

Product: DAVID BROWN FOUR-CYLINDER DIESEL ENGINE Service Manual
Full Download: <https://www.arepairmanual.com/downloads/david-brown-four-cylinder-diesel-engine-service-manual/>

DAVID BROWN

FOUR-CYLINDER DIESEL ENGINE

1200 AND 990 SELECTAMATIC TRACTORS

REPAIR MANUAL

PUBLICATION 9-37121

DAVID BROWN TRACTORS LIMITED
MELTHAM · YORKSHIRE · ENGLAND HD7 3AR

April 1971

Sample of manual. Download All 48 pages at:
<https://www.arepairmanual.com/downloads/david-brown-four-cylinder-diesel-engine-service-manual/>

Product: DAVID BROWN FOUR-CYLINDER DIESEL ENGINE Service Manual
Full Download: <https://www.arepairmanual.com/downloads/david-brown-four-cylinder-diesel-engine-service-manual/>

Sample of manual. Download All 48 pages at:
<https://www.arepairmanual.com/downloads/david-brown-four-cylinder-diesel-engine-service-manual/>

Introduction

All engines are stamped on the right-hand side of the cylinder block with a type designation and serial number, e.g. 455001/4001 or 449002/1001, etc. The engine designation number is built up according to the following formula, commencing at the left:

First digit — number of cylinders.

Second and third digits — together these give the nominal capacity, in cubic inches, of one cylinder. (The approximate capacity, in cubic inches, of an engine can be obtained by multiplying the first digit by the second and third digits, e.g.: $4 \times 55 = 220$ cu. in. and $4 \times 49 = 196$ cu.in.)

Fourth digit — type of fuel: 0 for diesel (1 would be gasoline).

Fifth digit — design series: 0 is the first series and 1 is the second, etc. This number is used to identify engines which are in different forms to suit different tractor frames.

Sixth digit — type of clutch: 1 Livedrive, 2 single plate, 5 twin-plate.

The designation is then followed by the engine serial number; these are consecutive and allow individual engines in each type to be identified.

Examples:

4 5 5 0 0 1 / 4 0 0 1 is a 4-cylinder, 200 cu. in. capacity, diesel, first series, Livedrive model, serial number 4001

4-cylinder }
 55 cu in. }
 diesel }
 first series }
 Livedrive }

4 4 9 0 0 2 / 1 0 0 1 is a 4-cylinder, 196 cu. in. capacity, diesel, first series, Non-Livedrive model, serial number 1001.

4-cylinder }
 49 cu in. }
 diesel }
 first series }
 Non-Livedrive }

Engine Designations and Tractor Models

<i>Engine Type</i>	<i>Tractor Model</i>	<i>Tractor Number</i>
455001	1200 Selectamatic Livedrive	700001 onward
455002	1200 Selectamatic Non-Livedrive	
449001	990 Selectamatic Livedrive	800001 onward
449002	990 Selectamatic Non-Livedrive	
449005	990 Non-Livedrive (Twin-plate clutch)	

CONTENTS

Section	Description	Page
	MAINTENANCE	1
	REPAIR OPERATIONS (in same order as Schedule of Repair Times TP670)	3
A1	Engine Tune	3
A2	Engine Removal and Replacement	3
B1	Adjusting Valve Clearance	8
B2	Removing and Replacing Cylinder Head	8
B3	Decarbonising Cylinder Head	9
C2	Pistons and Connecting Rods	14
C4	Camshaft	15
D1	Injectors	17
D2	Fuel Feed Pump	20
D3	Fuel Filter	20
D4	Venting Fuel System	21
D8	Fuel Injection Pump	23
D9	Fuel Tank	26
E1	Lubricating Oil Filter	28
E3	Lubricating Oil Pump	28
F3	Air Cleaner	31
G1	Timing Cover	31
G3	Timing Gears	32
H6	Water Pump	35
	DIMENSIONAL DATA	36
	SUMMARY OF DESIGN CHANGES	40

MAINTENANCE

Daily

Engine Oil: Check oil level in engine sump and top up if necessary.

Air Cleaner: Remove filter bowl and examine condition of oil. In dusty conditions the oil should be changed frequently, the detachable wire element removed, washed in diesel fuel, and allowed to stand until all fuel has drained off. (Fig. 1.)

Paper Element Pre-Cleaner: This is an alternative fitting to the centrifugal type pre-cleaner and incorporates a replaceable paper element. Frequency of attention depends on working conditions and in dusty climates the cover should be removed every few hours of use and the element examined. The element can be cleaned by tapping its side to shake off the loose dust. If the element becomes very dirty, or contaminated with oil or water, it should be renewed. *Do not attempt to wash an element.* (Fig. 2.)

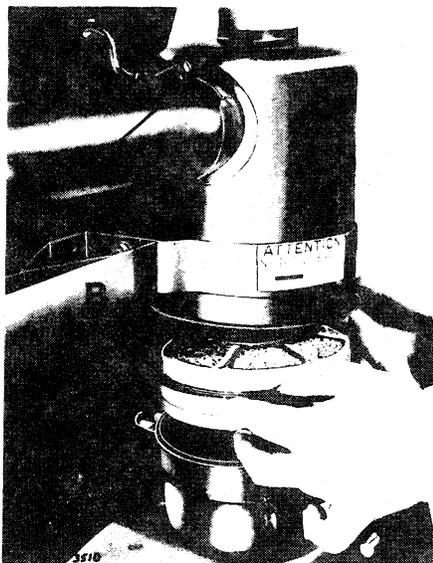


Figure 1. AIR CLEANER

- | | | |
|-----------------------|-----------------|------------------------|
| A. Oil bowl | B. Wire mesh | C. Rubber sealing ring |
| D. Cleaner inlet pipe | E. Cleaner body | |

Every 60 Hours

Engine Oil: Check oil level in engine sump and top up to within "safe" range if required.

Cooling System: Check radiator water level and top up to within 1 in. (2.5 cm) from top of filler neck if required. *If engine is hot, remove radiator cap slowly as system is pressurised and may scald hand if opened quickly.*

Sediment Bowl: Visually examine feed pump sediment bowl. Remove and clean if there is any accumulation of dirt or water. (Fig. 3.)

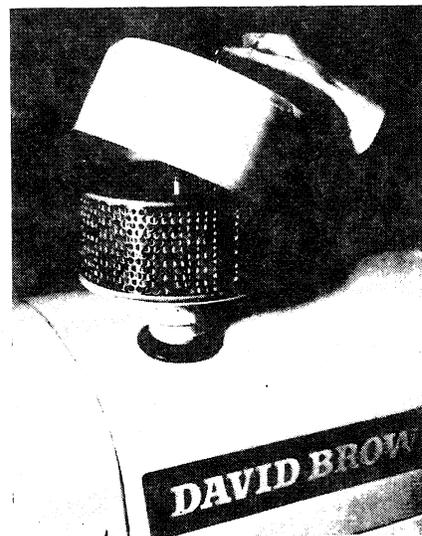


Figure 2. PAPER ELEMENT PRE-CLEANER

Air Cleaner: Remove bowl and detachable wire mesh element. Clean out bowl and refill with new, clean oil.

The depth of dust deposit in cleaner bowl must not be allowed to exceed $\frac{1}{4}$ in. (6.3 mm) when checked after standing overnight, otherwise oil pull-over into induction manifold will take place due to raised oil level. Oil in the induction manifold, which indicates oil pullover, can be checked through ether plug in manifold. Oil pullover will cause rapid engine wear and must be prevented by adequate cleaner maintenance.

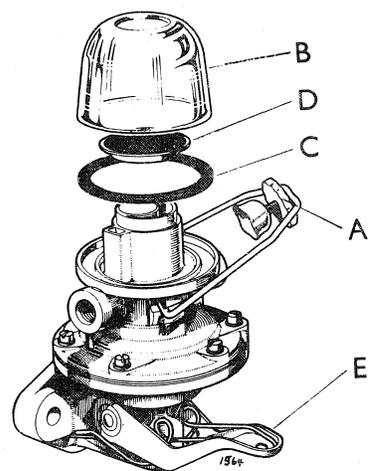


Figure 3. FEED PUMP SEDIMENT BOWL

- | | |
|----------------------|------------------|
| A. Bowl securing nut | B. Sediment bowl |
| C. Sealing ring | D. Filter screen |
| E. Priming lever | |

Every 125 Hours

Engine Oil: Drain oil, when engine is warm, through plug on underside of sump. Refill with approved oil to upper mark on dipstick.

Injection Pump (1200 Tractors only): Drain lubricating oil from injection pump, by means of drain plug in pump base, and refill with new engine oil until it commences to run out of level plug. (Fig. 37.)

Every 250 Hours

Oil Filter: Fit new element in engine lubricating oil filter. Do not attempt to wash a filter element. (See page 28.)

Every 500 Hours

Fuel Filter: Fit a new element in the first fuel filter but do not disturb second fuel filter. (See Page 20.)

Do not attempt to clean fuel filter elements and do not change elements from one filter to another.

Sediment Bowl: Remove and flush out feed pump sediment bowl, remove filter screen and clean with air blast. As the feed pump is lower than the fuel tank it is necessary to slacken outlet union on fuel tank, so that fuel will not siphon out when bowl is removed. Replace screen and bowl, ensuring that it seats on sealing ring in pump body then retighten fuel pipe union.

Injectors: Remove injectors for cleaning. Failure to clean injectors will result in the nozzle carbon deposit becoming so hard that it cannot be removed and a new nozzle will be required. (See Page 17.)

Valve Clearances: This should be done whilst injectors are removed and engine is cold. (See Page 8.)

Dynamo: Remove small rubber plug from centre of dynamo rear end-plate and inject a few drops of engine oil through hole and replace plug.

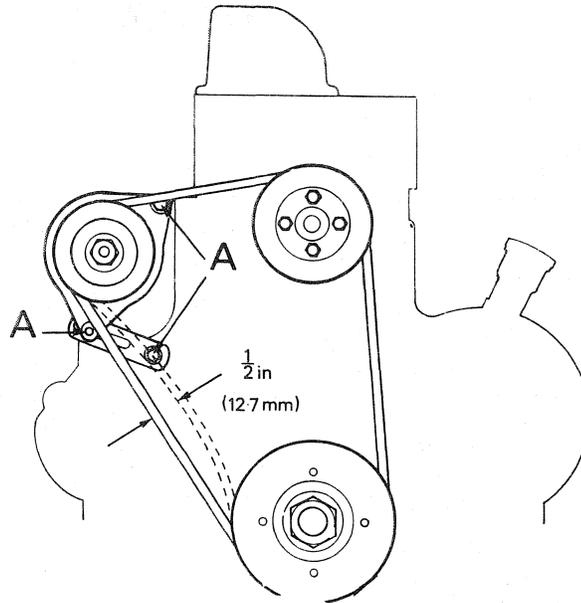


Figure 4. FAN BELT ADJUSTMENT

A. Dynamo mounting bolts

Fan Belt: Check fan belt tension by deflecting belt midway between fan and crankshaft pulleys. Belt should deflect approximately 1 in. (25 mm) and if necessary may be adjusted by releasing the three dynamo mounting bolts and swinging dynamo on two upper mounting bolts. Tighten lower bolt first as this will hold dynamo in position whilst upper bolts are tightened. Do not overtighten the belt. A taut belt will place excessive load on dynamo and water pump bearings and cause rapid belt wear. Renew belt if it has insufficient tension when dynamo lower mounting bolt is at end of adjusting slot. (Fig. 4.)

Every 1000 Hours

Fuel Filter: Using the same procedure as in 500 hours' service, fit new elements in both first and second fuel filters. Do not attempt to clean or interchange filter elements.

