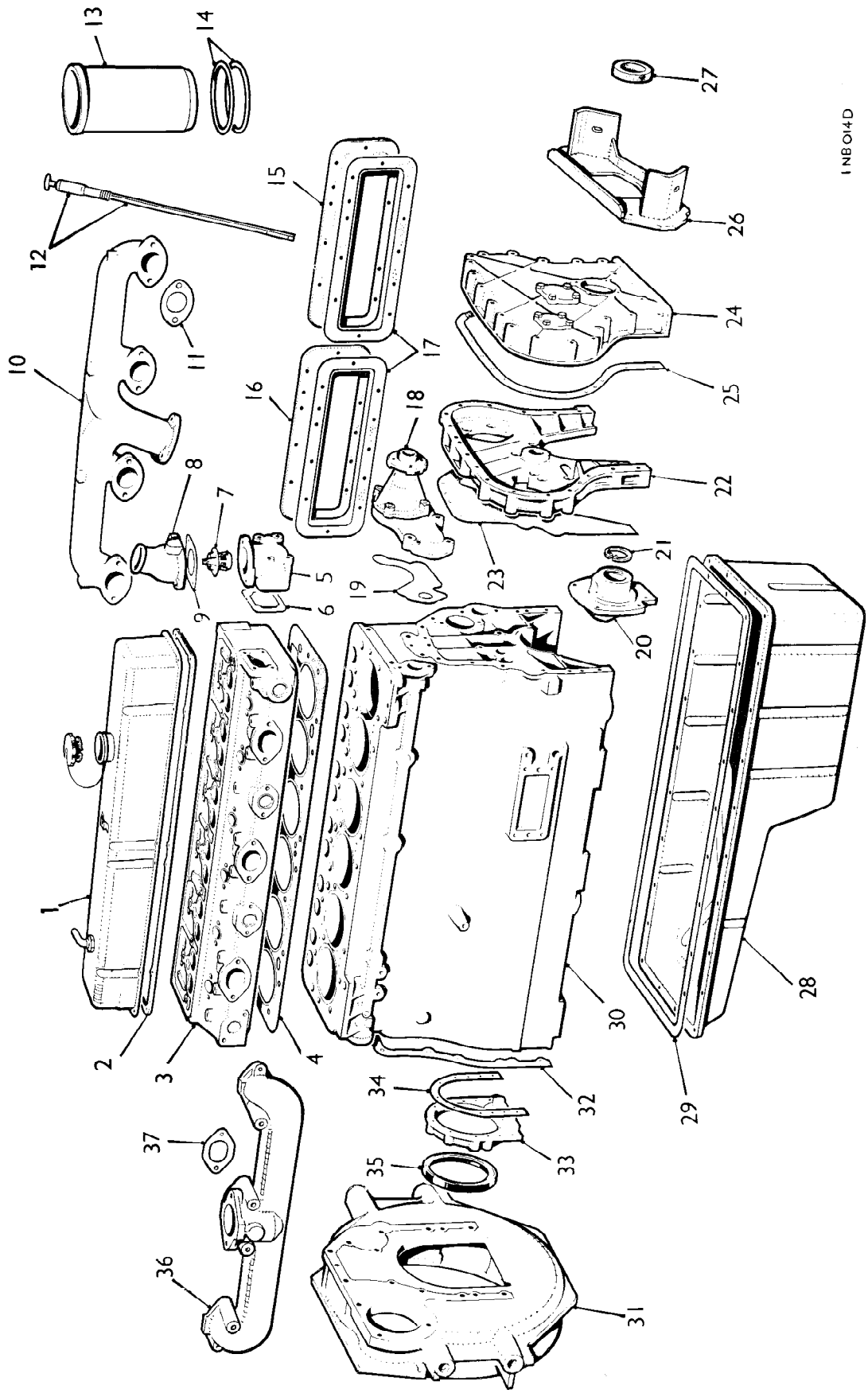
INTERNAL COMPONENTS (FOUR-CYLINDER ENGINE)



KEY TO INTERNAL COMPONENTS (FOUR-CYLINDER ENGINE)

1. Piston
2. Piston rings (compression)
3. Piston ring (oil control)
4. Gudgeon pin
5. Circlip
6. Little-end bush
7. Connecting rod and cap
8. Big-end bearing
9. Crankshaft
10. Camshaft
11. Valve spring (outer)
12. Valve spring (inner)
13. Valve spring collar
14. Valve cotters
15. Spring clip
16. Inlet valve thimble
17. Inlet valve oil seal
18. Inlet valve key
19. Inlet valve guide
20. Inlet valve
21. Exhaust valve
22. Exhaust valve guide
23. Retainer for exhaust valve oil seal
24. Exhaust valve oil seal
25. Valve rocker distance collar
26. Valve rocker
27. Valve rocker shaft
28. Shaft plug
29. Rocker adjusting screw
30. Locknut
31. Push-rod
32. Tappet
33. Camshaft bearing
34. Camshaft thrust plate
35. Camshaft gear and key
36. Camshaft nut
37. Tab washer
38. Main idler gear
39. Main idler gear thrust washer
40. Main idler gear shaft
41. Injection pump drive gear
42. Drive gear hub
43. Bearing
44. Bearing distance collar
45. Circlip
46. Key for crankshaft pulley
47. Key for crankshaft gears
48. Crankshaft gear (oil pump drive)
49. Crankshaft gear (timing)
50. Crankshaft oil thrower
51. Crankshaft pulley
52. Crankshaft nut
53. Lock washer
54. Auxiliary idler gear
55. Bearing
56. Auxiliary idler gear spindle
57. Circlip for spindle
58. Collar for circlip
59. Bearing circlip
60. Distance collar
61. Auxiliary idler gear retaining plate
62. Power steering pump drive gear
63. Oil pump gear
64. Oil pump nut
65. Oil pump body
66. Oil pump rotors
67. Crankshaft thrust washers
68. Oil pump cover
69. Oil pressure relief valve
70. Relief valve spring
71. Tab washer
72. Relief valve plug
73. Flywheel
74. Balancer support bracket
75. Balancer rear cover
76. Balancer drive shaft
77. Balancer driven shaft
78. Balancer drive gear
79. Balance gears
80. Thrust washers
81. Bearing bushes
82. Key
83. Washer
84. Nut
85. Exhaust valve seat insert
86. Main bearings
87. Main bearing cap

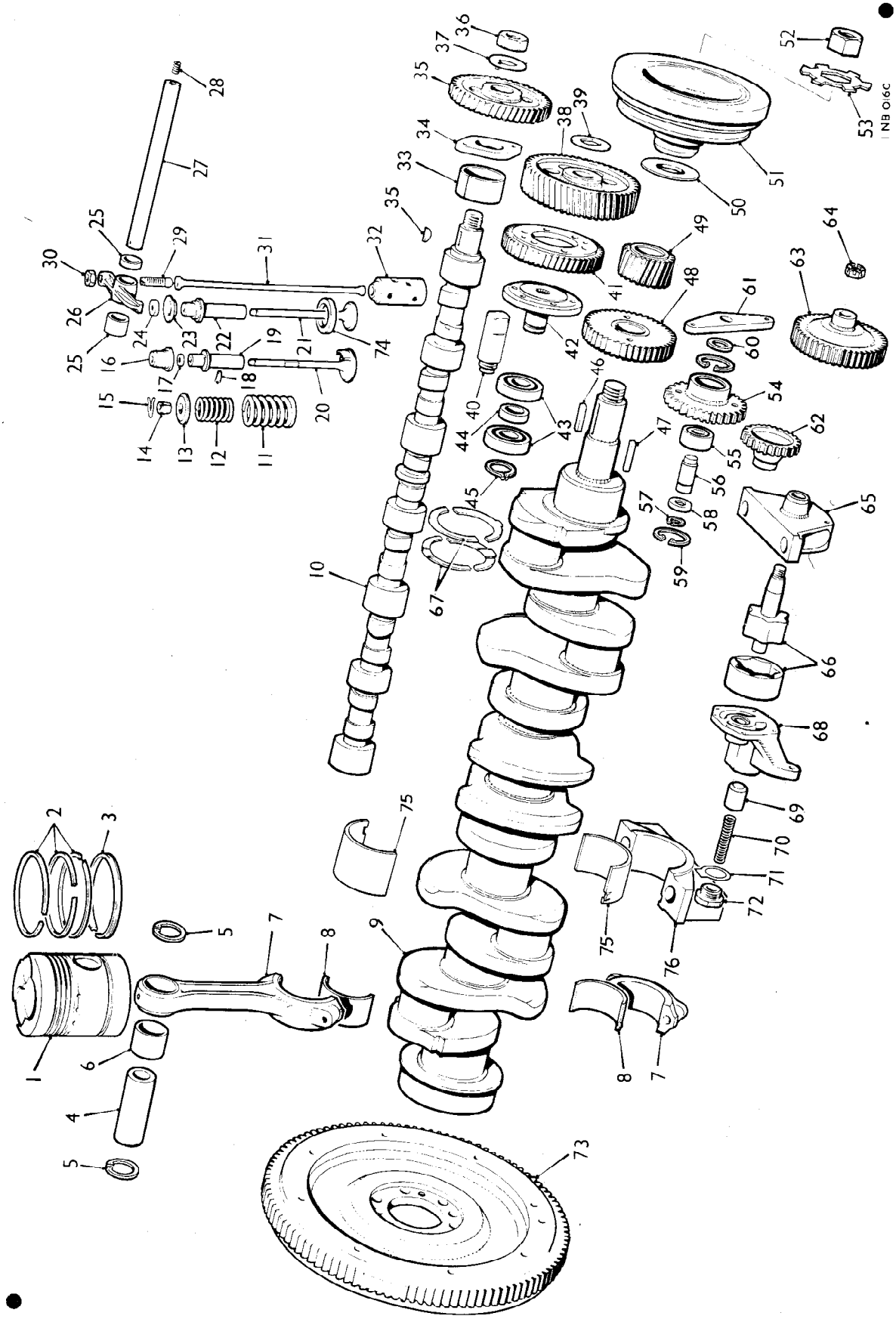
EXTERNAL COMPONENTS (SIX-CYLINDER ENGINE)



KEY TO EXTERNAL COMPONENTS (SIX-CYLINDER ENGINE)

1. Rocker cover
2. Gasket
3. Cylinder head
4. Gasket
5. Thermostat housing
6. Gasket
7. Thermostat
8. Water outlet pipe
9. Gasket
10. Exhaust manifold
11. Gasket
12. Oil dipstick and guide tube
13. Cylinder liner
14. Sealing rings
15. Tappet cover (front)
16. Tappet cover (rear)
17. Gasket
18. Water pump
19. Gasket
20. Bearing housing
21. Circlip
22. Timing case
23. Gasket
24. Timing cover
25. Gasket
26. Engine front mounting plate
27. Crankshaft front oil seal
28. Sump
29. Gasket
30. Cylinder block
31. Flywheel housing
32. Gasket
33. Crankshaft rear oil seal housing
34. Gasket
35. Crankshaft rear oil seal
36. Inlet manifold
37. Gasket

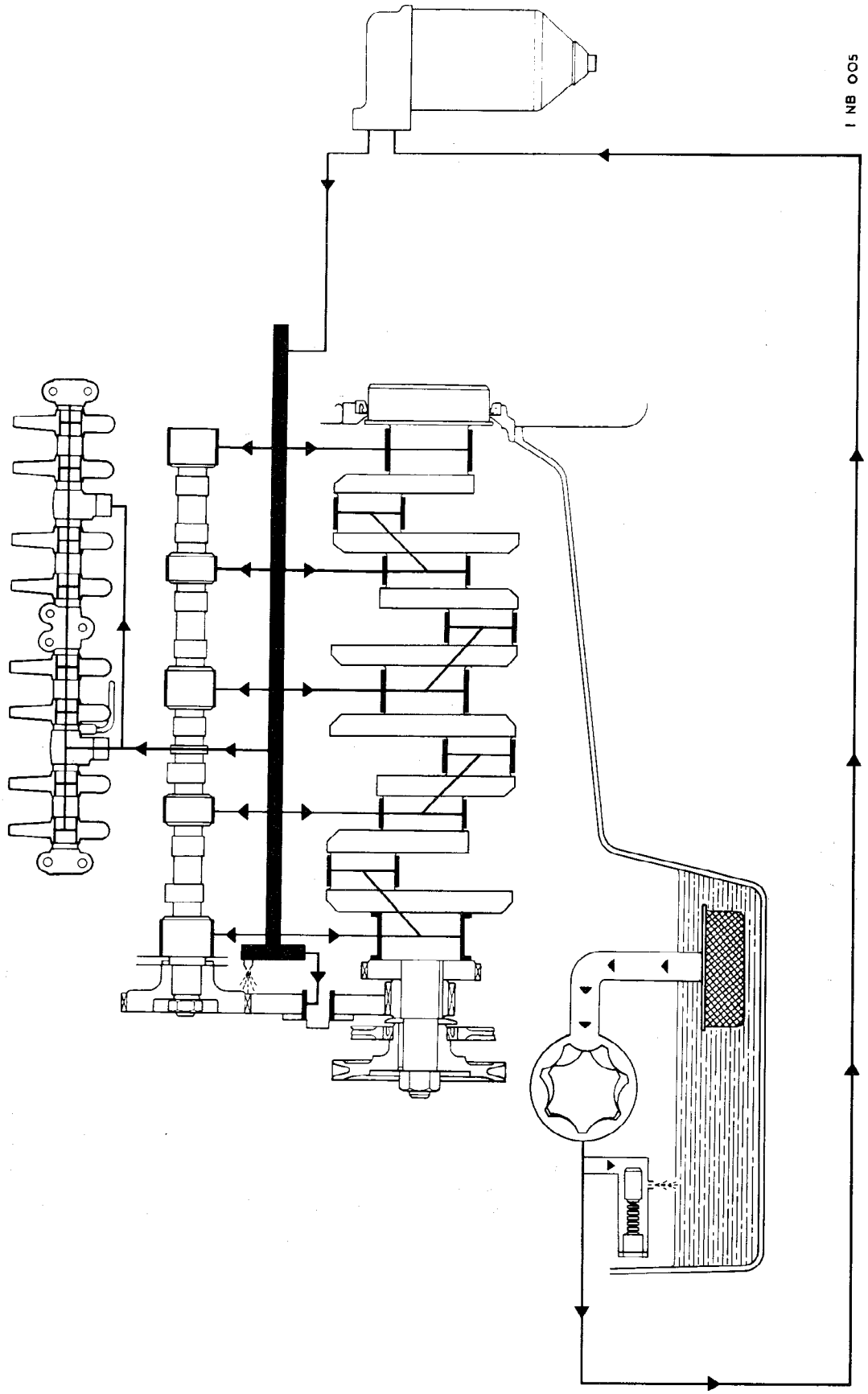
INTERNAL COMPONENTS (SIX-CYLINDER ENGINE)

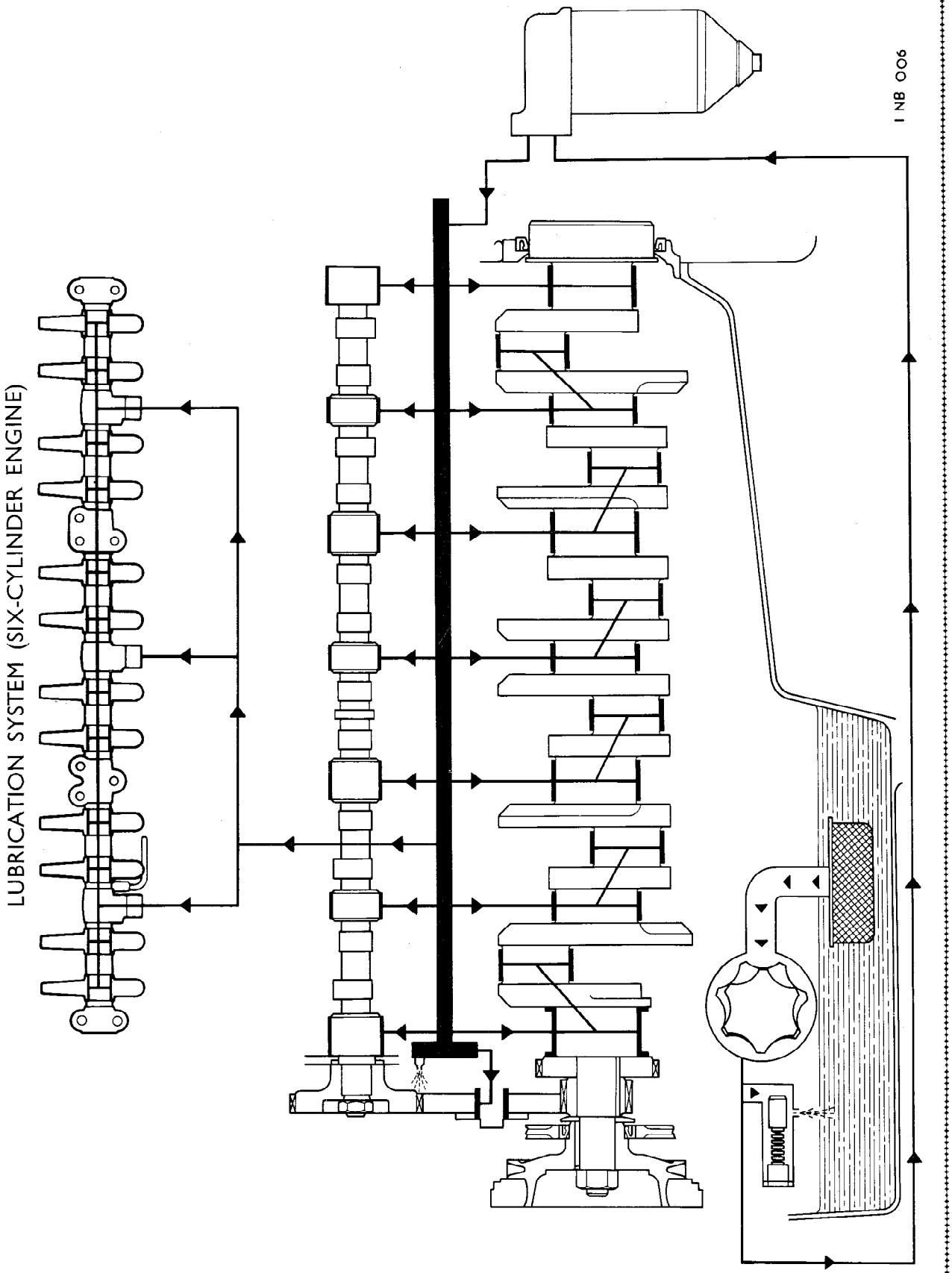


KEY TO INTERNAL COMPONENTS (SIX-CYLINDER ENGINE)

1. Piston
2. Piston rings (compression)
3. Piston ring (oil control)
4. Gudgeon pin
5. Circlip
6. Little-end bush
7. Connecting rod and cap
8. Big-end bearing
9. Crankshaft
10. Camshaft
11. Valve spring (outer)
12. Valve spring (inner)
13. Valve spring collar
14. Valve cotters
15. Spring clip
16. Inlet valve thimble
17. Inlet valve oil seal
18. Inlet valve key
19. Inlet valve guide
20. Inlet valve
21. Exhaust valve
22. Exhaust valve guide
23. Retainer for exhaust valve oil seal
24. Exhaust valve oil seal
25. Valve rocker distance collar
26. Valve rocker
27. Valve rocker shaft
28. Shaft plug
29. Rocker adjusting screw
30. Locknut
31. Push-rod
32. Tappet
33. Camshaft bearing
34. Camshaft thrust plate
35. Camshaft gear and key
36. Camshaft nut
37. Tab washer
38. Main idler gear
39. Main idler gear thrust washer
40. Main idler gear shaft
41. Injection pump drive gear
42. Drive gear hub
43. Bearing
44. Bearing distance collar
45. Circlip
46. Key for crankshaft pulley
47. Key for crankshaft gears
48. Crankshaft gear (oil pump drive)
49. Crankshaft gear (timing)
50. Crankshaft oil thrower
51. Crankshaft pulley
52. Crankshaft nut
53. Lock washer
54. Auxiliary idler gear
55. Bearing
56. Auxiliary idler gear spindle
57. Circlip for spindle
58. Collar for circlip
59. Bearing circlip
60. Distance collar
61. Auxiliary idler gear retaining plate
62. Power steering pump drive gear
63. Oil pump gear
64. Oil pump nut
65. Oil pump body
66. Oil pump rotors
67. Crankshaft thrust washers
68. Oil pump cover
69. Oil pressure relief valve
70. Relief valve spring
71. Tab washer
72. Relief valve plug
73. Flywheel
74. Exhaust valve seat insert
75. Main bearings
76. Main bearing cap

LUBRICATION SYSTEM (FOUR-CYLINDER ENGINE)




LUBRICATION SYSTEM (SIX-CYLINDER ENGINE)
1 NB 006

Section A1

FAULT FINDING PROCEDURE

Difficult starting
Start with check No. 1 and proceed as directed.

Incorrect idling
Start with check No. 22 and proceed as directed.

Loss of power (ensure that the vehicle is not overloaded)
Start with check No. 30 and proceed as directed.

Misfiring
Start with check No. 25 and proceed as directed.

Excessive exhaust
Start with check No. 13 and proceed as directed.

Check	*Action*
1. Is the cranking speed below 180 rev/min for the 4.98 engine, or below 170 rev/min for the 6.98 engine?	Yes: Check 2. No: Check 6.
2. Is the engine oil of the correct grade?	Yes: Check 3. No: Change the engine oil.
3. Is the battery fully charged and in good condition?	Yes: Check 4. No: Change or re-charge the battery as necessary.
4. Are the connections in the starter circuit satisfactory?	Yes: Remove the starter and check 5. No: Make all starter circuit connections satisfactory.
5. Is the starter motor performance satisfactory on a test bench?	Yes: Investigate the engine for tightness. No: Overhaul or renew the starter motor.
6. Is fuel reaching the injectors?	Yes: Check 13. No: Check 7.
7. Is the stop control correctly set and is its linkage free?	Yes: Check 8. No: Reset the control position or linkage as necessary.
8. Is there a supply of clean fuel in the tank?	Yes: Check 9. No: Refuel the tank and bleed the fuel system.
9. Are there leaks at fuel pipes or connections?	No: Check 10. Yes: Cure the leaks and bleed the fuel system.
10. Is there a blockage in the fuel system?	No: Check 11. Yes: Clear the blockage or renew the filter element as necessary, then bleed the fuel system.
11. Is the lift pump delivering fuel?	Yes: Check 12. No: Overhaul or renew the lift pump and bleed the fuel system.
12. Does the fuel system require bleeding	No: Overhaul the injection pump, refer to Group 26, **'FUEL INJECTION EQUIPMENT'.** Yes: Bleed all air from the fuel system.

Check	Action
13. Are the injector pipes connected in their correct firing order?	Yes: Check 14. No: Correct the firing order and bleed the fuel system.
14. Are the correct injectors correctly fitted?	Yes: Check 15. No: Correct the error and bleed the fuel system.
15. Are the injection pump timing marks correctly aligned?	Yes: Check 16. No: Re-set the injection pump timing.
16. Is the air cleaner or induction system blocked?	No: Check 17. Yes: Clear the blockage or renew the cleaner element as necessary.
17. Is the exhaust system restricted?	No: Remove the injectors and check 18. Yes: Clear the restriction.
● 18. Is the injector opening pressure and performance satisfactory?	Yes: Remove the injection pump and check 19. No: Overhaul, refer to Group 26, **'FUEL INJECTION EQUIPMENT'** or renew the injectors. ●
● 19. Is the injection timing pointer correctly positioned when checked with tools AMK 9990 and 18G 1206, or MS 67? ●	Yes: Check 20. No: Re-set the injection timing pointer.
● 20. Is the injection pump performance satisfactory on a test bench?	Yes: Check 21. No: Overhaul, refer to Group 26, **'FUEL INJECTION EQUIPMENT'** or renew the injection pump. ●
21. Is the valve/rocker clearance and valve timing correct?	Yes: Investigate the engine for wear or damage causing lack of compression. No: Correct the valve/rocker clearance and/or valve timing.
22. Does the throttle linkage interfere with the idling speed setting?	No: Check 23. Yes: Correct the throttle linkage adjustment.
23. Does the stop control linkage interfere with the position of the stop lever?	No: Check 24. Yes: Set the stop control linkage correctly.
● 24. Is the idling stop screw setting correct?	Yes: Check 25. No: Adjust the engine idling speed, refer to Group 26, **'FUEL INJECTION EQUIPMENT'.** ●
25. Is the fuel tank air vent restricted?	No: Check 26. Yes: Clear the fuel tank air vent.
26. Are there leaks at the fuel pipes or connections?	No: Check 27. Yes: Cure the leaks and bleed the fuel system.
27. Is there a blockage in the fuel system?	No: Check 28. Yes: Clear the blockage or renew the filter element as necessary then bleed the fuel system.
28. Does the fuel system require bleeding?	No: Check 29. Yes: Bleed all air from the fuel system.

Check	*Action*
29. Is the lift pump delivery pressure above 0·37 kgf/cm² 36·2 kN/m² (5·25 lbf/in²)?	Yes: Check 13. No: Overhaul or renew the lift pump.
30. Are the vehicle brakes binding?	No: Check 31. Yes: Adjust the brakes.
31. Is the throttle linkage transmitting full travel to the throttle lever?	Yes: Check 32. No: Adjust or renew the throttle linkage as necessary.
32. Is the maximum speed stop screw setting correct?	Yes: Check 25. No: Adjust the engine maximum speed, refer to Group 26, **'FUEL INJECTION EQUIPMENT'.** ●

B

REMOVING AND REFITTING COMPONENTS

Section B1

ROCKER SHAFT AND TAPPETS

Removing

1. Remove the rocker cover.
2. Remove the bolts from the rocker shaft brackets and remove the rocker shaft assembly.
3. Withdraw the push-rods.
4. Remove the cylinder head oil feed pipe from the crankcase and cylinder head.
5. Remove the fuel lift pump delivery pipe from the lift pump and fuel filters.
6. Release the alternator (or dynamo) from its mountings and adjustment link and lift the alternator (dynamo), together with the fan belt from the engine.
7. Remove the tappet cover(s).
8. Lift out the tappets.

Refitting

9. Reverse the procedure 1 to 8, noting:
   a. Refer to Data for torque wrench settings.
   b. Adjust the valve/rocker clearance (refer to **'MAINTENANCE'**) to the figure given in Data.
   c. Bleed the fuel system.

Data

Torque wrench settings for rocker bracket bolts:	
$\frac{5}{16}$ in diameter	2·1 kgf m (15 lbf ft)
$\frac{3}{8}$ in diameter	4·1 kgf m (30 lbf ft)
Valve/rocker clearance (engine hot or cold):	
Inlet and exhaust	0·33 mm (0·013 in)

Section B2

CYLINDER HEAD

Removing

1. Remove the fuel lift pump delivery pipe from the lift pump and fuel filters. Disconnect the injection pump supply and return pipes and the constant bleed pipe from the fuel filters and remove the filters and mounting bracket.
2. Remove the bolts securing the injector spill rail to the injectors. Remove the rail.
3. Remove the hose from between the water pump and thermostat housing.
4. Remove the rocker cover.
5. Remove the bolts from the rocker shaft brackets and remove the rocker shaft assembly.
6. Withdraw the push-rods.
7. Remove the brackets retaining the injector high-pressure feed pipes.
8. Remove the high-pressure pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
9. Remove the injectors and discard their copper sealing washers.
10. Disconnect the cylinder head oil feed pipe banjo unions from the cylinder head and crankcase and remove the pipe.
11. Remove the nuts securing the cylinder head and lift the cylinder head clear of the studs.
12. Lift the cylinder head gasket from the two locating roll-pin dowels and cylinder block studs. On early engines, unscrew the two locating dowels from the cylinder block face and remove the cylinder head gasket.

Refitting

13. Reverse the procedure 1 to 12, noting:
    - *a.* Fit a new cylinder head gasket with the side marked 'HEAD FACE' to the cylinder head.
    - *b.* Fit new injector sealing washers.
    - *c.* Refer to Data for torque wrench settings.
    - *d.* Tighten the cylinder head nuts in the order shown in Fig. 1 or Fig. 2.
    - *e.* Adjust the valve/rocker clearance (refer to **'MAINTENANCE'**) to the figure stated in Data.
    - *f.* Bleed the fuel system.

      Important. To ensure a satisfactory cylinder head to block seal, it is imperative that the procedure detailed below be followed.