REPAIR OPERATIONS

● OPERATION A1

Engine Tune

If engine becomes difficult to start, or does not develop full power, carry out the following engine tune:

1. **Compression Test:** Use a test gauge as shown in the Service Tool List. Remove all injectors and, using a correct length of extension, fit gauge into No. 1 injector bore. Tighten down with injector nuts to give an airtight seal, and with the stop control in the "stop" position spin engine with starter motor. It is advisable to use a fully-charged battery as the higher the cranking speed the better. Note the gauge reading then repeat the procedure on the remaining cylinders. If the four readings are approximately the same, proceed with the engine tune. If there is a difference of more than 50 lb/sq. in. (3.5 kg/sq. cm) it will be necessary to remove the cylinder head as the loss of performance is due to weak compression and an engine tune will not be fully effective.
2. **Valve Clearance:** Whilst the injectors are out, remove valve rocker cover and check valve clearance (see Page 8). Adjust if necessary, noting that exhaust valves with a cap on the stem end (Fig. 20) should have 0.007 in. (0.18 mm) clearance, but exhaust valves not fitted with caps (Fig. 20) and all inlet valves should have 0.010 in. (0.25 mm) clearance.
3. **Injectors:** Service the injectors (see Page 17) before replacing. Take care to fit copper sealing washers on injector nozzles and tighten nuts down evenly to avoid distortion.
4. **Air Cleaner:** Clean out oil bath and refill to correct level with new oil. Wash wire mesh element, clean out inside of inlet pipe and pre-cleaner. If a paper element pre-cleaner is fitted clean or renew the element (see Page 31).
5. **Fuel- Filters:** Clean out fuel sediment bowl and replace fuel filter elements as necessary (see Page 20). Vent fuel system (see Page 21).
6. Start engine, allow to reach working temperature then check idling and maximum speeds. Re-set if necessary (see Page 22).

● OPERATION A2

Engine Removal and Replacement 1200 Tractors and 990 6-speed Tractors

Place tractor on firm and reasonably level ground and within reach of suitable lifting equipment.

Remove silencer and bonnet. Drain cooling system and disconnect battery earth lead.

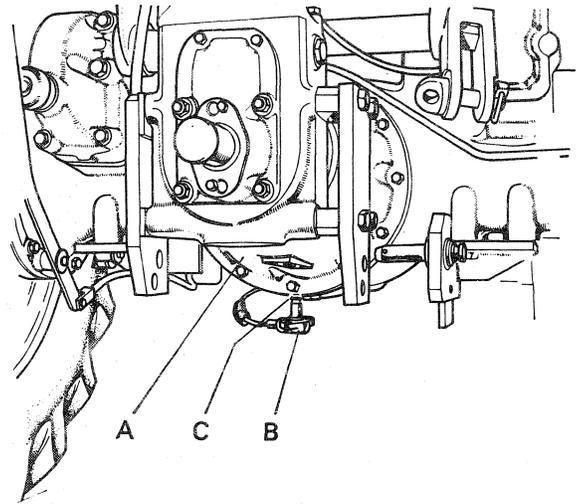


Figure 5. HYDRAULIC FILTER SWITCH — 990 Tractors

A. PTO case B. Adaptor C. 'O' ring—adaptor

Disconnect hoses and remove fan. Remove radiator on 990 Tractors; on 1200 Tractors the radiator and bonnet front need not be removed but the hydraulic pump driveshaft must be disconnected by releasing coupling from crankshaft pulley and removing rubber distance piece.

Disconnect fuel and leak-off pipes from tank; if tank is full it is advisable to drain the fuel to lighten tank. Remove hand throttle lever, disconnect instrument panel wiring and engine speed indicator drive cable. Remove fuel tank mounting bolts and remove tank complete with instrument panel.

Clean gearbox cover, top of rear axle case and adjacent areas to prevent dirt entering main frame when gearbox cover is removed.

Remove steering-box, complete with column and wheel: on 1200 Tractors the box should first be drained of oil. If tractor is fitted with hydrostatic steering, disconnect and drain oil reservoir, then disconnect pipes from servo valve and pump. Remove pump reservoir and servo valve complete with column and mounting bracket. Remove all pipes and *seal all pipe ends and unions* to prevent dirt entering system.

Remove starter and cable from battery to starter. Remove clutch housing — four bolts are positioned inside steering-box cavity — taking care of wedge and shims.

Release seat adjustment and slide seat fully rearwards. Remove gearbox cover bolts and lift off cover.

On Livedrive tractors it is necessary to drain the transmission oil into *clean containers*, remove PTO unit and withdraw cardan shaft clear of clutch. On 990 Tractors the hydraulic filter switch adaptor passes through underside of PTO case and *this adaptor must be removed* before PTO unit is withdrawn. (Fig. 5.)

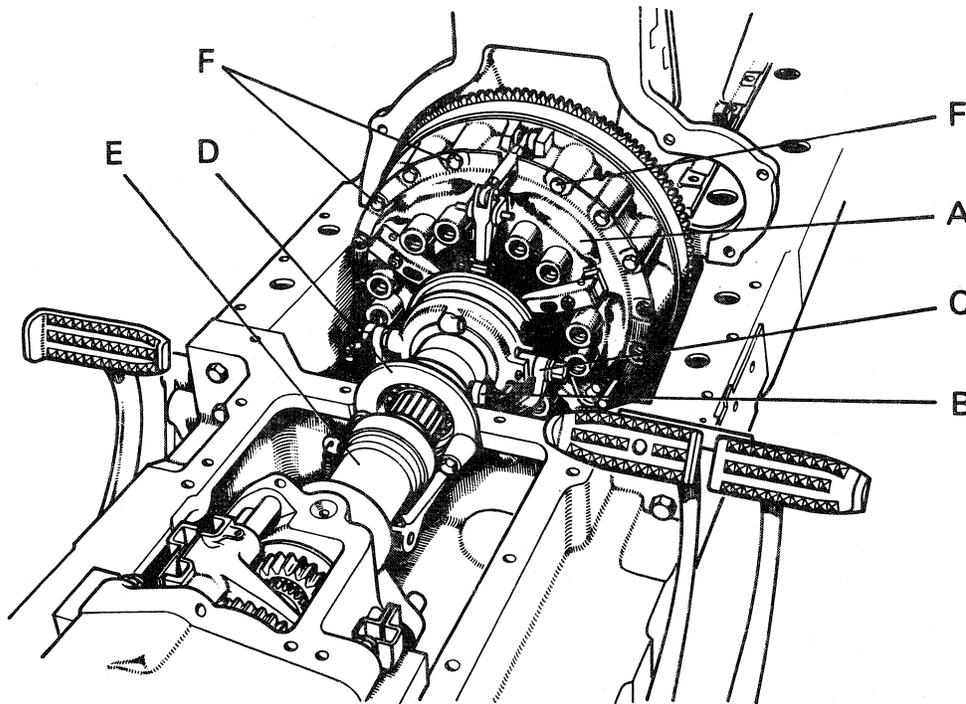


Figure 6. 1200 TRACTOR WITH CLUTCH HOUSING AND GEARBOX COVER REMOVED

- | | | |
|--------------------|------------------------------|-----------------------------|
| A. Clutch assembly | B. Transmission release fork | C. PTO release fork |
| D. Support snout | E. Muff coupling | F. Bolts—clutch to flywheel |

Disconnect clutch stop brake band, by removing pins from each end of band. Remove bolts attaching stop assembly to main frame and allow assembly to rest in bottom of frame.

Early 1200 Tractors have a plunger in each end of muff coupling and these should be removed by sliding spring clip to one side and then extracting plungers.

Release clutch driveshaft circlip from groove and slide muff coupling forward clear of gearbox shaft. On 990 Tractors the clutch-stop drum must be slid fully forward on shaft, to allow sufficient movement of muff coupling. On 1200 6-speed tractors slide muff coupling rearwards clear of clutch shaft.

On 1200 Tractors disconnect PTO release bearing housing from its fork by removing pivot bolt from left-hand side and split pin from right-hand side (Fig. 6). Disconnect bearing lubrication pipe if fitted.

On 990 Tractors remove the two figure-of-eight spring clips attaching clutch release bearing to its fork.

Remove bolts attaching cylinder block to main frame and fit lifting bracket (Fig. 7) on cylinder-head lifting nuts then lift engine unit, complete with clutch driveshaft and support snout, vertically out of frame. Guide muff coupling clear of gearbox as engine is raised and take care not to damage oil pump when lowering engine on to stand on bench. (Fig. 8.)

Refit engine in reverse order of removal, using new gaskets and seals, etc. Clean main frame and cylinder block faces, removing all traces of old gasket. Smear main frame and both sides of gasket with jointing compound before placing them in position. Fit new bearing-cap seals, pushing ends of seals into holes in block so that seals fit closely in bearing-cap grooves.

Two $\frac{3}{8}$ UNC studs temporarily screwed into main frame at opposite points will assist in locating engine and allow it to be lowered into position without disturbing the gaskets.

Fit clutch driveshaft, complete with release bearing, support snout, circlips, clutch-stop drum and muff coupling, into clutch assembly.

On 1200 Tractors the transmission release fork engages with slots in bearing sleeve and *care must be taken to position sleeve so that slots fit over fork when engine is lowered into position.* (Fig. 9.)

After lowering engine into position check that cylinder block is correctly seated on main frame, with both locating dowels engaged, and support snout is in line with frame holes. Connect the clutch release bearings to their forks and check that they operate quite freely.

Ensure that gearbox and clutch shafts are in line by checking that muff coupling can be freely engaged on shaft splines in all positions through full 360°.

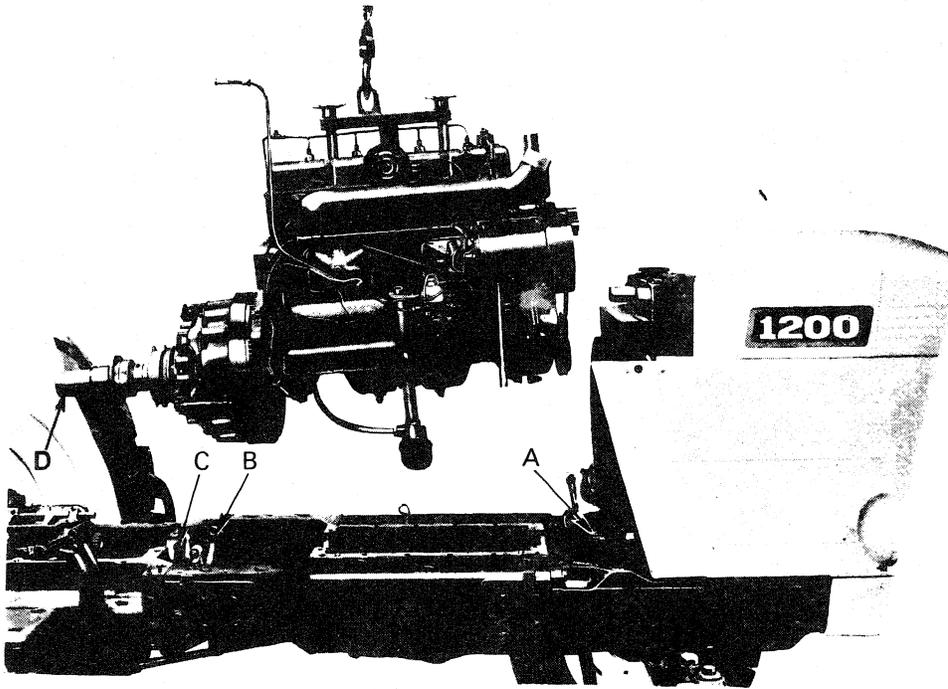


Figure 8. REMOVING ENGINE UNIT

- | | |
|------------------------------|--------------------|
| A. Hydraulic pump driveshaft | B. PTO clutch fork |
| C. Transmission clutch fork | D. Muff coupling |