    - ●*g.* Run the engine until it reaches its normal working temperature, then run it for a further half-hour. Stop the engine and slacken, then tighten, to the correct torque, each cylinder head nut one flat in the sequence shown in Fig. 1 or Fig. 2.●

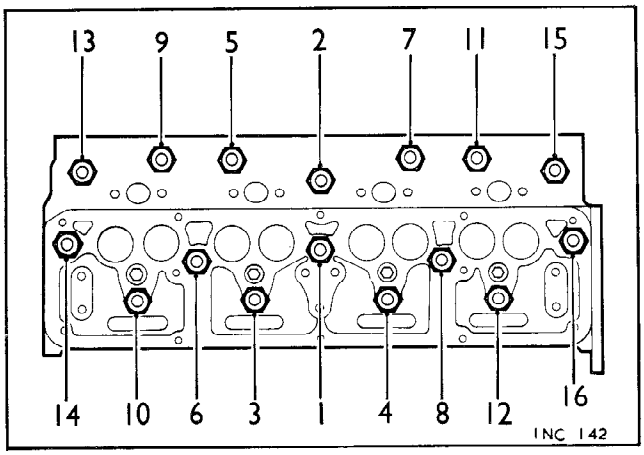


Fig. 1

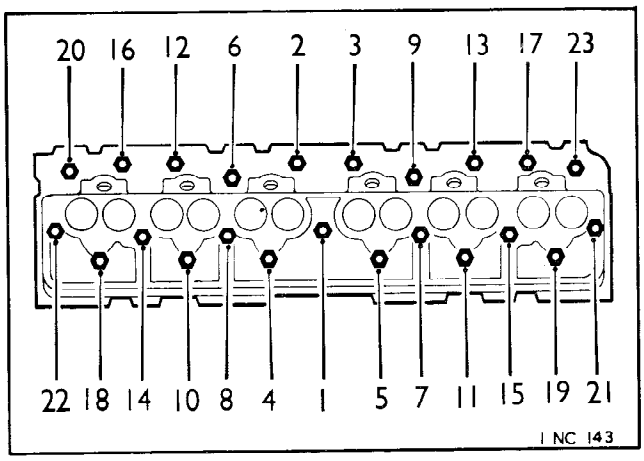


Fig. 2

Data

Torque wrench settings for:	
Cylinder head nuts	13·8 kgf m (100 lbf ft)
Injector securing bolts	1·65 kgf m (12 lbf ft)
Rocker bracket bolts:	
$\frac{5}{16}$ in diameter	2·1 kgf m (15 lbf ft)
$\frac{3}{8}$ in diameter	4·1 kgf m (30 lbf ft)
Valve/rocker clearance (engine hot or cold):	
Inlet and exhaust	0·33 mm (0·013 in)

Section B3

OIL PUMP AND CRANKSHAFT THRUST WASHERS

NOTE.—For four-cylinder engines refer to Section B4.

Removing

1. Withdraw the dipstick and remove the sump.
2. Release the oil pump delivery pipe from the crankcase.
3. Remove the front main bearing nuts and withdraw the oil pump, noting:
   a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
   b. Shims are inserted between the oil pump and the main bearing cap.
4. Remove the front main bearing cap complete with bearing half and thrust washer lower halves.
5. Slide the thrust washer upper halves around the crankshaft and out of the crankcase.

Refitting

6. Reverse the procedure 1 to 5, noting:
   a. Refer to Data for torque wrench settings.
   b. Lubricate the bearing surfaces and the thrust washers with engine oil.
   c. Fit the thrust washers with their grooved faces towards the crankshaft thrust faces.
   ●*d.* Ensure that the crankshaft end-float is as stated in Data (measure the end-float with the main bearing caps secured). ●
   e. Ensure that the oil pump gear back-lash is as stated in Data.
   ●*f.* Apply sealing compound to both sides of the sump gasket. ●

Data

Torque wrench settings for main bearing nuts	13·8 kgf m (100 lbf ft)
Crankshaft end-float	0·20 to 0·38 mm (0·008 to 0·015 in)
●End-float adjustment	Fit new thrust washers ●
Thrust washer thickness (new)	2·31 to 2·36 mm (0·091 to 0·093 in)
Oil pump drive gear back-lash	0·08 to 0·15 mm (0·003 to 0·006 in) between teeth of oil pump drive gear and crankshaft gear
Back-lash adjustment	Fit selective shims between oil pump and No. 1 main bearing cap
●Sump gasket sealing compound	Hylomar or Wellseal ●

Section B4

CRANKSHAFT BALANCE GEAR (Four-cylinder Engine)

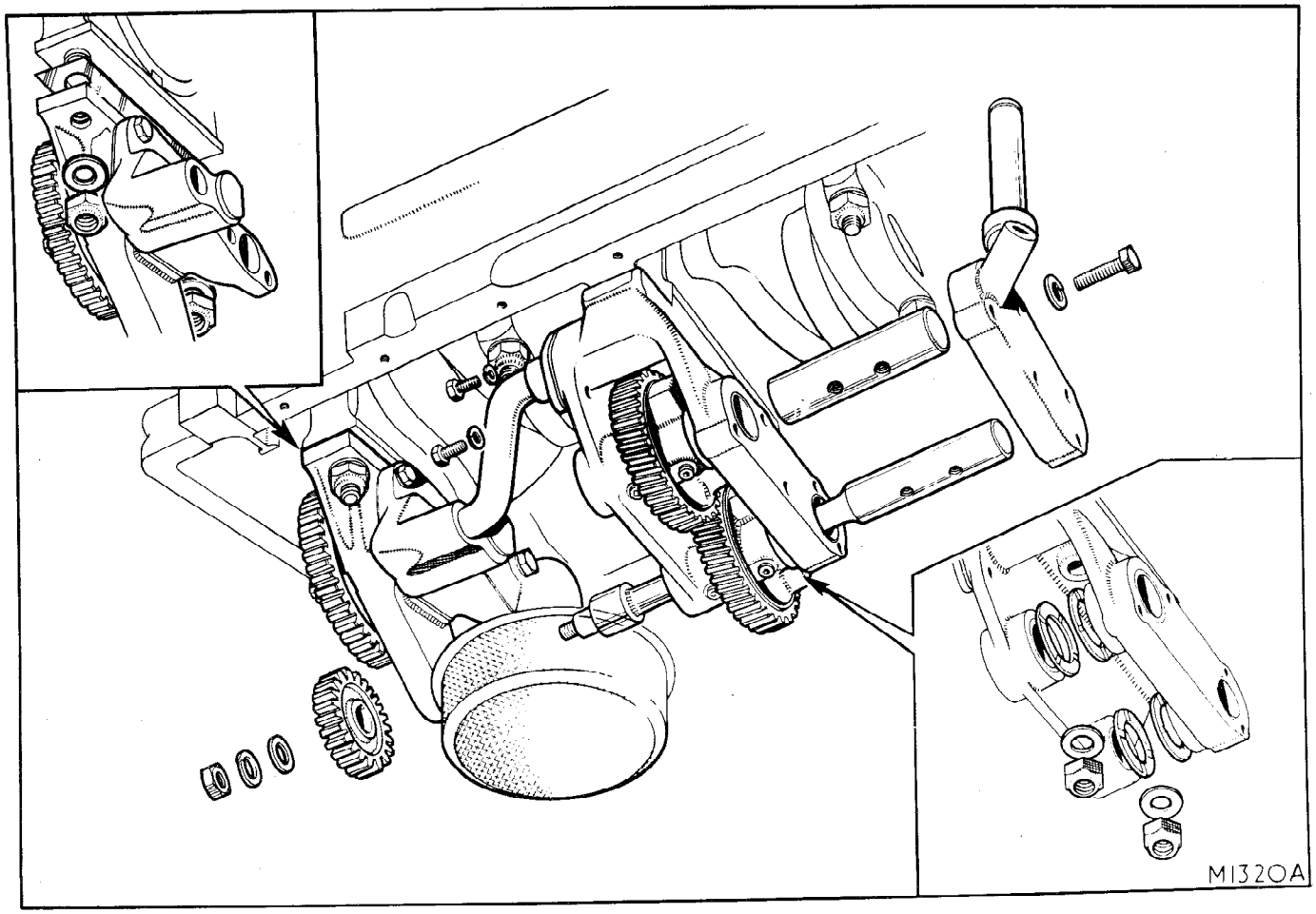


Fig. 1

Removing

1. Withdraw the dipstick and remove the sump.
2. Remove the balancer drive gear from the drive shaft, using tool 18G 2.
3. Remove the two bolts and disconnect the oil delivery pipe from the balancer.
4. Remove the five bolts and remove the balancer rear cover.
   NOTE.—The balance gear screws are secured by Loctite adhesive.
5. Remove the screws securing the right-hand balance gear to the drive shaft.
6. Remove the drive shaft and remove the right-hand balance gear and its thrust washers.
7. Remove the front main bearing nuts and withdraw the oil pump, using tool 18G 1185, noting:
   a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
   b. Shims are inserted between the oil pump and the bearing cap.
8. Remove the front main bearing cap complete with bearing half and thrust washer lower halves.
9. Slide the thrust washer upper halves around the crankshaft and out of the crankcase.
10. Remove the screws securing the left-hand balance gear to the driven shaft.
11. Withdraw the driven shaft and remove the left-hand balance gear and its thrust washers, noting that the dowel bolt holes are situated towards the rear end of the shaft.
12. Remove the two nuts and withdraw the balance gear housing, noting:
    a. The balancer mounting studs are also the mounting location for No. 3 main bearing cap.

Refitting

13. Reverse the procedure 1 to 12, noting:
    a. Refer to Data for torque wrench settings.
    b. Lubricate the bearing surfaces and the thrust washers with engine oil.
    c. Fit the thrust washers with their grooved faces towards the crankshaft thrust faces.
    d. Renew the balancer 'O' ring seals.

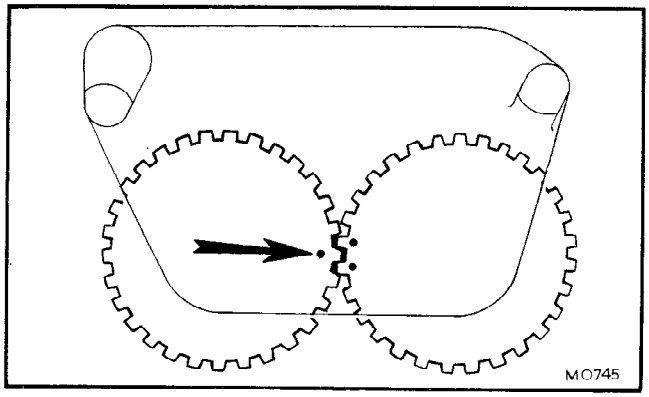
●e. Refit the balancer gears with thrust washers on both sides of the gears, and with the timing marks aligned as shown in Fig. 2. Apply Loctite to the gear securing screw threads. ●

f. Ensure that the oil pump gear is correctly aligned to the crankshaft and balancer gears, as shown in Fig. 3.

g. Ensure that the crankshaft end-float is as stated in Data (measure the end-float with the main bearing caps secured).

h. Ensure that the oil pump gear back-lash is as stated in Data.

●*i.* Apply sealing compound to both sides of the sump gasket. ●



● *Fig. 2* ●

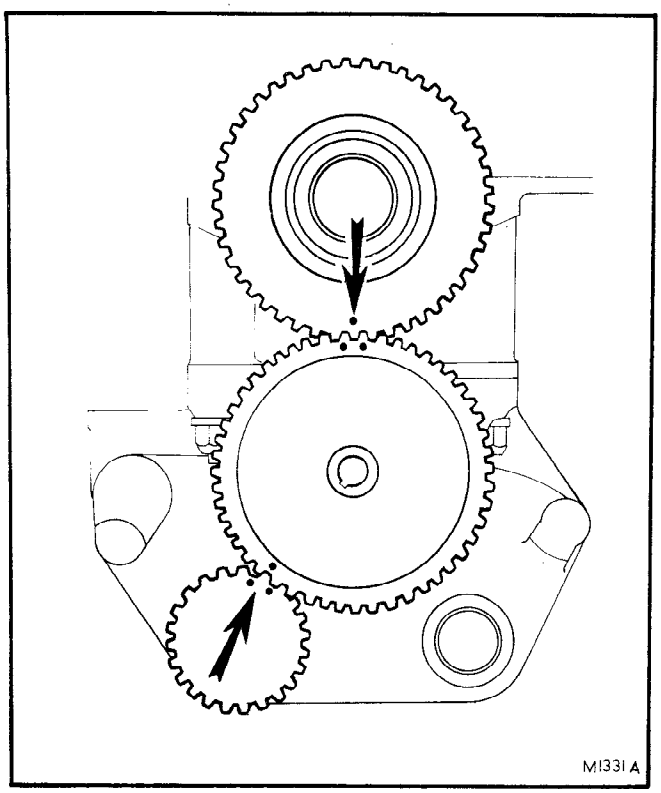


Fig. 3

Data

Torque wrench settings for main bearing nuts	13·8 kgf m (100 lbf ft)
Crankshaft end-float	0·20 to 0·38 mm (0·008 to 0·015 in)
●End-float adjustment	Fit new thrust washers ●
Thrust washer thickness (new)	2·31 to 2·36 mm (0·091 to 0·093 in)
Oil pump drive gear back-lash	0·08 to 0·15 mm (0·003 to 0·006 in) between teeth of oil pump drive gear and crankshaft gear
Back-lash adjustment	Fit selective shims between oil pump and No. 1 main bearing cap
●Sump gasket sealing compound	Hylomar or Wellseal ●

Section B5

FLYWHEEL AND CRANKSHAFT REAR OIL SEAL

Removing

1. *For a 33·0 cm (13 in) diameter single clutch:* Fit a 6·4 mm ($\frac{1}{4}$ in) thick spacer between each clutch release lever and the clutch cover to hold the springs in compression and so facilitate assembly.
2. *For both double clutches:* Fit the transit clips (tool 18G 498, Borg and Beck clutch) over the main clutch release levers and hook them beneath the clutch cover in order to keep the levers depressed.
3. Reference mark the cover and flywheel and remove the bolts securing the clutch to the flywheel. Remove the clutch assembly and the clutch driven plate.
4. Release the three lockplates and remove the bolts securing the flywheel. Draw the flywheel from the crankshaft by screwing $\frac{3}{8}$ in U.N.F. bolts into the extractor holes.
5. Extract the two roll-pin dowels from the rear oil seal housing.
6. Remove the oil seal housing securing bolts, including the two which pass through the sump flange.
7. ● Remove the sump and gasket. ●
8. Remove the oil seal and housing from the crankshaft.
9. Remove the oil seal from its housing.

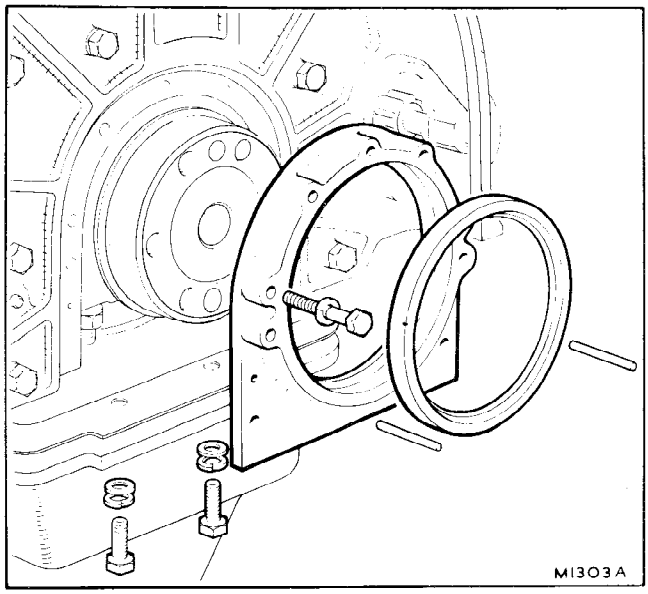


Fig. 1

Refitting

10. Reverse the procedure 1 to 9, noting:
    - *a.* Use tools 18G 134 and 18G 134 CP to fit the oil seal to its housing.
    - *b.* Lubricate the oil seal and crankshaft with engine oil.
    - ●*c.* Apply sealing compound to the lower portion of the oil seal housing where it contacts the crankcase, and to both sides of the sump gasket. Use tool 18G 1110 to fit the oil seal and housing to the crankshaft, then fit the roll-pin dowels before tightening the bolts. ●
    - *d.* The flywheel dowels are offset to ensure the correct timing position of the flywheel on the crankshaft.
    - *e.* Refer to Data for torque wrench setting.
    - *f.* *Borg and Beck single and double clutches.* The driven plate must be fitted so that the face with the flanged boss is facing away from the flywheel.
    - *g.* *Laycock clutch:* The driven plate must be assembled so that the face with the longer boss fits into the flywheel.
    - *h.* Use the transmission shaft to centralize the driven plate.
    - *i.* Remove the retaining staples, or spacers if a single clutch.
    - *j.* Pack the flywheel spigot bearing with grease.

Data

Torque wrench settings for:	
Flywheel bolts	13·8 kgf m (100 lbf ft)
Laycock clutch securing bolts	4·1 kgf m (30 lbf ft)
Spigot bearing grease specification	Duckhams D.B.500
● Sump gasket and oil seal housing sealing compound	Hylomar or Wellseal ●

Section B6

FLYWHEEL HOUSING

Removing

1. *For a 33·0 cm (13 in) diameter single clutch:* Fit a 6·4 mm ($\frac{1}{4}$ in) thick spacer between each clutch release lever and the clutch cover to hold the springs in compression and so facilitate assembly.
2. *For both double clutches:* Fit the transit clips (tool 18G 498, Borg and Beck clutch) over the main clutch release levers and hook them beneath the clutch cover in order to keep the levers depressed.
3. Reference mark the cover and flywheel, remove the bolts securing the clutch to the flywheel and remove the clutch assembly and the clutch driven plate.
4. Release the three lockplates and remove the bolts securing the flywheel. Draw the flywheel from the crankshaft by screwing $\frac{3}{8}$ in U.N.F. bolts into the extractor holes.
5. Remove the three nuts securing the starter motor and withdraw the starter motor from the flywheel housing.
6. Remove the bolts securing the flywheel housing to the engine.
7. Tap the flywheel housing off its three locating dowels.

Refitting

8. Reverse the procedure 1 to 7, noting:
   a. Refer to Data for torque wrench settings.
   b. The flywheel dowels are offset to ensure the correct timing position of the flywheel on the crankshaft.
   c. *Borg and Beck single and double clutches:* The driven plate must be fitted so that the face with the flanged boss is facing away from the flywheel.
   d. *Laycock clutch:* The driven plate must be assembled so that the face with the longer boss fits into the flywheel.
   e. Use the transmission shaft to centralize the driven plate.
   f. Remove the retaining staples, or spacers if a single clutch.
   g. Pack the flywheel spigot bearing with grease.

Data

Torque wrench settings for:	
Flywheel bolts	13·8 kgf m (100 lbf ft)
Laycock clutch securing bolts	4·1 kgf m (30 lbf ft)
Spigot bearing grease specification	Duckhams D.B.500

Section B7

CRANKSHAFT FRONT OIL SEAL

Removing

1. Release the alternator (or dynamo) and remove the drive belt.
2. Release the lock washer and unscrew the crankshaft nut.
3. Remove the crankshaft pulley.
4. Withdraw the crankshaft front oil seal from the timing cover, using tool 18G 1111 (refer to Fig. 1).

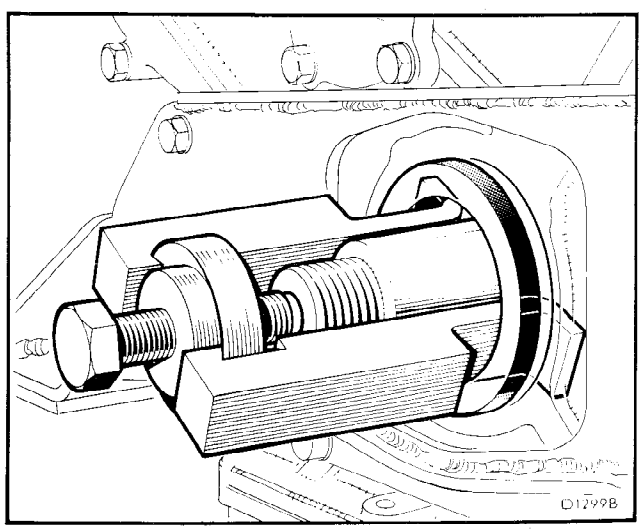


Fig. 1

Refitting

5. Reverse the procedure 1 to 4, noting:
   a. Lubricate the oil seal and crankshaft with engine oil.
   b. Use tool 18G 1111 to fit the oil seal (refer to Fig. 2).
   c. Refer to Data for torque wrench settings.
   d. Position the alternator (or dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).

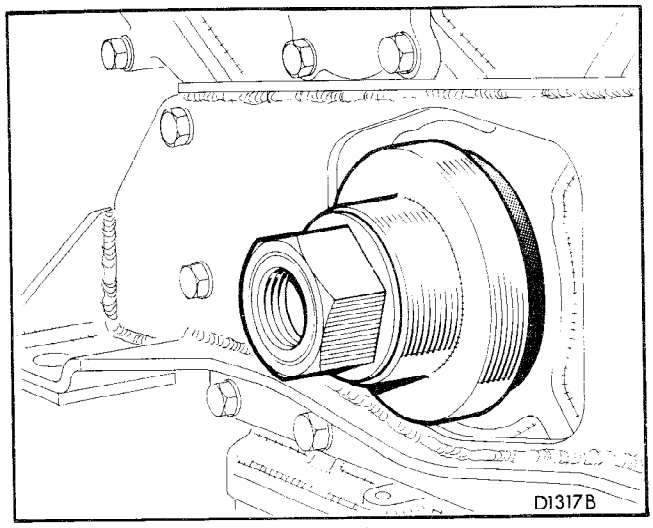


Fig. 2

Data

● Torque wrench setting for crankshaft nut	.. ..	34·5 to 38 kgf m (250 to 275 lbf ft) ●

Section B8

CRANKSHAFT

Removing

1. Release the alternator (or dynamo) and remove the drive belt.
2. Remove the fan and water pump pulley.
3. Withdraw the dipstick and remove the sump.
4. Release the lock washer and unscrew the crankshaft nut.
5. Remove the crankshaft pulley and extract the key from the crankshaft.
6. Remove the alternator (or dynamo) and its mounting bracket from the timing case.
7. Remove the engine front mounting plate.
8. Remove the timing cover securing bolts and pull the timing cover off its two locating dowels.
9. *For a 33·0 cm (13 in) diameter single clutch:* Fit a 6·4 mm ($\frac{1}{4}$ in) thick spacer between each clutch release lever and the clutch cover to hold the springs in compression and so facilitate assembly.
10. *For both double clutches:* Fit the transit clips (tool 18G 498, Borg and Beck clutch) over the main clutch release levers and hook them beneath the clutch cover in order to keep the levers depressed.
11. Reference mark the cover and flywheel and remove the clutch and clutch driven plate from the flywheel.
12. Release the three lockplates and remove the bolts securing the flywheel. Draw the flywheel from the crankshaft by screwing $\frac{3}{8}$ in U.N.F. bolts into the extractor holes.
13. Extract the two roll-pin dowels and remove the crankshaft rear oil seal and housing.
14. Remove the bolts securing the flywheel housing to the engine and tap the flywheel housing, complete with the starter motor, off its three locating dowels.
15. Remove the retaining plate and distance collar from the auxiliary idler gear spindle. Draw the auxiliary idler gear from the spindle, using tools 18G 231 and 18G 231 C.
16. Remove the main idler gear and its thrust washer.
17. Remove the injector feed pipes, spill-rail and injectors.
18. Invert the engine so that the crankshaft is uppermost.

NOTE.—For a six-cylinder engine omit operations 19 to 29.

19. Remove the balancer drive gear from the drive shaft, using tool 18G 2.
20. Remove the two bolts and disconnect the oil delivery pipe from the balancer.
21. Remove the five bolts and remove the balancer rear cover.

    NOTE.—The balance gear screws are secured by Loctite adhesive.

22. Remove the screws securing the right-hand balance gear to the drive shaft.
23. Remove the drive shaft and remove the right-hand balance gear and its thrust washers.
24. Remove the front main bearing nuts and withdraw the oil pump, using tool 18G 1185, noting:
    a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
    b. Shims are inserted between the oil pump and the bearing cap.
25. Remove the front main bearing cap complete with bearing half and thrust washer lower halves.
26. Slide the thrust washer upper halves around the crankshaft and out of the crankcase.
27. Remove the screws securing the left-hand balance gear to the driven shaft.

28. Withdraw the driven shaft and remove the left-hand balance gear and its thrust washers, noting that the dowel bolt holes are situated towards the rear end of the shaft.
29. Remove the two nuts and withdraw the balance gear housing, noting:
    a. The balancer mounting studs are also the mounting location for No. 3 main bearing cap.
30. Release the oil pump delivery pipe from the crankcase and remove the oil pump noting:
    a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
    b. Shims are inserted between the oil pump and main bearing cap.
31. Turning the crankshaft to assist, slacken all the connecting rod cap bolts.
32. Tap the connecting rods to release them from the crankshaft.
33. Remove the connecting rod bolts, caps and bearing halves, then push the connecting rods down their cylinders. Carry out this instruction in the following sequence:
    i. Connecting rods 3 and 4 (2 and 3—4-cylinder engine).
    ii. 1 and 6 (1 and 4).
    iii. 2 and 5.
34. Position the connecting rods to the left-hand side of the engine (looking from the flywheel end). Turn the crankshaft until crank pins 3 and 4 (2 and 3, four cylinder engine) are to the left-hand side and horizontal.
35. Remove the main bearing caps; do not turn the crankshaft.
36. Lift out the crankshaft turning it anti-clockwise (looking on the timing gear end) to allow the crankshaft centre webs to clear the oil pump delivery pipe connection in the crankcase.
37. Collect the main bearing upper halves (and crankshaft thrust washer upper halves—6-cylinder engine).
38. Remove the oil pump driving gear and the crankshaft gears, using tools 18G 231 and 18G 231 B.

Refitting

39. Reverse the procedure 1 to 38 as necessary, noting:
    a. Refer to Data for torque wrench settings.
    b. Before refitting the crankshaft lubricate the crankshaft, front and rear crankshaft oil seals, thrust washers, big-end bearings and main bearings with engine oil.
    c. Big-end and main bearing caps are reference marked to the crankcase.
    d. Fit the thrust washers with their grooved faces towards the crankshaft thrust faces.
    e. Check the crankshaft bearing clearance and end-float, refer to Data (measure the end-float with the main bearing caps secured).
    f. Renew the balancer 'O' ring seals.
    g. Assemble the timing gears with their timing marks positioned as shown in Fig. 1.

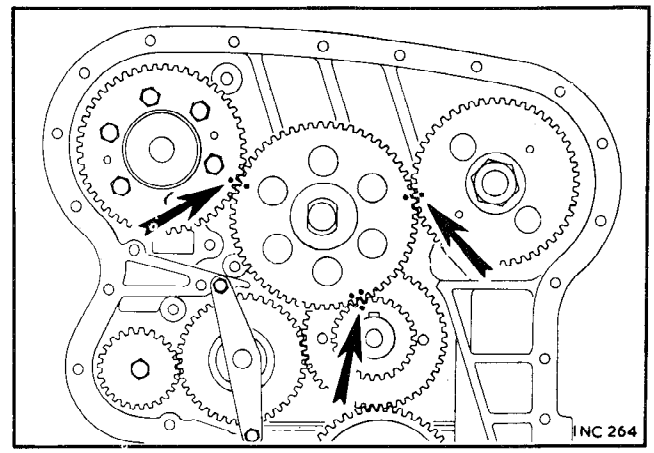


Fig. 1

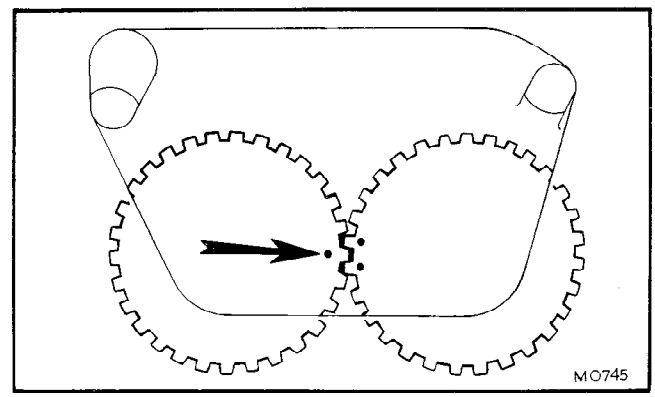


Fig. 2

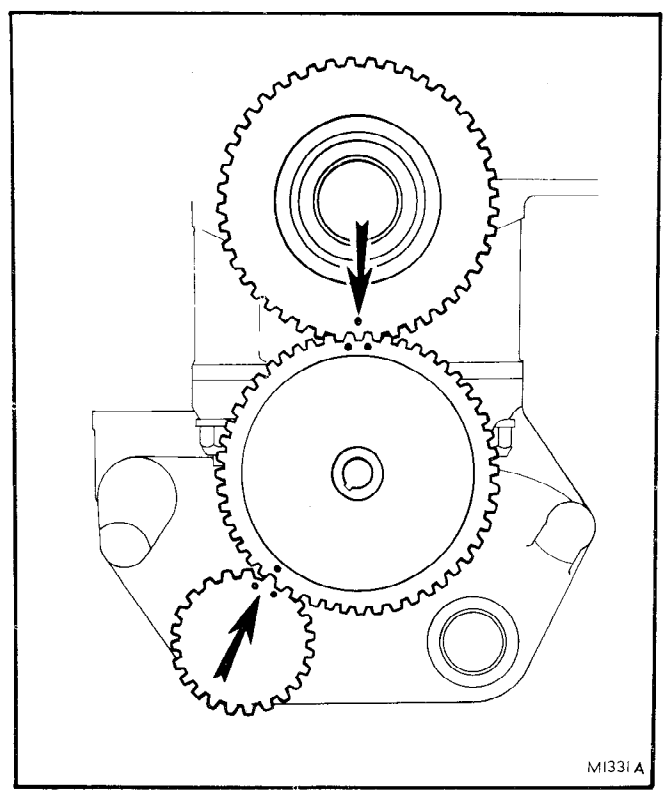


Fig. 3

h. Refit the balancer gears with the thrust washers on both sides of the gears, and with the timing marks aligned as shown in Fig. 2. Apply Loctite to the gear securing screw threads.

i. Ensure that the oil pump gear back-lash is as stated in Data and is aligned with the crankshaft gear as shown in Fig. 3.

j. Fit the idler gear thrust washer with its grooved side towards the gear.

k. Fit the crankshaft oil thrower with its chamfered face towards the gear.

●*l.* Apply sealing compound to the lower portion of the oil seal housing where it contacts the crankcase, and to both sides of the sump gasket. Use tool 18G 1110 to fit the rear oil seal and housing to the crankshaft, then fit the roll-pin dowels before tightening the securing bolts. ●

m. The flywheel dowels are offset to ensure the correct timing position of the flywheel on the crankshaft.

n. *Borg and Beck single and double clutches:* The driven plate must be fitted so that the face with the flanged boss is facing away from the flywheel.

o. *Laycock clutch:* The driven plate must be assembled so that the face with the longer boss fits into the flywheel.

p. Use the transmission shaft to centralize the driven plate.

q. Remove the retaining staples, or spacers if a single clutch.

r. Position the alternator (or dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).

●*s.* Fit new injector sealing washers. ●

t. Bleed the fuel system.

u. Pack the flywheel spigot bearing with grease.

Data

Torque wrench settings for:	
●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft) ●
Connecting rod bolts	8·3 kgf m (60 lbf ft)
Flywheel bolts	13·8 kgf m (100 lbf ft)
Main bearing nuts	13·8 kgf m (100 lbf ft)
Fan and water pump pulley bolts	2·7 kgf m (20 lbf ft)
Laycock clutch securing bolts	4·1 kgf m (30 lbf ft)
Injector securing bolts	1·65 kgf m (12 lbf ft).
Clearances:	
Main bearing journals	0·07 to 0·10 mm (0·003 to 0·004 in)
Crankpins in big-end bearings	0·04 to 0·08 mm (0·0015 to 0·004 in)
Crankshaft end-float	0·20 to 0·38 mm (0·008 to 0·015 in)
●End-float adjustment	Fit new thrust washers ●
Thrust washer thickness (new)	2·31 to 2·36 mm (0·091 to 0·093 in)
Oil pump drive gear back-lash	0·08 to 0·15 mm (0·003 to 0·006 in) between teeth of oil pump drive gear and crankshaft gear
Back-lash adjustment	Fit shims between the oil pump and No. 1 main bearing cap
Spigot bearing grease specification	Duckhams D.B.500
●Sump gasket and oil seal housing sealing compound	Hylomar or Wellseal ●

Section B9

TIMING GEARS AND CASE

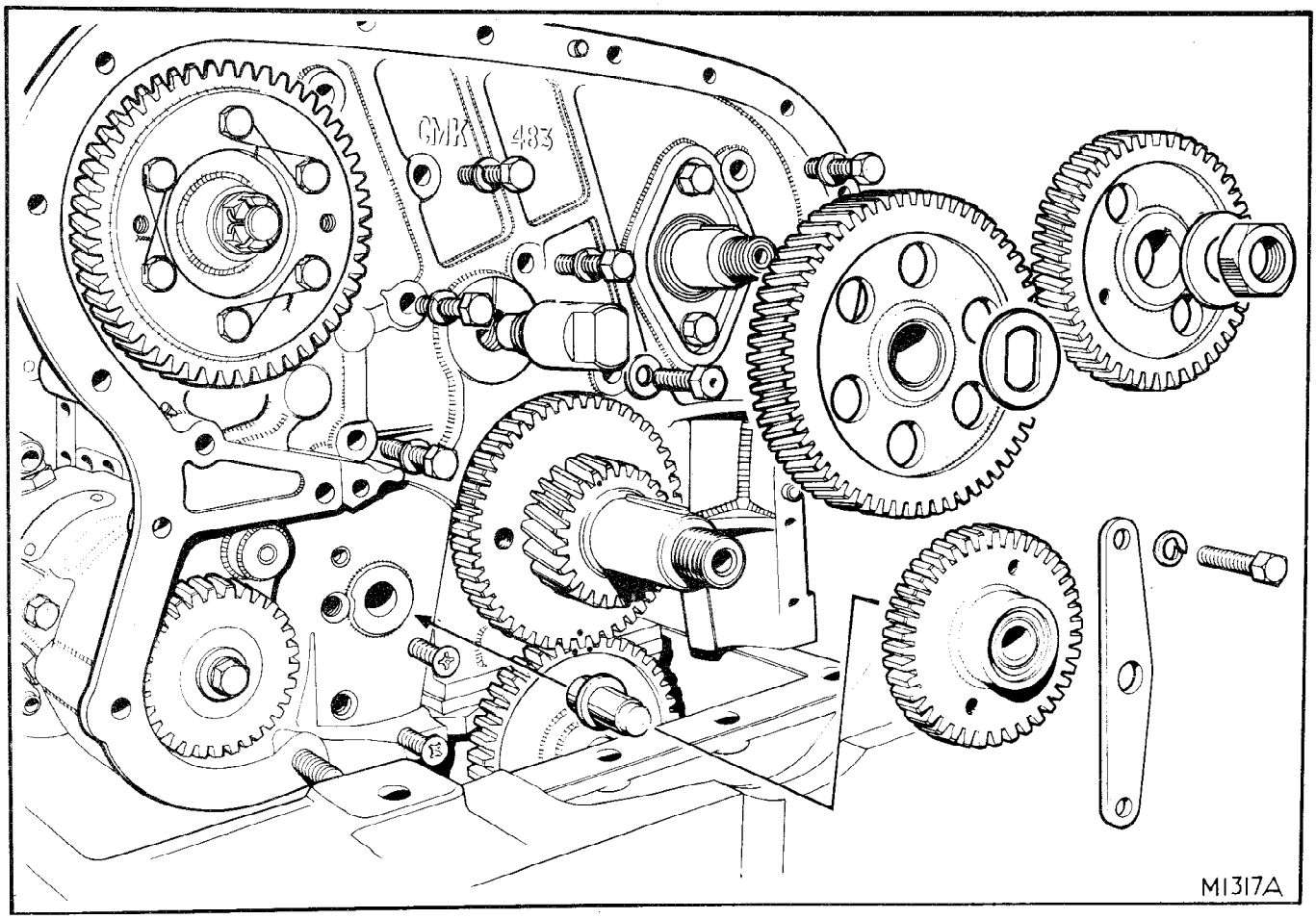


Fig. 1

Removing

1. Release the alternator (or dynamo) and remove the drive belt.
2. Remove the fan and water pump pulley.
3. Remove the alternator (or dynamo) and its mounting bracket from the timing case.
4. Release the lock washer and unscrew the crankshaft nut.
5. Remove the crankshaft pulley and extract the key from the crankshaft.
6. Remove the engine front mounting plate from the timing case.
- ●7. Remove the sump and gasket.●
8. Remove the fuel delivery and return pipes from between the injection pump and fuel filters.
9. Remove the brackets retaining the injector high-pressure feed pipes.
10. Remove the high-pressure feed pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
11. *If a Simms in-line injection pump is fitted:* Disconnect the lubricating oil overflow pipe from the injection pump.
12. Remove the timing cover securing bolts and detach the front lifting bracket.
13. Withdraw the timing cover from the two dowels locating it to the timing case.

●**NOTE.**—The idler gear thrust washer may stick to the timing cover.●

14. Check the back-lash of the timing gears; if in excess of the figure quoted in Data, renew the gears.
15. Remove the oil thrower from the crankshaft and the thrust washer from the main idler gear shaft.
16. Refit the crankshaft nut and rotate the crankshaft until the timing marks on the timing gears are in the positions shown in Fig. 2, then remove the nut.
17. Release the lock washer from the camshaft gear and remove the nut. Draw the gear from the camshaft, using tools 18G 231, 18G 231 C and 18G 231 D.
18. Remove the main idler gear and, if necessary, the gears from the crankshaft, using tools 18G 231 and 18G 231 B. (If it is necessary to remove the idler gear shaft, note that the shaft has a left-hand thread.)

CAUTION.—Do not rotate the crankshaft or camshaft when the idler gear has been removed unless the valve rocker adjusting screws are slackened off, permitting the valves to remain fully closed. Failure to observe this caution will result in the pistons fouling the valves.

19. Remove the retaining plate and distance collar from the auxiliary idler gear spindle.
20. Remove the auxiliary idler gear from its spindle, using tools 18G 231 and 18G 231 C.
21. Remove the two countersunk screws that were hidden by the auxiliary idler gear.
22. Remove the timing gear oil feed jet.
23. Remove the bolts securing the timing case to the cylinder block.
24. Tap the timing case, complete with injection pump (and power steering pump, if fitted) off the three dowels locating it on the cylinder block.
25. If it is necessary to remove the auxiliary idler gear spindle, extract the circlip and tap the spindle from the timing case.

Refitting

26. Reverse the procedure 1 to 25, noting:
    a. Refer to Data for torque wrench settings.
    b. Assemble the timing gears with their timing marks positioned as shown in Fig. 2.
    c. Assemble the auxiliary idler gear distance collar with its recessed face to the gear.

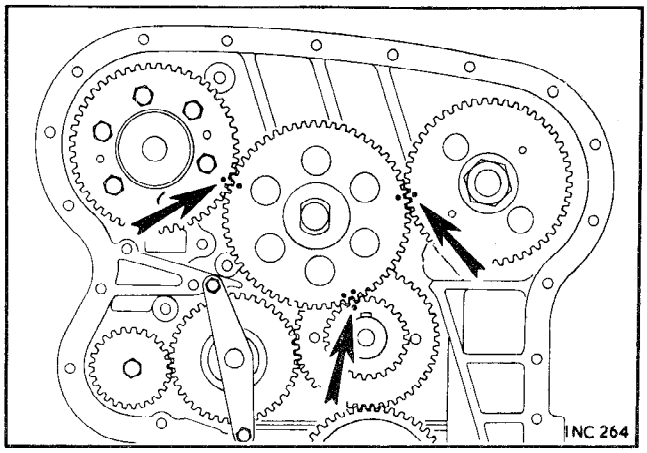


Fig. 2

d. Check the main idler gear thrust washer thickness, renew if less than the figure quoted in Data. Fit the thrust washer with its grooved side towards the gear.
e. Fit the crankshaft oil thrower with its chamfered face towards the gear.
●*f.* Apply sealing compound to both sides of the sump gasket.●
●*g.* Position the alternator (or dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).
h. ●Bleed the fuel system.

Data

Torque wrench settings for:

●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft)●
Fan and water pump pulley bolts	2·7 kgf m (20 lbf ft)
Back-lash for timing gears	0·10 to 0·15 mm (0·004 to 0·006 in)
Thickness of main idler gear thrust washer	1·73 to 1·78 mm (0·68 to 0·70 in)
●Sump gasket sealing compound	Hylomar or Wellseal●

Section B10

CAMSHAFT

Removing

1. Remove the rocker cover.
2. Release the rocker brackets from the cylinder head and lift off the rocker shaft assembly.
3. Withdraw the push-rods.
4. Disconnect the fuel lift pump delivery pipe from the fuel lift pump and fuel filters and remove the lift pump.
5. Release the alternator (or dynamo) from its mountings and adjustment link and lift the alternator (dynamo), together with the fan belt from the engine.
6. Disconnect the cylinder head oil feed pipe banjo unions from the cylinder head and crankcase and remove the pipe.
7. Remove the tappet cover(s).
8. Lift out the tappets.
9. Remove the fan and water pump pulley
10. Release the lock washer and unscrew the crankshaft nut.
11. Remove the crankshaft pulley.
12. Remove the engine front mounting plate from the timing cover.
- 13. Remove the sump and gasket. -
14. Remove the timing cover securing bolts, detach the front lifting bracket, and withdraw the timing cover from the two dowels locating it to the timing case.
NOTE.—The main idler gear thrust washer may - stick to the timing case. -
15. Remove the oil thrower from the crankshaft and the thrust washer from the main idler gear shaft.
16. Refit the crankshaft nut and rotate the crankshaft until the timing marks on the timing gears are in the positions shown in Fig. 1. Remove the crankshaft nut.
17. Release the lock washer from the camshaft gear and remove the nut. Draw the gear from the camshaft, using tools 18G 231, 18G 231 C and 18G 231 D.
18. Remove the camshaft thrust plate and withdraw the camshaft applying a rotary motion.

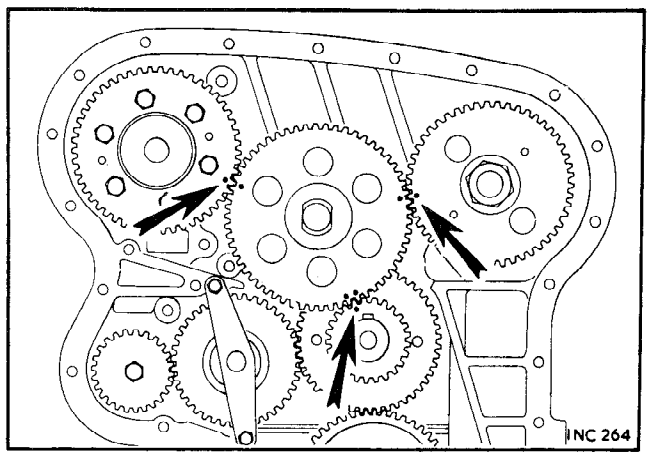


Fig. 1

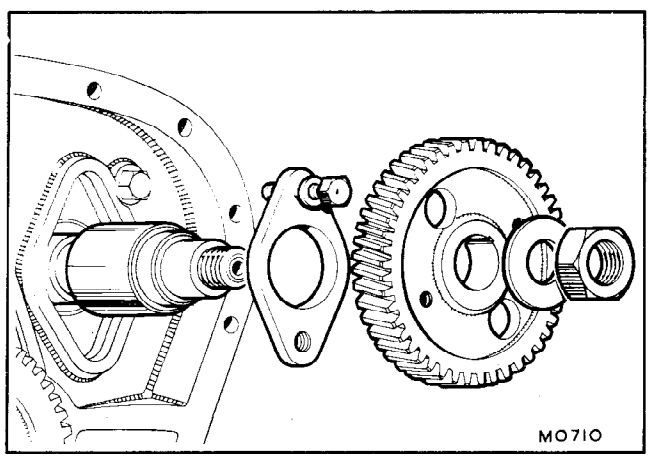


Fig. 2

Refitting

19. Reverse the procedure 1 to 18, noting:
   a. Lubricate the camshaft, tappets and camshaft thrust plate with engine oil.
   b. *For early engines only:* Fit the camshaft thrust plate with its insert facing forward.
   c. Disengage the main idler gear, assemble the camshaft gear and then the main idler gear so that the timing gears are positioned as shown in Fig. 1.
   d. Fit the main idler gear thrust washer with its grooved side towards the gear.
   e. Fit the crankshaft oil thrower with its chamfered face towards the gear.
- *f.* Apply sealing compound to both sides of the sump gasket. -
- *g.* Refer to Data for torque wrench settings.
   h. Position the alternator to give the correct drive belt tension (refer to **'MAINTENANCE'**).
   i. Adjust the valve/rocker clearance (refer to **'MAINTENANCE'**) to the figure given in Data.
   j. - Bleed the fuel system.

Data

Torque wrench settings for:	
●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft) ●
Rocker bracket bolts:	
$\frac{5}{16}$ in diameter	2·1 kgf m (15 lbf ft)
$\frac{3}{8}$ in diameter	4·1 kgf m (30 lbf ft)
Fan and water pump pulley bolts	2·7 kgf m (20 lbf ft)
Valve/rocker clearance (engine hot or cold)	
Inlet and exhaust	0·33 mm (0·013 in)
●Sump gasket sealing compound	Hylomar or Wellseal ●

Section B11

D.P.A. INJECTION PUMP DRIVE

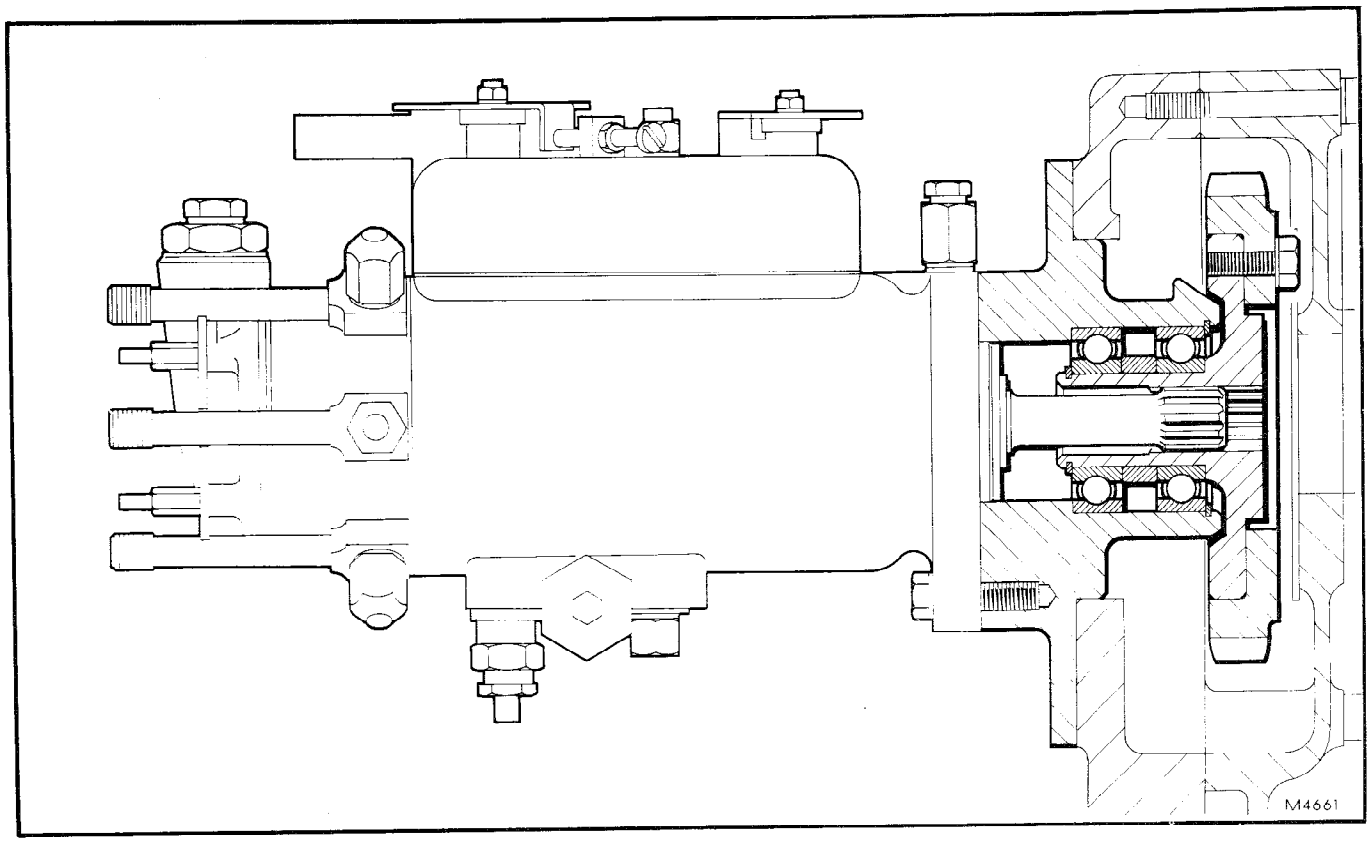


Fig. 1

Removing

1. Remove the fuel delivery and return pipes from between the injection pump and fuel filters.
2. Remove the brackets retaining the injector high-pressure feed pipes.
3. Remove the high-pressure pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
4. Remove the three securing nuts and withdraw the injection pump.
5. Release the alternator (or dynamo) and remove the drive belt.
6. Remove the fan and water pump pulley.
7. Remove the alternator (or dynamo) and its mounting bracket from the timing case.
8. Release the lock washer and unscrew the crankshaft nut.
9. Remove the crankshaft pulley.
10. Remove the engine front mounting plate from the timing cover.
- 11. Remove the sump and gasket. ●

12. Remove the timing cover securing bolts, detach the front lifting bracket, and pull the timing cover off the two dowels locating it to the timing case.
NOTE.—The main idler gear thrust washer may ●stick to the timing cover.●
13. Remove the oil thrower from the crankshaft, and the thrust washer from the main idler gear shaft.
14. Refit the crankshaft nut and rotate the crankshaft until the timing marks on the timing gears are in the positions shown in Fig. 2. Remove the nut.
15. Remove the bolts securing the injection pump drive gear and remove the gear from its hub.
16. Remove the circlip from the hub inside the rear end of the bearing housing.
17. Withdraw the gear hub forward, from the hub bearings, using tools 18G 284 and 18G 284 AAB.
18. Remove the securing bolts and nuts, and withdraw the bearing housing rearwards from the timing case.

Refitting

19. Reverse the procedure 1 to 18, noting:
   a. Refer to Data for torque wrench settings.
   b. Disengage the main idler gear, fit the injection pump drive gear to its hub with the hub and gear timing marks aligned as shown in Fig. 3. Engage the main idler gear so that the timing gears are positioned as shown in Fig. 2.
   c. Fit the main idler gear thrust washer with its grooved side towards the gear.
   d. Fit the crankshaft oil thrower with its chamfered face towards the gear.
   ●*e.* Apply sealing compound to both sides of the sump gasket.●
   ●*f.* Position the alternator (or dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).
   g. ●Check the position of the injection pump timing pointer as follows:
      i. With No. 1 piston at the beginning of its compression stroke, insert timing pin AMK 9990 through the hole in the flywheel housing and into the hole in the flywheel.
      ii. If necessary, maintain a light pressure on the timing pin and turn the crankshaft in its normal direction of rotation until the timing pin engages the hole in the flywheel.
      iii. Using tool 18G 1206 check and, if necessary, adjust the position of the injection pump timing pointer (refer to Fig. 4). Remove the ●timing pin and timing tool.●

   ●*Procedure using timing gauge MS 67. Carry out instructions i and ii above, then proceed as follows:*●
      i. Remove the scribing arm from timing gauge MS 67 and locate the hexagonal handle through the gauge body so that the corner marked 'O' is in line with the 240° position marked on the gauge body spigot (refer to Fig. 5). Insert the splined end of the gauge into the injection pump drive gear hub and slide the gauge body forward until it abuts the

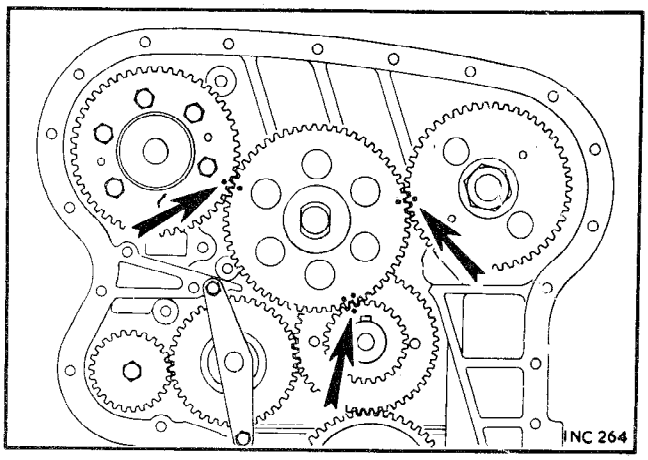


Fig. 2

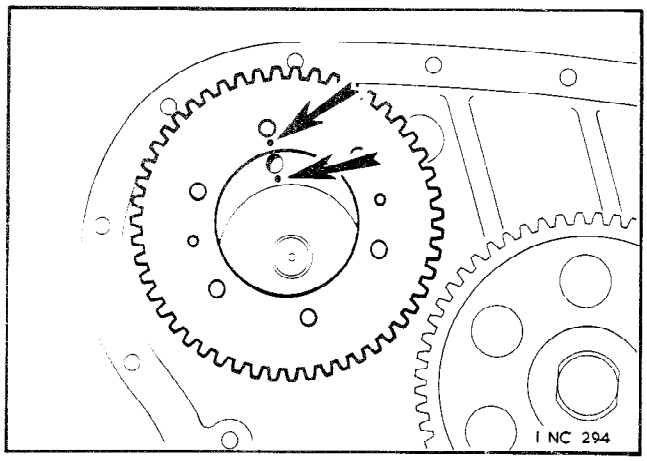


Fig. 3

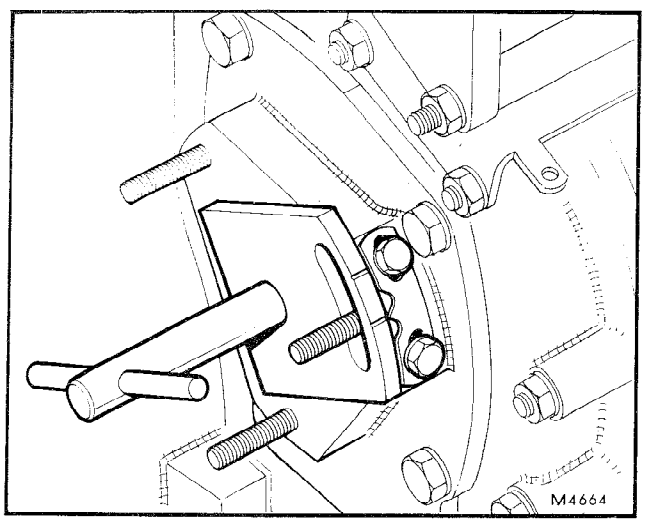


Fig. 4

timing case flange, then lock in position using the knurled screw. ●

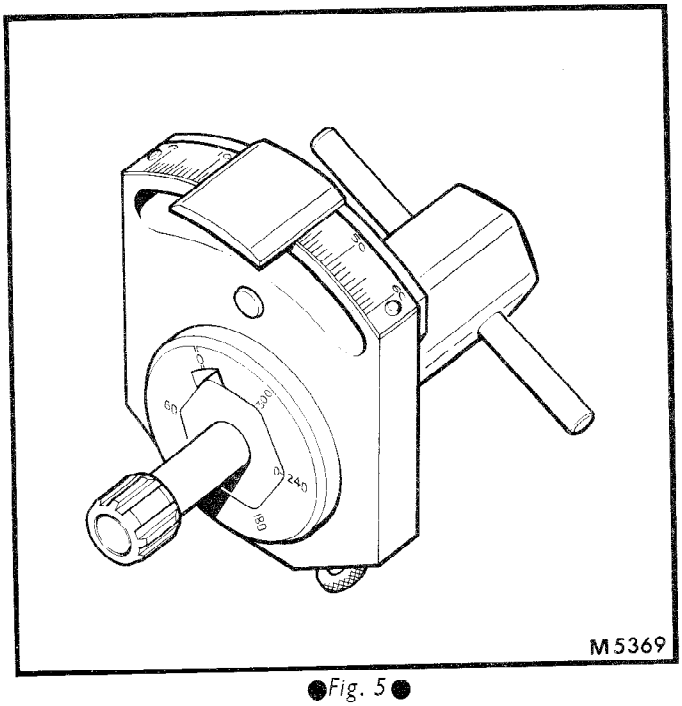
●ii. *Four-cylinder engine:* Check that the timing pointer on the engine aligns with the 15° mark on the scale of the gauge body (refer to Fig. 6).

Six-cylinder engine: Check that the timing pointer on the engine aligns with the 32° mark on the scale of the gauge body.

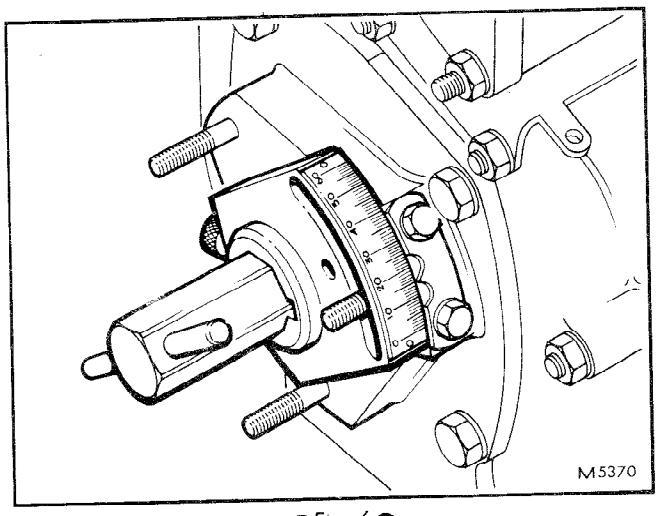
iii. If necessary, adjust the position of the injection pump timing pointer. Remove the timing gauge and pin. ●

●*h.* Fit the injection pump with its scribed timing mark on its mounting flange in line with the timing pointer.

i. ●Bleed the fuel system.