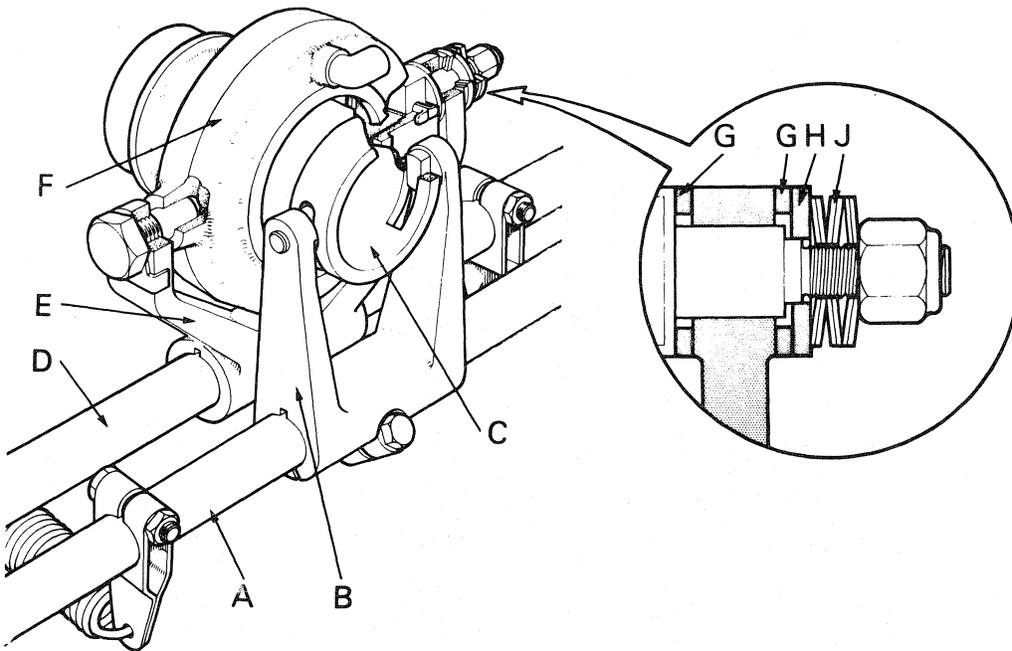


Figure 9. CLUTCH RELEASE MECHANISM — 1200 TRACTORS

- | | | | | |
|----------------|-----------------------|--------------------|--------------|-----------------------|
| A. Cross shaft | } Transmission clutch | D. Cross shaft | } PTO clutch | G. Friction washer |
| B. Fork | | E. Fork | | H. Special washer |
| C. Sleeve | | F. Bearing carrier | | J. Belleville washers |

except for last gallon, which will have accumulated most of the sediment, and top up with new oil.

When re-assembly is complete, carry out a full engine tune. (See Page 3.)

990 12-Speed Tractors

As these tractors do not have a muff coupling — the clutch driveshaft fits directly into the gearbox — the engine cannot be lifted from main frame with the clutch in position. To remove the engine it is therefore necessary to first "split" the tractor, to disengage clutch from driveshaft, then lift engine from front half of frame.

With the tractor standing on firm, level ground and positioned within reach of lifting equipment, remove bonnet and disconnect battery.

Remove hand throttle lever, disconnect engine controls. Disconnect engine speed indicator cable and instrument panel wiring. Disconnect leak-off and fuel pipes from tank, then remove fuel tank, complete with instrument panel. Place a jack under front end of main frame to support rear half of tractor when front half is withdrawn. Place a wooden block between jack and main frame and extend jack so that it takes weight but does not lift tractor. Drive two suitable wooden wedges between each side of front extension and axle beam, to ensure that front half of tractor will remain upright when separated. Drive wedges firmly into position to prevent any possibility of them becoming dislodged.

Place a trolley-jack under flywheel housing so that front half of frame can be eventually drawn forward.

Remove drop-arm from steering-box shaft and remove starter motor.

If tractor is fitted with hydrostatic steering disconnect and remove pipes from servo valve. Seal all pipe ends and unions to prevent dirt entering system.

Adjust height of trolley-jack so that it takes weight but does not lift tractor, then remove bolts attaching clutch housing and rear main frame to front half of tractor. Adjust so that they support tractor level, with main frame faces parallel, then draw front half of tractor forward until it is clear. Drain cooling system, remove radiator hoses and fan. Attach lifting bracket (Fig. 10) to lifting nuts on cylinder head, remove bolts holding engine to main frame then lift engine unit, complete with flywheel and clutch. Take care not to damage oil pump when lowering engine on to stand or bench.

Replace engine in reverse order of removal, using new gaskets, etc. Clean main frame and cylinder block faces, removing all traces of old gasket. Smear main frame and both sides of gaskets with jointing compound then place gaskets in position on frame. Fit new bearing cap seals, pushing ends of seals into holes in block so that seals fit into bearing cap grooves.

Lower engine carefully on to main frame; two $\frac{3}{8}$ UNC studs screwed into main frame at opposite points will assist in locating engine and allow it to be lowered into position without disturbing the seals.

Before pushing halves of tractor together check clutch release bearing and PTO cardan shaft. Push and turn shaft to ensure that it is engaged on PTO

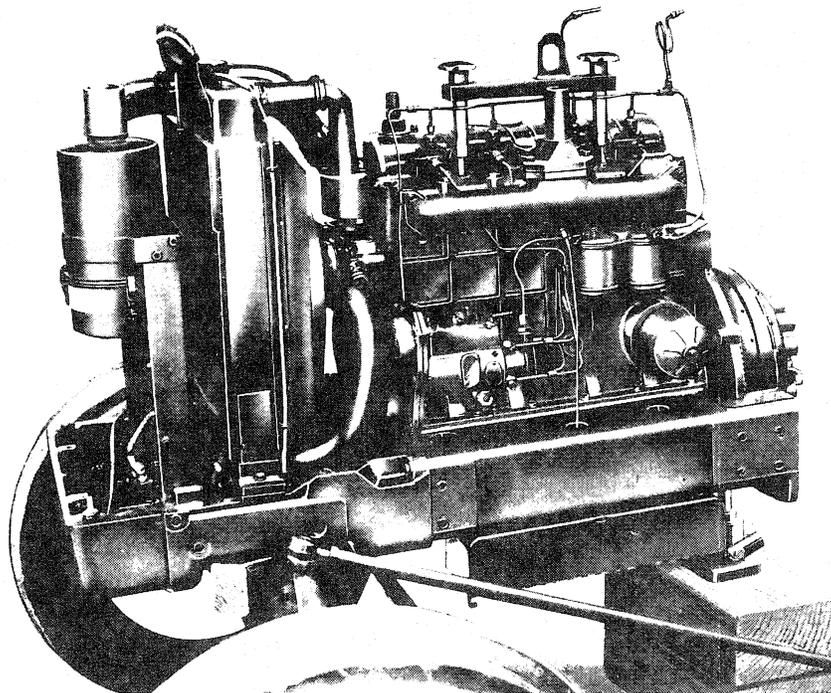


Figure 10. 990 TRACTOR 'SPLIT' FOR ENGINE REMOVAL

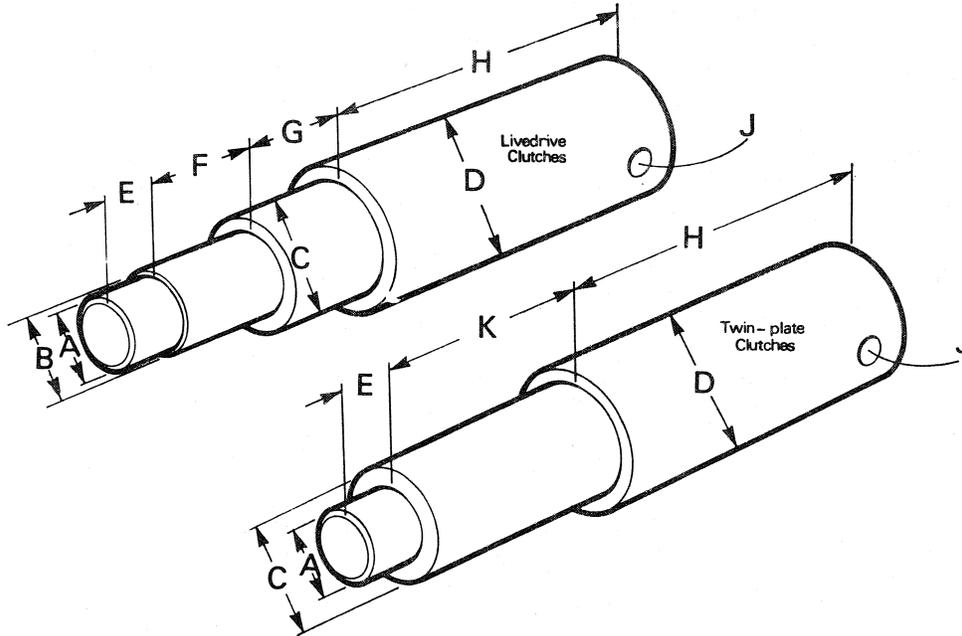


Figure 11. CLUTCH PLATE PILOT — 990 TRACTORS

A. 0.874 in. (22.20 mm)	B. 0.915 in. (23.24 mm)	C. 1.420 in. (36.07 mm)	D. 1.771 in. (44.98 mm)
E. $\frac{5}{8}$ in. (15.88 mm)	F. $1\frac{1}{2}$ in. (38.10 mm)	G. $1\frac{3}{4}$ in. (44.45 mm)	H. 5 in. (127 mm)
	J. $\frac{5}{8}$ in. (9.5 mm) dia.	K. $3\frac{1}{2}$ in. (82.55 mm)	

shaft splines. If clutch has been disturbed — and it is advisable to service clutch unit whilst it is accessible — ensure that clutch plates have been centralised by using a clutch pilot (Fig. 11) when clutch assembly is fitted to flywheel.

Bring two halves of tractor together, adjusting height of jacks to bring gap between frames parallel — two $\frac{7}{16}$ UNC studs screwed into frame at opposite points will assist in centralising the two halves. When driveshafts enter clutch, engage low gear and turn engine until transmission plate splines engage on driveshaft. At the same time, engage PTO high ratio and turn PTO shaft until cardan shaft splines enter clutch plate. When frames are together and dowels entered, fit bolts and tighten evenly to avoid distorting frame flanges.

When re-assembly is completed, and cooling system refilled with water, tune engine as described on Page 3.

● OPERATION B1

Valve Clearance Adjustment: As the valve clearance must only be checked when the valve is at the back of cam — this position is reached when the opposite valve is full open — remove valve rocker cover and adjust valves in the following order:

- Adjust No. 1 valve when No. 8 valve is full open.
- Adjust No. 6 valve when No. 3 valve is full open.
- Adjust No. 4 valve when No. 5 valve is full open.
- Adjust No. 2 valve when No. 7 valve is full open.
- Adjust No. 8 valve when No. 1 valve is full open.
- Adjust No. 3 valve when No. 6 valve is full open.

Adjust No. 5 valve when No. 4 valve is full open.
Adjust No. 7 valve when No. 2 valve is full open.

Check clearance between tip of rocker arm and end of valve stem and if incorrect adjust by means of adjusting screw on rocker arm. Firmly tighten lock-nut after resetting screw then recheck clearance. (Fig. 12.)

All inlet valves, and also exhaust valves not fitted with a stem end cap (Fig. 20) should have 0.010 in. (0.25 mm) clearance, but exhaust valves with a cap on the stem end (Fig. 20) should have 0.007 in. (0.18 mm) clearance.

Check tightness of all adjusting-screw locknuts before replacing rocker cover.

● OPERATION B2

Cylinder Head Removal: Drain cooling water from radiator and cylinder block. Remove air inlet pipe and both manifolds. Remove top water hose and valve rocker cover. Disconnect oil feed pipe to cylinder head, remove rocker shaft and push rods.

Remove cylinder head nuts and bolts in the reverse order of tightening (Fig. 13). Remove gasket, clean block face and oil cylinder bores before covering with a cloth for protection.