●*Fig. 5* ●



●*Fig. 6* ●

Data

Torque wrench settings for:	
●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft) ●
Fan and water pump pulley bolts	2·7 kgf m (20 lbf ft)
●Sump gasket sealing compound	Hylomar or Wellseal ●

Section B12

SIMMS IN-LINE INJECTION PUMP DRIVE

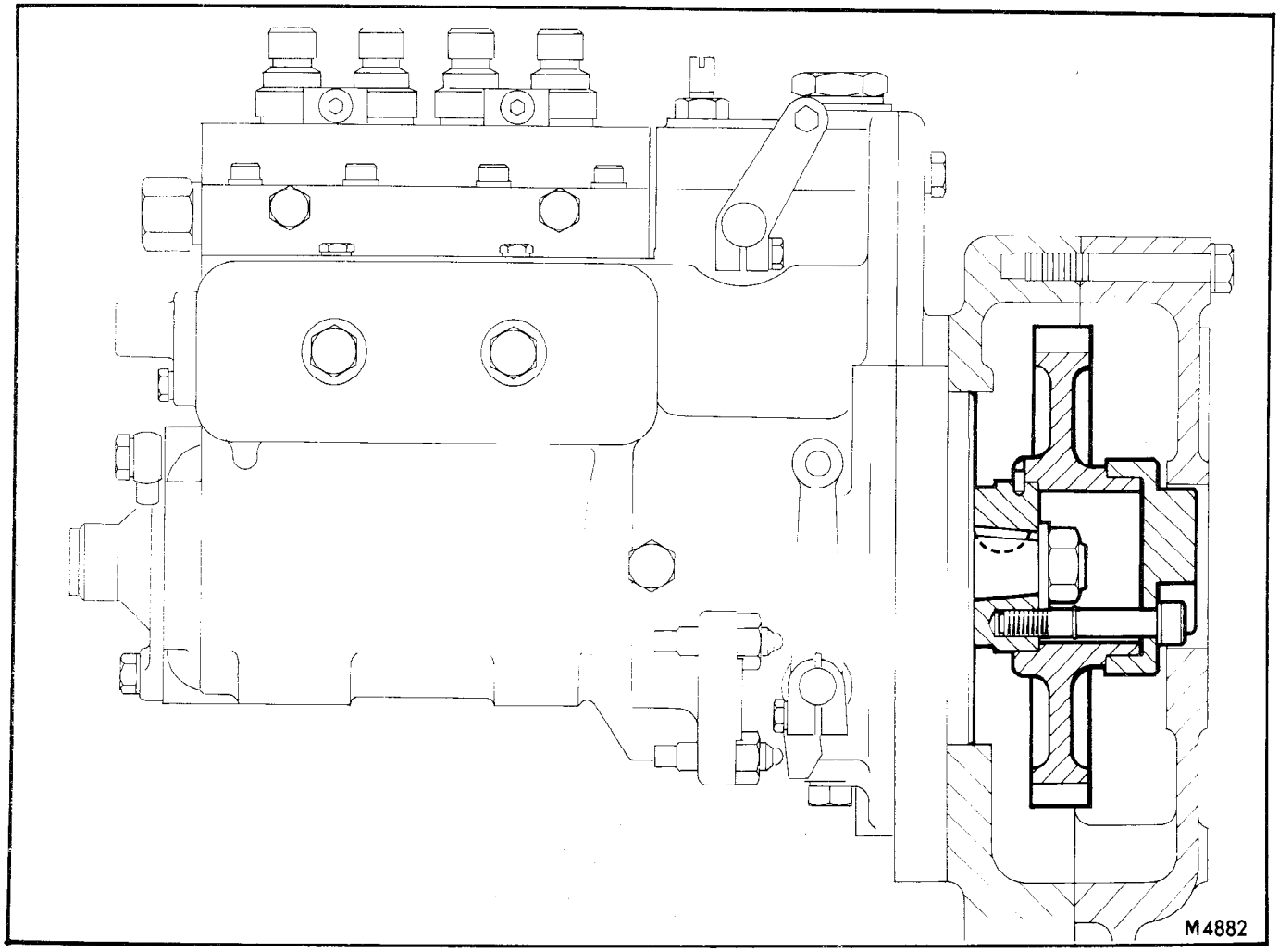


Fig. 1

Removing

1. Remove the fuel delivery pipe from the injection pump and fuel filters.
2. Remove the brackets retaining the injector high-pressure feed pipes.
3. Remove the high-pressure pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
4. Disconnect the lubricating oil overflow pipe from the injection pump.
5. Release the alternator (or dynamo) and remove the drive belt.
6. Remove the fan and water pump pulley.
7. Remove the alternator (or dynamo) and its mounting bracket from the timing case.
8. Release the lock washer and unscrew the crankshaft nut.
9. Remove the crankshaft pulley.
10. Remove the engine front mounting plate from the timing cover.
11. Remove the sump and gasket.
12. Remove the timing cover securing bolts, detach the front lifting bracket, and pull the timing cover off the two dowels locating it to the timing case.
    NOTE.—The main idler gear thrust washer may stick to the timing cover.
13. Remove the oil thrower from the crankshaft and the thrust washer from the main idler gear shaft.

14. Refit the crankshaft nut and rotate the crankshaft until the timing marks on the timing gears are in the positions shown in Fig. 2. Remove the nut.
15. Remove the three Allen screws securing the injection pump drive gear to the pump camshaft and withdraw the drive gear.
16. Remove the securing nuts and withdraw the injection pump from the timing case.

Refitting

17. Reverse the procedure 1 to 16, noting:
    a. Refer to Data for torque wrench settings.
    b. Disengage the main idler gear, fit the injection pump drive gear and cap to the pump camshaft, aligning the slot in the gear with the pin on the shaft. Secure the gear with the Allen screws. Engage the main idler gear so that the timing marks are positioned as shown in Fig. 2.
    c. Fit the main idler gear thrust washer with its grooved side towards the gear.
    d. Fit the crankshaft oil thrower with its chamfered face towards the gear.
    ●*e.* Apply sealing compound to both sides of the sump gasket.●
    ●*f.* Position the alternator (or dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).
    g. Check the injection pump timing as follows:
        i. With No. 1 piston at the beginning of its compression stroke, insert timing pin AMK 9990 through the hole in the flywheel housing, and into the hole in the flywheel.
        ii. If necessary, maintain a light pressure on the timing pin and turn the crankshaft in its normal direction of rotation until the timing pin engages the hole in the flywheel.
        iii. Remove the tractometer drive housing from the pump. Fit timing pointer 18G 1114 to the pump camshaft and check that the pointer aligns with the timing mark on the pump body, refer to Fig. 3. If necessary, slacken the Allen screws securing the drive gear to the pump camshaft and rotate the camshaft until the tool and mark are aligned. Tighten the ●drive gear Allen screws and remove the timing pointer. Refit the tractometer drive housing.●
        iv. Remove the timing pin AMK 9990.
    h. ●Bleed the fuel system.

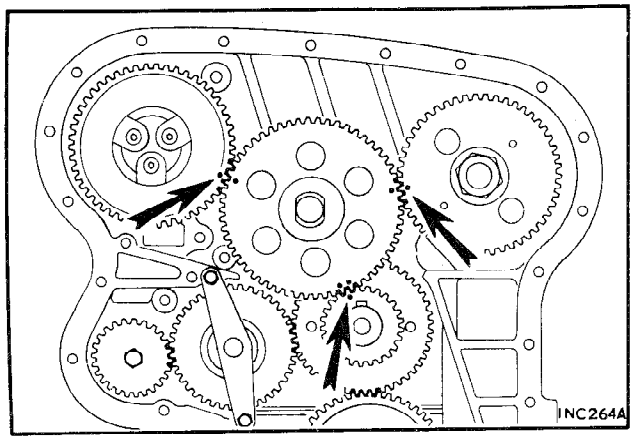


Fig. 2

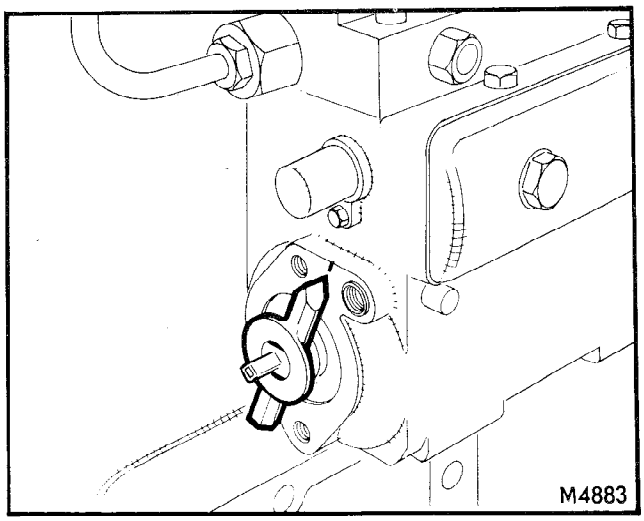


Fig. 3

Data

Torque wrench settings for:	
●Crankshaft nut	34·5 to 38 kgf m (250 to 275 lbf ft)●
Fan and water pump pulley bolts	2·7 kgf m (20 lbf ft)
●Sump gasket sealing compound	Hylomar or Wellseal●

Section B13

PISTON AND CYLINDER LINER

Removing

1. Remove the rocker cover.
2. Remove the bolts from the rocker shaft brackets and remove the rocker shaft assembly.
3. Withdraw the push-rods.
4. Remove the fuel lift pump delivery pipe from the lift pump and fuel filters. Disconnect the injection pump supply and return pipes and constant bleed pipe from the fuel filters and remove the filters and mounting bracket.
5. Remove the bolts securing the injector spill rail to the injectors. Remove the rail.
6. Remove the hose from between the water pump and thermostat housing.
7. Remove the brackets retaining the injector high-pressure feed pipes.
8. Remove the high-pressure feed pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
9. Remove the injectors and discard their copper sealing washers.
10. Disconnect the cylinder head oil feed pipe banjo unions from the cylinder head and crankcase, and remove the pipe.
11. Remove the nuts securing the cylinder head and lift the cylinder head clear of the studs.
12. Lift the cylinder head gasket from the two locating roll-pin dowels and cylinder block studs. On early engines, unscrew the two locating dowels from the cylinder block face and remove the gasket.
13. Withdraw the dipstick and remove the sump.

●*Six-cylinder engine:*

If No. 1, 2 or 3 piston (or cylinder liner) is to be removed complete operation 14, but omit operations 15 to 23.

14. Release the oil pump delivery pipe from the crankcase, remove the front main bearing nuts and withdraw the oil pump, noting:
    a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
    b. Shims are inserted between the oil pump and the main bearing cap.

Four-cylinder engine:

If No. 1, 2 or 3 piston (or cylinder liner) is to be removed complete operations 15 to 23.

15. Remove the balancer drive gear from the drive shaft, using tool 18G 2.
16. Remove the two bolts and disconnect the oil delivery pipe from the balancer.
17. Remove the five bolts and remove the balancer rear cover.

    NOTE.—The balance gear screws are secured by Loctite adhesive.
18. Remove the screws securing the right-hand balance gear to the drive shaft.

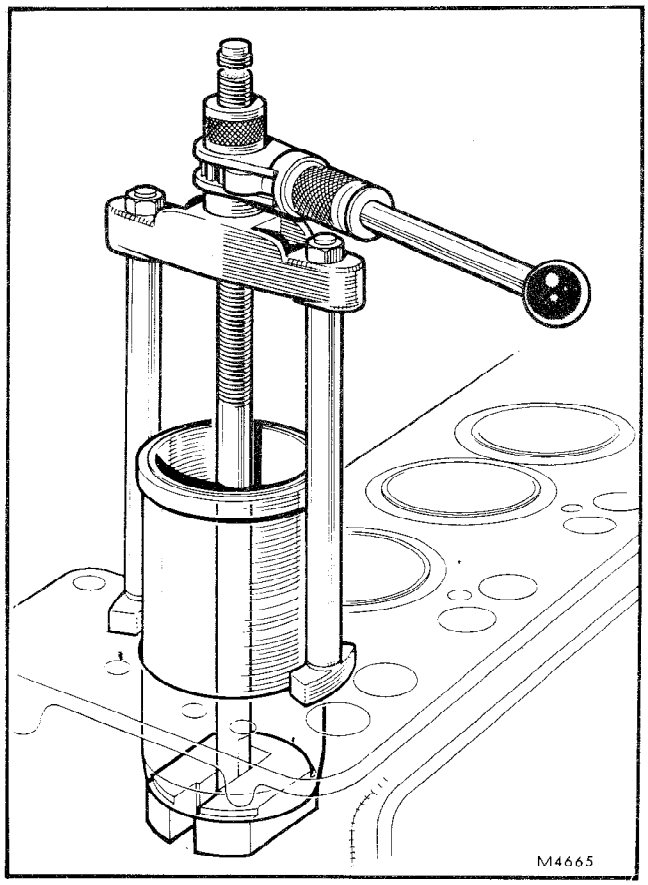


Fig. 1

19. Remove the drive shaft and remove the right-hand balance gear and its thrust washers.
20. Remove the front main bearing nuts and withdraw the oil pump, using tool 18G 1185, noting:
    a. The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap.
    b. Shims are inserted between the oil pump and the bearing cap.
21. Remove the screws securing the left-hand balance gear to the driven shaft.
22. Withdraw the driven shaft and remove the left-hand balance gear and its thrust washers, noting that the dowel bolt holes are situated towards the rear end of the shaft.
23. Remove the two nuts and withdraw the balance gear housing, noting:
    a. The balancer mounting studs are also the mounting location for No. 3 main bearing cap. ●
24. Remove the connecting rod cap and withdraw the piston through the top of the cylinder block.
25. Withdraw the cylinder liner from the top of the cylinder block, using tool 18G 227 E, refer to Fig. 1.
26. Remove the cylinder liner sealing rings from the grooves in the cylinder block.

Refitting

27. Insert the liner into the cylinder block without its sealing rings.
28. Clamp the liner into the cylinder block and check the cylinder liner standing height, refer to Data. If necessary, correct the standing height by fitting shims under the liner flange.
29. Remove the liner and fit new sealing rings in the cylinder block.
30. Refit the liner and check its bore. If ovality exceeds the figure given in Data, renew the liner and sealing rings.
31. Reverse the procedure 1 to 24 as necessary, noting:
    a. Lubricate the bore of the cylinder liner, piston and crankshaft bearing surfaces with engine oil.
    b. Refer to Data for torque wrench settings.
    c. Use tool 18G 55 A to compress the piston rings.
    d. The top of the piston, connecting rod cap and the right-hand side of the crankcase are reference marked for correct assembly.

● *Four-cylinder engines only complete operations e, f, and g:*

    e. Renew the balancer 'O' ring seals.
    f. Refit the balancer gears with the thrust washers on both sides of the gears, and with the timing marks aligned as shown in Fig. 4. Apply Loctite to the gear securing screw threads.
    g. Ensure that the oil pump gear is correctly aligned to the crankshaft and balancer gears, as shown in Fig. 5.
    h. Ensure that the oil pump gear back-lash is as stated in Data.
    i. Apply sealing compound to both sides of the sump gasket.
    j. Fit a new cylinder head gasket with the side marked 'HEAD FACE' to the cylinder head.
    k. Fit new injector sealing washers.
    l. Tighten the cylinder head nuts in the order shown in Fig. 2 or Fig. 3.
    m. Adjust the valve/rocker clearance (refer to **'MAINTENANCE'**) to the figure given in Data.
    n. Bleed the fuel system. ●

    Important. To ensure a satisfactory cylinder head to block seal, it is imperative that the procedure detailed below be followed.

● *o.* Run the engine until it reaches its normal working temperature, then run it for a further half-hour. Stop the engine and slacken, then tighten, to the correct torque, each cylinder head nut one flat in the sequence shown in Fig. 2 or Fig. 3. ●

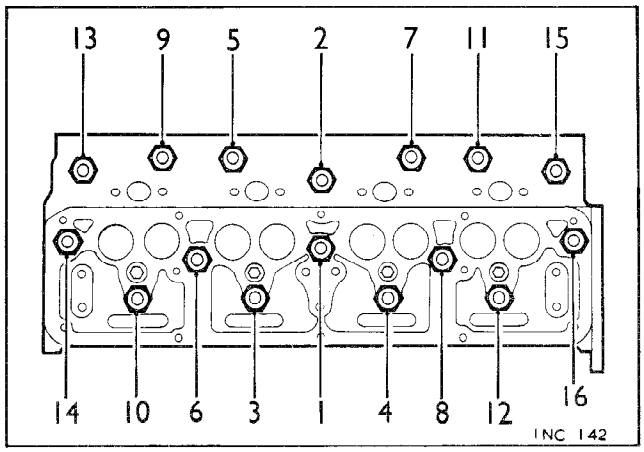


Fig. 2

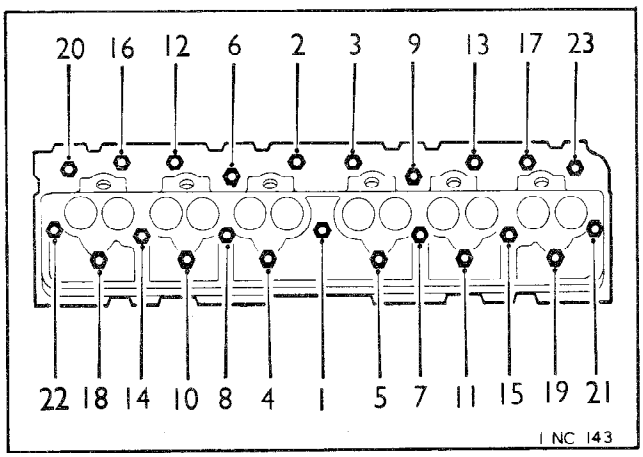


Fig. 3

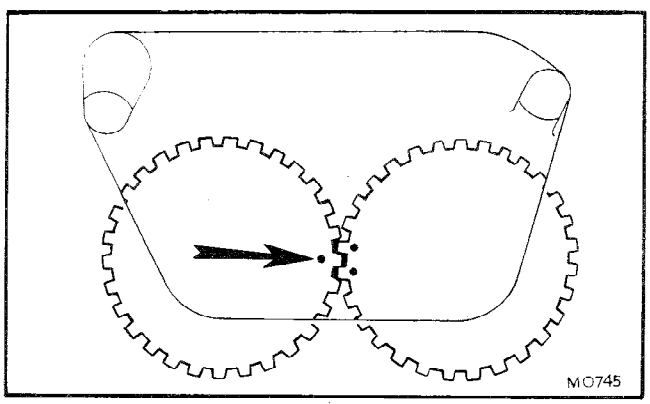


Fig. 4

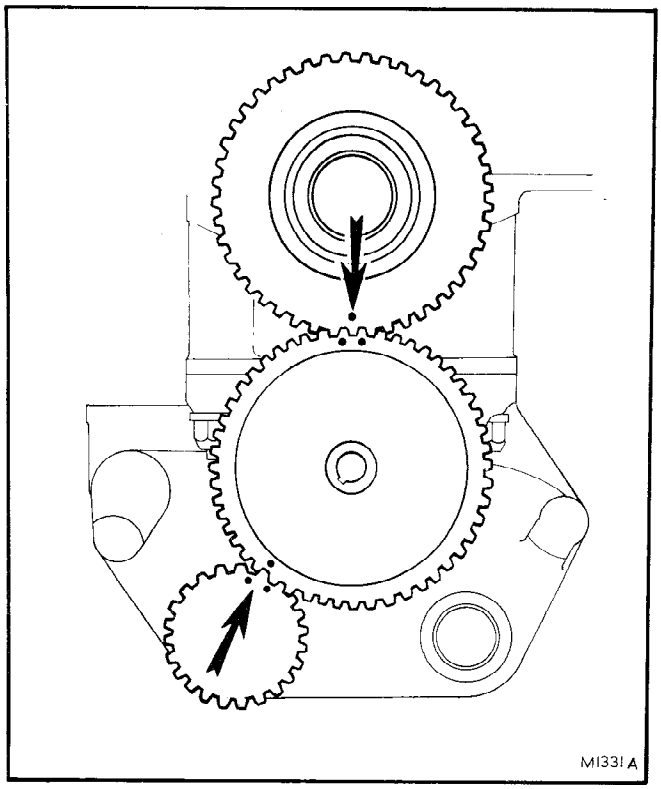


Fig. 5

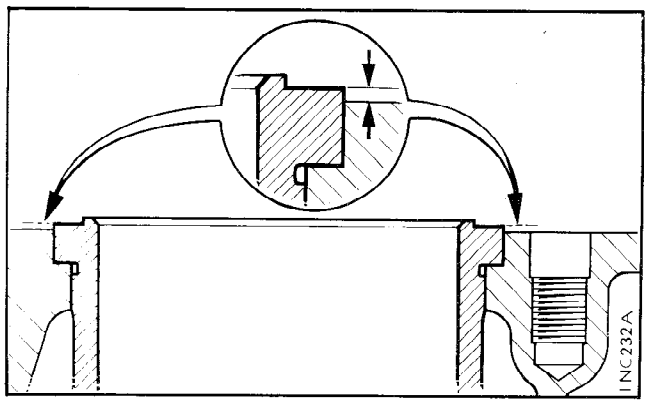


Fig. 6

Data

●Cylinder liner standing height (refer to Fig. 6):●
0·07 to 0·15 mm (0·003 to 0·006 in)

Method of adjustment	Shims under liner flange
Shim thicknesses	0·076, 0·101, 0·127 mm (0·003 in, 0·004 in, 0·005 in)
●Piston crown height (at T.D.C.) to cylinder block top face	0·30 to 0·61 mm (0·012 to 0·024 in)●
Permissible cylinder liner ovality	0·050 mm (0·002 in)
Torque wrench settings for:	
Connecting rod bolts	8·3 kgf m (60 lbf ft)
Cylinder head nuts	13·8 kgf m (100 lbf ft)
Main bearing nuts	13·8 kgf m (100 lbf ft)
Injector securing bolts	1·65 kgf m (12 lbf ft)
Rocker bracket bolts:	
$\frac{5}{16}$ in diameter	2·1 kgf m (15 lbf ft)
$\frac{3}{8}$ in diameter	4·1 kgf m (30 lbf ft)
Valve/rocker clearance (engine hot or cold):	
Inlet and exhaust	0·33 mm (0·013 in)
Oil pump drive gear back-lash	0·08 to 0·15 mm (0·003 to 0·006 in) between teeth of oil pump drive gear and crankshaft gear
Back-lash adjustment	Fit selective shims between oil pump and No. 1 main bearing cap
●Sump gasket sealing compound	Hylomar or Wellseal●

Section B14

INJECTOR SLEEVE

Removing

1. Disconnect the spill rail from the injectors.
2. Disconnect the high-pressure pipe from the injector.
3. Remove the securing bolts and withdraw the injector.
4. Insert the sealing plug of tool 18G 213 A into the injector sleeve, then use the remainder of the tool to cut a thread in the sleeve (refer to Fig. 1).
5. Using tool 18G 213 D (refer to Fig. 2) extract the injector sleeve from the cylinder head and remove the sealing plug for future use.

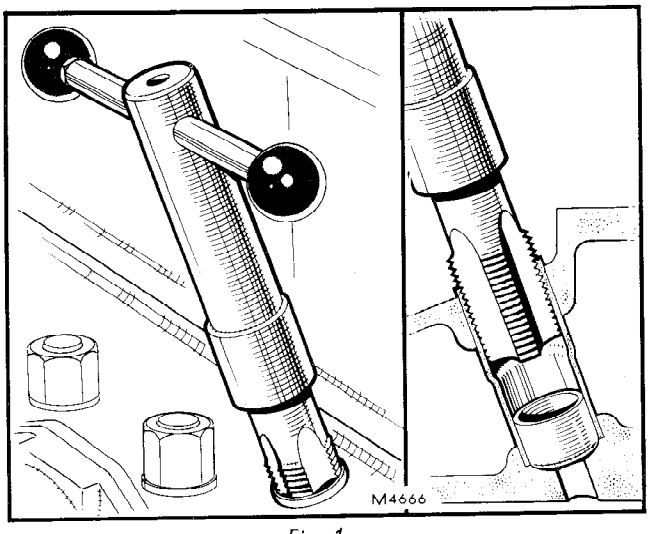


Fig. 1

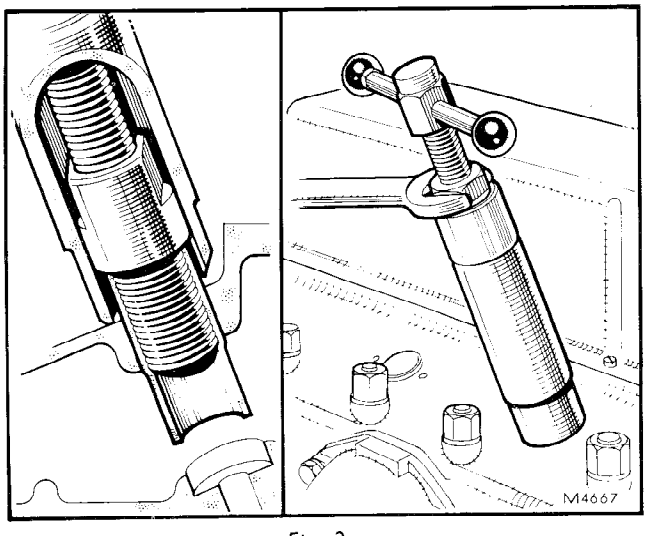


Fig. 2

Refitting

6. Position the piston at the bottom of its stroke.
7. Push the injector sleeve into position.
8. Insert tool LC 173 into the injector sleeve. Withdraw the tool approximately 6·4 to 9·5 mm ($\frac{1}{4}$ to $\frac{3}{8}$ in), then expand the top portion of the injector sleeve into the cylinder head by applying pressure and a clockwise rotary motion to the expander rod until it reaches the limit of its travel. Withdraw the tool using an anti-clockwise rotary motion (refer to Fig. 3).
9. Using the same procedure employed for the top portion, expand the bottom portion of the injector sleeve, using tool LC 174 (refer to Fig. 4).
10. Reverse the procedure 1 to 3, noting:
    a. Fit a new injector sealing washer.
    b. Refer to Data for torque wrench setting.
    c. Bleed the injector feed pipe.

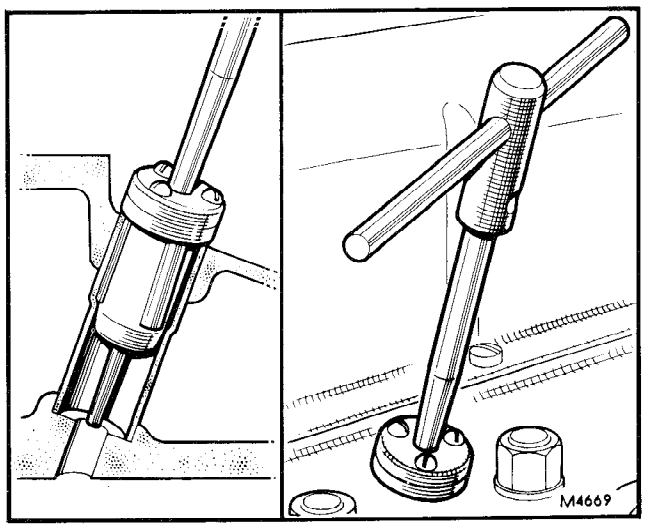


Fig. 3

Data

Torque wrench setting for injector securing bolts:
1·65 kgf m (12 lbf ft)

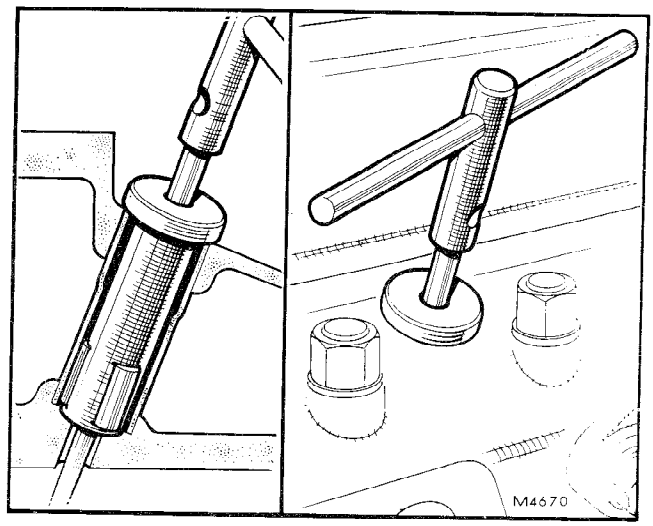


Fig. 4

C

OVERHAULING

Section C1

VALVE ROCKER SHAFT

1. Remove the rocker shaft locating screws.
2. Separate the rocker shafts and slide the components off the individual shafts.
   NOTE.—The plugs can be unscrewed from the outer ends of the shafts for cleaning the internal oilways.
3. Check the clearance of the rockers on the shafts against the figures in Data.
4. *Four-cylinder engine:*
   Assemble the rocker shaft components in the order shown in Fig. 1, noting:
   a. Refer to Data for the positions of the distance collars.
   b. Ensure that the locating screws engage the holes in the rocker shafts.
5. *Six-cylinder engine:*
   Assemble the rocker shaft components in the order shown in Fig. 2, noting:
   a. Refer to Data for the positions of the distance collars.
   b. Ensure that the unplugged shaft is fitted in the centre position.
   c. Ensure that the locating screws engage the holes in the rocker shafts.

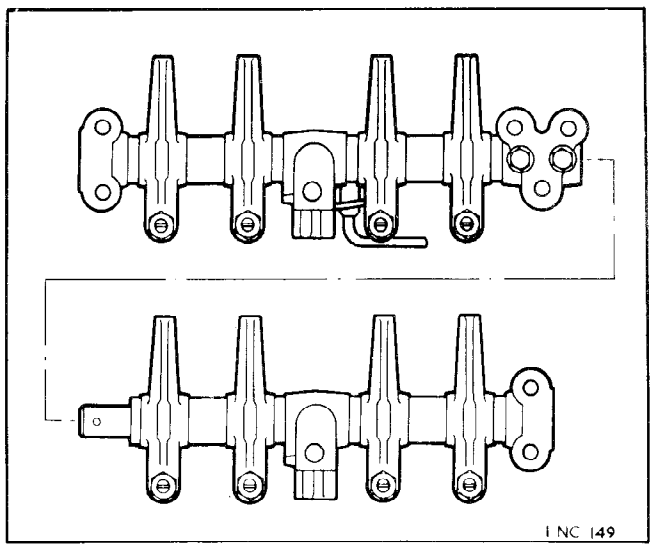


Fig. 1

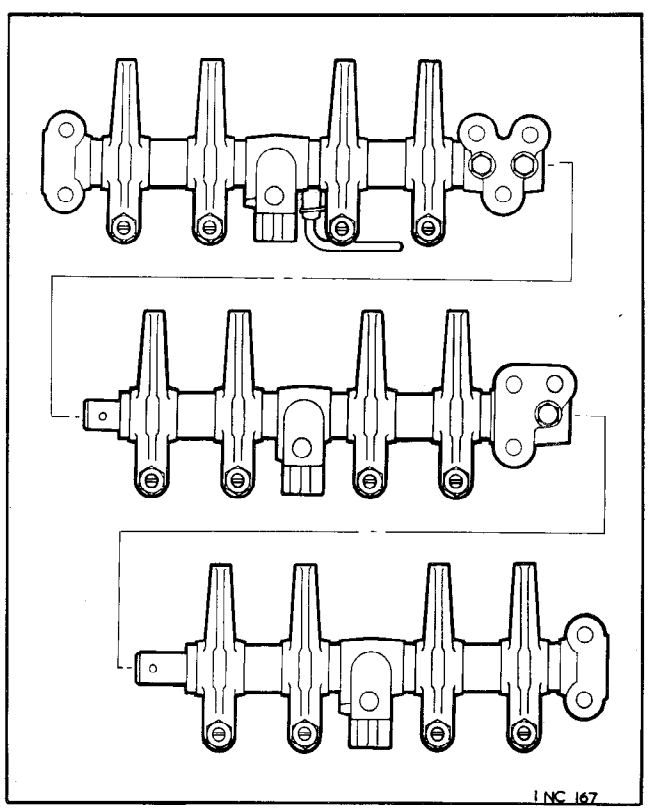


Fig. 2

Data

Rocker shaft diameter	18·229 to 18·242 mm (0·7177 to 0·7182 in)
Rocker to rocker shaft clearance	0·025 to 0·064 mm (0·001 to 0·0025 in)
Rocker shaft distance collar thickness:	
Four-cylinder engine:	
Between each pair of rockers	20·46 to 20·64 mm (0·8055 to 0·8125 in)
Between each rocker and bracket	6·17 to 6·35 mm (0·243 to 0·250 in)
Six-cylinder engine:	
Between each pair of rockers	20·46 to 20·64 mm (0·8055 to 0·8125 in)
Between rockers and centre bracket	8·64 to 8·71 mm (0·340 to 0·343 in)
Between rockers and remaining brackets	6·17 to 6·35 mm (0·243 to 0·250 in)

Section C2

CONNECTING ROD AND PISTON

1. Separate the connecting rod from the piston.
2. Check the gudgeon pin clearance in the little-end bush. If the clearance is greater than the maximum stated in Data, renew the bush. Ensure that the oil hole in the new bush aligns with the oil hole in the connecting rod. Press the bush in the connecting rod, using tool 18G 616.
3. Check the piston ring groove clearance and the piston ring gap. To measure the ring gap remove the rings from the piston and enter each ring in turn in the cylinder liner bore, using the piston to position the ring square, then measure the gap. Refer to the dimensions in Data. It should be noted, however, that when measuring the ring gap in a worn cylinder liner any carbon deposit in the bore must be carefully removed and the ring gap measured with the ring positioned at the extreme top of the bore.
4. Renew the rings, or piston and rings, as necessary, noting:
   a. Fit Nos. 2 and 3 piston rings with the side marked 'TOP' uppermost.
5. Assemble the piston to the connecting rod with the valve clearance recesses to the cap side of the connecting rod as shown in Fig. 1.

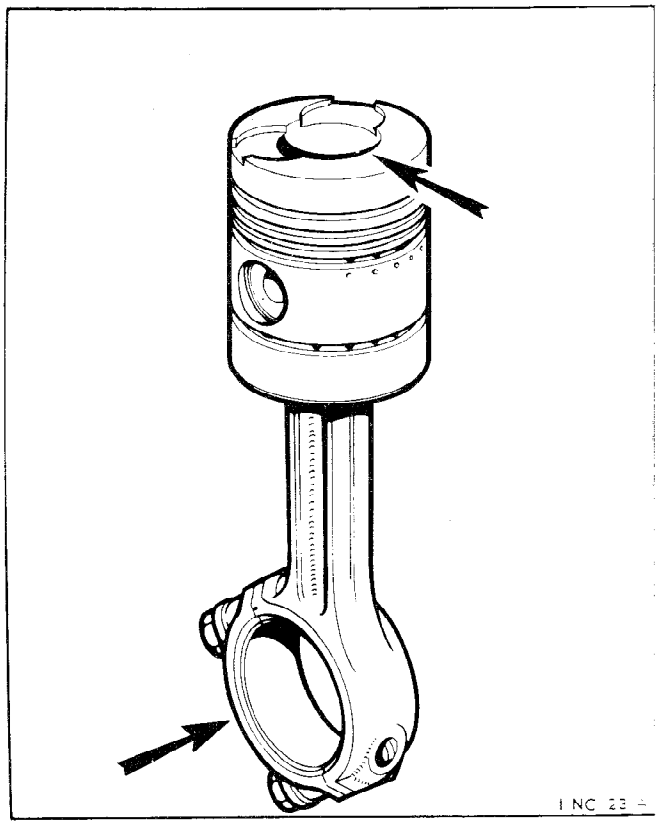


Fig. 1

Data

Gudgeon pin:	
Clearance in little-end bush	0·013 to 0·033 mm (0·0005 to 0·0013 in)
Fit in piston	0·005 mm (0·0002 in) interference to 0·006 mm (0·00025 in) clearance
Connecting rod alignment:	
Maximum out-of-parallel of big and little-end bores	0·0001 cm per cm (0·0001 in per inch) effective mandrel length
Piston ring/groove clearance:	
No. 1—compression	0·08 to 0·13 mm (0·003 to 0·005 in)
Nos. 2 and 3—compression	0·05 to 0·10 mm (0·002 to 0·004 in)
Oil scraper	0·05 to 0·10 mm (0·002 to 0·004 in)
Piston ring gap (new rings and liner) *:	
No. 1—compression	0·36 to 0·51 mm (0·014 to 0·020 in)
Nos. 2 and 3—compression	0·28 to 0·41 mm (0·011 to 0·016 in)
Oil scraper	0·28 to 0·41 mm (0·011 to 0·016 in)

* For a worn liner 0·064 mm (0·0025 in) should be added to the above ring gap clearances for every 0·025 mm (0·001 in) increase in bore diameter above 97·99 mm (3·858 in) the new liner bore minimum diameter.

●Section C3

CYLINDER LINER

Data

New cylinder liner bore diameter	97·99 to 98·02 mm (3·8583 to 3·8591 in)
Maximum worn cylinder liner diameter	98·17 mm (3·8651 in)
Maximum worn cylinder liner taper (over ring-pack travel)	0·10 mm (0·004 in)
Maximum worn cylinder liner ovality (over ring-pack travel)	0·05 mm (0·002 in)●

●Section C4●

CYLINDER HEAD

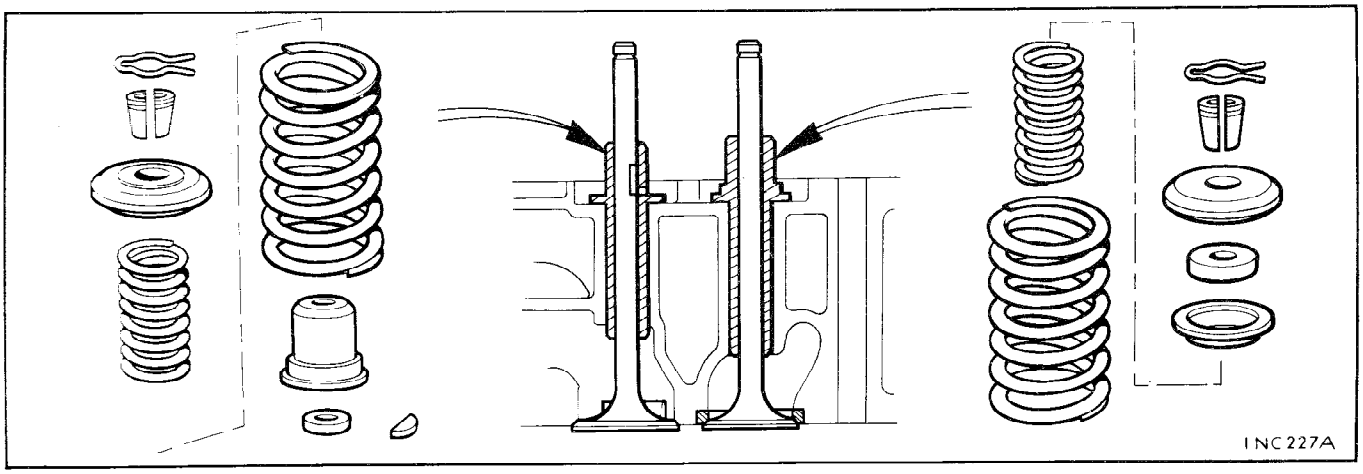


Fig. 1

1. Detach the spring clips from the valve cotters.
2. Remove the valves and their components, using tool 18G 106 to compress the valve springs.
3. Check the cylinder head face for flatness. If necessary re-surface the face, referring to Data for the necessary dimensions.
4. Renew the valve springs if they are not as specified in Data.
5. If the valve guides are worn, drive them out through the upper face of the cylinder head, using tool 18G 228. Ensure that the slot in the flange of each new inlet guide engages its locating peg in the cylinder head, and that the valve seats are concentric with the bores of the new guides.
6. If necessary, regrind the valves to the angle given in Data and re-face the valve seats using the tools listed in **'SERVICE TOOLS'.**
7. Lap the valves to their seats, using tool 18G 29.
8. Check the valve head stand-proud (refer to Data). If the stand-proud is less than the minimum allowed, even with a new valve fitted:

●*a.* *Exhaust valves.* Extract the seat insert using tools 18G 284 and 18G 284 AAH. Fit a new insert using tool LC 176.

b. *Inlet valves.* Extract the exhaust valve seat inserts, using tools 18G 284 and 18G 284 AAH. Skim the cylinder head face, maintaining minimum head depth as specified in Data. Machine the exhaust valve insert bore depth to maintain insert stand-down as specified in Data. Fit new exhaust valve seat inserts using tool LC 176 and re-face the inlet valve seats; refer to Data for machining dimensions and to **'SERVICE TOOLS'** for tools required.●

9. Renew the valve stem oil seals, align the flat in the inlet valve stem with the slot in the guide, fit the key, then assemble the valve components to the cylinder head as shown in Fig. 1.

Data

Cylinder head:

Maximum permissible bow:	
Longitudinal, transverse and diagonal	0·025 mm per 304 mm (0·001 in per ft)
Valve stand-proud	1·6 to 1·8 mm (0·062 to 0·072 in)
Valve seat angle	45°
Valve seat face width (at 45°)	1·40 to 1·78 mm (0·055 to 0·070 in)
Valve port nominal diameters:	
Inlet	40·39 mm (1·590 in)
Exhaust	34·54 mm (1·360 in)
Minimum cylinder head depth after machining	90·1 mm (3·55 in), i.e. 0·76 mm (0·020 in) maximum skim
Injector nozzle protrusion after machining	3·99 to 4·17 mm (0·157 to 0·164 in)
Valve seat insert (refer to Fig. 2):	
A. Insert bore depth	5·72 to 6·60 mm (0·225 to 0·260 in)
B. Insert bore diameter	41·33 to 41·36 mm (1·6275 to 1·6285 in)
C. Radius at bottom of insert bore	0·13 to 0·18 mm (0·005 to 0·007 in)
D. Insert stand-down	0·13 to 0·33 mm (0·005 to 0·013 in)

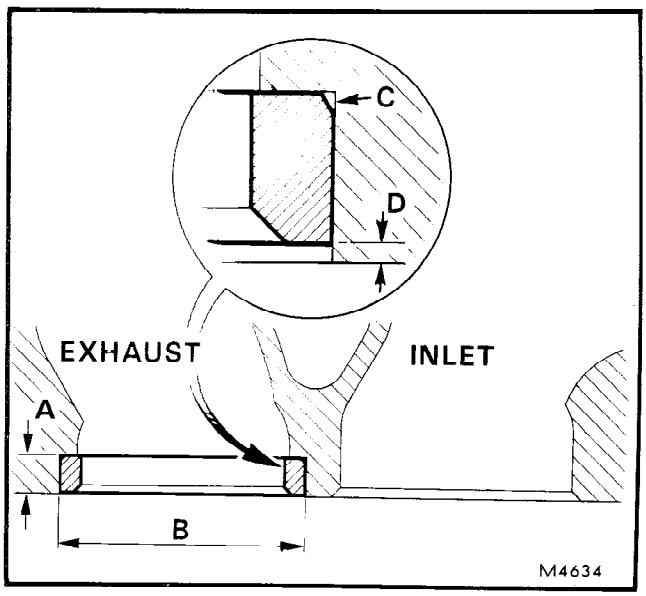


Fig. 2

	Inner	*Outer*
Valve springs		
Free length	45·72 mm (1·8 in)	57·15 mm (2·25 in)
Fitted length (valve open)	29·56 mm (1·164 in)	36·70 mm (1·445 in)
Load at fitted length (valve open)	18·14 kgf (40 lbf)	40·82 kgf (90 lbf)
Valves		
Valve stem to guide clearance	0·025 to 0·064 mm (0·001 to 0·0025 in)	
Valve seat angle	45°	

●Section C5●

TAPPETS

Data

Tappet diameter	28·536 to 28·556 mm (1·12350 to 1·12425 in)
Clearance in guide	0·013 to 0·058 mm (0·0005 to 0·0023 in)

●Section C6●

MAIN IDLER GEAR

1. If the idler gear bush is worn (refer to Data) renew the bush, using tool 18G 683.
2. Broach the new bush to size, using the broach of tool 18G 683 liberally lubricated with clean paraffin (kerosene).

Data

Idler gear shaft diameter	28·65 to 28·67 mm (1·1235 to 1·1240 in)
Idler gear bush to shaft clearance	0·025 to 0·050 mm (0·001 to 0·002 in)

●Section C7●

FLYWHEEL

1. If the teeth on the starter ring are worn or damaged, remove the starter ring by drilling a hole in the ring, then splitting the ring across the hole using a hammer and chisel.
2. Heat the new starter ring uniformly to the temperature specified in Data.
3. Fit the starter ring with its bore chamfer to the flange of the flywheel and allow it to cool naturally.

Data

Starter ring fitting temperature	275°C (527°F)

●Section C8●

CRANKSHAFT

Data

Diameters:	
Journals	82·53 to 82·55 mm (3·249 to 3·250 in)
Crankpins	66·66 to 66·67 mm (2·6245 to 2·6250 in)
Clearances:	
Journals in main bearings	0·07 to 0·10 mm (0·003 to 0·004 in)
Crankpins in big-end bearings	0·04 to 0·08 mm (0·0015 to 0·0030 in)
Crankshaft end-float	0·20 to 0·38 mm (0·008 to 0·015 in)
●End-float adjustment	Fit new thrust washers●
Thrust washer thickness (new)	2·31 to 2·36 mm (0·091 to 0·093 in)
Undersizes (journals and crankpins):	
First	—0·381 mm (—0·015 in)
Second	—0·762 mm (—0·030 in)
Third	—1·143 mm (—0·045 in)

NOTE.—98 mm engine crankshafts are identified by a groove in the end face at the flywheel end.

●Section C9●

CAMSHAFT

Data

Journal diameters:	
No. 1	50·72 to 50·74 mm (1·997 to 1·998 in)
Remainder	47·52 to 47·54 mm (1·871 to 1·872 in)
Journal clearances in bearings:	
No. 1 (bush)	0·04 to 0·10 mm (0·0015 to 0·0040 in)
Remainder	0·07 to 0·12 mm (0·00275 to 0·00475 in)
End-float (controlled by thrust plate)	0·05 to 0·30 mm (0·002 to 0·012 in)
End-float adjustment	Renew thrust plate
Thrust plate thickness	7·14 to 7·24 mm (0·281 to 0·285 in)

●Section C10●

OIL PUMP

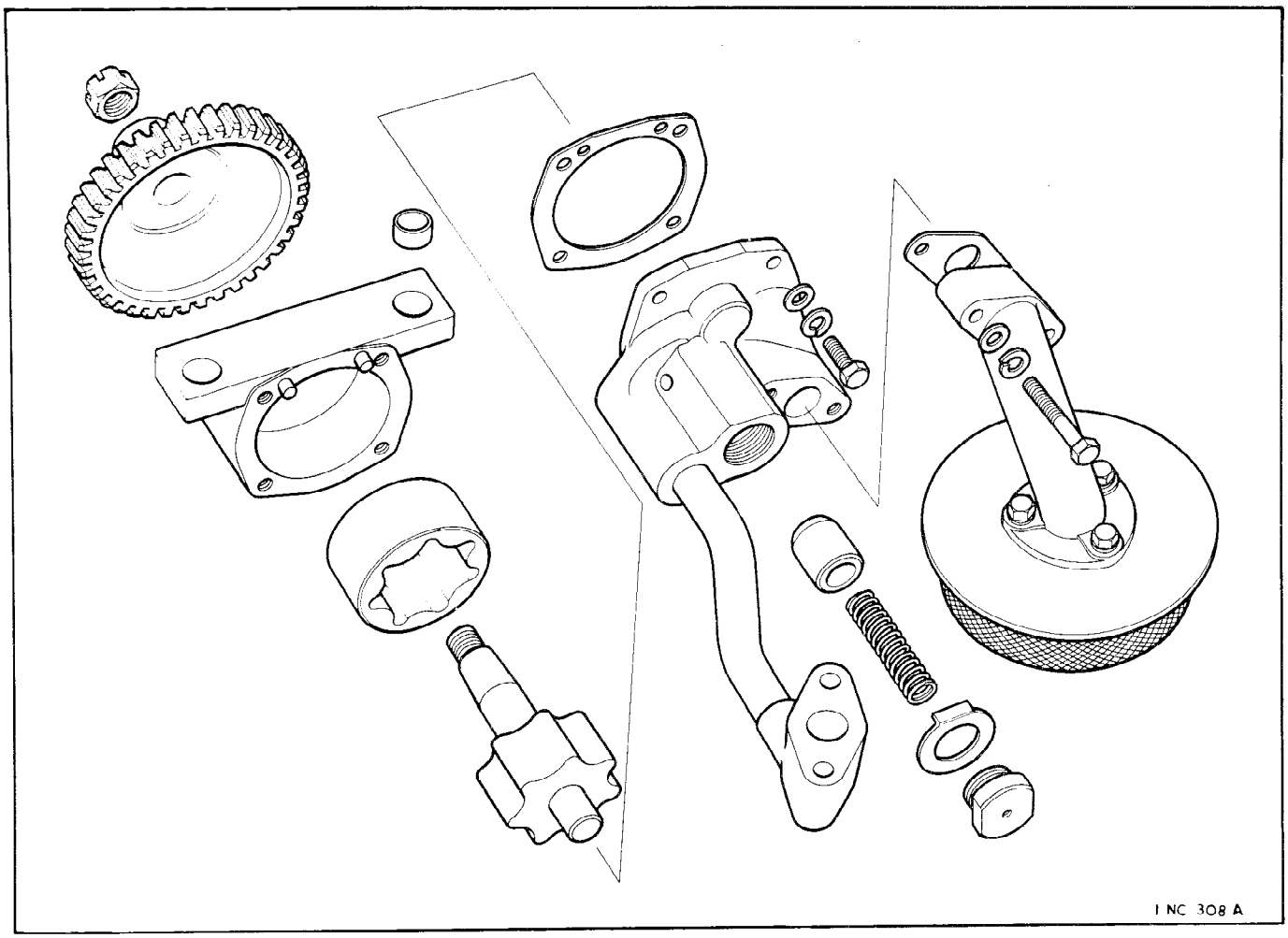


Fig. 1

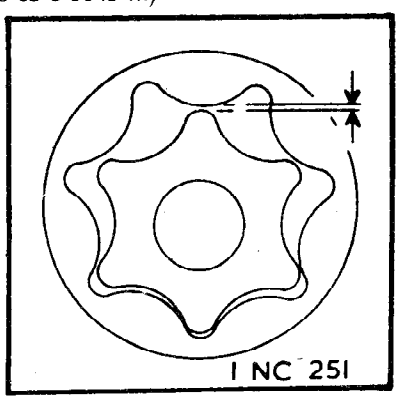
1. Withdraw the oil delivery pipe and its sealing ring from the oil pump body.
2. Remove the oil suction pipe and strainer.
3. Release the lock washer and remove the oil-pressure relief plug, spring, and valve from the pump body. Check the spring free length; renew if not as specified in Data.

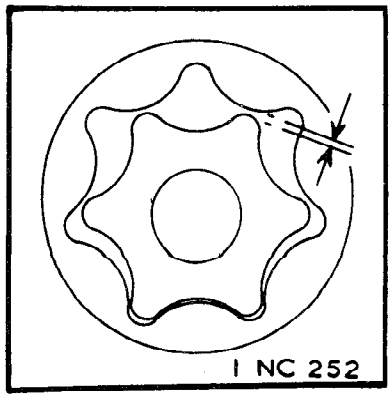
●4. Remove the oil pump drive gear, and, for early engines, remove the key.●

5. Remove the pump cover and withdraw the rotors.
6. Check the rotors, and renew if not as specified in Data.
7. Assemble the oil pump, ensuring that the chamfered edge of the outer rotor is innermost in the pump body, and renewing the oil delivery pipe sealing ring.
8. Test the pump to ensure that its performance is not below the figures specified in Data.

Data

Rotor end-float	0·05 to 0·11 mm (0·0020 to 0·0045 in)
Rotor lobe clearance:	0·203 mm (0·008 in) minimum





Rotor lobe clearance	0·152 mm (0·006 in) maximum
Relief valve spring free length	57·54 mm (2·265 in)
Load to compress spring to fitted length 50·8 mm (2 in)	5·33 kgf (11·75 lbf)
Delivery capacity	30·7 litres min (6·75 gal/min) at 4·22 kgf/cm² (60 lbf/in²) at 1000 rev min
●Torque wrench setting for oil pump drive gear nut (gear without key)	11·06 kgf m (80 lbf ft)●

●Section C11●

VALVE ROCKER SHAFT OIL PRESSURE RELIEF VALVE

1. Remove the plug from the relief valve body and withdraw the spring, spring seat, and ball.
2. Check the spring and ball, referring to the specifications in Data, and ensure that the ball seat in the valve body is in good condition.
3. Assemble the components in the order shown in Fig. 1, using a new tab washer and new copper washers.

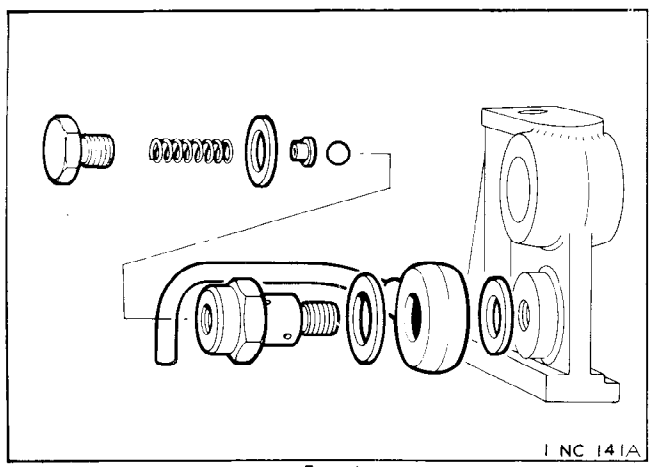


Fig. 1

Data

Spring free length	19 mm (¾ in)
Load to compress spring to 16 mm (⅝ in)	85 gf (3 ozf)
Diameter of ball	6 mm (0·236 in)

●Section C12●

BEARING HOUSING (D.P.A. Injection pump drive)

1. Remove the internal circlip from inside the bearing housing.
2. Press out the two bearings and their spacer.
3. Renew the bearings and/or housing if they are worn or damaged.
4. Refit the bearings, spacer, and circlip.

●Section C13●

BALANCER SUPPORT BRACKET

1. Press out the old bushes from the inside face of the bracket as illustrated in Fig. 1, using tool 18G 1186.
2. Press in new bushes from the inside face of the bracket as illustrated, using tool 18G 1186.
3. The bushes are pre-finished and do not need reaming.

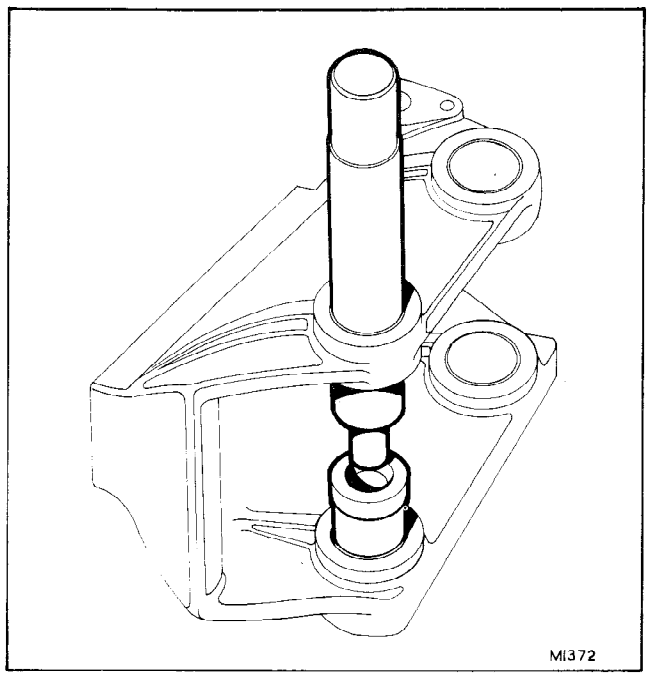


Fig. 1

●DIESEL FUEL SYSTEM●

A TESTING

B REMOVING AND REFITTING COMPONENTS

C OVERHAULING

Section A1

TESTING THE LIFT PUMP

If failure of the lift pump is suspected, the following checks should be carried out.

1. Connect a vacuum gauge to the pump inlet. Operate the priming lever approximately 12 times. A steady vacuum of 25·4 to 38·1 cmHg (10 to 15 inHg) should be obtainable and should hold for several minutes.
2. Connect a pressure gauge to the pump outlet. Operate the priming lever approximately 12 times. A steady pressure of 0·37 kgf/cm² (5·25 lbf/in²) should be obtainable and should hold for several minutes.
3. If a leak is suspected, block the outlet connection with a plug and connect an air supply not exceeding 0·352 kgf/cm² (5 lbf/in²) maximum to the inlet connection. Submerge the pump in a container of fuel; any leaks will be indicated by air bubbles.

B

REMOVING AND REFITTING COMPONENTS

Section B1

BLEEDING THE SYSTEM (D.P.A. Injection Pump)

●**CAUTION.**—The injection pump is lubricated by fuel under pressure; therefore no attempt should be made to bleed the fuel system by towing the vehicle in gear.●

NOTE.—After renewing the fuel filter elements it will only be necessary to carry out procedures 1 and 2 provided the engine has not been cranked while the filters were dismantled.

1. Ensure that there is an adequate supply of fuel in the tank.
2. Slacken the bleed plug in the fuel filter head and operate the lift pump priming lever. Tighten the bleed plug when air-free fuel flows from it.
3. Slacken the vent screws on the injection pump governor and the hydraulic head. Operate the lift pump and when air-free fuel flows from both vent screws, tighten the hydraulic head vent screw followed by the governor vent screw.
4. Slacken the high pressure pipe union on any two injectors and, with the stop control pushed in and the accelerator pedal depressed, motor the engine on the starter motor. Tighten the union nuts when air-free fuel flows from both unions.
5. Start the engine and allow it to run until it is firing on all cylinders.