Refitting Cylinder Head: Refit the head in the reverse order of removal, paying attention to the following:

1. Check thermostat and renew if necessary (see Page 34) Fit a new sealing ring on water pump by-pass connection.

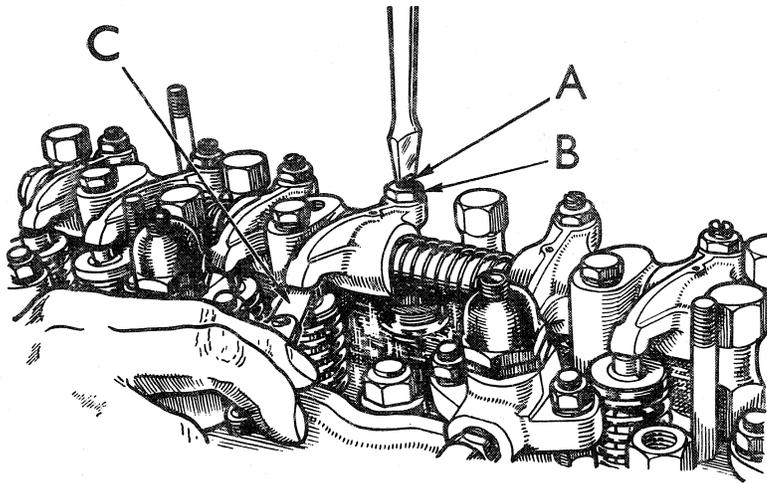


Figure 12.

SETTING THE VALVE CLEARANCES

- A. Adjuster screw
- B. Locknut
- C. Feeler gauge

2. Clean and lightly oil the cylinder bores.
3. Coat both sides of head gasket with Wellseal, or a good brand of thin non-hardening jointing compound. The use of an unsatisfactory jointing compound may allow water seepage.
4. Ensure that head and block faces are clean and the gasket is fitted with the word "Top" towards the cylinder head.
5. Tighten head bolts and nuts in the order shown in Fig 13 and in three stages of 30, 60 and 90 lb ft (4, 8 and 12.5 kg metres).
6. Renew any bent push rods and if exhaust valves have stem end caps do not forget to replace these. Firmly tighten the rocker shaft pedestal bolts.
7. Carry out a full engine tune (valve clearances, air cleaner, etc.) as described on Page 3.
8. After the engine has run for approximately 1½ hours check rocker shaft bolts, tighten head bolts to 90 lb ft (12.5 kg metres) then check valve clearances.

CAUTION: Never run an engine without cooling water as this may cause cylinder glazing and subsequent high oil consumption.

● **OPERATION B3**

Decarbonising the Engine: When compression is low, or engine is down in power due to an accumulation of carbon inside combustion chamber, the cylinder head should be removed, cleaned of carbon and the valves re-seated

Remove injectors for servicing. Mark valves lightly for identification and, using a suitable compressor, remove valve cotters, cups and springs. Remove inlet valve seals, clean carbon from cylinder head and inspect head face, valve seats and guides.

● **OPERATION B3a**

Valves: Remove all carbon and examine the valve heads and stems. Discard valves if cotter location or valve stem is worn. If seat is pitted valves may be refaced at 45° provided that sufficient metal remains to avoid a sharp edge on valve head.

Valve Changes: The current valve, Part No. 928622, is now fitted to both inlet and exhaust on 4/55 and 4/49 engines. This valve may be used to

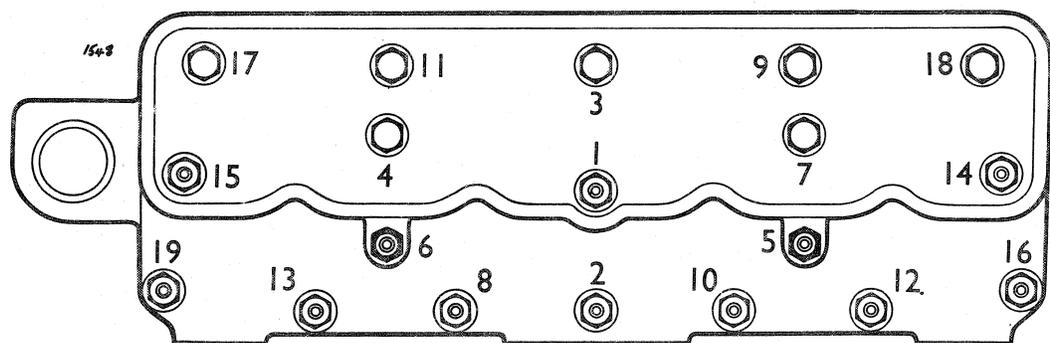


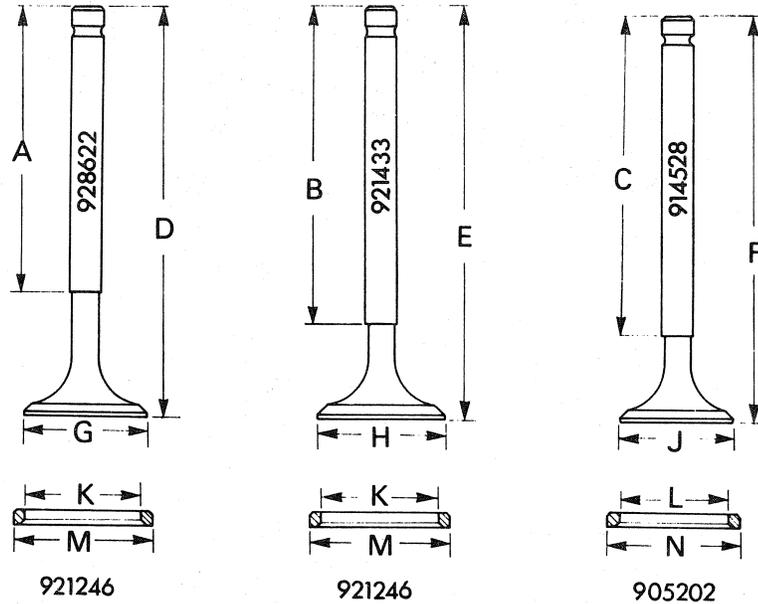
Figure 13. CYLINDER HEAD TIGHTENING SEQUENCE

Tighten bolts and nuts in order shown and in three stages of 30, 60 and finally 90 lb. ft. (4, 8 and 12.5 kg metres)

Figure 14.

INLET VALVES AND SEAT INSERTS

- A. $3\frac{1}{2}$ in. (88.52 mm)
- B. $3\frac{1}{4}$ in. (95.25 mm)
- C. $3\frac{1}{8}$ in. (96.84 mm)
- D. 4.890 in. (124.21 mm)
- E. 4.860 in. (123.44 mm)
- F. 4.840 in. (122.94 mm)
- G. 1.505 in. (38.23 mm)
- H. 1.475 in. (37.46 mm)
- J. 1.380 in. (35.05 mm)
- K. $1\frac{3}{8}$ in. (34.92 mm)
- L. $1\frac{9}{32}$ in. (32.54 mm)
- M. 1.631 in. (41.43 mm)
- N. 1.568 in. (39.83 mm)



replace inlet valve 921433, previously used on all 4/49 engines from commencement of production, and 4/55 engines fitted with high-lift camshaft and larger diameter valves, but cannot be used to replace 914528 inlet valves, which were used on 4/55 engines up to No. 4912. (Fig. 14.)

The 928622 valve may be used to replace exhaust valves 921434, which were fitted on all 4/49 engines from commencement of production, and 4/55 engines fitted with high-lift camshaft and larger

diameter valves, provided that the original stem end caps, cotters and cup are discarded and the latest type cotters and cups are fitted. The 928622 valve should not be used to replace 900417 exhaust valves, which were fitted to 4/55 engines up to No. 4912. (Fig. 15.)

When fitting 928622 valves ensure that the width of seat in the head insert is not less than 0.045 in. (1.14 mm) wide, to ensure that the valve does not seat at the edge of the valve head.

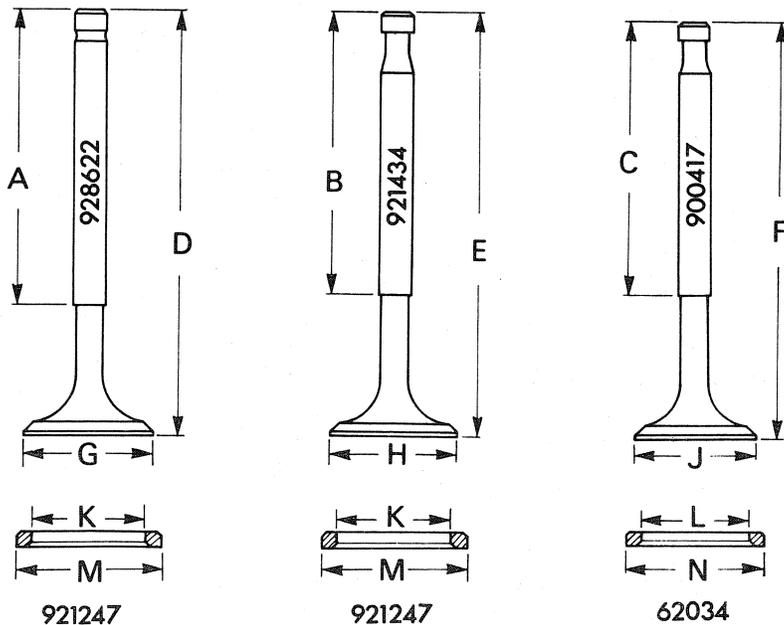
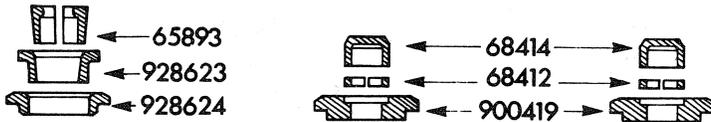


Figure 15.

EXHAUST VALVES AND SEAT INSERTS

- A. $3\frac{1}{2}$ in. (88.52 mm)
- B. $3\frac{1}{4}$ in. (82.55 mm)
- C. $3\frac{5}{8}$ in. (80.17 mm)
- D. 4.890 in. (124.21 mm)
- E. 4.835 in. (122.81 mm)
- F. 4.798 in. (121.87 mm)
- G. 1.505 in. (38.23 mm)
- H. 1.456 in. (36.98 mm)
- J. 1.362 in. (34.59 mm)
- K. $1\frac{5}{16}$ in. (33.34 mm)
- L. $1\frac{7}{32}$ in. (30.96 mm)
- M. 1.631 in. (41.43 mm)
- N. 1.568 in. (39.83 mm)

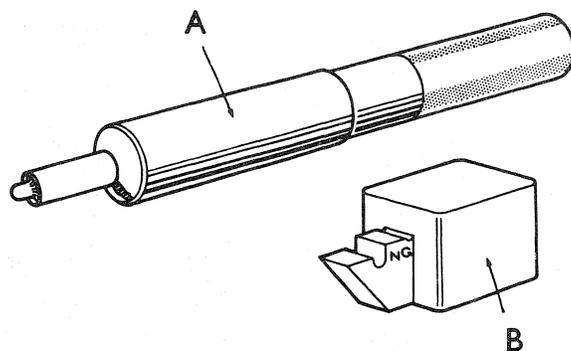


Figure 16. CYLINDER HEAD FACE GAUGES

A. Depth gauge (960938) B. Slip gauge (960940)

● OPERATION B3b

Valve Seat Inserts: Examine the seats for pitting, cracking, looseness and excessive seat width. If the seats are in good condition, grinding in the valves will be all that is required, but if the seats are pitted they may be recut to 45° after using a glaze breaker. Seat width should not be more than 0.065 in. (1.7 mm) and may be reduced slightly using 15° and 75° cutters.

Cracked or loose inserts should be renewed. Do not attempt to secure a loose insert by centre-punching the cylinder head face.

Removing a Seat Insert: Very carefully drill the insert at two opposite points, without damaging the cylinder head, then split the insert so that it can be removed without enlarging the head counterbore.

Fitting a Seat Insert: New standard inserts may be fitted if the diameter of the head recess is not greater than the initial machining dimensions shown on Page 37, otherwise a special insert will have to be made to maintain the original interference fit.

The cylinder head must be very clean and heated in water to near boiling point: a steam jenny is ideal for this purpose. Cool the insert in dry ice (solid carbon dioxide) then place it on a suitable mandrel, or guide, and quickly tap it into the head recess: chamfer on outside of insert towards cylinder head.

After fitting the insert, lightly cut at 45° until the seat is 0.045–0.055 in. (1.14–1.40 mm) wide and within 0.0015 in. (0.04 mm) of being concentric with valve stem bore.

● OPERATION B3c

Valve Guide Bores: The valve stems operate directly in the cylinder head (no separate guides) and if, after cleaning, the bores are found to be larger than 0.381 in. (9.68 mm) — or 0.006 in. (1.52 mm) clearance with a new valve — the bores should be reamed oversize and appropriate oversize valves fitted. Use the reamer, Part No. 960989 (0.010 in. oversize), or 961824 (0.020 in. oversize),

in a vertical pillar drill, running at its slowest speed; apply a liberal quantity of cutting fluid and take special care not to damage the sharp edge at top of exhaust bores.

Cylinder Head Face: This should be free from distortion or damage, otherwise the gasket will be unable to provide an effective seal. Check the face with a straight-edge and feeler gauge and reface if distorted more than 0.003 in. in any 6 in. (0.075 mm in any 150 mm).

As the maximum amount of metal that should be removed from the head face is 0.030 in. (0.76 mm) use Service Tools 960938 and 960940 (Fig. 16) to check how much metal can be removed. Insert depth gauge into injector bore, ensuring that both bore and gauge are clean, then check protrusion of depth gauge above head face with slip gauge. If face G of slip gauge beak fouls end of depth gauge the cylinder head face has been previously ground to the limit and no further grinding is permissible. If beak face G passes over the end of depth gauge the head face can be ground and the thickness of the feeler gauge which can be fitted between tip of depth gauge and face G is the maximum amount of metal that should be removed. (Fig. 17.)

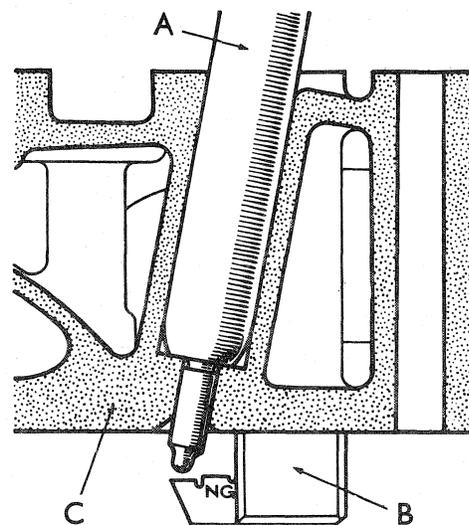


Figure 17. CHECKING CYLINDER HEAD BEFORE REFACING

A. Depth gauge B. Slip gauge C. Cylinder head

If the head face is reground, care must be taken to obtain a smooth finish: use a fine stone with a slow feed.

Valve Grinding: If rectification of valves and seats has been carefully carried out only light regrinding will be necessary to obtain a good air-tight seat.

Distorted valves, eccentric seats, irregular seats, excessive seat width, excessive refacing of valves and excessive valve stem clearance will all cause compression loss and result in shortened valve life.

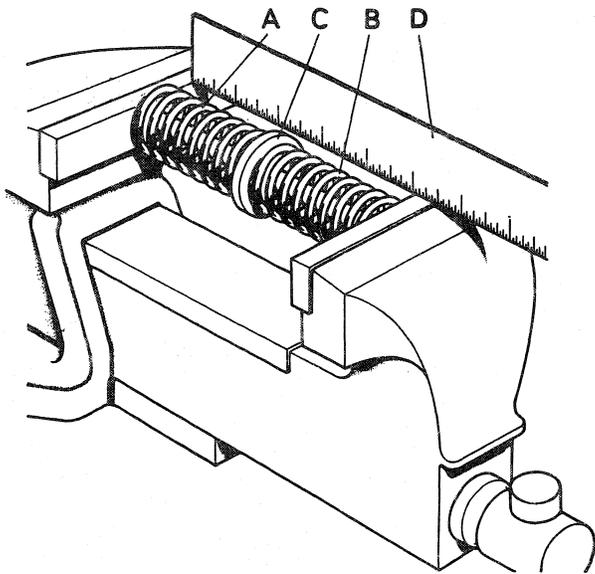


Figure 18. CHECKING VALVE SPRINGS

- | | |
|---------------|---------------|
| A. New spring | B. Old spring |
| C. Spacer | D. Rule |

When all valves have been ground-in, wash the head and valves in kerosene until all traces of grinding compound has been removed, then dry with an air-line.

Valve Springs: If suitable equipment is available, check spring lengths when under load. If equipment is not available check springs by comparing their

tension with the tension of new springs. (Fig. 18.)

1. Select an average length spring from a set of new springs to use as a guide.
2. First compare free-length of new spring against old springs and discard any springs whose free-length is over $\frac{1}{8}$ in. (1.5 mm) shorter than the new spring.
3. Finally compare loaded length of springs by compressing the new spring and each old spring in turn, in series between vice jaws. For safety fit a short piece of bar, slightly smaller than inner diameter of springs, inside the springs and fit a short spacer between the spring ends. Compress springs between vice jaws until new spring is reduced to its loaded length (see data page) then measure length of old spring. If old spring is within $\frac{1}{8}$ in. (1.5 mm) of length of new spring it is satisfactory and can be refitted but any spring whose compressed length is more than $\frac{1}{8}$ in. (1.5 mm) shorter than new spring is weak and must be discarded.

Replace any weak, broken or corroded springs. If the engine has been run for a large number of hours it is advisable to replace the complete set of springs.

Valve Rockers: Remove rocker shaft assembly and place on bench. Unscrew brass plugs from ends of shaft and remove springs, rockers and shaft brackets, placing them in order on bench.

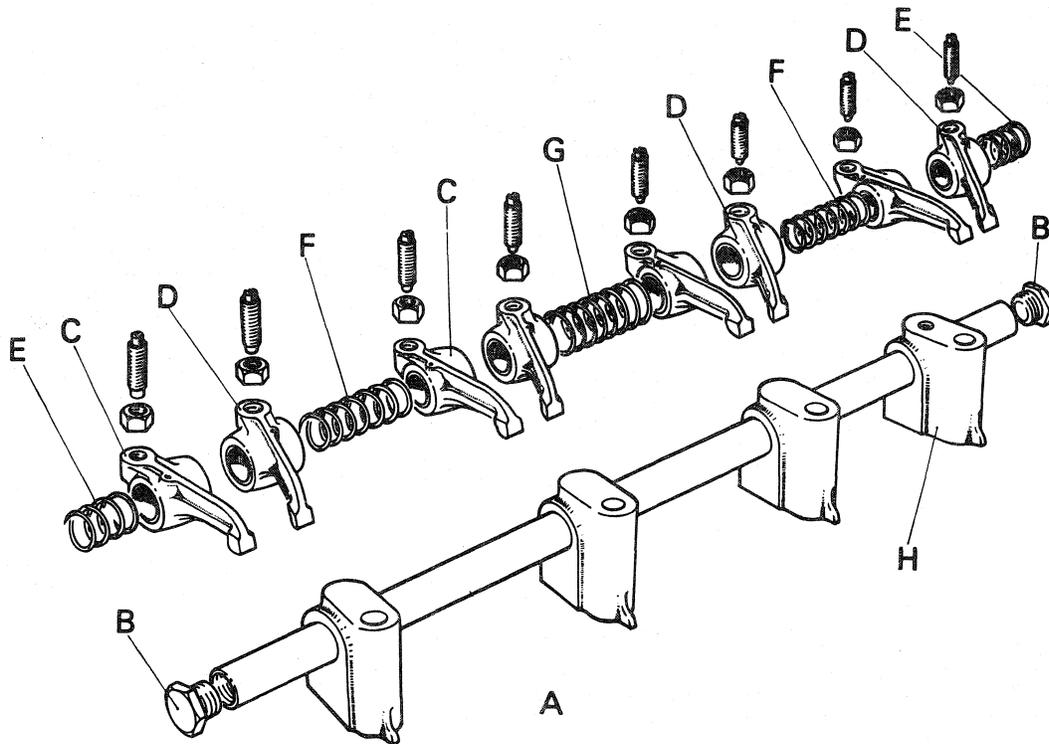


Figure 19. ROCKER SHAFT ASSEMBLY

- | | | |
|-----------------------|-----------------|------------------------|
| A. Rocker shaft | B. End plug | C. Rocker, left-hand |
| D. Rocker, right-hand | E. End spring | F. Intermediate spring |
| G. Centre spring | H. Rear bracket | |

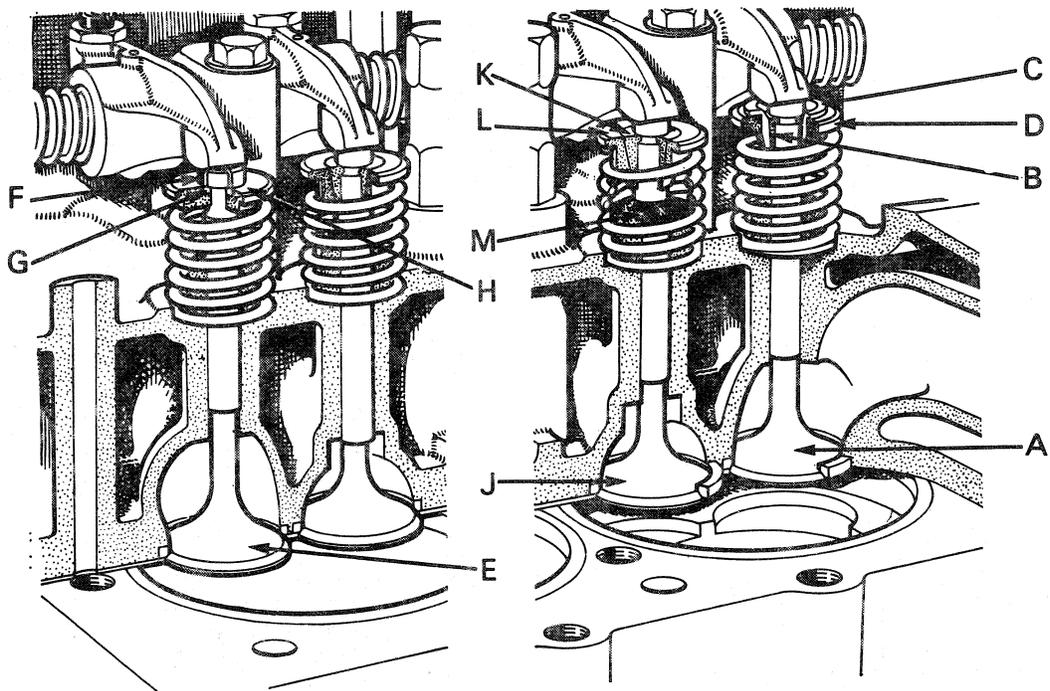


Figure 20. CYLINDER HEAD AND VALVES

A. Exhaust valve	} Late type valve	E. Exhaust valve	} Early type valve	J. Inlet valve
B. Cotters		F. Cap—stem		K. Cotters
C. Collar		G. Cotters		L. Cup
D. Cup		H. Cup		M. Seal

● OPERATION B3d

Renew any rockers that are excessively worn on the tip. If rocker bushes are worn, these can be renewed. Press out worn bush and press new bush into position, ensuring that oil-holes are aligned. Hone or ream bush after fitting until rocker is free to slide on shaft.

Clean out the rocker shaft, ensuring that all the oilways are clear. Check that rocker bracket faces are completely flat where they seat on the cylinder head. Renew any brackets that are distorted or worn.

Assemble rockers, springs and brackets on shaft in same order as removed. Fit locating screw into rear bracket — oil-holes in shaft are towards bottom of brackets — then lock screw by peening bracket over screw-hole. (Fig. 19.)

Inlet Valve Seals: Having thoroughly cleaned the head and valves, fit new inlet valve stem seals. Ensure there are no burrs in the head chamfer and use Service Tool 961236, or a hollow drift. *Do not use a drift that touches the sharp edge of the seal.* Place seal on tool, smear seal with grease and place in recess, then drive seal home with two or three sharp taps with a copper hammer. Do not use undue force.