Section B2

BLEEDING THE SYSTEM (Simms In-line Injection Pump)

NOTE.—After renewing the fuel filter elements it will only be necessary to carry out procedures 1 and 2 provided the engine has not been cranked while the filters were dismantled.

1. Ensure that there is an adequate supply of fuel in the tank.
2. Slacken the leak-off banjo union in the filter head of the main fuel filter. Operate the lift pump and, when the fuel coming from the union is free of air bubbles, tighten the banjo union.
3. Slacken the vent plugs in the injection pump body. Operate the lift pump and, when the fuel coming from the plugs is free of air bubbles, tighten the plugs.
4. Slacken each high-pressure pipe union at its injector in turn. Operate the starter until the fuel coming from the union is free of air bubbles, and tighten the union.
5. Repeat procedure 4 for the remaining injectors.

Section B3

D.P.A. INJECTION PUMP

Removing

1. Remove the fuel delivery and return pipes from between the injection pump and fuel filter.
2. Remove the brackets retaining the injector high-pressure feed pipes.
3. Remove the high-pressure pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
4. Remove the three securing nuts and withdraw the injection pump.

Refitting

5. Reverse the procedure 1 to 4, noting:
   a. Check the position of the injection pump timing pointer as follows:
      i. With No. 1 piston at the beginning of its compression stroke, insert timing pin AMK 9990 through the hole in the lower front face of the flywheel housing and into the hole in the flywheel.
      ii. If necessary, maintain a light pressure on the timing pin and turn the crankshaft in its normal direction of rotation until the timing pin engages the hole in the flywheel.

iii. Using tool 18G 1206 check and, if necessary, adjust the position of the injection pump timing pointer (refer to Fig. 1). Remove the ●timing pin and timing tool.●

●*Procedure using timing gauge MS 67; carry out instructions i and ii above, then proceed as follows:*

i. Remove the scribing arm from timing gauge MS 67 and locate the hexagonal handle through the gauge body so that the corner marked 'O' is in line with the 240° position marked on the gauge body spigot (refer to Fig. 2). Insert the splined end of the gauge into the injection pump drive gear hub and slide the gauge body forward until it abuts the timing case flange then lock in position using the knurled screw.

ii. *Four-cylinder engine:* Check that the timing pointer on the engine aligns with the 15° mark on the scale of the gauge body (refer to Fig. 3).
Six-cylinder engine: Check that the timing pointer on the engine aligns with the 32° mark on the scale of the gauge body.

iii. If necessary, adjust the position of the injection pump timing pointer. Remove the timing gauge and pin.●

b. Fit the injection pump with its scribed timing mark on its mounting flange in line with the timing pointer.

c. Bleed the fuel system.

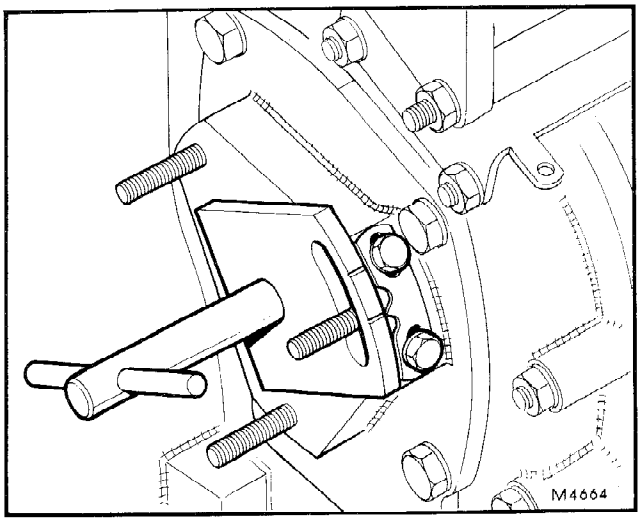
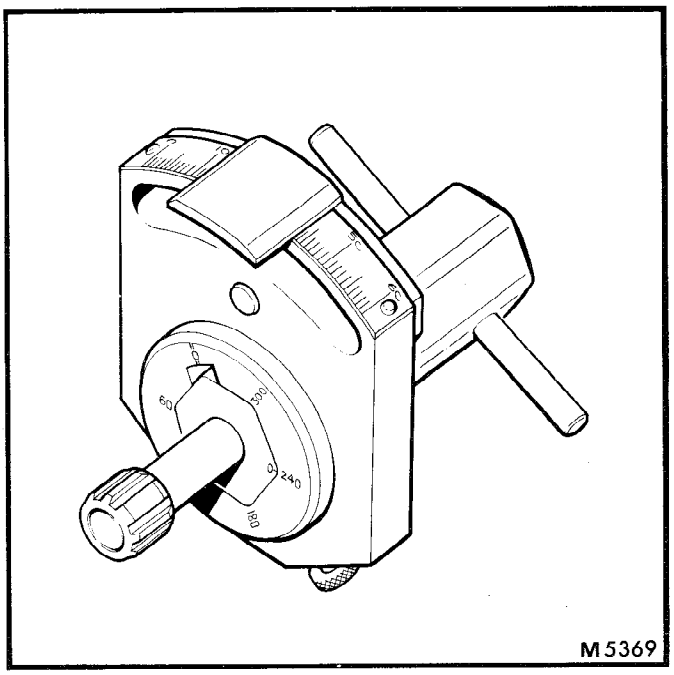
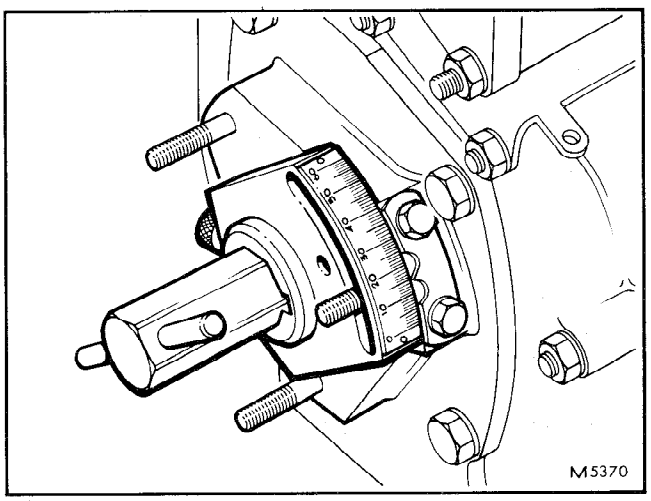


Fig. 1



●*Fig. 2*●



●*Fig. 3*●

Section B4

SIMMS IN-LINE INJECTION PUMP

Removing

1. Remove the fuel delivery pipe from the injection pump and filters.
2. Remove the brackets retaining the injector high-pressure feed pipes.
3. Remove the high-pressure pipes from the injection pump and injectors. Fit protective caps over the threaded ends of the injection pump delivery connections.
4. Disconnect the lubricating oil overflow pipe from the injection pump.
5. Rotate the engine crankshaft until No. 1 piston is on its compression stroke, then insert timing pin AMK 9990 through the hole in the flywheel housing and into the hole in the flywheel.
6. If necessary, maintain a light pressure on the timing pin and turn the crankshaft in its normal direction of rotation until the timing pin engages the hole in the flywheel.
7. Remove the pump drive inspection cover from the timing cover.
8. Scribe a line across the gear cap and timing cover.
9. Remove the Allen screws in the gear cap.
10. Remove the four securing nuts and withdraw the injection pump from the timing case.

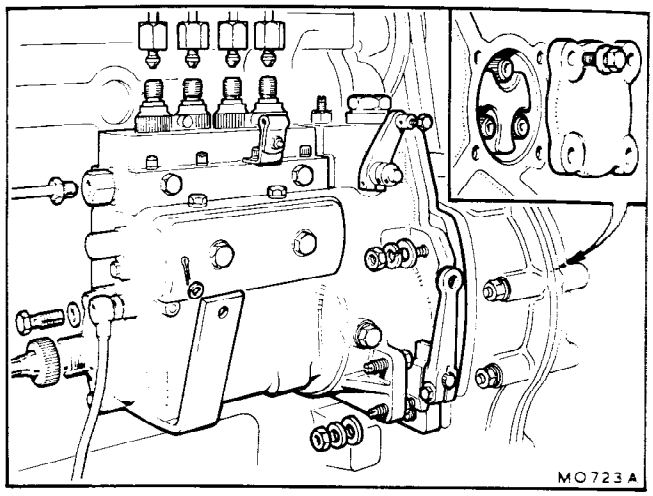


Fig. 1

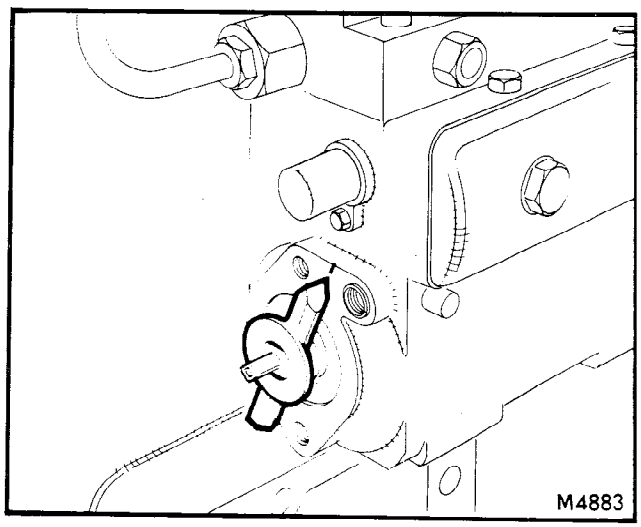


Fig. 2

Refitting

11. With the crankshaft positioned as in procedure 5, align the roll-pin in the injection pump camshaft with the slot in the drive gear hub.
12. Fit the injection pump, engaging the pump camshaft with the drive gear, and tighten the pump mounting nuts.
13. Check the gear cap to cover scribed line to ensure that the drive gear has not moved.
14. Tighten the Allen screws in the gear cap, then slacken them about half a turn.
15. Remove the tractometer drive housing from the pump.
16. Fit timing pointer 18G 1114 to the pump camshaft and rotate the camshaft to align the pointer with the timing mark on the pump body, refer to Fig. 2.
    ●Tighten the drive gear Allen screws and remove the timing pointer.●
17. Refit the lubricating oil overflow pipe.
18. Refit the high-pressure feed pipes and their retaining brackets.
19. Refit the fuel delivery pipe.
20. Refit the tractometer drive housing.
21. Refit the injection pump drive inspection cover.
22. Remove the timing pin AMK 9990.
23. Bleed the fuel system.

Section B5

INJECTORS

Removing

1. Disconnect the spill rail from the injectors.
2. Disconnect the high pressure pipe(s) from the injector(s).
3. Remove the securing bolts and withdraw the injector(s).

Refitting

4. Reverse the procedure 1 to 3, noting:
   a. Fit new injector sealing washers.
   b. Tighten the injector securing bolts to the torque figure given in Data.
   c. *D.P.A. fuel pump:* If all the injectors have been removed, bleed two of the high-pressure pipes, then run the engine until it is firing on all cylinders.
   d. *Simms in-line fuel pump:* Slacken each high pressure pipe union at its injector in turn. Operate the starter until the fuel coming from the union is free of air bubbles, and tighten the union. Repeat the procedure for the remaining injectors.

Data

Torque wrench setting for injector securing bolts	..	1·65 kgf m (12 lbf ft)

FUEL INJECTION EQUIPMENT

NOTE.—Further information and overhaul instructions for fuel injection equipment can be obtained from the maker's local agents (C.A.V./Simms), or from:

C.A.V. & Simms Service
C.A.V. Limited
P.O. Box 36
Warple Way
LONDON W3 7SS

Quote engine and fuel pump type and serial number on application.

C

OVERHAULING

Section C1

LIFT PUMP

1. Scribe an assembly mark across the body joint flanges.
2. Remove the domed cover, sealing ring, and filter gauze.
3. Remove the securing screws and separate the top and bottom halves of the pump.
4. Press the diaphragm lightly downwards, rotate it through 90°, and withdraw the diaphragm and spring.
5. Check the rocker arm pin and linkage for wear or damage. If necessary, secure the rocker arm in a vice and tap the face of the pump mounting flange to dislodge the rocker arm pin and its components. Renew the components as necessary, then assemble the rocker arm, operating link, and packing washers onto the rocker arm pin. Place this assembly, and the rocker arm return spring, in position in the pump body and tap the rocker arm pin retainers fully into their grooves.
6. If the valves require renewing, lever them out carefully. Renew the valve gaskets, press in the new valves and stake them in position.
7. Renew the diaphragm if necessary.
8. Check the diaphragm spring and if it requires renewal ensure that the new spring is of the same colour as the original.
9. Assemble the pump, reversing the procedure 1 to 4.

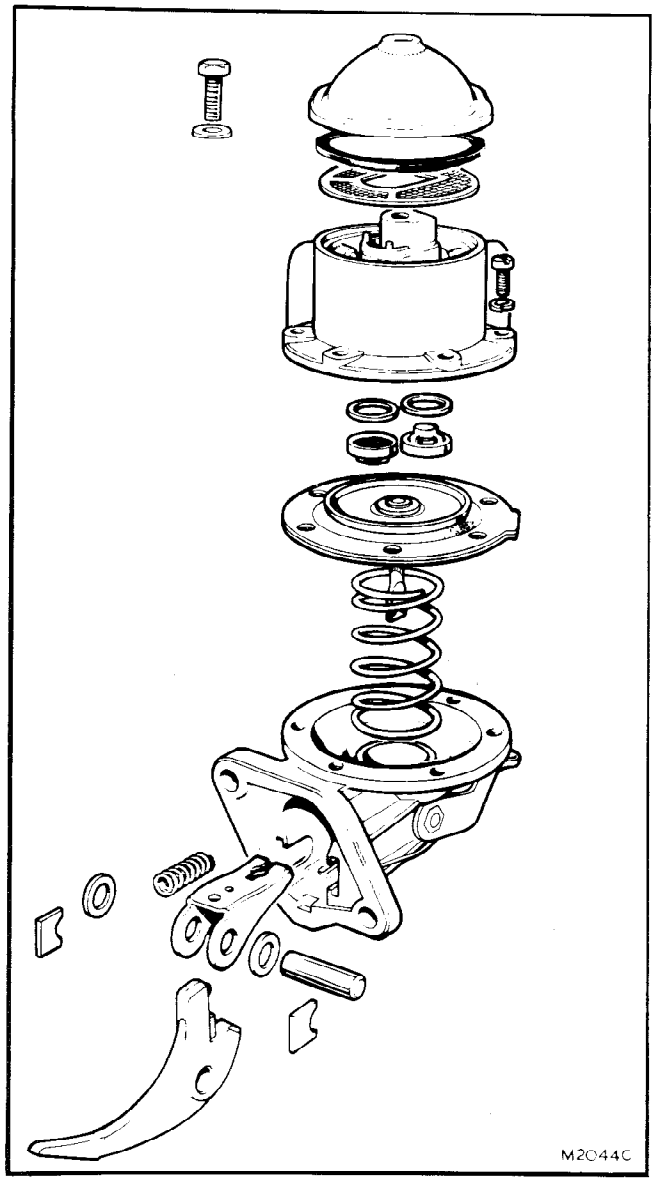


Fig. 1

COOLING SYSTEM

B REMOVING AND REFITTING COMPONENTS

C OVERHAULING

Section B1

THERMOSTAT

Removing

1. Remove the water outlet pipe and gasket.
2. Lift out the thermostat.

Refitting

3. Reverse the procedure 1 and 2, using a new gasket.

Section B2

FAN BLADES, PULLEY, AND WATER PUMP

Removing

1. Release the alternator (or dynamo) and remove the drive belt.
2. Unscrew the bolts securing the fan blades, and remove the fan blades and pulley.
3. Disconnect the hoses from the water pump.
   NOTE.—If renewing the pump impeller or bearing, remove only the front assembly from the pump body, as illustrated in Fig. 1.
4. Remove the bolts retaining the water pump body to the cylinder block and detach the water pump body.

Refitting

5. Reverse the procedure 1 to 4, using a new gasket. Position the alternator (dynamo) to give the correct drive belt tension (refer to **'MAINTENANCE'**).

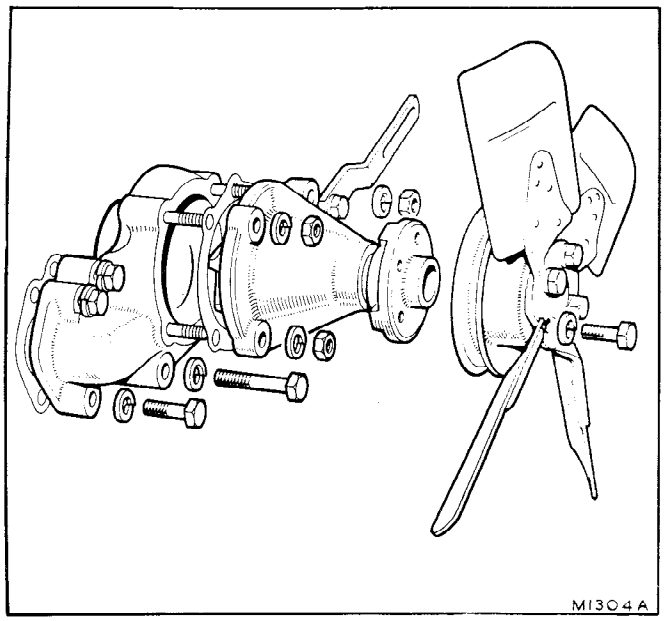


Fig. 1

C

OVERHAULING

Section C1

WATER PUMP

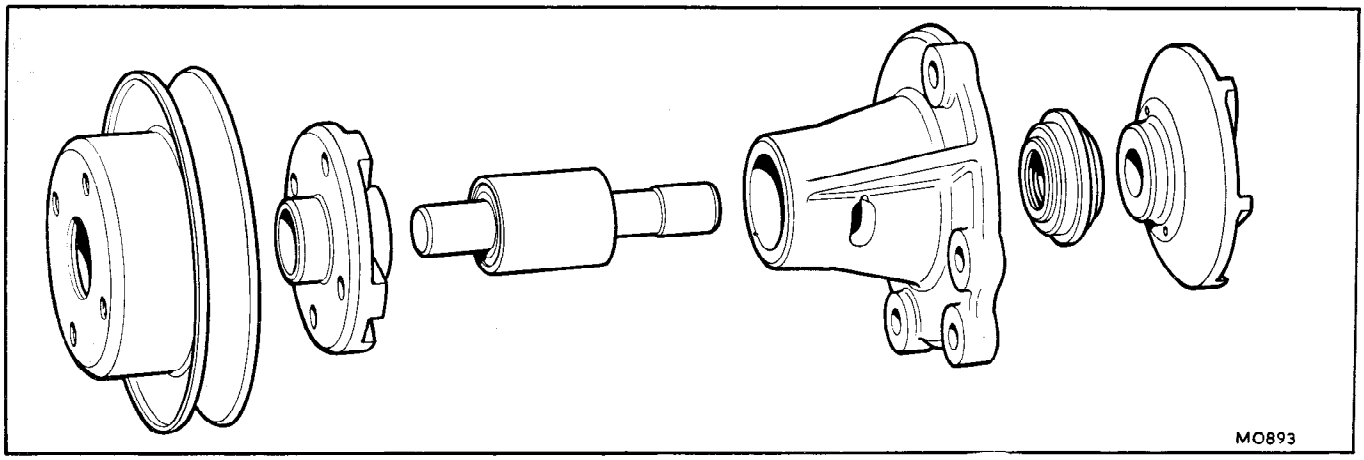


Fig. 1

1. Remove the belt pulley and fan from its hub.
2. Press the spindle (and pump body) out of the pulley hub.
3. Support the pump body and press out the bearing assembly, complete with spindle and impeller, rearwards.
4. Press the spindle and bearing assembly out of the impeller.
5. Remove the water seal from the spindle.
6. Renew any components which are worn or damaged. Renew the bearings as an assembly.
7. Press the bearing assembly into the pump body.
8. Support the spindle and press the pulley hub onto the spindle to the dimension given in Data.
9. Fit the water seal into the pump body, support the spindle and press the impeller onto the spindle to the dimension given in Data.

Data

Spindle diameter	15·91 to 15·92 mm (0·6262 to 0·6267 in)
Impeller bore	15·86 to 15·88 mm (0·6244 to 0·6252 in)
Pulley hub bore	15·85 to 15·87 mm (0·6239 to 0·6247 in)
Bearing assembly diameter	30·01 to 30·02 mm (1·1813 to 1·1818 in)
Body bore	29·99 to 30·00 mm (1·1807 to 1·1811 in)

Assembly dimensions:
A = 18·57 to 18·75 mm (0·731 to 0·738 in)
B = 93·22 to 93·98 mm (3·670 to 3·700 in)

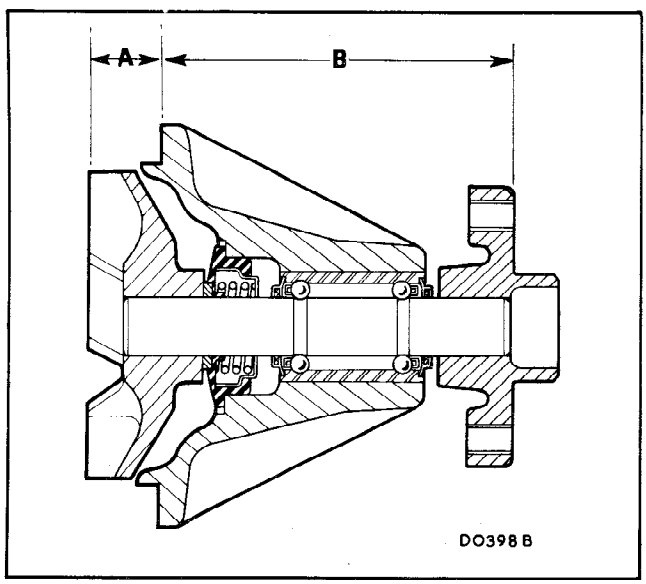


Fig. 2

CLUTCH

C OVERHAULING

Section C1

BORG and BECK SINGLE CLUTCH—28 cm (11 in) and 33 cm (13 in) diameter

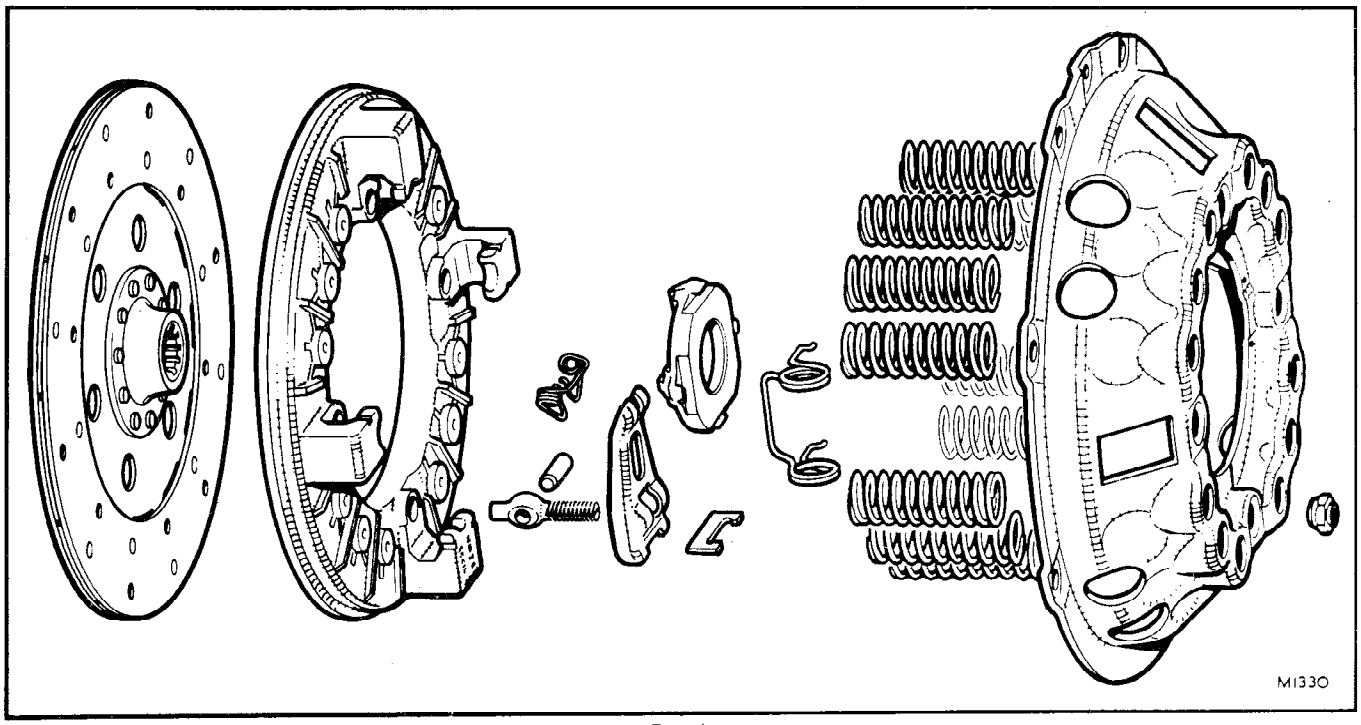


Fig. 1

1. Mark the pressure plate lugs in relation to the clutch cover and the release positions for correct assembly.
2. Compress the pressure springs:
   a. 28 cm (11 in) clutch—use tool 18G 99 A.
   b. 33 cm (13 in) clutch—use tools 18G 99 A and 18G 99 C.
3. Detach the eyebolt adjusting nuts. These are peened over for security.
4. Release the pressure on the springs and lift off the cover.
5. Remove the release lever anti-rattle springs.
6. Lift out the release levers, keeping the eyebolts in position in the pressure plate.
7. Lift out the eyebolts, complete with pins.
8. Examine all components for excessive wear or damage, and renew as necessary.
9. Refit the eyebolts, pins and release levers together with the struts.
10. Renew the pressure springs, if not as specified in Data, as a complete set.
11. Refit the anti-rattle springs and lower the clutch cover over the assembled components.
12. Compress the pressure springs:
    a. 28 cm (11 in) clutch—use tool 18G 99 A.
    b. 33 cm (13 in) clutch—use tools 18G 99 A and 18G 99 C.
13. Refit the adjusting nuts to the eyebolts.
14. Set the release levers at the correct height by use of the adjusting nuts.
    a. 28 cm (11 in) clutch—use tool 18G 99 A.
    b. 33 cm (13 in) clutch—use tools 18G 99 A and 18G 99 C.
15. Peen over the adjusting nuts to lock them in position.
16. Refit the release lever plate.
17. Examine the release bearing, and if wear or roughness is evident, renew the bearing.
18. Examine the clutch driven plate for wear on the splines in the centre hub, wear or distortion of the linings or damage to the damper springs. Renew as a complete assembly.