Do not fit seals until cylinder head is ready for assembling and do not withdraw a valve once it has

been fitted through a seal. Pulling a valve stem through a seal causes the cotter groove to trap and damage the sharp edge of the seal and it is therefore necessary to fit a new seal once a valve is removed.

Assembling Cylinder Head: Smear valve stems with clean oil and fit into their correct positions in cylinder head. Replace springs, collars and cotters, using a suitable tool to compress the valve springs.

Exhaust Valve Caps: If the exhaust valves are fitted with caps, check the stem-end clearance with a Plastigauge. The clearance should be 0.002 to 0.006 in. (0.05 to 0.15 mm) and can be reduced by grinding the cap, provided the cap edge remains square and the sharp corner is removed. (Fig. 20.)

Manifolds: Clean both manifolds, ensuring that the drain-hole and pipe in the exhaust manifold are clear.

Cylinder Block: If the bores are scored, or worn more than 0.010 in. (0.25 mm), they should be rebored to 0.020 in. or 0.040 in. oversize. To maintain balance, always rebore all four cylinders to the same oversize diameter.

Sealing Rings: The sealing rings at the top of the bores have 0.003 in. (0.08 mm) protrusion above the block and it is necessary to remove the rings to rebore the cylinders. New rings, with the appropriate oversize bore, should be fitted after reboring. Ensure the block recesses are clean, smear the rings with

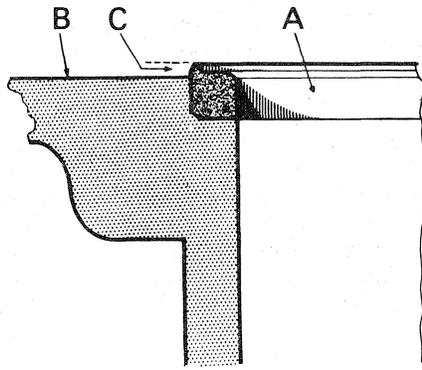


Figure 21. CYLINDER BLOCK SEALING RINGS

A. Sealing ring B. Cylinder block face C. Protrusion

Wellseal, or similar non-hardening jointing compound, then push into place, taking care not to damage the ridge on the ring top edge. Wipe off all surplus jointing compound. (Fig. 21.)

● OPERATION C2

Pistons and Connecting Rods

Piston Removal: The pistons cannot be removed through the sump when crankshaft is in position but can be withdrawn upwards after removing cylinder head. Mark pistons before removal and remove all connecting rod bolts, otherwise bolt heads may score the bore. Connecting rod bolts are $\frac{7}{16}$ BSF thread and the nuts are $\frac{3}{8}$ in. across flats.

Pistons: The pistons fitted in 4/55 and 4/49 engines are the same diameter and use the same rings, but are not interchangeable due to their different heights: 4/55 pistons may be identified by the two scallops at the bottom of the skirt.

Pistons on engines with a high-lift camshaft have slightly deeper valve recesses and pistons with

shallower recesses must not be fitted to engines having a high-lift camshaft as the valve heads may foul the piston. High-lift camshafts are fitted to all 4/49 engines, and 4/55 engines from No. 4913, and when fitting new pistons to these engines ensure that only pistons with the larger, 1.58 in. (40.1 mm) diameter, valve recesses are used. (Fig. 22.)

When refitting pistons in cylinder block, space the ring gaps so that they are as far apart as possible and ensure that the piston is fitted with the *valve recesses towards the camshaft side of cylinder block.*

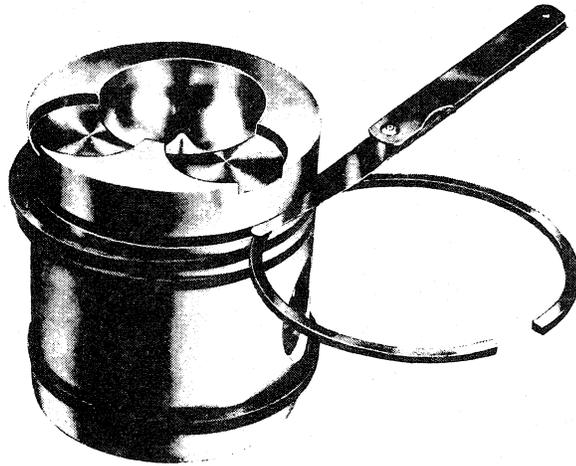


Figure 23. CHECKING PISTON RING GAP

● OPERATION C2b

Piston Rings: There are three compression rings and a scraper ring on each piston. The top compression ring is chromed and the second and third rings have an internal step and must be fitted with the word "Bottom" stamped on the ring towards the piston skirt.

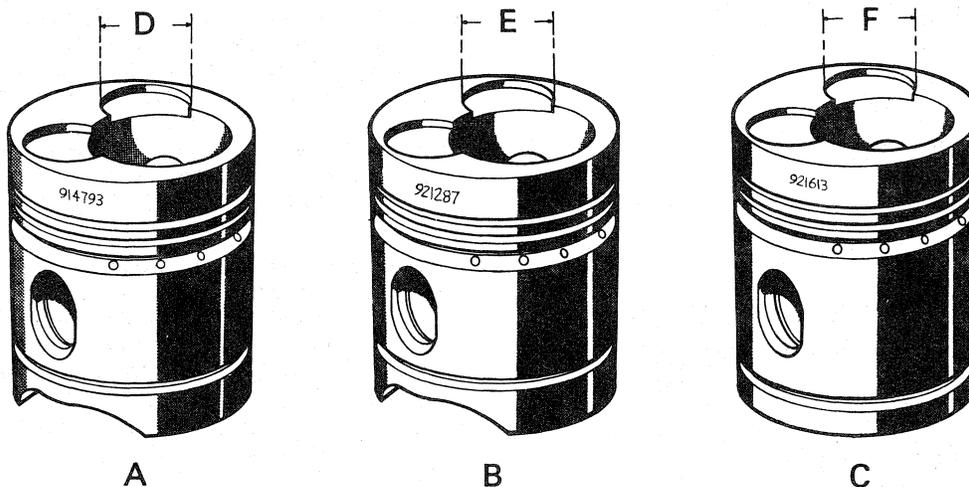


Figure 22. IDENTIFICATION OF PISTONS

A. Early 1200 piston
D. 1.50 in. (38.1 mm) dia.

B. Later 1200 piston
E. 1.58 in. (40.1 mm) dia.

C. 990 Piston
F. 1.58 in. (40.1 mm) dia.

After removing carbon from the top, unworn part of the cylinder bore, place the rings in position and check the ring gaps (Fig. 23). New rings will be required if the gaps exceed 0.060 in. (1.52 mm). Excessive top ring wear may be attributed to the ingress of dusty air, due to lack of air cleaner maintenance, and excessive lower ring wear may be caused by dirty oil, due to infrequent oil and filter changes.

If the cylinder bores are worn, but not sufficiently for reboring, a set of oil control rings may be fitted. These sets, which are available for both standard and oversize bores, include spring-loaded steel scraper rings and special top rings, which have a shoulder at the top, so that they do not foul the ridge at the top of the bores. For further guidance on bore wear see Page 37.

● OPERATION C2c

Gudgeon Pins: The fully floating gudgeon pins are retained by a circlip at each end of pin. To remove pin from piston: mark connecting rod and piston, remove both circlips, then immerse piston in hot oil. This will expand piston and allow pin to be pushed out. Refit pin in same manner, using hot oil, and ensure circlips are fully seated in piston grooves.

● OPERATION C2d

Connecting Rods: The small end of connecting rod is bushed and this can be replaced if worn. Press out worn bush, using a suitable sized mandrel,

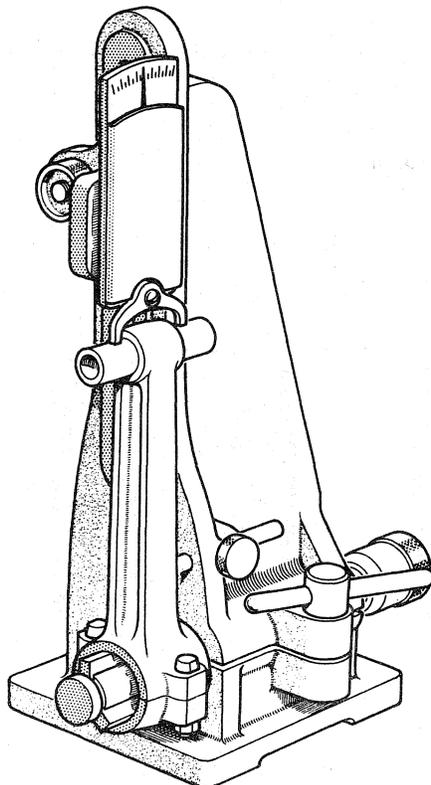


Figure 24. CONNECTING ROD ALIGNMENT GAUGE

and press in new bush, ensuring that oil-hole is opposite hole in end of rod. Hone, or ream, bush after fitting until gudgeon pin is a light push fit.

Connecting rods should always be checked for alignment whenever they are removed and especially if the piston skirt marking is uneven. The easiest way of checking alignment is by means of a proprietary aligning tool such as shown in Fig. 24, but if such a tool is not available mandrels and V-blocks may be used. Renew any rod that is out of alignment (see Page 38). Do not attempt to straighten a distorted connecting rod.

● OPERATION C4

Camshaft is fitted from front of cylinder block and retained in position by locating-plate behind camshaft gear. To remove camshaft it is necessary to remove valve rockers, push rods, lubricating oil and fuel feed pumps. Bolts attaching locating-plate to cylinder block are behind camshaft gear and are accessible through holes in gear. As the tappets will fall and jam against shaft journals when shaft is moved forward it is necessary to invert cylinder block, or if engine is *in situ* to hold tappets up with spring clips or by placing a ½ in. (12.7 mm) diameter 'O' ring on each tappet.

Camshaft bearings are pressure fed from the oil gallery and the shaft journals run directly in cylinder block. Rear journal is drilled to supply a reduced flow of oil to valve rocker shaft.

High-lift camshaft, Part No. 921769, is fitted to all 4/49 engines and 4/55 engines from Serial No. 4913, and when fitting a new camshaft on 4/55 engines prior to this number ensure that an early type shaft — this may be identified by the part number (914673) cast between the two rear cam lobes — is fitted, otherwise the valve heads may foul the pistons.

Crankshaft and Bearings

The steel-backed crankshaft bearings are faced with a thin coating of soft anti-friction material. Early bearings were faced with different material (upper shells with white metal and lower shells with aluminium tin), but later upper shells are faced with aluminium tin and the same shell is used in both upper and lower positions. The later shells are interchangeable but must always be fitted in pairs. Do not fit early white metal upper shells in the lower position.

Once they have run against a journal, bearing shells are not interchangeable and if not renewed must be refitted against the original journal. Bearing caps and shells are very accurately machined and no attempt should be made to file a bearing cap or scrape a bearing. Connecting-rod caps must only be used with their original connecting rod, and main bearing caps must only be fitted to their original cylinder block.