Data

28 cm (11 in) diameter clutch

Pressure springs:	
Colour	Black
Free length	71·04 mm (2·798 in)
Fitted length	40·80 mm (1·688 in)
Pressure (fitted)	65·76 to 72·57 kgf (150 to 160 lbf)

33 cm (13 in) diameter clutch

Pressure springs:	
Colour	Yellow/light green
Free length	68·07 mm (2·68 in)
Fitted length	40·80 mm (1·688 in)
Pressure (fitted)	54·42 to 65·76 kgf (135 to 145 lbf)

Section C2

BORG AND BECK DOUBLE CLUTCH

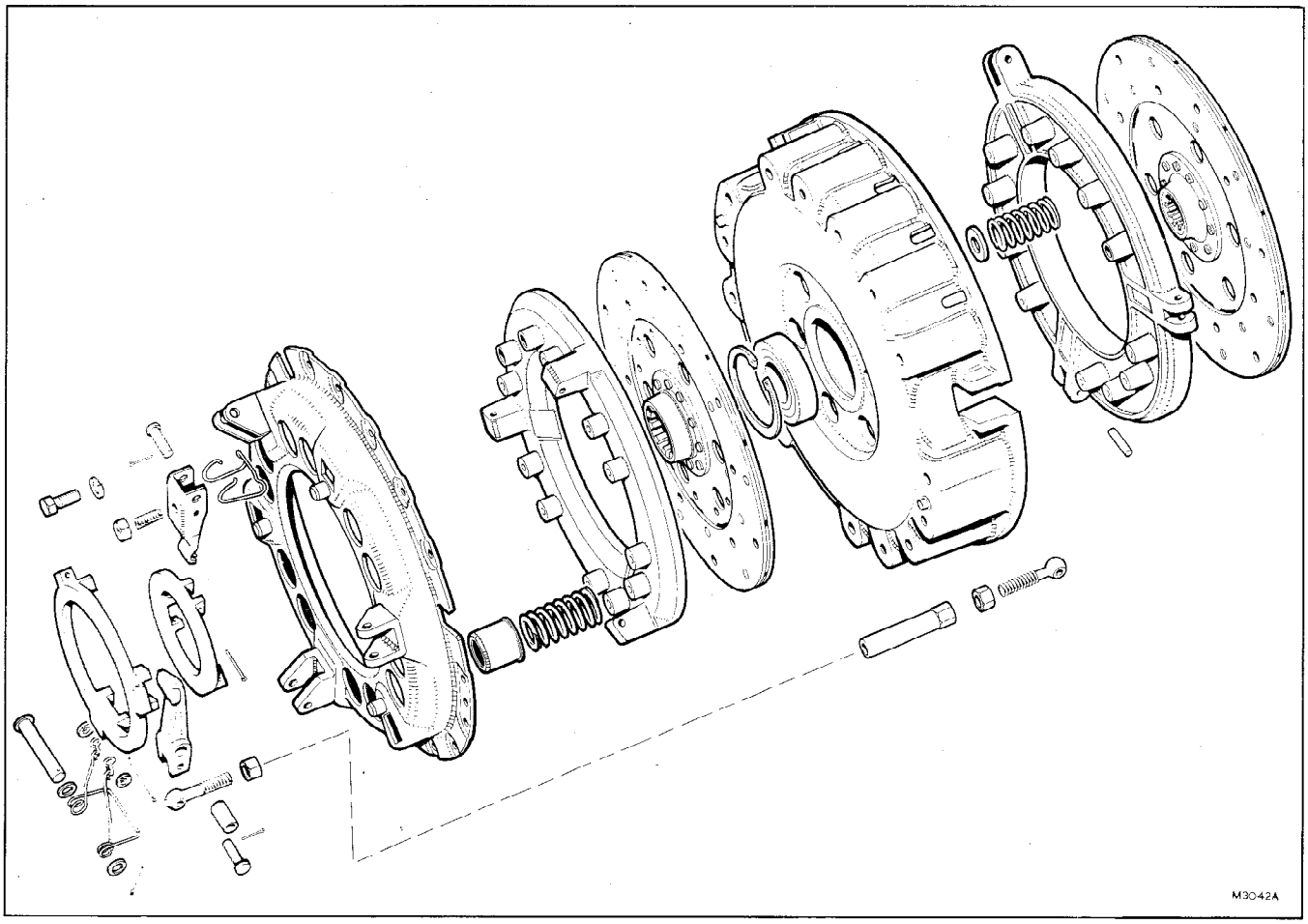


Fig. 1

1. Remove the flywheel from the engine and use as a base plate.
2. Assemble the clutch gauging fixture tool 18G 563 C as follows:
   a. Fit the bridge plate using countersunk screws to the flywheel, noting that the boss in the centre of the bridge plate is facing downwards, and fit four spacers (code No. 3) an equal distance around the pressure face of the flywheel.
   b. Fit the clutch without the main driven plate to flywheel using nine long bolts (tool 18G 563/6).
   c. Fit the long spacer adaptor, joggling platform and lever assembly.
3. Using the assembled clutch gauging fixture (18G 563 C), remove the retaining staples (18G 498) and remove the joggling lever and platform.
4. Mark the following to assist assembly:
   a. I.P.T.O. clutch cover and pressure plate.
   b. Main clutch cover and pressure plate.
5. Remove the clevis pin retaining:
   a. The turnbuckles to the main clutch release levers.
   b. The I.P.T.O. release levers to the I.P.T.O. pressure plate.

   NOTE.—The split pin end of the clevis pins face the direction of rotation.

6. Of the six bolts securing the I.P.T.O. clutch cover to the main clutch, remove every alternate bolt (three) (see 2 in Fig. 2) and substitute three 1¼ in (31·7 mm) long $\frac{5}{16}$ in U.N.F. set screws and plain washers, screwed into the full depth of the holes.
7. Unscrew the nine long bolts half a turn at a time until the main clutch is free ot spring pressure (see 1 in Fig. 2).
8. Unscrew the three standard I.P.T.O. clutch cover bolts half a turn at a time until the I.P.T.O. clutch cover contacts the three bolts inserted in operation 6 (see 3 in Fig. 2).
9. Continue to unscrew all bolts half a turn at a time until both clutches are free of spring pressure
10. Remove the I.P.T.O. clutch cover, springs, cups and pressure plate and driven plate.
11. Remove the main clutch cover, springs, insulating washers, and pressure plate.
12. Remove the main clutch release plate (see Fig. 1).
13. Remove the I.P.T.O. clutch release plate (see Fig. 1).
14. Remove the circlip from the inner cover, using tool 18G 1004, and withdraw the pilot bearing.
15. Remove the pins to release the turnbuckles from the I.P.T.O. pressure plate.
    NOTE.—The eyebolts and locknuts at the release lever end of the turnbuckles are left-hand thread.
16. Check the pressure springs and renew if not as specified in Data.
17. Install the pilot bearing and secure with the circlip, using tool 18G 257.
18. Reverse operations 13 and 14, ensuring that each I.P.T.O. release lever is installed with its leaf spring on the release plate side of the split pin.
19. Refit the turnbuckles to the I.P.T.O. pressure plate.
20. Place four spacers (code No. 3) equal distance around the pressure face of the flywheel.
21. Fit the main clutch pressure plate with its springs and insulating washers over the spacers.
22. Fit the main clutch cover to the pressure plate, aligning the marks made prior to dismantling.
23. Place four spacers (code No. 3) equal distance around the pressure face of the main clutch cover.
24. Fit the I.P.T.O. pressure plate with its springs and cups over the spacers.
25. Fit the I.P.T.O. clutch cover to the pressure plate, aligning the marks made prior to dismantling.
26. Bolt up the assembly in the following order.
    a. Three 1¼ in set screws and plain washers.
    b. Three standard bolts and spring washers.
    c. Nine long bolts and plain washers.
27. Fit the turnbuckles to the main clutch levers, and the I.P.T.O. release levers to the I.P.T.O. pressure plate. Do not secure the turnbuckle clevis pins with split pins if the clutch is to be re-set.
28. Refit the joggling lever and platform (tool 18G 563 C) and operate the lever several times to settle the main clutch components.
29. Remove the joggling lever and platform.

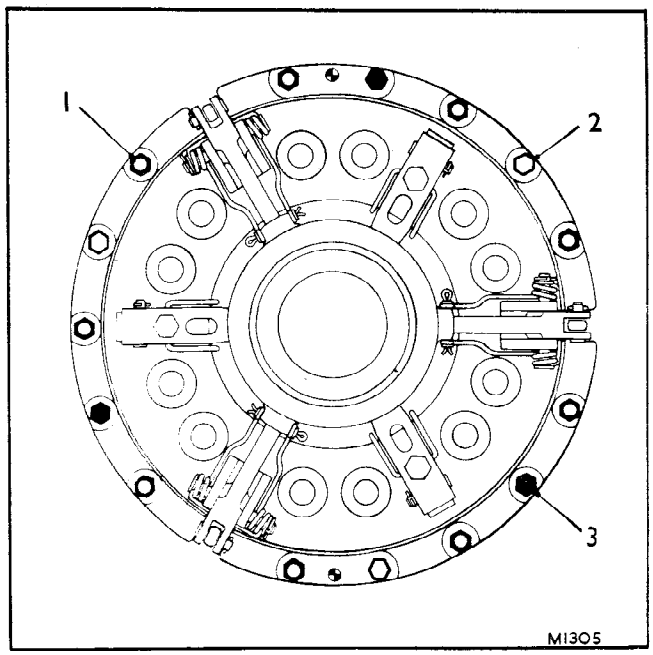


Fig. 2

30. Fit the centre pillar, spacer adaptor (code No. 4) with its recessed end downwards, gauge finger body, nut and long gauge finger (all part of tool 18G 563 C).
31. Adjust the turnbuckles until the main clutch release plate is 0·04 mm (0·0015 in) below the gauge finger.
32. Press the gauge body and finger downwards and adjust the turnbuckles until the gauge finger just touches the release plate at all points on its circumference. Tighten the lock nuts.
33. Remove the centre pillar gauge body and finger.
34. Refit the joggling lever and platform, operate the lever several times to ensure the main clutch components are settled, then re-check the turnbuckle adjustment as in operations 30 to 32.
35. Remove the centre pillar, gauge body and long spacer adaptor.
36. Fit the short spacer adaptor joggling lever assembly, and operate several times to settle the I.P.T.O. clutch components.
37. Remove the joggling lever assembly.
38. Fit the centre pillar, spacer adaptor (code No. 4) with its recessed end downwards, gauge finger body and short gauge finger.
39. Adjust the release lever adjusting screws and locknuts until the I.P.T.O. release plate is 0·04 mm (0·0015 in) below the gauge finger.
40. Press the gauge body and finger downwards and re-adjust the screws until the gauge finger just touches the release plate at all points on its circumference. Tighten the locknuts.
41. Remove the gauge body, gauge finger and centre pillar.

42. Refit the joggling lever assembly, operate the lever several times to ensure that the I.P.T.O. clutch components are settled, then re-check the I.P.T.O. clutch adjustment.
43. Remove the centre pillar, gauge body, gauge finger and short spacer adaptor.
44. Release the turnbuckles from the release levers.
45. Remove the nine long bolts, three standard bolts, and three $1\frac{1}{4}$ in set screws.
46. Remove the I.P.T.O. clutch cover and four spacers from the main clutch pressure face.
47. Fit the I.P.T.O. driven plate and clutch cover to the main clutch pressure face.
48. Centralize the driven plate with tool 18G 563 A.
49. Fit the nine long bolts and six short standard bolts (refer to Fig. 2).
50. Fit the turnbuckles to the release levers and secure the clevis pins with the split pins.
51. Remove the driven plate centralizer tool 18G 563 A.
52. Fit the long spacer adaptor joggling platform and lever assembly.
53. Actuate the joggling lever and place the three staples (18G 498) over the three main clutch release levers, and hook the end of each staple beneath the clutch cover.
54. Remove the joggling lever, platform and long spacer adaptor.
55. Remove the nine long bolts (see 1 in Fig. 2) and four spacers from the flywheel pressure face.

Data

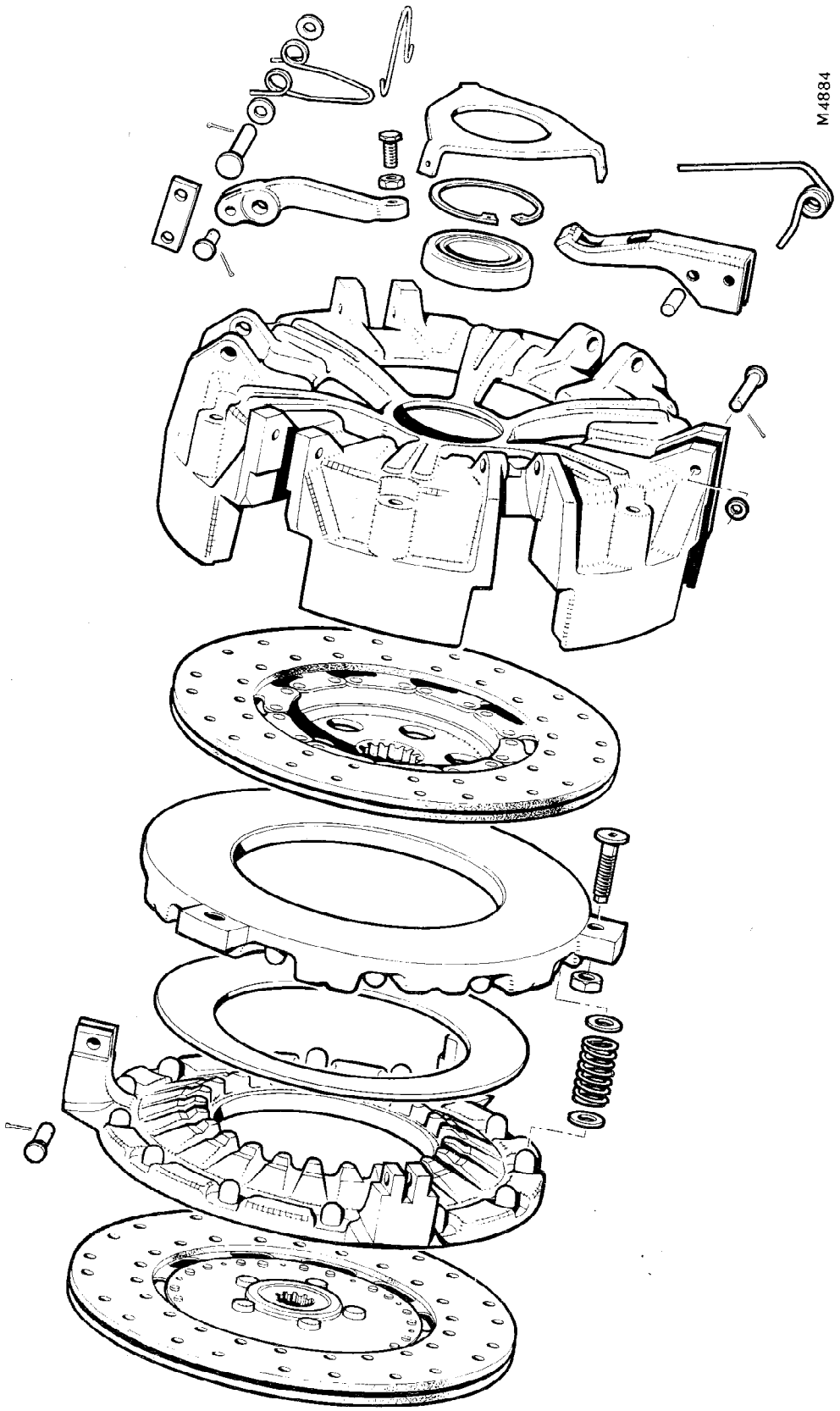
Clutch Type BB11/141E

Pressure springs:	
Colour	Cream
Fitted length	40·80 mm (1·688 in)
Pressure (fitted)	54·4 to 59·0 kgf (120 to 130 lbf)

Clutch Type BB11/249

Pressure springs:	
Colour	Light green/lavender
Fitted length	42·93 mm (1·690 in)
Pressure (fitted)	45·36 to 49·90 kgf (100 to 110 lbf)

LAYCOCK DOUBLE CLUTCH



Section C3

LAYCOCK DOUBLE CLUTCH

1. Remove the transit clips which were fitted to the main release levers when the clutch was removed from the vehicle.
2. Remove the split pins from the I.P.T.O. release lever pivot pins and withdraw the pivot pins.
3. Lift out the I.P.T.O. release lever return springs and remove the release plate.
4. Lift each I.P.T.O. release lever from the clutch cover together with its roller pin.
5. Clamp the clutch in a suitable fixture* and remove the split pins from the main return lever pivot pins and slide the pins from the clutch cover.
6. Remove the main return lever springs.
7. Reference mark the clutch cover and both pressure plates.
8. Swing the main release levers out from the clutch cover and progressively release the special fixture screws clamping the clutch until it is free of spring pressure.
9. Remove the cover, coil pressure springs, insulating washers, and Belleville pressure spring.
10. Unlock and remove the three I.P.T.O. release lever adjusting screws.
11. Remove the I.P.T.O. pressure plate and driven plate.
12. Remove the split pins from the main release lever pivot pins and link pins and remove the levers and links.
13. Remove the circlip from the cover bore, using tool 18G 1004, and withdraw the bearing.
14. Renew all worn or damaged components. Check the free length of the pressure springs, Belleville spring free height, and return spring angle; refer to the figures quoted in Data.
15. Lubricate the sides of the drive lugs and the Belleville spring pivot locations on both pressure plates with a high-melting-point (150°C min.) graphite grease (refer to Data).
16. Assemble the clutch using a suitable clamping fixture. *
17. Place the main pressure plate, friction face down, onto the clamping fixture and place insulating washers and pressure springs into their recess locations.
18. Locate the Belleville spring on the main pressure plate.
19. Assemble the main release levers and links, and secure the levers to the main pressure plate. Swing the levers out from the clutch.
    NOTE.—The pivot pin holes in the links are off-centre, ensure that the links are fitted as shown in Fig. 2.
20. Insert the insulating washers in their recesses in the I.P.T.O. pressure plate.
21. Locate the I.P.T.O. pressure plate, friction face uppermost, on the pressure springs and Belleville spring.

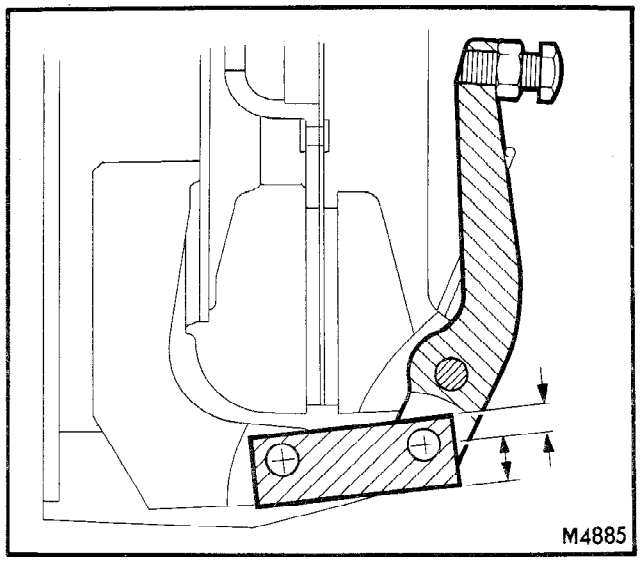


Fig. 2

22. Place the I.P.T.O. driven plate, with the bossed face leading, onto the I.P.T.O. pressure plate.
23. Insert the bearing in the clutch cover bore and fit the circlip.
24. Place the clutch cover onto the I.P.T.O. pressure plate and, using a dummy shaft,* align the pressure plate and clutch cover.
    NOTE.—Ensure that the reference marks, made on the pressure plates and clutch cover prior to dismantling, are aligned.
25. Compress the assembly, using the screws of the clamping fixture,* until the main release levers can be fitted to the clutch cover. Remove the dummy shaft.
26. Assemble the main release levers and return springs, insert and secure the pivot pins.
27. Insert the adjusting screws into the I.P.T.O. pressure plate and fit, but do not secure, the locknuts.
28. Fit the rollers into the I.P.T.O. release levers and assemble the levers to the clutch cover (do not insert the pivot pins).
29. Assemble the release plate so that the tabs locate in the slots of the I.P.T.O. release levers. Insert the longer legs of the return spring into the hole in the release plates.
30. Align the pivot pin holes in each I.P.T.O. release lever and the loop of the return springs with the holes in the cover, then insert and secure the pivot pins.
31. Using the special fixture settle the clutch components.

32. Set the position of the main release levers by adjusting the screws, then lock the screws with the locknuts. Measure from the recessed face of the clutch cover. Refer to Fig. 3 and Data for the setting dimension and tolerances.
33. Set the position of the release plate by turning the squared end of the adjusting screws, then lock the screws with the locknuts. Measure from the recessed face of the clutch cover. Refer to Fig. 3 and Data for the setting dimensions and tolerances.
34. Fit the transit clips over the main release levers and hook them under the clutch cover, then progressively release the clamping screws of the special fixture. Remove the clutch from the special fixture.
* **NOTE.**—Details of the special fixture will be made available when finalized.

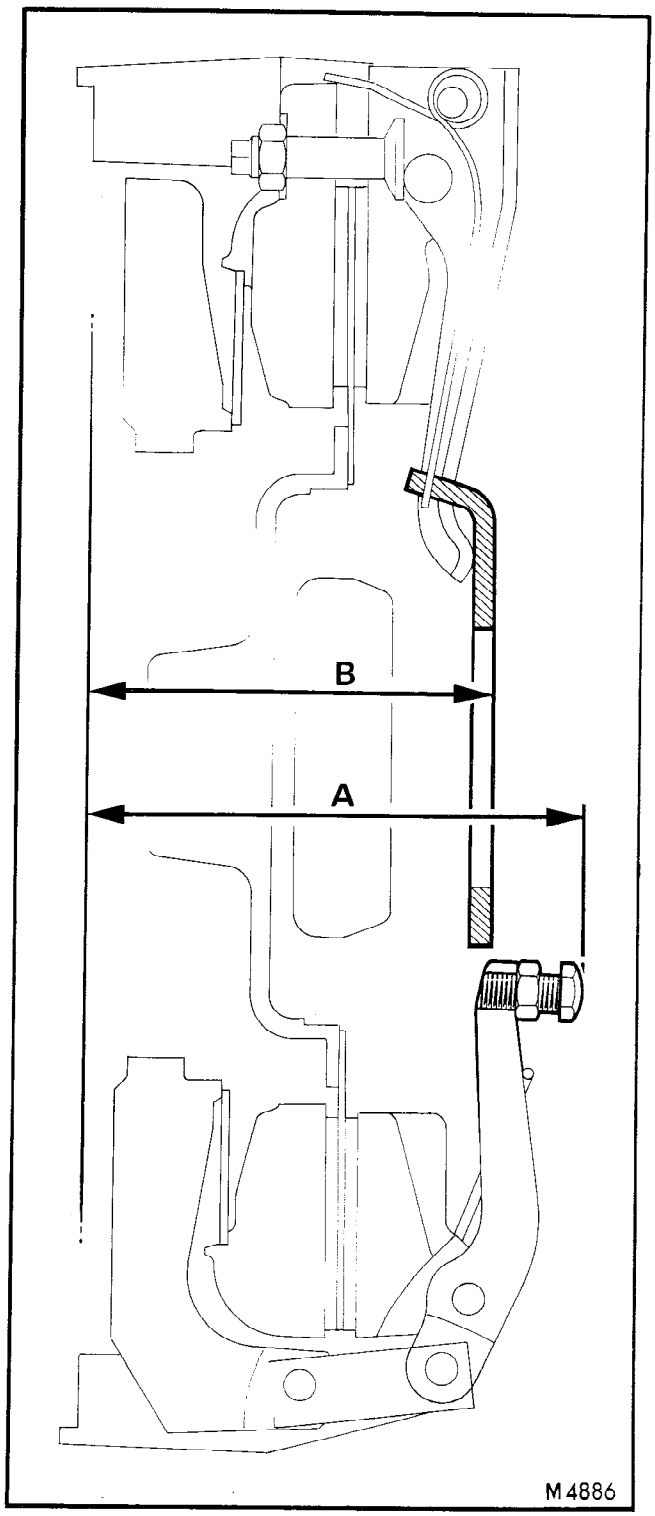


Fig. 3

Data

Coil pressure spring free length	38·51 mm (1·516 in)
Belleville spring free height	9·80 mm (0·386 in)
Return spring angle (between arms):	
Main release lever springs	75°
I.P.T.O. release lever springs	160°
Main release lever setting dimension (A)	130·02±0·25 mm (5·125±0·010 in)
Release plate setting dimension (B)	104·78±0·25 mm (4·125±0·010 in)
Clutch lubricant	Gredag 1546G (Acheson Colloids) or equivalent

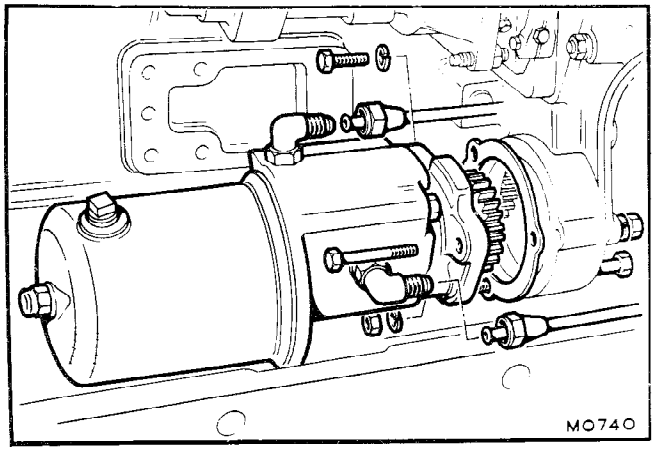
POWER STEERING

Section B1

POWER STEERING PUMP

Removing

1. Disconnect the pipes from the pump.
2. Remove the bolts and nut securing the pump to the timing case and withdraw the pump.



Refitting

3. Reverse the procedure 1 and 2.
4. Fill the reservoir with one of the recommended fluids.
5. With the engine running, operate the steering from lock to lock to expel all air from the system.
6. Refit the filler/level plug.

NOTE.—Always top up the reservoir with the engine running and the steering on full right lock.

C

OVERHAULING

Section C1

POWER STEERING PUMP

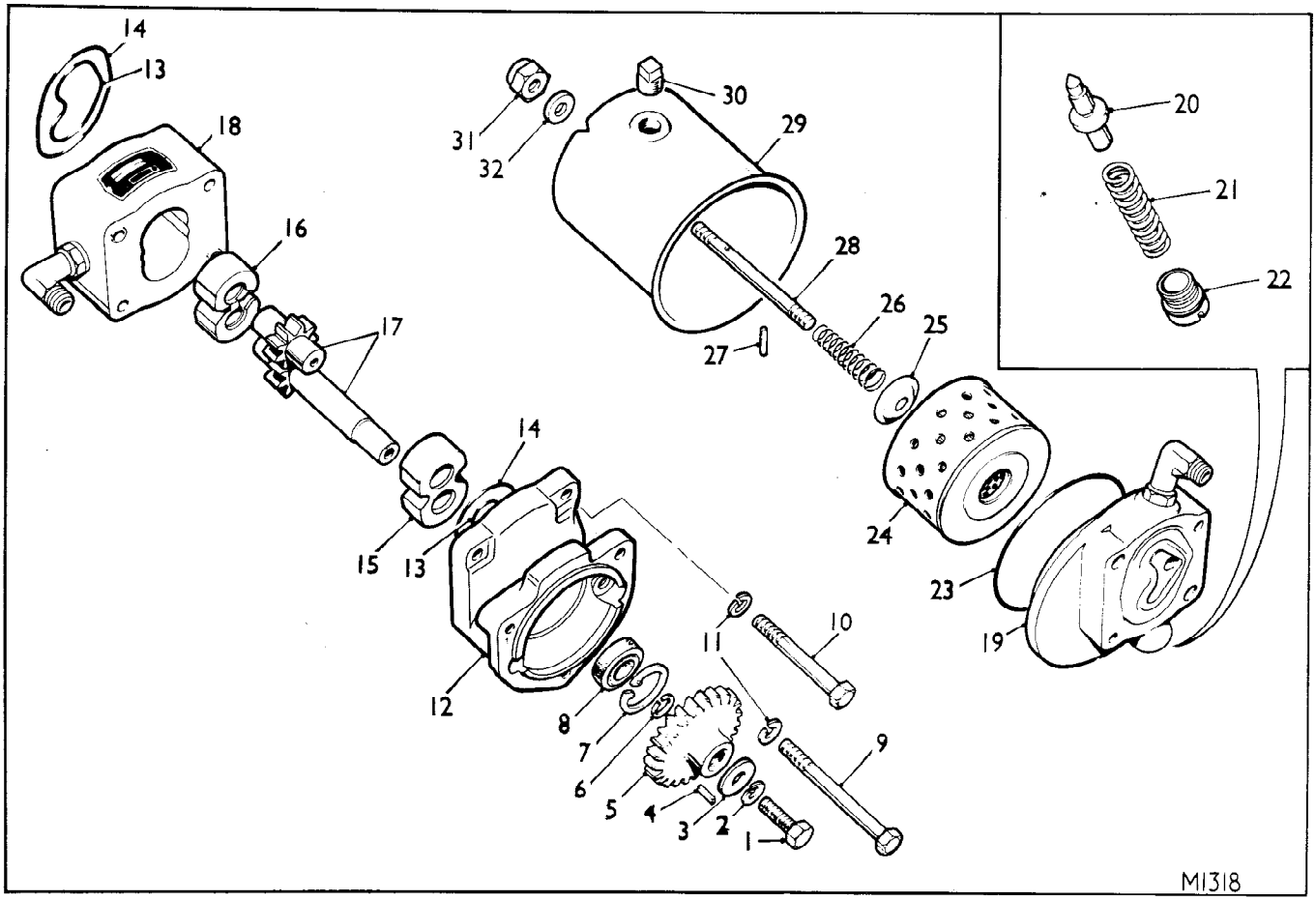


Fig. 1

Power steering pump components

1. Bolt for drive gear
2. Spring washer
3. Plain washer
4. Key for drive gear
5. Drive gear
6. Circlip for drive gear
7. Circlip for oil seal
8. Oil seal
9. Through-bolt (long)
10. Through-bolt (short)
11. Spring washer for bolt
12. Flange
13. Pressure loading ring
14. Sealing ring
15. Bearing block (front)
16. Bearing block (rear)
17. Pump gears
18. Pump body
19. Rear cover
20. Relief valve poppet
21. Relief valve spring
22. Relief valve plug
23. 'O' ring for reservoir
24. Filter element
25. Sealing cup for element
26. Spring for element
27. Roll-pin for spring
28. Stud for reservoir
29. Reservoir
30. Filler plug for reservoir
31. Nut for reservoir stud
32. Sealing washer

1. Remove the drive gear, tapered key and circlip from the pump shaft.
2. Drain and remove the reservoir.
3. Remove the filter roll-pin, spring, sealing cup and filter element.
4. Detach the reservoir 'O' ring.
5. Mark the relative positions of the pump flange, body and rear cover for assembly.
6. Remove the through-bolts and separate the flange and rear cover from the pump body.
7. Withdraw the gears and bearing blocks from the pump body.
8. Remove the sealing rings and pressure loading rings from the inner faces of the flange and rear cover.
9. Unscrew the pressure relief valve plug from the rear cover and withdraw the spring and valve.
10. Remove the circlip and oil seal from the front of the flange.
11. Check that all sealing faces are perfectly flat.

12. Check the pump body, gears, and journals referring to the specifications in Data.
13. Ensure that the relief valve seats correctly in the rear cover, If necessary, the valve may be lightly lapped onto its seat with fine lapping paste.
14. Renew all seals.
15. Assemble the relief valve, spring, and plug to the rear cover.
16. Fit the oil seal and circlip to the flange and pack the oil seal internal groove with grease.
17. Fit the pressure loading rings and sealing rings to the inner faces of the flange and rear cover.
18. Fit the rear cover to the pump body.
19. Assemble the bearing blocks to the pumping gears, noting:
    a. The narrow bearing block is fitted to the front (drive end).
    b. The relieved face of both blocks go towards the gears.
    c. The relieved periphery of both blocks are on the delivery (outlet) side of the pump.
20. Fit the assembled gears and blocks to the pump body, and ensure that the end-float of the gear and bearing block is as specified in Data.
21. Fit the flange, using a seal guide on the end of the drive shaft to protect the oil seal during fitting.
22. Fit the through-bolts and tighten them to the torque figure specified in Data.
23. Fit the circlip, key, and drive gear to the drive shaft.
24. Tighten the reservoir stud to the torque figure specified in Data.
25. Fit the reservoir 'O' ring to the rear cover and assemble the filter element, sealing cup, spring and roll-pin.
26. Fit the reservoir, ensuring that the projection in the reservoir locates in the slot in the rear cover.
27. Tighten the reservoir nut to the torque figure specified in Data.
28. Mount the pump on a test rig and carry out the tests as described in Data.

Data

Permissible gear track depth in pump body	0·10 mm (0·004 in) maximum
Width difference between driving and driven pump gears	0·005 mm (0·0002 in) maximum
Diameter difference between journals of any one gear ..	0·13 mm (0·005 in) maximum
End-float of complete gear and bearing assembly in pump body	0·10 to 0·20 mm (0·004 to 0·008 in)
Torque wrench settings:	
Through-bolts	3·47 to 4·15 kgf m (25 to 30 lbf ft)
Reservoir stud	1·11 to 2·77 kgf m (8 to 20 lbf ft)
Reservoir nut	0·28 to 0·41 kgf m (2 to 3 lbf ft)

Testing

Conditions of test:

1. Test fluid to be Tractor Universal Oil or equivalent.
2. Fluid temperature to be 45 to 50°C (113 to 122°F) at inlet port.
3. Pump speed to be 1500 rev/min clockwise rotation.
4. Relief valve on pump to remain screwed down (preventing poppet from lifting) until it is adjusted in the tests.
5. Test circuit to consist of:
    a. Gauze strainer in suction line.
    b. Pump under test.
    c. Calibrated pressure gauge.
    d. Pressure relief valve set at 140 kgf/cm² (2000 lbf/in²).
    e. Pressure control valve.
    f. 10 micron filter.
    g. Graduated measuring vessel with quick-release valve.

Test procedure:

Test	*Duration of Test*	*Test Pressure*	*Remarks*
1	1 minute	0·36 kgf/cm² (5 lbf/in²)	This test is applied to the pump reservoir containing 1·14 litres (2 pints) of oil. No leakage is permissible.
2	3 minutes	52·5 kgf/cm² (750 lbf/in²)	No measurable leakage from any point on the pump is acceptable.
3	3 minutes	●119·5 kgf/cm² (1700 lbf/in²) ●	No measurable leakage from any point on the pump is acceptable.
4	2 minutes	105 kgf/cm² (1500 lbf/in²)	During this test check pump delivery. Time to deliver 4·5 litres (1 gal) is 31 seconds maximum.
5	—	101·5 to 105 kgf/cm² (1450 to 1500 lbf/in²)	Adjust the pump relief valve to give full by-pass (zero delivery from outlet port) between the two pressures stated. Lock relief valve adjusting screw by staking bore over into screwdriver slot.

ELECTRICAL

C OVERHAULING

Section C1

ALTERNATOR (Type 16ACR)

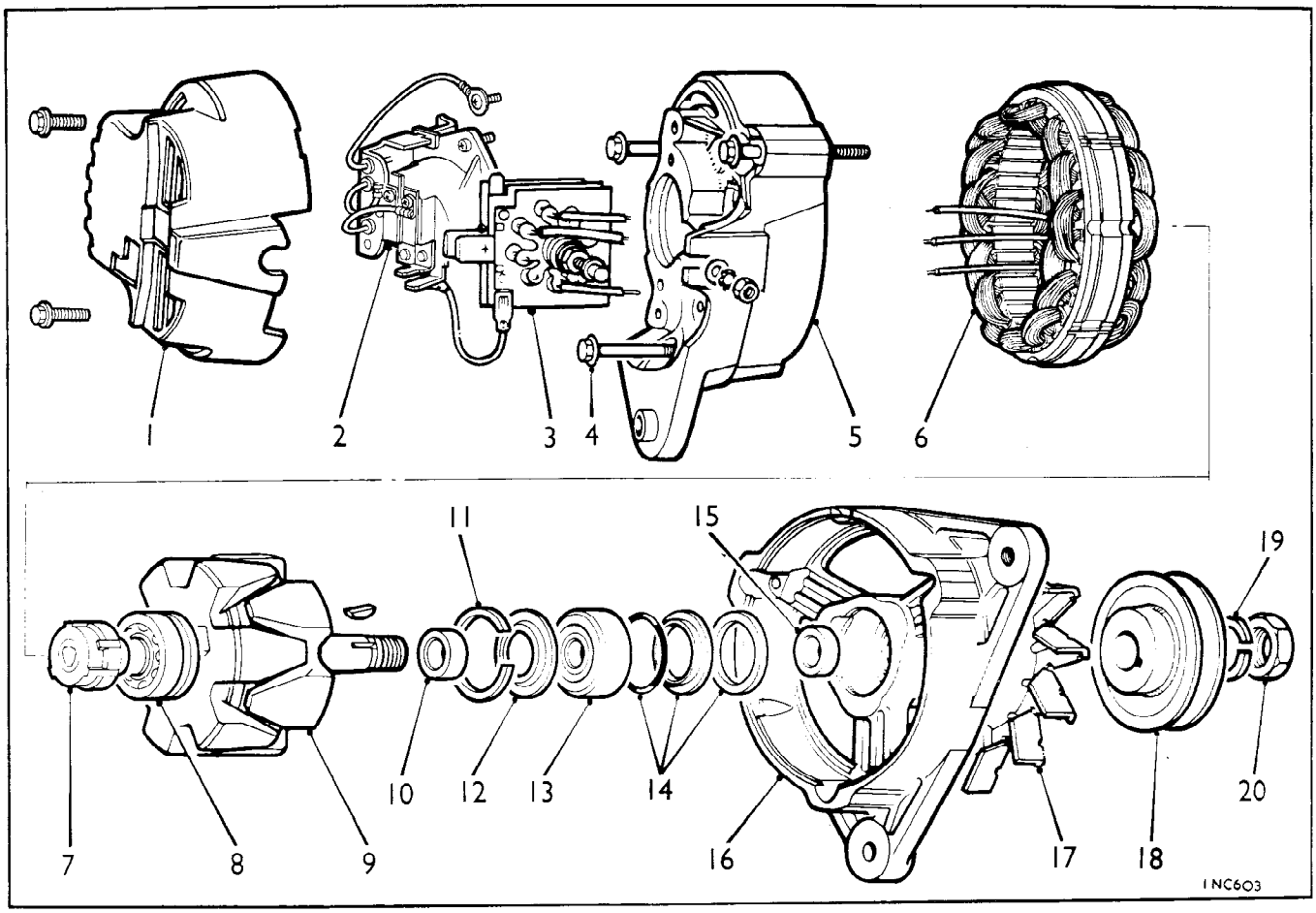


Fig. 1

Alternator components

1. End cover
2. Regulator and brush gear
3. Rectifier pack
4. Through-bolt
5. Slip-ring end bracket
6. Stator
7. Slip-ring assembly
8. Slip-ring end bearing
9. Rotor
10. Distance piece
11. Circlip
12. Plate
13. Drive end bearing
14. Seal
15. Distance piece
16. Drive end bracket
17. Fan
18. Pulley
19. Spring washer
20. Nut

1. Remove the alternator end cover.
2. Unsolder the three stator cables from the rectifier pack, noting the cable positions (use a pair of pliers as a thermal shunt to avoid overheating the diodes).
3. Slacken the nut on the rectifier assembly bolt and remove the screws securing the brush box and the regulator to the slip-ring end bracket.
4. Remove the brush box, regulator, and rectifier as an assembly.
5. Renew the brush assemblies if the brush length and/or brush spring pressure are not as given in Data.
6. If necessary clean the slip-ring surfaces, using a suitable solvent or very fine glass paper.
7. Test the field (rotor) windings (see Data):
   a. Measure either resistance or current flow by connecting either a battery operated ohmmeter or a 12-volt battery and ammeter across the slip-rings.
   b. Test the insulation by connecting the test equipment between one of the slip-rings and one of the rotor poles.
8. Test the stator windings (see Data):
   a. Test for continuity by connecting any two of the cables in series with the test equipment, then repeat, using the third cable in place of one of the first two.

b. Test the insulation by connecting the test equipment between one of the three cables and the stator laminations.

9. Test each diode in turn by connecting the test equipment (see Data) between the diode pin and the particular heatsink into which the diode is soldered, then reversing the connections. Current should flow in one direction only. If any diode is defective, renew the rectifier pack.

NOTE.—Certain alternators are provided with a surge protection diode which is fitted to the outer face of the slip-ring end bracket (not to be confused with a suppression capacitor similarly fitted in the end bracket) and is connected between terminal 'IND' and the end bracket. The testing procedure for this diode involves the use of a special rig.

If the stator, rotor, slip-rings, or bearings are to be renewed continue dismantling as follows:

10. Make assembly marks on the drive end bracket, stator and slip-ring end bracket.
11. Remove the through-bolts.
12. Remove the slip-ring end bracket by passing a tube over the slip-ring assembly and driving the bearing out of the slip-ring end bracket.
13. Remove the drive pulley, fan, and key.
14. Press the rotor from the drive end bracket.
15. Remove the circlip from the drive end bracket and extract the plate, bearing, and seal.
16. Unsolder the field connections from the slip-ring assembly. Withdraw the slip-ring assembly and the bearing from the rotor shaft.
17. Assemble the alternator, reversing the procedure in 1 to 4 and 10 to 16 as necessary, noting:
    a. Fit the slip-ring end bearing with its shielded side towards the slip-ring assembly.
    b. Use Fry's H.T.3 solder to re-make the field to slip-ring connections.
    c. Support the inner track of the bearing when refitting the rotor to the drive end bracket.
    d. Use 'M' grade 45–55 tin-lead solder to re-make the stator to rectifier pack connections (use pliers as a thermal shunt to avoid overheating the diodes).

Data

Minimum brush length	5 mm (0·2 in) protruding beyond brush box moulding
Brush spring pressure	255 to 368 gf (9 to 13 ozf) when brush is pushed in flush with brush box face
Rotor field winding:	
Resistance	4·33 ohms
Current flow at 12 volts	3 amperes
Insulation test equipment	110 volt a.c. supply and 15-watt lamp
Stator windings:	
Continuity test equipment	12-volt d.c. supply and 36-watt lamp
Insulation test equipment	110-volt a.c. supply and 15-watt lamp
* Diode current flow test equipment	12-volt d.c. supply and 1·5 watt lamp
Torque wrench setting for pulley nut	4·1 kgf m (30 lbf ft)

Section C2

DYNAMO (Type C40T)

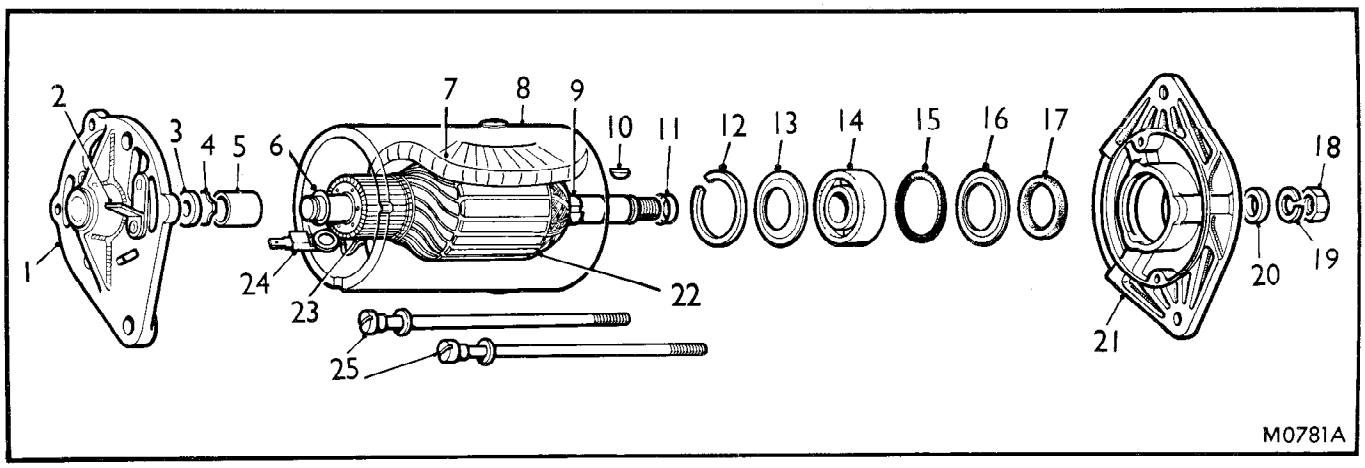


Fig. 1

Dynamo components

1. Commutator end bracket
2. Output terminal
3. Felt ring
4. Felt ring retainer
5. Bearing bush
6. Thrust washer
7. Field coil
8. Yoke
9. Bearing collar
10. Key
11. Collar retaining cup
12. Circlip
13. Bearing retaining plate
14. Bearing
15. 'O' ring
16. Felt ring retaining plate
17. Felt ring
18. Shaft nut
19. Spring washer
20. Pulley spacer
21. Drive-end bracket
22. Armature
23. Commutator
24. Field terminal
25. Through-bolts

1. Remove the drive pulley, fan, and key from the armature shaft.
2. Remove the two through-bolts and detach the commutator-end bracket.
   NOTE.—For insulated-return versions: Disconnect the field coils from the brush boxes (or brush arms) before withdrawing the end bracket.
3. Remove the thrust washer from the armature shaft.
4. Detach the yoke.
5. Press out the armature from the bearing in the drive-end bracket.
6. Test the brush spring pressure:
   a. Fit new brushes.
   b. Refit the commutator-end bracket to the armature, without the yoke in position.
   c. Use a spring balance to pull each brush just clear of the commutator, with the spring balance attached to the spring arm as close to the brush as possible.
   d. Renew the springs if the pressure is less than that quoted in Data.
7. Connect an ohmmeter between the field terminal and the yoke to test the field coils. The reading should be as given in Data.
8. Check the armature by substituting a new one. Do not skim the commutator to remove pits and burrs to the extent that it is below the dimension given in Data.
9. Examine the fit of the armature shaft in the drive-end bush. If the bush requires renewal, screw a suitable tap squarely into the bush for use as an extractor.
10. Remove and clean the felt ring retainer and the felt ring. Renew the felt ring if necessary.
11. New bushes must be soaked in engine oil for 24 hours before fitting, or soaked in engine oil at a temperature of 100°C (212°F) for two hours, and allowed to cool before being removed from the oil. Fit the new bush, using a tool to the dimensions specified in Data. Do not ream the bush.
12. Remove the circlip and retaining plate from the drive-end bracket and press out the bearing. Extract the rubber seal, felt ring retainer and felt ring from the housing. Renew the felt ring if necessary.
13. Check the bearing for wear or roughness. Renew if necessary.
14. Reverse the procedure 1 to 5, noting:
   a. The brushes must be held clear of the commutator when refitting the commutator-end bracket.
15. Bench-test the generator (refer to Data).

Data

Brush spring pressure	510 gf (18 ozf) minimum
Field coil resistance	6·0 ohms
Minimum diameter of commutator	36·83 mm (1·45 in)
Cut-in speed	1150 generator rev/min at 13·0 volts
Maximum output	18 amperes at 2150 generator rev/min

Bush fitting tool dimensions

1. $\frac{3}{8}$ in B.S.F. thread
2. Extracting nut
3. Fitting pin
4. Bearing housing
5. Hand press
6. Squared end
7. Sleeve
8. Bush

A. 38 mm ($1\frac{1}{2}$ in)
B. 10·2 cm (4 in)
C. 31·8 mm ($1\frac{1}{4}$ in)
D. 23·8 mm ($\frac{13}{16}$ in)
E. 15·87 mm (0·625 in)
F. 15·37 mm (0·605 in)
G. 6·35 mm ($\frac{1}{4}$ in)
H. 15·05 mm (0·5924 in)

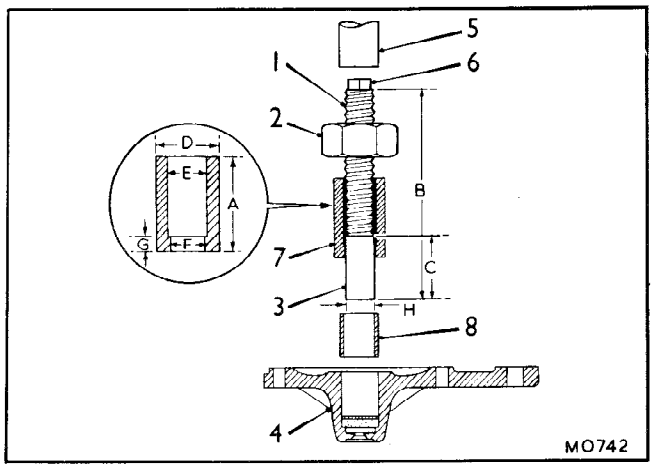


Fig. 2

Section C3

STARTER MOTOR (Type M50 Standard Windowless)

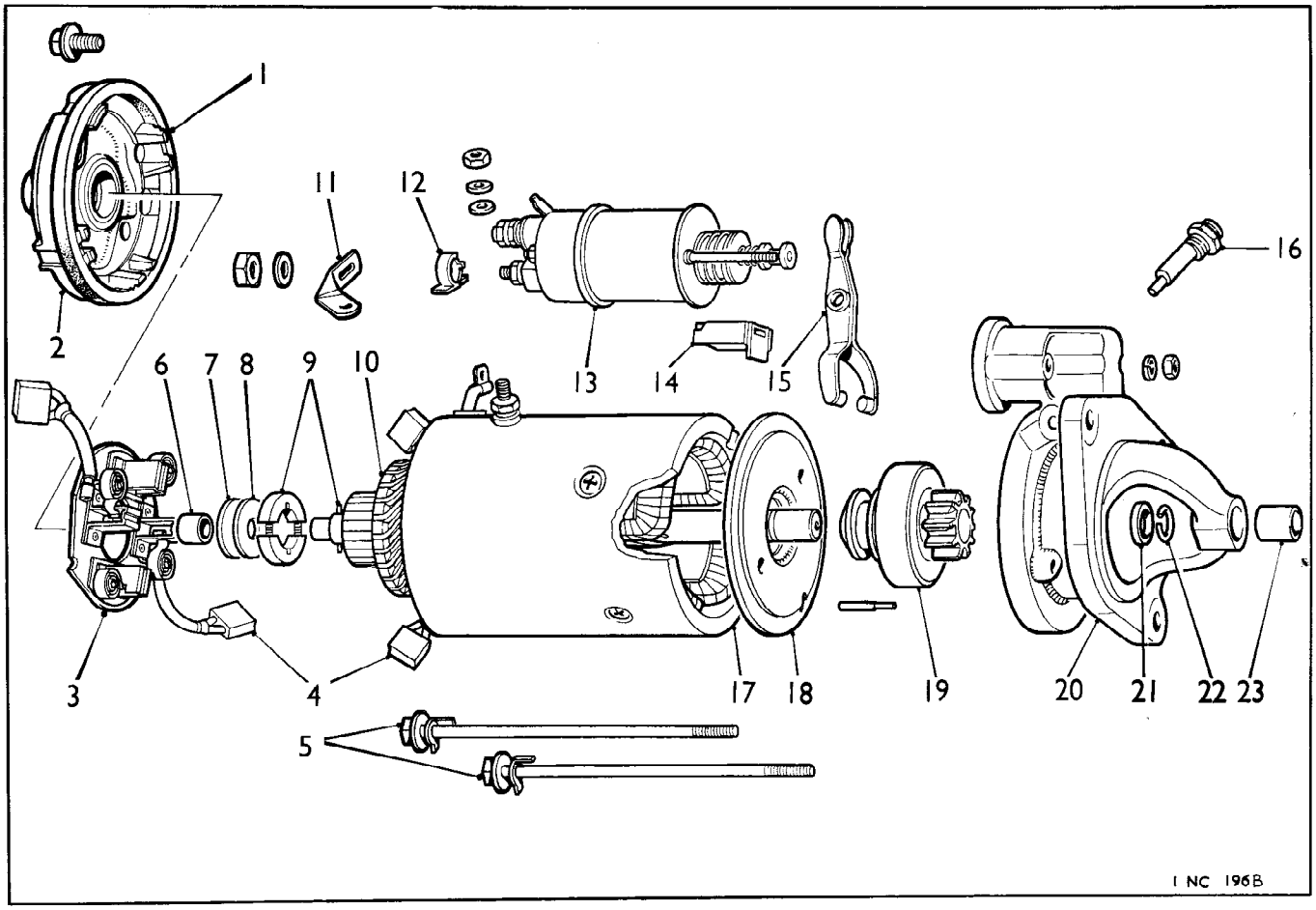


Fig. 1

Starter motor components

1. Seal
2. Commutator end bracket
3. Brush carrier assembly
4. Brushes
5. Through-bolts
6. Commutator end bush
7. Fibre washer
8. Thrust washer
9. Brake-shoes and cross-peg
10. Armature
11. Copper link
12. Insulation piece
13. Solenoid
14. Seal
15. Engagement lever
16. Engagement lever pivot pin
17. Yoke
18. Intermediate bracket
19. Drive assembly
20. Drive end bracket
21. Pinion thrust washer
22. Retaining ring
23. Drive end bush

NOTE.—The conventional M50 starter motor has 'windows' in the yoke and a cover band, but no seal between the commutator end bracket and yoke.

1. Remove the copper link from the solenoid and yoke.
2. Disconnect the flexible lead from the solenoid terminal.
3. Remove the solenoid.
4. Remove the through-bolts.
5. Remove the two screws from the face of the commutator end bracket.
6. Remove the commutator end bracket and seal.
7. Withdraw the brushes from their boxes and remove the brush carrier assembly.
8. Remove the yoke.
9. Remove the brake-shoes, springs, and steel and fibre thrust washers from the commutator end bracket.
10. Extract the seal from the drive end bracket.
11. Remove the engagement lever pivot pin.
12. Remove the drive end bracket.
13. Remove the engagement lever.
14. Tap back the pinion thrust washer and remove its retaining ring.
15. Remove the thrust washer, drive assembly, and intermediate bracket (note the shims between the bracket and the armature core).
16. Renew worn brushes; refer to Data for minimum brush length.

17. Check the brush spring pressures; refer to Data.
18. Clean the commutator. If badly worn, skim it in a lathe, removing as little metal as possible (refer to Data) and then polish with very fine glass paper. Do not undercut the insulators.
19. Check for lifting of the conductors from the commutator risers. This indicates overspeeding, so check that the roller clutch takes up instantaneous drive in one direction but rotates freely and smoothly in the opposite direction.
20. Test the armature winding insulation by connecting the test equipment (refer to Data) between the armature shaft and each commutator segment in turn. If a short-circuit is suspected, check the armature on a growler.
21. Test the insulated brush boxes by connecting the test equipment (refer to Data) between the commutator end bracket and each brush box in turn.
22. Ensure that the brushes are clear of the yoke and check the field coil insulation by connecting the test equipment (refer to Data) between the field coil eyelet and each brush in turn. Make a visual inspection of the field coils; discoloration of the insulation tape could indicate short-circuiting. If in doubt about the field coil assembly, check it by substitution.
23. Check the armature bearing bushes for wear and renew any bush if its internal diameter exceeds the dimension given in Data. Soak new bushes in engine oil for 24 hours before fitting. This period may be shortened by heating the oil to 100°C (212°F) for two hours and allowing it to cool before removing the bushes. Use a shouldered highly polished mandrel (refer to Data) to fit the bushes. Do not ream these porous bronze bushes.
24. Test the solenoid resistance (refer to Data).
    a. Test the closing coil by connecting the test equipment between the terminal 'S2' and the Lucar terminal.
    b. Test the hold-on winding by connecting the test equipment between the Lucar terminal and the solenoid casing.
25. Assemble the starter, reversing the procedure 1 to 15, noting:
    a. Check the armature shaft end-float against the figure in Data and, if necessary, adjust by means of the shims between the intermediate bracket and the armature core.
    b. Ensure that the cross-peg in the armature shaft engages the slots in the brake-shoes.
    c. Tighten the through-bolts, solenoid securing nuts, and solenoid terminal nuts to the torque figures given in Data.
26. Set the pinion movement:
    a. Connect a 6-volt d.c. supply, with a switch in circuit, between the Lucar terminal on the solenoid and the starter motor yoke.
    b. Close the switch to move the pinion into its engaged position, lightly press the pinion towards the armature and rotate the engagement lever pivot pin to set the pinion to thrust washer clearance at the figure given in Data.
    NOTE.—The adjustment range of the engagement lever pivot pin is 180°. The centre of this range is when the two arrow heads are in line.
    c. Tighten the pivot pin locknut and remove the 6-volt supply and switch.
27. Check the starter motor performance, referring to Data for specifications.

Data

Minimum brush length	8·0 mm ($\frac{5}{16}$ in)
Brush spring pressure	1·2 kgf (42 ozf) minimum on new brush
Commutator diameter	38·0 mm (1·5 in) minimum
Armature winding, Brush boxes, Field coils — Insulation test equipment	110-volt a.c. supply and 15-watt lamp
Bush bore diameters:	
Commutator end bush	12·83 mm (0·505 in) maximum
Intermediate bush	28·82 mm (1·127 in) maximum
Drive end bush	17·14 mm (0·675 in) maximum
Diameters of mandrels for fitting bushes:	
Commutator end bush mandrel	12·71 mm (0·5005 in)
Intermediate bush mandrel	28·51 mm (1·1226 in)
Drive end bush mandrel	17·03 mm (0·6705 in)
Solenoid resistance:	
Closing coil	0·13 to 0·15 ohm
Hold-on coil	0·63 to 0·73 ohm
Armature shaft end-float	0·05 to 0·63 mm (0·002 to 0·025 in)

Torque wrench settings for:	
Through-bolts	1·38 kgf m (10 lbf ft)
Solenoid securing nuts	0·62 kgf m (4·5 lbf ft)
Brush gear screws in end bracket	0·34 kgf m (2·5 lbf ft)
Pivot pin locknut	2·21 kgf m (16 lbf ft)
Pinion setting (in engaged position)	0·40 to 0·63 mm (0·015 to 0·025 in) between pinion face and thrust washer

Performance (using a 128 Ah, 20-hour rate, 12-volt battery):

Test	*Amps*	*Rev/min*	*Torque*
Light running	100	5500 to 7500	—
Running torque	590	1000	2·21 kgf m (16·0 lbf ft)
Lock torque	980	—	4·7 kgf m (34·0 lbf ft)

SERVICE TOOLS

Operation	Tool No.
GENERAL	
Circlip removing and refitting	18G 1004
Gear, pulley and flange remover	18G 2
ENGINE	
Balancer bushes overhauling	18G 1185
Camshaft removing and refitting	18G 231 18G 231 C 18G 231 D
Connecting rods and pistons overhaul	18G 616
Crankshaft removing and refitting	18G 231 18G 231 B 18G 231 C 18G 688 18G 1110
Crankshaft front oil seal removing and refitting	18G 1111
Cylinder head overhaul	18G 27 18G 28 18G 28 A 18G 28 B 18G 28 C 18G 29 18G 106 18G 174 18G 174 A 18G 174 B 18G 174 C 18G 228 18G 230 ● 18G 284 and 18G 284 AAH ● LC176
Cylinder head removing and refitting	18G 396
Flywheel and crankshaft rear oil seal removing and refitting	18G 134 18G 134 CP 18G 1110
Idler gear overhaul	18G 683
D.P.A. injection pump drive removing and refitting	AMK 9990 18G 284 18G 284 AAB 18G 1206 ● MS 67 (supersedes tool 18G 1206) ●
Simms in-line injection pump drive removing and refitting	AMK 9990 18G 1114

SERVICE TOOLS

Injector sleeve removing and refitting	18G 213 A 18G 213 D LC 173 LC 174
Oil pump removing and refitting	18G 1185
Piston and cylinder liner removing and refitting	18G 55 A 18G 227 E
Timing gears and case removing and refitting	18G 231 18G 231 B 18G 231 C 18G 231 D

FUEL SYSTEM

D.P.A. injection pump removing and refitting	MS 67 (supersedes tool 18G 1206) 18G 1206 AMK 9990
Simms in-line injection pump removing and refitting	18G 1114 AMK 9990

CLUTCH

Borg and Beck double clutch overhaul	18G 257 18G 498 18G 563 A 18G 563 C 18G 563/6
Single clutch overhaul, 28 and 33 cm (11 and 13 in) diameter	18G 99 A 18G 99 C

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