Crankshaft Regrinding: If the crankshaft journals are scored, or worn, the shaft should be reground to 0.010, 0.020 or 0.030 in. undersize and appropriate undersize bearings fitted. Regrind centre

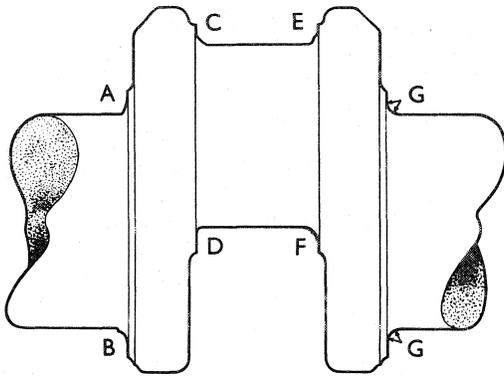


Figure 25. EXAMPLES OF REGROUND FILLET RADII

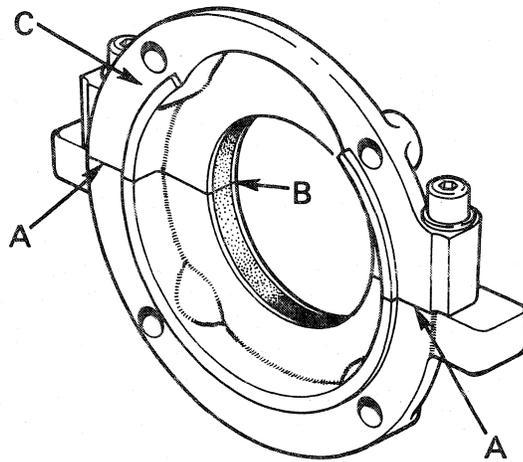
- | | | |
|-----------|---|--|
| Incorrect | } | A. No radius |
| | | B. Radius not smoothly blended |
| | | C. Radius too large |
| | | D. Radius too small |
| | | E. Radius too small |
| Correct | } | F. Radius roughly finished |
| | | G. Correct radius smoothly finished and correctly blended. |

journal thrust faces to 0.010 or 0.040 in. oversize (see Wear Limits Page 37).

When regrinding crankshaft it is important that the original bearing fillet radius is maintained. It is also important that the surface of the radius is as smooth as the surface of the journal, and the radius is smoothly blended into both surfaces. *A fillet that is incorrectly radiused, roughly finished or not smoothly blended, weakens a shaft and may cause fatigue failure during service.* (Fig. 25.)

Crankshaft Rear Oil Seal: The rear main bearing is sealed by an oil retainer bolted to the block and cap. The retainer is in two halves and the method of obtaining a seal was changed from an internal scroll in the retainer to split asbestos packings, which make positive contact with the crankshaft. The two retainers are interchangeable and when overhauling an engine the latest type retainer should be fitted.

Worn or damaged packings should be replaced. Remove the old packings and clean out the retainer grooves. Smear one of the packings with adhesive to prevent it turning during service, then press packings carefully into retainer grooves. Roll packings into position with a smooth bar then trim ends flush with retainer face and press corners into a chamfer, so that they will not spread out between retainer faces. Clamp retainer on to a 2.5 in. (63.5 mm) diameter mandrel (collar, Part No.



- Figure 26. CRANKSHAFT REAR OIL SEAL
- Check that Allen screws have sufficient clearance to permit both halves to be in line.
 - Ensure that ends of packings do not cause gap between halves of retainer.
 - Check mounting face for distortion and if necessary correct by filing.

907503, can be used) to press packings into position and check that halves of retainer seat squarely together. (Fig. 26.)

Refitting Oil Seal: To ensure that there is no possibility of oil leakage between the two halves of the retainer, or between retainer and cylinder block, refit the retainer as follows:

- Polish crankshaft with worn 320 grade emery cloth to a highly polished finish.
- If gasket is in two halves (later gaskets are in one piece) trim each half so that edges will touch but not overlap. Smear retainer faces with a medium texture, non-hardening jointing compound. *Do not use a thick, hardening type of jointing compound and do not use gaskets thicker than standard.*
- Do not fit spring washers on socket screws and setscrews, but fit copper washers (Part No. 626850) and fit retainer in inverted position, i.e., socket screw heads towards top.
- Tighten bolts in the following order:
 - Tighten socket screws then unscrew half-a-turn.
 - Tighten setscrews firmly then firmly re-tighten socket screws.
 - Unscrew all four setscrews half-a-turn then retighten evenly and firmly.

FUEL SYSTEM

The performance of a diesel engine depends very largely on the fuel system and the most important factor in trouble-free operations is *cleanliness of the fuel*. Dirt and dust — particularly the very fine dust readily carried in the air and in suspension in the fuel tank — can cause rapid and extensive damage to the injection pump and injectors, resulting in bad starting, loss of power and expensive repairs.

The importance of clean fuel storage and the precautions to be taken to prevent fuel contamination when refuelling must be impressed on the operator.

Care should also be exercised in the workshop. The bench used for servicing fuel injection equipment should be situated in a well-lit and separate part of the workshop. If possible an insulated and dust-proof room should be provided in which the servicing equipment can be permanently installed.

Special equipment is required and the minimum essentials consist of the following: Two safety containers — one filled with petrol for soaking dirty nozzles and the other filled with test oil, or clean diesel fuel, for assembly of cleaned components. A nozzle bench plate, which should be screwed to the bench with the jig end overhanging, so that an injector can be slackened or tightened. A nozzle setting outfit should also be securely bolted to the bench with a suitable canister to collect the spray and protect the operator against accidental contact with the spray. The flushing device used in conjunction

with the setting outfit is essential. The nozzle cleaning kit (Fig. 27) includes a probing tool but not needles: correct diameter needles can be obtained separately as required.

Although the above items are an essential minimum for injector servicing, more complex apparatus or additional equipment are available where the volume of work makes their purchase worthwhile.

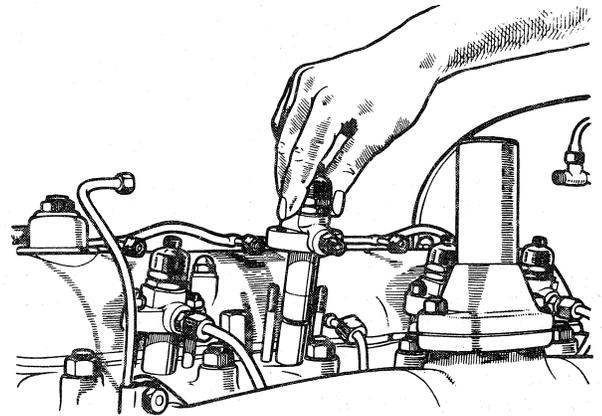


Figure 28. INJECTOR REMOVAL

● OPERATION D1

Injector removal:

1. Wipe injectors and adjacent areas.
2. Disconnect and remove leak-off pipe (Fig. 28.)
3. Disconnect high-pressure pipe unions from injectors.
4. Remove nuts holding down injectors evenly, to prevent distortion.
5. Withdraw injectors carefully. Seal inlet with cap and fit a protection sleeve on nozzle end.
6. Clean injector bores in head and remove copper sealing washers. Plug bores with clean rag to prevent dirt entering cylinders.

It is essential that the copper washer be used under injector when refitting to engine. Check that the seat in head is clean and that the old washer has not been left in the recess. The use of two washers will raise nozzle tip so that the spray impinges on cylinder head. This causes a loss of efficiency and excessive exhaust smoke.

Injector Servicing

Nozzle Testing: The hand tester shown in Fig. 29 is adequate for testing and pressure setting injectors.

Attach injector to tester and place a canister round the nozzle to ensure that spray does not

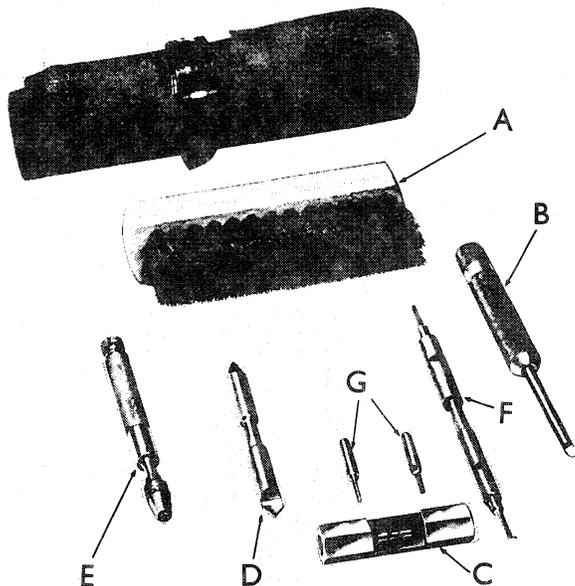


Figure 27. C.A.V. NOZZLE CLEANING KIT

- | | |
|--------------------------------|-------------------------------|
| A. Brass wire brush | B. Nozzle body groove scraper |
| C. Nozzle plunger cleaner | D. Nozzle body seat scraper |
| E. Holder—probing needle | F. *Pintle hole cleaner |
| G. *Probes—pintle hole cleaner | |

*Not required for D.B. Nozzles.

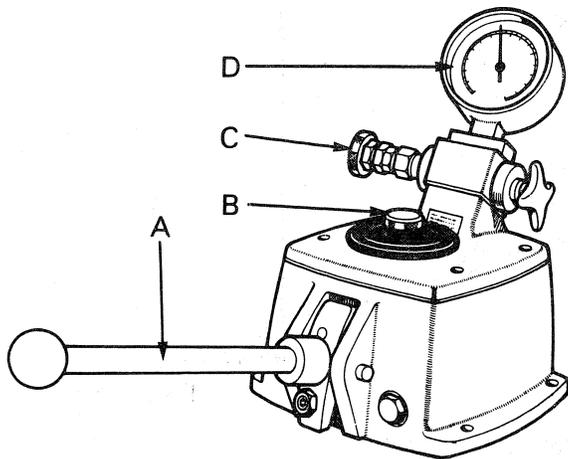


Figure 29. INJECTOR NOZZLE TESTER

- | | |
|------------------------|-------------------|
| A. Pump handle | B. Reservoir |
| C. Injector connection | D. Pressure gauge |

contact the body. The force of the spray is such that it will easily penetrate the skin, even through clothing. The resultant oil under the skin is very difficult to treat and can be a very uncomfortable wound. The canister will also help to condense the very fine spray which forms an objectionable atmosphere. If regular nozzle testing is contemplated a totally enclosed test chamber with exhauster is advocated.

● OPERATION D1a

Pressure Test: With injector mounted in the test outfit, depress hand lever several times to fill injector and expel any air. Depress lever very slowly and observe highest pressure reading that is obtained before needle on pressure gauge flicks. This is the pressure at which injection takes place. The correct pressure for new injectors is 185 atmospheres (188 kg/cm²), and for used injectors 175 (180 kg/cm²) atmospheres.

If pressure is incorrect but nozzle is clean and otherwise satisfactory, it should be set to correct figure as follows: Remove dome cap and slacken locknut, and using a large screwdriver in pressure adjusting screw adjust the screw. Only a very small movement will be required unless the nozzle has only just been assembled and the pressure not previously set. When screw has been adjusted, tighten locknut and recheck pressure. (Fig. 30)

Back Leakage Test: Operate hand pump until pressure is about 170 atmospheres. Release the handle quickly and measure, with a stop-watch, the time taken between pressure gauge pointer passing the marks for 150 and 100 atmospheres (154 and 104 kg/cm²) as it gradually falls. For a satisfactory nozzle the time taken should be between 6 and 25 seconds.

Dry Seat Test: Carefully wipe nozzle dry. Build up pressure to 10 atmospheres below the injection

pressure. Examine nozzle whilst under this pressure. It should be dry and free from leakage. If the nozzle is inadvertently caused to inject, the tip should be re-wiped dry and tested again.

Examine injector for signs of leakage at nozzle cap nut, spring adjusting nut, and copper sealing washers.

Atomisation Test: Isolate pressure gauge by closing valve. Apply eight quick jerks and examine the spray quality. The sprays should be free from coarse or solid streaks and the tip should remain dry. There should be four sprays equally spaced at an inclusive angle of 140°. They are offset 10° to allow for the tilt of the injector in the cylinder head.

● OPERATION D1b

Nozzle Cleaning: If injector fails to pass any of the above tests it must be dismantled, cleaned and retested. Note that spring pressure must be released before removing nozzle. Unscrew nozzle cap, using a close-fitting spanner on the flats provided, and

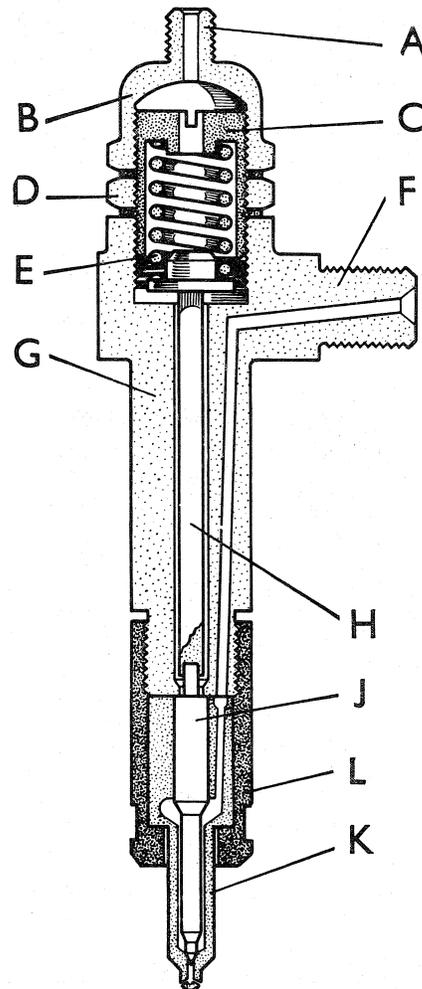


Figure 30. SECTIONED INJECTOR

- | | | |
|------------------------|---------------|--------------------------|
| A. Leak-off connection | B. Cap | C. Adjusting screw |
| D. Locknut | E. Spring | F. Fuel inlet connection |
| G. Holder | H. Plunger | J. Needle |
| K. Nozzle | L. Nozzle nut | |

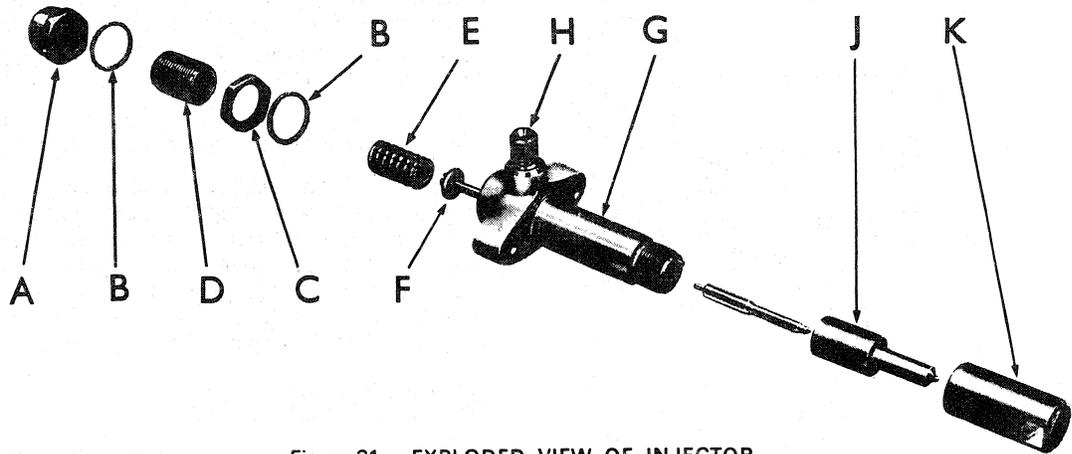


Figure 31. EXPLODED VIEW OF INJECTOR

- | | | | |
|-----------|-------------------|---------------|--------------------------|
| A. Cap | B. Sealing washer | C. Locknut | D. Adjusting screw |
| E. Spring | F. Plunger | G. Holder | H. Fuel inlet connection |
| | J. Nozzle | K. Nozzle nut | |

remove nozzle, noting that it will only fit in one position because of the locating dowels. Remove needle valve and place in petrol to soften carbon. Examine nozzle and needle for damage, overheating or scratch marks on the lapped working surfaces. If excessive overheating has occurred, denoted by a dark blue colour of the needle, or if seat or working surfaces are damaged, reconditioning will be required and a new nozzle should be fitted.

If the nozzle is not damaged it should be cleaned using the special tools provided in the nozzle cleaning kit shown in Fig. 27. Firstly clean fuel oil channels and bores in nozzle. Scrape carbon from valve seat with the brass scraper.

Using the special groove scraper, clear carbon deposits from oil gallery. Clean spray holes with probing tool fitted with a probing wire of the correct diameter.

Great care should be exercised when using the probing wires. If a wire is broken off in the hole it is often impossible to remove it, and the nozzle is then useless. After clearing the holes scrape carbon from valve seat with the V-tipped brass tool. Next use the tool with the thin blade radiused at its tip to clean carbon out of the sac. After cleaning with the tools, the nozzle should be thoroughly cleaned with fuel. This should be done by placing nozzle, without needle, in the reverse flushing attachment and connecting to pressure tester in place of an injector. Operation of the tester will then thoroughly flush all particles of loose carbon from the nozzle.

With the brass wire brush, gently clean needle valve, paying particular attention to valve seat and needle tip. Brush carbon from nozzle stem and tip.

Reassembly: The needle valve should be fitted to nozzle whilst both are under the surface of clean fuel oil or test oil. Only in this way can dust be excluded from assembly. The needle should slide smoothly in the nozzle and this should be tried several times whilst under the surface of fluid. Needle and nozzle are assembled as a pair and under no account should they be interchanged.

The nozzle should then be assembled on to injector body. In order to avoid distorting needle or plunger the spring should be released. Remove dome cap, slacken locknut and slacken pressure adjusting screw right back until there is no pressure on spring. Make sure that mating surfaces between nozzle and injector body are perfectly clean. Place nozzle on body with the dowels in correct engagement so that the two faces are in perfect contact, i.e., not held apart by spring pressure. Place cap over nozzle and tighten adequately but not overtight. Retighten pressure adjusting screw and reset the pressure on spray tester. Test the spray, leak back, etc. If the injector is not required for immediate use

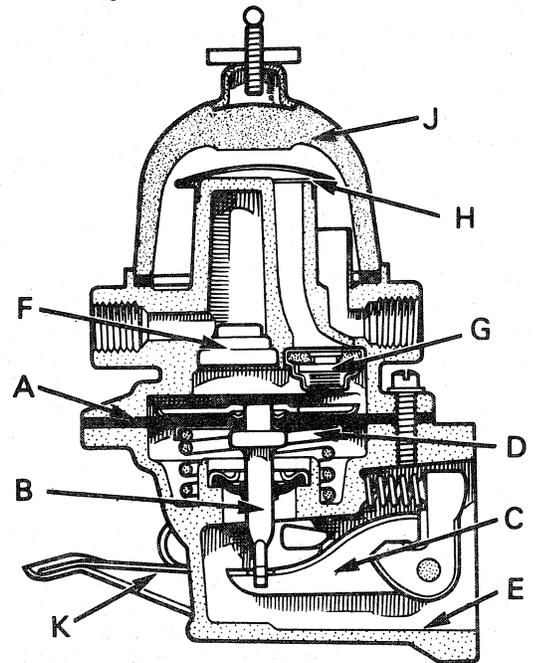


Figure 32. FUEL FEED PUMP

- | | | |
|----------------|-----------------------|--------------------|
| A. Diaphragm | B. Diaphragm pull-rod | C. Connecting link |
| D. Spring | E. Body | F. Outlet valve |
| G. Inlet valve | H. Filter screen | J. Sediment bowl |
| | K. Hand primer | |

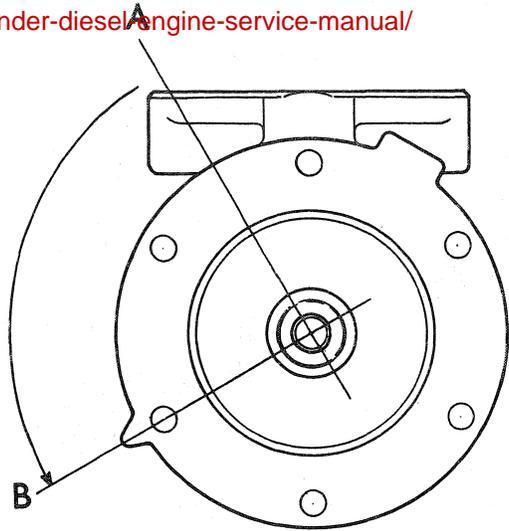


Figure 33. FITTING FEED PUMP DIAPHRAGM

With the diaphragm tab at position A, fit diaphragm on to pump body until pull rod enters link slot, then turn diaphragm 90°, so that tab moves to position 'B' to lock pull-rod in link slot.

it should be stored in a sealed plastic bag or similar container. (Fig. 31.)

Fuel Feed Pump: The fuel feed pump is mounted on right-hand side of engine crankcase and actuated by a short push-rod from an eccentric on the camshaft.

● **OPERATION D2**

To remove feed pump, first disconnect fuel pipe union at fuel tank end of pipe, so that fuel will not siphon out of tank when pump end of pipe is disconnected. Disconnect both pipes from pump

and remove the two bolts attaching pump to cylinder block. When the pump has been removed, the push-rod may be withdrawn from cylinder block.

● **OPERATION D2a**

Renewing Diaphragm: Clean exterior of pump and mark top and bottom halves so that they can be replaced in the same position. Remove the six screws attaching upper half of pump to base then remove the upper half. (Fig. 32.)

Remove diaphragm complete with pull-rod by turning diaphragm through 90°, which should release pull-rod from connecting link.

Clean both halves of the pump. Position new diaphragm with tab at position shown in Fig. 33. Press centre of diaphragm down against spring until the "T" end of pull-rod enters slot in connecting link, then turn diaphragm through 90° so that pull-rod and connecting link are locked together. Refit upper half, ensuring that assembly marks are aligned, and replace screws. Hold the priming lever depressed whilst tightening the six retaining screws so that the diaphragm is not taut.

Fuel Filter: The double fuel filter has two paper elements connected in series so that all fuel must pass through both filters. The element in the first filter should be renewed every 500 hours and the second filter element renewed every 1000 hours. Do not change elements from one filter to another and do not attempt to clean an element: always discard the dirty element and fit a new one. (Fig. 34.)

● **OPERATION D3**

To Fit a New Filter Element: Clean outside of filter then remove bolt securing base of first filter

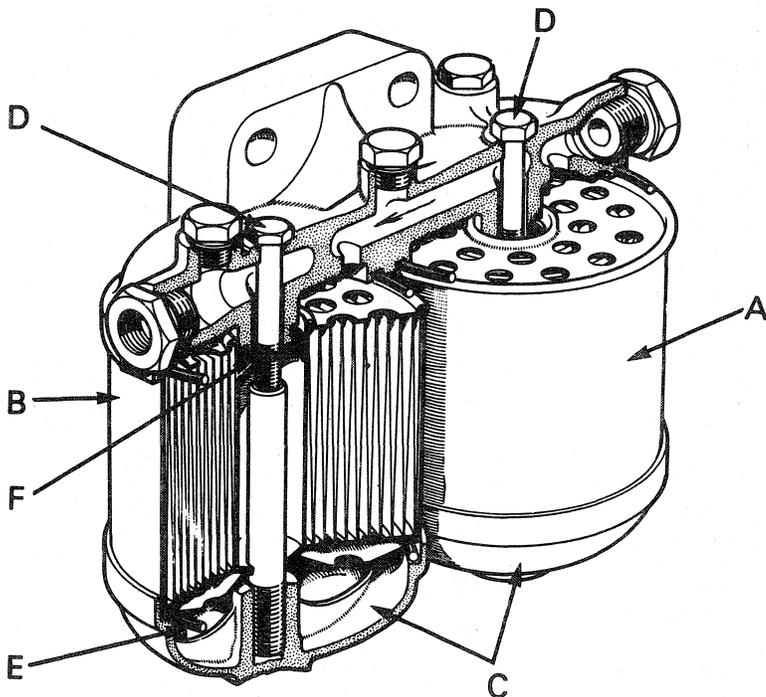


Figure 34. FUEL FILTER

- A. Element—first filter
- B. Element—second filter
- C. Bowl
- D. Retaining bolt
- E. Sealing ring—outer
- F. Sealing ring—inner